INTEGRATED MUNICIPAL SOLID WASTE (MSW) MANAGEMENT PROJECT FOR ZONE-IV OF ANDHRA PRADESH

DRAFT DETAILED PROJECT REPORT (DPR) FOR NELLORE (CLUSTER V)
NELLORE CLUSTER – ATMAKUR, KAVALI, GUDUR & NELLORE

Submitted to:
Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC), Govt. of Andhra Pradesh

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1.0 PROJECT BACKGROUND

Waste disposal is one of the major problems being faced over the world and India is no exception. Management of Solid Waste, though an essential service, is given low priority. This, coupled with lack of financial resources, institutional weaknesses, improper choice of technology & rapid urbanization, whose ramifications are more pronounced with uncontrolled growth rate of population, has made this service far from satisfactory, thus creating serious environmental and health problems.

1.1 SOLID WASTE MANAGEMENT (SWM)..... a definition

Solid Waste Management (SWM) is an organized process of storage, collection, transportation, processing, and disposal of solid refuse residuals in an engineered sanitary landfill. It is an integrated process comprising several collection methods, varied transportation equipment, storage, recovery mechanisms for recyclable material, reduction of waste volume, and quantity by methods such as composting; refuse derived fuel (RDF), waste-to-energy, and disposal in a designated engineered sanitary landfill.

The selection of a suitable SWM process is driven by the source and quality of waste produced. Solid waste is generated from a number of sources which include households (kitchen and yard), commercial areas (shops, hotels and restaurants), industries (raw material and packaging), institutions (schools, hospitals and offices), construction and demolition sites, wild and domesticated animals (carcasses of dead animals, manure), parks (fallen branches, leaves from trees), and streets (sand, silt, clay, concrete, bricks, asphalt, residues from air deposition, and dust).

1.2 PROBLEMS DUE TO SOLID WASTE

Accumulation of solid waste in open areas is an eyesore, diminishing real estate and property value, a breeding ground for insects, and other vectors (rats and mice, wild and domesticated animals). It also causes odor nuisance, reflects the unorganized nature of the community, and creates a poor environment for growing children.

Improper and unorganized disposal of Municipal Solid Waste (MSW) in open areas and landfills have a negative impact on the living conditions of human beings as well as the overall environment. It results in spread of communicable and non-communicable diseases among human beings and animals, thus affecting the welfare, livelihood, and economic productivity. In addition, it causes contamination of soil, surface water, ground water and generation of toxic and greenhouse gases. However, using adequate information, resources, and efficient management practices, one can turn solid waste into a useful resource.
1.3 CURRENT STATUS OF SWM IN INDIA

Management of Solid Wastes is of growing concern to the general public at large, local authorities and business communities in cities and towns across India. The problem is exacerbating in urban areas due to rapid strides in population growth, coupled with an economic boom that encourages the consumption of goods and, hence, wastes generation. As per Census 2011, the urban population accounts for 31.16 percent of the total Indian population.

The Local Governing Bodies (LGBs), viz. municipalities and municipal corporations, are responsible for providing SWM services in the urban areas. In most of the urban areas, insufficient funds, use of obsolete/inefficient technologies, lack of public awareness/training, and improper infrastructure have resulted in a state of poor SWM.

1.4 INITIATIVES TO IMPROVE SWM IN INDIA

In recent years, the Government of India has taken several initiatives to improve existing SWM practices in the country. Some of the key initiatives and recommendations are discussed below:

1.4.1 Hon’ble Supreme Court of India Recommendations

In recent years, the current SWM system in India has received considerable attention from the Central and State Governments and local municipalities. The first initiative was taken by the Honorable Supreme Court of India in 1998, which resulted in the formation of a Committee to study the current status of SWM in Indian cities. This Committee identified the deficiencies/gaps in the existing SWM system in the country and prepared the “Interim Report on SWM Practices in Class I Cities”. Class I are cities with a population ranging between one lakh to ten lakhs (1,00,000 – 10,00,000).

1.4.2 Municipal Solid Waste Management Rules

As a second initiative, the Ministry of Environment and Forests (MoEF), Government of India, published “Municipal Solid Waste (Management and Handling) Rules 2000” (MSW Rules 2000). These rules were developed in conformance with Sections 3, 6 and 25 of the Environment Protection Act, 1986 and aim at standardization and enforcement of SWM practices in the urban sector. They dictate that, “Every municipal authority shall, within the territorial area of the municipality, be responsible for the implementation of the provisions of these rules and infrastructure development for collection, storage segregation, transportation, processing and disposal of municipal solid wastes”. In addition, “the CPCB shall coordinate with State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) in the matters of MSW disposal and its management and handling”.

Average Composition of MSW
MSW primarily comprises of 51% of organic fraction, 17% of recyclables (paper, glass and plastic), 32% of inert material, and less than one-percent glass and metal (Report of Task Force on Waste to Energy).
1.4.3 Jawaharlal Nehru National Urban Renewal Mission

The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) is the third notable initiative undertaken by Government of India. JNNURM provides funding for urban infrastructure development in 63 cities and towns of the country. This mission was initiated in 2006 and is slated to continue until 2011.

1.4.4 Urban Infrastructure Development Scheme for Small and Medium Towns

The primary objective of this scheme is to improve the urban infrastructure in towns and cities in a planned manner and to promote public–private partnership (PPP) in infrastructure development. This scheme was introduced in the year 2005-06 and will continue for seven years. This scheme is applicable to all cities/towns as per 2001 census, except the cities/towns covered under the JNNURM. One of the components of this scheme is to renew the old sewerage and solid waste disposal systems in inner (old) areas.

1.4.5 Swachh Bharat Mission

Swachh Bharat Mission (SBM) was launched on 2nd of October, 2014 with a vision to achieve a clean India as a tribute to the father of the nation, Mahatma Gandhi, on his 150th birth anniversary, in 2019. SBM is being implemented by the Ministry of Urban Development (M/o UD) and by the Ministry of Drinking Water and Sanitation (M/o DWS) for urban and rural areas with a given set of guidelines for improved sanitary services and capacity building initiatives.

Municipal Solid Waste Management (MSWM) a major component of the SBM (urban) - “refers to a systematic process that comprises of waste segregation and storage at source, primary collection, secondary storage, transportation, secondary segregation, resource recovery, processing, treatment, and final disposal of solid waste.”

Under the provisions of SWM, the local bodies are to prepare Detailed Project Reports in consultation with the state government based on the identified needs of the City Sanitation Plans. Provision also mentions clustering of smaller cities for attracting Private investment. The DPRs should be prepared in lines with Govt. of India’s goals outlined in the NUSP 2008, SWM rules, advisories, CPHEEO manuals (including cost-recovery mechanisms), O&M practices and Service-level Benchmark advisories released by M/o UD and Manual on Municipal Solid Waste Management, 2000.

States will contribute a minimum of 25% funds for SWM projects to match 75% Central Share (10% in the case of North East States and special category states). 80% of the urban population to be covered by SWM.
services (allowing for a 2% increase year on year) covering all statutory towns. Central government Grant / VGF may also be used to promote projects of waste to energy.

1.4.6 Fourteen Finance Commission Recommendations

Constituted by the President of India, under Article 280 of the constitution, the Finance Commission is to recommend on distribution of central tax revenues between the Union and the States. Supporting Local bodies through grant, subsequent to the passage of the 73rd and 74th constitutional amendments was first time announced in the 10th Finance Commission for providing basic services at the grassroots level and strengthening decentralization.

The 13th Finance Commission has recommended two categories of Grants to Local Bodies namely (1) General Basic Grant and (2) General Performance Grant. The Basic Grants will be released on furnishing the U.Cs for the last releases and the General Performance Grant will be released on fulfillment of nine conditions by the State Government, as stipulated in para 10.16.1 of the report of the 13th Finance Commission by March of a particular financial year. Performance-related funds under the 13th Finance Commission have been linked to improvements in SLBs including SWM.

Further, in 2009, MoUD initiated Service Level Benchmarking (SLB) with respect to basic municipal services including solid waste management. SLB has been introduced in 30 states and across 1700 ULBs. Performance-related funds under the 13th Finance Commission have been linked to improvements in SLBs including SWM. The 13th Finance Commission also recommends that of all grants to be given to the ULBs, 50% should be for SWM (2010-2015). Moreover, the Ministry of New and Renewable Energy has funded five Waste-to-Energy plants for utilization of MSW.

The grant recommended to ULBs in Andhra Pradesh is Rs. 1919.20 crores for the XIII FC period of 2010-2015. Under such grant every local body is mandated preparing an Annual Development Plan where in the component integrated solid waste management under PPP mode (excluding purchase of equipment for collection and transport of garbage) is to be incorporated.

1.4.7 National Green Tribunal Recommendations

Action Plan for Management of Municipal Solid Waste (MSW)

CPCB has framed and notified the “Action Plan for Management of Municipal Solid Waste (MSW)” in compliance with the National Green Tribunal order dated 5th Feb-2015 in the matter of OA No. 199 of 2014. The Action Plan emphasizes on strengthening the planning exercise at national, state as well as city level by improvising through the waste management value chain. In addition to that, The Plan suggested the concept of regional cluster approach as well as technology options on the basis of quantum of MSW generation which has been re-produced below in nutshell.

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1 Statutory towns are urban areas defined by administrative units that have been defined by ‘statute’ as urban such as municipal corporations, municipalities, cantonment boards, notified town area committees, town panchayats, or nagar palikas;
The Regional Cluster approach is based on the concept of discouraging setting up of individual waste processing and disposal facilities leading to mushrooming of innumerable facilities which are difficult to monitor and sustain. The approach requires a detailed survey of the study area and identification of location for regional facility with adequate size of land free from public objections. An indicative distance of say up to 50 km for each local body may be feasible based on local condition, fixing of criteria by the local body to transport the waste for common disposal point without causing public nuisance and traffic hurdles. However, alternate options can be worked out for smaller local bodies.

Common facility should be ‘integrated’ with facilities for sorting, compost, RDF and energy plant and followed by inert recycling/re-use. Only a fraction of inert waste should go for land-filling.

The Action Plan has outlined indicative plan based on the quantum of waste generated in the cluster. The indicative plans have been given for towns in four ranges of waste generation.

**Table 1.1: Indicative Plans for Municipal Solid Waste Management**

<table>
<thead>
<tr>
<th>Range</th>
<th>Plan</th>
</tr>
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<tbody>
<tr>
<td>&gt;500 TPD</td>
<td>• Modernization/ mechanization of waste storage and transportation facilities</td>
</tr>
<tr>
<td></td>
<td>• Privatization/ contract with ‘operators’ for collection of waste from various sources and its transportation</td>
</tr>
<tr>
<td></td>
<td>• Seeking support of Private entrepreneurship in setting up of waste processing and disposal facility</td>
</tr>
<tr>
<td><strong>Between 100-500 TPD</strong></td>
<td>• Modernization/ mechanization of waste storage and transportation facilities</td>
</tr>
<tr>
<td></td>
<td>• Privatization/ contract with ‘operators’ for collection of waste from various sources and its transportation</td>
</tr>
<tr>
<td></td>
<td>• Seeking support of Private entrepreneurship in setting up of waste processing and disposal facility</td>
</tr>
<tr>
<td><strong>Less than 100 TPD</strong></td>
<td>• Proper system for waste collection, storage and transportation considering the local situation</td>
</tr>
<tr>
<td></td>
<td>• Aerobic composting</td>
</tr>
<tr>
<td></td>
<td>• Such towns can be the member of Cluster/Regional facility</td>
</tr>
<tr>
<td><strong>Less than 50 TPD</strong></td>
<td>• Technological solutions which could be managed without high skill operations</td>
</tr>
<tr>
<td></td>
<td>• Proper collection of waste and motivating citizens for segregation of waste</td>
</tr>
<tr>
<td></td>
<td>• Composting</td>
</tr>
<tr>
<td></td>
<td>• Such towns located near the Regional facility, should be the part of it.</td>
</tr>
</tbody>
</table>

1.5 PROJECT BACKGROUND & OBJECTIVES

There is a need to enhance the existing MSWM system for all 23 ULBs falling under the three districts namely Nellore, Chittor and Prakasam and thus improve the health and living standards of its residents. The purpose of this project is to identify the existing MSWM practices within all the towns, recognize deficiencies/gaps in the present system and propose a comprehensive plan for MSWM including segregation, collection, transportation and regional/cluster approach for processing & scientific disposal in Integrated Municipal Solid Waste Management Facility in compliance with the MSW Rules 2000. In addition, analyze options for waste processing for effective and scientific management of MSW generated.
In short, the objective of the project is to introduce appropriate technologies for management of MSW so as to prevent the waste from causing pollution and health hazards

1.6 SCOPE OF STUDY

- Realistic assessment of quantity, Characterization and classification of MSW
- Detailed survey of the prevailing conditions
- Situation/Gap Analysis of the existing condition with respect to MSW Rules, 2000
- Detailed planning for resource requirement & implementation strategy
- Design of MSW management system viz. Collection System (Primary/ Secondary), Transportation & Fleet Management Plan, waste processing system and sanitary landfill in accordance with MSW Rules 2000 & CPHEEO Manual, Govt. of India
- Techno economic and environmental analysis of various options for MSWM
- Preparation of conceptual and detailed drawings
- Preparation of Bill of Quantities (BOQs)
- Capital and Operation & Maintenance (O&M) cost estimates
- Identification and formation of the clusters on the basis of geographical locations
- MSW management model including privatization aspects
- Preparation of Detailed Project Report (DPR)

The deliverables will ultimately achieve the following goals:

- 100% source segregation of wet & dry waste
- Primary collection of waste
- Secondary collection and transportation of waste
- Creating and sustaining a supply chain for recycled waste
- Streamlining and optimization of transportation system
- Analysis for the need of transfer station and its basic design
- Innovative processes and their enforcement for making the habitations litter free, bin free and dump free to prevent the health hazard.
- Options for processing the biodegradable waste
- Feasibility study for the exploration of waste to power on the basis of cluster approach
- Options for using the inert material like construction & demolition material
- Reclamation and bio-mining of old dump sites
- Implementation of zero landfill concept
- Innovative incentive structure to the operating personnel for motivation
- Financial model and institutional framework
- Measures for the involvement of all stakeholder
- Information, Education and Communication (IEC) campaign models and enforcement plans

**Other Management Aspects**

- Stakeholders’ complaints
- Management of Information Systems (MIS)
- Environment, Health and Safety (EHS)
2.0 Evolution of Solid Waste Management

Solid wastes comprise all the wastes arising from human and animal activities that are normally solid and are discarded as useless or unwanted. It is an all-inclusive, encompassing heterogeneous mass of throwaways from urban community as well as homogeneous accumulation of agricultural, industrial and mineral wastes.

2.1 Solid Waste.....A consequence of life

From the days of primitive society, human and animals have used the resources of the earth to support life and to dispose-off wastes. During the early times, the disposal of human and other wastes did not pose a significant problem, for the population was small and amount of land available for the assimilation of wastes was large. Although emphasis is currently being placed on recycling the energy and fertilizer value of solid wastes, indications of recycling may still be seen in the primitive, yet sensible agricultural practices in many of the developing nations where farmer recycle solid wastes for fuel or fertilizer values.

Problems with disposal of wastes can be traced from the times when humans first began to congregate in tribes, villages & communities and accumulation of wastes became a consequence of life. Littering of food and other solid wastes in medieval towns – the practice of throwing wastes on unpaved streets, roads, streets and vacant land, led to breeding of rodents with their attendant fleas. It was not until 19th century that public health control measures became vital and food wastes were collected and disposed off in a manner to control rodents and flies, the vectors of disease.

Ecological phenomena such as water and air pollution have also been attributed to improper management of solid wastes. For example, liquid (leachate) from dumps and un-engineered landfills have contaminated ground water. Although, nature has the capacity to dilute, disperse, degrade, absorb or otherwise reduce the impact of unwanted residues in the atmosphere; ecological imbalances have occurred where the natural assimilative capacity has been exceeded.

2.2 Waste Generation in the Technological Society

The development of technological society can be traced to the beginnings of the Industrial Revolution (renaissance era), unfortunately, so cans a major increase in solid waste disposal problems. Thus, along with the benefits of technology, have also come the problems associated with the disposal of resultant wastes.

2.2.1 Materials Flow and Waste Generation

An indication of how and where the solid wastes are generated in our technological society is shown in simplified materials flow diagram in fig. 2.1. Solid wastes (debris) are generated at the start of the process, beginning with mining of raw materials. It is apparent from figure that one of the best ways to reduce the amount of solid wastes that must be disposed off, is to limit the consumption of raw materials and increase the rate of recovery and reuse of waste materials. Although the concept is simple, effecting the change in a modern technological society has proved extremely difficult. Unlike water borne and air dispersed wastes, solid waste will not go away. “Where the waste is thrown today, is where it will be found in future”.

2.2.2 The Effects of Technological Advances

Modern technological advances in the production and packaging of goods create a constantly changing set of parameters for designing solid waste facilities. For example, the latest trend of use of frozen food and packaged meals reduce the quantities of food wastes in the homes but increase the quantities at agricultural processing plants. These continuing changes present problems in designing engineering structures for processing solid wastes as they involve large capital expenditures and must be designed to be functional for at least 25 years.

Therefore, every possible prediction technique must be used in this ever changing technological society so that flexibility and utility can be designed into facilities. In short, a facility should be functional and efficient over its useful life.

2.3 The Development of Solid Waste Management

Solid Waste Management may be defined as discipline associated with the control of generation, storage, collection, transfer & transport, processing and disposal of solid wastes in a manner, that is in accord with the best principles of public health, engineering, conservation, aesthetics and other environmental considerations and also, responsive to public attitudes.

2.3.1 Historical Development

The most commonly recognized methods for the final disposal of solid wastes at the turn of the century were dumping on land, dumping in water, plowing into the soil, feeding to hogs, reduction and incineration. However, not all these methods were applicable to all type of wastes. Plowing into the soil was used for food wastes and street sweepings whereas feeding to hogs and reduction were used specifically for food wastes.

Enlightened solid waste management, with the emphasis on controlled tipping (popularly known as sanitary landflling), began in the early 1930s in the developed countries and much later in the developing countries. However, absence of efficient and proper methods of disposal resulted in scenic blights, created
serious hazards to public health including water and air pollution, increased vectors of disease and adversely affected land values.

### 2.3.2 Functional Elements of Solid Waste Management System

The activities associated with the management of solid wastes from the point of generation to final disposal are divided into following functional elements:

i. Waste Generation
ii. Waste Handling & Separation at Source
iii. Collection
iv. Separation, Processing & Transformation
v. Transfer & Transport
vi. Disposal

The inter-relationship between these functional elements is identified in fig. 2.2.

![Inter-relationship between functional elements in SWM System](image)

**Figure 2.2: Inter-relationship between functional elements in SWM System**

**I. Waste Generation**

Waste generation encompasses activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal. It is important to note that in waste generation, there is identification step and that this step varies with each individual waste.

Waste generation is, at present an activity that is not very controllable. Source reduction, though not controllable, is now included in system evaluation as a method of limiting the quantity of waste generated.

**II. Waste Handling & Separation at Source**
Waste handling and separation involves the activities associated with the management of wastes until they are placed in storage containers for collection. Handling also encompasses a movement of loaded containers to the point of collection. Separation of waste components is an important step in the handling and storage of solid waste at source. From standpoint of material specifications and revenue from sale of recovered materials, the best place to separate the recovered materials for reuse and recycling, is the source of generation.

On-site storage is of primary importance because of public health concerns and aesthetic considerations. Open ground storage and unsightly makeshift containers, both of which are undesirable, are often seen at many residential and commercial sites.

III. Collection

The functional element of collection includes not only the gathering of wastes but also the transport of these materials, after collection, to an intermediate location, where the collection vehicle is emptied. This intermediate location can be materials processing facility (waste storage depot, WSD) or a transfer station. In small cities, where final disposal sites are nearby, the hauling of wastes is not a serious problem. But in large cities, where the haul distance to the point of final disposal is often greater, the haul may have significant economic implications. Where long distances are involved, transfer and transport facility is normally used.

IV. Separation, Processing & Transformation

The recovery of separated materials, separation & processing of solid waste components and transformation of solid wastes that occur primarily in locations away from source of waste generation are encompassed by this functional element. Processing often includes separation of bulky items, separation of ferrous metals, manual separation of waste components and volume reduction by compaction.

Transformation processes are used to reduce volume and weight of waste requiring disposal and to recover conversion products. The most commonly used chemical transformation process is combustion, which is used in conjunction with recovery of energy in the form of heat. The most commonly used biological transformation process is composting. The selection of given set of processes depends on the waste management objectives to be achieved.
V. Transfer and Transport

This element involves two steps, viz. transfer of waste from smaller collection vehicles to larger transport equipment and second, subsequent transport of wastes to final disposal site.

VI. Disposal

Disposal is the final functional element in the solid waste management system. Today, disposal of waste by landfilling is the ultimate fate of all solid wastes. A modern sanitary landfill is not a dump, rather it is an integrated, engineered facility used for disposing solid waste on land without creating nuisance or hazards to public health and safety.

In most cities, planning for waste disposal involves dealing with municipality, development authority and other agencies. Thus, land-use planning becomes a primary determinant in the site selection, design and operation of processing facilities and landfills. Environment Impact Assessment (EIA) is required for any new landfill site to ensure compliance with public health, aesthetics and future use of land.
3.0 CLUSTERISATION OF ULBs

Solid waste management is one of the most significant functions carried out by ULBs. However, the scarcity of suitable landfill sites is one of the constraints increasingly being faced by ULBs in the discharge of their functions. As a result, even several years after the issuance of the SWM Rules 2016, the state of solid waste management systems in the country continues to raise serious public health concerns.

Regional or inter-municipal solutions provide a viable option to redress this situation. Working together can be a practical and cost-effective way to discharge common tasks, share resources, and take advantage of the economies of scale that such arrangements would provide. This is applicable in the case of both large municipal bodies which experience scarcity of land resources, as well as smaller ones which may find technical and financial resources a challenge. Regional solid waste management Facility has many advantages over a standalone processing and disposal facility.

- Authorities estimate the total waste quantities generated across their regional jurisdictions to take advantage of economies of scale in processing and disposal of solid waste.
- It will reduce the financial and technical burden on each individual Authority and help the Authorities discharge their obligation for solid waste management in a cost-effective manner with better technologies.
- It will result in more efficient use of land and other scarce natural resources in the region.
- Enable easier monitoring, with an optimal number of manpower required to handle the facility.

**Figure 3.1: Advantages of a Regional Landfill Facility**

Source: Guidance Note on Municipal Solid Waste Management on Regional Basis, Ministry of Urban Development (GoI)

- **Land Constraint**: Larger landfills can be utilised to a greater height, that is, they contain a greater load per unit area of land. A 9 times increase in Area will give 17.5 times more airspace.

- **Capital Cost**: Capital Cost reduces with increase in the capacity of the Landfill Facility. A 7.5 times increase in the Landfill Capacity will inflate the Capital Cost by only 4 times.

- **Operation Cost**: The savings accruing from the development and operations of a regional landfill will compensate for the increased cost of transportation over longer distances (upto a certain extent).
3.1 Guidelines for Developing Regional Processing & Landfill Facility Action Plan for Management of Municipal Solid Waste

CPCB has framed and notified the “Action Plan for Management of Municipal Solid Waste (MSW)” in compliance with the National Green Tribunal order dated 5th Feb-2015 in the matter of OA No. 199 of 2014. The Action Plan emphasizes on strengthening the planning exercise at national, state as well as city level by improvising through the waste management value chain. In addition to that, The Plan suggested the concept of regional cluster approach as well as technology options on the basis of quantum of solid waste generation which has been re-produced below in nutshell.

The Regional Cluster approach is based on the concept of discouraging setting up of individual waste processing and disposal facilities leading to mushrooming of innumerable facilities which are difficult to monitor and sustain. However, bigger facilities for a cluster of municipalities will bring in economies of scale in capital as well as in Operation & Maintenance cost. The Action Plan has laid out a set of parameters on the basis of which ULBs should be clustered for Regional SWM Facility.

- A detailed survey of all the ULBs and their distance with each other has to be carried out. An indicative distance of say up to 50 km from the regional facility for each local body is feasible. However, alternatives have to be identified for smaller ULBs who may find difficulty in transporting solid waste at daily basis. As per the guidelines, fixing of criteria may vary with the local conditions but should not cause public nuisance and traffic hurdles.

- Land for regional facility should be free from public objection and should not have settlement at least around 3-5 kms from its periphery.

- Design of common facility should be based on the quantum of waste generation. Though, it is advisable to design a regional facility with per day waste generation quantum of 3000-5000 tons per day.

- Common facility should be ‘integrated’ with facilities for sorting, compost, RDF and energy plant and followed by inert recycling / re-use. Only a fraction of inert waste should go for land-filling.

- The Action Plan has outlined indicative plan based on the quantum of waste generated in the cluster. The indicative plans have been given for towns in four ranges of waste generation.

Table 3.1: Indicative Plans for Solid Waste Management

<table>
<thead>
<tr>
<th>Range</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;500 tons per day</td>
<td>- Modernization/ mechanization of waste storage and transportation facilities</td>
</tr>
<tr>
<td></td>
<td>- Privatization/ contract with ‘operators’ for collection of waste from various sources and its transportation</td>
</tr>
<tr>
<td></td>
<td>- Seeking support of Private entrepreneurship in setting up of waste processing and disposal facility</td>
</tr>
<tr>
<td>Between 100-500 t/day</td>
<td>- Modernization/ mechanization of waste storage and transportation facilities</td>
</tr>
<tr>
<td></td>
<td>- Privatization/ contract with ‘operators’ for collection of waste from various sources and its transportation</td>
</tr>
<tr>
<td></td>
<td>- Seeking support of Private entrepreneurship in setting up of waste processing and disposal facility</td>
</tr>
<tr>
<td>Less than 100 t/d</td>
<td>- Proper system for waste collection, storage and transportation considering the local situation</td>
</tr>
<tr>
<td></td>
<td>- Aerobic composting</td>
</tr>
<tr>
<td></td>
<td>- Such towns can be the member of Cluster/Regional facility</td>
</tr>
</tbody>
</table>
3.2 Examples of Regional-Cluster Facility in India

3.2.1 Regional Waste Management Strategy - Gujarat

Gujarat recognized the need for an integrated approach to solid waste management in 2005, and, in view of the huge lacunae in treatment and disposal facilities, adopted a state-wide regional (Clusterisation) approach to meet requirements for safe disposal. The state-wide strategy was implemented through Gujarat Urban Development Company (GUDC) which was chosen in 2006 and mandated to develop a state-wide Solid Waste Management Programme within five-year period using 12th Finance Commission grants.

Bhaskaracharya Institute for Space Applications and Geo-Informatics (BISAG) and Indian Institute of Management, Ahmedabad were selected as the technical group for identification of appropriate land parcels using GIS and mathematical model for verification of clusters respectively.

The basic model that was finalized was initial treatment of wastes, through vermi-composting, to be undertaken individually by each ULB, to reduce the volume of waste required to be transported for land filling. Individual ULBs were required to identify sites for vermicomposting facilities on the basis of area as well as location criteria as per the SWM Rules 2016. Each vermi-composting facility was also to serve as a transfer station at the ULB level, for transportation of residual waste for land filling on a regional basis. Till date, 77 such facilities have been constructed, and are being operated by non-governmental organisations (NGOs).

The finalization of Clusters for disposal arrangements was done through an iterative process. The Clusterisation was based on the maximum travel distance from the facility of 50 kms. 28 clusters were identified in the state with a regional facility each. For each of the cluster, the effort focused on government owned wastelands closest to the largest generator of waste in each cluster to optimize the travel cost of the solid waste of each cluster.

3.2.2 Punjab Solid Waste Project

Department of Local Government, Government of Punjab has prepared a Punjab Model Municipal Solid Waste Management Plan-2014 of 146 Urban Local Bodies (ULBs) generating approximately 4250 tons of solid waste every day. The Government has adopted a pioneering approach of clustering the ULBs and formulated 8 clusters comprising of 8 to 26 ULBs in each cluster covering all the ULBs in the state. The Project is in implementation stages right now and all the concessionaries have been selected to deliver the project on Public Private Partnership (PPP) mode for a
concession period of 25 years. The Solid Waste Operation Plan comprises of solid waste segregation at Source, Door to door collection of solid waste, Transportation of solid waste and Processing & Disposal.

The Plan has been separately developed for all the components of the system as well as regulatory measures have also been designed for all kinds of waste generators. The Plan is strategized to minimize waste at the ULB level so that minimum waste is transported to the regional facility. The Processing technology to be adopted for each cluster also varies as per the quantification of waste and waste characterization in each cluster. For selection of suitable processing technology several parameters are considered namely quantity and quality of waste, capital investments, scale of operation, Recurring expenditure, environmental impact and learning’s from past Indian experience.

3.3 The Concept of Clusterisation in Zone-IV

The Project Area (Zone-IV) is divided into three districts having 23 ULBs.

- Nellore (7 towns)
  Nellore is the District Headquarter
- Prakasam (8 towns)
  Ongole is the District Headquarter
- Chittoor (8 towns)
  Chittoor is the District Headquarter

There are a total of 4 municipal corporations which have population varying from 1.9 lakhs to 6 lakhs. Rest 19 are small municipalities mostly having population less than 1 lakh.

Our Concept of Clusterisation was broadly based on two parameters:

- Achieving maximum quantum of waste with the available options
- Minimizing the travel distance of solid waste from the regional facility

Figure 3.3: Functioning of a Regional Cluster Facility

There are a total of 4 municipal corporations which have population varying from 1.9 lakhs to 6 lakhs. Rest 19 are small municipalities mostly having population less than 1 lakh.
Our Approach was focused to identify clusters ensuring optimization of the quantity of solid waste and travel distance in the best possible way for the current scenario. While finalising the clusters for SWM Management in Zone-IV, following assumptions have been considered.

- As per NGT Norms, a distance of 50 km have been considered for clustering ULBs (+/- 10% of solid waste Quantity in some cases)
- ULB with maximum quantum of waste generation is considered as Lead ULB

Following Clusters have been finalised for the setting up of regional processing and disposal facilities:

Table 3.2: Finalized Clusters

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Cluster No.</th>
<th>Name of the town</th>
<th>Lead ULB</th>
<th>Distance from Lead ULB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Madanapalle</td>
<td>Madanapalle</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Punganur</td>
<td></td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Palamaner</td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>Chittoor</td>
<td>Tirupati</td>
<td>71</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Nagari</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Puttur</td>
<td></td>
<td>34</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Tirupati</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Srikalahasti</td>
<td></td>
<td>37</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Venkatgiri</td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>Naidupet</td>
<td>Naidupet</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Sullurpet</td>
<td></td>
<td>31</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>Gudur</td>
<td>Nellore</td>
<td>43</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>Nellore</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Atmakur</td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Kavali</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>Ongole</td>
<td>Ongole</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>Chimakurthy</td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>Kandukur</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>Addanki</td>
<td></td>
<td>38</td>
</tr>
</tbody>
</table>

Only 19 ULBs out of 23 have been clustered for the setting up of regional processing and disposal facilities and 4 ULBs will be developed standalone because of huge distance from the Lead ULB of the closest cluster.

---

1 Lead ULB is the ULB which will have the processing and disposal facility amongst all ULBs in a cluster
4.0 Brief about the Project Area

This chapter provides an overview of the location, current extents of Nellore town and their existing population, physical & social infrastructure.

4.1 DISTRICT OVERVIEW: Nellore

Nellore is the southernmost coastal district among the 13 districts of Andhra Pradesh with a total area of 17,626 km² (4.75% of the total state area) and population of 2,966,082 (29.07% urban) as per 2011 census. It is the Sixth largest city in the state of Andhra Pradesh. India’s prestigious and only satellite launch center known as SHAR is stationed at Sriharikota Island. The district is bordered by the Bay of Bengal to the east, Kadapa district to the west, Prakasam District to the north, Chittoor district and Thiruvallur district of Tamil Nadu to the south. Nellore Municipal Corporation constituted on 18.10.2004. Recently Government has included the adjoining 15 Gram Panchayats into Nellore Municipal Corporation Vide G.O .Ms. No.113 Dated 25-3-2013

The District has varied climatic conditions. The year may be divided into four seasons. The summer season from March to May is followed by South West monsoon season which extends up to end of September (The Normal Rainfall of the District is 1080 mm. During the year 2010-11 the actual Rainfall received was 1080 mm), October and November constitute the retreating monsoon or post monsoon season. The period from December to February is the North East monsoon season.

4.2 History

Nellore once known as Vikramasimhapuri has a prominent place in the history of India. Culturally, Nellore city stands unique among the other cities of Andhra Pradesh as it is the place where the greatest of the Telugu poets, Tikkana Somayaji, translated the Mahabharata into Telugu, lived. Even the first Poetess Molla was born in this place. World famous Lord Talpagiri Ranganathaswami has chosen this Nellore and He lives in the temple near the river Penna. It is supposed that Nellore was situated in Dandakaranya forests into which the Aryas first penetrated as adventurous sages with the rise of the Mouryan Empire. Nellore also
seems to have under its influence and was part of the Ashoka Empire in the 3rd century B.C. It was next included in the Pallava Dominion between the fourth and sixth century A.D.

4.3 Demography

There was an 11.05% of growth in the population of Nellore district from 2001-2011 census with a current population of 2,963,557 of which 857,630 people lives in urban areas (28.94%) and 2,105,927 lives in rural areas (71.06%) with a population density of 227 people per sq. km. The Sex ratio is 985 females per 1000 males across urban and rural are fairly above the national sex ratio of 940 females per 1000 males as per 2011 census.

4.4 Geography

Nellore District, the Southern most Coastal District of Andhra Pradesh lies between 13-30’ and 15-6’ of the Northern latitude and 70-5’ and 80-15’ of the Eastern Longitude and extending over an area of 13076 Sq.Kms, accounting for 4.75% of the total area of the state. It is bounded on the north by Prakasam District on the East by Bay of Bengal on the South by Chittoor District and Chengalpattu District of Tamil Nadu and on the West by Veligonda Hills which separate it from Kadapa District. The district broadly categorized into 2 natural divisions from North to South. The eastern Half of the District adjoins coastal belt is fairly fertile and the western half of the district has low elevation towards west with large track of low shrub jungles diversified with rocky will stony plains. The Pennar and Swarnamukhi are the principal rivers, besides the streams like Kandaleru and Boggeru. The District is endowed with variety of major and minor minerals; they are Mica, Silica etc.

4.5 Economy

The prime economy of the district is agriculture with 70% of population engaged in the sector and 41.3 % of its land area under cultivation majorly growing Paddy, Jowar, Bajra along with Tobacco, Chillies, Groundnut and sugarcane. Agro based industries have come up in the district like rice bran oil plants, rice and paraboiled rice mills and sugar factories. Proximity to the sea has also allowed Aqua culture in the district with prawn culture gaining considerable interest as Nellore is called the “Shrimp Capital of India”. Nellore and Kavali has textile business noted for their traditional handcrafted fine cotton and silk sarees embroded with pure zari. Some of the important industries of the region are Mica Mines and thermal power plant.

4.6 Land Use

The total Geographical area of the District is 13.08 lakh Hectares. Of this 20.09% is forest area. The rest is distributed among Barren and Uncultivable Land (10.56%) and Land put into Non Agricultural uses (18.68%). The net area sown forms 25.96% while cultivable waste and fallow (current and old) lands Constitute 17.75%.

4.7 Coastal

The District has a coastal line of 169 Kms covering 12 mandals. There are 93 coastal fishermen habitations having 82500 populations out of which 16300 are active fishermen. The estimated marine landings in the District are 54941 mts. There is a Pulicat Lake which is the 2nd biggest Brackish Water Lake in the country with an area of 468 Sq.Kms. The lake accounts for annual production of 6500 Mts. of Fishey wealth providing livelihood to 11000 Fishermen covering 20 Kuppams around the lake

4.8 Administration
Administratively the District is divided into 46 Mandalas, under three Revenue Divisions with headquarters at Nellore, Gudur and Kavali. Zilla Parishad (ZP) Nellore- has six major administrative units:

- Nellore Municipal Corporation
- Kavali Municipality
- Gudur Municipality
- Nellore Municipality
- Atmakur Municipality
- Sullurpet Municipality
- Naidupet Nagar Panchayat

Distance of the other municipalities from Nellore is mentioned below in the table.

**Table 4.1: Distance of District Headquarters from other Towns**

<table>
<thead>
<tr>
<th>Name of Municipality/Municipal town</th>
<th>Approximate Distance from the District Head Quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nellore-Kavali</td>
<td>57.4 km</td>
</tr>
<tr>
<td>Nellore-Gudur</td>
<td>43.6 km</td>
</tr>
<tr>
<td>Nellore-Venkatagri</td>
<td>81.9 km</td>
</tr>
<tr>
<td>Nellore-Atmakur</td>
<td>52.4 km</td>
</tr>
<tr>
<td>Nellore-Sullurpet</td>
<td>96.0 km</td>
</tr>
<tr>
<td>Nellore-Naidupet</td>
<td>71.8 km</td>
</tr>
</tbody>
</table>

**4.2 Overview: Nellore**
4.1.1 Location and Extents

Nellore is a city and municipal corporation in the state of Andhra Pradesh. Nellore is the 4th most populous city after the separation of Telengana from Andhra Pradesh and the Sri Potti Sri Ramulu Nellore district administrative headquarters. The Nellore Municipality dates back to 1862. Nellore Municipal Corporation was constituted in on 18.10.2004. The municipal boundaries were extended after the merging of 15 gram panchayats, Vide G.O .Ms.No.113 Dated 25-3-2013. After the merger, the Population of NMC increased from 565258 to 600869. Nellore has secured 150 rank in the sanitation ratings by MoUD in 2010.

Table 4.2: Nellore Town Profile

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (Census 2011)</td>
<td>600869</td>
</tr>
<tr>
<td>Area (In Sq. Kms)</td>
<td>150.48</td>
</tr>
<tr>
<td>No. of Households (Census 2011)</td>
<td>128526</td>
</tr>
<tr>
<td>No. of Wards</td>
<td>54</td>
</tr>
<tr>
<td>Length of Roads (km)</td>
<td>715</td>
</tr>
<tr>
<td>Length of Drains (km)</td>
<td>1215</td>
</tr>
<tr>
<td>Length of Strom Water Drains (km)</td>
<td>72</td>
</tr>
</tbody>
</table>

Source: Nellore Municipal Corporation
Figure 4.2: City Map of Nellore

Source: Official Website of Sri Potti Sriramulu Nellore District

4.1.2 Climate

Nellore’s climate is classified as tropical. In winter, there is much less rainfall than in summer. The average temperature in Nellore is 29.1 °C. Precipitation here averages 984 mm. Precipitation is the lowest in February, with an average of 3 mm. Most precipitation falls in October, with an average of 268 mm. At an average temperature of 33.7 °C, May is the hottest month of the year. In December, the average temperature is 24.5 °C. It is the lowest average temperature of the whole year. The average temperatures vary during the year by 9.2 °C.

Figure 4.3: Climate graph
4.1.3 Population

As per 2011 census, population of Nellore has reached 600869 from 505751 after merging of 15 gram panchayats into Nellore Municipal Corporation. The table below examines the population variation in the town over the Six decades and the population growth trends over the years. Between the period of 2001 and 2011, the town has witnessed a growth of 48% while is the highest growth rate observed between the period of 1981 and 2011. The population of the city and the growth rate is presented in the table and figure below:

Table 4.3: Census Population

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Year</th>
<th>Population</th>
<th>Decadal Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1961</td>
<td>106776</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1971</td>
<td>133590</td>
<td>25.1</td>
</tr>
<tr>
<td>3</td>
<td>1981</td>
<td>237065</td>
<td>77.5</td>
</tr>
<tr>
<td>4</td>
<td>1991</td>
<td>316606</td>
<td>33.6</td>
</tr>
<tr>
<td>5</td>
<td>2001</td>
<td>404775</td>
<td>27.8</td>
</tr>
<tr>
<td>6</td>
<td>2011</td>
<td>600869</td>
<td>48.4</td>
</tr>
</tbody>
</table>

Figure 4.4: Population trend of Nellore

The population projections considered in the CPHEEO Manual have been made after studying the population growth trend from 1961 onwards. It is an important step in order to bridge the supply demand gap and also
to estimate the future requirement of the urban infrastructure. The population of Nellore has been projected for the year 2045 using statistical methods based on population trends in the previous years. The following methods have been used to project the future population of the town based on the past year population such as:

- Arithmetic Method
- Geometric Method
- Incremental Method
- State Urban Average
- Graphical Increase
- Average Population

In order to make a choice among these methods (Attached in Annexure 3.1) which have been used to project the population of the city, the table below provides a summary of all the projected population numbers from the chosen methods:

<table>
<thead>
<tr>
<th>Year</th>
<th>Arithmetic method</th>
<th>Incremental method</th>
<th>Geometric method</th>
<th>State Urban Average</th>
<th>Graphical Increase</th>
<th>Average Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>633809</td>
<td>643288</td>
<td>698000</td>
<td>702976</td>
<td>655664</td>
<td>666747</td>
</tr>
<tr>
<td>2020</td>
<td>674983</td>
<td>703930</td>
<td>841782</td>
<td>830610</td>
<td>747881</td>
<td>759837</td>
</tr>
<tr>
<td>2025</td>
<td>716157</td>
<td>773035</td>
<td>1015182</td>
<td>958244</td>
<td>847108</td>
<td>861945</td>
</tr>
<tr>
<td>2030</td>
<td>757332</td>
<td>850605</td>
<td>1224301</td>
<td>1085877</td>
<td>953346</td>
<td>974292</td>
</tr>
<tr>
<td>2035</td>
<td>798506</td>
<td>936639</td>
<td>1476496</td>
<td>1213511</td>
<td>1066595</td>
<td>1098349</td>
</tr>
<tr>
<td>2040</td>
<td>839681</td>
<td>1031136</td>
<td>1780642</td>
<td>1341145</td>
<td>1186854</td>
<td>1235892</td>
</tr>
<tr>
<td>2045</td>
<td>880855</td>
<td>1134098</td>
<td>2147440</td>
<td>1468779</td>
<td>1314124</td>
<td>1389059</td>
</tr>
</tbody>
</table>

The Incremental Increase method has been adopted as population projections arrived as per Incremental Increase method, which is also suggested & approved in the master plan. The population of the city may increase at a higher pace than the existing rate due to the merging of 15 gram panchayats into Nellore Municipal Corporation. Also people from village in the district and also neighboring districts are migrating to Nellore town for the reasons that the Nellore Town is main attraction for its rich facilities and civilization i.e. why there is high population growth in the town. The figure below provides the projected population of the city for the coming years:

Figure 4.5: Projected population for Nellore
4.1.4 Existing Infrastructure

4.1.4.1 Physical Infrastructure

Various infrastructure facilities within the city have been studied in depth such as roads, water supply, sewerage system, drainage system, industries, electricity and social infrastructure.

1. Roads

Nellore is a coastal town in Andhra Pradesh and the district headquarters of Potti Sriramulu Nellore district. The Town is located on Chennai-Kolkata National Highway at a distance of 173 Km from Chennai. Nellore is situated about 279 km south of the state capital Andhra Pradesh Capital City and 168 km north of Chennai on the Chennai-Kolkata highway. It is located on the banks of the Penna river. Total length of road in the town is 715 km (concrete road - 240 km, BT road - 80 km, WBM road – 162 km, Kutchta road- 233 km) and total length of drains in the town is 1215 km (Pucca Drains – 523 & Kutchta Drains – 620) whereas total storm water drain length is 72 km.

2. Water Supply System

The status report on municipal water supply indicates that water supply at present is 47.67 million litres per day. Per capita availability of water supply is stated to be 106 LPCD against the prescribed norm of 135 LPCD. The key sources of water supply are head works with river Penna as source, infiltration galleries at Bujjamma revu and 8 mini water supply schemes as well as bore wells. There are 32622 house service connections, 1861 public stand posts, 3 industrial connections, 62 public wells, 626 hand bores and 3 municipal tankers, all served by 453 km of piped distribution network and 23 elevated service reservoirs. Number of house service connections is seen to be small fraction of the total number of households with public stand posts constituting the major source of water supply to the households. Supply of water is not continuous but only two hours in the morning and evening in a day. It was noticed that there was a substantial quantity of untapped and free water going to household and public places.

For treatment of water, filtration plants of total 52 MLD capacities are located at Bujjamma revu (35.78 MLD) and mini schemes (16.22 MLD). For storage and distribution of water a total of 25 elevated service
Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC)

Preparation of Detailed Project Report for MSW Management

reservoirs (ELSRs) and 4 ground level service reservoirs (GLSRs) are located across the city, whose total capacity is 25.42 MLD. Total length of distribution network is 453 kms. Water is supplied through tankers where there is no water supply network.

3. **Sewerage System**

The system consists of sewer lines of 150 mm to 375 mm of stoneware pipes and RCC pipes for higher sizes up to 36” (900 mm). It is ascertained from municipal authorities that RCC pipes have served its life and in few places bursting of pipes occur. As much as the coverage of the existing sewer system is a small area and the pipes are old and also the quantity of flow is much higher, there is a need to replace the existing pipelines with the new pipelines. Sewerage network is partially covered (18.54 sq km) of the city. Only 10 wards are covered by sewerage network (18, 19, 38, 40, 41, 43, 46, 47, 48 & 49) of the city is covered with sewerage network system. There are 9500 sewerage connections are connected to UGD. 85% of these connections are household connections and rest is commercial connections. In estimation there are 47500 sanitary latrines are connected to UGD. The total sewerage pipeline network is badly damaged and in an irreparable condition.

4. **Drainage System**

The town has 279 km length of drains which are equally divided into pucca and kutcha drains. Around 70% of the town is covered by open drainage system. In many places of the town the drains are in a dilapidated condition. The existing drains have been constructed for a particular area in an adhoc manner without any continuity for the adjoining area and as a result many areas and roads are flooded during the rainy season. The drains are not integrated or well connected to the main drain. Desilting of drains is taken up prior to the monsoon season. In Nellore Municipal Corporation there is no system to maintain and record incidence of water logging in the city. The terrain of the town has low spots coupled with an absence of proper drainage arrangements in the city. As a result some of the areas face inundation during rainy season.

5. **Industrial & Commercial Aspects**

Nellore is one of the fastest developing cities in Andhra Pradesh and is of strategic commercial importance as it lies between the cities of Vijayawada and Chennai. Nellore is also famous for its production of mica (gudur), lemon (gudur) and agricultural products such as rice. Nellore is also known for aquaculture and called as Aquaculture capital of India. The town is an important Commercial Educational and Industrial Centre having important industries such as Nippo Factory, Sugar Factory, Straw Board Factory, Spinning Mill and Poultry feed units. Nellore is famous for the production of ‘Molagolukulu’ Rice. The city is the main shopping centre for cloths, furniture, electronics, health needs, jewels etc. The Main assets of Nellore are its Businessmen, once was the best exporting capital of Mica to countries such as UK as well. The city makes revenue mainly from cloth emporiums, movie theatres, Nellore cuisine restaurants and hotels, hospitals and educational coaching centres. Nellore district is called the “Shrimp capital of India” due to is high production of cultured shrimp.

6. **Tourism**

The town is an important Pilgrim Centre having temples in and around the town, such as Lord Sri Ranganadha Swamy in Nellore, Lord Sri Narasimha Swamy at Narasimhulu Konda and Penchalakona and
abode of goddess Kamakshithai at Jonnawada. Mypadu beach and Krishnapatnam Port are also located at a shortest distance, from the town which entices tourism at a larger scale. Satish Dhawan Space Research Centre (SHAR) near Sullurpet has the worldwide significance of scientific importance. Pulicat Lake is an important sightseeing place extended to about 12 Kms. Udayagiri Fort and Bhairavakona are historical places of importance.

4.1.4.2 Social Infrastructure

1. Educational Activities

The City is the one of the important educational centers in the State having Vikrama Simhapuri University, Medical College, Engineering Colleges, Arts & Science Colleges, Post Graduate Centers, Polytechnic Colleges, Law College and other technical institutions in the City

2. Health Facilities

Nellore is known for having the high density of health care providers. People's Polyclinic, previously known as Ramachandra Reddy Hospital and Jayabharath Hospital serve poor people. Most notable hospitals are St. John's Hospital, Bollineni Super Speciality Hospital, Bollineni Eye Hospital and ABM Hospital (American Baptist Hospital), Bollineni Super Speciality Hospital in Nellore. The town is also having Government Head Quarters Hospital, Maternity Hospital, and Children Hospital besides a number of private hospitals.
5.0 STATUS OF EXISTING MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM

This chapter discusses the existing SWM practices prevalent in Nellore city. The various sources of waste generation, current primary & secondary waste collection practices, waste transportation & disposal mechanisms and gaps in the existing SWM system w.r.t. MSW Rules, 2000 & Draft MSW Rules, 2015 and MSW Manual, CPHEEO, Govt. of India are identified in this chapter.

The information provided in this chapter was furnished through interactions with various stakeholders, officials of Nellore Municipal Corporation (NMC) and site investigations performed by the IPE Global’s project team.

5.1 Methodology Adopted for Understanding the System

This section describes the various sources of waste generation, existing waste handling & management methods prevalent in Nellore city.

5.2 Sources of Waste Generation

The success of any solid waste management scheme can be measured through the extent of cooperation and participation of people, effectiveness of the proposed system and operational efficiency. The people of the cities should be made accountable for their activities and administration system should support them in dealing with the repercussions of their lifestyle. In this regard, IEC plan plays an important role as citizens are unaware or partially aware of hazards that have come into place due to generation of MSW by them. The Information, Education and Communication components of IEC plan are discussed as follows:

This section describes the various sources of waste generation and the type of waste generated from these sources. The section is comprehensively designed to include all the possible sources of waste generation.

5.2.1 Residential and Commercial Establishments

Residential and Commercial Establishments are the major sources of waste generation.

Residential waste comprises of the municipal solid waste that originates from single and multi-family household units. These wastes are generated as a consequence of household activities such as cooking, cleaning, repairs, hobbies, redecoration, empty containers, packaging, clothing, books and other miscellaneous items. However, the waste generated from this source basically comprise of food waste, cooking being a daily performed activity in households whereas generation of other types of waste is dependent on the life-style of a household. Rice is the staple food of the state which is consumed along with various local curries (sambhar, rasam) having high moisture content. This prevalent food habit is responsible for high moisture content in the waste generated at household levels.
Commercial waste comprises of the solid wastes that originate in offices, wholesale and retail stores, restaurants, hotels, markets, warehouses and other commercial establishments. The waste generated from these establishments is dependent on the type of establishment and the services it provides.

Table 5.1: Type of Waste Generation from different Establishments

<table>
<thead>
<tr>
<th>Type of Establishment</th>
<th>Predominant Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential &amp; Commercial</td>
<td>Biodegradable (Wet) Waste</td>
</tr>
<tr>
<td>Hotel</td>
<td>Biodegradable &amp; Non-Biodegradable (Dry) Waste</td>
</tr>
<tr>
<td>Wholesale &amp; Retail Stores</td>
<td>Non-Biodegradable (Dry) Waste</td>
</tr>
<tr>
<td>Vegetable &amp; Fruit Market</td>
<td>Biodegradable (Wet) Waste</td>
</tr>
<tr>
<td>Institutions</td>
<td>Non-Biodegradable (Dry) Waste</td>
</tr>
</tbody>
</table>

5.2.2 Hospitals & Nursing Homes

Hospital waste consists of mainly three types of wastes: Medical waste, infectious waste and domestic waste.

“Medical waste” refers to materials accumulated as a result of patient diagnosis, treatment or immunization of human beings.

“Infectious waste” refers to the portion of medical waste that is in contact with a patient who has infectious disease and it is capable of producing an infectious disease.

“Domestic waste” comes under the category of municipal solid waste and generally the responsibility of municipal administration.

As per international practices, BMW should not be transported along with MSW and the proposed plan is developed considering that BMW would not be dumped at the collection sites nor will it be transported along with MSW transportation mechanism.
5.2.3 Slaughter House

Slaughter house waste is generally biodegradable consisting of meat, bones, feathers and skin.

5.2.4 Street Sweeping

This term applies to wastes that are collected from streets, parks and vacant lots. Street Sweeping is a common practice in developing countries, where littering of public places is a far more widespread and acute problem whereas Mechanized street sweeping is the dominantly practiced in the developed countries. Street wastes include paper, cardboard, plastic, dirt, dust, leaves and other vegetable matter. The general character of the waste is found to be either recyclable or inert.

5.2.5 Drain Silt

Most of the waste generated from various sources is disposed off in open drains and retained until it is degraded and becomes a part of drain silt. Drain silt is one of the major problems for choking and thus, overflowing of drains. Generation of drain silt waste is dependent on the frequency of street sweeping as unswept waste on the street usually becomes the part of the drain silt. The general character of the waste is found to be either recyclable or inert.

5.2.6 Construction and Demolition Debris

This type of waste varies from time to time depending on the construction or demolition activities. Construction and demolition wastes are the waste materials generated by the construction, refurbishment, repair and demolition of houses, commercial buildings and other structures. It mainly consists of earth, stones, concrete, bricks, roofing materials, and plumbing materials, heating systems and electrical wires and parts of the general municipal waste stream. A major portion of this waste is generally used in reconstruction activities or for filling up of the low lying areas.

This type of waste has direct correlation with the pace of development activities in a particular city. Andhra Pradesh, after being reorganized, is under process of developing new capital, ports and road networks. These interventions may attract inter-linked development activities in the town due to migration of population to the affected towns. However, there is no defined method to project construction and demolition waste as the same is generated during the redevelopment phase.

5.3 Existing Municipal Solid Waste (MSW) Management System: Nellore

This section explains the existing solid waste management system in detail. To understand the system, our team did exhaustive primary survey of the MSW handling system of all the three towns falling in the Cluster-V.

Table 5.2: STATUS OF NELLORE MUNICIPAL CORPORATION

<table>
<thead>
<tr>
<th>TOWN PARTICULARS</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected Population (2015)</td>
<td>643288</td>
</tr>
<tr>
<td>Estimated Waste Quantity (2015)</td>
<td>271 MT/day</td>
</tr>
<tr>
<td>Per Capita Waste Generation</td>
<td>421 grams</td>
</tr>
<tr>
<td>No. of Wards</td>
<td>54</td>
</tr>
</tbody>
</table>
5.3.1 Segregation at Source

There is no practice followed for segregation of MSW at source in to biodegradable (wet) and non-biodegradable (dry) waste in the town. However, rag-pickers do the segregation & pick recyclables like polythene; plastics etc. at transit point located in ward no. 5 as well as at existing dumping site located at Dhontali and sell to private agencies.

5.3.2 Primary Collection System

Project team did an exhaustive survey at macro level to assess the primary collection systems prevalent in Nellore. NMC is involved in the organized door to door collection in 19 wards (ward no. 4, 5, 6, 7, 8, 17, 39, 40, 42, 43, 44, 45, 49, 52, 20, 28, 29, 30 & 35) out of total 54 wards. There is no predetermined primary collection in the remaining wards since municipal workers collect the waste thrown along the roadside and designated open dumps. 46 autos (Three-Wheeler) of 1.5 cum capacity with a hooter and 50 push carts with 4 bins of 60 litre capacity are engaged in dedicated wards for primary collection of waste. All the autos are fitted with GPS instrument for the effective monitoring of the system. They are making 3 trips in day.

Details of collection methods from each of the waste generation source are briefed below:

- The waste from household establishments and left-over food from eating joints is lifted to the designated dumpsites from open areas by means of three wheelers. The waste is collected between 6:00 a.m. and 3:00 p.m.
- The construction and demolition debris is carried to the low lying areas/secondary collection points privately, in open vehicles hired by the private individuals

5.3.3 Street Sweeping

The waste generated during the street sweeping is being collected by municipal workers/ sweeper, by the means of handcart. This activity is performed 3 times a day on a daily basis between 5:30 a.m. and 10:30 a.m. 3:00 p.m. to 6:00 p.m. and 10:00 p.m. to 4:00 a.m.for the major main roads and once a day between 5:30 am to 10:30 a.m. for the minor roads. Sweepers are provided with brooms, tubs and hand-carts. They collect the waste from road sides, which is then transported to the nearby secondary collection points for disposal by means of handcarts.
5.3.4 Slaughter House Waste

There is only one slaughter house in the city. However, this slaughter houses do not follow clean methods of processing meat. The waste from slaughter houses (skin, horns, and bones) gets mixed with MSW.

No records are maintained by Nellore Municipal Corporation (NMC) regarding the quantity of waste generated from this slaughter house.

5.3.5 Secondary Waste Collection System

The MSW collected from each of the primary collection points mentioned above through the auto-tippers (3-wheelers), is transported to the Transit Point while the waste is being dumped at the secondary collection points by unorganized workers through hand carts/wheel barrow.

There are 127 dumper placer (DP) bins placed at secondary collection points having 2.5 cum capacity each spread in 54 wards, waste is being dumped in to these bins. There are 06 twin bin DP vehicles which are engaged for the transportation of said DP bins. In addition to this, there are 4 municipal and 10 private tractor-trolleys engaged in the collection of waste from the designated open sites, commercial areas and from the road sides and transport the waste to the Transit Point located at ward no.5 making 3-4 trips in a day.

A reconnaissance/overview survey of the town exhibits open dumping in some areas where organized door to door collection is not in practiced.

5.3.6 Drain Silt

There are mostly open drains where waste generated from various sources is disposed off. All internal drains are cleaned daily and big drains are cleaned weekly once.

Sweepers are provided with jharoo (brooms) hand-carts, bamboo stick used to clean nalas [drains]). They collect the waste on road sides, which are then transported by means of tractors manually.

5.3.7 MSW Transportation System

This section describes the workshop for maintenance of transportation vehicles, the transportation equipment available with the NMC, the routing details of these vehicles, and the current MSW transportation practices followed in Nellore.
Workshop

At present, there is one designated workshop under Nellore Municipal Corporation located at Rajendra Nagar. Repairing, washing and other works of waste transportation vehicles done here. Other major repairs are outsourced locally. Total area of the workshop is approximate 2.4 acres.

Transportation Equipment

There are 06 tippers (12.5 m$^3$), 17 mini-tippers (5 cum), 46 three-wheelers (1.2 cum), 1 back-hoe loaders, 14 tractor-trolleys and around 50 push carts. NMC has floated the tender to purchase around 173 new pushcarts; they have already procured 50 out of 173. The details of distribution of secondary collection infrastructure are tabulated below:

Table 5.3: Transportation Infrastructure

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type of Vehicles</th>
<th>Nos.</th>
<th>Capacity in Cum</th>
<th>Year of Purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tipper</td>
<td>06</td>
<td>12.5</td>
<td>----</td>
</tr>
<tr>
<td>2</td>
<td>Mini-Tipper</td>
<td>17</td>
<td>5</td>
<td>----</td>
</tr>
<tr>
<td>3</td>
<td>Auto-Tipper</td>
<td>46</td>
<td>1.2</td>
<td>2007</td>
</tr>
<tr>
<td>4</td>
<td>Tractor-Trolley</td>
<td>14</td>
<td>3 &amp; 4</td>
<td>----</td>
</tr>
<tr>
<td>5</td>
<td>Dumper Placer</td>
<td>06</td>
<td>6</td>
<td>----</td>
</tr>
<tr>
<td>6</td>
<td>Back Hoe</td>
<td>01</td>
<td></td>
<td>----</td>
</tr>
</tbody>
</table>

Source: Discussions with officials of NMC

Routing of Vehicles

The drivers of vehicles used for transportation of MSW workshop in the wee hours of morning (6:00 am) where they are briefed by Garage In charge regarding the locations from where the waste is to be collected and route to be followed. Municipal officials informed that there are no specific routes followed by drivers as the location from where waste is to be lifted keeps on changing on day to day basis. Based on quantity of waste at a
particular location, DP vehicle is allocated. Also, allocation of fuel depends upon the route to be taken and no. of locations to be visited by a particular driver/vehicle.

The vehicles make three to four trips per day to transport the MSW to existing dumpsite. It takes about an hour or two to make one trip depending on the distance and traffic conditions prevailing at that time.

Transfer Stations

Currently, there is only one transfer station present as part of the MSW transportation process in Nellore city. However, there are some intermediate dumping points where waste is put after collection by workers and from here waste is transported to the trenching ground.

5.3.8 Waste Processing and Disposal Mechanisms

This section describes the waste processing and disposal mechanisms, for each type of wastes, as adopted in Nellore. Various types of wastes were identified in Nellore viz. combustible, bio-degradable and non-bio-degradable wastes.

Recyclable Wastes

The recyclable waste is segregated manually by rag-pickers. The kabadiwalas purchase recyclable waste from these rag-pickers and pay them on daily wage basis. However, these recyclables are not segregated to the maximum extent, thereby allowing them to be a part of the landfill waste.

Bio-degradable Wastes

The bio-degradable waste is not segregated either at the primary collection points, secondary collection points, or dumping sites. Currently, there is no processing of biodegradable waste and is dumped along with other waste streams.

Non-biodegradable Wastes

Street sweepings and drain silt is a major constituent of the non-biodegradable wastes. This type of waste is disposed off at the dumping sites along with other wastes without any prior processing.

The field investigations performed by the project team indicate that:

- The waste is cleaned only on main roads while undeveloped/old city areas do not have sufficient staff for performing the collection and cleaning activities.
- Precautions like wearing gloves, shoes and mask are not taken up by municipal workers while picking up waste from open dumps.
- Currently, the waste being dumped outside the city along the roads or at any vacant places. No prior segregation is carried out before final dumping. Since existing open trenches within municipal boundaries are not engineered landfills, therefore they are prone to ground water and soil pollution, vector nuisance, odor problem, besides becoming breeding grounds for mosquitoes.

Figure 5.9: Dumping Site
Disposal of Waste

The municipal solid waste generated in the town is disposed at open ground located in Dhontali. At present, there is no waste processing facility as well as no scientific disposal method being followed, the garbage is left open for the natural decomposition. The untreated waste has piled up to almost an height of 5-6 feet. Dhontali site is operational at 25 acres area and it is around 25 kms away from the center of city.

Since existing open trenches are not engineered landfills, therefore they are prone to ground water and soil pollution, vector nuisance, odor problem, besides becoming breeding grounds for mosquitoes, flies, etc. The leachate generated may cause unsanitary condition in the surroundings.

A few rag pickers and informal workers segregating non-biodegradables at the above dumping site and often burn the waste which is environmental

5.3.9 Quantification of MSW

Quantification of MSW generated was carried out by IPE Global separately for different sources of waste generation such as residential, commercial establishments, hotels/restaurants/Dhabas, institutional, street sweeping and drain cleaning etc. Quantities of MSW are essential as:

- It provides the basic data on which the management system is planned, designed and operated.
- The changes/trend in composition and quantity of waste over a period of time are known which help in future planning.
- It provides the information for the selection of equipment and appropriate technology.
- It indicates the amount and type of material suitable for processing, recovery and recycling.
- The forecast trends assist designers and manufacturers in the production of vehicles and equipment suitable for the future needs.

The waste generation rates have been worked out on the basis of field surveys, waste sampling and discussion with the different waste generators and the officials of Municipality. The results of the study are set out in this section.

Residential

An exhaustive survey, for seven consecutive days, was carried out for 100 residential establishments so as to assess the per capita waste generated. The survey included residential establishments under different income groups, viz. Low Income Group (LIG), Middle Income Group (MIG), High Income Group (HIG) and Economical Weaker Section (EWS) characterized as per standard of living conditions prevalent in the city. Based on the survey conducted for domestic households and analysis done, per capita MSW generation is estimated for each of the household at 283.19 grams/capita/day.
Table 5.4: Household Waste Generation in Nellore

<table>
<thead>
<tr>
<th>Projected Population in 2015</th>
<th>Waste Generation Factor per HH per day kg/capita/day</th>
<th>Average of Total MSW generated from H/Hs (In TPD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>643288</td>
<td>1323.94</td>
<td>182.17</td>
</tr>
</tbody>
</table>

Source: Field survey done by IPE Global

Municipal solid waste generations from the households are around 182 TPD in Nellore city as per projected population of year 2015.

However, it is to be noted that these households are scattered over the town i.e. respective income groups are not a domain of particular zone/area but are spread over the town. Hence, the waste generated differs on a daily basis. Further, waste generation per capita obtained for different groups does not include street sweeping, drain silt and construction debris. The residents belonging to the residential establishments do not segregate the waste source as well do not keep the two bin system.

**Commercial Establishment (Shops, Offices, Institutes, Hotels, Restaurants etc.)**

The waste from the commercial establishments like shops and offices, wholesale and retail stores, Paint shops, and general stores, institutions and hotels/restaurants/dhabas have been considered in this category. The number of commercial establishments are given in the below table. In order to assess the waste generated by these establishments, field visits and quantity assessment surveys were carried out in the commercial areas. Discussions were also held, with the shop owners on the amount of waste generated by each of them and disposal practices. Hence, based on the survey the waste generation factor of each type of establishment is given in table below.

Table 5.5: MSW generated from Commercial Establishments in Nellore City

<table>
<thead>
<tr>
<th>Establishments</th>
<th>No. of Units</th>
<th>Average Generation Factor</th>
<th>Waste Generated (TPD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Shops</td>
<td>4854</td>
<td>5.6</td>
<td>27.0</td>
</tr>
<tr>
<td>Hotels/Lodges/banquet Halls</td>
<td>164</td>
<td>18</td>
<td>3.0</td>
</tr>
<tr>
<td>Restaurants</td>
<td>125</td>
<td>35</td>
<td>4.4</td>
</tr>
<tr>
<td>Schools</td>
<td>67</td>
<td>25</td>
<td>1.7</td>
</tr>
<tr>
<td>Colleges</td>
<td>8</td>
<td>22</td>
<td>0.2</td>
</tr>
<tr>
<td>Offices</td>
<td>65</td>
<td>20</td>
<td>1.3</td>
</tr>
<tr>
<td>Hospital/Nursing Homes/Diagnostics</td>
<td>16</td>
<td>38</td>
<td>0.6</td>
</tr>
<tr>
<td>Vegetable</td>
<td>3</td>
<td>1500</td>
<td>4.5</td>
</tr>
<tr>
<td>Fish Market</td>
<td>3</td>
<td>1300</td>
<td>3.9</td>
</tr>
<tr>
<td>Slaughter House</td>
<td>1</td>
<td>1200</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Total commercial waste generation in Nellore City is estimated approximately 47.68 TPD

Street Sweeping
It is mainly an inert waste comprising of dust, sand and stones. This waste also contains litter, dry leaves, plastic, paper and animal waste. Currently, most of the waste generated in the town is collected as street sweeping, since wastes from majority of residential and commercial establishments are discarded on and along the roads. It is therefore not possible to accurately assess the waste generation rate from street sweeping. However, based on the discussion with the sweepers and sanitary staff, it was estimated that average waste is in the range of 30 kg/km/day for double roads. For the total 715 km of road, it is estimated that 21 TPD of street sweeping wastes are generated.

### Table 5.6: Street Sweeping Waste in Nellore City

<table>
<thead>
<tr>
<th>Category</th>
<th>Length</th>
<th>Unit</th>
<th>Waste generation factor in kg</th>
<th>Total waste generation (TPD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street Sweeping Waste</td>
<td>715</td>
<td>kg/km/day</td>
<td>30</td>
<td>21</td>
</tr>
</tbody>
</table>

**Drain Silt**

### Table 5.7: Waste generated from Drain silt

<table>
<thead>
<tr>
<th>Category</th>
<th>Length</th>
<th>Unit</th>
<th>Waste generation factor in kg</th>
<th>Total waste generation (TPD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt from small Drains</td>
<td>698</td>
<td>Kg/km/day</td>
<td>25</td>
<td>20</td>
</tr>
</tbody>
</table>

Drain cleanings are the major components of waste in urban areas. It is removed by municipal workers on daily basis and/or as and when the drain gets choked. The silt so removed is disposed off on the dumping ground or open land on the outskirts of the city. A major portion of sanitary worker’s time goes for the cleaning of streets and drains. Waste quantification for the drains was done based on the field visit and field assessment survey while cleaning the drains and waste generation factor are estimated.

### Table 5.8: Total MSW generated in Nellore City

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Source</th>
<th>Quantity (TPD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Households</td>
<td>182</td>
</tr>
<tr>
<td>2</td>
<td>Commercial Establishments</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>Street Sweeping</td>
<td>21</td>
</tr>
<tr>
<td>4</td>
<td>Drains</td>
<td>20</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>271</td>
</tr>
</tbody>
</table>

**5.3.10 Characterization of Waste**

Physical and chemical composition of solid wastes varies depending on sources and types of solid wastes.

**Physical Characterization**

Information and data on the physical composition of solid wastes are important in the selection and operation equipment and facilities, in assessing the feasibility and in the analysis and design of disposal facilities. Waste composition, moisture content, waste density, temperature and pH are important as
these affect the extent and rate of degradation of waste. These are determined on components of solid wastes.

Samples were collected from different service command areas viz. households and commercial establishments and weighted average was calculated for physical characterization (results are given in the table). An approximate waste from 100 households were collected and segregated on-site for estimating physical characterization and waste from commercial areas is also surveyed in the similar way. In order to quantify and characterize the MSW, project team did detailed survey of the town. In summary, the physical composition of waste excluding drain silt is given in the table below. The characterization has been done excluding drain silt (251 TPD) as the same is considered to be of completely inert nature and to be disposed in low-lying areas.

<table>
<thead>
<tr>
<th>Waste Characteristics</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-degradable</td>
<td>48%</td>
</tr>
<tr>
<td>Recyclable</td>
<td>24%</td>
</tr>
<tr>
<td>Coconut</td>
<td>6%</td>
</tr>
<tr>
<td>Horticulture/Dry Leaves</td>
<td>4%</td>
</tr>
<tr>
<td>Inert Waste</td>
<td>19%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Figure 5.12: Waste composition in Nellore city
Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC)

Preparation of Detailed Project Report for MSW Management

The major proportion of the waste is biodegradable followed by recyclable waste comprising of plastic, paper, glass, metals, tetra-pack, rubber and leather. Interestingly, coconut consumption is higher because of the unique food habits.

Chemical Characterization of the waste

Information on the chemical composition of solid wastes is important in evaluating alternative technology for processing and recovery options.

The methodology for chemical characterization is adopted keeping in consideration the utilization of the results at later stages of analysis for finalizing the processing technology. The methodology is described below in detail:

- One sample of the Mixed Waste from the secondary collection points, existing dumpsite and transit point (transfer station) was collected. All these samples were taken from the inside and outside of solid waste heap and thoroughly mixed to avoid homogeneity. Ultimate Analysis of mixed waste is also performed.
- One sample of Bio-Degradable waste was collected from the households in segregated form during the primary collection of waste in early morning (only from the lead ULBs).
- One sample of Dry Waste from the households and one sample from the commercial waste were collected in segregated form. These two samples were mixed thoroughly to make further one composite sample (only from the lead ULBs).

Table 5.10: Various Chemical parameters of MSW in Nellore

<table>
<thead>
<tr>
<th>Parameters analysed</th>
<th>Unit</th>
<th>Biodegradable</th>
<th>Dry Waste</th>
<th>Commercial Waste</th>
<th>Mixed Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>%</td>
<td>49.2</td>
<td>24.1</td>
<td>29.6</td>
<td>29.3</td>
</tr>
<tr>
<td>Calorific Value</td>
<td>Kcal/Kg</td>
<td>798</td>
<td>2018</td>
<td>1090</td>
<td>1337.0</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
<td>7.7</td>
<td>8</td>
<td>8.11</td>
<td>8.1</td>
</tr>
<tr>
<td>C/N Ratio</td>
<td>-</td>
<td>34.1</td>
<td>22.9</td>
<td>27.3</td>
<td>28.2</td>
</tr>
<tr>
<td>Organic Carbon</td>
<td>%</td>
<td>43.6</td>
<td>33.8</td>
<td>18.6</td>
<td>17.8</td>
</tr>
<tr>
<td>Total Solids</td>
<td>%</td>
<td>32.1</td>
<td>27</td>
<td>29.7</td>
<td>32.5</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>%</td>
<td>0.99</td>
<td>0.81</td>
<td>0.76</td>
<td>0.7</td>
</tr>
<tr>
<td>Phosphorus as P2O5</td>
<td>%</td>
<td>0.57</td>
<td>0.92</td>
<td>0.87</td>
<td>0.5</td>
</tr>
<tr>
<td>Potassium K2O</td>
<td>%</td>
<td>0.6</td>
<td>0.76</td>
<td>0.51</td>
<td>0.3</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>Kg/m3</td>
<td>482</td>
<td>325</td>
<td>354</td>
<td>364.0</td>
</tr>
</tbody>
</table>

5.3.11 Waste Projections

Not only the present scenario but future demands assessment is also carried out based on the projected population. The average quantities of waste generation based on the design population of Nellore including total waste generation. Assumption for per capita increase is taken 1.3 grams per annum as per MoUD guidelines.

Table 5.11: Waste projections
### Table 5.12: Year wise expenditure by municipalities on MSW

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent Workers</td>
<td>220</td>
<td>1100</td>
<td>1100</td>
<td>850</td>
<td>650</td>
<td>43%</td>
</tr>
<tr>
<td>Sanitary Workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.3.12 MSW Management System in Nellore City

This section describes the MSW Management and Handling System prevalent in the town. The management system is headed by the Executive Engineer and the work is undertaken by the staff under his guidance.

![Diagram of Administrative system of NMC](image)

5.3.13 Expenditure on MSW

The Municipal Corporations and City Governments create and maintain assets with funds provided by central and state Grants, funds internally generated by local Governments through taxes and tariffs, capital markets etc. Solid waste management is a non-revenue generating activity for municipalities in India, majority of which is spent on manpower and fuel. This section briefly enquires the efficiency (in terms of cost per tonne) of municipality in executing the MSW collection, transportation and disposal activities.
The last 5 year expenses of Nellore Municipality shows that the maximum expenditure for solid waste management is done on salary (81%) and other expenses are only 19%.

### 5.4 Gaps in Existing MSW Management System

There are very detailed and specific criteria for management of municipal solid waste. It includes guidelines, guidance notes and specific work standards to be adopted by municipal personnel or personnel involved with solid waste management (directly or indirectly) for organized SWM practices (starting from waste collection, segregation, transportation, to environmentally safe waste disposal practices).

The Project team identified that the SWM system in Brazzaville city requires significant improvements/total transformation to meet the performance standards as per international best practices.

Some of the significant gaps observed by project team are as under:

#### 5.4.1 No Segregation Practiced at Source

There is no practice of waste segregation into biodegradables and non-biodegradables at source in Nellore. The Project team identified that these generators (households, restaurants, shops, etc.) dump mixed waste into drains, common points and secondary collection points which finally reaches to dumping yard.

As a standard practice, MSW has to be segregated into biodegradable and non-biodegradable wastes and disposed off in separate containers at household level and also during transportation to aid in efficient waste processing and disposal mechanisms. There must be acceptance of 3R’s (Reuse, Reduce & Recycle) among society for the efficient MSW Management & less burden on existing landfills.

#### 5.4.2 Primary collection of solid waste is not appropriate

There is an established door to door system in Nellore. The waste collected from various sources is mixed waste including road sweepings and drain sludge, which reaches the dump site. Waste from households which
are not covered under door to door collection system and other establishments are thrown on the open dump sites or in the municipal bins un-segregated due to this. By and large, crude dumping of waste is done in the town without following the principles of scientific sanitary land filling.

The sanitary workers do the street sweeping, collect drain silt and waste heaps from roadsides and dispose them off at a nearby open dumps. These unorganized disposal methods have resulted in accumulation of solid waste on roadsides, vacant plots, in low lying areas and storm water drains.

There should be proper segregation at source and mixed waste should not be dumped directly to the dumping ground without prior processing and treatment. The roadside waste collected by street sweepers must be directly dumped into a separate bin at the secondary waste collection point. As per the norms, BMW shall be processed separately by hospitals and shall not be mixed with Municipal Solid Waste during collection and transportation

5.4.3 Secondary storage of solid waste is unorganized

The Project team observed that only open dumps, broken dustbins and uncleared overflowing dumper bins are placed for secondary storage of MSW. In the absence of proper secondary storage facility for MSW, it is dumped at any location in the vicinity – drains, street corners and other open areas. Heaps and stretches of un-segregated waste in open areas is an eyesore, thereby causing environmentally hazardous & unhygienic conditions across the city, thus creating conditions for breeding of mosquitoes, grazing by cattle.

Separate colored bins with proper distinction at the secondary storage location for biodegradable and non-biodegradable and recyclable/ combustible wastes. The bins must be covered and cleared at the scheduled time to prevent storage of waste for a long time and to avoid littering of waste outside the bins. Bins should be placed at each colony or locality and must be accessible by each households and commercial areas.

5.4.4 Solid waste is transported in open vehicles

It was observed that solid waste is transported in open three wheelers/ open trucks. The Project team observed that these open vehicles are overloaded with waste, resulting in road littering during transportation. The loading and unloading of waste is done manually and municipal workers involved in this activity do not use any Personal Protection Equipment (PPE) for their protection.

The waste transportation vehicles must be covered at all times expect while loading and unloading activities and the loaded waste should not exceed the capacity of the waste transportation vehicles.

5.4.5 Collection and disposal of construction waste is not appropriate

The construction/ demolition waste generated by local residents is disposed off in open/ low-lying areas in the vicinity, privately.

The construction and demolition waste must not be dumped in any open areas in an unorganized manner. It must be handled under the guidance of Municipality officials.
5.4.6 Disposal of solid waste is not appropriate

The solid waste collected from various sources is disposed off in open dumps indiscriminately without segregation or preprocessing. There is no engineered sanitary landfill site for safe disposal of solid waste.

According internationally accepted norms, biodegradable waste shall be processed and converted into compost; recyclables shall be segregated and stored separately to be processed by recyclers; no hazardous waste/bio-medical waste be dumped along with MSW; construction waste to be segregated and used for filling low lying areas and only remaining waste shall be dumped into engineered landfill facility without creating nuisance or hazard to public health or safety, such as breeding of rodents and insects and contamination of groundwater.

5.4.7 Slaughter waste is mixed with the MSW

Waste from slaughter houses is dumped along with the MSW. As such, there is no provision for segregation and safe disposal.

Slaughter house waste should be collected separately and disposed off by controlled incineration, burial, anaerobic digestion, or other approved processing methods.

5.4.8 Manual handling of solid waste

Municipal workers involved in primary collection of MSW do not use any Personal Protection Equipment (PPEs) such as face masks, disposable gloves, boots, hats, and proper safety clothing (sturdy colored uniform) to avoid direct contact with waste and reduce the likelihood of on-the-job injury.

5.4.9 Lack of awareness among city residents and civic authorities

The municipality is responsible for managing MSW in all the towns. However, due to absence of requisite policy, they are completely ignorant of internationally accepted best practices for implementation of robust system. The current state of affairs indicates that a change is needed and municipal officials need to understand the environmental, social, and economic implications of an unorganized MSW management system. Likewise, public participation is very essential in successful implementation of the MSW management plan in any town. Therefore, a planned and concerted effort is required to bring about awareness among the public and make them realize their responsibilities as individuals and as a community on the whole. In summary, public awareness, community participation, transparent administration, accountability at all levels is the need of hour so as to ensure success of any MSW management plan.
5.5 Good Practices

Overlooking at good practices is as important as identifying the loopholes in the system to robustly link the proposed system with the local requirements. As per team interactions with the municipality, there has been many innovative ways to promote cleanliness and improve solid waste management system in Andhra Pradesh which is worth mentioning.

5.5.1 Bin Monitoring System

Bin Monitoring System is an application developed by Government of Andhra Pradesh (GoAP). The system is implemented through Off-site Real Time Monitoring System (OSRT) in all the ULBs in Andhra Pradesh. All the secondary collection points are marked and monitored for daily lifting of garbage through a well-established network of sanitary inspectors and supervisors. The bins are reported cleared, not-cleared or not reported daily by the designated sanitary inspector. The application is monitored by the municipal minister directly.

5.5.2 E-Governance

Given the diversity of the functionality and platforms of the existing applications, it was recognized that there was a need to develop a comprehensive and integrated solution that meets the requirement of the ULBs across the State and thereby provide an opportunity for an “integrated view” of the data. The need was also stimulated by the fact that an integrated view offers a better scope for management information and decision-making. Solid waste management is also a part of the same e-governance platform to be implemented by all ULBs. The tracking of dumping sites and digitising route plans of municipal vehicles is envisaged to be instigated under the same plan.

5.5.3 Bin free City

The concept of “Bin free city” comes from having 100% door to door collection of waste with reduced or no need of secondary collection points/dustbins. Many towns in Andhra Pradesh are looking forward to this concept and implementing ways to strengthen their door to door collection system. The practice was most evident in Kavali and Kandukur where many dustbins have been removed in past few months.

5.5.4 Adarsh Wards

Adarsh wards are the wards selected on pilot basis for the implementation of door to door collection and segregation of waste. Municipalities have developed phase wise plan to scale the coverage of services from pilot stage to city level.
5.5.5 Hundred days Sanitation Program

“Hundred days Sanitation Program” is a kind of Sanitation drive done to promote cleanliness and increase awareness about handling solid waste amongst the local people and sanitation department. The drive took place in the municipalities and people were provided knowledge about segregation of waste and its significance for processing and generating value out of the waste.
6.0 PROPOSED MSW MANAGEMENT SYSTEM

6.1 INTRODUCTION

The integrated Municipal Solid Waste Management (MSWM) plan for primary & secondary waste collection and transportation system for Nellore city has been included in this chapter. The proposed plan also includes the infrastructure requirements, quantities and corresponding cost estimates for the collection and transportation systems. The proposed SWM system is broadly based on the 4R Environmental Protection Rules (Reduce, Recycle, Reuse, and Recover) and is in accordance with the MSW Rules, 2000 & MSW Rules, 2015 (Drafted). The primary aspects of the proposed plan include the following:

- Compliance with Municipal Solid Waste (Management & Handling) Rules, 2000
- Compulsory segregation at the source
- Provision of segregated infrastructure at all stages of collection and transportation
- Waste to be covered at all stages of handling
- Elimination of manual handling of waste, and provision of proper PPEs to the workers
- 100% collection and transportation of the generated waste
- Maximum recovery of resources by segregating recyclables and biodegradable
- Advocate 4R’s i.e. reduce, recycle, reuse, and recover materials in MSW management
- Adopt proven technologies for waste processing
- Promote Information, Education and Communication (IEC) across the stakeholders to ensure system efficiency and sustainability
- Ensure economic sustainability of the proposed system by introducing public private partnership (PPP) in MSW management
- Adequate health and safety provisions for workers at all stages of waste handling
- Regular environmental monitoring at waste processing and disposal facilities
- Have robust complaint-handling system in place
- Conduct regular internal and external independent audits on the efficiency of entire SWM system

The proposed system comprises of

- Primary Storage & Collection System
- Secondary Storage, Collection & Transportation System
- Integrated Solid Waste Management (ISWM) Facility on Cluster Approach at Nellore

The proposed infrastructure for primary waste collection will enforce segregation of waste at all the waste generation sources followed by separate collection and transportation system. The blueprint of the same is given below.
Figure 6.1: Blueprint of proposed C&T System

Vantage point at the start of the locality shall be identified by Concessionaire and vehicle shall be parked at vantage point. Helper of vehicle shall carry a whistle and walk in the locality to announce arrival of vehicle.
6.2 PROPOSED C&T SYSTEM: NELLORE CITY

6.2.1 Basis of Design of Proposed MSWM Plan

The proposed waste management plan and infrastructure/equipment for primary & secondary waste collection and transportation system for Nellore city have been framed based on the following:

- Population data of past six decades starting from 1961
- Projected populations for the design period based on CPHEEO manual
- Spread of Nellore city
- Current MSW quantities as per IPE Global’s MSW survey data
- Projected MSW quantities are based on the present waste generation data
- Current and projected per-capita waste (considering 1.3% increase per capita per year as per MoUD Guidelines)
- Projected Characterization of waste based on current characterization (test report)
- Existing waste collection location have been considered for primary & secondary collection of waste

The past and current projected populations, waste quantities, and per-capita waste for Nellore city, used for proposed SWM plan and infrastructure design are summarized in table 6.1.

Table 6.1: Population Estimates, Waste Quantities and Waste Characterization as per (Base Year 2017)

<table>
<thead>
<tr>
<th>Waste Composition</th>
<th>Waste Percentage (%)</th>
<th>Quantity (MT/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-degradable</td>
<td>44.10</td>
<td>126.96</td>
</tr>
<tr>
<td>Recyclable</td>
<td>22.00</td>
<td>63.44</td>
</tr>
<tr>
<td>Non-biodegradable</td>
<td>33.90</td>
<td>97.56</td>
</tr>
<tr>
<td>Total Waste</td>
<td>100</td>
<td>287.95</td>
</tr>
<tr>
<td>Gross Per-capita Waste</td>
<td></td>
<td>0.432 kg/person/day</td>
</tr>
</tbody>
</table>

The field survey shows that the Non-Biodegradable waste mainly comprises of horticulture, drain silt & street sweepings etc. In the proposed MSWM system there will be 100% segregation of waste at source into Biodegradable (wet) and Non-Biodegradable (dry). The Biodegradable and Non-Biodegradable waste would be collected and transported in segregated manner to Integrated Waste Management Facility for processing and disposal.

For SWM infrastructure design purpose the inert waste & recyclable waste is further categorized as follows

Table 6.2: Classification of Non-biodegradable Waste (Design Year 2017)

<table>
<thead>
<tr>
<th>Type of Inert Waste</th>
<th>Waste (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inert including Street sweepings</td>
<td>17.40</td>
<td>To Landfill</td>
</tr>
<tr>
<td>Drain silt</td>
<td>7.4</td>
<td>100% which is mainly silt will be used for filling low lying areas</td>
</tr>
</tbody>
</table>
Horticulture (dry leaves, straw & hay) 3.7 Will be used as a combustible material
Coconut 5.4 Will be used as a combustible material
Construction & Demolition waste --- Will be reused for filling low lying areas, or as a soil cover for sanitary landfill
Total 33.90

6.2.2 Proposed MSW Management Plan

The Nellore city is one of the few cities in the Andhra Pradesh where 90% primary collection of waste is being done. While planning the proposed management system, the collection, storage & transportation of waste has been planned in segregated manner, where in the Bio-degradable waste and Non-Biodegradable waste would be collected and transported on daily basis.

The Bio-degradable would be transported to proposed ISWM site located at Dhontali for processing. The Non-Biodegradable waste would be transported at aforesaid site for processing and recovery for recycling & re-use. The inert portion and rejects from compost plant which is non-combustible and non-recyclable would be only land filled in sanitary manner at proposed SLF in the same site. The combustible material will be further processed for the conversion of RDF and will be used as a feed stock for waste to energy plant. The construction & debris waste would be directly transported from place of generation to the proposed integrated site for waste management for processing, for re-use as raw materials for soil cover.

This section describes a step by step approach for safe & efficient collection, storage and transportation of MSW for Nellore city. They include primary waste collection, secondary waste collection & storage and waste transportation for subsequent processing and disposal. For estimation of collection and transportation infrastructure, year 2017 is taken as the design year and appropriate infrastructure is provided to ensure that infrastructure is sufficient to handle waste for the next five years.

The management plan has been designed to comply with MSW Rules 2000.

6.2.2.1 Storage of Waste at Households (Primary Storage)

The efficiency of the proposed waste management plan is driven by the segregation of waste in to Biodegradable (wet) and Non-Biodegradable (dry) at primary level.

The waste will be stored by the households and other generators in two separate bins, one for bio-degradable and one for non-biodegradable. Use of green plastic or metal containers with lid is advised for the storage of bio-degradable waste and a similar size bin of blue color may be used for storage of non-biodegradable waste. One container of 10 litre capacity and one container of 20 litre capacity for a family of 5-6 members would ordinarily be adequate.

Table 6.3: Infrastructure required at the source of waste generation

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Description</th>
<th>No. of Households (as per census 2017)</th>
<th>Required Bins (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covered bins for storage of Bio-degradable waste at household level</td>
<td>10 litre capacity of bin</td>
<td>142635</td>
<td>142635</td>
</tr>
</tbody>
</table>
Covered bins for storage of Non-biodegradable waste at household level

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 litre</td>
<td>142635</td>
</tr>
</tbody>
</table>

10 litre capacity of bin 142635

Covered bins for storage of Non-biodegradable waste at household level

Note:
*Storage of Bio-degradable waste in Green color bin
Storage of Non-Biodegradable waste in Blue color bin*

### 6.2.3 Collection and Transportation System of MSW from Households

The door-to-door collection of waste shall be done on a day-to-day basis i.e. between 6:00 AM – 1:00 PM and Nellore Municipal Corporation (NMC) shall be responsible for providing door to door primary MSW collection service within the jurisdiction of municipal area. The NMC shall ensure that infrastructure is made available for undertaking this activity in compliance with the MSW Rules 2000.

- Auto-Tippers with minimum 1.75 cu m capacity-hydraulically operated hopper covering mechanism from top having two compartments for carrying wet and dry waste separately with a hooter to be deployed *(henceforth called AT 1.75).*

- **AT 1.75** shall collect the MSW and transfer the wet waste directly into Mobile Transfer Station,

  *(Mobile Transfer Station shall mean Refuse Collector cum Compactor Vehicle henceforth referred to as MTS.)*

- Dry waste from **AT 1.75** shall be transported in a separate mobile transfer station to be stationed at the designated point.

- Auto tippers engaged in this service shall not dump the waste at any secondary collection bin/open site or any other location in any circumstances and shall transfer waste only in the specified MTS.

- In case MTS is not stationed at the designated location at that point of time for any reason, then the ‘loaded Auto Tipper’ shall go to the next designated location of the ‘MTS to unload the waste.

- Narrow streets that cannot be serviced by **AT 1.75**, a 3-Wheeler Motorized vehicle with hydraulically operated hopper covering mechanism from top having two compartments for carrying wet and dry waste separately with a hooter , compatible with mobile transfer station *(referred to as MTW)* shall be deployed.

- Smaller, narrow and congested streets/lanes where even a 3-wheeler cannot operate, vantage point/s shall be designated at the start of the locality/ street where Auto Tipper are to be parked and the

**Figure 6.2: Proposed Transportation Equipment’s**
helper/driver of vehicle shall carry a whistle and walk in the locality to announce arrival of vehicle for collecting the waste. Time table for such collection system to be displayed at the notice board.

h. The services of street level collection and transportation of waste shall be provided on all 365 days in a year irrespective of any National Holidays, Festivals and Sundays.

The proposed infrastructure for primary waste collection is given below.

<table>
<thead>
<tr>
<th>Ward No.</th>
<th>Household Waste (2022)</th>
<th>Total No. of Trips</th>
<th>Total Infrastructure Required</th>
<th>Secondary Transportation: Refuse Compactor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3-wheeler</td>
<td>4-wheeler</td>
<td>3-wheeler</td>
</tr>
<tr>
<td>1</td>
<td>5.37</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3.24</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>4.17</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>3.60</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>3.77</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>4.94</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>5.85</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>4.95</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>6.33</td>
<td>5</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>5.08</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>3.52</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>5.06</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>4.52</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>3.81</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>5.73</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>4.02</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>2.33</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
<td>5.49</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>19</td>
<td>3.94</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>20</td>
<td>4.64</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>21</td>
<td>4.56</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>22</td>
<td>3.40</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>23</td>
<td>4.83</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>4.34</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>3.98</td>
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</tr>
<tr>
<td>26</td>
<td>5.08</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>27</td>
<td>5.24</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>28</td>
<td>4.77</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>29</td>
<td>3.81</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>30</td>
<td>4.57</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>4.07</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>32</td>
<td>4.67</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>33</td>
<td>3.80</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>34</td>
<td>4.90</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>35</td>
<td>4.53</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>36</td>
<td>3.74</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>37</td>
<td>4.64</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Ward No.</td>
<td>Household Waste (2022)</td>
<td>Total No. of Trips</td>
<td>Total Infrastructure Required</td>
<td>Secondary Transportation: Refuse Compactor</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------</td>
<td>-------------------</td>
<td>-----------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3-wheeler</td>
<td>4-wheeler</td>
</tr>
<tr>
<td>38</td>
<td>3.55</td>
<td>3- wheeler</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>39</td>
<td>4.51</td>
<td>3- wheeler</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>40</td>
<td>4.33</td>
<td>3- wheeler</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>41</td>
<td>5.86</td>
<td>4- wheeler</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>42</td>
<td>4.54</td>
<td>3- wheeler</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>43</td>
<td>4.81</td>
<td>4- wheeler</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>44</td>
<td>3.18</td>
<td>2- wheeler</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>45</td>
<td>4.53</td>
<td>3- wheeler</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>46</td>
<td>4.96</td>
<td>4- wheeler</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>47</td>
<td>5.48</td>
<td>4- wheeler</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>48</td>
<td>3.96</td>
<td>3- wheeler</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>49</td>
<td>3.03</td>
<td>2- wheeler</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>50</td>
<td>4.24</td>
<td>3- wheeler</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>51</td>
<td>4.33</td>
<td>3- wheeler</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>52</td>
<td>4.26</td>
<td>3- wheeler</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>53</td>
<td>3.55</td>
<td>3- wheeler</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>54</td>
<td>4.50</td>
<td>3- wheeler</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>238.90</td>
<td>179.17</td>
</tr>
</tbody>
</table>

6.2.4 Collection and Transportation of MSW from All Markets, Hotels, Dhabas, Restaurants, Banquet Hall, Institution, Farm House & Other Commercial Establishments

a. It is proposed that AT 1.75 with mechanical “Bin-Lifting” capability to lift 240 liter bin/120 litre bin (AT 1.75 with Bin lifting Capability) will be deployed to collect the MSW and transfer the wet waste directly into MTS. Dry waste from AT 1.75 with Bin lifting Capability shall be transported to the designated recycling centers. Dry waste from AT 1.75 shall be transported in a separate mobile transfer station to be stationed at the designated point.

b. A separate dedicated infrastructure will be placed for the collection of MSW from above said establishments. However, requirement of same has been calculated which is mentioned in table below.

c. NMC shall plan to collect waste from Markets, Hotels, Dhabas, Restaurants, Banquet Hall, Farm House & other Commercial Establishments in coinciding with opening time of these establishments.

d. Auto tippers engaged in this service shall not collect the waste from any other source viz. open site, ground, street corner bin and drain etc.

e. MTS shall transfer the MSW directly to proposed Integrated Solid Waste Management (ISWM) site located at Allipuram village

f. This service shall be provided on all 365 days in a year irrespective of any National Holidays,
Festivals and Sundays.
Number of hotels/ restaurants in Nellore city is provided in table below. The waste from these establishments includes left-over food, sweepings and dry horticulture waste (leaves, twigs, etc.). It is proposed to provide primary collection facility for wet and dry waste in each Hotel/ Guesthouse / Restaurant and other commercial establishments.

**Table 6.4: Number of Commercial Establishments in Nellore City**

<table>
<thead>
<tr>
<th>Type of Commercial Establishments</th>
<th>Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotels/Lodges/Banquet Halls</td>
<td>164</td>
</tr>
<tr>
<td>Restaurants</td>
<td>125</td>
</tr>
<tr>
<td>Shops</td>
<td>4854</td>
</tr>
<tr>
<td>Schools</td>
<td>67</td>
</tr>
<tr>
<td>Colleges</td>
<td>8</td>
</tr>
<tr>
<td>Offices</td>
<td>65</td>
</tr>
<tr>
<td>Hospital/Nursing Homes/Diagnostics</td>
<td>16</td>
</tr>
<tr>
<td>Vegetable</td>
<td>3</td>
</tr>
<tr>
<td>Fish Market</td>
<td>3</td>
</tr>
</tbody>
</table>

It is proposed to have one 120 litre capacity bin with two wheels at each hotel, restaurant, banquet hall, school, college, office and hospital for collection of wet waste and one 120 litre capacity bin with two wheels for dry waste. Apart from this, it is also proposed to have bins of 10 & 20 litre capacity for each shop to promote the segregation of MSW at source. The waste would be collected using dedicated Auto-Tipper in segregated manner and finally transported to proposed ISWM site directly by means of Refuse Compactors.

**Infrastructure Requirement for Collection from Commercial Establishments:**

<table>
<thead>
<tr>
<th>Establishments</th>
<th>Design Waste (2022)</th>
<th>Infrastructure Proposed</th>
<th>Total No. of trips</th>
<th>Infrastructure required</th>
<th>Secondary Transportation: Refuse Compactor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Shops</td>
<td>25.44</td>
<td>4-Wheeler</td>
<td>39.75</td>
<td>13.25</td>
<td>2.38</td>
</tr>
<tr>
<td>Hotels/Lodges</td>
<td>5.59</td>
<td></td>
<td>8.74</td>
<td>2.91</td>
<td>0.52</td>
</tr>
<tr>
<td>Restaurants/Dhaba/Roadside eateries</td>
<td>19.78</td>
<td></td>
<td>30.91</td>
<td>10.30</td>
<td>1.85</td>
</tr>
<tr>
<td>Schools</td>
<td>0.29</td>
<td></td>
<td>0.46</td>
<td>0.15</td>
<td>0.03</td>
</tr>
<tr>
<td>Colleges</td>
<td>0.03</td>
<td></td>
<td>0.05</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>Offices</td>
<td>0.61</td>
<td></td>
<td>0.95</td>
<td>0.32</td>
<td>0.06</td>
</tr>
<tr>
<td>Slaughter House</td>
<td>0.81</td>
<td></td>
<td>1.27</td>
<td>0.42</td>
<td>0.08</td>
</tr>
<tr>
<td>Hospital/Nursing Homes/Diagnostics</td>
<td>4.91</td>
<td></td>
<td>7.67</td>
<td>2.56</td>
<td>0.46</td>
</tr>
<tr>
<td>Vegetable/Fish Market</td>
<td>4.15</td>
<td></td>
<td>6.49</td>
<td>2.16</td>
<td>0.39</td>
</tr>
<tr>
<td>Celebration House (Banquet)</td>
<td>8.14</td>
<td></td>
<td>12.71</td>
<td>4.24</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td><strong>69.76</strong></td>
<td></td>
<td><strong>109</strong></td>
<td><strong>36.3</strong></td>
<td><strong>6.51</strong></td>
</tr>
</tbody>
</table>

**Secondary Transportation:**

<table>
<thead>
<tr>
<th>No. of trips</th>
<th>Total No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.79</td>
<td>0.17</td>
</tr>
<tr>
<td>0.62</td>
<td>0.01</td>
</tr>
<tr>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>0.15</td>
<td>0.13</td>
</tr>
</tbody>
</table>
6.2.5 Collection and Transportation of Silt Generated during De-silting of Drains up to 4 feet

a. NMC is responsible for the de-silting of surface drains including the collection, transportation and disposal of silt generated from these drains.

b. NMC shall prepare their ‘Action Plan for de-silting’ of drains upto 4 feet in advance with the operator using the computerized System.

c. Based on the Action Plan, operator will make its plan for de-silting of drains and lift the ‘silt’ deposited alongside de-silted drains within 24 hours.

d. Silt will be transported to the low lying areas or any other site/plant by using a tractor-trolley available with the NMC.

e. Drain Silt collected using this service shall not under any condition be unloaded onto the open sites, dust bin locations, ground or any other points or mixed with any other type of waste.

f. Requirement of the infrastructure calculated for the silt management is summarized below in table 6.5.

Table 6.5: Infrastructure Requirement for Drain Cleaning

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tractors Required for Effective Servicing</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Total Tractors required with Contingency (Y1-15%)</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Man power required for Tractors (1 driver + 1 helper) considering the 72 days leaves in a year with 20% back-up</td>
<td>12</td>
</tr>
</tbody>
</table>

Note: Existing tractors available with the Municipal Corporation may be used for the collection and transportation of silt

6.2.6 Collection and Transportation of Construction & Demolition (C&D) Waste

The construction and demolition waste will be collected on need basis. It is the responsibility of generator to inform NMC that construction waste need to be collected from the site.

In the year 2015, quantity of construction waste generation per day = 30 MT/day

Assuming that average quantity of construction waste per location is 2 MT. Therefore approximate number of locations from where construction waste gets generated everyday = 30/2 = 15 locations

One tipper truck having 10 Ton carrying capacity can cover 5-6 locations in one trip and one truck can make approximately 2 trips in a day. Therefore, number of tipper trucks required = 30/10/2 = 1.5 = 2

Vehicles available with NMC shall be used to carry C&D waste.

6.2.7 Collection of Bulky Items

The bulky items organic or inorganic in nature would be collected on demand from the residents using tippers/tractors available with NMC and transported to landfill site (ISWM facility) for processing and disposal. The organic bulky items like banana trunks and trunks of other type of plants would be send to preprocessing area of compost plant for composting after shredding for which shredder has been provided in preprocessing area of compost plant. The bulky inorganic waste would be taken to MRF facility for processing and disposal.

6.2.8 Collection of Dairy Waste

All dairy waste shall be sent to the compost plant. Existing trucks with NMC can be used for this purpose. The compost plant operator shall have understanding with dairy owners and NMC for collection and transportation of dairy waste from source to the compost plant site.
**Required Infrastructure for Door to Door Collection and Transportation from Households & Other Commercial Establishments**

The infrastructure is calculated at ward level. Based on field survey, it is proposed to use Auto-Tipper (4-wheeler) and 3-wheeler for door-to-door collection of waste.

It is proposed to collect wet waste and dry waste on daily basis. The number of infrastructure required has been estimated based on quantity of waste generated.

The quantity of waste generation from each ward is estimated based on its population and per capita waste generation in Nellore.

In order to design infrastructure for primary collection and transportation, ward 1 has been taken for detailed design and based on same criteria, the requirement of infrastructure has been framed.

**Sample Calculation for infrastructure requirement for primary Collection & Transportation of MSW (except the silt and C&D waste) in ward no. 1**

**Total MSW**

<table>
<thead>
<tr>
<th>Quantity of MSW generated from ward 1</th>
<th>= 6.0 TPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto-Tippers of 1.75 cum capacity with two compartments and having the carrying capacity of approximate 600 kg waste will be used for the primary collection</td>
<td></td>
</tr>
<tr>
<td>Total nos. of trips done by 1 auto-tipper = 6 x 1000/600 = 10 trips</td>
<td></td>
</tr>
<tr>
<td>One auto-tipper will make maximum 03 trips during the door to door collection. <strong>Hence, total number of auto-tippers required = 10/3 = 3.3 = 3</strong></td>
<td></td>
</tr>
<tr>
<td>Refuse Collector cum Compactor (MTS) of 14 cum capacity and having minimum 8 Ton capacity will be used for the transportation of wet and dry waste separately.</td>
<td></td>
</tr>
</tbody>
</table>

On the basis of the above, the requirement of number of infrastructure has been calculated on the basis of ward wise waste generation and the details are given in Table 6.6:

This activity will be undertaken by the private operator. The total number of workers required by a private operator is based on the assumption that the private workers will not get more than 60 days leave in a year.

**Street Sweeping**

The street sweeping shall be done on a day-to-day basis. It is desirable to split the 8 hours of duty of sweepers into two shifts, 4 hour in the morning (from 6:00 am to 10:00 am) and 4 hour in the night (10:00 pm to 2:00 am). The street sweeping is to be done by safai karamchari as per the proposed plan.

**The total length of roads in Nellore city = 715 km**

<table>
<thead>
<tr>
<th>Type of Roads</th>
<th>Km</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC Road</td>
<td>240</td>
</tr>
<tr>
<td>Bituminous Road</td>
<td>80</td>
</tr>
<tr>
<td>WBM</td>
<td>162</td>
</tr>
<tr>
<td>Kutchha Road</td>
<td>233</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>715</strong></td>
</tr>
</tbody>
</table>

Sanitary workers shall be responsible to do the street sweeping and transfer the waste into specified (colour-black) covered RC bins of 0.6 cum capacity to be provided at designated Secondary Collection Points (SCPs). Operator shall in a time bound plan transport Road sweeping waste from SCP to the proposed ISWM site located at Dhontali or other designated landfill site using **Refuse Collector Truck (Tipper)** having mechanical
“Bin-Lifting” capability to lift 0.6/1.1 cum bins

Estimated quantity of street sweeping waste in 2015 (including drain silt) = 21.45 TPD
Assuming density of street sweeping waste as 1MT/m$^3$, quantity = 21.45 m$^3$

**Manual Street Sweeping**

It is assumed that 10% of these roads have divider. Hence, the total length to be cleaned = 715 x 1.1 = 787 km

In 787 kms, approximately 20% of the roads will be cleaned daily, 50% of the roads will be cleaned on alternate days and 30% of the roads will be cleaned twice in a week.

**As per the work norms, on an average every street sweeper can clean 500m length of road in a day, therefore total number of workers required per day**

$$= \frac{(787 \times 0.2) + (787 \times 0.5)/2 + (787 \times 0.3) \times 2/7}{0.50} = 843$$

To ensure that street sweeping is done properly and there is accountability at individual level, it is proposed that teams of two sweepers each shall be made responsible for a stretch of road. As mentioned above, it is assumed that each sweeper will clean approximately 500m of road stretch, therefore two sweepers between themselves are responsible for cleaning 1 km of road. One wheelbarrow (with brakes) shall be shared by a team of two sweepers. The sanitary supervisors will have the complete road map with area-wise responsibility distribution marked on it. The sanitary supervisor will be responsible for making surprise checks and identifying if any team is not working properly. This activity may be undertaken by existing workers.

MSW services will be provided 365 days a year. Assuming that one government worker will work on 80% days a year, total workforce required to run operations 365 days = 843 x 1.14 = 961

*Safai karamcharis* shall do street sweeping daily. The infrastructure required for street sweeping is also estimated based on length of roads in Nellore and *safai karamcharis* required for street sweeping.

Therefore, number of wheelbarrows required per day = 843/2 = 421
Total number of wheelbarrows with 5% back-up infrastructure = 421 x 1.05 = 442 wheel barrows

**Other Tools and Equipment’s**
Other working tools required for street sweeping staff include shovel and broom.

Number of brooms required = 961
Number of shovels required = 961

PPEs required for the street sweeping staff include gloves, boots, safety mask and uniform. Therefore,

Required number of pair of gloves = 961
Required number of pair of boots = 961
Required number of safety mask = 961
Required 2 set of uniform = 1922

Table 6.8: Requirement of Infrastructure for the Street Sweeping Waste Management

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars</th>
<th>Nos.</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total number of bins required for street sweeping waste (1 bin at 1 location) in Black Colour</td>
<td>227</td>
<td>660 Litre</td>
</tr>
<tr>
<td>2</td>
<td>Number of Refuse Collector vehicles required for transportation</td>
<td>1</td>
<td>8 Cum</td>
</tr>
</tbody>
</table>

6.2.9 Secondary Waste Storage System (CONCEPT OF BIN LESS CITY)

As present, Nellore is a city which is having 01 unorganized transfer station of approximate 2 acre area located at Bodigari Thota and 127 secondary collection points spread in entire city for the unloading of waste collected through primary collection.

It is not recommended to provide the bins for the MSW at SCPs to make the city bin less in city. However, provisions of the some bins have been kept in initial phase for the dumping of waste by unorganized sector.

However, litter bins of 100 litre twin-bin set with S.S. frame shall be placed near all public, market and tourist places including schools, colleges, offices, post office, and market areas and parks. It is proposed to provide 200 pairs of 100 litre bins for placement across the city.

The litter bin is proposed capable of displaying advertisement also with two separate bins for collection of wet & dry waste. The Nellore Municipal Corporation could earn revenue by seeking advertisements from agencies on these litter bins. Apart from the litter bins, it is proposed to place 210 bins of 0.6 cum capacity for the collection of street sweeping waste.

It is proposed to synchronize primary collection and secondary collection & transportation to avoid the need for secondary storage bins/depots.

Segregated waste at the household level will be collected by primary collection vehicles (through autotippers), which will be directly transported in to secondary collection vehicles (refuse collector cum compactor vehicles referred as MTS). Secondary collection vehicles will be 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 system. 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 when there is sufficient fleet of secondary collection vehicles to synchronize with primary collection and where good coordination systems exist.

**Table 6.10: Quantity and Cost Estimates for Secondary Storage Infrastructure**

*Equipment rate includes two year equipment warranty.*

**6.2.10 Proposed Waste Transportation System**

- Hydraulically operated equipment shall be used for transportation of waste. The waste, under any circumstances, shall not be handled manually.

The transportation vehicle requirement is based on following assumptions:

- It is proposed to use 14 m³ capacity Refuse Collector cum Compactor (Mobile Transfer Station refereed as MTS) for receiving MSW from the Auto-Tippers directly. It is assumed that a MTS will make two trip of loading waste to proposed ISWM site located at Allipuram village.
- In addition to above, separate transportation vehicles have been proposed for the management of street sweeping waste, silt and construction & demolition waste.

**Workshop**

The auto workshop shall be fully equipped to undertake maintenance of transportation vehicles and shall have all infrastructure including waste water treatment plant, etc. as per the statutory requirements. Existing vehicle shed located at Rajendra Nagar, Nellore will be upgraded in to fully auto workshop for repair and maintenance including the servicing of Collection & Transportation vehicles.

Workshop site should be maintained properly and be fully equipped to provided services at par with Good Industry Practice and should have all arrangements to meet emergency situations as per applicable Laws. Maintenance and painting of the workshop site should be carried out at least once in a year. Minimal following infrastructure to be installed at Workshop facility:

**Table 6.11: List of Minimum Equipment required for the Workshop**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Facility / Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Office</td>
</tr>
<tr>
<td>2</td>
<td>Engine room</td>
</tr>
<tr>
<td>3</td>
<td>Tool storage and oil/lubricant, spares storage facility</td>
</tr>
<tr>
<td>4</td>
<td>Welding Facility</td>
</tr>
<tr>
<td>5</td>
<td>5 HP Air Compressor and jet cleaning machine</td>
</tr>
<tr>
<td>6</td>
<td>Washing facility for vehicles</td>
</tr>
<tr>
<td>7</td>
<td>Hydraulic lifting system</td>
</tr>
<tr>
<td>8</td>
<td>Battery charging machine having capacity of 12 volt, 6 batteries, battery tester such as hydrometer, volt meter etc.</td>
</tr>
<tr>
<td>9</td>
<td>Tube vulcanizing machine tyre inflator</td>
</tr>
<tr>
<td>10</td>
<td>Pneumatic grease pump, grease gun etc.</td>
</tr>
</tbody>
</table>
Capital cost required for the upgradation of existing vehicle shed is mentioned below in the table below.

**Table 6.12: Cost Estimates for the up-gradation of Existing Workshop**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Unit</th>
<th>Size</th>
<th>Rate In INR</th>
<th>Total cost (In INR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boundary Wall</td>
<td>RM</td>
<td>260</td>
<td>1744</td>
<td>453391</td>
</tr>
<tr>
<td>Gardening Area</td>
<td>Sq. m</td>
<td>744</td>
<td>112</td>
<td>82963</td>
</tr>
<tr>
<td>Storm Water Drain</td>
<td>RM</td>
<td>260</td>
<td>1387</td>
<td>360638</td>
</tr>
<tr>
<td>Office Room</td>
<td>Sq. m</td>
<td>35</td>
<td>15000</td>
<td>525000</td>
</tr>
<tr>
<td>Engine/Tool Room</td>
<td>Sq. m</td>
<td>80</td>
<td>12000</td>
<td>960000</td>
</tr>
<tr>
<td>Covered Area with sheet</td>
<td>Sq. m</td>
<td>300</td>
<td>8800</td>
<td>2640000</td>
</tr>
<tr>
<td>Two Washing Facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Guard Room</td>
<td>Sq. m</td>
<td>9</td>
<td>12000</td>
<td>108000</td>
</tr>
<tr>
<td>Cost of workshop equipments</td>
<td>LS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of the furniture</td>
<td>LS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tube well boring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td>7988586</td>
</tr>
</tbody>
</table>

**6.2.11 SUMMARY OF COLLECTION AND TRANSPORTATION INFRASTRUCTURE**

Total outlay for Collection and Transportation infrastructure proposed for Panaji city is summarized in table 6.13 below:

**Table 6.13: Summary of Cost Estimates for Collection and Transportation Infrastructure**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars</th>
<th>Capacity</th>
<th>Unit</th>
<th>Unit Cost (in INR)</th>
<th>Proposed Nos.</th>
<th>Existing Nos.</th>
<th>Required Nos.</th>
<th>Total Cost (in INR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bins for Households</td>
<td>10</td>
<td>Litre</td>
<td>135</td>
<td>285270</td>
<td></td>
<td></td>
<td>38511450</td>
</tr>
<tr>
<td>2</td>
<td>4-wheelers Auto-Tippers for MSW collection</td>
<td>1.75</td>
<td>cum</td>
<td>475000</td>
<td>65</td>
<td>25</td>
<td>40</td>
<td>19000000</td>
</tr>
<tr>
<td>3</td>
<td>3-wheelers Auto-tippers for MSW collection</td>
<td>1</td>
<td>cum</td>
<td>450000</td>
<td>45</td>
<td>46</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Wheel barrows for Street Sweepers</td>
<td>250</td>
<td>litre</td>
<td>8750</td>
<td>442</td>
<td></td>
<td>442</td>
<td>3867500</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>61378950</td>
</tr>
<tr>
<td>1</td>
<td>Litter bins for Markets (with space for advertisement)</td>
<td>100</td>
<td>Litre</td>
<td>4879</td>
<td>200</td>
<td>200</td>
<td></td>
<td>975800</td>
</tr>
<tr>
<td>2</td>
<td>RC Bins for street sweeping waste</td>
<td>0.6</td>
<td>cum</td>
<td>18500</td>
<td>267</td>
<td>267</td>
<td></td>
<td>4939500</td>
</tr>
<tr>
<td>5</td>
<td>Refuse Collector vehicles required for transportation of sweeping waste</td>
<td>8</td>
<td>cum</td>
<td>2790000</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2790000</td>
</tr>
<tr>
<td>6</td>
<td>Refuse Compactors to receive MSW directly from Auto-Tippers</td>
<td>14</td>
<td>cum</td>
<td>3270000</td>
<td>10</td>
<td>10</td>
<td></td>
<td>32700000</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>35490000</td>
</tr>
<tr>
<td>10</td>
<td>Establishment of the Workshop</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td>7988586</td>
</tr>
<tr>
<td>11</td>
<td>Parking Site (1 acre area)</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td>5000000</td>
</tr>
</tbody>
</table>
GIS-GPS based MIS System | LS | 7420000
 Complaint Redressal System | LS | 1000000

**TOTAL** | **21408586**
**GRAND TOTAL** | **118277536**

### 6.2.12 OPERATION & MAINTENANCE (O&M) COSTS FOR COLLECTION & TRANSPORTATION SYSTEM

The detailed operation and maintenance plan for MSW collection and transportation system will be developed at the Project Management & Construction Stage. The budget for Project Management has been included in Chapter 9.

At this stage, operation and maintenance cost is estimated for MSW transportation system proposed in table 6.14. These costs include salaries for the O&M personnel and O&M costs for waste transportation infrastructure.

**Table 6.14: O&M Cost for Waste Transportation Infrastructure and Personnel**

<table>
<thead>
<tr>
<th>particular</th>
<th>No.</th>
<th>Salary/Cost</th>
<th>Months</th>
<th>Total Cost Per Annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>drivers for primary collection of MSW</td>
<td>110</td>
<td>10796</td>
<td>12</td>
<td>14250720</td>
</tr>
<tr>
<td>helpers (waste collector) for primary collection of MSW</td>
<td>110</td>
<td>7452</td>
<td>12</td>
<td>9836640</td>
</tr>
<tr>
<td>drivers for refuse compactor (secondary collection of MSW)</td>
<td>10</td>
<td>10796</td>
<td>12</td>
<td>1295520</td>
</tr>
<tr>
<td>helpers for refuse compactor (secondary collection of MSW)</td>
<td>10</td>
<td>7452</td>
<td>12</td>
<td>894240</td>
</tr>
<tr>
<td>street sweepers</td>
<td>961</td>
<td>7452</td>
<td>12</td>
<td>85936464</td>
</tr>
<tr>
<td>drivers for silt transportation</td>
<td>6</td>
<td>10796</td>
<td>12</td>
<td>796240</td>
</tr>
<tr>
<td>Table 6.15: Diesel Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>Distance</td>
<td>Month</td>
<td>Total cost per annum</td>
</tr>
<tr>
<td>Diesel Cost for 4 wheeler mini auto tippers</td>
<td>65</td>
<td>30</td>
<td>12</td>
<td>4233004</td>
</tr>
<tr>
<td>Diesel Cost for 3 wheeler mini auto tipper</td>
<td>45</td>
<td>24</td>
<td>12</td>
<td>1935087</td>
</tr>
<tr>
<td>Diesel Cost for Refuse Compactor</td>
<td>10</td>
<td>60</td>
<td>12</td>
<td>3240000</td>
</tr>
<tr>
<td>Diesel cost for the Refuse Collector</td>
<td>1</td>
<td>80</td>
<td>12</td>
<td>576000</td>
</tr>
<tr>
<td>Diesel cost for the Tractor to be used for Silt Transportation</td>
<td>5</td>
<td>60</td>
<td>12</td>
<td>1518945</td>
</tr>
<tr>
<td>Total Cost of Diesel</td>
<td></td>
<td></td>
<td></td>
<td>11503037</td>
</tr>
</tbody>
</table>
Table 6.16: Cost of Consumables

<table>
<thead>
<tr>
<th>Consumables</th>
<th>Street Sweepers</th>
<th>Drivers for primary collection</th>
<th>Helpers for primary collection</th>
<th>Drivers for secondary transportation</th>
<th>Helpers for secondary transportation</th>
<th>Rate (in Rs.)</th>
<th>Total Cost per Annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gloves</td>
<td>961</td>
<td>110</td>
<td>22</td>
<td>22</td>
<td>50</td>
<td>55765</td>
<td></td>
</tr>
<tr>
<td>Shoes</td>
<td>961</td>
<td>110</td>
<td>22</td>
<td>22</td>
<td>300</td>
<td>334588</td>
<td></td>
</tr>
<tr>
<td>Cap</td>
<td>961</td>
<td>110</td>
<td>22</td>
<td>22</td>
<td>50</td>
<td>55765</td>
<td></td>
</tr>
<tr>
<td>Dust Pan</td>
<td></td>
<td>160</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uniform (two times in a year)</td>
<td>1922</td>
<td>220</td>
<td>220</td>
<td>44</td>
<td>44</td>
<td>500</td>
<td>1115292</td>
</tr>
<tr>
<td>Safety masks (four times in a year)</td>
<td>3844</td>
<td>440</td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>218629</td>
</tr>
<tr>
<td>Broom (four times in a year)</td>
<td>3844</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>384400</td>
</tr>
<tr>
<td>Shovels (one time in a year)</td>
<td>961</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200</td>
<td>192200</td>
</tr>
<tr>
<td>Spade (one time in a year)</td>
<td>199</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>300</td>
<td>59829</td>
</tr>
<tr>
<td>Chemicals viz. lime &amp; bleaching powder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>500000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>2948467</strong></td>
</tr>
</tbody>
</table>
7.0 INTEGRATED SOLID WASTE MANAGEMENT (ISWM) FACILITY

NMC has identified an area of 25 acres approximately for the Solid Waste Management Facility at Dhontali. For the effective management of the Municipal waste being generated from the Cluster V, complete site of 25 acres will be utilized for the development of processing facility and disposal facility.

The Facilities to be provided at the ISWM facility for the Processing and Disposal of segregated MSW coming from the 4 towns are as follows:-

- For processing of MSW: Waste to Energy Plant
- For the Final Disposal of the Inert Waste and the Rejects from the above mentioned Processing Facilities: Sanitary Landfill

7.1 Waste to Energy Plant

The waste will be processed in the Waste to Energy Plant.

7.2 Sanitary Landfill

The inert waste and rejects from compost plant would be landfilled in sanitary manner. The area available for landfilling is sufficient up to 2042 A.D. The detailed cost estimates have been done for 25 years. The details of landfill is given in Chapter 9.

The ISWM site will have following facilities, which will be common for the Processing & Disposal facilities except the Waste to Energy plant.

The site will be provided with a boundary wall of 2194 m length all along its periphery. Also, a peripheral road of 7.5 m width along with side-drains. The green buffer would be provided along the ISWM site periphery covering the common facilities, staff quarters and landfill facility of 5 m wide.

For the purpose of continuous environmental monitoring at the site, Ground Water Monitoring Wells will be provided. A common laboratory would be provided with instruments for testing the compost quality and the characteristics of Leachate generated in the landfill.

The drawing of Layout Plan is appended as A.P/Zone-4/Nellore Cluster/01

---

1 The Waste to Energy Plant Works have been already awarded to a private concessionaire
8.0 WASTE TO ENERGY PLANT

Urban waste generation is rapidly increasing with population expansion and economic development. Improper management of this waste poses an enormous risk to human health and environment. There is thus an urgent need to address this problem with a more scientific approach than the commonly adopted crude dumping of waste. Moreover due to the increased scarcity of land, the option of simply dumping MSW on landfill is not viable anymore. With this objective, this chapter explores the option of Waste to Energy (WTE) as a mode of waste disposal.

8.1 Waste to Energy Technologies

Energy recovery in the form of electricity, heat and fuel from the waste using different technologies is possible through variety of processes, including incineration, gasification, pyrolysis and anaerobic digestion which are often termed as “Waste to Energy Technologies” and they are broadly grouped as:

- Bio-Chemical Waste to Energy Technologies
- Thermo-Chemical Waste to Energy Technologies

8.1.1 Bio-Chemical Waste to Energy Technologies

**Biomethanation**

Biomethanation is anaerobic digestion of organic materials which is converted into biogas, a gaseous combustible mixture, of methane (CH4). Biomethanation is a biological treatment method that can be used to recover both nutrients and energy contained in biodegradable municipal waste. Biomethanation of organic wastes is accomplished by a series of biochemical transformations - which include in the first stage hydrolysis, acidification and liquefaction followed by a second stage where acetate, hydrogen and carbon dioxide are transformed into methane. The process generates biogas with high content of methane (55–70%) which can directly be used as fuel and by employing gas engines can also generate electricity.

8.1.2 Thermo-Chemical Waste to Energy Technologies

MSW thermal technologies are processes that create energy in the form of electricity, fuel or heat from thermo-chemical processes such as, gasification, pyrolysis incineration or mass burning of municipal solid wastes. MSW after limited or full preprocessing is used in most of these thermal technologies. Thermal facilities are also referred to as waste to energy or transformation facilities. Incineration, which is a well-established process, has limited efficiency from the thermodynamics point of view. Incineration efficiency could improve up to some extent if it is preceded by conversion of combustible fraction of MSW to so-called “RDF” (refuse derived fuel) since the Indian wastes in raw form are not suitable for incineration.

**Pyrolysis**

Pyrolysis uses heat to break down combustible polymeric materials in the absence of oxygen, producing a mixture of combustible gases (primarily methane, complex hydrocarbons, hydrogen, and carbon monoxide), liquids and solid residues. The products of pyrolysis process are: (i) a gas mixture; (ii) a liquid (bio-oil/tar); (iii) a solid residue (carbon black). Relatively low temperatures (400-9000C, but usually about 6500C) are
employed compared to gasification. The proportion and composition of the various fractions depends on a variety of parameters. Two technologies exist and differ on the method of heat transfer: fast pyrolysis for production of bio-oil and slow pyrolysis for production of charcoal called carbon black. The caloric values of pyrolysis gas typically lie between 5 and 15 MJ/Nm³ based on composition of MSW and between 15 and 30 MJ/Nm³ on RDF.

Gasification
Gasification is the main technology for biomass conversion to energy and an attractive alternative for the thermal treatment of solid waste. Gasification produces combustible gas such as hydrogen, synthetic fuels and is a process that converts dry organic or fossil based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide at elevated temperature (500-1800°C). The syngas can be used as a feedstock for the chemical industry (through some reforming processes, or as a fuel for efficient production of electricity and/or heat. The number of different uses of gas shows the flexibility of gasification and therefore allows it to be integrated with several industrial processes, as well as power generation systems. Air gasification produces a low-energy gas (4-7 MJ Nm⁻³ net calorific value), while oxygen gasification produces a medium-energy gas (10-18 MJ Nm⁻³ NCV). The purpose of gasification of waste is to generate power more efficiently at lower power level (< 2MW) and also to minimize emissions.

Incineration and Mass Burning
Incineration technology is complete combustion of waste with the recovery of heat to produce steam that in turn produces power through steam turbines. There are a number of combustor designs used to burn combustible fraction of MSW. Complete combustion optimally involves a two-stage transformation of fuel, in this case solid waste, into CO₂ and water vapor.

The secondary phase of incineration (combustion) takes place as the combustible materials (e.g., paper, plastics, and organic materials containing carbon, hydrogen and oxygen) combine with oxygen to form carbon dioxide and water vapor (oxidizes). But in incinerators, since the waste stream is so heterogeneous, other compounds are also formed and buoyed upward off the grate by the heat of combustion. There are unburned carbon particles, incompletely burned carbon-based compounds (e.g. organic products of incomplete combustion (PICs) such as carbon monoxide, PAH's, and the more toxic dioxins and furans often referred to as "products of incomplete combustion, or PICs), and incombustible elements such as heavy metals, Sulphur, nitrogen, and chlorine, which combine with oxygen and hydrogen in the furnace to form compounds such as HCl, SO₂ and oxidized metals.

Figure 8.1: Block diagram of Incineration Process
In most mass burn plants the grate system moves the solid waste through the drying, burning, and burnout zones, while promoting combustion. This is done by ensuring that adequate (but not excessive) quantities of air enter from below via holes in the grates. The efficiency of the combustion process, and therefore incineration, is characterized by the "three T's": temperature, time and turbulence. To achieve the temperature requirement, an adequately high and uniform temperature profile must be maintained throughout the furnace volume at all times in order to destroy PICs reliably. In order to optimize combustion of these gases, it is generally considered that the temperature profile (or the secondary chamber) should not fall outside the range of about 1800-2000o F. This means that the temperature should be uniform with no cool spots or short cuts for the gases to exit. Considering the heterogeneous nature of municipal solid waste, with some components highly combustible and others not, strict maintenance of at least a minimum temperature throughout the furnace is necessary. RDF and pre-processed MSW are used as fuel in the specially designed boilers and for generation of electricity through steam turbines. RDF being low density fuel generates more fly ash during combustion. Fly ash acts as catalyst for de-novo synthesis (at 200-450 degrees) for production 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 to the range of 200-450 degrees. This requires multiple passes in radiative section of boiler and results in much bigger boiler for W to E plants. The flue gases produced in the boilers have to be treated by an elaborate air pollution control system. The resultant ash from incineration of solid waste can be used as construction material after necessary processing while the residue can be safely disposed of in a landfill.

**Using RDF as a fuel** in incinerators is a better option because it is typically formed by augmenting calorific value of combustible wastes with the help of some high calorie-rich industrial wastes or biomass and through application of pressure and/or heat and with the help from binders physical shapes of pellets or briquette are extruded. It is a possible solution for making W to E a success in India because RDF is easy to transport, has adequate shelf life and it can be prepared in small and medium scale decentralized facilities and conveniently transported to a regional W to E facility in a radius of 100 km catchment zone.

Recyclable materials such as paper, plastics, woods, cloth etc. and also the fiber in the green waste are the sources of energy in MSW. The major technology options for energy recovery include combustion, anaerobic digestion, landfill gas, fuel pellets, etc. However, the combustion process is considered to be the most suitable due to the following advantages:

- Volume and weight is reduced drastically (approx. 90% volume and 75% weight reduction)
- Waste reduction is immediate, no long term residency required
- Destruction of waste happens in seconds whereas landfills requires hundreds of years
- Ash residue is non-putrescible, sterile and inert
- Area requirement is comparatively less

**8.2 Proposed Arrangement of Clusters**

As discussed in Chapter 3(Clusterisation of ULBs), six clusters have been finalized incorporating 19 ULBs and rest 4 ULBs will be developed as individual processing and disposal facilities for management of MSW. All the clusters have one lead ULB and other participating ULBs. The lead ULB having maximum share of waste in a particular cluster, will be developed as the regional cluster facility for the regional management of MSW of the self and participating ULBs. The entire MSW of Participating ULBs will be transported to the regional cluster facility located at the lead ULB for the processing and scientific disposal.
### Table 8.1: Proposed Arrangement of Clusters

<table>
<thead>
<tr>
<th>Name of the Cluster</th>
<th>Towns Covered under this Cluster</th>
<th>Population (Census 2011)</th>
<th>Proposed area for Installing Processing Unit</th>
<th>Distance of the Proposed locality from each town (In Kms)</th>
<th>Quantity of MSW (In TPD)</th>
<th>Total Waste Quantity of the Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster I</td>
<td>Punganur</td>
<td>54746</td>
<td>Madanpalle</td>
<td>27</td>
<td>23</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>Madanpalle</td>
<td>136629</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cluster II</td>
<td>Chittoor</td>
<td>189332</td>
<td>Chittoor</td>
<td>0</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Palamaneru</td>
<td>51163</td>
<td></td>
<td>41</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Cluster III</td>
<td>Srikalahasti</td>
<td>80056</td>
<td>Tirupati</td>
<td>37</td>
<td>40</td>
<td>281</td>
</tr>
<tr>
<td></td>
<td>Tirupati</td>
<td>296156</td>
<td></td>
<td>0</td>
<td>195</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Puttur</td>
<td>54141</td>
<td></td>
<td>34</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nagari</td>
<td>62225</td>
<td></td>
<td>48</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Cluster IV</td>
<td>Venkatgiri</td>
<td>51494</td>
<td>Naidupet</td>
<td>40</td>
<td>20</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Sullurpet</td>
<td>45836</td>
<td></td>
<td>31</td>
<td>16</td>
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</tr>
<tr>
<td></td>
<td>Naidupet</td>
<td>45055</td>
<td></td>
<td>0</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Cluster V</td>
<td>Nellore</td>
<td>600869</td>
<td>Nellore(North)</td>
<td>0</td>
<td>251</td>
<td>331</td>
</tr>
<tr>
<td></td>
<td>Atmakur</td>
<td>30556</td>
<td></td>
<td>47</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gudur</td>
<td>73617</td>
<td></td>
<td>43</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kavali</td>
<td>104000</td>
<td></td>
<td>40</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>Cluster VI</td>
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<td>252739</td>
<td>Ongole</td>
<td>0</td>
<td>114</td>
<td>164</td>
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<tr>
<td></td>
<td>Chimakurthy</td>
<td>30332</td>
<td></td>
<td>23</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Addanki</td>
<td>40353</td>
<td></td>
<td>37.5</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kandukur</td>
<td>57246</td>
<td></td>
<td>43</td>
<td>21</td>
<td></td>
</tr>
</tbody>
</table>

Figure 8.2: Cluster Map of Zone-IV
The regional waste management facility will have pre-sorting units, compost plant, RDF Plant (With bailer except the Nellore Cluster). The RDF prepared after the processing of dry waste in all the clusters will be transported to the Nellore Cluster (Cluster-V) to be used as feed-stock for the Waste to Energy Plant (Based on RDF)

8.3 Assessment of Energy Recovery Potential

A rough assessment of the potential of recovery of energy from MSW through different treatment methods can be made from knowledge of its calorific value and organic fraction.

In thermo-chemical conversion all of the organic matter, biodegradable as well as non-biodegradable, contributes to the energy output. However, our design is based on RDF only.

Total waste quantity: 311.5 TPD

Net Calorific Value: NCV k-cal/kg

GCV = 3000 Kcal/Kg (approximate)

NCV = GCV - 5.84*(9*M_h + M_m)

= 3000 – 5.84 * (9*6.3 + 12.34) = 2597 Kcal/kg

Energy recovery potential (kWh) = NCV x W x 1000/860 = 1.16 x NCV x W

Power generation potential (kW) = 1.16 x NCV x W/ 24 = 0.048 x NCV x W

Conversion Efficiency = 25%

Net power generation potential (kW) = 0.012 x NCV x W = 0.012 * 2597 * 311.5 = 9707.59 kW = 10 MW

8.4 Site Selection for Waste to Energy Plant

Nellore has been identified as the location for setting up the waste to energy plant due to the following reasons:

- The city generates the maximum quantum of the waste out of all the 23 ULBs
- The geographical location of the city is such that it is accessible from all the towns lying in the Zone-IV

Further, the site selection for installing the “Waste to Energy” Plant at Nellore is done on the following parameters:

- Availability of Fuel
- Availability of adequate water resource at the site
- Availability of Un-habituated, Un-cultivated non-forest
- Availability of Infrastructural facilities like road for transportation

---

1 For total quantity of RDF, refer 9.4.1 (Availability of fuel: RDF)
2 Ultimate analysis of RDF is enclosed as annexure
Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC)

Draft Detailed Project Report (DPR) for MSWM

- Proximity to near-by substations for power evacuation
- Adequate area for handling disposal of ash
- Suitability of soil characteristics for construction

The Allipuram Site has been identified based on the above parameters.

Figure 8.3: Proposed Waste to Energy Site at Allipuram

8.4.1 Availability of fuel: RDF

The Proposed “Waste to Energy Plant” will be RDF based. The RDF obtained from processing of dry waste in all the Clusters will be used as the feed-stock for the proposed Waste to Energy Plant. Hence, the design capacity of the plant will also depend on the input (RDF feedstock) from all the clusters.

Table 8.2: Quantity of RDF in all the 6 Clusters (2015)

<table>
<thead>
<tr>
<th>Name of the Cluster</th>
<th>Towns Covered under this Cluster</th>
<th>Quantity of MSW (In TPD)</th>
<th>Total Waste Quantity of the Cluster (In TPD)</th>
<th>Combustible Material (in percentage)</th>
<th>Total RDF (In TPD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster I</td>
<td>Punganur</td>
<td>23</td>
<td>79</td>
<td>29%</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>Madanpalle</td>
<td>56</td>
<td></td>
<td>29%</td>
<td>17.3</td>
</tr>
<tr>
<td>Cluster II</td>
<td>Chittoor</td>
<td>80</td>
<td>100</td>
<td>30%</td>
<td>27.2</td>
</tr>
<tr>
<td></td>
<td>Palamaneru</td>
<td>20</td>
<td></td>
<td>24%</td>
<td>5.1</td>
</tr>
<tr>
<td>Cluster III</td>
<td>Srikalahasti</td>
<td>40</td>
<td>281</td>
<td>28%</td>
<td>10.4</td>
</tr>
<tr>
<td></td>
<td>Tirupati</td>
<td>195</td>
<td></td>
<td>30%</td>
<td>62.8</td>
</tr>
<tr>
<td></td>
<td>Puttur</td>
<td>21</td>
<td></td>
<td>28%</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>Nagari</td>
<td>25</td>
<td></td>
<td>29%</td>
<td>8.1</td>
</tr>
<tr>
<td>Cluster IV</td>
<td>Venkatgiri</td>
<td>20</td>
<td>53</td>
<td>26%</td>
<td>5.4</td>
</tr>
</tbody>
</table>
### Name of the Cluster | Towns Covered under this Cluster | Quantity of MSW (In TPD) | Total Waste Quantity of the Cluster (In TPD) | Combustible Material (In percentage) | Total RDF (In TPD)
--- | --- | --- | --- | --- | ---
Sullurpet | 16 | | | 28% | 5.1
Naidupet | 17 | | | 27% | 4.8
Nellore | 251 | 331 | | 30% | 80.3
Atmakur | 13 | | | 26% | 3.6
Gudur | 26 | | | 24% | 6.6
Kavali | 41 | | | 28% | 12.3
Ongole | 114 | 164 | | 29% | 34.8
Chimakurthy | 13 | | | 27% | 3.7
Addanki | 16 | | | 26% | 4.7
Kandukur | 21 | | | 27% | 6.0
Total Refuse Derived Fuel (RDF) | | | | | 311.5

The percentage of combustible material is calculated based on the characterization of waste (Refer Chapter-5: Existing System of MSWM)

As per the quantification and characterization of MSW done by IPE Global, the quantity of RDF from each town as well as cluster has been estimated. The total quantity of RDF to be obtained from all the clusters are 311.5 TPD as per survey conducted in 2015.

Thus, the design input for the Plant is taken as 311.5 TPD for the year 2017.

The transportation of RDF from each cluster will be critical for the functioning of plant at the required efficiency levels. Therefore, distance of transportation will be a major cost for ULBs during the functioning of plant.

#### Table 8.3: Distance and Cost of transportation for RDF to Nellore Cluster

<table>
<thead>
<tr>
<th>Clusters</th>
<th>Regional Cluster Facility</th>
<th>Distance from Nellore Cluster (km)</th>
<th>RDF Quantity (In TPD)</th>
<th>No. of trips</th>
<th>Total Distance to be travelled (km/day)</th>
<th>Annual Cost of Transportation (In lakhs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster I</td>
<td>Madanpalle</td>
<td>252</td>
<td>24</td>
<td>1</td>
<td>504.6</td>
<td>21.78</td>
</tr>
<tr>
<td>Cluster II</td>
<td>Chittoor</td>
<td>205</td>
<td>32</td>
<td>2</td>
<td>818.8</td>
<td>35.42</td>
</tr>
<tr>
<td>Cluster III</td>
<td>Tirupati</td>
<td>135</td>
<td>88</td>
<td>4</td>
<td>1082.4</td>
<td>46.66</td>
</tr>
<tr>
<td>Cluster IV</td>
<td>Naidupet</td>
<td>70</td>
<td>15</td>
<td>1</td>
<td>140</td>
<td>6.05</td>
</tr>
<tr>
<td>Cluster V</td>
<td>Nellore</td>
<td>0</td>
<td>103</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cluster VI</td>
<td>Ongole</td>
<td>130</td>
<td>49</td>
<td>2</td>
<td>519.2</td>
<td>22.46</td>
</tr>
</tbody>
</table>

For utilizing combustible waste, centralized W to E project facilities should be sufficiently large to handle at least 300 TPD of combustible waste and private sector should be encouraged to invest in such projects on Design, Build, Finance, Operate and Transfer (DBFOT) basis.
The transportation of RDF to the proposed Allipuram Site from all the clusters will require 15 trips and total transportation of 3065 kms/day.\(^3\) The cost of transportation of Rs. 13.23 Crores would be borne by each municipality depending on their share of RDF.

### 8.4.2 Availability of Water Requirement

The raw water of approximate 1.5 MLD will be required for the functioning of plant. The water will be sourced from the nearby Sewage Treatment Plant (STP) of capacity 105 MLD proposed in phases at the same Site situated at Allipuram. The capacity of the plant is proposed to be 74 MLD in the base year 2017 which will be extended to 105 MLD by 2047.

### 8.4.3 Availability of Unhabituated Land

The Allipuram Land belongs to the municipal corporation of Nellore and far from the habituated areas. The total area of the Site is around 169 acres. However, the tentative land requirement for the waste to energy plant is approximately 10 acres and the separate provision of land has been already given for Sanitary Landfill (Refer Chapter 8: Processing of MSW)

<table>
<thead>
<tr>
<th>S. N.</th>
<th>Details</th>
<th>Land requirement (In Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Main Plant, Auxiliaries and Laydown areas</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Land for Green belt development</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Land for fuel Storage yard</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Land for Ash Disposal Landfill</td>
<td>10 acres</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 8.4.4 Availability of Infrastructure: Roads

The proposed site is located at Allipuram village. The geographical location of the proposed W2E Plant is approximately at 14° 27’ 43.01’’ N Latitude and 80° 01’ 20.82’’ E Longitude. The approach details are as below:

Nearest Road Access: Guntur – Chennai Highway (1 kms away)

Nearest Town: Nellore

The site is located approximate 500 m away from nearest habitation i.e. Allipuram village.

### 8.4.5 Availability of Substation

The nearest substation of 33/11 KVA is 1.6 kms away from the Allipuram Site at Madipadu Road, Navalak Garden Park. The availability of substation is critical for power transmission as the capital cost of laying transmission lines is huge. However, location of the same substation is shown in the Google Imaginary which is mentioned below.

---

\(^3\) The capacity of tipper truck is taken as 22 cum and density of waste as 0.9
8.4.6 Area for disposal of ash

The integrated waste management facility also includes sanitary landfill which is designed for a period of 25 years. The ash residue obtained from the waste to energy plant will be disposed in the same landfill.

The technical feasibility of waste to energy plant is briefly discussed in the chapter based on the identified parameters. The site may be suitable for the setting-up of the plant as it suffices the requirements of all the parameters. The economic feasibility of any facility is appraised on its O&M expenditure and the subsequent returns. In the current approach of Clusterisation, the expenditure for transporting RDF to Nellore cluster will be huge which is to be borne by each municipality in the proportion of their share of RDF. The annual expenditure on transporting RDF will be much higher than their usual expenses on SWM, especially for small municipalities. Therefore, it is critical to strike a balance between the economic feasibility of setting up a plant and operation expenditure of the same for small ULBs. Moreover, the agreement on such arrangement by the ULBs and coordination between them is a critical requirement for the functioning of plant.
9.0 Design of Sanitary Landfill Facility

Preliminary design & engineering has been done for the construction of Regional Integrated Municipal Solid Waste (MSW) Landfill facility on cluster approach for Nellore, Gudur, Kavali and Atmakur town. The regional facility for all four towns will be developed at Nellore city; the site is located at Allipuram village. This facility shall comprise of a secured landfill facility (SLF), office building, laboratory, security room, weighbridge, parking area, internal roads, workshop and other associated facilities. The construction of landfill shall be taken up into five phases. Each phase will serve for approximately 5 years. After filling of each phase, it will be covered with top cover and subsequently the landfill will be used. The integrated landfill facility shall require around 39 acres (157976 sq. m) of area to accommodate the landfillable waste for 25 years of Nellore, Gudur, Kavali and Atmakur town. The landfill can be further adjusted with the remaining available area for future use. In this chapter, a summary of the design considerations are discussed.

9.1 Site Selection

Selection of a landfill site usually comprises of the following steps: (i) setting up of a locational criteria (ii) identification of search area (iii) drawing up a list of potential sites (iv) data collection (v) selection of few best-ranked sites (vi) environmental impact assessment and (vii) final site selection & land acquisition.

9.1.1 Locational Criteria

Landfill sites shall meet following specifications as given in Schedule –III of the MSW (Management & Handling) Rules 2000:-

1. Selection of landfill sites shall be based on examination of environmental issues. The Department of Urban Development of the State or Swachh Andhra Pradesh (AP) Corporation shall coordinate with the concerned organizations for obtaining the necessary approvals and clearances.
2. The landfill site shall be planned and designed with proper documentation of a phased construction plan as well as a closure plan.
3. The landfill sites shall be selected to make use of waste generated in nearby towns.
4. 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.
5. The landfill site shall be large enough to last for 20-25 years.
6. 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.
7. A buffer zone of no-development shall be maintained around landfill site and shall be incorporated in the Town Planning Department’s land-use plans.
8. 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.

As per Manual on MSW Management, following locational criteria have to be followed:-

1. Lake or Pond: No landfill should be constructed within 200 m of any lake or pond. Because of concerns regarding runoff of waste water contact, a surface water monitoring program should be established if a landfill is sited less than 200m from a lake or pond.
2. River: No landfill should be constructed within 100 m of a navigable river or stream. The distance may be reduced in some instances for non-meandering rivers but a minimum of 30m should be maintained in all cases.
3. **Flood Plain**: No landfill should be constructed within a 100 year flood plain. A landfill may be built within the flood plain of secondary streams if an embankment is built along the stream side to avoid flooding of the area. However, landfills must not be built within the flood plains of major rivers unless properly designed protection embankments are constructed around the landfills.

4. **Highway**: No landfill should be constructed within 200 m of the right of way of any state or national highway. This restriction is mainly for aesthetic reasons. A landfill may be built within the restricted distance, but no closer than 50 m, if trees and berms are used to screen the landfill site.

5. **Habitation**: A landfill should be at least 500 m from a notified habituated area. A zone of 500 m around a landfill boundary should be declared a No-Development Buffer Zone after the landfill location is finalized.

6. **Public Park**: No Landfill may be constructed within the restricted distance if some kind of screening is used with a high fence around the landfill and a secured gate.

7. **Critical Habitat Area**: No landfill should be constructed within critical habitat areas. If there is any doubt then the regulatory agency should be contacted.

8. **Wetlands**: No Landfill should be constructed within wetlands. It is often difficult to define a wetlands area. Maps are available for some wetlands, but in many cases such maps are absent or incorrect. If there is any doubt, then the regulatory agency should be contacted.

9. **Ground water Table**: A landfill should not be constructed in areas where water table is less than 2 m below ground surface. Special design measures to be adopted, if this cannot be adhered to.

10. **Airports**: No landfill should be constructed within the limits prescribed by regulatory agencies (MOEF/CPCB/Aviation Authorities) from time to time.

11. **Water Supply Well**: No landfill should be constructed within 500 m of any water supply well. It is strongly suggested that this location restriction be abided by at least down gradient wells. Permission from the regulatory agency may be needed if a landfill is to be sited within the restricted area.

12. **Coastal Regulation Zone**: A landfill should not be located in potentially unstable zones such as landside prone areas, fault zone etc.

13. **Buffer Zone**: A landfill should have a buffer zone around it, up to a distance prescribed by regulatory agencies.

### 9.1.2 Locational of the Proposed ISWM Facility Including Sanitary Landfill

Location for the setting up of the proposed Integrated Solid Waste Management (ISWM) Facilities including sanitary landfill located at Allipuram Village is marked on the Google Earth imaginary mentioned below.
9.2 Conceptual Design

Some of the issues that have direct influence on the design are discussed. They are:

- Waste to be Handled
- Access Road
- Land Area
- Surface Drainage
- Operational Plan
- Layout of MSW landfill
- Completed Waste Fill Features
- Estimation of landfill Capacity
- Selection of Liner Systems
- Selection of Leachate Control Facilities
- Selection of landfill Gas Control Facilities
- Aesthetic Considerations
- Monitoring Facilities
- Determination of Equipment Requirements
- Design life
- Post Closure Care

These issues are elaborated in detail as under:

9.2.1 Waste to be handled

A detailed inventory survey indicated that, 267.20 MT/day MSW is generated in Nellore, 26.98 MT/day in Gudur, 43.3 MT/day in Kavali and 13.89 MT/day MSW is generated in Atmakur town in year 2017. This MSW does not included the silt and C&D waste generation as silt will be dumped in low lying areas and C&D may
be used as a soil cover for the landfill. For designing the landfill, year 2041 has been considered. The total land fillable waste quantity for a period of 25 years by future projection has been taken as 1035688 MT. For the designing of MSW landfill adopting a waste density of 0.85 MT/m$^3$. Therefore, total capacity of landfill is estimated = $1035688/0.85 = 1218456$ cum. A combined landfill has been designed for Nellore, Gudur, Kavali and Atmakur town (design year 2041).

A detail of the landfillable waste for all four town is given below in table 9.1.

**Table 9.1: Details of the Landfillable Waste of Nellore, Gudur, Kavali & Atmakur Town**

<table>
<thead>
<tr>
<th>Year</th>
<th>NELLORE</th>
<th>GUDUR</th>
<th>KAVALI</th>
<th>ATMAKUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>251.31</td>
<td>47</td>
<td>25.80</td>
<td>4</td>
</tr>
<tr>
<td>2016</td>
<td>259.11</td>
<td>48</td>
<td>26.39</td>
<td>4</td>
</tr>
<tr>
<td>2017</td>
<td>267.20</td>
<td>50</td>
<td>26.98</td>
<td>4</td>
</tr>
<tr>
<td>2018</td>
<td>275.60</td>
<td>52</td>
<td>27.59</td>
<td>4</td>
</tr>
<tr>
<td>2019</td>
<td>284.31</td>
<td>53</td>
<td>28.20</td>
<td>5</td>
</tr>
<tr>
<td>2020</td>
<td>293.34</td>
<td>55</td>
<td>28.82</td>
<td>5</td>
</tr>
<tr>
<td>2021</td>
<td>302.70</td>
<td>57</td>
<td>29.45</td>
<td>5</td>
</tr>
<tr>
<td>2022</td>
<td>312.41</td>
<td>58</td>
<td>30.09</td>
<td>5</td>
</tr>
<tr>
<td>2023</td>
<td>322.45</td>
<td>60</td>
<td>30.74</td>
<td>5</td>
</tr>
<tr>
<td>2024</td>
<td>332.86</td>
<td>62</td>
<td>31.40</td>
<td>5</td>
</tr>
<tr>
<td>2025</td>
<td>343.63</td>
<td>64</td>
<td>32.07</td>
<td>5</td>
</tr>
<tr>
<td>2026</td>
<td>354.78</td>
<td>66</td>
<td>32.74</td>
<td>5</td>
</tr>
<tr>
<td>2027</td>
<td>366.31</td>
<td>69</td>
<td>33.43</td>
<td>5</td>
</tr>
<tr>
<td>2028</td>
<td>378.24</td>
<td>71</td>
<td>34.12</td>
<td>5</td>
</tr>
<tr>
<td>2029</td>
<td>390.58</td>
<td>73</td>
<td>34.83</td>
<td>6</td>
</tr>
<tr>
<td>2030</td>
<td>403.34</td>
<td>75</td>
<td>35.55</td>
<td>6</td>
</tr>
<tr>
<td>2031</td>
<td>416.52</td>
<td>78</td>
<td>36.27</td>
<td>6</td>
</tr>
<tr>
<td>2032</td>
<td>430.14</td>
<td>80</td>
<td>37.01</td>
<td>6</td>
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<tr>
<td>2033</td>
<td>444.22</td>
<td>83</td>
<td>37.75</td>
<td>6</td>
</tr>
<tr>
<td>2034</td>
<td>458.75</td>
<td>86</td>
<td>38.51</td>
<td>6</td>
</tr>
</tbody>
</table>
### 9.2.2 Estimation of Landfill Capacity, Landfill Height, Landfill Area

#### Table: Total landfills generated in 25 years

<table>
<thead>
<tr>
<th>Year</th>
<th>Generation (MT/Day)</th>
<th>Compaction (%)</th>
<th>AOD (%)</th>
<th>Windrow (%)</th>
<th>RDF (%)</th>
<th>Street Sweeping (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2035</td>
<td>473.76</td>
<td>89</td>
<td>39.28</td>
<td>6</td>
<td>69.83</td>
<td>11</td>
<td>25.51</td>
</tr>
<tr>
<td>2036</td>
<td>489.26</td>
<td>91</td>
<td>40.06</td>
<td>6</td>
<td>71.68</td>
<td>11</td>
<td>26.38</td>
</tr>
<tr>
<td>2037</td>
<td>505.25</td>
<td>94</td>
<td>40.84</td>
<td>7</td>
<td>73.58</td>
<td>11</td>
<td>27.28</td>
</tr>
<tr>
<td>2038</td>
<td>521.76</td>
<td>98</td>
<td>41.64</td>
<td>7</td>
<td>75.53</td>
<td>12</td>
<td>28.21</td>
</tr>
<tr>
<td>2039</td>
<td>538.79</td>
<td>101</td>
<td>42.45</td>
<td>7</td>
<td>77.53</td>
<td>12</td>
<td>29.17</td>
</tr>
<tr>
<td>2040</td>
<td>556.35</td>
<td>104</td>
<td>43.27</td>
<td>7</td>
<td>79.57</td>
<td>12</td>
<td>30.17</td>
</tr>
<tr>
<td>2041</td>
<td>574.47</td>
<td>107</td>
<td>44.10</td>
<td>7</td>
<td>81.66</td>
<td>13</td>
<td>31.19</td>
</tr>
<tr>
<td>2042</td>
<td>593.15</td>
<td>111</td>
<td>44.94</td>
<td>7</td>
<td>83.81</td>
<td>13</td>
<td>32.25</td>
</tr>
<tr>
<td>2043</td>
<td>612.41</td>
<td>115</td>
<td>45.80</td>
<td>7</td>
<td>86.00</td>
<td>13</td>
<td>33.34</td>
</tr>
</tbody>
</table>

Total landfills generated in four towns in 25 years is estimated at 926188 MT/Day.

For details of the waste projections of Nellore, Atmakur, Kavali and Gudur, please refer annexure no. 5.1, 5.3, 5.5 and 5.7.

Sanitary Landfilling of non-biodegradable/non-recyclables/inert component of municipal solid waste is mandatory as per the MSW rules 2000. Therefore it is proposed to set up a Regional Integrated Sanitary Landfill facility for final disposal of inert waste/rejects from compost plants, RDF and street sweeping which cannot be further processed for any use.

In order to design the sanitary landfill facility, the base year for garbage generation has been taken as 2017 and design year has been considered as 2042 A.D.

- **Base Year**: 2017 AD
- **Design Year**: 2042 AD
- **Design of Landfill**: 2042 AD
- **Total Operative Life of the Landfill**: 25 Years (Considering that from 2017, waste will start coming to the Landfill Site)

---

**Fig 9.2: Sanitary landfill**
**Method of Calculation**

1. Current Waste Generation per Year :- $W$ (ton per Year)
2. Estimated rate of increase (or decrease) of waste generation per year :- $X$ (percent)
   (Use rate of population growth where waste generation growth rate estimates are not available)
3. Proposed Life of Landfill (in years) :- $n$ (years)
4. Waste Generation after $n$ years :- $W \left(1 + \frac{X}{100}\right)^n$ (tons per year)
5. Total waste generation in $n$ years (T) in tons
   $$T = \frac{1}{2} \left[ W + W \left(1 + \frac{X}{100}\right)^n \right] n$$
6. Total volume of waste in $n$ years ($V_w$) (on the assumption of 0.85 t/Cum density of waste)
   $$V_w = \frac{T}{0.85}$$
7. Total Volume of daily cover in $n$ years ($V_{dc}$) (on the basis of 15 cm soil cover on top and sides for lift height of 1.5 m to 2 m)
   $$V_{dc} = 0.1 V_w$$
8. Total Volume required for components of liner system and of cover system (on the assumption of 1.5 m thick liner system (including leachate collection layer) and 1.0 m thick cover system (including gas collection layer)
   $$V_c = k V_w$$
   ($k = 0.25$ for 10 m high landfill, $0.125$ for 20 m high landfill and $0.08$ for 30 m high landfill. This is valid for landfills where width of landfill is significantly larger than height)
9. Volume likely to become available within 10 years due to settlement / biodegradation of waste
   $$V_s = m V_w$$
   ($m = 0.10$ for bio-degradable waste; $m$ will be less than $0.05$ for incinerated / inert waste)
10. First estimate of landfill Capacity ($C_i$)
    $$C_i = V_w + V_d + V_c - V_s$$
11. Likely shape of landfill in plans and section (To be based on topography of area, depth to ground water table and other factors)
12. First Estimate of Landfill Height and Area
   
   (a) Restricted Area Available = $A_r$ (Sq. m)
   Area required for infrastructural facilities = $0.15 A_r$
   Area available for landfilling = $0.85 A_r$
Average landfill height required (first estimate) above base level

\[ H_i = \frac{C_i}{0.9} \text{ (Sq. m)} \] (Valid for area type landfill)

(b) No limitation on Area
Possible maximum average landfill Height (first estimate)

\[ H_i \text{ (typically between 10 to 20 m, rarely above 30 m)} \]

Area required for landfilling separations

\[ A_i = C_i \text{ (Sq. m)} \] (valid for area type landfill)

Total area required (including infrastructural facilities) (first estimate)

\[ A_i = 1.15 A_i \]

**BASIC DATA**

As per the CPHEEO Manual, maximum 20% of total MSW generation will be allowed for landfilling. Therefore, we have considered the same for calculation:

| Waste Generation | :- 63 tons per day (in 2017) |
| Design Life      | :- 25 years |
| Water table      | :- 16 m below ground surface |

Note: The ground water table varies between 5-10 meter below existing ground level

**LANDFILL CAPACITY, LANDFILL HEIGHT, LANDFILL AREA**

(a) Landfill Waste Generation in 2017 A.D

70 TPD (Actual it is 36 but taken 70 TPD)

(b) Proposed Landfill Waste Generation in 2042 A.D

147 TPD (Actual it 136 but taken 147 TPD)

(c) Total Landfill Waste Generation in 25 Years

\[ = 0.5 (70 + 147) \times 365 \times 25 \]

\[ = 990063 \text{ ton} \]

(d) Total Waste Volume (assumed density 0.85 t / cum for inert waste as per CPHEEO manual)

\[ = 990063 \div 0.85 \]

\[ = 1164779 \text{ cum} \]

(e) Volume of Daily Cover

\[ = 0.1 \times 1164779 = 116478 \text{ cum} \]

(f) Volume of Liner and Cover System

\[ = 0.25 \times 1164779 = 291195 \text{ cum} \]

(g) Volume of settlement

\[ = 0.05 \times 1164779 = 58239 \text{ cum} \]

(h) First Estimate of landfill Volume

\[ C_i = (1164779+116478+291195-58239) \]

\[ = 1514213 \text{ cum} \]
(i) Likely Shape of Landfill
Rectangular in plan (length: width = 2:1)

(j) Area Restriction
:- Nil

(k) Possible Maximum Landfill Height
= 12 m

(l) Area Required
= \((1514213) / 12 = 126184\) sq. m

(m) Approximate Areas including area of embankment
= 157976 sq. m

**LANDFILL SECTION AND PLAN**
Landfill Section and Plan is evaluated on the basis of:
(i) 4:1 side slope for the above-ground portion of the landfill.
(ii) 2:1 side slope for the below-ground portion of the landfill.
(iii) Material balance for daily cover, liner and final cover material through excavation at site.
(iv) Extra space around the waste filling area for infrastructural facilities.

**LANDFILL PHASES**
(i) Active Life of the Landfill :- 25 Years
(ii) Duration of one phase :- 5 Years
(iii) Number of Phases :- 5 (each phase extends from base to final cover)
(iv) Volume of phase-I (2017-2022) :- 1514213/302842 Cum

**LINER AND LEACHATE COLLECTION SYSTEM**
Liner System for inert Waste
The liner system will comprise of the following layers below the waste:
(i) 0.3 m thick leachate drainage layer comprising of sand (coarse sand) or gravel (stone dust with no fines)
(ii) 0.2 m thick protective layer of silty soil
(iii) 1.50 mm thick HDPE geo-membrane
(iv) 0.9 m thick clay layer

Leachate Evaluation
The leachate collection layer is provided in the granular soil (drainage) layer of the bottom liner system. The collection layer shall comprise of a network of perforated HDPE lateral pipes laid at a slope of 2% and 20 m c/c spacing. These laterals collect leachate and transfer it to the HDPE header pipe, which is laid at a slope of 1%. The header pipe ultimately transfers the leachate into the Leachate collection sump. The general arrangement of header and laterals is provided in the layout plan of MSW landfill.

The landfill receives municipal solid waste only. All operations are planned in such a way that generation of liquid waste is minimum and the leachate directly reaches the leachate collection sump for treatment. Apart from the leachate generated as a result of inflow of rainwater into the landfill, the seepage from the moisture content present in the solid waste and the moisture present in the daily soil cover are the few sources of leachate generation. 10% evaporation has been considered.
Total Base Area of landfill = 132000 sq. m
Operational Area = 132000/25 = 5280 sq. m
Max. Daily rainfall = 168.5 mm (recorded in Nellore)

Table 9.2: Sizing of Leachate Pipe

<table>
<thead>
<tr>
<th>Leachate Pipe Sizing</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of landfill for first phase i.e. for 5 years</td>
<td>5280</td>
<td>m²</td>
</tr>
<tr>
<td>Intensity of rainfall</td>
<td>168.5</td>
<td>mm/day</td>
</tr>
<tr>
<td>Velocity in pipes</td>
<td>1</td>
<td>m/sec</td>
</tr>
<tr>
<td>Leachate generation per hour</td>
<td>37.07</td>
<td>m³/hr</td>
</tr>
<tr>
<td>Evaporation</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Leachate to be managed</td>
<td>33.36</td>
<td>m³/hr</td>
</tr>
</tbody>
</table>

**Leachate Collection System**

**Header Sizing**
- Header is running 0.5 full (value in decimal)
- Diameter of header 0.154 m
- 150 mm
- Provide Header Pipe (PN6, HDPE, 15mm thk.) 200 mm (min)
- Quantity of Header Pipe 652 m

**Lateral Sizing**
- Lateral is running 0.15 full (value in decimal)
- Number of laterals 16 Nos
- Diameter of lateral 0.038 m
- 110 mm
- Provide Lateral Pipe (PN6, HDPE, 5mm thk.) 110 mm (min)
- Quantity of Lateral pipe 6400 m

**Leachate Tank**
- Leachate Generation 33.36 m³/day
- Leachate collection for 3 days 100.09 m³/day
- Dimensions 6m x 5m x 3m

**COVER SYSTEM DESIGN**

**Cover System**
The cover system will comprise of the following layer above the waste.

(i) 0.45 m thick gas collection layer comprising of gravel size 25 mm – 50 mm
(ii) 0.6 m thick barrier layer (sandy silt + 5% bentonite)
(iii) 0.3 m thick surface layer of local top soil for vegetative growth

**Passive Gas Vents**
Passive gas vents 1 m high (above ground surface) will be provided at a spacing of 75m x 75m.

**9.3 Monitoring Facilities**
The soil, air and water in the area shall be continuously monitored for no contamination. Both sampling methods and non-sampling methods are adopted and monitored as per the monitoring plan for timely action to be taken before water contamination and leakage of gases into the soil. The facility is provided
with a minimum four monitoring wells for soil water and gas measurements. The details of the monitoring plan are given in Table 10.1, wherein instruments/monitoring areas proposed are listed.

Table 9.3: Monitoring Plan

<table>
<thead>
<tr>
<th>Monitoring Method</th>
<th>Type of Monitoring</th>
<th>Equipment Used</th>
<th>Information/data to be recorded</th>
</tr>
</thead>
</table>
| **Sampling Monitoring Method**  
(Methods involving collection of samples for laboratory analysis) | Air Monitoring  
(Collection of Air samples) | Gas Syringes  
Air Bags | Air quality/analysis of gas |
| Ground Water Monitoring  
(Collection of ground Water) | Monitoring wells  
(Background wells) – both single depth and multiple depth | | Water quality |
| (Collection of Ground Water) | Piezometers | | Water quality |
| (Collection of Leachate samples) | In landfill piezometers | | Leachate quality |
| Vadose Zone Monitoring | Collection Lysimeters, Soil gas probes & Suction Cup Lysimeters | | Analysis of Leachate between, VOC in soil, Gas monitoring, liquid monitoring in Vadose zone |
| **Non-sampling Monitoring Method**  
(Methods involving Physical and Electrical measurements) | Ground water Conductivity | Conductivity cells | Monitor changes in Groundwater Conductivity |
| Leachate Monitoring | Inland fill Piezometers | | Measure depth of Leachate in landfill |
| Temperature | Temperature probes | | Measure temperature in landfill |
| Vadose zone | Electric probes | | Salinity of vadose zone |
| | Electric Resistance Block | | Changes in the water content |
| | Gamma ray attenuation probes | | For monitoring of moisture content |
| | Neutron Moisture meter | | Moisture content in the soil |
| | Tensiometer | | Used to measure negative pressure that exists in soil/landfill |
| | TDR meter & Thermocouple psychomotor | | For recording Thermo Dielectric Properties of water and soil – any change in temperature and |
The monitoring requires lab testing and acquisition of all the instruments for such small quantity of waste will be un-economical. Therefore some tests could be conducted by common lab, whereas major tests like water quality monitoring viz-a-viz for metals used to be conducted through authorized laboratory. Apart from the above, regular inspection and monitoring of important components of the landfill shall be done as per the schedule given below:

**Final Top Cover:** Once in a year and after each substantial rainfall it should be checked for any erosion, landslides, movement of soil, slope, etc.

**Vegetation:** Four times in a year a check should be made for existence of dead plants/trees. Any plant/tree found dead shall be removed immediately.

**Final Grade:** Twice a year should be checked for ponding/logging of water. If any abnormalities found, slope should be corrected by putting soil.

**Surface drains:** Four times a year and after each substantial rain should be checked for any blockages. Leaves, debris or any other accumulation found in the drain shall be removed immediately.

**Gas Monitoring:** As required in the Management Plan it should be checked for strong presence of odor. The gas monitoring equipment’s (compressor, pipes, flaring stand, etc) should be checked to ensure their workability as they might become inoperable due to high gas generation.

**Groundwater Monitoring:** As per the Action Plan. A regular inspection shall be done to check for any failures in the monitoring system.

**Leachate Management:** As required by the plan.

### 9.4 Determination of Equipment Requirements

The landfill facility shall have minimum operating equipment for the construction stages and no earth moving machinery is planned as the work shall be done by engaging suitable contracting agency. For the operations of daily cover the following nominal equipment shall be provided:

- **Front-end loader/ICB**
- **Diesel Generator**
- **Vibro-Compactor**
- **Safety Equipment’s**
- **Fire Fighting Equipment**

- 1 No
- 1 No
- 1 No
- 1 Lot
- 1 Lot

### 9.5 Design Life

The landfill design life relates to active period, closure period and post closure period. The active period is the period in which actual filling takes place. In this case, this will be **25 years**. The closure and post-closure period for which a landfill will be monitored and maintained shall be 25 years after the active period.

### 9.6 Construction and Operational Practice of Sanitary Landfill

The Construction and Operation of a landfill consists of the following steps:

1. **Site Development**
2. Phase Development
3. Phase Operation
4. Phase Closure
5. Landfill Closure

**Site Development**

The following construction activities are undertaken during site development:

1. Construction of perimeter fence and entrance gate
2. Construction of main access road near the entrance gate with parking area
3. Construction of main access road along the perimeter of the site and well as construction of arterial load to tipping area of the first phase.
4. Acquisition and installation of weighbridges
5. Construction of weighbridge room / office, administrative office and site vehicle cleaning area
6. Installation of direction signs, site lighting, firefighting facilities, communication facilities
7. Construction of water supply and waste water / sewage disposal system
8. Construction of main leachate pipe, tank and treatment facility
9. Installation of environmental monitoring facilities
10. Construction of gas collection pipe and treatment facility

**Site Procedures**

It is important to formalize and document the record keeping procedures as well as waste acceptance procedures to be followed at the landfill site.

**Record Keeping**

Records will be kept on a daily, weekly and monthly basis. In addition a site manual will be kept at the site office giving all site investigation, design and construction details – these are necessary as landfill design may get modified during the operational phase.

**Site Manual:** The site manual will contain the following information:

a. Data collected during site selection
b. Environmental impact assessment report
c. Site investigation and characterization data
d. Detailed topographical map
e. Design of all landfill components
f. Landfill layout and its phases
g. Construction plans
h. Details of Leachate Management Plan
i. Details of Gas Management Plan
j. Environmental Monitoring Programme
k. Closure and Post – Closure Plan
l. All permissions / Licenses from concerned authorities.

**Site Report:** The daily, weekly and monthly reports will comprise of the following:

a. Weighbridge data (daily inflow and outflow for each vehicle)
b. Waste inspection data (daily)
c. Materials, stores etc. (daily)
Waste Inspection Procedure
Each vehicle carrying the waste must be checked for:

- Incoming weight (full)
- Outgoing weight (empty)
- Availability of relevant documents
- Visual check at weigh – in (if feasible)
- Visual inspection after discharge at tipping area (inspection report to be filed for each vehicle). A visual inspection checklist must be framed which should list visual features for identification of unacceptable material. This checklist must be filled for every unloading by a vehicle in tipping area at the working phase in the landfill.

If there is reason to doubt the presence of unacceptable waste, the vehicle will be taken to the waste inspection facility, the waste down – loaded, inspected visually and sampled (if necessary). Vehicles having non-conforming waste will be held up and matter reported to engineer or manager of the site.

Phase Development
Development of each phase is done in stages. These stages are:

- Clearing the area of all shrubs and vegetation,
- Excavation (if required)
- Stockpiling of excavated material and material imported from borrow area,
- Levelling of base and side slopes of landfill and achieving desirable grades at the base of the landfill,
- Construction of embankment and temporary berms along the perimeter of the phase,
- Construction of temporary surface water drains,
- Installation of monitoring instruments,
- Liner construction
- Leachate collection and removal system.

Phase Operation
At the design stage the phases of a landfill are clearly demarcated. Operation of a phase requires planning and execution of daily activities – daily waste filling plan and demarcation, waste discharge and inspection, waste placement, waste compaction, daily covering of waste, prevention of pollution and fires.

On the completion of a phase and before the start of a new phase, a waste filling plan for daily cells must be evolved. A study of the landfill base contour maps and the final cover levels of the phase allows such a plan to be developed. If a phase is to be operational for 365 days, all 365 cells must be marked in plan and in
sectional drawings. These may require revision as a landfill is constructed because waste quantities may vary in an unforeseen manner. The area and height proposed to be filled every day should be demarcated at the site on a daily or weekly basis using temporary markers or bunds.

**Waste Discharge and Inspection**

Waste must be discharged by tipping at the working area of a landfill, within the area demarcated for the cell. Every discharged load should be visually inspected by a designated operator. Working area personnel should be trained and competent at waste identification in order that they can recognize waste which may be non-conforming. In the event of reasonable doubt as to the waste acceptability, the operator should inform the waste reception facility and / or the site manager immediately and the consignment should be isolated pending further inspection.

Once waste has been discharged it must be spread in layers and compacted in a well-defined manner to ensure that the completed slopes of a daily cell are at the designed gradients. Waste placement (spreading) can be done by the following methods:

a. Face tipping Method: Waste is deposited on top of existing surface and spread horizontally by tipping over an advancing face.

b. Inclined layering method (onion skin tipping): Similar to (a) but inclined layering (gentle slope) done instead of advancing of face.

c. Working upwards: Waste is deposited on the lower surface and pushed upwards.

**Waste Compaction**

It has become conventional practice to level and compact the waste as soon as it is discharged at the working area. Steel wheeled mobile landfill compactors (cleated / spiked / special wheels) are generally accepted as the best equipment for this purpose. They have largely replaced the small crawler-tracked machines which previously were in general use. These steel wheel compactors have been developed specifically for landfill operations with different patterns of cleated wheels designed to break up and compact waste. For small sites receiving low volumes of waste, a compactor alone may be adequate to spread and compact the waste as well as handle and place cover material. However, a compactor is not designed to be a multi-purpose machine and at busy sites it is more usual to provide a tracked dozer or wheeled bucket loader for spreading followed by a compactor for densification. Compactors help to (a) chop and homogenize the waste; (b) reduce the void fraction of the waste; (c) produce an even and stable surface; and (d) pin down waste to minimize litter and make the site less attractive to birds and vermin.

Landfill compactors are not manufactured in India. However, they are available overseas in a wide range of sizes and operating weights (typically ranging from 12 tons to 30 tons). Apart from size, the differences between machines are the cleat patterns on the wheels and the wheel configuration. The wheel configuration is relevant when determining the number of passes required achieving the desired amount of compaction.

**Daily Cover**

The advantages of using daily cover are primarily in preventing windblown litter and odours, deterrence to scavengers, birds and vermin and in improving the site’s visual appearance. It is also advocated as a means of shedding surface water during the filling sequence, thereby assisting in leachate management by reducing infiltration, although its effectiveness in this respect is doubtful.
It is important that site location and waste inputs are taken into account when considering the type and application of daily cover. Soils used as daily cover will give a pleasing uniform appearance from the site boundary. To achieve this, a thickness of about 150 mm is usually adequate and should be adopted. About 300 mm needs to be used to avoid paper, etc being seen from close proximity. This is excessive for other purposes and the visibility of waste through daily cover should not be regarded as the sole criterion of effectiveness.

At sites where daily covered is spread by machines such as dozers etc., a thickness less than 150 mm will not be feasible, keeping in view the uneven surface of the waste. At sites where daily cover is spread manually, a thickness of 100 mm can be attempted if soil is used; this thickness should not be less than 150 mm if construction debris is used.

Cover material takes up valuable void space for primary wastes and if a 150 mm deep layer is placed over every 2 m layer of waste, about 7.5% of the void space is lost. The covering of faces and flanks will cause even more loss of void space and most operators estimate that the total loss of void space is between 10% and 20%.

If compacted, daily cover can have a relatively low permeability which results in the partial containment of each layer of waste as a result, leachate becomes perched and difficult to extract. Landfill gas then moves preferentially sideways giving greater potential for migration off-site and both gas and leachate become difficult to extract. Hence daily cover way not be compacted by rollers.

Traditionally soil material has been used for daily cover. Whenever possible daily cover is obtained by planned excavation from within the landfill area and thereby causes no net consumption of space. This will optimize the commercial value of the waste accepted. Where a site is deficient in appropriate resources, daily cover may come through the gate from construction activities. Construction waste is now also used to form screening bunds and for landscaping at the construction site.

Results so far have failed to identify any single material which can be used as a simple substitute for soil materials and all of them have given rise to secondary problems.

**Pollution Prevention during Operation**

Measures are needed to ensure that the landfill operation does not adversely affect local environment within and outside the landfill. Operators may appoint community liaison officers to be available to visit complainants and establish the nature and source of the problem. This is reported to the site manager so that corrective measures can be taken.

**Traffic:** Heavy lorry traffic can give rise to nuisance, damage to road surface and verges and routing problems. The following guidelines are helpful:

- Routing to avoid residential areas
- Using one-way routes to avoid traffic conflict in narrow roads
- Carrying out road improvements, for example, strengthening or widening of roads, improved provision of footpaths, improvement of sight lines, provision of passing places, provision of new roads.
- Limiting the number of vehicle movements
- Restrictions on traffic movement hours which are staggered with respect to peak traffic hours.
Noise: Adverse impacts on the local community from noise may arise from a number of sources including – throughput of vehicles and fixed and mobile plant, for example compactors, generators at the site. Peripheral noise abatement site measures should be adopted.

Odour: Offensive odours at landfill sites may emanate from a number of sources, including waste materials, which have decomposed significantly prior to landfilling, leachates and leachate treatment system, and landfill gas.

Good landfill practices will greatly reduce general site smell and reduce impact from odours which could lead to complaints from the local community, site users and site staff. Good practice includes: (a) adequate compaction; (b) speedy disposal and burial of malodorous wastes; (c) effective use of appropriate types of daily cover; (d) progressive capping and restoration; (e) effective landfill gas management; (f) effective leachate management and (g) consideration of prevailing wind direction when planning leachate treatment plants, gas flares, and direction of tipping.

Litter: Poor litter control both on and off site is particularly offensive to neighbors. Good operational practice should be adhered to in terms of waste discharge, placement, compaction and covering to minimize the occurrence of windblown litter. Measures for controlling litter include:

(a) Consideration of prevailing wind direction and strength when planning the filling direction and sequence.
(b) Strategically placed mobile screen close to the tipping area or on the nearest downwind crest.
(c) Temporary banks and bunds immediately adjacent to the tipping area.
(d) Permanent catch fences and netting to trap windblown litter.
(e) Restricting incoming vehicles to only those which are sheeted and secured will reduce litter problems on the highways.

Litter pickers should be employed to collect litter which escapes the preventative measures. Litter screens, fences, nets and perimeter ditches should be maintained free of litter.

Bird Control: Birds are attracted to landfill sites in large numbers, particularly where sites receive appreciable amounts of food wastes. Usually only large birds such as eagles, gulls are regarded as a nuisance. Bird control techniques should be carefully planned taking into account the species likely to be affected. Measures which can be used to mitigate bird nuisance include the employment of good landfill practice, working in small active areas and progressive prompt covering of waste, together with the use of bird scaring techniques. Measures involving explosions or distress calls have inherently adverse environmental impacts in terms of noise.

Vermin and Other Pests: Landfills have potential to harbor flies and vermin, particularly where the waste contains food materials. Modern landflling techniques including prompt emplacement, consolidation and covering of wastes in well-defined cells are effective in the prevention of infestation by rodents and insects. Rats and flies are the main pests which require control. Sites with extensive nonoperational land can become infested with rabbits.

Effective measures to deal with rodent infestation include regular visits by pest control contractors or fully trained operatives. The use of insecticides on exposed faces and flanks of the tipping area, by spraying and fogging, is an effective means of exterminating insects.
Dust: Dust from landfill operations is mainly a problem during periods of dry weather but can also arise from dusty waste as it is tipped. Dust is generally associated with (a) site preparation and restoration activities; (b) the disposal of waste comprising of fine particles, for example powders; and (c) traffic dust. Dust suppression can be effected by (a) limiting vehicle speed; (b) spraying roads with water; and (c) spraying site and powder type waste with water.

Mud on the Road: Mud on the public highway is one of the most common causes of public complaint. It is, therefore, in the interests of the landfill operator to provide adequate wheel cleaning facilities to ensure that mud is not carried off site by vehicles.

Landfill Fire Management: Fires in waste and landfill sites are not uncommon and it is important for site operators to be aware of the dangers, how to treat fires and to address the problems associated with them. All fires on-site should be treated as a potential emergency and dealt with accordingly. All sites should have an emergency tipping area set aside from the immediate working area where incoming loads of material known to be on fire or suspected of being so can be deposited, inspected and dealt with. Waste that is burning on delivery should be doused with water or more preferably covered progressively with adequate supplies of damp soil / cover followed by cooling and finally removal to its disposal point. It should not normally be allowed to burn itself out as this will give rise to nuisance from smoke and odour and may constitute a health risk. Firefighting techniques should be appropriate for the waste type. Fires within the operational area are either surface fires or deep-seated fires. The former usually occur in recently deposited and as yet un-compacted materials adjacent to the current working area, whilst the latter are found at depth in material deposited weeks or months earlier. Site operators should have a plan to deal with each type of fire and have a code of practice for their operators stating exactly how to tackle any outbreak. Regardless of the circumstances, no individual should ever tackle a landfill fire alone. Deep-seated fires require expensive remediation techniques including vertical cut-offs.

Landfill Safety Aspects
Training of employees should include site safety, first aid and the handling of dangerous materials where appropriate. Since landfill sites can pose dangers to both site operator and users, emergency plans should be laid down. Landfill sites should be regarded as potentially hazardous locations and the operator should have a written safety plan for the site. Safety hazards present at landfill sites may include: (a) moving plant and vehicle; (b) steep slopes; (c) bodies of standing water; (d) contaminated, putrescible, toxic, flammable or infective material and (e) noxious, flammable, toxic or hazardous gas. All employees and visitors to the site should be made aware of the potential hazards and the safety procedures to be implemented including fire safety.

Phase Closure
After the last set of cells of a phase is placed on the highest lift, an intermediate or final cover is constructed. If another phase is to be placed over the just completed phase, an intermediate cover is provided. However if the just completed phase has reached the final height of the landfill, the final cover system and surface water drainage system is provided. An intermediate cover is made of locally available soil (preferably low-permeability) and is 45 to 60cm thick. It is compacted with smooth steel drum rollers and provided a suitable gradient (3 to 5%) to encourage
surface water to run-off from the cover and thus minimize infiltration. The side slopes of the intermediate cover are compacted by the crawler tracked dozer moving up and down the slope.

Final cover construction and quality control issues are similar to those for liner construction. The layer below the low-permeability layer, referred to as the grading layer or gas venting layer, should be constructed using poorly graded sand. A grain size analysis for every 400 Cu.m of material used is recommended for quality control purposes. The layer should be compacted to above 75% relative density to provide a firm sub-base for the low-permeability layer above. The density should be tested at 30m grid points.

Laying of the topsoil layer should be done as soon as the protective layer construction is finished. Heavy construction equipment should not be allowed on the finished surface. The nutrient and liming requirements for the topsoil should be assessed from a competent agricultural laboratory. In the absence of a regulatory recommendation / requirement regarding seed mix, a horticulturist or soil scientist should be consulted. A combination of grass and bush type vegetation capable of surviving without irrigation water should be planted. At least five samples of topsoil per hectare (2.4 acres) should be tested for nutrient and liming requirements. Nutrient and seed mix application rates should be supervised on site for quality control purpose.

The final cover is provided a gradient of 3 to 5 percent to assist surface run-off. Lined ditches or channels are constructed on the final cover to intercept and carry surface water off the cover to the storm water basin. On the cover of each phase, settlement devices are installed for monthly measurement of settlement of the landfill cover. This helps in identifying the quantity of soil required periodically for repair of the landfill cover.

**Landfill Closure**

As each phase is completed and as the final cover level is reached in successive phases, the following interconnectivities are established:

a. The leachate collection system of each phase is sequentially connected (if so designed)

b. The surface water drainage system at the cover of each phase is sequentially connected (if so designed)

c. The temporary surface water drainage system constructed at the base of each completed phase is dismantled.

d. The gas collection system (if provided) of each phase is sequentially connected.

Upon completion of all phases a final check is made of the proper functioning of all inter connected systems. An access road is provided on the landfill cover to enable easy approach for routine inspection of the landfill cover.

**9.7 Post Closure Care**

Post closure care involves the routine inspection of the completed landfill site, maintenance of infrastructure and environmental monitoring. A well-defined closure plan shall be formulated for effective implementation.

**9.8 Technical Specifications**

The detail technical specifications of the following items have been given in Annexure 10.1

1. Preparation of work area/ clearing site/ jungle
2. Stripping
3. Excavation & filling work
4. Excavation of trenches
5. Borrow areas
6. Cast-in-situ cement concrete
7. Formwork and staging
8. Reinforcement
9. Structural steel work
10. Stone work-random rubble masonry
11. Filling for clay liner and foundation
12. Foundation for embankment
13. Earthen embankment
14. Turfing
15. HDPE liner
16. Clay liner
17. Leachate collection system
18. HDPE Pipes
19. Sand layer
20. Gravel layer
21. Vertical centrifugal pump
22. Valves
23. Leachate treatment plant
24. Weighbridge
25. Piezometers
26. Electrical works
27. Schedule of Makes
28. Quantity assurance check list
29. List of mandatory spares

9.9 Drawings
- Sanitary Landfill for 25 years at Nellore as Dwg. No. A.P._DPR/MSWM/ZONE-4/14
- Details of the Leachate Collection System as Dwg. No. A.P._DPR/MSWM/ZONE-4/12
- Sectional Details of Sanitary Landfill 25 year capacity as Dwg. No. A.P._DPR/MSWM/ZONE-4/13
9.10 Cost Estimates
The yearly O&M cost, Detailed Cost estimates and Yearly Cost estimates are given in table below.

Table 9.4: Operation & Maintenance Cost for Sanitary landfill

<table>
<thead>
<tr>
<th>O&amp;M COST FOR SANITARY LANDFILL</th>
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<tbody>
<tr>
<td><strong>Manpower Cost</strong></td>
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<td>S. No.</td>
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<tr>
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</tr>
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<td>1</td>
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<tr>
<td>2</td>
</tr>
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<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Consumables Cost</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
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<td><strong>Electricity</strong></td>
</tr>
<tr>
<td>5</td>
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<tr>
<td><strong>Environmental Monitoring Cost</strong></td>
</tr>
<tr>
<td>Ambient air monitoring</td>
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<tr>
<td>Ground water monitoring</td>
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<tr>
<td><strong>Repair &amp; Maintenance</strong></td>
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<tr>
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</tr>
<tr>
<td><strong>Total O&amp;M Cost Per Annum</strong></td>
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<td></td>
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Table 9.5: Cost Estimates of Sanitary Landfill for 25 years

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Item No.</th>
<th>Description</th>
<th>Unit</th>
<th>No.</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Heigh (m)</th>
<th>Quantity</th>
<th>Rate (Rs.)</th>
<th>Amount (Rs.)</th>
</tr>
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<tr>
<td>1</td>
<td></td>
<td><strong>Earthwork in Embankment</strong></td>
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<tr>
<td>1.1</td>
<td>Item No. 2.25 of DSR-2013</td>
<td>Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.</td>
<td>cum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50424</td>
<td>106</td>
<td>19564512</td>
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<tr>
<td>1.2</td>
<td>Item No. 2.26.1 of DSR-2013</td>
<td>Extra for every additional lift of 1.5 m</td>
<td>cum</td>
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<td></td>
<td></td>
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<td>44</td>
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<tr>
<td>1.3</td>
<td>Item No. 1.1.2 of DSR-2013</td>
<td>Extra lead of 3 km for the earth has been taken</td>
<td>cum</td>
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<td></td>
<td></td>
<td></td>
<td>238</td>
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<tr>
<td>2</td>
<td></td>
<td><strong>Doob Grass in Outer Slope Area</strong></td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>2.1</td>
<td>Item No. 23.10 of DSR-2013</td>
<td>Grassing with selection No.1 grass including watering and maintenance of the lawn for 30 days or more till the grass forms a thick lawn, free from weeds and fit for mowing including supplying good earth, if needed (the good earth shall be paid for separately).</td>
<td>Sq. m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9930</td>
<td>3.10</td>
<td>30783</td>
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<tr>
<td>3</td>
<td></td>
<td><strong>Bottom Liner System (Five Years) Base Area = 132000 m² &amp; Inner surface area of embankment =10133 m²</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3.1</td>
<td>Quotation is included</td>
<td>Providing and laying of Geo-textile membrane of 250 gsm above the drainage layer</td>
<td>Sq. m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>142133</td>
<td>90</td>
<td>12791970</td>
</tr>
<tr>
<td>3.2</td>
<td>Telangana SOR</td>
<td>Providing &amp; laying 0.3 m drainage layer of sand with permeability more than 0.01 cm/sec (extra lead of 3 km is taken)</td>
<td>Cum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>42640</td>
<td>708</td>
<td>30189049 .2</td>
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<tr>
<td>3.3</td>
<td>Quotation is included</td>
<td>Providing and laying of Geo-textile membrane of 250 gsm above the drainage layer</td>
<td>Sq. m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>142133</td>
<td>90</td>
<td>12791970</td>
</tr>
<tr>
<td>3.4</td>
<td>Quotation is</td>
<td>Providing &amp; laying 1.5 mm thick HDPE Geo</td>
<td>Sq. m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>142133</td>
<td>275</td>
<td>39086575</td>
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<tr>
<td><strong>3.5</strong></td>
<td>Quotation included</td>
<td>Installation of HDPE liner of 1.5 mm by fusion method</td>
<td>Sq. m</td>
<td>142133</td>
<td>60</td>
<td>8527980</td>
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<tr>
<td><strong>3.6</strong></td>
<td>Quotation included</td>
<td>Providing &amp; laying of Geo Synthetic Clay Liner (6-7 mm thickness) above the clay layer (Non-laminated)</td>
<td>Sq. m</td>
<td>142133</td>
<td>300</td>
<td>42639900</td>
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<tr>
<td><strong>3.7</strong></td>
<td>Telangana SOR</td>
<td>Providing &amp; laying 0.3 m Clay layer of permeability of less than $10^{-7}$ cm/sec.</td>
<td>Cum</td>
<td>42640</td>
<td>398.46</td>
<td>16990295</td>
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<td><strong>4</strong></td>
<td></td>
<td>Leachate Collection System</td>
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<td><strong>4.1</strong></td>
<td>Quotation included</td>
<td>Length of lateral pipe (110 mm OD)</td>
<td>Per m</td>
<td>6400</td>
<td>6400</td>
<td>945</td>
<td>6048000</td>
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<td><strong>4.2</strong></td>
<td>Quotation included</td>
<td>Length of header pipe (200 mm OD)</td>
<td>Per m</td>
<td>352</td>
<td>352</td>
<td>3085</td>
<td>1085920</td>
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<tr>
<td><strong>5</strong></td>
<td></td>
<td>Top Cover System over the waste fill (Five years) Top cover area = 131350</td>
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<tr>
<td><strong>5.1</strong></td>
<td>Code no. 983 of DSR-2013</td>
<td>Providing &amp; laying 0.45 m thick Gas collection layer-Gravel</td>
<td>per m$^3$</td>
<td>59107.5</td>
<td>580</td>
<td>34282350</td>
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<td><strong>5.2</strong></td>
<td>Market Rate</td>
<td>Providing &amp; laying 0.6 m thick Barrier layer of Compacted Clay</td>
<td>per m$^3$</td>
<td>78810</td>
<td>398.46</td>
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<tr>
<td><strong>5.3</strong></td>
<td>Item No. 23.2 of DSR-2013</td>
<td>Providing &amp; laying 0.3 m thick surface layer of good soil for vegetation growth (extra lead of 3 km is taken)</td>
<td>per m$^3$</td>
<td>1970.25</td>
<td>708</td>
<td>1394937</td>
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<td><strong>5.4</strong></td>
<td>Market Rate</td>
<td>Providing and fixing 110 mm dia GI gas vent pipes including fabrication, erection complete.</td>
<td>Nos.</td>
<td>328</td>
<td>600</td>
<td>197025</td>
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<td><strong>5.5</strong></td>
<td>Item No. 23.10 of DSR-2013</td>
<td>Grassing with Doob grass including watering and maintenance of the lawn for 30 days or</td>
<td></td>
<td>131350</td>
<td>3.10</td>
<td>407185</td>
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</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td>Quantity</td>
<td>Rate (per m³)</td>
<td>Amount</td>
<td></td>
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<tr>
<td>6.1</td>
<td>Earthwork in excavation foundation trenches or drains (not exceeding 1.5 m in width as well as 10 sqm on plan) including disposal of excavated earth, lead up to 50 m and lift upto 1.5 m</td>
<td>8.49</td>
<td>16.49</td>
<td>3.53</td>
<td>494.2</td>
<td>187</td>
<td>92415.5</td>
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<tr>
<td>6.2</td>
<td>Filling available excavated earth in trenches, sides of foundations in layers not exceeding 20 cm in depth</td>
<td>8.8</td>
<td>16.49</td>
<td>3.53</td>
<td>165.33</td>
<td>107</td>
<td>17690.39</td>
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<tr>
<td>6.3</td>
<td>Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering. All work up to plinth level</td>
<td>6.69</td>
<td>14.69</td>
<td>3.53</td>
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<tr>
<td>6.3.1</td>
<td>Providing and laying cement concrete (1:3:6) excluding cost of centering and shuttering in all works upto foundation and plinth level</td>
<td>7.59</td>
<td>15.59</td>
<td>0.15</td>
<td>17.75</td>
<td>3132</td>
<td>55590.54</td>
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<tr>
<td>6.4</td>
<td>Providing and laying in position specified grade of reinforced cement concrete excluding the cost of centering, shuttering, finishing and reinforcement. All work up to plinth level</td>
<td>7.14</td>
<td>15.14</td>
<td>0.15</td>
<td>16.21</td>
<td>3590</td>
<td>58212</td>
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<tr>
<td>6.4.1</td>
<td>Providing and laying RCC 1:2:4 (1cement: 2coarse sand: 4 graded stone aggregate 20 mm nominal size) excluding cost of centering and shuttering and reinforcement in all works upto foundation and plinth level</td>
<td>3</td>
<td>5</td>
<td>0.23</td>
<td>3</td>
<td>20.7</td>
<td>3521</td>
<td>72885</td>
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<td>6.4.2</td>
<td>Providing and laying RCC 1:2:4 (1cement: 2coarse sand: 4 graded stone aggregate 20 mm nominal size) excluding cost of centering and shuttering and reinforcement in all works upto foundation and plinth level</td>
<td>3</td>
<td>5</td>
<td>0.23</td>
<td>3</td>
<td>20.7</td>
<td>3521</td>
<td>72885</td>
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<td>Description</td>
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<td>Total</td>
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</tr>
<tr>
<td>6.5.1</td>
<td>Centering and shuttering including strutting, propping etc. and removal of form for: <strong>Walls and Base of the Tank.</strong> Extra for centering and shuttering in R.C.C works of beam, stiffner and column in foundation and plinth (Having similar design and specifications as for such works in superstructure) as per specification and direction of E/I . <strong>Column</strong></td>
<td>3</td>
<td>6.91</td>
<td>0.3</td>
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<td>0.58725</td>
<td>145</td>
<td>85.15</td>
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<td>Item no. 4.3.3 of DSR-2013</td>
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<td>6.14</td>
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<td>0.05</td>
<td>0.58725</td>
<td>145</td>
<td>85.15</td>
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<tr>
<td>6.6.1</td>
<td><strong>Reinforcement for R.C.C work</strong> including straightening, cutting, bending, placing in position and binding all complete</td>
<td></td>
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<td>6.6.2</td>
<td>Item no. 5.22 A of DSR-2013</td>
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**Reinforcement for R.C.C work** including straightening, cutting, bending, placing in position and binding all complete

<table>
<thead>
<tr>
<th>Dia (mm)</th>
<th>MT</th>
<th>10 mm</th>
<th>12 mm</th>
<th>16 mm</th>
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<td>6</td>
<td>Sub-</td>
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<tr>
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<td>6</td>
<td>6</td>
<td>1141537</td>
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<td>16</td>
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<table>
<thead>
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<th>Dia (mm)</th>
<th>MT</th>
<th>10 mm</th>
<th>12 mm</th>
<th>16 mm</th>
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<tbody>
<tr>
<td>10</td>
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<td>6</td>
<td>Sub-</td>
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<tr>
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<td>S.No.</td>
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<td>--------------------------------------------------</td>
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<td>7</td>
<td>Storm Water Drain Around the Sanitary Landfill</td>
<td>cum</td>
<td>1598</td>
<td>1.21</td>
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<tr>
<td>7.1</td>
<td>Item no. 2.6 of DSR-2013</td>
<td>Earth work in excavation by mechanical means (hydraulik excavator) /manual means over area (exceeding 30cm in depth, 1.5 mtr in width as well as 10 sqm on plan ) including disposal of excavated earth, lead up to 50m and lift up to 1.5m disposed earth to be levelled and neatly dessed: All kinds of soil.</td>
<td>cum</td>
<td>1598</td>
</tr>
<tr>
<td>7.2</td>
<td>Item no. 2.25 of DSR-2013</td>
<td>Filling available excavated earth (excluding rock) in trenches, plinth</td>
<td>cum</td>
<td>1598</td>
</tr>
<tr>
<td>7.3</td>
<td>Item no. 4.1.6 of DSR-2013</td>
<td>Providing P.C.C.M -100 with nominal mix of (1:3:6) in foundation with approved quantity of stone metal grade -IV (40 nominal mm size) clean coarse sand</td>
<td>cum</td>
<td>1598</td>
</tr>
<tr>
<td>7.4</td>
<td>Item no. 6.1.1 of DSR-2013</td>
<td>Brick work with common burnt clay F.P.S. (non modular) bricks of class designation 7.5 in foundation and plinth cement: mortar 1 cement :4 coarse sand</td>
<td>cum</td>
<td>1598</td>
</tr>
<tr>
<td>7.5</td>
<td>Item no. 13.1.1 of DSR-2013</td>
<td>12 mm thick plaster 1 cement : 6 fine sand</td>
<td>Sq. m</td>
<td>1598</td>
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<td>8</td>
<td>Daily Cover Area for Landfill</td>
<td>Sq. m</td>
<td>450</td>
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<tr>
<td>9</td>
<td>Tipping Area for Landfill</td>
<td>Sq. m</td>
<td>600</td>
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**Table 9.6: Cost of Machinery**
### SANITARY LANDFILL FACILITY FOR TWENTY FIVE YEARS

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<tr>
<th>S.No.</th>
<th>Item Description</th>
<th>Total Amount (Rs.)</th>
<th>Phase I (1-5 Years)</th>
<th>Phase II (6-10 Years)</th>
<th>Phase III (11-15 Years)</th>
<th>Phase IV (16-20 Years)</th>
<th>Phase V (21-25 Years)</th>
</tr>
</thead>
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<td>1</td>
<td>Infrastructure</td>
<td>19595295</td>
<td>3919059</td>
<td>3919059</td>
<td>3919059</td>
<td>3919059</td>
<td>3919059</td>
</tr>
<tr>
<td>2</td>
<td>Bottom Liner</td>
<td>163017739</td>
<td>32603548</td>
<td>32603548</td>
<td>32603548</td>
<td>32603548</td>
<td>32603548</td>
</tr>
<tr>
<td>3</td>
<td>Top Cover</td>
<td>83446130</td>
<td>16689226</td>
<td>16689226</td>
<td>16689226</td>
<td>16689226</td>
<td>16689226</td>
</tr>
<tr>
<td>4</td>
<td>Facilities for Landfill</td>
<td>4402801</td>
<td>4402801</td>
<td>4402801</td>
<td>4402801</td>
<td>4402801</td>
<td>4402801</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Cost 1 (Rs.)</td>
<td>Cost 2 (Rs.)</td>
<td>Cost 3 (Rs.)</td>
<td>Cost 4 (Rs.)</td>
<td>Cost 5 (Rs.)</td>
<td>Cost 6 (Rs.)</td>
</tr>
<tr>
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<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>5</td>
<td>Leachate Management &amp; Leachate Collection</td>
<td>8275457</td>
<td>8275457</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Equipment at Landfill</td>
<td>18263000</td>
<td>18263000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total (Rs.)</td>
<td>297000422</td>
<td>84153091</td>
<td>53211833</td>
<td>53211833</td>
<td>53211833</td>
<td>53211833</td>
</tr>
</tbody>
</table>
10.0 COST OF THE PROPOSED SYSTEM

The total project outlay is estimated at Rupees 52.71 Crores.

The commercial production of Waste to Energy Plant and use of facilities will commence. The landfill site, with a total life of 25 years, however, will be developed in phases. The proposed scheme considers the cost of development of landfill site for use during the first 5 years.

10.1 Sharing of Cost involved between Nellore, Gudur, Atmakur and Kavali:

A common integrated municipal solid waste management facility is proposed to be developed for Nellore, Gudur, Atmakur and Kavali towns. The costing of the integrated ISWM facility has been worked out for the waste generating in four towns. The cost incurred in the common ISWM facility would be shared in the same proportion as that of waste being generated in the respective town. In year 2017, total waste generated in Nellore Municipal Corporation 288 TPD, waste from Gudur Municipality is 28.83, waste from Atmakur is 15.81 TPD and waste from Kavali Municipality is 47.53 TPD. Therefore the cost involved would be divided into ratio that Nellore will share 75.76% cost, Gudur will share 7.58%, Atmakur will share 4.16% cost and Kavali will share the 12.50% cost of the total cost of the proposed processing and disposal facilities.

10.2 Cost of the Proposed System

Details of the cost of the proposed scheme are given in Table 10.1:

Table 10.1: Breakup of the Cost of the Proposed Scheme

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars</th>
<th>Sharing for Nellore</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Capital cost Collection and Transportation Cost</td>
<td>11.83</td>
<td>Chapter 6</td>
</tr>
<tr>
<td>B</td>
<td>Capital cost of Waste to Energy Plant</td>
<td>32.43</td>
<td>Chapter 9</td>
</tr>
<tr>
<td>C</td>
<td>Capital cost of the Sanitary Landfill</td>
<td>6.37</td>
<td>Chapter 10</td>
</tr>
<tr>
<td>D</td>
<td>IEC Cost</td>
<td>0.296</td>
<td>Chapter 12</td>
</tr>
<tr>
<td>E</td>
<td>Sub Total (A to F)</td>
<td>50.93</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Contingencies @ 3% on A to E</td>
<td>1.53</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Administrative Cost @ 0.5% on A to E</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Total Capital Cost</td>
<td>52.71</td>
<td></td>
</tr>
</tbody>
</table>
11.0 INSTITUTIONAL FRAMEWORK FOR THE CLUSTER FACILITY

Traditionally, Solid Waste Management has remained the responsibility of the Urban Local Bodies. These local bodies mostly suffer from lack of funds and manpower to perform the required functions. Moreover, with increasing urbanisation and rate of solid waste generation, the burden has also magnified. The MSW Rules, 2000 have set responsibilities for ULBs, State governments and Central & State pollution control boards for different aspects of MSW management. These rules make ULBs responsible for their implementation and for any other infrastructure development pertaining to collection, storage, segregation, transportation, processing and disposal of municipal solid waste. They are also entrusted to aware the waste generators with the responsibility to avoid littering and promote segregation. The ULBs are supposed to organize awareness programs for segregation of wastes and promotion of recycling or reuse of segregated materials.

Various departments are involved in the formulation of policies, rules and preparation of guidelines for Solid Waste Management at the Central level. The Central Government also plays a major role in monitoring the working of ULBs through Central Pollution Control Board (CPCB). State Government is also involved as the nodal body for the disbursements of grants provided by the Central Government and also for effective penetration of policies. The lowest tiers of government, Urban Local Bodies are responsible for service delivery for solid waste management.
11.1 Need for an Effective Institutional Framework

Our approach for the current study is based on Clusterisation of municipalities for setting up of regional facility. In cases where multiple agencies are involved, a robust institutional framework is a must. It is required to determine essentialities for institutional strengthening and internal capacity building to ensure that endeavour to improve the existing scenario is successful.

A regional facility requires some kind planning for a sound and effective Institutional arrangement that enables the coming together of the partnering Municipalities. The participating municipalities should establish a regional management organization which will serve the following purposes:

- It serves as formal management structure and streamlines the requirement of coordination
- It helps in the implementation of the project in a planned way
- Enables economies of scale and thus ensures efficient use of resources as single facility will be used.
- Reduce the financial and technical burden on each individual Authority and help the Authorities discharge their obligation for MSW management in a cost-effective manner with better technologies

The recommendations for the institutional framework are based on the specific tasks to be carried out under the proposed MSW Project. The activities which need to be focused as per the proposed plan include:

- Segregation of Waste
- Mechanism of Waste Collection
  - Primary collection
  - Secondary collection
- Transportation of waste from secondary collection locations.
- Operation and Maintenance
  - Landfill
  - Composting
  - Transportation

Based on our study of the merits and demerits of the existing system, it is proposed that the institutional framework for above proposed MSW should include following works.
Figure 11.2: Solid Waste Management Activities

12.2 Models of Arrangement

Though the MSW Rules makes the ULBs responsible for management of waste, there are various examples where innovative partnerships models have been developed to carry out the waste management services in the Indian cities. Broadly, four models of engagement are existing:

- ULBs
- ULB + Private Operator (PPP mode)
- ULB + Community
- ULB + Private Operator + Community

However, a more robust arrangement is required for regional facilities where more than one ULBs are involved and will be sharing the processing and disposal facility. In the case of Punjab (MSW Management Plan-Punjab), State level and Cluster level MSW Committee were formulated. The State level committee comprised of Director, Department of Local Government; Commissioners of all municipal corporations; Regional Deputy Director; Chief Engineer; Health Officer of all Corporations; One specific MSW Professional
and one specific Project Management Professional. The Cluster level Committee comprised of Commissioners of respective Municipal Corporation; One Representative of State Level MSW Management Cell; Officers of respective council of Clusters; Health Officers of all corporations; Nodal Officers of Clusters and MSW Monitoring cell headed by Executive Engineer. Specific technical entities for operation and maintenance of Collection & Transportation System as well as Processing & Disposal facilities were created.¹

11.3 Proposed Institutional Framework for the Regional Cluster Facility

The Proposed Institutional Framework is designed as shown in the flow chart below. A body called ‘Project Implementation Unit’ would be formulated at each Cluster comprising of One Lead ULB and other participating ULB. The ‘Project Implementation Unit’ will be entrusted to appoint a developer (Special Purpose Vehicle, SPV1) for the regional processing and disposal facility which would be developed on the land provided by the Lead ULB. An agreement will be signed between the lead ULB and participating ULB for the supply of MSW. The Lead ULB, in turn will sign an ‘MSW Supply agreement with SPV1. The agreement should be a binding on each ULB for the quantity and quality of MSW to be supplied for processing. A Special Purpose Vehicle (SPV2) will be appointed by the State Government in consultation with the ‘Project Implementation Unit’ of all the 6 Clusters. The SPV2 will be responsible for setting up of the Waste to Energy Plant at the Nellore Cluster and also for its operation and maintenance. An agreement will also be signed between SPV2 and SPV1 (Processing & Disposal Facility Developer) of all the clusters for the quantity of waste to be received at their doorstep. SPV1 will be responsible will be responsible for supplying the agreed quantity of waste to SPV2.

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¹ Punjab Model Municipal Solid Waste Management Plan-2014, Government of Punjab, Department of Local Government
Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC)

Draft Detailed Project Report (DPR) for MSWM

Figure 11.4: Proposed Institutional Framework
In the Current Framework, ULB is liable to sign an agreement on the quantity and quality of MSW to be supplied to SPV1 for ensuring proper functioning of the facility. Further, SPV1 will be liable to supply segregated dry waste to the SPV2.

The Institutional Framework has been outlined for the Processing and Disposal Facility to be installed at the Nellore Cluster. However, institutional framework for MSW Segregation at Source, Primary & Secondary Collection, and Transportation of the MSW to the Regional Facility has to be designed separately for all the four towns.

Figure 11.5: Responsibility Flow in the Institutional Framework

It is proposed to carry out the collection and transportation of the MSW is carried out by the SPV1 (Operator for processing of waste) and separate private operator shall be identified in other three towns. In such a framework involving multiple agencies, responsibility for every stakeholder should be laid for proper coordination and functioning. A responsibility sheet has been formulated as shown below.
Table 11.1: Responsibility Sheet for Stakeholders

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>ULB</th>
<th>Private Operator (C&amp;T)</th>
<th>SPV1</th>
<th>NGO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Collection/Segregation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implementation Plan for C&amp;T</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procurement of vehicles and machinery</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Manpower deployment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitization of residents/public about segregation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orientation/sensitization of sanitary workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide facilities/bins for segregation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collection from households</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involve NGO’s / CBO’s in awareness</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Transportation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring and supervision of agency work</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redressal of complaints</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring management and coordination</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance of equipment’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collection/ lifting of waste from secondary collection points.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation and maintenance of vehicles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation of waste to site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Processing and Disposal Facility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selection of agency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Designing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procurement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction of the facility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervision of Construction and Commissioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O&amp;M of the facility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tipping Fee</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finance</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
12.0 PUBLIC AWARENESS THROUGH INFORMATION, EDUCATION & COMMUNICATION AND CAPACITY BUILDING OF URBAN LOCAL BODIES FOR SUSTAINABLE MSW MANAGEMENT

Solid Waste Management comprises a substantial and critical component of work of any ULBs. This is also an area where citizens need to be made aware of their role in achieving clean and health cities. Design of IEC material for SWM aims to reach out to different stakeholders including children, youth, housewives, offices, institutions, commercial groups etc. With the rapid population growth in the cities, there has been a substantial increase in the generation of solid waste resulting into the contamination of air, water and land resources. It is not only affecting environment but also degrading the sanitation and hygiene conditions of the society, which create various types of problems effecting citizen’s health also.

With the existing technology, the management of solid waste by trained engineers will only solve the technical aspects, however to keep the environment clean, it requires not only the technical solution but also public acceptance, co-operation and active people’s participation. After all every individual contributes one’s own mite to the generation of solid waste and therefore it is necessary that individuals should be disciplined so as to decrease further pollution of the environment. To enable people to participate in the development process, it is necessary that people have adequate knowledge about the nature and content of these Programs. Public Awareness through Information, Education and Communication (IEC), therefore, assumes added significance in the context of the Programs. Through IEC techniques the stakeholders and local community could be educated and aware about the issues and advantages of existing and implementing system of the solid waste management. The basic approach of IEC plan is to create effectiveness of the Solid Waste Management System. Its operational efficiency can be improved through Information, Education and Communication (IEC) techniques.

12.1 Objective

IEC can be defined as an approach which attempts to change or reinforce a set of behaviors in a “target audience” regarding a specific problem in a predefined period of time. IEC strategies involve planning, implementation, monitoring and evaluation. When carefully carried out, the communication strategies help to foster positive waste management practices individually and institutionally and can contribute to sustainable changes in the environment.
The major objectives of the IEC and Capacity Building are as follows:

- Bringing of attitudinal and behavioural changes among the residence about the segregation of waste and sanitation improvement.
- Public awareness through IEC programmes and educating the masses on various aspects of solid waste management and achieve the target of receiving segregated waste from each household.
- Creating Public Participation in Planning and Management of MSW Activities.
- Capacity Building of the personnel's involved in implementing MSW i.e. Institutional Capacity of Sanitary and Health Department of the local bodies for Improved MSW Management.
- Integration and involvement of private sweepers and Rag Pickers in improving MSW management.

**Figure 12.1: Objectives of IEC activities**

### 12.2 Public participation and awareness through Information, Education and Communication Plan

The success of any solid waste management scheme can be measured through the extent of cooperation and participation of people, effectiveness of the proposed system and operational efficiency. The people of the cities should be made accountable for their activities and administration system should support them in dealing with the repercussions of their lifestyle. In this regard, IEC plan plays an important role as citizens are unaware or partially aware of hazards that have come into place due to generation of MSW by them. The Information, Education and Communication components of IEC plan are discussed as follows:

#### 12.2.1 Information

Information is the starting step in building up the people’s involvement in any public welfare project. Therefore integrated solid waste management would also remain incomplete if proper information is not passed to various stakeholders of the project. They would include residents, private firms, municipal officers, NGOs, Media houses and workers etc. The stakeholders are referred to as target groups as well in this document for convenience and are discussed in the upcoming section of IEC strategy.

The information would spread across all areas of the region and would comprise of small and big pieces of data required to familiarize the people with MSW system. It will have activities where in people will know what is MSW, Why it’s being collected from door-to-door, who will come to collect and where will it go? Once the people of the region are supplied with this background, they can get a better understanding of the waste management system and can come forward in supporting the efforts of implementing agencies.
12.2.2 Education

Education becomes the next significant factor in creating public awareness. It requires people to have basic understanding in waste management project activities. They will be briefed on various aspects of MSW system right from its generation to disposal. The education would also disseminate them with ideas such as why it needs to be discussed at such big platform, what will be the benefits of processing it scientifically and why if not treated properly; it can lead to havoc in coming years. This component shall help in bringing citizens together from various walks of life such as students, NGOs, intellectual class and teachers etc. They can share a platform to partner with the authorities who are engaged in waste treatment technologies so that system shows high level of efficiency and effectiveness.

As the MSW is people’s unwanted item or refuse, it can only be turned into a resource for them if they get right education in this direction. Hence education which is imparted through wide range of events and activities will turn around the mind sets of stakeholders and will give desired results in the project.

12.2.3 Communication

Communication is an integral part of planning for sustainable development. The development of human society is largely because of its ability to communicate information and ideas with each other and to use such information and ideas for progress.

The Programs being implemented by the Govt. Departments aim at sustainable holistic development in all development projects. The success of these programs is critically dependent on the participation of the people, particularly target groups, in the implementation process. The approach should be to emphasize on communication with target groups, local community for the implementing programme of Solid Waste Management in respective areas.

12.3 Approach of IEC Plan

The basic approach of Information, Education and Communication Plan is to make the public aware about the need of reduction and segregation of waste from the households along with the collection system of waste to take public cooperation for making the environment pollution free and to develop proper hygienic conditions.

Attitudinal and behavioral changes of the residents are important for the success of the segregated waste collection and its sustainability. For this purpose, communication with the residents is required through various techniques and modes. The proposed PP&A programme may be carried out using localized and area specific
popular tools that may be identified during project implementation period. However, one of the effective tools to forge public participation shall include the followings:

- Prepare **suitable strategies for various target groups** such as different housing groups (LIG/HIG/MIG/JJ Clusters/ Villages/ Resettlement Colonies/Unauthorized / Commercial Area/ Markets/ daily markets/ Sabzi Mandi/ School and College students etc.
- Establish **two way communication mechanisms with stakeholders** of the project such as citizens, the media, RWAs/Trade Organizations on one hand and the implementing agencies like Concessionaire or/and MUNICIPALITY on the other hand.
- **Prepare and design** Short Films, Advertisement Campaign, Posters, Brochures, Flax, Hoardings, Pamphlets, Stickers, Radio jingles, etc. for the campaign.

- Monitor quality and accuracy of contents of the advertisement material
- Lay out **word wise annual plan for conducting campaign events** such as: meetings, workshops, street corner plays, movies etc. Detailing number of event content, schedule, target group which are to be conducted by the Concessionaire in association with RWAs/Trade Associations/ School and college Managements/ NGOs and MUNICIPALITY, etc.
- **Train resource persons** from the MUNICIPALITY, Concessionaire, RWA/ Trade Associations etc. for propagating awareness
- Conduct **workshops for staff of Concessionaire and MUNICIPALITY** and training them by using manuals and other IEC materials
- Any other activity as may be approved by MUNICIPALITY.

**12.4 Information, Education and Communication Strategy**

The Information, Education and Communication Plan is supposed to follow a structure approach to effectively involve people in the implementation mechanism and further incentive and disincentive schemes should also be integrated to ensure the desired results. “Getting the right knowledge to the right people in the right place at the right time” is the crucial component of any IEC Plan. Thus, the identification of the target group for awareness
creation is a crucial part of the methodology. The Plan will follow a below mentioned strategy in a structured way for carrying out effective awareness activities.

12.4.1 Identification and Action

Identification and selection of target groups plays a key role in creating effective awareness in residents. For solid waste management, it becomes more important as the source of MSW starts from houses due to which target starts from household female head, youths and children who require some form of role model or different methods to influence their behavior. It is a very important aspect which starts from waste generators level and may reduce, reuse and recycle their waste. The other part of target groups may be waste collector and waste managers. These types of target groups are directly involved with the solid waste management. Along with this, there are other groups which can be helpful for the better management of MSW segregation, waste collection, operation, handling and proper disposal. The major target groups are as following:
Table 12.1: Action Plan for target groups

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Target Groups</th>
<th>Target Group Details</th>
<th>Action Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Waste Generator</td>
<td>• Residential Areas (Women (household), Maids, children and Youths)</td>
<td>• Holding locality-wise meetings, seminars, targeted community meetings with self-help groups, through street plays, technical and pictorial presentation along with aware them about health hazards and remedial measures and sanitation improvement.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Commercial Areas (Shopping areas, Vegetable markets, Offices, Hotels, Restaurants)</td>
<td>• Informing and suggesting them about the segregated waste management and their important role.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Institutional Areas (Jr. High Schools, Colleges)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Waste Collector</td>
<td>• Sweepers</td>
<td>• They all should be involved and sensitize about the need of segregated waste collection and sanitation improvement.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Rag pickers</td>
<td>• The waste collection, transportation and disposal of the waste in proper timing so that waste could not be overflow.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Waste loaders</td>
<td>• The waste collector should be trained about the collection of segregated waste.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Truck drivers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Landfill supervisors</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Waste Managers</td>
<td>• Administrators and supervisors</td>
<td>• Presenting them about the Rules and Regulation and updating them about the ongoing activities and techniques for MSW management.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Control and monitoring team</td>
<td>• Training programmes for the technical staffs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Complaint handlers</td>
<td>• Providing the reviews of progress and monitoring activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Computer software operators and specialists</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Leaders</td>
<td>• Political Leaders (Local MLA, MP)</td>
<td>These leaders can be motivated to participate actively in promotional efforts of community involvement in segregated solid waste management.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Religious Leaders</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Community Leaders</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>School Teachers and Students</td>
<td>• Primary Schools</td>
<td>• School teachers can be informed and involved in the segregated solid waste management scheme and can be motivated to educate the children for the sanitary improvement.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Jr. High Schools</td>
<td>• The students can be educated and trained for the segregated waste</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Public Schools</td>
<td></td>
</tr>
</tbody>
</table>
Once the target groups have been identified, the responsibility lies in developing the approach for informing, educating and communicating with these groups. For successful implementation of any program involving public participation at large, it is essential to spell out clearly and make them know the manner in which the problem is proposed to be tackled to keep area clean and improve the quality of life.

The information plan means familiarizing the people with waste management concept. To many the idea is new and it takes time for internalization. The target groups will be informed by authorities about waste segregation and its disposal practices. In information plan following activities can be undertaken-

- **Site visits by administrative officers** – This will be attracting attention of citizens on subject matter.
- **Meeting of Resident welfare associations** - RWAs can meet and discuss on door to door collection of waste and its separation at generation level.
- **A brief Introduction by Safai mitra** - workers or safai mitra can give a brief talk on waste collection and transportation to the people of the region. This way people can get engaged in segregation of waste at source level.
- **Display of data and information through pictures/hoardings** - the information on MSW can be shared with various target groups using methods like putting up pictures and boards at public places. These pictures can tell about the hazards of unscientific treatment of solid waste and need to handle the issue with better technologies for sustainable growth and development.

Likewise Education plan will also be put in place where various channels of making people aware on waste management will be exploited. This can include the following –

**12.4.2 Development of an IEC Plan**

| 6. | Media | • Print Media  
| • Electronic Media | Launching mass campaign for educating and motivating local communities and families about the need of segregation of Solid Waste and its management for sanitation and hygienic improvement. |

| 7. | Elite groups or social organizations | • NGOs, Societies  
| • CBOs  
| • Sr. citizens Association  
| • Rotary Clubs/ Lions Club | Sensitize and motivate local influential people like Sr. citizens, leading businessmen, social club members, NGOs and CBOs etc. to undertake or sponsor such activities for solid waste management for effective strategy of public participation and awareness. |
i. **Participation of schools and colleges** - Schools are important stakeholders of public welfare projects. Environmental awareness is part of curriculum at school and university level. This opportunity can be utilized to educate not only students but their family members too on waste and management and its social, economic and environmental benefits.

ii. **Public Meetings** – Public platform can be used to educate the people. They must know why this activity has been undertaken and what good it will do to them once gets operationalized. The idea is to make them know that solid waste is wealth and it can be converted into various useful components such as manure, eco-bricks and finally energy/electricity.

iii. **Dissemination of written material** – the pamphlets, booklets and other small informative brochures can be given to the stakeholders who in turn will take the responsibility to spread the word at local and community level on solid waste management.

The communication plan is last but not the least component of the IEC strategy. It is the most exhaustive of all and requires great efforts to reach to the massed. It shows the best results if implemented well.

In this, the communication material should be developed and must be utilized in public awareness program through the tools of publicity. The use of various publicity tools as public address meetings, workshops, School Activities, Street Plays, Distribution of handbills, pamphlets etc. can be used. However these activities overlap with the activities of Information and education plan but their scope and coverage is much more vast than the other two. The given table discusses the detailed communication plan as follows:

**Table 12.2: Communication Objective for each target group**

<table>
<thead>
<tr>
<th>Target Audience</th>
<th>Communication Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIG/MIG Households</strong></td>
<td>• To create awareness on importance of separate storage of wet and dry waste at source</td>
</tr>
<tr>
<td></td>
<td>• To encourage use of two dustbins</td>
</tr>
<tr>
<td></td>
<td>• To encourage for payment of collection charges for door-to-door collection</td>
</tr>
<tr>
<td></td>
<td>• To disseminate information on services and infrastructure provided by MUNICIPALITY</td>
</tr>
<tr>
<td></td>
<td>• Encourage participation in door-to-door or street level waste management in their area</td>
</tr>
<tr>
<td></td>
<td>• Promote 3Rs and usage of Recycling Centre in the area</td>
</tr>
<tr>
<td></td>
<td>• Share information on municipal rules and laws regarding waste management</td>
</tr>
<tr>
<td><strong>LIG/EWS/JJ/Resettlement Households</strong></td>
<td>• Motivation for use of dustbins for storage and disposal of household waste</td>
</tr>
<tr>
<td></td>
<td>• To create awareness on importance of separate storage of wet, and dry waste at source</td>
</tr>
<tr>
<td></td>
<td>• Encourage use of dustbins or designated places for disposal household waste</td>
</tr>
<tr>
<td></td>
<td>• To encourage use of dustbins whenever out of house</td>
</tr>
<tr>
<td></td>
<td>• To encourage for payment of collection charges for door-to-door</td>
</tr>
</tbody>
</table>
collection
- To disseminate information on services and infrastructure provided for waste management
- Encourage participation in door-to-door or street level waste management in their area
- Promote 3Rs and usage of Recycling Centre in the area
- Share information on municipal rules and laws regarding waste management

| Owners and workers of commercial establishments | To create awareness on importance of proper disposal of waste to the designated sites/bins/places |
|                                               | To sensitize them to keep the area around their establishment clean for better sales and re-visits of customers |
|                                               | To sensitize them on the payment of user/collection fee |
|                                               | Encourage participation in the street level waste management in their area |
|                                               | Promote 3Rs and usage of Recycling Centre in the area |
|                                               | To disseminate information about the services and infrastructure provided for commercial area for waste collection and disposal |
|                                               | Share information on municipal rules and laws regarding waste management in commercial areas. |
|                                               | Awareness on their role to improve the system through Compliant Redressal System, |

| School children                              | To educate and create awareness on various aspects of solid waste management and environmental sanitation issues |
|                                             | Awareness on impact of poor waste management on health |
|                                             | Promote volunteerism and motivation for taking active part in promoting “clean city” drives and other environmental sanitation, and waste management activities in the city |
|                                             | Encourage participation of family in the ‘Clean City’ campaign |
|                                             | To disseminate information about the services and infrastructure provided in their localities for waste collection and disposal |

| Associations and organizations               | Encourage their participation in the Sanitation programme of MUNICIPALITY and take their support in meeting the objectives of the project. |
|                                             | Use the influence and good-will of these organizations in seeking community support for the programme. |
|                                             | Using them to monitor the performance or outputs of the project, and report shortcomings, if any. |
|                                             | Use such organizations to create awareness on various aspects of solid waste management and environmental sanitation issues |
|                                             | Use such organizations to disseminate information about the services and infrastructure provided in their localities for waste collection and disposal |
|                                             | Share information on municipal rules and laws regarding waste management and for disseminating them to their members |
|                                             | Creating their role to improve the system through Compliant Redressal System. |


| **NGOs and CBOs** | • Encourage their participation in the Sanitation programme of MUNICIPALITY and take their support in meeting the objectives of the project.  
• Use the influence and good-will of these organizations in seeking community support for the programme.  
• Using them to monitor the performance or outputs of the project, and report shortcomings, if any.  
• Use such organizations to create awareness on various aspects of solid waste management and environmental sanitation issues  
• Use such organizations to disseminate information about the services and infrastructure provided in their localities for waste collection and disposal  
• Share information on municipal rules and laws regarding waste management and for disseminating them to their members  
• Creating their role to improve the system through Compliant Redressal System.  
• Using them to organize IEC programme in the communities of their influence |  
| **Rag-pickers and kabariwalas** | • To create awareness on safe handling of recyclables collected from the waste  
• To create awareness on importance of segregation of waste and harmful effects of littering  
• To encourage and educate rag pickers for joining the Company as partners/employees of the SPV  
• To integrate them into the project |  
| **Sanitary workers** | • To create awareness on the new system introduced and their role  
• To create awareness on safe handling and disposal of waste  
• To create awareness on importance of segregation of waste.  
• To encourage participation in waste management system.  
• Disposal of waste to the secondary designated points, benefits of compactor stations, street to street collection system and its benefits  
• How to handle street sweeping waste  
• How to handle drain silt |  
| **Service providers- Municipality/Concessionaire and NGOs** | • To sensitize on the importance of regular and repetitive IEC experience activities covering all aspects of waste management  
• Based on the experience and leaning from past, improve and modify IEC plan  
• Devise monitoring of IEC plan  
• Seek reports from the Target Audience through survey / or any other means on effectiveness of the campaign |  
| **Councilors and local leaders** | • Sensitization on the issues of waste management and its impact on the public health  
• Motivate to mobilize the community support for waste management in their area of operation/wards |
12.4.3 Training and Capacity Building programme

The basic approach of Training & Capacity Building is to create effectiveness of the Solid Waste Management System and its operational efficiency of sanitary staff of the municipality. The municipality involves many officials and sanitary staffs. To know it deeply, a baseline data collection should be taken through questionnaire survey, discussion with the sanitary officials and sanitary staffs which will give an impression to identify and segmentation of Target Group.

On the basis of the findings of the study, training programmes and training schedule of Health officials would be prepared and Capacity Building component, the primarily focus would be on the institutional development aspect of the study. It is proposed to study the existing institutional framework along with the respective roles and activities of each stakeholder. The identification of roles and activities of employees of implementing unit and stakeholder would help us to identify and develop various alternatives for the institutional framework for the sustainability of the system.

Objective of the Program

The Capacity Building/training programs must have the aim:

- To sensitize the involved group with working knowledge of the benefits of waste reduction, segregation and management.
- To impart clear instructions about the respective roles from generator to waste managers.

For achieving these objectives, a core group of trainers needs to be organized for continuous in-house training of the manpower to be deployed and other sanitation staff. For the success of this program it is essential that training and orientation cause be planned for all the people involved in various activities of solid waste management at different levels viz Administrative and Officials, Technical and non-technical staff etc. Along with these, private sanitary staff and rag-pickers should also be motivated for their active role in waste collection process.

12.4.4 Methodology for Conducting Training Program

Awareness is to be created on how to handle the waste, ensuring complete participation, consultation and commitment from all stakeholders at all levels, efficient and effective segregation at generator level as well as for workers handling waste at primary and secondary level. Awareness on usage of safety equipment and Personal Protection Equipment (PPEs) is to be promoted. Thus, it is anticipated that customized training programs needs to be conducted for the staff at all levels.
Well-equipped devices will be required to make these awareness campaigns/training programs successful. First of all, sufficient place/venue for conducting these programs needs to be finalized. Well-trained trainers will be required to deliver these training programs. A group of experienced trainers who have similar kind of experience in conducting the awareness campaigns/training programs should provide training to the target group on municipal solid waste management practices. During the training program, participants should be given questionnaires, which must be used to collect feedback from the participants. This will help to review the success of the program.

**Programme Communication**
- Health Workers & Volunteers (Door to door campaign)
- Public Address Meetings (Workshops/ Community Meeting)
- Media Support (Print & Electronic Media)
- Folk Media (Nukkad Natak)
- Supporting Materials (Printing Materials as Handouts, Pamphlet, Hand-notes, printing Cards; Banner, Fact sheets etc. Hoarding)

**Social Mobilization**
- Educational Institutions (Schools, College etc)
- Voluntary Organizations/ NGOs/ CBOs/ Societies Support /Sr. citizens association
- Sr. Officials/ Administration Officers / Sr. Citizens
- Local Elected leader support (MP, MLA/Councilor etc.)

Figure 12.8: Public Awareness through IEC Plan

### 12.5 Communication Strategy

While no one opposes the concept of cleanliness, everyone feels that ‘everyone else’ is making the environment dirty. The communication strategy, therefore, should design a call for ‘shaking up the residents’, bringing to ‘top-of-the-mind’ the need for getting the septic tanks cleaned on time to avoid bursting and ban indiscriminate disposal of waste. This is expected to arouse the public conscience that ‘We all have role to play’ and ‘must change our ways’. The next stage is a more constructive one where the communication will play up the people’s expressed desire to be associated with clean things - clean homes and clean surroundings and make
them feel ‘proud’ to be part of an initiative for a cleaner and environmentally sound cities. The expected response for this is, ‘I must do my bit to make it happen’.

The key expected outcome would be “.... I like living in a clean city. Do you?”

Communication Planning is an integral part of planning for sustained development. The development of human society has largely been due to its ability to communicate information and ideas with each other and to use such information and ideas for progress. First attempt would be a public campaign, which is the objective of the IEC Plan, will be launches to raise awareness about cleanliness.

12.5.1 Door to Door Campaign

For door to door information spreading, involvement of sanitary workers/staff would be easy and speedy along with the volunteers. It will also create a platform for better communication among public and sanitary staff. The volunteers and health workers will help in spreading the project information with the help of support material like pamphlet, booklet, cartoons etc. which will be helpful for providing effective information along with time saving.

12.5.2 Public Address Meeting

Interpersonal and community meeting is a great tool to share the information, views and direct interaction for the effective involvement and awareness among the residents. The information and people commitment can be taken for the segregation and better management for the Segregated Solid Waste Management Scheme. Some workshop and seminars will also lead to inform the stakeholders at a time with proper preparation and communication and their participation and cooperation for sanitary improvement.

12.5.3 Media Support

Media support is essential and a very important part of IEC programme to inform, educate and aware the masses. Media support includes the use of television, radio, print media and folk theatre therefore, accords priority for the promotion of non-formal sanitary improvement education and creation of awareness among all sections of the society through diverse activities using traditional and modern media of communication. The media should be informed and involved for each programme which would be conducting according to the IEC plan.
12.5.4 Folk Programme

Street play which is an important tool for creating entertained information, education and basically aware the lower income group and lower middle income group residents. The street play theme should be to the point on the IEC plan and in local point of view to realize the residents as of their part. Mass media should also be encouraged for their support in public awareness program.

12.5.5 Social Mobilization

For the social mobilization, attitudinal and behavioral changes of the residents’ involvement of major and social stakeholder are essential. For this purpose institutional and other organizations involved in social activities are a great awareness center for the social mobilization and public awareness as indicated below:

- Educational Institutions (Schools and Colleges etc.)
- NGOs/ CBOs/ Societies Support
- Sr. Officials/ Administration Officers / Sr. Citizens
- Ministerial Supports etc.

![Figure 12.10: Social Mobilization through IEC](image)

1. Determine roles and responsibilities of each official in specific terms.
2. Establish better coordination amongst the staff and departments to carry out different functions related to MSW management.
3. Enhance the knowledge base on problems and issues concerning to solid waste management for each area and pockets.
4. Lead to develop effective O&M of facilities such as tri-cycles, Dustbins and Waste containers with the help of public.
5. Develop an effective monitoring mechanism with the proper involvement of officials responsible.
The role of Municipality or Concessionaire in the programmes will be

- Organize *colony/community level events* comprising workshops and meetings with RWAs etc. as per the IEC plan prepared by the SWM Plan and showing audio-visual tapes and CDs, short films, presentations etc. during such meetings/workshops with the involvement of RWA and other supporting networks.
- Conducting *orientation programs for all workers* belonging to MSW Service.
- Conducting *door-to-door campaign to elucidate participation* of citizen in the programme (including distribution of brochures & pamphlets)
- *Distribution/ putting up campaign materials* like brochures, posters, stickers etc, provided by MUNICIPALITY as per plan provided by SWM Plan.
- *Placing and painting information boards* at various localities for disseminating information to public for availing the services envisaged in the project.
- *Creation of website* of the SWM, wherein all information, such as schedules, timings, charges, complaint redressal system, Asset details, services, etc. that are required by the public are available. The web-site to be bilingual (English, Hindi and Telugu).
- Organize *School level programmes* as per plan/programme prepared by the Communication partner.
- Organize *IEC programme for rag-pickers and kabadi-wallas* to integrate them into the project.
- Perform such activities as may be required for the success of the project and ensure participation of citizen

12.6 Incentives and Disincentives – MUNICIPALITY

Incentives and reward play major role in improving behavior. In order to gain better results from the IEC campaign, there will be a provision of incentives and disincentives. The organizations especially RWAs and market associations which have shown good results should be felicitated in public functions to motivate and encourage others to replicate the same. Some of the incentives and disincentives which may be used during the campaign are;

Figure 12.11: Incentives & Disincentives for promoting SWM
The Concessionaire and MUNICIPALITY shall make necessary assessments to identify the prize-winners; MUNICIPALITY shall organize half yearly felicitation programme for granting incentives/ dis-incentives. The cost of organizing such programme shall be borne by MUNICIPALITY.

Disincentives should also be entangled in the system in such a way that the waste littering is demoted and waste segregation is promoted. Several ways can be adopted to disincentivise such practices.

- Penalties on the waste generator if the segregated waste is not provided to the waste collector
- Penalties on the waste generator if two bin system is not followed
- Penalties on littering of waste on the roads
- Negative publicity of the waste generators in the case of default

### 12.7 Phasing of the Programme

To create awareness and promote adoption of desired behaviours in all stakeholders, a phase-wise approach will be followed.
intervention (especially when it forms a part of larger social intervention), efforts must be made to review communication inputs periodically for guiding and improving programme implementation.

In addition, it is essential to incorporate a feedback mechanism that is short, quick and reliable. The feedback needs to be on parameters like

- The target group’s interest in the campaign;
- Its understanding of the contents, themes and subjects
- Its reaction to the format, language and characters used;
- Visual appeal (where relevant) of the material;
- Sensitivity of the material to the environment and culture; and
- Situation of the target group.

The feedback should be action-oriented and aimed at making changes to improve effectiveness immediately. It should, in particular, provide key inputs to modify the messages and media used to reach specific target audiences.

Evaluation plays a key role in the success of the implementation of a communication strategy, as it helps to gauge the effectiveness of the messages. Of course, in many cases, the impact or change will be qualitative in nature. But, efforts must be made to quantify the change, wherever possible, to evaluate the effectiveness of the media and communication mix. For this, some indicators that will track the success of the communication endeavor can be developed in a participatory manner.

It is suggested that a recall survey is done after 3 months of the IEC campaign to assess the impact of intervention with regard to retention of messages communicated and understandability. Depending upon the results of the recall survey, IEC materials to address areas with had less recall value can be looked at to ensure all aspects that can influence behavior is reiterated to the target audience. Based on recall the IEC materials can be refined and made contextual to the changing needs of the target group.

Increase in awareness level among the stakeholders will result into increased demand for the services and infrastructure for which an advance planning and preparedness will be required by the ULB. For this, remedial & redressal measures would be built in IEC campaigns so that the credibility of IEC messages remains high. To strengthen the service delivery system, a complain registering mechanism would be developed in the IEC cell where general public can register or lodge a complaint through a toll free number in case of poor waste management, garbage disposal, misbehavior or for any such things which may be decided by the MCF. Besides the
complaint mechanism, use of IVRS (interactive voice recognition system) will also help people to acquire information on waste management in their locality and on other related issues. The numbers and details of such system would be publicized during the IEC campaign to make public aware about the complaint mechanism.
Table 12.3: Awareness and capacity buildings schedule and estimated activities costing for a year

**Estimated Cost for IEC and Capacity Building programme for one year in Nellore**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Activities</th>
<th>Resource</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Design and Development of Communication Material</td>
<td>LS</td>
<td>500000</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Implementation of Plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Program Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Door to door campaign : one to one interaction (Health workers &amp; NGO field staff and volunteers)</td>
<td>10 Volunteer @ Rs. 500 per day for 120 days (In parts)</td>
<td>5000</td>
<td>600000</td>
</tr>
<tr>
<td>3</td>
<td>Public Address (Focus group meetings, corner meetings, stakeholders meeting workshops and seminars)</td>
<td>1 meeting in every ward in 1 quarter</td>
<td>3000</td>
<td>636000</td>
</tr>
<tr>
<td>4</td>
<td>School Programmes (Essay, painting, poster, debates, quiz competitions/ Introduce projects, games and role play &amp; Rallies through students)</td>
<td>1 activity per school</td>
<td>5000</td>
<td>335000</td>
</tr>
<tr>
<td>5</td>
<td>Printing &amp; Distribution of the IEC material</td>
<td>LS</td>
<td>200000</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Broadcasting of stips on local Cable/ TV channel</td>
<td>bi monthly Continuous for 1 year at least on local leading channel</td>
<td>15000</td>
<td>270000</td>
</tr>
<tr>
<td>S. No.</td>
<td>Activities</td>
<td>Resource</td>
<td>Unit Cost</td>
<td>Total Cost</td>
</tr>
<tr>
<td>-------</td>
<td>------------</td>
<td>----------</td>
<td>-----------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7000</td>
<td>210000</td>
</tr>
<tr>
<td></td>
<td>Folk Media : (Nukkad Nataks)</td>
<td>Street Plays in each middle and lower strata of societies about 30 numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subtotal (A)</td>
<td></td>
<td></td>
<td>2251000</td>
</tr>
<tr>
<td>b)</td>
<td>Training and Capacity Building</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Training need assessment study</td>
<td>Stakeholder training need assessment Study</td>
<td>Once in each Sanitary Zone</td>
<td>20000</td>
</tr>
<tr>
<td>2</td>
<td>Waste Collector</td>
<td>a) Sweepers, Waste Loaders and Truck Drivers</td>
<td>12 per year</td>
<td>12000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Landfill Supervisors</td>
<td>6 per year</td>
<td>12000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) Private Waste Collectors and Rag Pickers/ Waste segregators</td>
<td>On Lump-sum basis (Depends on areas/colonies/ societies and RWAs) = 24 meetings</td>
<td>8000</td>
</tr>
<tr>
<td>3</td>
<td>Administration and Monitoring</td>
<td>a) Administrators and Supervisors</td>
<td>10 per year</td>
<td>10000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) Computer/ software operators &amp; Specialist and Control &amp; Monitoring Team and Complaint Handlers</td>
<td>10 per year</td>
<td>10000</td>
</tr>
<tr>
<td>C</td>
<td>Monitoring and Evaluation</td>
<td>Development of M&amp;E Indicators</td>
<td>To be borne by Municipality:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Periodic Audits after completion of first Phase of IEC Activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appraisal of the Programme</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subtotal (B)</td>
<td></td>
<td></td>
<td>708000</td>
</tr>
<tr>
<td></td>
<td>Grand Total</td>
<td></td>
<td></td>
<td>2959000</td>
</tr>
</tbody>
</table>
### 13.0 PROJECT IMPLEMENTATION PLAN

Table 13.1: Implementation Plan for ISWM Project in Nellore

<table>
<thead>
<tr>
<th>S.N.</th>
<th>DESCRIPTION</th>
<th>MONTHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Approval of the DPR (*)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Statutory Clearances</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Preparation of the Detailed Bid Documents (RFQ, RFP &amp; Concession Agreement in line with approved DPR)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Approval of the Bid Documents</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Issuance of Notice for Inviting Tender</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Issuance of Notice for RFQ</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Screening and shortlisting of Bidders</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Issuance of Notice for RFP for Shortlisted Bidders</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Receipt of Tenders from Bidders</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Bid Evaluation and Recommendation of Bidder</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Award of Works Contract to Successful Bidder(s)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Preparation of Implementation Plan &amp; Construction Schedule</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Procurement of the C&amp;T vehicles/equipments through tendering process</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Establishment of the C&amp;T system</td>
<td></td>
</tr>
<tr>
<td>Processing &amp; Disposal Facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Site Handover by NMC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 Survey and Soil Investigation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Evaluation and Approval of Engineering Drawings &amp; Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 Complete Site Clearance and Levelling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 Construction of Boundary Wall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Construction of Security Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 Construction of Office with Amenities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 Installation of Weighbridge at the Site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 Construction of QC Laboratory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 Construction of Internal Roads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 Construction of Change/Canteen Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 Construction of Drainage System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27 Construction of Wheel Wash Pit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 Construction of Power Room/DG Platform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 Construction of Meter Room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 Development of the Green Belt Area</td>
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<td>31 Construction of UG Tank &amp; Pump Room</td>
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<td>32 Compost Plant</td>
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<td>a Tipping Section</td>
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<tr>
<td>b Tipping area (waste receiving area)</td>
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<td>c Pre-sorting unit shed</td>
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<td>d Composting Pad</td>
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<td>e Monsoon shed over composting pad</td>
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<td>f Compost Preparatory &amp; Finishing Shed</td>
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<td>g Compost refinement unit shed</td>
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<td>h Compost curing shed</td>
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<td>i Store room for compost</td>
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<td>j Water supply storage &amp;</td>
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<td><strong>distribution</strong></td>
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<td>k</td>
<td>Leachate collection &amp; disposal system</td>
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<td>Power connection, control room, substation</td>
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<td><strong>33 RDF Plant</strong></td>
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<td>a</td>
<td>RDF Plant Machinery Section</td>
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<td>b</td>
<td>RDF Storage Section</td>
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<td><strong>34 Sanitary Landfill</strong></td>
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<td>Excavation</td>
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<td>Binding</td>
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<td>c</td>
<td>Clay liner</td>
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<td>d</td>
<td>HDPE liner laying &amp; Anchoring</td>
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<td>Soil layer</td>
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<td>f</td>
<td>Providing leachate pipes</td>
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<td>Providing drainage media &amp; leachate collection system</td>
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<td>Installation of environmental monitoring system</td>
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<td><strong>35 Bought Out Items</strong></td>
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<td>Pre-Soring Unit</td>
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<td>b</td>
<td>Compost plant Machinery</td>
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<td>c</td>
<td>Other vehicles/equipments for compost plant</td>
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<td>d</td>
<td>Lab equipments/Furniture</td>
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<td>Vehicles &amp; Equipments for SLF</td>
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<td>f</td>
<td>RDF Plant Equipments</td>
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<td>g</td>
<td>Erection &amp; Commissioning of Compost Plant</td>
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<td>Erection &amp; Commissioning of RDF Plant</td>
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<td>Trial &amp; Run</td>
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<td><strong>36 Workshop</strong></td>
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<tr>
<td>a</td>
<td>Construction of the workshop for maintenance of the vehicles</td>
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</tbody>
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**Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC)**

**Draft Detailed Project Report (DPR) for MSWM**

**129/13**
Table 14.2: Implementation Plan for Waste to Energy Plant in Nellore

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Activity</th>
<th>Project Schedule for Waste to Energy Plant</th>
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<tbody>
<tr>
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<td>Month</td>
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<td>1</td>
<td>Financial Closure</td>
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</tbody>
</table>

*Note: The table entries indicate the start of activities.*
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 Municipal Solid Waste (Management and Handling) Rules, 2000, except as respect things done or omitted to be done before such supersession, the Central Government hereby makes the following rules for management of Solid Waste, namely:-

S.O. 1357(E).—Whereas the draft of the Solid Waste Management Rules, 2015 were published under the notification of the Government of India in the Ministry of Environment, Forest and Climate Change number G.S.R. 451 (E), dated the 3rd June, 2015 in the Gazette of India, part II, Section 3, sub-section (i) of the same date inviting objections or suggestions from the persons likely to be affected thereby, before the expiry of the period of sixty days from the publication of the said notification on the Solid Waste Management Rules, 2015 in supersession of the Municipal Solid Waste (Management and Handling) Rules, 2000;

And whereas, copies of the said Gazette were made available to the public on the 3rd June, 2015;

And whereas, the objections or comments received within the stipulated period were 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 Municipal Solid Waste (Management and Handling) Rules, 2000, except as respect things done or omitted to be done before such supersession, the Central Government hereby makes the following rules for management of Solid Waste, namely:-
1. **Short title and commencement.-**
   (1) These rules may be called the Solid Waste Management Rules, 2016.
   (2) They shall come into force on the date of their publication in the Official Gazette.

2. **Application.-** These rules shall apply to every urban local body, outgrowths in urban agglomerations, census towns as declared by the Registrar General and Census Commissioner of India, notified areas, notified industrial townships, areas under the control of Indian Railways, airports, airbases, Ports and harbours, defence establishments, special economic zones, State and Central government organisations, places of pilgrims, religious and historical importance as may be notified by respective State government from time to time and to every domestic, institutional, commercial and any other non residential solid waste generator situated in the areas except industrial waste, hazardous waste, hazardous chemicals, bio medical wastes, e-waste, lead acid batteries and radio-active waste, that are covered under separate rules framed under the Environment (Protection) Act, 1986.

3. **Definitions** — (1) In these rules, unless the context otherwise requires,- (1) **“aerobic composting”** means a controlled process involving microbial decomposition of organic matter in the presence of oxygen; (2) **“anaerobic digestion”** means a controlled process involving microbial decomposition of organic matter in absence of oxygen; (3) **"authorisation"** means the permission given by the State Pollution Control Board or Pollution Control Committee, as the case may be, to the operator of a facility or urban local authority, or any other agency responsible for processing and disposal of solid waste; (4) **“biodegradable waste”** means any organic material that can be degraded by micro-organisms into simpler stable compounds; (5) **"bio-methanation”** means a process which entails enzymatic decomposition of the organic matter by microbial action to produce methane rich biogas; (6) **“brand owner”** means a person or company who sells any commodity under a registered brand label. (7) **“buffer zone”** means zone of no development to be maintained around solid waste processing and disposal facility, exceeding 5 TPD of installed capacity. This will be maintained within total and area allotted for the solid waste processing and disposal facility. (8) **“bulk waste generator”** means and includes buildings occupied by the Central government departments or undertakings, State government departments or undertakings, local bodies, public sector undertakings or private companies, hospitals, nursing homes, schools, colleges, universities, other educational institutions, hostels, hotels, commercial establishments, markets, places of worship, stadia and sports complexes having an average waste generation rate exceeding 100kg per day; (9) **"bye-laws”** means regulatory framework notified by local body, census town and notified area townships for facilitating the implementation of these rules effectively in their jurisdiction. (10) **“census town”** means an urban area as defined by the Registrar General and Census Commissioner of India; (11) **“combustible waste”** means non-biodegradable, non-recyclable, non-reusable, non hazardous solid waste having minimum calorific value exceeding 1500 kcal/kg and excluding chlorinated materials like plastic, wood pulp, etc; (12) **"composting”** means a controlled process involving microbial decomposition of organic matter; (13) **“contractor”** means a person or firm that undertakes a contract to provide materials or labour to perform a service or do a job for service providing authority; (14) **“co-processing”** means use of non-biodegradable and non recyclable solid waste having calorific value exceeding 1500k/cal as raw material or as a source of energy or both to replace or supplement the natural mineral resources and fossil fuels in industrial processes; (15) **“decentralised processing”** means establishment of dispersed facilities for maximizing the processing of biodegradable waste and recovery of recyclables closest to the source of generation so as to minimize transportation of waste for processing or disposal; (16) **"disposal”** means the final and safe disposal of post processed residual solid waste and inert street sweepings and silt from surface drains on land as specified in Schedule I to prevent contamination of ground water, surface water, ambient air and attraction of animals or birds; (17) **“domestic hazardous waste”** means discarded paint drums, pesticide cans, CFL bulbs, tube lights, expired medicines, broken mercury thermometers, used batteries, used needles and syringes and contaminated gauge, etc., generated at the household level;
18. "door to door collection" means collection of solid waste from the door step of households, shops, commercial establishments, offices, institutional or any other non residential premises and includes collection of such waste from entry gate or a designated location on the ground floor in a housing society, multi storied building or apartments, large residential, commercial or institutional complex or premises;

19. "dry waste" means waste other than bio-degradable waste and inert street sweepings and includes recyclable and non recyclable waste, combustible waste and sanitary napkin and diapers, etc;

20. "dump sites" means a land utilised by local body for disposal of solid waste without following the principles of sanitary land filling;

21. "extended producer responsibility" (EPR) means responsibility of any producer of packaging products such as plastic, tin, glass and corrugated boxes, etc., for environmentally sound management, till end-of-life of the packaging products;

22. "facility" means any establishment wherein the solid waste management processes namely segregation, recovery, storage, collection, recycling, processing, treatment or safe disposal are carried out;

23. "fine" means penalty imposed on waste generators or operators of waste processing and disposal facilities under the bye-laws for non-compliance of the directions contained in these rules and/or bye-laws

24. "Form" means a Form appended to these rules;

25. "handling" includes all activities relating to sorting, segregation, material recovery, collection, secondary storage, shredding, baling, crushing, loading, unloading, transportation, processing and disposal of solid wastes;

26. "inerts" means wastes which are not bio-degradable, recyclable or combustible street sweeping or dust and silt removed from the surface drains;

27. "incineration" means an engineered process involving burning or combustion of solid waste to thermally degrade waste materials at high temperatures;

28. "informal waste collector" includes individuals, associations or waste traders who are involved in sorting, sale and purchase of recyclable materials;

29. "leachate" means the liquid that seeps through solid waste or other medium and has extracts of dissolved or suspended material from it;

30. "local body" for the purpose of these rules means and includes the municipal corporation, nagar nigam, municipal council, nagarpalika, nagar Palikaparishad, municipal board, nagar panchayat and town panchayat, census towns, notified areas and notified industrial townships with whatever name they are called in different States and union territories in India;

31. "materials recovery facility" (MRF) means a facility where non-compostable solid waste can be temporarily stored by the local body or any other entity mentioned in rule 2 or any person or agency authorised by any of them to facilitate segregation, sorting and recovery of recyclables from various components of waste by authorised informal sector of waste pickers, informal recyclers or any other work force engaged by the local body or entity mentioned in rule 2 for the purpose before the waste is delivered or taken up for its processing or disposal;

32. "non-biodegradable waste" means any waste that cannot be degraded by micro organisms into simpler stable compounds;

33. "operator of a facility" means a person or entity, who owns or operates a facility for handling solid waste which includes the local body and any other entity or agency appointed by the local body;

34. "primary collection" means collecting, lifting and removal of segregated solid waste from source of its generation including households, shops, offices and any other non-residential premises or from any collection points or any other location specified by the local body;

35. "processing" means any scientific process by which segregated solid waste is handled for the purpose of reuse, recycling or transformation into new products;

36. "recycling" means the process of transforming segregated non-biodegradable solid waste into new material or product or as raw material for producing new products which may or may not be similar to the original products;

37. "redevelopment" means rebuilding of old residential or commercial buildings at the same site, where the existing buildings and other infrastructures have become dilapidated;
38. "refused derived fuel" (RDF) means fuel derived from combustible waste fraction of solid waste like plastic, wood, pulp or organic waste, other than chlorinated materials, in the form of pellets or fluff produced by drying, shredding, dehydrating and compacting of solid waste;

39. "residual solid waste" means and includes the waste and rejects from the solid waste processing facilities which are not suitable for recycling or further processing;

40. "sanitary land filling" means the final and safe disposal of residual solid waste and inert wastes on land in a facility designed with protective measures against pollution of ground water, surface water and fugitive air dust, wind-blown litter, bad odour, fire hazard, animal menace, bird menace, pests or rodents, greenhouse gas emissions, persistent organic pollutants slope instability and erosion;

41. "sanitary waste" means wastes comprising of used diapers, sanitary towels or napkins, tampons, condoms, incontinence sheets and any other similar waste;

42. "Schedule" means the Schedule appended to these rules;

43. "secondary storage" means the temporary containment of solid waste after collection at secondary waste storage depots or MRFs or bins for onward transportation of the waste to the processing or disposal facility;

44. "segregation" means sorting and separate storage of various components of solid waste namely biodegradable wastes including agriculture and dairy waste, non-biodegradable wastes including recyclable waste, non-recyclable combustible waste, sanitary waste and non-recyclable inert waste, domestic hazardous wastes, and construction and demolition wastes;

45. "service provider" means an authority providing public utility services like water, sewerage, electricity, telephone, roads, drainage, etc;

46. "solid waste" means and includes solid or semi-solid domestic waste, sanitary waste, commercial waste, institutional waste, catering and market waste and other non-residential wastes, street sweepings, silt removed or collected from the surface drains, horticulture waste, agriculture and dairy waste, treated bio-medical waste excluding industrial waste, bio-medical waste and e-waste, battery waste, radio-active waste generated in the area under the local authorities and other entities mentioned in rule 2;

47. "sorting" means separating various components and categories of recyclables such as paper, plastic, cardboard, metal, glass, etc., from mixed waste as may be appropriate to facilitate recycling;

48. "stabilising" means the biological decomposition of biodegradable wastes to a stable state where it generates no leachate or offensive odours and is fit for application to farm land, soil erosion control and soil remediation;

49. "street vendor" means any person engaged in vending of articles, goods, wares, food items or merchandise of everyday use or offering services to the general public, in a street, lane, sidewalk, footpath, pavement, public park or any other public place or private area, from a temporary built up structure or by moving from place to place and includes hawker, peddler, squatter and all other synonymous terms which may be local or region specific; and the words “street vending” with their grammatical variations and cognate expressions, shall be construed accordingly;

50. "tipping fee" means a fee or support price determined by the local authorities or any state agency authorised by the State government to be paid to the concessionaire or operator of waste processing facility or for disposal of residual solid waste at the landfill;

51. "transfer station" means a facility created to receive solid waste from collection areas and transport in bulk in covered vehicles or containers to waste processing and, or, disposal facilities;

52. "transportation" means conveyance of solid waste, either treated, partly treated or untreated from a location to another location in an environmentally sound manner through specially designed and covered transport system so as to prevent the foul odour, littering and unsightly conditions;

53. "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 volume and potential to cause harm;

54. "user fee" means a fee imposed by the local body and any entity mentioned in rule 2 on the waste generator to cover full or part cost of providing solid waste collection, transportation, processing and disposal services.

55. "vermi composting" means the process of conversion of bio-degradable waste into compost using earthworms;

56. "waste generator" means and includes every person or group of persons, every residential premises and non-residential establishments including Indian Railways, defense establishments, which generate solid waste;

57. "waste hierarchy" means the priority order in which the solid waste is to be managed by giving...
emphasize to prevention, reduction, reuse, recycling, recovery and disposal, with prevention being the most preferred option and the disposal at the landfill being the least;

58. **“waste picker”** means a person or groups of persons informally engaged in collection and recovery of reusable and recyclable solid waste from the source of waste generation the streets, bins, material recovery facilities, processing and waste disposal facilities for sale to recyclers directly or through intermediaries to earn their livelihood.

(2) Words and expressions used herein but not defined, but defined in the Environment (Protection) Act, 1986, the Water (Prevention and Control of Pollution) Act, 1974, Water (Prevention and Control of Pollution) Cess Act, 1977 and the Air (prevention and Control of Pollution) Act, 1981 shall have the same meaning as assigned to them in the respective Acts.

4 **Duties of waste generators.**—(1) Every waste generator shall,—

(a) segregate and store the waste generated by them in three separate streams namely bio-degradable, non bio-degradable and domestic hazardous wastes in suitable bins and handover segregated wastes to authorised waste pickers or waste collectors as per the direction or notification by the local authorities from time to time;

(b) wrap securely the used sanitary waste like diapers, sanitary pads etc., in the pouches provided by the manufacturers or brand owners of these products or in a suitable wrapping material as instructed by the local authorities and shall place the same in the bin meant for dry waste or non-bio-degradable waste;

(c) store separately construction and demolition waste, as and when generated, in his own premises and shall dispose off as per the Construction and Demolition Waste Management Rules, 2016; and

(d) store horticulture waste and garden waste generated from his premises separately in his own premises and dispose of as per the directions of the local body from time to time.

(2) No waste generator shall throw, burn or bury the solid waste generated by him, on streets, open public spaces outside his premises or in the drain or water bodies.

(3) All waste generators shall pay such user fee for solid waste management, as specified in the bye-laws of the local bodies.

(4) No person shall organise an event or gathering of more than one hundred persons at any unlicensed place without intimating the local body, at least three working days in advance and such person or the organiser of such event shall ensure segregation of waste at source and handing over of segregated waste to waste collector or agency as specified by the local body.

(5) Every street vendor shall keep suitable containers for storage of waste generated during the course of his activity such as food waste, disposable plates, cups, cans, wrappers, coconut shells, leftover food, vegetables, fruits, etc., and shall deposit such waste at waste storage depot or container or vehicle as notified by the local body.

(6) All resident welfare and market associations shall, within one year from the date of notification of these rules and in partnership with the local body ensure segregation of waste at source by the generators as prescribed in these rules, facilitate collection of segregated waste in separate streams, handover recyclable material to either the authorised waste pickers or the authorised recyclers. The bio-degradable waste shall be processed, treated and disposed off through composting or bio-methanation within the premises as far as possible. The residual waste shall be given to the waste collectors or agency as directed by the local body.

(7) All gated communities and institutions with more than 5,000 sqm area shall, within one year from the date of notification of these rules and in partnership with the local body, ensure segregation of waste at source by the generators as prescribed in these rules, facilitate collection of segregated waste in separate streams, handover recyclable material to either the authorised waste pickers or the authorized recyclers. The bio-degradable waste shall be processed, treated and disposed off through composting or bio-methanation within the premises as far as possible. The residual waste shall be given to the waste collectors or agency as directed by the local body.

(8) All hotels and restaurants shall, within one year from the date of notification of these rules and in partnership with the local body ensure segregation of waste at source as prescribed in these rules, facilitate collection of segregated waste in separate streams, handover recyclable material to either the authorised waste pickers or the authorised recyclers. The bio-degradable waste shall be processed, treated and disposed off through composting or bio-methanation within the premises as far as possible. The residual waste shall be given to the waste collectors or agency as directed by the local body.

5 **Duties of Ministry of Environment, Forest and Climate Change.**—(1) The Ministry of Environment, Forest and Climate Change shall be responsible for over all monitoring the implementation of these rules in the country. It shall constitute a Central Monitoring Committee under the Chairmanship of Secretary, Ministry of Environment, Forest and Climate Change comprising officer not below the rank of Joint Secretary or Advisor from the following namely,—
1) Ministry of Urban Development
2) Ministry of Rural Development
3) Ministry of Chemicals and Fertilizers
4) Ministry of Agriculture
5) Central Pollution Control Board
6) Three State Pollution Control Boards or Pollution Control Committees by rotation
7) Urban Development Departments of three State Governments by rotation
8) Rural Development Departments from two State Governments by rotation
9) Three Urban Local bodies by rotation
10) Two census towns by rotation
11) FICCI, CII
12) Two subject experts

2. This Central Monitoring Committee shall meet at least once in a year to monitor and review the implementation of these rules. The Ministry of Environment, Forest and Climate Change may co-opt other experts, if needed. The Committee shall be renewed every three years.

6. **Duties of Ministry of Urban Development.**-(1) The Ministry of Urban Development shall coordinate with State Governments and Union territory Administrations to,-

(a) take periodic review of the measures taken by the states and local bodies for improving solid waste management practices and execution of solid waste management projects funded by the Ministry and external agencies at least once in a year and give advice on taking corrective measures;

(b) formulate national policy and strategy on solid waste management including policy on waste to energy in consultation with stakeholders within six months from the date of notification of these rules;

(c) facilitate States and Union Territories in formulation of state policy and strategy on solid management based on national solid waste management policy and national urban sanitation policy;

(d) promote research and development in solid waste management sector and disseminate information to States and local bodies;

(e) undertake training and capacity building of local bodies and other stakeholders; and

(f) provide technical guidelines and project finance to states, Union territories and local bodies on solid waste management to facilitate meeting timelines and standards.

7. **Duties of Department of Fertilisers, Ministry of Chemicals and Fertilisers.** (1) The Department of Fertilisers through appropriate mechanisms shall,-

(a) provide market development assistance on city compost; and

(b) ensure promotion of co-marketing of compost with chemical fertilisers in the ratio of 3 to 4 bags: 6 to 7 bags by the fertiliser companies to the extent compost is made available for marketing to the companies.

8. **Duties of Ministry of Agriculture, Government of India.**- The Ministry of Agriculture through appropriate mechanisms shall,-

(a) provide flexibility in Fertiliser Control Order for manufacturing and sale of compost;

(b) propagate utilisation of compost on farm land;

(c) set up laboratories to test quality of compost produced by local authorities or their authorised agencies; and

(d) issue suitable guidelines for maintaining the quality of compost and ratio of use of compost vis-a-vis chemical fertilizers while applying compost to farmland.

9. **Duties of the Ministry of Power.**-The Ministry of Power through appropriate mechanisms shall,-

(a) decide tariff or charges for the power generated from the waste to energy plants based on solid waste.

(b) compulsory purchase power generated from such waste to energy plants by distribution company.

10. **Duties of Ministry of New and Renewable Energy Sources**- The Ministry of New and Renewable Energy Sources through appropriate mechanisms shall,-
(a) facilitate infrastructure creation for waste to energy plants; and
(b) provide appropriate subsidy or incentives for such waste to energy plants.

11. **Duties of the Secretary–in-charge, Urban Development in the States and Union territories.**-(1) The Secretary, Urban Development Department in the State or Union territory through the Commissioner or Director of Municipal Administration or Director of local bodies shall,-

(a) prepare a state policy and solid waste management strategy for the state or the union territory in consultation with stakeholders including representative of waste pickers, self help group and similar groups working in the field of waste management consistent with these rules, national policy on solid waste management and national urban sanitation policy of the ministry of urban development, in a period not later than one year from the date of notification of these rules;

(b) while preparing State policy and strategy on solid waste management, lay emphasis on waste reduction, reuse, recycling, recovery and optimum utilisation of various components of solid waste to ensure minimisation of waste going to the landfill and minimise impact of solid waste on human health and environment;

(c) state policies and strategies should acknowledge the primary role played by the informal sector of waste pickers, waste collectors and recycling industry in reducing waste and provide broad guidelines regarding integration of waste picker or informal waste collectors in the waste management system.

(d) ensure implementation of provisions of these rules by all local authorities;

(e) direct the town planning department of the State to ensure that master plan of every city in the State or Union territory provisions for setting up of solid waste processing and disposal facilities except for the cities who are members of common waste processing facility or regional sanitary landfill for a group of cities; and

(f) ensure identification and allocation of suitable land to the local bodies within one year for setting up of processing and disposal facilities for solid wastes and incorporate them in the master plans (land use plan) of the State or as the case may be, cities through metropolitan and district planning committees or town and country planning department;

(h) direct the town planning department of the State and local bodies to ensure that a separate space for segregation, storage, decentralised processing of solid waste is demarcated in the development plan for group housing or commercial, institutional or any other non-residential complex exceeding 200 dwelling or having a plot area exceeding 5,000 square meters;

(i) direct the developers of Special Economic Zone, Industrial Estate, Industrial Park to earmark at least five percent of the total area of the plot or minimum five plots or sheds for recovery and recycling facility.

(j) facilitate establishment of common regional sanitary landfill for a group of cities and towns falling within a distance of 50 km (or more) from the regional facility on a cost sharing basis and ensure professional management of such sanitary landfills;

(k) arrange for capacity building of local bodies in managing solid waste, segregation and transportation or processing of such waste at source;

(l) notify buffer zone for the solid waste processing and disposal facilities of more than five tons per day in consultation with the State Pollution Control Board; and

(m) start a scheme on registration of waste pickers and waste dealers.

12. **Duties of District Magistrate or District Collector or Deputy Commissioner.**- The District Magistrate or District Collector or as the case may be, the Deputy Commissioner shall,-

(a) facilitate identification and allocation of suitable land as per clause (f) of rules 11 for setting up solid waste processing and disposal facilities to local authorities in his district in close coordination with the Secretary-in-charge of State Urban Development Department within one year from the date of notification of these rules;

(b) review the performance of local bodies, at least once in a quarter on waste segregation, processing, treatment and disposal and take corrective measures in consultation with the Commissioner or Director of Municipal Administration or Director of local bodies and secretary-in-charge of the State Urban Development.

13. **Duties of the Secretary–in-charge of Village Panchayats or Rural Development Department in the State and Union territory.**-(1) The Secretary–in-charge of Village Panchayats or Rural Development Department in the State and Union territory shall have the same duties as the Secretary–in-charge, Urban Development in the States and Union territories, for the areas which are covered under these rules and are under their jurisdictions.

14. **Duties of Central Pollution Control Board.**-The Central Pollution Control Board shall,
(a) co-ordinate with the State Pollution Control Boards and the Pollution Control Committees for implementation of these rules and adherence to the prescribed standards by local authorities;

(b) formulate the standards for ground water, ambient air, noise pollution, leachate in respect of all solid waste processing and disposal facilities;

(c) review environmental standards and norms prescribed for solid waste processing facilities or treatment technologies and update them as and when required;

(d) review through State Pollution Control Boards or Pollution Control Committees, at least once in a year, the implementation of prescribed environmental standards for solid waste processing facilities or treatment technologies and compile the data monitored by them;

(e) review the proposals of State Pollution Control Boards or Pollution Control Committees on use of any new technologies for processing, recycling and treatment of solid waste and prescribe performance standards, emission norms for the same within 6 months;

(f) monitor through State Pollution Control Boards or Pollution Control Committees the implementation of these rules by local bodies;

(g) prepare an annual report on implementation of these rules on the basis of reports received from State Pollution Control Boards and Committees and submit to the Ministry of Environment, Forest and Climate Change and the report shall also be put in public domain;

(h) publish guidelines for maintaining buffer zone restricting any residential, commercial or any other construction activity from the outer boundary of the waste processing and disposal facilities for different sizes of facilities handling more than five tons per day of solid waste;

(i) publish guidelines, from time to time, on environmental aspects of processing and disposal of solid waste to enable local bodies to comply with the provisions of these rules; and

(j) provide guidance to States or Union territories on inter-state movement of waste.

15. Duties and responsibilities of local authorities and village Panchayats of census towns and urban agglomerations.- The local authorities and Panchayats shall,-

(a) prepare a solid waste management plan as per state policy and strategy on solid waste management within six months from the date of notification of state policy and strategy and submit a copy to respective departments of State Government or Union territory Administration or agency authorised by the State Government or Union territory Administration;

(b) arrange for door to door collection of segregated solid waste from all households including slums and informal settlements, commercial, institutional and other non residential premises. From multi-storage buildings, large commercial complexes, malls, housing complexes, etc., this may be collected from the entry gate or any other designated location;

(c) establish a system to recognise organisations of waste pickers or informal waste collectors and promote and establish a system for integration of these authorised waste-pickers and waste collectors to facilitate their participation in solid waste management including door to door collection of waste;

(d) facilitate formation of Self Help Groups, provide identity cards and thereafter encourage integration in solid waste management including door to door collection of waste;

(e) frame bye-laws incorporating the provisions of these rules within one year from the date of notification of these rules and ensure timely implementation;

(f) prescribe from time to time user fee as deemed appropriate and collect the fee from the waste generators on its own or through authorised agency;

(g) direct waste generators not to litter i.e throw or dispose of any waste such as paper, water bottles, liquor bottles, soft drink canes, tetra packs, fruit peel, wrappers, etc., or burn or bury waste on streets, open public spaces, drains, waste bodies and to segregate the waste at source as prescribed under these rules and hand over the segregated waste to authorised the waste pickers or waste collectors authorised by the local body;

(h) setup material recovery facilities or secondary storage facilities with sufficient space for sorting of recyclable materials to enable informal or authorised waste pickers and waste collectors to separate recyclables from the waste and provide easy access to waste pickers and recyclers for collection of segregated recyclable waste such as paper, plastic, metal, glass, textile from the source of generation or from material recovery facilities; Bins for storage of bio-degradable wastes shall be painted green, those for storage of recyclable wastes shall be printed white and those for storage of other wastes shall be printed black;
(i) establish waste deposition centres for domestic hazardous waste and give direction for waste generators to deposit domestic hazardous wastes at this centre for its safe disposal. Such facility shall be established in a city or town in a manner that one centre is set up for the area of twenty square kilometers or part thereof and notify the timings of receiving domestic hazardous waste at such centres;

(j) ensure safe storage and transportation of the domestic hazardous waste to the hazardous waste disposal facility or as may be directed by the State Pollution Control Board or the Pollution Control Committee;

(k) direct street sweepers not to burn tree leaves collected from street sweeping and store them separately and handover to the waste collectors or agency authorised by local body;

(l) provide training on solid waste management to waste-pickers and waste collectors;

(m) collect waste from vegetable, fruit, flower, meat, poultry and fish market on day to day basis and promote setting up of decentralised compost plant or bio-methanation plant at suitable locations in the markets or in the vicinity of markets ensuring hygienic conditions;

(n) collect separately waste from sweeping of streets, lanes and by-lanes daily, or on alternate days or twice a week depending on the density of population, commercial activity and local situation;

(o) set up covered secondary storage facility for temporary storage of street sweepings and silt removed from surface drains in cases where direct collection of such waste into transport vehicles is not convenient. Waste so collected shall be collected and disposed of at regular intervals as decided by the local body;

(p) collect horticulture, parks and garden waste separately and process in the parks and gardens, as far as possible;

(q) transport segregated bio-degradable waste to the processing facilities like compost plant, bio-methanation plant or any such facility. Preference shall be given for on site processing of such waste;

(r) transport non-bio-degradable waste to the respective processing facility or material recovery facilities or secondary storage facility;

(s) transport construction and demolition waste as per the provisions of the Construction and Demolition Waste management Rules, 2016;

(t) involve communities in waste management and promotion of home composting, bio-gas generation, decentralised processing of waste at community level subject to control of odour and maintenance of hygienic conditions around the facility;

(u) phase out the use of chemical fertilizer in two years and use compost in all parks, gardens maintained by the local body and wherever possible in other places under its jurisdiction. Incentives may be provided to recycling initiatives by informal waste recycling sector.

(v) facilitate construction, operation and maintenance of solid waste processing facilities and associated infrastructure on their own or with private sector participation or through any agency for optimum utilisation of various components of solid waste adopting suitable technology including the following technologies and adhering to the guidelines issued by the Ministry of Urban Development from time to time and standards prescribed by the Central Pollution Control Board. Preference shall be given to decentralised processing to minimize transportation cost and environmental impacts such as-

a) bio-methanation, microbial composting, vermi-composting, anaerobic digestion or any other appropriate processing for bio-stabilisation of biodegradable wastes;

b) waste to energy processes including refused derived fuel for combustible fraction of waste or supply as feedstock to solid waste based power plants or cement kilns;

(w) undertake on their own or through any other agency construction, operation and maintenance of sanitary landfill and associated infrastructure as per Schedule 1 for disposal of residual wastes in a manner prescribed under these rules;

(x) make adequate provision of funds for capital investments as well as operation and maintenance of solid waste management services in the annual budget ensuring that funds for discretionary functions of the local body have been allocated only after meeting the requirement of necessary funds for solid waste management and other obligatory functions of the local body as per these rules;

(y) make an application in Form-I for grant of authorisation for setting up waste processing, treatment or disposal facility, if the volume of waste is exceeding five metric tones per day including sanitary landfills from the State Pollution Control Board or the Pollution Control Committee, as the case may be;

(z) submit application for renewal of authorisation at least sixty days before the expiry of the validity of authorisation;
(za) prepare and submit annual report in Form IV on or before the 30th April of the succeeding year to the Commissioner or Director, Municipal Administration or designated Officer;

(zb) the annual report shall then be sent to the Secretary -in-Charge of the State Urban Development Department or village panchayat or rural development department and to the respective State Pollution Control Board or Pollution Control Committee by the 31st May of every year;

(zc) educate workers including contract workers and supervisors for door to door collection of segregated waste and transporting the unmixed waste during primary and secondary transportation to processing or disposal facility;

(zd) ensure that the operator of a facility provides personal protection equipment including uniform, fluorescent jacket, hand gloves, raincoats, appropriate foot wear and masks to all workers handling solid waste and the same are used by the workforce;

(ze) ensure that provisions for setting up of centers for collection, segregation and storage of segregated wastes, are incorporated in building plan while granting approval of building plan of a group housing society or market complex; and

(zf) frame bye-laws and prescribe criteria for levying of spot fine for persons who litters or fails to comply with the provisions of these rules and delegate powers to officers or local bodies to levy spot fines as per the bye laws framed; and

(zg) create public awareness through information, education and communication campaign and educate the waste generators on the following; namely:-

(i) not to litter;

(ii) minimise generation of waste;

(iii) reuse the waste to the extent possible;

(iv) practice segregation of waste into bio-degradable, non-biodegradable (recyclable and combustible), sanitary waste and domestic hazardous wastes at source;

(v) practice home composting, vermi-composting, bio-gas generation or community level composting;

(vi) wrap securely used sanitary waste as and when generated in the pouches provided by the brand owners or a suitable wrapping as prescribed by the local body and place the same in the bin meant for non-biodegradable waste;

(vii) storage of segregated waste at source in different bins;

(viii) handover segregated waste to waste pickers, waste collectors, recyclers or waste collection agencies; and

(ix) pay monthly user fee or charges to waste collectors or local bodies or any other person authorised by the local body for sustainability of solid waste management.

(zh) stop land filling or dumping of mixed waste soon after the timeline as specified in rule 23 for setting up and operationalisation of sanitary landfill is over;

(zi) allow only the non-usable, non-recyclable, non-biodegradable, non-combustible and non-reactive inert waste and pre-processing rejects and residues from waste processing facilities to go to sanitary landfill and the sanitary landfill sites shall meet the specifications as given in Schedule–I, however, every effort shall be made to recycle or reuse the rejects to achieve the desired objective of zero waste going to landfill;

(zj) investigate and analyse all old open dumpsites and existing operational dumpsites for their potential of bio-mining and bio-remediation and wheresoever feasible, take necessary actions to bio-mine or bio-remediate the sites;

(zk) in absence of the potential of bio-mining and bio-remediation of dumpsite, it shall be scientifically capped as per landfill capping norms to prevent further damage to the environment.

16. **Duties of State Pollution Control Board or Pollution Control Committee.**- (1) The State Pollution Control Board or Pollution Control Committee shall,-

(a) enforce these rules in their State through local bodies in their respective jurisdiction and review implementation of these rules at least twice a year in close coordination with concerned Directorate of Municipal Administration or Secretary-in-charge of State Urban Development Department;

(b) monitor environmental standards and adherence to conditions as specified under the Schedule I and Schedule II for waste processing and disposal sites;

(c) examine the proposal for authorisation and make such inquiries as deemed fit, after the receipt of the application for the same in Form I from the local body or any other agency authorised by the local body;
(d) while examining the proposal for authorisation, the requirement of consents under respective enactments and views of other agencies like the State Urban Development Department, the Town and Country Planning Department, District Planning Committee or Metropolitan Area Planning Committee, as may be applicable, Airport or Airbase Authority, the Ground Water Board, Railways, power distribution companies, highway department and other relevant agencies shall be taken into consideration and they shall be given four weeks time to give their views, if any;

(e) issue authorisation within a period of sixty days in Form II to the local body or an operator of a facility or any other agency authorised by local body stipulating compliance criteria and environmental standards as specified in Schedules I and II including other conditions, as may be necessary;

(f) synchronise the validity of said authorisation with the validity of the consents;

(g) suspend or cancel the authorization issued under clause (a) any time, if the local body or operator of the facility fails to operate the facility as per the conditions stipulated:

provided that no such authorization shall be suspended or cancelled without giving notice to the local body or operator, as the case may be; and

(h) on receipt of application for renewal, renew the authorisation for next five years, after examining every application on merit and subject to the condition that the operator of the facility has fulfilled all the provisions of the rules, standards or conditions specified in the authorisation, consents or environment clearance.

(2) The State Pollution Control Board or Pollution Control Committee shall, after giving reasonable opportunity of being heard to the applicant and for reasons thereof to be recorded in writing, refuse to grant or renew an authorisation.

(3) In case of new technologies, where no standards have been prescribed by the Central Pollution Control Board, State Pollution Control Board or Pollution Control Committee, as the case may be, shall approach Central Pollution Control Board for getting standards specified.

(4) The State Pollution Control Board or the Pollution Control Committee, as the case may be, shall monitor the compliance of the standards as prescribed or laid down and treatment technology as approved and the conditions stipulated in the authorisation and the standards specified in Schedules I and II under these rules as and when deemed appropriate but not less than once in a year.

(5) The State Pollution Control Board or the Pollution Control Committee may give directions to local bodies for safe handling and disposal of domestic hazardous waste deposited by the waste generators at hazardous waste deposition facilities.

(6) The State Pollution Control Board or the Pollution Control Committee shall regulate Inter-State movement of waste.

17. Duty of manufacturers or brand owners of disposable products and sanitary napkins and diapers.- (1) All manufacturers of disposable products such as tin, glass, plastics packaging, etc., or brand owners who introduce such products in the market shall provide necessary financial assistance to local authorities for establishment of waste management system.

(2) All such brand owners who sell or market their products in such packaging material which are non-biodegradable shall put in place a system to collect back the packaging waste generated due to their production.

(3) Manufacturers or brand owners or marketing companies of sanitary napkins and diapers shall explore the possibility of using all recyclable materials in their products or they shall provide a pouch or wrapper for disposal of each napkin or diapers along with the packet of their sanitary products.

(4) All such manufacturers, brand owners or marketing companies shall educate the masses for wrapping and disposal of their products.

18. Duties of the industrial units located within one hundred km from the refused derived fuel and waste to energy plants based on solid waste- All industrial units using fuel and located within one hundred km from a solid waste based refused derived fuel plant shall make arrangements within six months from the date of notification of these rules to replace at least five percent of their fuel requirement by refused derived fuel so produced.

19. Criteria for Duties regarding setting-up solid waste processing and treatment facility.- (1) The department in-charge of the allocation of land assignment shall be responsible for providing suitable land for setting up of the solid waste processing and treatment facilities and notify such sites by the State Government or Union territory Administration.

(2) The operator of the facility shall design and set up the facility as per the technical guidelines issued by the Central Pollution Control Board in this regard from time to time and the manual on solid waste management prepared by the Ministry of Urban Development.
(3) The operator of the facility shall obtain necessary approvals from the State Pollution Control Board or Pollution Control Committee.

(4) The State Pollution Control Board or Pollution Control Committee shall monitor the environment standards of the operation of the solid waste processing and treatment facilities.

(5) The operator of the facility shall be responsible for the safe and environmentally sound operations of the solid waste processing and or treatment facilities as per the guidelines issued by the Central Pollution Control Board from time to time and the Manual on Municipal Solid Waste Management published by the Ministry of Urban Development and updated from time to time.

(6) The operator of the solid waste processing and treatment facility shall submit annual report in Form III each year by 30th April to the State Pollution Control Board or Pollution Committee and concerned local body.

20. **Criteria and actions to be taken for solid waste management in hilly areas.**— In the hilly areas, the duties and responsibilities of the local authorities shall be the same as mentioned in rule 15 with additional clauses as under:

(a) Construction of landfill on the hill shall be avoided. A transfer station at a suitable enclosed location shall be setup to collect residual waste from the processing facility and inert waste. A suitable land shall be identified in the plain areas down the hill within 25 kilometers for setting up sanitary landfill. The residual waste from the transfer station shall be disposed of at this sanitary landfill.

(b) In case of non-availability of such land, efforts shall be made to set up regional sanitary landfill for the inert and residual waste.

(c) Local body shall frame Bye-laws and prohibit citizen from littering wastes on the streets and give strict direction to the tourists not to dispose any waste such as paper, water bottles, liquor bottles, soft drink canes, tetra packs, any other plastic or paper waste on the streets or down the hills and instead direct to deposit such waste in the litter bins that shall be placed by the local body at all tourist destinations.

(d) Local body shall arrange to convey the provisions of solid waste management under the bye-laws to all tourists visiting the hilly areas at the entry point in the town as well as through the hotels, guest houses or like where they stay and by putting suitable hoardings at tourist destinations.

(e) Local body may levy solid waste management charge from the tourist at the entry point to make the solid waste management services sustainable.

(f) The department in-charge of the allocation of land assignment shall identify and allot suitable space on the hills for setting up decentralised waste processing facilities. Local body shall set up such facilities. Step garden system may be adopted for optimum utilisation of hill space.

21. **Criteria for waste to energy process.**— (1) Non recyclable waste having calorific value of 1500 K/cal/kg or more shall not be disposed of on landfills and shall only be utilised for generating energy either or through refuse derived fuel or by giving away as feed stock for preparing refuse derived fuel.

(2) High calorific wastes shall be used for co-processing in cement or thermal power plants.

(3) The local body or an operator of facility or an agency designated by them proposing to set up waste to energy plant of more than five tones per day processing capacity shall submit an application in Form-I to the State Pollution Control Board or Pollution Control Committee, as the case may be, for authorisation.

(4) The State Pollution Control Board or Pollution Control Committee, on receiving such application for setting up waste to energy facility, shall examine the same and grant permission within sixty days.

22. **Time frame for implementation.**— Necessary infrastructure for implementation of these rules shall be created by the local bodies and other concerned authorities, as the case may be, on their own, by directly or engaging agencies within the time frame specified below:

<table>
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<th>Sl. No.</th>
<th>Activity</th>
<th>Time limit from the date of notification of rules</th>
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<tbody>
<tr>
<td>(1)</td>
<td>Identification of suitable sites for setting up solid waste processing facilities</td>
<td>1 year</td>
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</table>
2. Identification of suitable sites for setting up common regional sanitary landfill facilities for suitable clusters of local authorities under 0.5 million population and for setting up common regional sanitary landfill facilities or stand alone sanitary landfill facilities by all local authorities having a population of 0.5 million or more. 1 year

3. Procurement of suitable sites for setting up solid waste processing facility and sanitary landfill facilities. 2 years

4. Enforcing waste generators to practice segregation of bio degradable, recyclable, combustible, sanitary waste domestic hazardous and inert solid wastes at source. 2 years

5. Ensure door to door collection of segregated waste and its transportation in covered vehicles to processing or disposal facilities. 2 years

6. Ensure separate storage, collection and transportation of construction and demolition wastes. 2 years

7. Setting up solid waste processing facilities by all local bodies having 100000 or more population. 2 years

8. Setting up solid waste processing facilities by local bodies and census towns below 100000 population. 3 years

9. Setting up common or stand alone sanitary landfills by or for all local bodies having 0.5 million or more population for the disposal of only such residual wastes from the processing facilities as well as untreated inert wastes as permitted under the Rules. 3 years

10. Setting up common or regional sanitary landfills by all local bodies and census towns under 0.5 million population for the disposal of permitted waste under the rules. 3 years

11. Bio-remediation or capping of old and abandoned dump sites. 5 years

23. **State Level Advisory Body.** – (1) Every Department in-charge of local bodies of the concerned State Government or Union territory administration shall constitute a State Level Advisory Body within six months from the date of notification of these rules comprising the following members, namely:-

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<tr>
<th>Sl. No</th>
<th>Designation</th>
<th>Member</th>
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<tbody>
<tr>
<td>1.</td>
<td>Secretary, Department of Urban Development or Local self government department of the State</td>
<td>Chairperson, ex-officio</td>
</tr>
<tr>
<td>2.</td>
<td>One representative of Panchayats or Rural development Department not below the rank of Joint Secretary to State Government</td>
<td>Member, ex-officio</td>
</tr>
<tr>
<td>3.</td>
<td>One representative of Revenue Department of State Government</td>
<td>Member, ex-officio</td>
</tr>
<tr>
<td>4.</td>
<td>One representative from Ministry of Environment, Forest and Climate Change Government of India</td>
<td>Member, ex-officio</td>
</tr>
</tbody>
</table>
5. One representative from Ministry of Urban Development, Government of India Member, ex-officio
6. One representative from Ministry of Rural Development, Government of India Member, ex-officio
7. One representative from the Central Pollution Control Board Member, ex-officio
8. One representative from the State Pollution Control Board or Pollution Control Committee Member, ex-officio
9. One representative from Indian Institute of Technology or National Institute of Technology Member, Ex-officio
10. Chief town planner of the state Member
11. Three representatives from the local bodies by rotation Member
12. Two representatives from census towns or urban agglomerations by rotation. Member
13. One representative from reputed Non-Governmental Organisation or Civil Society working for the waste pickers or informal recycler or solid waste management Member
14. One representative from a body representing Industries at the State or Central level Member
15. One representative from waste recycling industry Member
16. Two subject experts Member
17. Co-opt one representative each from agriculture department, and labour department of State Government. Member

(2) The State Level Advisory Body shall meet at least one in every six months to review the matters related to implementation of these rules, state policy and strategy on solid waste management and give advice to state government for taking measures that are necessary for expeditious and appropriate implementation of these rules.

(3) The copies of the review report shall be forwarded to the State Pollution Control Board or Pollution Control Committee for necessary action.

24. Annual report.- (1) The operator of facility shall submit the annual report to the local body in Form-III on or before the 30th day of April every year.

(2) The local body shall submit its annual report in Form-IV to State P Control Board or P Committee and the Secretary-in-Charge of the Department of Urban Development of the concerned State or Union Territory in case of metropolitan city and to the Director of Municipal Administration or Commissioner of Municipal Administration or Officer in-Charge of Urban local bodies in the state in case of all other local bodies of state on or before the 30th day of June every year.

(3) Each State Pollution Control Board or Pollution Control Committee as the case may be, shall prepare and submit the consolidated annual report to the Central Pollution Control Board and Ministry of Urban Development on the implementation of these rules and action taken against non-complying local body by the 31st day of July of each year in Form-V.

(4) The Central Pollution Control Board shall prepare a consolidated annual review report on the status of implementation of these rules by local bodies in the country and forward the same to the Ministry of Urban Development.
and Ministry of Environment, Forest and Climate Change, along with its recommendations before the 31\textsuperscript{st} day of August each year.

(5) The annual report shall be reviewed by the Ministry of Environment, Forest and Climate Change during the meeting of Central Monitoring Committee.

25. Accident reporting- In case of an accident at any solid waste processing or treatment or disposal facility or landfill site, the Officer-in-charge of the facility shall report to the local body in Form-VI and the local body shall review and issue instructions if any, to the in-charge of the facility.

SCHEDULE I
[see rule 15 (w),(zi), 16 (1) (b) (e), 16 (4)]

Specifications for Sanitary Landfills

(A) Criteria for site selection.-

(i) The department in the business allocation of land assignment shall provide suitable site for setting up of the solid waste processing and treatment facilities and notify such sites.

(ii) The sanitary landfill site shall be planned, designed and developed with proper documentation of construction plan as well as a closure plan in a phased manner. In case a new landfill facility is being established adjoining an existing landfill site, the closure plan of existing landfill should form a part of the proposal of such new landfill.

(iii) The landfill sites shall be selected to make use of nearby wastes processing facilities. Otherwise, wastes processing facility shall be planned as an integral part of the landfill site.

(iv) Landfill sites shall be set up as per the guidelines of the Ministry of Urban Development, Government of India and Central Pollution Control Board.

(v) The existing landfill sites which are in use for more than five years shall be improved in accordance with the specifications given in this Schedule.

(vi) The landfill site shall be large enough to last for at least 20-25 years and shall develop ‘landfill cells’ in a phased manner to avoid water logging and misuse.

(vii) The landfill site shall be 100 meter away from river, 200 meter from a pond, 200 meter from Highways, Habitations, Public Parks and water supply wells and 20 km away from Airports or Airbase. However in a special case, landfill site may be set up within a distance of 10 and 20 km away from the Airport/Airbase after obtaining no objection certificate from the civil aviation authority/Air force as the case may be. The Landfill site shall not be permitted within the flood plains as recorded for the last 100 years, zone of coastal regulation, wetland, Critical habitat areas, sensitive eco-fragile areas..

(viii) A buffer zone of no development shall be maintained around solid waste processing and disposal facility, exceeding five Tonnes per day of installed capacity. This will be maintained within the total area of the solid waste processing and disposal facility. The buffer zone shall be prescribed on case to case basis by the local body in consultation with concerned State Pollution Control Board.

(ix) The biomedical waste shall be disposed of in accordance with the Bio-medical Waste Management Rules, 2016, as amended from time to time. The hazardous waste shall be managed in accordance with the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, as amended from time to time. The E-waste shall be managed in accordance with the e-Waste (Management) Rules, 2016 as amended from time to time.

(xi) Temporary storage facility for solid waste shall be established in each landfill site to accommodate the waste in case of non-operation of waste processing and during emergency or natural calamities.

(B) Criteria for development of facilities at the sanitary landfills.-

(i) Landfill site shall be fenced or hedged and provided with proper gate to monitor incoming vehicles, to prevent entry of unauthorised persons and stray animals

(ii) The approach and / internal roads shall be concreted or paved so as to avoid generation of dust particles due to vehicular movement and shall be so designed to ensure free movement of vehicles and other machinery.

(iii) The landfill site shall have waste inspection facility to monitor waste brought in for landfilling, office facility for record keeping and shelter for keeping equipment and machinery including pollution monitoring equipment. The operator of the facility shall maintain record of waste received, processed and disposed.
Provisions like weigh bridge to measure quantity of waste brought at landfill site, fire protection equipment and other facilities as may be required shall be provided.

Utilities such as drinking water and sanitary facilities (preferably washing/bathing facilities for workers) and lighting arrangements for easy landfill operations during night hours shall be provided.

Safety provisions including health inspections of workers at landfill sites shall be carried out made.

Provisions for parking, cleaning, washing of transport vehicles carrying solid waste shall be provided. The wastewaster so generated shall be treated to meet the prescribed standards.

**Criteria for specifications for landfill operations and closure on completion of landfilling.**

(i) Waste for landfill shall be compacted in thin layers using heavy compactors to achieve high density of the waste. In high rainfall areas where heavy compactors cannot be used, alternative measures shall be adopted.

(ii) Till the time waste processing facilities for composting or recycling or energy recovery are set up, the waste shall be sent to the sanitary landfill. The landfill cell shall be covered at the end of each working day with minimum 10 cm of soil, inert debris or construction material.

(iii) 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.

(iv) After completion of landfill, a final cover shall be designed to minimise 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 cm of clay or amended soil with permeability coefficient less than $1 \times 10^{-7}$ 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 minimise erosion.

**Criteria for pollution prevention.** In order to prevent pollution from landfill operations, the following provisions shall be made, namely:-

(i) The storm water drain shall be designed and constructed in such a way that the surface runoff water is diverted from the landfilling site and leachates from solid waste locations do not get mixed with the surface runoff water. Provisions for diversion of storm water discharge drains shall be made to minimise leachate generation and prevent pollution of surface water and also for avoiding flooding and creation of marshy conditions.

(ii) 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) shall have liner of composite barrier of 1.5 mm thick high density polyethylene (HDPE) geo-membrane or geo-synthetic liners, or equivalent, overlying 90 cm of soil (clay or amended soil) having permeability coefficient not greater than $1 \times 10^{-7}$ cm/sec. The highest level of water table shall be at least two meter below the base of clay or amended soil barrier layer provided at the bottom of landfills.

(iii) Provisions for management of leachates including its collection and treatment shall be made. The treated leachate shall be recycled or utilized as permitted, otherwise shall be released into the sewerage line, after meeting the standards specified in Schedule- II. In no case, leachate shall be released into open environment.

(iv) Arrangement shall be made to prevent leachate runoff from landfill area entering any drain, stream, river, lake or pond. In case of mixing of runoff water with leachate or solid waste, the entire mixed water shall be treated by the concern authority.

**Criteria for water quality monitoring.**

(i) 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 meter of the periphery of landfill site shall be periodically monitored covering different seasons in a year that is, summer, monsoon and post-monsoon period to ensure that the ground water is not contaminated.

(ii) Usage of groundwater in and around landfill sites for any purpose (including drinking and irrigation) shall be considered only after ensuring its quality. The following specifications for drinking water quality shall apply for monitoring purpose, namely :-
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<td>Arsenic</td>
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<td>Cadmium</td>
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<td>Chromium(as Cr(^{6+}))</td>
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<td>Copper</td>
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<td></td>
<td>Lead</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Mercury</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Nickel</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Nitrate as NO(_3)</td>
<td>45.0</td>
</tr>
<tr>
<td></td>
<td>pH</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td></td>
<td>Iron</td>
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</tr>
<tr>
<td></td>
<td>Total hardness (as CaCO(_3))</td>
<td>300.0</td>
</tr>
<tr>
<td></td>
<td>Chlorides</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>Dissolved solids</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>Phenolic compounds (as C(_6)H(_5)OH)</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Zinc</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>Sulphate (as SO(_4))</td>
<td>200</td>
</tr>
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</table>

**Criteria for ambient air quality monitoring.**

(i) Landfill gas control system including gas collection system shall be installed at landfill site to minimize odour, prevent off-site migration of gases, to protect vegetation planted on the rehabilitated landfill surface. For enhancing landfill gas recovery, use of geomembranes in cover systems along with gas collection wells should be considered.

(ii) The concentration of methane gas generated at landfill site shall not exceed 25 per cent of the lower explosive limit (LEL).

(iii) 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 escape directly to the atmosphere or for illegal tapping. Passive venting shall be allowed in case if its utilisation or flaring is not possible.

(iv) Ambient air quality at the landfill site and at the vicinity shall be regularly monitored. Ambient air quality shall
meet the standards prescribed by the Central Pollution Control Board for Industrial area.

**G. Criteria for plantation at landfill Site.** A vegetative cover shall be provided over the completed site in accordance with the following specifications, namely:-

(a) Locally adopted non-edible perennial plants that are resistant to drought and extreme temperatures shall be planted;
(b) The selection of plants should be of such variety 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 minimise soil erosion.
(e) Green belts shall be developed all around the boundary of the landfill in consultation with State Pollution Control Boards or Pollution Control Committees.

**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 and around landfill;
(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 emission and leachate quality analysis complies with the specified standards and the soil stability is ensured.

**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 local body with the approval of the concerned State Pollution Control Board or the Pollution Control Committee. The local body shall set up processing facilities for utilisation of biodegradable organic waste. The non-biodegradable recyclable materials shall be stored and sent for recycling periodically. The inert and non-biodegradable waste shall be used for building roads or filling-up of appropriate areas on hills. In case of constraints in finding adequate land in hilly areas, waste not suitable for road-laying or filling up shall be disposed of in regional landfills in plain areas.

**J. Closure and Rehabilitation of Old Dumps** Solid waste dumps which have reached their full capacity or those which will not receive additional waste after setting up of new and properly designed landfills should be closed and rehabilitated by examining the following options:

(i) Reduction of waste by bio mining and waste processing followed by placement of residues in new landfills or capping as in (ii) below.
(i) Capping with solid waste cover or solid waste cover enhanced with geomembrane to enable collection and flaring / utilisation of greenhouse gases.
(iii) Capping as in (ii) above with additional measures (in alluvial and other coarse grained soils) such as cut-off walls and extraction wells for pumping and treating contaminated ground water.
(iv) Any other method suitable for reducing environmental impact to acceptable level.

**SCHEDULE II**

[see rule 16 (1), (b), (e), 16 (4)]

**Standards of processing and treatment of solid waste**

**A. Standards for composting.** The waste processing facilities shall include composting as one of the technologies for processing of biodegradable waste. In order to prevent pollution from compost plant, the following shall be complied with namely:-

(a) The incoming organic waste at site shall be stored properly 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;
(b) Necessary precaution shall be taken to minimise nuisance of odour, flies, rodents, bird menace and fire hazard;
(c) 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;

(d) 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-recyclable high calorific fractions to be segregated and sent to waste to energy or for RDF production, co-processing in cement plants or to thermal power plants. Only rejects from all processes shall be sent for sanitary landfill site(s).

(e) The windrow area shall be provided with impermeable base. Such a base shall be made of concrete or compacted clay of 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;

(f) Ambient air quality monitoring shall be regularly carried out. Odour nuisance at down-wind direction on the boundary of processing plant shall also be checked regularly.

(g) Leachate shall be re-circulated in compost plant for moisture maintenance.

(h) The end product compost shall meet the standards prescribed under Fertilizer Control Order notified from time to time.

(i) In order to ensure safe application of compost, the following specifications for compost quality shall be met, namely:

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<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Arsenic (mg/Kg)</td>
<td>10.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Cadmium (mg/Kg)</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Chromium (mg/Kg)</td>
<td>50.00</td>
<td>50.00</td>
</tr>
<tr>
<td>Copper (mg/Kg)</td>
<td>300.00</td>
<td>300.00</td>
</tr>
<tr>
<td>Lead (mg/Kg)</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Mercury (mg/Kg)</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Nickel (mg/Kg)</td>
<td>50.00</td>
<td>50.00</td>
</tr>
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<td>1000.00</td>
</tr>
<tr>
<td>C/N ratio</td>
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<td>Less than 20:1</td>
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<tr>
<td>pH</td>
<td>6.5-7.5</td>
<td>(1:5 solution) maximum 6.7</td>
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<td>Moisture, percent by weight, maximum</td>
<td>15.0-25.0</td>
<td>25.0</td>
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<tr>
<td>Bulk density (g/cm$^3$)</td>
<td>&lt;1.0</td>
<td>Less than 1.6</td>
</tr>
<tr>
<td>Total Organic Carbon, per cent by weight, minimum</td>
<td>12.0</td>
<td>7.9</td>
</tr>
<tr>
<td>Parameter</td>
<td>Standards</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-------------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inland surface water</td>
<td>Public sewers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Nitrogen (as N), per cent by weight, minimum</td>
<td>0.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Total Phosphate (as P₂O₅) percent by weight, minimum</td>
<td>0.4</td>
<td>10.4</td>
</tr>
<tr>
<td>Total Potassium (as K₂O), percent by weight, minimum</td>
<td>0.4</td>
<td>-</td>
</tr>
<tr>
<td>Colour</td>
<td>Dark brown to black</td>
<td>-</td>
</tr>
<tr>
<td>Odour</td>
<td>Absence of foul Odor</td>
<td>-</td>
</tr>
<tr>
<td>Particle size</td>
<td>Minimum 90% material should pass through 4.0 mm IS sieve</td>
<td>Minimum 90% material should pass through 4.0 mm IS sieve</td>
</tr>
<tr>
<td>Conductivity (as ds/m-l), not more than</td>
<td>4.0</td>
<td>8.2</td>
</tr>
</tbody>
</table>

* 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 meet the following standards, namely:

<table>
<thead>
<tr>
<th>S. No</th>
<th>Parameter</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Inland surface water</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td></td>
<td>(2)</td>
</tr>
<tr>
<td>1.</td>
<td>Suspended solids, mg/l, max</td>
<td>100</td>
</tr>
<tr>
<td>2.</td>
<td>Dissolved solids (inorganic) mg/l, max.</td>
<td>2100</td>
</tr>
<tr>
<td>3</td>
<td>pH value</td>
<td>5.5 to 9.0</td>
</tr>
<tr>
<td>4</td>
<td>Ammonical nitrogen (as N), mg/l, max.</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>Total Kjeldahl nitrogen (as N), mg/l, max.</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>Biochemical oxygen demand (3 days at 27°C) max.(mg/l)</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>Chemical oxygen demand, mg/l, max.</td>
<td>250</td>
</tr>
<tr>
<td>8</td>
<td>Arsenic (as As), mg/l, max</td>
<td>0.2</td>
</tr>
<tr>
<td>9</td>
<td>Mercury (as Hg), mg/l, max</td>
<td>0.01</td>
</tr>
<tr>
<td>10</td>
<td>Lead (as Pb), mg/l, max</td>
<td>0.1</td>
</tr>
<tr>
<td>11</td>
<td>Cadmium (as Cd), mg/l, max</td>
<td>2.0</td>
</tr>
<tr>
<td>Parameter</td>
<td>Emission standard</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>Particulates</td>
<td>50 mg/Nm³</td>
<td>Standard refers to half hourly average value</td>
</tr>
<tr>
<td>HCl</td>
<td>50 mg/Nm³</td>
<td>Standard refers to half hourly average value</td>
</tr>
<tr>
<td>SO2</td>
<td>200 mg/Nm³</td>
<td>Standard refers to half hourly average value</td>
</tr>
<tr>
<td>CO</td>
<td>100 mg/Nm³</td>
<td>Standard refers to half hourly average value</td>
</tr>
<tr>
<td></td>
<td>50 mg/Nm³</td>
<td>Standard refers to daily average value</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td>20 mg/Nm³</td>
<td>Standard refers to half hourly average value</td>
</tr>
<tr>
<td>HF</td>
<td>4 mg/Nm³</td>
<td>Standard refers to half hourly average value</td>
</tr>
<tr>
<td>NOx (NO and NO2 expressed as NO2)</td>
<td>400 mg/Nm³</td>
<td>Standard refers to half hourly average value</td>
</tr>
<tr>
<td>Total dioxins and furans</td>
<td>0.1 ng TEQ/Nm³</td>
<td>Standard refers to 6-8 hours sampling. Please refer guidelines for 17 concerned congeners for toxic equivalence values to arrive at total toxic equivalence.</td>
</tr>
<tr>
<td>Cd + Th + their compounds</td>
<td>0.05 mg/Nm³</td>
<td>Standard refers to sampling time anywhere between 30 minutes and 8 hours.</td>
</tr>
<tr>
<td>Hg and its compounds</td>
<td>0.05 mg/Nm³</td>
<td>Standard refers to sampling time anywhere between 30 minutes and 8 hours.</td>
</tr>
</tbody>
</table>

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. Standards for incineration: The Emission from incinerators/thermal technologies in Solid Waste treatment/disposal facility shall meet the following standards, namely:-

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Emission standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
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</tr>
<tr>
<td>Particulates</td>
<td>50 mg/Nm³</td>
</tr>
<tr>
<td>HCl</td>
<td>50 mg/Nm³</td>
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<td>SO2</td>
<td>200 mg/Nm³</td>
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<tr>
<td>CO</td>
<td>100 mg/Nm³</td>
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<tr>
<td></td>
<td>50 mg/Nm³</td>
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<tr>
<td>Total Organic Carbon</td>
<td>20 mg/Nm³</td>
</tr>
<tr>
<td>HF</td>
<td>4 mg/Nm³</td>
</tr>
<tr>
<td>NOx (NO and NO2 expressed as NO2)</td>
<td>400 mg/Nm³</td>
</tr>
<tr>
<td>Total dioxins and furans</td>
<td>0.1 ng TEQ/Nm³</td>
</tr>
<tr>
<td>Cd + Th + their compounds</td>
<td>0.05 mg/Nm³</td>
</tr>
<tr>
<td>Hg and its compounds</td>
<td>0.05 mg/Nm³</td>
</tr>
</tbody>
</table>
## ANNEXURE 1: Population Projections of Nellore

<table>
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<tr>
<th>S.No.</th>
<th>Year</th>
<th>Arithmetic increase</th>
<th>Incremental increase</th>
<th>Geometric increase</th>
<th>State urban average</th>
<th>Graphical increase</th>
<th>Average Population</th>
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### ANNEXURE 2: Waste Projections of Nellore Town

**Year-wise Waste Generation**

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<th>Per capita per year generation with 1.3% increase per capita per year as per NEERI report in kg/year</th>
<th>waste quantity in MT/Day</th>
<th>Gross Per capita generation (in kgs/Day)</th>
<th>Total waste quantity in MT/Year</th>
<th>Biodegradable</th>
<th>Recyclable</th>
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ANNEXURE 3: Chemical Characterisation of MSW in Nellore Town

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SAMPLE COLLECTION INFORMATION
1. Sample Collected From
   - Secondary collection point
   - Transit Point
   - Dumping site
2. Time of Sample Collection
   - 8.30 am
   - 10:00 am
   - 12:30 pm

(Authorised/Signatory)
Mr. Rajesh Jain
### DETAILS OF TEST REPORT - NELLORE CITY

**Company name**: IPE Global Private Limited  
**Address**: IPE Global House, B - B4, Defense Colony, New Delhi  
**D/o Report Issue**: 11/06/2015  
**D/o Sample Received**: 01/06/2015  
**Nature of Sample**: Solid Waste  
**Qty. of Sample**: 10 kg  
**Sample Bag**: Polybag  
**Sample Collected by**: AEL Staff  
**Sampling Location**: Nellore City  
**Date of Sample collection**: 28/05/2015  
**D/o of Completion Analysis**: 09/06/2015

### TEST RESULTS

#### CHEMICAL CHARACTERISTICS

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#### SAMPLE COLLECTION INFORMATION

1. **Sample Collected From**: Household  
2. **Time of Sample Collection**: 8.00 am  
   Household=Commercial  
   Commercial

(Authorized/Signatory)

Mr. Rajesh Jain  
Director
ANNEXURE 4: Quotation for Proposed Infrastructure

NILKAMAL LIMITED

Head Office: Nilkamal House, No. 14, M.I.D.C., Andheri East, Mumbai - 400 053, Tel: 022-28813628/3626
Registered Office: “Nilkamal Complex”, 17th Main, W. 17th Phase, 1st Cross, C. G. Road, Porur, Chennai - 600 016

To,
IPE Global Private Limited
IPE Global House, B-04,
Delhi NCR, New Delhi - 110 074, India

SUBJECT: SOLID WASTE BINS BUDGETARY OFFER

Dear Sir,

We would like to introduce ourselves as a NILKAMAL LIMITED, a company into manufacture of moulded plastic material handling crate & furniture. We are a Public Limited company having dynamism characterised.

NILKAMAL’s Core Businesses in 5 Key:
1. Material Handling Crate, Containers and Rims
2. Molded Furniture such as Chairs, Tables and Cabinets
3. Custom Holders & OEM suppliers for specific customers
4. @Home: the Mega Home Store Retail Chain
5. Service Products for Hospitality Industry

We are glad to inform you that we have been awarded “ISO 9001: CERTIFICATE” by “TUV SUDDISCHUTZ-GERMANY”, as a mark of our very high Quality Management System for manufacturing of Material Handling products i.e. Plastic Crates, SWM Waste Bins, Baskets both type, Turnover Mold & Injection Mold, Racking System & Various Types of Material Handling Equipment.
NILKAMAL LIMITED

Head Office: Nilkamal House, Street No. 1A, M.I.D.C., Andheri East, Mumbai - 400 059. Tel 022-26418888/26419999. Regional Office: "Aarpee Chamber" 2nd Floor, N. Swaraj Chambers, Cal. Rd., Navrangpura, Ahmedabad - 380 009. Tel. 079-2644024 / 26440000. Fax 079-26430002. Email: details@nilkamal.com; www.demobin.nilkamal.com

NILKAMAL has come up with state-of-the-art in HIGH TECH WASTE BINS. We have designed various types of Solid Waste Bins as per the current development and requirement. These Bins are used by various Municipalities, Hotels, Airport, Commercial Complexes, Residential Areas & also public places like parks etc.

The following are the Salient Features:
1. Environment Friendly
2. Long lasting
3. Easy to use and Maintain
4. Safeguard Public Health
5. Prevent Disease, Safe for Workers
6. Resistant to UV Radiation

We are pleased to inform you that NILKAMAL has supplied SOLID WASTE BINS to several Government Authorities they are as follows:

1. AHMEDABAD MUNICIPAL CORPORATION
2. CANDERMAKAR URBAN DEVELOPMENT AUTHORITY
3. DISTRICT RURAL DEVELOPMENT - MEHSANA
4. DISTRICT RURAL DEVELOPMENT - HANGDOD
5. DISTRICT RURAL DEVELOPMENT - PANCHMahAI-GODDARD
6. DISTRICT RURAL DEVELOPMENT - MARSHAD - RANIPALO
7. DISTRICT RURAL DEVELOPMENT - ANRELI
8. RAJKOT URBAN DEVELOPMENT AUTHORITY
9. SURATURBAN DEVELOPMENT AUTHORITY
10. WADODARAMAHANACAR SEVA SADAN
11. TOWN MUNICIPAL COUNCIL K. R. PET - BANGALORE
12. CITY MUNICIPAL COUNCIL - MANDYA - BANGALORE
13. SHIMOGA MUNICIPAL COUNCIL - BANGALORE

Page 2 of 9
As per your requirement we have offered the following best quotes they are as follows:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
<th>Rate @ INR (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HOUSEHOLD BINS:</td>
<td>Rs. 177/-</td>
</tr>
<tr>
<td></td>
<td>MODEL: HMCONSLID101TRW1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manufacturing Process: MOLD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dimension:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imp. Diam.: 142 mm approx.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bottom Diam.: 212 mm approx.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Height (With Lid) : 350 mm approx.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacity: 10 Ltrs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Handle: Flexible Handle with Strong Strength</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Material: HM-HDPE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colour: Red, Blue, Yellow, Crown / White</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Usage: Lock-lid Airtight Container for Door to Door Collection.</td>
<td></td>
</tr>
</tbody>
</table>

Page 3 of 9
### HOUSEHOLD BINS:

<table>
<thead>
<tr>
<th>Model: RC10L1</th>
<th>Injection Mold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions:</td>
<td>Rs. 135/-</td>
</tr>
<tr>
<td>Top O.D.: Dia 270 mm</td>
<td></td>
</tr>
<tr>
<td>Top I.D.: Dia 240 mm</td>
<td></td>
</tr>
<tr>
<td>Bottom O.D.: Dia 200 mm</td>
<td></td>
</tr>
<tr>
<td>Height: 290 mm</td>
<td></td>
</tr>
<tr>
<td>Capacity: 10 Ltrs.</td>
<td></td>
</tr>
<tr>
<td>Material: HDPE</td>
<td></td>
</tr>
<tr>
<td>Colour: Red / Green</td>
<td></td>
</tr>
</tbody>
</table>

### HOUSEHOLD BINS:

<table>
<thead>
<tr>
<th>Model: SPCONL19 20LTR WH</th>
<th>Blow Mold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions:</td>
<td>Rs. 304/-</td>
</tr>
<tr>
<td>Top O.D.: 328 X 360 mm approx.</td>
<td></td>
</tr>
<tr>
<td>Bottom O.D.: 274 mm approx.</td>
<td></td>
</tr>
<tr>
<td>Height (Without Lid): 328 X 75 mm approx.</td>
<td></td>
</tr>
<tr>
<td>Height (Overall): 400 mm approx.</td>
<td></td>
</tr>
<tr>
<td>Capacity: 201Ltr.</td>
<td></td>
</tr>
<tr>
<td>Material: HMHDPE</td>
<td></td>
</tr>
<tr>
<td>Colour: Red / White / Green / Yellow</td>
<td></td>
</tr>
</tbody>
</table>

### TRI-CYCLE WITH 6 BINS:

<table>
<thead>
<tr>
<th>Model: RC3Q40L1</th>
<th>Roto Mold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions:</td>
<td>Rs. 26.709/-</td>
</tr>
<tr>
<td>Top O.D.: 350 X 350 mm approx.</td>
<td></td>
</tr>
<tr>
<td>Bottom O.D.: 285 X 195 mm</td>
<td></td>
</tr>
</tbody>
</table>
**Preparation of Detailed Project Report for MSW Management**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pushcart with 4 bins</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Liner Bin without MS Frame</td>
<td></td>
</tr>
</tbody>
</table>

**NILKAMAL LIMITED**

- **Height**: 455 mm approx.
- **Capacity**: 40 Ltrs.
- **Material**: LDPE
- **Colour**: Blue / Green / Olive Green
- **Price quoted along with TRICYCLE & BINS**

**Pushcart with 4 bins**

- **Model**: HS01
- **Manufacturing Process**: INJECTION MOLD
- **Dimension**: Top OD: 657 mm approx; Bottom OD: 370 mm approx
- **Height**: 485 mm approx
- **Capacity**: 50 ltrs.
- **Material**: HDPE
- **Colour**: Red / Blue / Green / Yellow
- **Price quoted along with PUSH CART & BINS**

**Liner Bin without MS Frame**

- **Model**: RFLB100L1
- **Manufacturing Process**: ROTO MOLD
- **Dimension**: Top OD: 496 X 496 mm approx; Bottom OD: 358 X 358 mm approx
- **Height (Without Lid)**: 705 mm approx
- **Height (With Lid)**: 915 mm approx
- **Capacity**: 100 Ltrs.
- **Material**: LLDE
### NILKAMAL LIMITED

**Address:**
- Head Office: Nilkamal House, Sec-13, Noida, Uttar Pradesh - 201301
- Regional Office: “Kanyadaan Grand” J-4 Floor, Sector 3, Noida-201301
- Email: sales@nilkamal.com

### LITTER BIN WITH MS FRAME

**Price Quoted along with MS Frames & Bin**

<table>
<thead>
<tr>
<th>Colour</th>
<th>Blue / Green / Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usage</td>
<td>Free Stand Litter Bin</td>
</tr>
</tbody>
</table>

- **Rs. 4879/-**

### WHEELED BINS:

**Model:** WB 120L

**Manufacturing Process:** INJECTION MOULDED

**Dimensions:**
- Top OD: 460(L) x 477(B) mm approx.
- Bottom OD: 495(L) x 490(B) mm approx.
- Height (Without Lid): 102 mm approx.
- Height (With Lid): 955 mm approx.
- Capacity: 120 Ltr.

**Material:** EDPE E1 Standard

**Colour:** Green

**Usage:** Wheel Bin

- **Rs. 2429/-**
### Wheel Barrow Model: RCWBL255L1
**Manufacturing Process:** ROTU MOLD  
**Dimensions:**  
- Top O.D.: 1155 x 870 mm approx.  
- Bottom O.D.: 745 x 455 mm approx.  
- Height: 450 mm approx.  
- Capacity: 255 Ltrs.  
- Material: LLDPE  
- Colour: Red/Blue/Green/Yellow

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>721.3/-</td>
</tr>
</tbody>
</table>

### R6 Bin:
**Model:** WB660L1  
**Manufacturing Process:** INJECTION MOLD  
**Dimensions:**  
- Length: 1265 mm approx.  
- Width: 775 mm approx.  
- Height (with Lid): 1165 mm approx.  
- Height (Without Lid): 1065 mm approx.  
- Capacity: 660 Ltrs.  
- Material: HDPE - UV  
- EN - 849 - 2 Standard  
- Colour: Olive Green Only

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2450.9/-</td>
</tr>
</tbody>
</table>
NILKAMAL LIMITED

Model: WB1100L1
Manufacturing Process: INJECTION MOLD
Dimensions:
- Length: 1295 mm approx.
- Width: 1350 mm approx.
- Height (with lid): 1075 mm approx.
- Capacity: 1100 ltrs.
Material: HDPE - UV EN - 840 - 2 Standard
Colours: Citrus Green Only

Rs. 30.774/-

OTHER TERMS & CONDITIONS:
- TAXES: INCLUSIVE
- DELIVERY: Within 20 Days after receipt of the confirm Purchase Order
- P.O.: Destination
- PAYMENT: 100% advance along with the Purchase Order
- VALIDITY: Offer valid for 15 Days
- SCREEN PRINTING: As per requirement in one colour
- OCTORI: If applicable will be borne by the customer
- ROAD PERMIT: If required has to be provided by the customer

It would give us a great pleasure to be associated with you for the keep the surrounding & environment green & clean by using of Solid Waste Bin.

Thanking you and assuring you our best of services for all times.

Page 8 of 9
To,
Programme Manager,
Infrastructure Engineering,
[Company Name]
[Address]

Dated: 04.06.2015

Dear Sir,

Please find our Comparative rates as under:

<table>
<thead>
<tr>
<th>Description</th>
<th>Capacity</th>
<th>Rate Per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Bin</td>
<td>60 litres</td>
<td>Rs. 3750/-</td>
</tr>
<tr>
<td>Litter Bin with MS Frame</td>
<td>100 litres</td>
<td>Rs. 5900/-</td>
</tr>
<tr>
<td>Litter Bin without MS Frame</td>
<td>100 litres</td>
<td>Rs. 2700/-</td>
</tr>
<tr>
<td>Wheeled Bin</td>
<td>120 litres</td>
<td>Rs. 1200/-</td>
</tr>
<tr>
<td>Wheelbarrow</td>
<td>75 litres</td>
<td>Rs. 3700/-</td>
</tr>
<tr>
<td>RC Bin M.S</td>
<td>1100 litres</td>
<td>Rs. 28500/-</td>
</tr>
<tr>
<td>MC Bin</td>
<td>600 litres</td>
<td>Rs. 14300/-</td>
</tr>
<tr>
<td>Tricycle with 6 bins 40 Ltr</td>
<td>Each Bin 40 litres</td>
<td>Rs. 21500/-</td>
</tr>
<tr>
<td>Pressure with 4 bins 50 Ltr</td>
<td>Each Bin 50 litres</td>
<td>Rs. 43000/-</td>
</tr>
<tr>
<td>Tipper Truck</td>
<td>10 cum</td>
<td>Rs. 27,00,000/-</td>
</tr>
<tr>
<td>Refuse Collector with 6 bins</td>
<td>8 cum</td>
<td>Rs. 27,00,000/-</td>
</tr>
<tr>
<td>Refuse Collector cum Compo</td>
<td>14 cum</td>
<td>Rs. 37,50,000/-</td>
</tr>
<tr>
<td>Auto-topper</td>
<td>1.75 cum</td>
<td>Rs. 1,70,000/-</td>
</tr>
<tr>
<td>Auto-tpper</td>
<td>8 cum</td>
<td>Rs. 6,50,000/-</td>
</tr>
</tbody>
</table>

Thanking you,

Yours faithfully,

[Signature]

Name: [Name]

[Company Name]

---

Preparation of Detailed Project Report for MSW Management
Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC)

Preparation of Detailed Project Report for MSW Management

PHOTOGRAPH OF 1120 LTR. BINS

PHOTOGRAPH OF 660 LTR. BINS
Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC)

Preparation of Detailed Project Report for MSW Management

PHOTOGRAPH OF 2 CUM VOLUME REFUSE COMPACTOR VEHICLE

PHOTOGRAPH OF 1.4 CUM VOLUME REFUSE COMPACTOR VEHICLE
# BUDGETARY PRICE SCHEDULE FOR EQUIPMENTS FOR SOLID WASTE MANAGEMENT

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>DESCRIPTION</th>
<th>UNIT PRICE INCLUDING TAXES, DUTIES, FREIGHT &amp; TRUCK CHASSIS (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>1100 Ltrs Capacity MS Bins compatible with Refuse Compactor Vehicle</td>
<td>32,500/-</td>
</tr>
<tr>
<td>2.0</td>
<td>660 Ltrs Capacity MS Bins compatible with Refuse Compactor Vehicle</td>
<td>29,500/-</td>
</tr>
<tr>
<td>3.0</td>
<td>Truck Mounted Garbage Collector Vehicle of 8 cum Volume mounted on 11-12 T GWY BS - IV Truck Chassis</td>
<td>29,50,000/-</td>
</tr>
<tr>
<td>4.0</td>
<td>Truck Mounted Garbage Compactor Vehicle of 14 cum Volume mounted on 16 T GWY BS - IV Truck Chassis</td>
<td>39,35,000/-</td>
</tr>
<tr>
<td>5.0</td>
<td>Truck Mounted Garbage Compactor Vehicle of 8 cum Volume mounted on 11-12 T GWY BS - IV Truck Chassis</td>
<td>31,95,000/-</td>
</tr>
<tr>
<td>6.0</td>
<td>Garbage Tipper 1.8 cum Volume mounted on TATA ACE/MAHINDRA Mini Chassis of Min GWY 1550 Kgs BS - IV Chassis</td>
<td>8,25,000/-</td>
</tr>
<tr>
<td>7.0</td>
<td>Garbage Tipper 1.0 cum Volume mounted on 2 Wheeler Chassis of Min GWY 990 Kgs BS - IV Chassis</td>
<td>6,25,000/-</td>
</tr>
<tr>
<td>8.0</td>
<td>Truck Mounted Road Sweeping Machine having Container Volume of 6 cum mounted on 16 T GWY BS - IV Truck Chassis</td>
<td>65,25,000/-</td>
</tr>
</tbody>
</table>

**Note:**
The above Prices are based on Terms and Conditions enclosed as Annexure-X.
<table>
<thead>
<tr>
<th><strong>TERMS AND CONDITIONS</strong></th>
<th><strong>ANNEXURE - X</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Price basis</strong></td>
<td><strong>Ex-Works Bhawal - Rajasthan</strong></td>
</tr>
<tr>
<td><strong>2. Truck Chassis</strong></td>
<td>The equipment shall be mounted on 1.5T/3T/10T GVW BS-IV Truck Chassis with Non Sleeper driver's cabin and PTO as per specifications.</td>
</tr>
<tr>
<td><strong>3. Excise Duty</strong></td>
<td><strong>FOR SL NO. 1.0, 2.0, 5.0 and 7.0:</strong> Extra as per applicable rates. The Present rate of Excise duty is 12.50%. We shall provide the transporter copy of Invoice to enable the client to avail CENVAT benefit if admissible. However, being a government levy, the payment for Excise duty shall be governed by the rules as shall be applicable at the time of supply.</td>
</tr>
<tr>
<td></td>
<td><strong>FOR SL NO. 3.0, 4.0, 5.0 and 8.0:</strong> Being a &quot;Special Purchase Motor Vehicle&quot; As per present rules Excise duty is Exempted on the truck mounted machines provided full Excise duty has been paid on the cost of truck chassis and no &quot;CENVAT CREDIT&quot; has been claimed on the cost of truck chassis. However, being a government levy, the payment for Excise duty shall be governed by the rules as shall be applicable at the time of supply.</td>
</tr>
<tr>
<td><strong>4. Sales Tax</strong></td>
<td>Extra as applicable. The Present Rate of Sales Tax is 14.5% without Form 'C'. Any Variation plus or minus in the sales tax by the government shall be to the account of the client.</td>
</tr>
<tr>
<td><strong>5. Entry Tax, Octroi and other government taxes and duties</strong></td>
<td>Our quoted prices do not include Entry Tax, Octroi or any other State and Central Government Taxes. Such taxes shall be paid by the client directly or in case, we are advised to pay these taxes the same shall be reimbursed to us as per actuals.</td>
</tr>
<tr>
<td><strong>6. Firmness of Price</strong></td>
<td>The quoted Ex-work Prices is firm. However any variation Plus or Minus in taxes and duties shall be to the account of Client.</td>
</tr>
<tr>
<td><strong>7. Freight</strong></td>
<td>By Client/As Quoted</td>
</tr>
<tr>
<td><strong>8. Transit Insurance</strong></td>
<td>The Client has to arrange the Transit Insurance of the equipment.</td>
</tr>
<tr>
<td><strong>9. Registration Vehicle</strong></td>
<td>As Quoted/By Client</td>
</tr>
<tr>
<td><strong>10. Delivery</strong></td>
<td>3-4 months or earlier Ex-works, Bhawal from the date of receipt of your technically and commercially clear and acceptable order along with advance.</td>
</tr>
</tbody>
</table>
11 Payment Terms

1. **Truck Chassis**:
   a. 100% of the cost of Truck chassis including Taxes against proforma invoice.

2. **Equipment**:
   a. 20% of basic cost of equipment as advance with order.
   b. 80% of basic cost of equipment with 100% Taxes and duties, transport charges, against inspection at the time of delivery in our plant.

12 Guarantee

The equipment shall be under warranty against defects in material and workmanship for a period of 18 months from the date of dispatch or 12 months from the date of commissioning whichever is earlier.

13 Commissioning

We shall depute one of our Commissioning Engineers for a period of 3-4 days for Commissioning of the Machine and for Training 2-3 personnel of the Client in Operation and Maintenance of the Machine.

The Client has to provide all the Consumables such as Diesel, Oil etc. for commissioning of the Machine.
ANNEXURE 5: Technical Specifications for Sanitary Landfill

1.0.0 PREPARATION OF WORK AREA / CLEARING SITE

1.1.0 Scope

This section covers site preparation of the area as indicated in the drawings.

1.2.0 General Requirements

All laboratory equipments and materials required for complete performance of the work in accordance with the drawings and specifications herein.

1.3.0 Clearing Site

Clearing and grubbing operations shall be performed in the entire landfill area. The sites should be cleared of all vegetation, rubbish and all other objectionable or organic matter such as dismantling of RCC, PCC, Brick work, RR masonry and structural steel of abandoned above ground and underground structures along with abandoned cables pipes etc. Trees of specified girth and/or any other cleared material shall be stockpiled and handed over to the Engineer-in-Charge or disposed as per direction of the Engineer-in-Charge.

2.0.0 STRIPPING

2.1.0 Scope

This section of the specification covers stripping of foundation for embankment and in the landfill area as described herein:

2.2.0 General Requirement

The implementing agency shall furnish all labour, equipment and materials--required for complete performance of the work in accordance with the drawings and as described herein.

2.3.0 Stripping of foundations

The entire area of embankment and landfill area as shown in the drawings shall be stripped to 0.15 meter as directed by the Engineer-in-Charge to remove all unsuitable materials. In the portion of the embankment where ground slope is steep the stripping shall be done in a fashion as directed by the Engineer-in-Charge

The unsuitable materials shall include all debris, vegetable matter including roots, weathered and disintegrated rocks, organic silts materials, that are unsuitable for use in the permanent construction or that might interfere with the proper binding of the embankment with the foundation, or the proper compaction of the materials in the embankment, or that may be otherwise objectionable.

The stripping shall be kept far enough in advance of other items of works to ensure that no undesirable material will get mixed with approved embankment material and to allow for inspection and measurement.

Materials from stripping operations shall be deposited on either side of the embankment away from the heel and toe of the embankment and unsuitable material shall be disposed off beyond 50 m but upto a lead of 500 m to an area identified by the
Engineer-in-Charge

Should the excavation be done deeper by error, the same shall be made good by filling the same with approved earth and properly compacted so that the required formation level is obtained at the Implementing agency’s cost except in areas where further excavation is required for laying clay foundation. In such cases the extra excavation under stripping may be considered under excavation if approved by Engineer-in-Charge

3.0.0 EXCAVATION & FILLING WORK

3.1.0 Scope

3.1.1 This section of specification covers the technical requirements for excavation and filling in and around structures, pipes, trenches, wall foundations, pits, drains and similar works. This also covers filling areas and plinth with selected materials, conveyance and disposal of surplus soils and/or stacking them properly as directed by Engineer-in-Charge

3.1.2 Existing trees, shrubs, any other plants, pole, lines, signs, monuments, buildings, pipelines, drains, sewers, facilities within or adjacent to the works being carried out which are not to be disturbed shall be protected from damage by the Implementing agency. The implementing agency shall provide and install suitable safeguards approved by the Engineer-in-Charge for this purpose.

3.1.3 During excavation, the implementing agency shall take all necessary precautions against soil erosion, water and environmental pollution and where required undertake additional works to achieve this objective. Before start of operations, the implementing agency shall submit to the Engineer-in-Charge for approval, his work plan and procedure he intends to follow for disposal of waste material etc. and the schedule for carrying out temporary and permanent works. However, the approval of the Engineer-in-Charge shall not absolve the implementing agency of his responsibility for safe and sound work.

3.2.0 Excavation in Soil

3.2.1 Sides and bottoms of excavation shall be sharp and true to line and level. Undercutting shall not be permitted. When machines are used for excavation, the last 300 mm before reaching the required level shall be excavated manually or by such equipment, such that soil at the required final level will be left in its natural condition. Suitability of strata (at the bottom of excavations) for laying the foundation there on shall be determined by the Engineer-in-Charge.

3.2.2 The bottom of all excavations shall be trimmed to required levels.

3.2.3 Necessary arrangements i.e. Cofferdams, sheeting, shoring, bracing, maintaining, suitable slopes, draining etc. shall be provided and installed to the satisfaction of the Engineer-in-Charge

3.2.4 Any water collected in excavated pits and other areas due to rain water/ground water, sludge’s, springs etc shall have to be constantly pumped out and maintain dry working conditions at all times until the excavation, placement of foundation/liner arrangement, backfilling etc. is completed. All slush/ muck from the excavated areas shall be removed to keep the work area dry.

3.2.5 All materials shall be removed arising from excavations from the vicinity to the work either for direct filling, stacking and subsequent filling or for ultimate disposal as directed by the Engineer-in-Charge. In no case shall the excavated soil be stacked within
a distance of 1.5 m from the edge of excavation or one-third the depth the excavation whichever is more. Material to be used for filling shall be kept separately.

3.3.0 Rock Excavation

3.3.1 Rock, when encountered, shall be removed up to the formation/bed level or as otherwise indicated on the Drawings. Where, however, unstable shale’s or other unsuitable materials are encountered at the formation/bed level, these shall be excavated to the extent of 500 mm below the formation/bed level or otherwise specified. In all cases; the excavation operations shall be so carried out that at no point on cut formation/bed the rock protrudes above the specified levels.

3.3.2 Where excavation is done to levels lower than those specified, the excess excavation shall be made good to the satisfaction of the Engineer-in-Charge

3.3.3 Slopes in rock cutting shall be finished to uniform lines corresponding to slope lines shown on the Drawings or as directed by the Engineer. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface which move when pierced by the crowbar shall be removed.

3.4.0 Carriage of excavated materials beyond the initial lead of 50 M

3.4.1 The disposal/stacking areas for excavated materials shall be indicated by the Engineer-in-Charge. The carriage of excavated materials shall be done by the methods mentioned below:

1. The excavated materials shall be carried beyond the initial lead of 50 m but up to 500 m by manual/animal labor or by mechanical means. If directed by the Engineer-in-Charge, this material shall be used directly for filling purposes.

2. For leads exceeding 500 m, the implementing agency shall transport the excavated materials by mechanical means or as directed by the Engineer-in-Charge, Nellore Municipal Corporation. The Implementing agency shall allow for movements on Kuchha road etc. Providing and maintaining Kuchha road shall be responsibility of the implementing agency.

3. The transported material shall be neatly stacked and dressed as directed by Engineer-in-Charge

3.5.0 Filling

3.5.1 Materials

Materials to be used for filling purpose shall be selected excavated material free from shingle, salts, organic materials, large roots and excessive amount of sod, lumps, concrete or any other foreign substances, which could harm or impair the strength of the substructure in any manner. In any case, the materials to be used for filling purpose shall have the prior written approval of the Engineer-in-Charge

3.5.2 Filling Procedure

1. After completion of foundation, footings, walls and other construction below the elevation of the final grades, and prior to filling, all temporary shoring, timber etc. shall be sequentially removed and excavation cleaned of all trash, debris, and
perishable materials. Filling shall begin with the approval of the Engineer-in-Charge. Also areas identified for filling shall be cleared of all soft pockets, vegetation, bushes, slush etc. In case of plinth and similar filling, the ground shall be dressed and consolidated by ramming and light rolling.

2. Filling materials shall not be dropped directly upon or against any structure or facility where there is danger of displacement or damage. Filling shall be started after the concrete masonry has fully set and shall be carried in such a manner so as not to cause any undue lateral thrust on any part of the structure.

3. All space between foundation (concrete or masonry) and the sides of excavation shall be filled to the original surface after making allowance for settlement. Fill shall be placed in horizontal layers not exceeding 200 mm loose thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may be required to obtain a compaction/density as specified.

4. Fill adjacent to pipes shall be free of stones, concrete etc. and shall be hand placed and compacted uniformly on both sides of the pipe and where practicable up to a minimum depth of 300 mm over the top of pipes. While tamping around the pipes, care should be taken to avoid unequal pressure.

5. Filling shall be accurately finished to line, slope, cross section and grade as shown on the drawings. Finished surface shall be free of irregularities and depressions and shall be within 20 mm of the specified level.

3.5.3 Compaction

1. Compaction to 95% Standard Proctor Density shall be done by mechanical means only. Where access is possible, compaction shall be by 8 to 10 tonnes rollers smooth wheeled, sheep foot or wobbly wheeled as directed by the Engineer-in-Charge. Smaller weight roller may be permitted by the Engineer-in-Charge. In special cases, but in any case not less than 6 passes of the roller will be accepted for each layer. Each layer shall be wetted or the material dried by aeration to moisture content of 3-5% above the optimum moisture content to be determined by the Implementing agency. Each layer shall be watered, rammed and compacted to the density as required.

2. For compacting each sand layer, water shall be sprayed over it to flood it and it shall be kept flooded for 24 hours to ensure maximum compaction. Vibro-compactors shall also be used if necessary to obtain the required degree of compaction. Any temporary works required to contain sand under flooded condition shall also be undertaken. The surface of the consolidated sand shall be dressed to required levels or slope.

3. The degree of compaction of compacted fill in place will be subjected to tests by the Engineer-in-Charge as the work progresses, and the Implementing agency shall provide the necessary facilities to make such tests. If any test indicates that the compaction achieved is less than the specified degree of compaction, the Engineer-in-Charge, Nellore Municipal Corporation may require all fill placed subsequent to the last successful test to be removed and re-compacted by the Implementing agency. Compaction procedure shall be amended as necessary to obtain satisfactory results.
3.6.0 Sampling, Testing and Quality Control

3.6.1 General

1. The Implementing agency shall carry out all sampling and testing in accordance with the relevant Indian Standards and/or International Standards and shall conduct such tests as are called for by the Engineer-in-Charge. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Engineer-in-Charge. Tests shall be done in the field and at a laboratory approved by the Engineer-in-Charge and the implementing agency shall submit to the Engineer-in-Charge, the test results in triplicate within three days after completion of a test. The Engineer-in-Charge may, at his discretion, waive some of the stipulations given below, for small and unimportant operations.

2. In case, work found unsuitable for acceptance shall be removed and replaced by the Implementing agency. Such work shall be redone as per specification requirements and to the satisfaction of the Engineer-in-Charge.

4.0.0 EXCAVATION OF TRENCHES

4.1.0 Scope

This section of the specification covers excavation of trenches for laying HDPE pipes underneath the embankment and other cross drainage works.

4.2.0 General

The Implementing agency shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings. Schedule of items and as described herein.

4.3.0 Excavation for trench

Drawings for trenches shall be prepared by the bidder and approved by the Engineer-in-Charge. Trenches as shown in the drawing shall be excavated below the foundation grade and the slopes of the excavation shall be as indicated in the drawings or as directed by the Engineer-in-Charge. The alignment and cross-section shown in the drawings will be subject to such changes as may be found necessary by conditions disclosed during the excavation. Excavation of trench shall be carried out in a manner as specified under the clause for the item of "Excavation & Filling work".

Material excavated from the trenches shall, if suitable, be used in the embankment after stock piling as directed. The suitability or otherwise of the material shall be determined by laboratory tests. Material excavated from trench shall not be placed in the embankment till the foundation for the embankment has been cleared, stripped and prepared as specified and adequate arrangements made for watering and rolling the layers of earth fill in the embankment.

5.0.0 BORROW AREAS

5.1.0 Scope

All materials required for the embankments which are not available from trench excavation or from other excavations shall be obtained from approved designated
borrow areas. The impervious material required for foundation shall be brought from any approved borrow areas.

The depths of cut in all parts of the borrow areas will be determined by the Engineer-in-Charge depending on the level of water table at the time of excavation and the cuts shall be made to such depths only. The excavation in borrow areas shall not be done below the water table. The type of equipment used and the operation in the excavation of materials in borrow areas shall be of such type that will produce the required uniformity of mixture of materials for the embankment.

Borrow area shall be opened so as not to impair the usefulness or mar the appearance of any part of the work or any other property. The excavation surfaces and surface of waste materials shall be left in a reasonably smooth and even condition. When the borrow area is located contiguous to the embankment alignment then it must be ensured that the borrow area shall not be opened within a distance of five times the height of embankment contiguous to the heel or the toe of the embankment or 25 meter whichever is more.

The material required for embankment construction and liner foundation shall be free of admixture of stiff clay, refuse, stumps, roots, rock, brush, weeds or other material which would be detrimental to the proper compaction of materials in the embankment.

5.2.0 Preparation of Borrow Areas

5.2.1 Site clearance

All areas required for borrowing earth for embankment shall be cleared of all rank vegetation and stumps, roots, bush, rubbish, and other objectionable material. Particular care shall be taken to exclude all organic matter from the material to be placed in the embankment. All unsuitable materials including rank vegetation, stumps shall be disposed off as specified elsewhere in this specification. The cleared, areas shall be maintained free of vegetation growth during the progress of the work. The unsuitable materials will be filled back, after borrowing earth for earthen embankment construction, as directed by the Engineer-in-Charge.

5.2.2 Stripping of Borrow Areas

Borrow areas shall be stripped of topsoil, sod and any other matter which is unsuitable for the embankment construction. Materials from stripping shall be disposed off up to a lead of 500 m at a place and in manner at the discretion of the Engineer-in-Charge and as directed by him. The depth of stripping shall be decided by the Engineer-in-Charge depending upon the nature of topsoil and the vegetation present.

5.2.3 Borrow Area Watering / Dewatering

The natural moisture content of material in the borrow areas as well as the optimum moisture content corresponding to the Proctor’s maximum dry density for the material in the particular borrow area shall be obtained from laboratory tests. Additional moisture if required shall be introduced into the borrow area by watering well in advance of excavation, to ensure uniformity of moisture content. If in any borrow area before or during excavation there is excess moisture, steps shall be taken to reduce the moisture by the selective excavation to secure the materials of required moisture by excavating drainage ditches, by allowing adequate time for drying or by other means. To avoid formation of pools in the borrow areas during excavation operations, drainage ditches from borrow areas to the nearest outlets shall be excavated.
6.0.0 CAST-IN-SITU CEMENT CONCRETE

6.1.0 Scope

This section of the specification deals with cast-in-situ cement concrete plain or reinforced for Leachate collection sump, leak detection sump and other miscellaneous items as shown in the drawings and covers the requirements for concrete materials, their properties, storage, handing, grading, concrete mix design, strength and quality, pouring at all levels, testing, protection, curing, finishing, admixtures, and other associated works.

6.2.0 General Requirements

The provision of latest IS: 456 shall be complied with unless permitted otherwise and any other Indian Standards Codes shall form the part of the specification to the extent it has been referred to or applicable within this specification.

The Implementing agency shall furnish all labor, materials and equipment to form, place, and compact and finish all structural concrete, plain concrete works for general and architectural works and miscellaneous items complete as indicated on the drawings and as described herein.

6.3.0 Materials

6.3.1 Materials Properties

1. Aggregates

For reinforced concrete work, aggregate conforming to IS: 383 & 2386 having a maximum size of 20 mm shall be used. However for lean concrete maximum size up to 40mm shall be used.

Aggregates (coarse or fine) with a specific gravity below 2.6 shall not be used without special permission of the Engineer-in-Charge. Machine-made sand will be acceptable provided the constituent is sound, hard, and dense and is acceptable to the Engineer-in-Charge. Sand natural gravel and crushed rock shall be prepared for use by such screening or washing or both, as necessary to remove all objectionable foreign matter.

2. Water

Water used for mixing and curing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete.

6.3.2 Storage & Handling of Materials

IS: 4082 shall be followed as a general guidance for storage and handling of construction materials at site and IS: 7969 shall be followed for safety measures.

1. Cement

The cement shall be stored in leak proof, weatherproof enclosed sheds. Different consignments of different types of cement shall be stacked separately with clear
identifiable stack numbers. Cement consignments shall be stored as received and shall be consumed in the order of their delivery. The implementing agency shall make their own arrangement for the storage of adequate quantity of cement.

2. Aggregates

Coarse and fine aggregates shall be stored separately on brick soling or on an equivalent platform. The stack height of coarse aggregates shall not exceed 120 cm to avoid coning and segregation.

### 6.3.3 Grades of Concrete

All concrete used for RCC work shall be of minimum M 25 grade design mix and in grades designated as specified in Drawing.

### 6.3.4 Nominal Mix Concrete

Nominal mix concrete shall be used only for plain cement concrete works and where shown on drawings or specifically allowed by the Engineer-in-Charge. Such concrete shall not require preparation of trial mixes and all such concrete shall be mixed in a mechanical mixer. A proportion for nominal mix concrete shall be according to Table 9 of IS: 456-2000. In addition standard proportion by volume shall be used wherever specified.

### 6.3.5 Design Mix Concrete

Design mix concrete shall only be used for all reinforced concrete works, except where specified otherwise or specially permitted by the Engineer-in-Charge. The mix proportion for all grades of concrete shall be designed to obtain, the required workability and the characteristic strength not less than the appropriate values given in Table 1 below, using standard deviation specified in IS: 10262. The minimum value of target strength of design mix of various grades of concrete shall be as per Table 1 below considering the quality control as ‘good’ as specified in IS: 10262. However, the Engineer-in-Charge may allow changing the target strength values based on adequate numbers of works test results.

**Table 1: GRADE OF CONCRETE**

<table>
<thead>
<tr>
<th>Grade Designation of concrete</th>
<th>Compressive strength of a 15 cm cube at 28 days (in N/Sq.mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preliminary Test Strength or (Target strength of trial mix) (N/mm²)</td>
</tr>
<tr>
<td>M-15</td>
<td>20.8</td>
</tr>
<tr>
<td>M-20</td>
<td>27.6</td>
</tr>
<tr>
<td>M-25</td>
<td>33.7</td>
</tr>
<tr>
<td>M-30</td>
<td>39.9</td>
</tr>
<tr>
<td>M-35</td>
<td>45.4</td>
</tr>
</tbody>
</table>
In designing the mix proportions of concrete, the quantity of both cement and aggregate shall be determined by mass. The Engineer-in-Charge may allow the quantity of aggregates to be determined by equivalent volume basis after the relationship between the weight and volume is well established by trial and the same shall be verified frequently.

Water shall be either measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition, and their accuracy periodically checked.

To keep the water cement ratio to the designed value, allowance shall be made for moisture contents in both fine and coarse aggregates and determination of the same shall be made in accordance with IS: 2386 (Part-III) as frequently as directed by the Engineer-in-Charge.

### 6.4.0 Mix Design

Preliminary tests/trial mix as specified or as directed by the Engineer-in-Charge shall be carried out sufficiently ahead of the actual commencement of the work, to arrive at the grading of aggregates, water cement ratio, workability and the quantity of cement required to give Preliminary (target) compressive strength as specified in Table 1.

Minimum cement contents, from durability consideration, for different exposures and sulphate attack shall be as per IS: 456. In case higher value is obtained from trial mixes from strength consideration, same shall be provided.

At least four trial mixes shall be made and minimum six test cubes shall be taken from each trial mix noting the slump for each type of mix. The cubes shall then be properly cured and three cubes for each mix shall be tested in a laboratory (approved by Engineer-in-Charge) at 7 days and remaining three at 28 days for compressive strength.

The implementing agency shall submit the test reports for mix design to the Engineer-in-Charge, indicating design criteria analysis and proportions of materials etc. The mix proportion by mass and water cement ratio determined on the basis of above reports shall yield the concrete with desired characteristic strength & suitable workability. The mix design to be adopted on the works shall be approved by the Engineer-in-Charge.

### 6.5.0 Workability

The workability of concrete shall be checked at frequent intervals. Workability of concrete measured in accordance with IS: 1199 shall be recorded with corresponding compressive strength results.

The degree of workability necessary to allow the concrete to be well compacted and to be worked into the corners of form work and around the reinforcement to give the required surface finish shall depend upon the type and nature of the structure and shall be based on experience and tests. The limits of consistency for various types of structures, shall be in accordance with IS: 1199.

### 6.6.0 Batching and mixing plant

A modern dependable batching and mixing plant with two mixers each of 20 cum. /hr. capacity preferable tilting type capable of producing concrete of specified quality and output required to meet the schedule shall be installed at a centralized location with the
approval of the Engineer-in-Charge. Transporting, handling, and placing equipment shall be provided at a location in a manner approved by Engineer-in-Charge. The concrete batching and mixing plant shall be completely installed and operated for sufficient length of time prior to scheduled date of placement of first concrete, to enable the Engineer in Charge to assess the performance for its satisfaction.

6.7.0 Conveying and Placing Concrete by pumping

6.7.1 Conveying Concrete

The suitably designed concrete will be conveyed by pressure applied by the pump through either rigid pipe or flexible hose and discharged directly into the desired area. Requisite number(s) of modern dependable concrete pump(s) capable of pumping concrete of specified quality/density at a rate required meeting the schedule, together with a balanced complement of pipe lines, accessories, sparing parts, power controlled placers, experienced pump operators and maintenance staff shall also be provided.

The pump shall be of piston type pump with net concrete pumping capacity of not less than 20 m³/hr. at a horizontal distance of 400 m and vertical distance of 30 m. The pumps shall be designed with adequate protection against adverse usage, shall be insensitive to rough treatment and operation on construction sites, have sturdy construction and easy to maintain.

Implementing agency shall make necessary standby (by providing additional spare/standby pumps) or alternate concreting arrangement in the event of failure of pumps.

6.7.2 Placing Concrete

Formwork and reinforcement steel shall be approved in writing by the Engineer-in-Charge before concrete is placed. The formwork in contact with the concrete shall be cleaned and thoroughly wetted and treated with an approved composition before placing the concrete. Care shall be taken that such approved composition is kept out of contact with the reinforcement. Concrete shall be deposited in its final position without segregation, re-handling or flowing. Care should be taken to avoid displacement of reinforcement or movement of formwork while placing concrete. Any drop over 180 cm shall have to be approved by the Engineer-in-Charge. Concrete when deposited shall have a temperature of not less than 4.5 degrees C and not more than 38 degrees C; it shall be compacted in its final position within 30 minutes of its discharge from the mixer. Once the concrete is deposited in its final position, it shall not be disturbed. IS: 7861 (Part-I) shall be followed for concreting in extreme hot weather.

The placing of concrete shall be a continuous operation with no interruption in excess of 30 minutes between the placing of continuous portion of concrete. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless proper construction joint is formed as per direction of the Engineer-in-Charge. Concrete shall be placed in continuous horizontal layers of 150 mm or higher thickness as directed before placing the next layer.

All excavated areas for concreting shall be kept under dry working conditions until such concrete work is completed. The implementing agency shall make provisions and furnish equipment as required for such dewatering, subject to the approval of the Engineer-in-Charge.
Concrete shall not ordinarily be placed under water. In unavoidable cases, such concreting shall be done only with the specific approval of the Engineer-in-Charge for the methods, equipment, materials and proportions of the mix to be used and relevant clauses of IS: 456 adhered to. No concrete shall be placed in open while it rains. If there has been any sign of washing of cement and sand, the concrete shall be entirely removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended.

Slabs, beams and similar members shall be poured in one operation normally. Except where otherwise agreed to by the Engineer-in-Charge concrete shall be deposited in horizontal layers, but it must be ensured that under layer is not already hardened. Bleeding of under layer, if any, shall be effectively removed. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer-in-Charge.

After the concrete has been placed, it shall be thoroughly compacted by approved mechanical vibrators to a maximum subsidence without segregation and shall be thoroughly worked around reinforcement or other embedded fixtures into the correct form and a shape. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during compaction of concrete.

Immersion vibrators shall be a ‘no load’ frequency amplitude and acceleration as per IS: 2505 depending upon the size of the vibrator. Immersion vibrators shall be operated by experienced men for their use. IS: 3558 shall be followed. Immersion vibrators shall penetrate both the layer poured and the under layer and shall not be allowed to come in contact with steel reinforcement, forms and finished surfaces after start of initial set.

These vibrators shall be immersed not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Such vibrators shall in no case be used to push concrete inside the forms and vibrators shall be withdrawn slowly.

6.7.3 Construction Joints

When the concreting work is to be interrupted, the concrete shall be rebated at joint so such shape and size as may be required by the Engineer-in-Charge or as shown on the drawings. All vertical construction joints shall be made with stop boards, which are suitably fixed, for sufficient lateral rigidity and slotted to allow for the passage of the reinforcement steel. In the case of water and/or underground structures, water stop of approved material shall be provided if so specified on the drawings or as desired by the Engineer-in-Charge. Construction joints shall be provided in positions as shown or described on the drawings. Where it is not described, the joints shall be in accordance with the following:

1. In a column, the joint shall be formed about 75 mm below the lowest offset of the beams framing into it.
2. Concrete in a beam shall be placed throughout without a joint, but if the provision of a joint is unavoidable, the joint shall be vertical and within middle third of the span.
3. A joint in a suspended floor slab shall be vertical, at one quarter point of the span and at right angle to the principal reinforcement.
4. In forming a joint, concrete shall not be allowed to slope away to a thin edge. The location of construction joints shall be planned by the Implementing agency well in advance of pouring and have to be approved by the Engineer-in-Charge.

Before fresh concrete is placed, the cement skin of the partially hardened concrete
which was poured earlier shall be thoroughly removed and aggregates shall be exposed by wire brushing, backing, water jetting or any other approved method, as directed with Engineer-in-Charge. The rough surface shall be thoroughly wetted and surface water shall be removed and shall be coated with 10-15 mm thick layer of 1:1 freshly mixed cement sand slurry. Care shall be taken to ensure that the first layer of concrete placed after a construction joint is thoroughly rammed against the existing layer.

6.7.4 Cleaning and Finishing

All concrete surfaces shall have an even finish, free from honey combs, air bubbles, fins or other blemishes.

The formwork joints marks and other projections on concrete work exposed to view shall be rubbed out with carborundum stone and made smooth and air holes, cavities and similar imperfections shall be first saturated with water and filled with cement sand mortar (1:2) and cured.

Except where a separate finish is to be applied, or where a trowel finish is called for, horizontal concrete surface shall be floated and steel troweled after achieving initial set to prevent excess fine materials from working to the surface.

Concrete surfaces to be subsequently plastered or where brickwork shall be built against it shall be adequately hacked as soon as the form is stripped off so that proper bond can develop.

6.8.0 Curing and Protection of Concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level be protected from falling earth during and after placing. Concrete placed in ground containing deleterious substances shall be kept free from contact with such ground or with water draining from such ground during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer-in-Charge. The ground water around newly poured concrete shall be kept to an approved level by pumping or other approved means of drainage. Adequate steps shall be taken to protect immature concrete from damage by debris, excessive loading, shocks, vibration, abrasion, traffic, rapid temperature changes, mixing with earth or other deleterious material, etc. that may impair the strength and durability of concrete.

As soon as the concrete has hardened sufficiently for the surface to be marked, it shall be covered either with wet sacking, canvas or similar materials and kept continuously wet for at the discretion of the Engineer-in-Charge, up to fourteen (14) days. Concrete slabs and floors shall be cured by flooding with water of minimum 25 mm depth for the periods mentioned above.

Masonry work over the foundations concrete may be started after 48 hours of its laying but the curing of concrete shall be continued for a minimum period of 7 days.

6.9.0 Sampling and Testing Criteria

6.9.1 General

1. Facilities required for sampling & testing materials and concrete in the field and in the laboratory shall be provided by the Implementing agency. All sampling and
testing shall be done in accordance with relevant Indian Standard and this specification. Tests shall be done in the field in the presence of the Engineer-in-Charge and the Implementing agency shall submit the test result in triplicate within 3 days after completion of any test.

2. Concrete samples shall be cured under laboratory conditions, except when in the opinion of the Engineer-in-Charge extreme weather conditions may prevail at which time the Engineer-in-Charge may require curing under job conditions.

3. If the “test strength” of the laboratory controlled cubes for any portion of the concrete work falls below the compressive strength specified, the Engineer-in-Charge shall have the right to order a change in the proportions or the water content for the remaining portion of the structure, and shall have the right to require provisions for temperature and moisture control, during the period of curing, as necessary to secure the required strength, and may require re-tests on the basis of core test as given in IS: 456.

4. Concrete found unsuitable for acceptance shall be removed and replaced by the implementing agency. The work shall be redone as per specification and to the satisfaction of the Engineer-in-Charge and at no extra cost to the owner.

5. Rebound hammer test shall be carried out for ascertaining the quality of concrete work, as directed by the Engineer-in-Charge.

6. Core test shall be done as described in IS: 516. The number of cores required shall be as decided by the Engineer-in-Charge and shall be represented of whole of the concrete concerned. In no case, however, shall fewer than three cores be tested.

Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to at least 85 percent of the cube strength of the grade of concrete specified for the corresponding age and no individual core has strength less than 75 percent.

### 6.9.2 Sampling of Concrete

Sampling from fresh concrete shall be taken according to IS: 1199 tested as per IS: 516. Normally only compressive test shall be performed but the Engineer-in-Charge may require other tests to be performed in accordance with IS: 516.

1. **Trial Mixes**

   At least four trial mixes shall be made with, minimum 6 test cubes for each.

2. **Works Tests**

   a. The minimum frequency of sampling of concrete of each grade shall be according to clause 15.2.2 of IS: 456-2000. However, after getting continuous satisfactory results and in the case of voluminous concrete works, the Engineer-in-Charge may at his discretion reduce the frequency of sampling.

   b. For each grade of concrete, and for each 8 hours (shift) of work or part thereof, at least one sample consisting of six specimens shall be taken from each 50 cum. Of concrete or part thereof, 3 specimens shall be tested at 7 days and remaining
3 shall be tested at 28 days. However, in all cases, the 28 days compressive strength shall alone be the criterion for acceptance or rejection.

To control the consistency of concrete from every mixing plant, slump tests and/or compaction factor tests in accordance with IS: 1199 shall be carried out by the implementing agency every two hours or as directed by the Engineer-in-Charge. Slumps corresponding to the test specimens shall be recorded for reference.

The strength of sample shall be the average of the strength of three specimens. The individual variation should not be more than ±15% of the average.

### 6.9.3 Acceptance criteria for concrete

The acceptance criteria of concrete shall be in accordance with Clause No. 16 of IS: 456. However, in exceptional circumstances, the Engineer-in-Charge may at his discretion accept concrete of lower strength than that specified at reduced rates pro-rata to the strength obtained. The concrete shall be deemed to comply with the strength requirements, if:

1. Every sample has test strength not less than the characteristic value

Or

2. The strength of one or more samples, though less than the characteristic value, in each case is not less than the greater of:

   a. The characteristic strength minus 1.35 times the standard deviation and
   b. 0.80 times the characteristic strength; and the average strength of all the samples is not less than the characteristic strength + [1.65 – 1.65/square root of (No. of Samples)] times the standard deviation.

### 6.9.4 Tolerance Limits

Unless otherwise specified, the tolerance in construction shall be as follows:

<table>
<thead>
<tr>
<th>Description of item/structural element</th>
<th>Permissible Deviation in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dimensions of concrete as cast when compared with those on the drawings shall be within the tolerance given below:</td>
<td></td>
</tr>
<tr>
<td>Faces of concrete in foundation and structural members against which backfill is placed</td>
<td>+ 25</td>
</tr>
<tr>
<td>Location of footing (for RCC framed structures only)</td>
<td>+ 25</td>
</tr>
<tr>
<td>Eccentricity of footing</td>
<td>2% of footing width of direction of misplacement but limited to 50 mm</td>
</tr>
<tr>
<td>Cross sectional dimensions of walls, slabs and similar structural elements</td>
<td>+ 5</td>
</tr>
<tr>
<td>Description of item/structural element</td>
<td>Permissible Deviation in mm</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Deviation from specified dimensions of cross section of columns and beams</td>
<td>+12 -6</td>
</tr>
<tr>
<td>Embedded parts (in any direction)</td>
<td>+5 -5</td>
</tr>
<tr>
<td>Centers of pockets of grooves with greatest lateral dimension not exceeding 150 mm</td>
<td>+10 -10</td>
</tr>
<tr>
<td>Plumb</td>
<td>3 mm for every meter subject to a maximum of 10 mm.</td>
</tr>
</tbody>
</table>

7.0.0 **FORMWORK AND STAGING**

7.1.0 **Scope**

This section of the specification deals with the requirements for the supply, erection, dismantling of formwork and staging required for cast-in-situ concrete works including for making pockets.

7.2.0 **General Requirements**

The implementing agency shall supply, fabricate erect and dismantle (after use) all temporary and permanent formwork and staging that is required for all activities covered under the specifications.

7.3.0 **Materials**

Formwork shall compose of steel, plywood or best quality wood. Timber shall be free from significant knots and shall be of medium grain as far as possible and hard woods shall be used as caps. Timber shall be well seasoned, free from sap, worm holes, wraps or other surface defects and shall smooth finish.

Staging unless specified otherwise shall generally be of mild steel tubes, steel beams and channels etc. or strong sowbellies 150 mm in diameter or above.

7.4.0 **Quality of Formwork and Staging**

The forms and staging shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete and the effects of vibration. The joints in the formwork shall be sufficiently tight to prevent any leakage of mortar. The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes.

Bevelled strips 25 x 25 mm shall be provided to form angels and in corners of columns and beam boxes for chamfering of corners if shown in drawings or directed by the Engineer-in-Charge.

The implementing agency shall maintain necessary camber in centering for all floor slabs and beams in all spanning directions, so as to offset the deflection and assume correct shape.

7.5.0 **Construction Operation**
All form shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before these are fixed in position. Before formwork is placed in position, the form surface that will be in contact with concrete shall be treated with approved non-staining oil or composition which is insoluble in water and not injurious to concrete. Care shall be taken that the oil or composition does not come in contact with reinforcing steel or stain the concrete surfaces.

7.6.0 Removal of Formwork

The Implementing agency shall begin the removal of formwork only after approval of the Engineer-in-Charge. He shall place on record the dates on which the concrete is placed in different parts of the work and the dates of the removal of formwork there from. This record shall be checked and countersigned by the Engineer-in-Charge.

Forms of various types of structural components shall, under normal circumstances, not be removed before the minimum periods specified in clause 11.3 of IS: 456-2000, which shall also be subject to the approval of the Engineer-in-Charge.

In normal circumstances and where ordinary Portland cement is used, forms may generally be removed after the expiry of the following periods, according to clause no. 11.3 of IS:456-2000.

<table>
<thead>
<tr>
<th>Description</th>
<th>Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls, columns and vertical faces of all structural members as directed by the Engineer-in-Charge</td>
<td>1 to 2 days</td>
</tr>
<tr>
<td>Slabs (Props left under)</td>
<td>3 days</td>
</tr>
<tr>
<td>Beams off its (props left under)</td>
<td>7 days</td>
</tr>
<tr>
<td>Removal of props under slabs</td>
<td></td>
</tr>
<tr>
<td>Spanning up to 4.5 M</td>
<td>7 days</td>
</tr>
<tr>
<td>Spanning over 4.5 M</td>
<td>14 days</td>
</tr>
<tr>
<td>Removal of props under Beams</td>
<td></td>
</tr>
<tr>
<td>Spanning up to 6 M</td>
<td>14 days</td>
</tr>
<tr>
<td>Spanning over 6 M</td>
<td>21 days</td>
</tr>
<tr>
<td>Cantilever Slabs</td>
<td>14 days</td>
</tr>
</tbody>
</table>

In case PPC/PSC is used instead of OPC, the removal of shuttering/support shall be after 50% more time from that being applied for OPC unless otherwise permitted by the Engineer-in-Charge. For concrete temperature above 40 Degree C. Stripping time shall be increased.

7.7.0 Reuse of Forms

Before reuse, all forms shall be thoroughly scraped, cleaned, holes and leaks satisfactorily plugged, joints examined and inside surfaces treated as specified herein before. Formwork shall not be used/reused, if declared unfit or unserviceable by the Engineer-in-Charge.

7.8.0 Dimensional Tolerance for Formwork

<table>
<thead>
<tr>
<th>Description</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levels and heights</td>
<td>± 6 mm</td>
</tr>
<tr>
<td>Plumb</td>
<td>3 mm for every meter subject to maximum of 10 mm</td>
</tr>
<tr>
<td>Unevenness of any surfaces</td>
<td>± 3 mm</td>
</tr>
</tbody>
</table>
ANDHRA PRADESH
URBAN FINANCE & INFRASTRUCTURE DEVELOPMENT CORPORATION (APUFINCORP)

Preparation of Detailed Project Report for MSW Management

Length or breadth  ± 12 mm
Diagonals  ± 15 mm

8.0.0 REINFORCEMENT

8.1.0 Scope

This section of the specification covers the technical requirements for fabricating and placing in position of mild steel or High strength deformed steel reinforcement bars for all RCC works as indicated in the drawings and as directed by the Engineer-in-Charge.

8.2.0 General Requirements

The implementing agency shall arrange for transport, fabricate and place reinforcement to shapes and dimensions as indicated in the approved drawings and specifications and/or as directed by the Engineer-in-Charge. The reinforcement shall be either mild steel or cold deformed twisted steel bars conforming to relevant IS specifications as specified in Schedule of Items and Drawings.

The implementing agency shall prepare bar bending schedules on the basis of information furnished in the drawings, approved for construction, and submit the same for approval by the Engineer-in-Charge. No work shall be commenced without the prior approval of the schedule by the Engineer-in-Charge.

Any adjustments in reinforcement to suit field conditions, construction joint etc., other than those shown on the drawings shall be subject to the approval of the Engineer-in-Charge, before placing.

8.3.0 Storage and Handling

Reinforcement and structural steel (including steel required for embedment) shall be stored consignment wise and size wise off the ground by at least 150 mm and protected from rusting, oil, grease and distortion by providing suitable cover. The storage area shall be such that water does not accumulate and steel does not get corroded.

8.4.0 Bending and Placing

8.4.1 Bending

Reinforcing bars supplied bent or in coils shall be straightened in cold without damaging the bars, before these are cut to size.

Reinforcing steel shall be bent in accordance with procedure specified in IS: 2502 and/or as approved by the Engineer-in-Charge. Bends and shapes shall comply strictly with the dimensions shown on the approved bar bending schedule and they shall be rechecked by the implementing agency before bending and he shall be entirely responsible for their correctness. The details of reinforcement shall be in accordance with IS: 5525 and SP: 34. Welding of bars to obtain continuity shall not be allowed particularly for cold twisted bars unless specifically approved by the Engineer-in-Charge. If welding is unavoidable, the work shall be carried out as per IS: 2751 and IS: 9417 and as directed by the Engineer-in-Charge.

8.4.2 Placing in Position
All reinforcement shall be accurately fixed and maintained in position as shown on the drawings by means of steel chairs and or concrete spacer blocks as per IS:2502. Bars intended to be in contact and crossing points, shall be securely bound together at all such points by two numbers annealed steel wire of 1.2 mm size conforming to IS:280.

The vertical distance between successive layers of bars shall be maintained by provision of spacer bars, and shall be so spaced that the main bars do not sag perceptively between adjacent spacers.

Laps and anchorage length of reinforcing bars shall be as shown on the drawings and shall be in accordance with IS: 456.

8.5.0 Cover to Reinforcement

Unless shown otherwise on the drawings, minimum clear concrete cover for reinforcement (exclusive of plaster or other finishes) shall be as per provisions of IS: 456, subject to minimum of the following:

For bottom reinforcement in footings, 75 mm, if concrete is laid against the ground or 50 mm if laid on a layer of lean concrete.

For retaining walls, grade beams, top and sides of footings and similar surfaces exposed to weather or ground, 50 mm for bars larger than 16 mm and 40 mm for bars up to 16 mm.

For concrete members exposed to the action of harmful chemicals, acids, alkalies, atmosphere, sulphurous smoke, sea water etc., the cover shall be as shown on the drawings.

For liquid retaining structures 40 mm or diameter of main bar whichever is larger.

Clear distance between reinforcing bars shall be in accordance with IS: 456 or as shown on approved drawings.

9.0.0 STRUCTURAL STEEL WORK

9.1.0 Scope

This section of specification covers the technical requirement for supply, fabrication & erection of structural steel and associated works.

The specification covers structural steel works involving rolled sections, pipes, plates, chequered plates, beams, fixing of embedded parts.

9.2.0 General Requirement

The implementing agency shall furnish all labour, plant, equipment’s, consumables, scaffolding, tools, tackles, materials etc., required for the completion of work on schedule in accordance with drawings and as described herein and/or as directed by the Engineer-in-Charge

9.3.0 Safe working
The implementing agency shall strictly follows, at all stages of fabrication, transportation and erection of steel structures, the stipulation contained in the Indian Standard Safety Code for erection of structural steel work IS: 7205.

9.4.0 Detailed Working/Fabrication Drawings

Fabrication drawings shall be prepared by the implementing agency based on the scope of drawings supplied by the owner. The detailed working drawings shall indicate complete details of fabrication and erection weld size, lengths etc.

9.5.0 Materials

Structural steel rolled sections and plates shall conform to IS: 2062. Pipes shall conform to IS: 1161. Chequered plates shall conform to IS: 3502. All other materials shall be as per the relevant Indian Standards and as specified in IS: 800.

9.6.0 Fabrication

Fabrication work shall be carried out in accordance with IS: 800 as well as stipulations contained in these specifications.

All steel materials shall be straightened and/or flattened, wherever required by straightening machine, though minor kinks or bends may be corrected by limited heating under careful supervision.

9.7.0 Cutting Plan

The implementing agency shall prepare cutting plan according to detailed working drawings, taking into consideration the availability of material, the cut pieces generated during work with the objective of minimizing waste

9.7.1 Straightening and Cutting

All steel materials shall be straightened and/or flattened, wherever required by straightening machine, though minor kinks or bends may be corrected by limited heating under careful supervision.

9.7.2 Cutting

Cutting may be effected by shearing, cropping sawing or by gas cutting by mechanically controlled torch. Gas cutting by hand may only be used when specifically authorized in writing by the Engineer-in-Charge.

9.7.3 Grinding

All the edges cut by flame shall be ground before they are welded.

9.7.4 Assembly

The components parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged.

9.7.5 Welding
Welding shall be carried as per IS: 816 and IS: 9595 and the welding procedure duly approved by the Engineer-in-Charge. All structural welding shall be done by welders who qualify the appropriate tests laid down in IS: 817 and IS: 1181. The entire weld of any structure joint shall be made by one welder.

9.7.6 Electrodes

The electrodes used shall be of suitable type and size depending upon specifications of the parent materials, the method of welding and quality of weld desired.

Where coated electrodes are used they shall meet the requirements of IS: 814. All electrodes shall be stored properly as per manufacturer’s recommendations.

Specific approval of the Engineer-in-Charge shall be taken by the implementing agency for the various electrodes proposed to be used on the work before any welding is started.

9.7.7 Preheating

Preheating shall be done wherever required as per IS: 9595

1. When base metal not otherwise required to be preheated is at a temperature below 0° C it shall be preheated to at least 20° C.
2. Thermo-chalk or other approved methods shall be used for measuring the plate temperature.

All welding shall be done in a proper sequence.

9.8.0 Inspection of Welds

9.8.1 Visual Inspection

100 percent of the welds shall be inspected visually after cleaning the weld surface with steel wire brushes/chisels to remove slag, scales, and the spatter metal. The weld shall be correct in size, length and shall be of regular height and width and shall be free from defects like craters on the surface under cuts, and visible cracks. Weld gauges shall be used to measure the weld sizes.

Wherever above mentioned defects are noticed, the welds, in such locations shall be removed by gouging process. The joints shall be prepared again by cleaning the burrs and residual matters with wire brushes and grinded and rewelded.

9.9.0 Erection Procedure

Before any steel work leaves the implementing agency's fabrication site it shall be suitably marked in accordance with the approved fabrication drawings.

9.9.1 Erection Scheme

The implementing agency shall submit for approval of the Engineer-in-Charge is erection scheme giving full details of the method of handling, transport, hoisting and erection including false work/staging, temporary bracing, guying etc.
Erection shall commence only after approval of the implementing agency's proposed erection scheme.

9.9.2 Dismantling of Steel Work

The new structure shall be dismantled wherever called for. Such dismantling shall be done carefully without causing damage to other structures and further modifications shall be done in the fabrication yard.

9.9.3 Modification

The work of modification may involve cutting of certain portions or gouging of welds, cuttings, grinding, fabrication, welding drilling holes, straightening, removal of bends, painting and touch up painting, transporting the cut and removed parts/items and new steel to be added.

9.9.4 Re-erection

The work of re-erection includes transportation of structures from field fabrication yard to erection site, lifting of same to the required portion aligning, erection in position, inclusive of erection bolts, tack welding, final welding and touch up painting etc., complete to the satisfaction of the Engineer-in-Charge.

9.10.0 Painting

After inspection and issue of test acceptance certificate, all steel surfaces shall be painted, as per the specifications given in the tender document and to the satisfaction of the Engineer-in-Charge.

9.10.1 Surface Preparation

The surface preparation shall be done as per IS: 1477 (Part-I) The surface shall be cleaned, de greased and descaled manually.

9.10.2 Application of Priming Coat

The primers shall consist of red oxide zinc chromate conforming to IS: 2074. Two coats of primer paint shall be applied first at the shop and the second after the erection is completed.

Application of primer shall be done by brush or by any other method specified in IS: 1477 (Part-II) Touch up painting shall be done after erection.

9.10.3 Application of Finishing Coats

Before application of finishing coats the second coat of primer paint shall be completed.

Finishing coat shall be synthetic enamel paint conforming to IS: 2932 & IS: 2933. Total coating thickness (DFT) of the painting shall not be less than 100 micron.

9.10.4 Embedded Parts
The embedded steel parts shall be properly placed in position with lugs. Temporary supports shall be provided to ensure proper installation of the embedded parts and these shall be in plumb and level. Concrete around the embedded parts shall be properly compacted so as to avoid voids or honeycombing. The structure shall be hoisted and placed in position carefully without any damage to itself or to the structure in which it is to be fixed and injury to workmen. If necessary, appliance such as lifting shall be used.

9.10.5 Hand Railings

Pipe hand rails shall be of standard weight galvanized steel pipes of flush welded construction, ground smooth, using 32 mm nominal bore medium class pipes with double rail, 1.2 meter above platform level and pipe posts spread not more than 1.5 meters apart as per the drawings or instructions of Engineer-in-Charge.

9.10.6 Covers

Chequered plates shall be fixed to supporting members by tack welding or by counter sunk bolts. Care shall be taken to avoid distortion of the plate while welding of stiffening angles/vertical stiffening ribs.

9.11.0 Bolts

Stainless steel Bolt with a 38 x 6 mm stainless steel flat bar shall be used to bind the HDPE liner with the concrete in leachate collection sump, leachate detection sump etc as shown in the drawings. Bolts shall generally conform to IS: 5624.

All bolts shall be embedded in concrete in plumb and in level at true location. The threads shall be protected by using PVC tape.

Hexagonal nuts and locknuts shall conform to 15:4218.

9.11.1 Permanent Bolts

Permanents bolts used for connection of structural steel members shall conform to 15:1363, 15:13643 and 15:1367. These shall be provided with washers, nuts and locknuts.

10.0.0 STONE WORK-RANDOM RUBBLE MASONRY

10.1.0 Scope

This section covers the furnishing of all labor, materials and equipment and the performing of all operations required for the stone masonry work and incidental items pertinent thereto all in accordance with the drawings, specifications, schedule of items and as directed by the Engineer-in-Charge.

10.2.0 General Requirements

The stone shall be of the type specified, shall be hard, sound and free from decay and weathering. This shall be obtained from an approved quarry. Stones with round surface shall not be used. Stones shall be properly hammered dressed on the face, the sides and the beds to enable it to come in close proximity with the neighboring stone. IS: 1597 shall be followed as general guidance for construction of stone masonry.
10.3.0 Mortar

Mortar used for joining shall be as specified and the ingredients shall conform to relevant IS codes or as specified.

10.4.0 Laying

All stones shall be wetted before use. The vertical faces shall be carried up truly plumb, or to the specified batter. Face stones shall extend well into backing. These shall be arranged to break joints as much as possible and to avoid vertical lines of joints. Their height shall not be greater than the breadth at the face of the depth inwards. The hearting or interior filling of the wall face shall consist of rubble stones which may be of any shape but do not pass through a circular ring of 15 cm. Inner diameter, thickness of these stones in any direction shall not be less than 10 cm. These shall be carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar, chips and spells of stone being used wherever necessary to avoid thick mortar beds or joints and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 20% of the quantity of stone masonry.

10.5.0 Bond Stones

Bond or through stones running right through the thickness of walls shall be provided in walls up to 60 cm thick. If the walls are more than 60 cm thick, two or more bond stones over lapping each other by at least 15 cm shall be provided in a line from face to back. At least one bond stone or a set of bond stones shall be provided for every 0.5 sq. meter of wall surface.

10.6.0 Quoins

The quoins shall be selected stones neatly dressed with the hammer or chisel to from the required angle, and laid header and stretcher alternately. No quoin stone shall be less than 25 x 25 x 25 cm.

10.7.0 Joints

Stones shall be so laid that joints are full of mortar. Face joints shall not be more than 2.5 cm thick.

10.8.0 Curing

Green work shall be protected from the effects of sun, rain etc. by suitable covering. All the masonry work shall be kept constantly moist on the faces for a period of seven days.

10.9.0 Embedding of Fixtures

All fixtures to be embedded in mortar and masonry units shall be properly fixed as indicated in the drawings.

10.10.0 Encasing of Structural Steel and Pipes
FILLING FOR CLAY LINER AND FOUNDATION

Scope

This section of specification covers the item of filling for clay liner and foundation as indicated in the drawings. This section also covers borrowing approved quality of impervious clay from approved designated borrow areas.

General Requirements

a. The Implementing agency shall furnish all labour, equipment and material required for complete performance of the work in accordance with the drawings, schedule of items and as described herein.

b. The foundation and clay liner shall be constructed in layers not exceeding 200 mm in compacted thickness and in the manner described under placing the Earth fill in Clause 8.5.0 using impervious clayey soil obtained from approved designated borrow areas having hydraulic conductivity in the range of 10^-7 cm/sec and plasticity index between 10 to 30%. The soil layers shall not contain soil particles or chunks of rocks larger than 25 mm in size, the suitability or otherwise of the material shall be determined by laboratory tests. Each layer of earth deposited shall the be compacted to have a dry density not less than 95% of the maximum dry density (standard proctor) for the soil with suitable tractor drawn heavy sheep foot tamping rollers or by any other method approved by the Engineer-in-Charge. The compaction will have to be uniform throughout the length and breadth of the layers. The roller should be made to travel over the entire section of each layer so that the earth is fully compacted and the roller leaves no visible marks on the surface, Where smooth rollers are used with the approval of the Engineer-in-Charge, the surface of each layer of compacted material shall be roughened with a harrow and thoroughly furrowed or raked before depositing the succeeding layer of material. Care shall be exercised to avoid occurrence of horizontal seams. Earthwork should be continuous from day-to-day. In case of break in compaction exceeding four days, the dried surface shall be well watered and harrowed before a fresh layer of earth is laid on it.

c. Before placing the HDPE pipes within the embankment, construction of embankment up to 600 mm above the RCC lining for pipes shall be carried out without actually placing the pipes. Later on, trenches shall be excavated for pipes and lining work and pits for cutoff collars. These trenches shall then be filled using CL-ML type soil (plasticity index 720). Earth layer deposited in these trenches shall be compacted with plate compactors to have a dry density not less than 95% of the maximum dry density (standard proctor).

d. The spreading of the next layer shall be carried out only after the underlying layer has been approved by the Engineer-in-Charge or his authorized representative.

Water for Clay filling works
The Implementing agency has to make his own arrangements for the supply of water for earth filling works. It shall be the responsibility of the Implementing agency to identify and develop water source or sources, running a pipe line/pipe lines laid at a distance not less 10 meters away from the toe/heel of the embankment for conveying the water required for the work from the supply sources, tapping water from manifolds provided at suitable intervals along the pipe line with the aid of water hoses and sprinkling jets for sprinkling water uniformly over the entire area (and not poured in patches) for bringing up the layers to the required moisture content. Alternately he may employ sufficient number of water tankers also. No separate payment for the above will be made and entire cost on account of the same shall be included in the rates for relevant items of schedule.

12.0.0 FOUNDATION FOR EMBANKMENT

12.1.0 Scope

This section covers the preparation/compaction of foundation of the embankment as indicated in the drawings and described herein.

12.2.0 General Requirements

a. Foundation preparation shall be performed as per drawings and as described herein subsequent to stripping of foundation and excavation, if any. No material shall be placed in any section of the fill portion until the foundation for that section of the fill has been dewatered, suitably prepared and has been approved by the Engineer-in-Charge. All portions of excavations made for test pits or other sub-surface investigation and all other existing cavities, found within the area are to be filled with earth and properly compacted and which extend below the established lines of excavation for foundation shall be filled with earth of the corresponding zone and properly compacted. The foundation should be free from all organic materials, vegetable sods. The topsoil of foundation should be stripped properly such that vegetable sods and top layers are removed to ensure proper bond between embankment and foundation.

b. Masonry surfaces of the back of retaining walls, wing walls and box culverts etc. against which the fill is to be placed, shall be cleaned and moistened prior to placing the earth. The foundation immediately adjacent to the masonry/concrete structures shall be thoroughly cleaned of loose materials and moistened. Pools of water shall not be permitted in the foundation and shall be drained and cleaned prior to placing the first layer of embankment material.

13.0.0 EARTHERN EMBANKMENT

13.1.0 Scope

This section of specification covers the earthwork involved in the embankment formation as per the drawings and as mentioned herein.

13.2.0 General Requirement
Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC)

Preparation of Detailed Project Report for MSW Management

The Implementing agency shall furnish all labour, equipment and materials required for complete performance of the work in accordance with drawings, schedule of items and as described herein.

13.3.0 Earthen Embankment

The embankment shall be constructed to the lines and grades shown on the drawings. Placement of fill shall be performed in an orderly way and in an efficient and workman like manner, so as to produce fills having such quantities of density, strength and permeability as will ensure the highest practicable degree of stability and performance of the embankment.

No bushes, roots, sods or other perishable or unsuitable materials shall be placed in the embankment. The suitability of each part of the foundation for placing embankment materials thereon and of all materials for use in embankment construction shall be determined by the Engineer-in-Charge. The embankment may be constructed in separate portions, provided that:

a. The slopes of the bonding surfaces between the previously completed portions of the embankment and materials to be placed in each zone shall not be steeper than 2.5 horizontal to 1 vertical along the centerline of the embankment.
b. The embankment is constructed right across the whole section in each portion.

13.4.0 Fill Materials

The materials for embankment shall be obtained from the designated borrow areas and available excavated material. In general all materials from the particular borrow area shall be a mixture of materials obtained for the full depth of the cut. Some earth material available from the excavation in the landfill area if found suitable will also be used for the embankment construction.

13.4.1 Placing the fill material

a. Before placing the fill the foundation shall be prepared and compacted as per chapter C6. Prior to placing the first layer of embankment on the foundation moistening and compacting the surface by rolling to achieve dry density not less than 95% of maximum dry density. (Standard Proctor) shall be done. The distribution and gradation of materials throughout the fill shall be as shown in the drawings or as directed. The fills shall be free from lenses, pockets, streaks, or layers of material differing suitably in texture or gradation from the surrounding material. The combined excavation and placing operations shall be such that the materials when compacted in the fill will be blended sufficiently to produce the specified degree of compaction and stability. The earth obtained from a particular borrow area as far as possible shall be used in forming the complete cross-section of the fill for a particular stretch. Sequencing of the placing of fill material shall be such that it shall be possible to identify at all stages of construction which borrow area material is used in which stretch of the fill/embankment.
b. No stones cobbles or rock fragments, having maximum dimensions of more than 5 cm shall be placed in the fill. Such stones and cobbles shall be removed either at the borrow pit or after being transported to the site but before the materials in the fill are rolled and compacted. Such stones or cobbles shall be placed in other portions of embankment if found suitable or rejected as directed. The materials shall be
placed in the fill in continuous horizontal layers, stretching right across the whole section, not more than 20 cm in compacted thickness and rolled as herein specified. During construction a small transverse slope from center towards the edges should be given to avoid pools or water forming due to rains. The surface of materials to be placed thereon shall be moistened and/or worked with harrow, or other suitable equipment, in an approved manner to a sufficient depth to provide a satisfactory bonding surface before the next layer of fill material is placed. If the rolled surface of any fill is found to be too wet for proper compaction, it shall be raked up, allowed to dry, or shall be worked with a harrow or any other approved equipment to reduce the moisture content to the required amount and then it shall be re compacted before the next layer of earth is placed.

c. When compacting the soils against steep rock abutment or walls or masonry or concrete structure the construction surface of embankment shall be sloped away from rock or masonry or concrete structures for a distance of 3 m to 4 m at an inclination not steeper than 6 horizontal to 1 vertical. If the foundation surface is too irregular to allow the use of a large roller directly against a structure or rock outcrop, the roller shall be used to compact the soil as close to the structure or the outcrop as possible and the portion of the embankment directly against the rock or the structure shall be compacted with pneumatic hand tampers in thin layers. The moisture content of the earth placed against the rock or the structure shall be high enough to allow it to be compacted into all irregularities of the rock. Care shall be taken in placing the first layer of the fill so that no damage is caused by the hauling machinery to the base grade as this may get concealed by the spread layer or fill. Sheep foot roller shall not be employed for compacting till the thickness of the layers already compacted by other means is greater by 30 cm than the depth of the feet on the roller drum. The soil for the first layer shall be at moisture content sufficient to enable bonding of the fill with the rock surface.

13.5.0 Weather Conditions

Embankment materials shall be placed only when the weather conditions are satisfactory to permit accurate control of the moisture content in the embankment materials.

13.6.0 Moisture Control

Prior to and during compacting operations, the materials in each layer of earth shall have moisture content about 2% less than the optimum moisture content. Laboratory investigations may impose some restrictions on the lower limits of the practicable moisture contents on the basis of studies of compaction in embankment. As far as practicable the materials shall be brought to the proper moisture content in the borrow area before excavation. If additional moisture content is required, it shall be added by sprinkling water before rolling. The Implementing agency shall make his own arrangements for supply of water in a manner described under water for earth fill work. If the moisture content is greater than required, the material shall be spread and allowed to dry before starting rolling. The moisture content shall be uniform throughout the layer of material and ploughing, dicing, harrowing or other methods of mixing may be required to obtain uniform distribution. If the moisture content is more or less than the range of the required particle, moisture content, or if it is not uniformly distributed throughout the layer, rolling shall be stopped and shall be started again only when the above conditions are satisfied.
13.7.0 Compaction Equipment

While the specifications provide that equipment of a particular type and size is to be furnished and used, it is to be understood that the use of improved equipment is to be encouraged. Tamping (sheep foot) rollers or pneumatic rollers and vibratory rollers shall be used for compacting cohesive materials and pneumatic rollers and vibratory rollers shall be used for compacting cohesion less materials

a. Tamping (Sheep foot) Rollers

Tamping rollers shall conform to the following requirements

b. Roller drums

Each drum of a roller shall have an outside diameter of not less than 1.5 m and shall not be more than 1.8 m in length. The space between two adjacent drums when on level surface shall neither be less than 30 cm nor more than 40 cm. Each drum shall be free to pivot about an axis parallel to the direction of travel.

c. Tamping Feet

At least one tamping foot shall be provided for each 600 sq.cm of drum surface. The shape measured on the surface of the drum between the centers of any two adjacent tamping feet shall not less than 25 cm.

The length of each tamping foot from the outside surface of the drum shall be maintained at not less than 25 cm. The cross sectional area of each tamping foot shall not be more than 60 sq cm and shall be maintained at not less than 45 sq. cm and not more than 60 sq. cm at a plane normal to the axis of the shank 15 cm from the drum surface and shall be maintained at not less than 45 sq. cm and not more than 60 sq. cm at a plane normal to the axis of the shank 20 cm from the drum surface.

d. Roller Weight

The weight of a roller when fully loaded shall not be less than 7000 kgs per drum. The loading used in the roller drums and operating of rollers shall be as required to obtain the desired breakdown and compaction of materials. If more than one roller is used on anyone layer of fill, all rollers so used shall be of the same type and essentially of the same dimensions. Tractors used for pulling rollers shall have sufficient power to pull them at a speed of about 4 km per hour with drums fully loaded. During the operation of rolling the spaces between the tamping feet shall be kept clear of materials which could impair the effectiveness of the tamping rollers. If the rollers used are at tandem, the tamper spacing shall be set so that the circumferential rows of the rear drums are in line with the midpoint between the circumferential rows on the forward drums.

e. Pneumatic rollers

Pneumatic rollers shall have four wheels equipped with pneumatic tyres and a body suitable for ballast loading so that the load per wheel may be varied as necessary from 7000 kgs to 11000 kgs. Tyre pressure shall not exceed 2.5 kgs/ sq. cm. The tyres shall be of such size and ply as can be maintained during rolling operations with tire.
pressure not greater than 2.5 kgs/ sq. cm for a 11000 kgs wheel load. The roller wheels shall be located abreast and each wheel and tire shall be mounted in such a way that all wheels exert approximately equal loads when traversing uneven grounds. The spacing of the wheels shall be such that the distances between the nearest edges of adjacent tyres at the imprint will not be greater than 50 per cent of the width of single tire. When one pneumatic roller is attached to a tractor, the entire tractor and roller unit shall be capable of executing a 180 deg turn on a 5 m radius.

f. Vibratory Rollers

Vibratory rollers shall have dead weight 5 to 15 tonnes and the vibrators shall have frequency between 1100 and 1800 pulses per minute and amplitude of vibration shall between 0.5 mm and 1.5 mm

13.8.0 Rolling and Tamping

a. Rolling

When each layer of material has been conditioned, so as to have the proper moisture content uniformly distributed throughout the material, it shall be compacted by passing the roller. The exact number of passes shall be decided after necessary field tests. The layers shall be compacted in strips overlapping not less than 0.6 m. The rollers or loaded vehicles shall travel in a direction parallel to the axis of the embankment. Turns shall be made carefully to ensure uniform compaction. Rollers shall always be pulled Density tests shall be made after rolling and the dry density attained shall be not less than 95% of maximum dry density (Standard Proctor) obtained in the Laboratory for the type of material used.

b. Tamping

Rollers will not be permitted to operate within 1.0 m of concrete and masonry structures. In locations where compaction of the earth fill material by means of the roller is impracticable or undesirable, which would be designated at the sole discretion of the Engineer-in-Charge the earth shall be specially compacted

Fill shall be spread in layers not more than 20 cm in compacted thickness and shall be moistened to have the required moisture content. When each layer of material has been conditioned to have the required moisture content it shall be compacted to achieve the dry density of not less than 95% of Maximum Dry Density (Standard Proctor) by special rollers mechanical tampers hand held vibratory tampers or by other approved methods and all equipment and methods used shall be subject to approval based on evidence of actual performance. The moisture control and compaction shall be equivalent to that obtained in the earth actually placed in the embankment in accordance with clause 8.7.0 and 8.9.1.

13.9.0 Inspection Test

Control tests shall be carried out in laboratory from time to time to determine whether the earth produced by methods employed satisfies the requirements of the specifications. Routine field tests shall also be carried out by the Engineer-in-Charge and
the work shall be inspected regularly. Field density test should be particularly and specially made in the following areas.

a. Where the degree of compaction is doubtful.
b. Where embankment operations are concentrated i.e. where 2 or more layers are placed one over the other on the same day.
c. To represent every 1000 cu. meters of embankment placed.
d. Atleast one test for every full or part shift of compaction operations and
e. Atleast one test for every 250 m length of embankment in each layer.

The Engineer-in-Charge shall determine whether the desired results are being obtained.

The Implementing agency shall provide all facilities such as labour conveyance equipment etc. required for collection of samples and to conduct test in situ or at laboratory. Relevant test to be conducted by the Engineer-in-Charge at his discretion at the borrow area, on embankment and at laboratory are listed out in the Annexure II.

13.10.0 Dressing and Trimming of the slopes

The outer slopes of the embankment shall be neatly dressed to line. Compaction shall extend over the full width of the embankment and the material in the slopes shall be compacted as for the rest of structure. To ensure proper compaction at the outer edge, the fill shall be constructed for a minimum of 0.5 m extra width on either edges or the outer edge dressed to true width and slope after compaction. No earth slope shall be left without trimming to design slope. Slopes shall be maintained until final completion and acceptance. Any material that is lost by weathering or due to any other cause shall be replaced. The trimmed material is permitted for reuse in the embankment. No separate payment will, however be made for forming extra width offsets or trimming the slopes and the unit rates for the embankment work shall therefore provide for the same.

13.11.0 Provision for Settlement

While forming the embankment due allowance shall be made to allow for settlement so as to maintain the top of embankment at designed elevation.

14.0.0 TURFING

14.1.0 Scope

This section of specifications covers turfing on the slope of the embankment as Indicated in the following drawing and mentioned herein with turf sods.

14.2.0 General Requirement

The implementing agency shall furnish all labour, equipment and materials required for the complete performance of the work in accordance with the drawings, schedule of items and as described herein.

Grass turf sods of approved variety shall be used in this work. No directing planting of grass on the embankment slope shall be permitted.

14.3.0 Placing

The slope of the embankment including berms if any shall be turf sodded. After the slope
has been dressed to line, it shall be slightly roughened and scarified. The entire slope surface shall then be covered with a layer of turf sod consisting of blocks of thin lining grass growth of approved species. The sods shall include a mat of roots and earth. Thick Sod containing an excessive amount of obnoxious weed growth shall be excluded Sod shall be carefully handled in transportation and placing so that a minimum amount of earth will be lost from the root mass. The blocks of sod shall be laid on the slope in close contact and then tamped firmly in place so as to fill and close the joints between blocks. The interval of time between cutting and laying shall be kept to a minimum and sod shall not be permitted to dry out. Immediately after placing the sods, slope shall be thoroughly wetted and then kept moist for 3 months or till such time the grass establishes itself uniformly on the surface whichever is later. The watering shall be done. The growth of weeds on the turfing shall be prevented by removing them and disposing off. The finished work shall be to the satisfaction of the Engineer-in-Charge and his decision shall be final in the matter.

15.0.0 HDPE LINER

15.1.0 Scope

This section covers the specifications for the supply, laying, jointing and testing of HDPE geomembrane liner as per the drawings and specifications mentioned herein to the satisfaction of the Engineer-in-charge.

15.2.0 Sheet Material

The HDPE sheet shall conform to the minimum average roll value requirements listed below in Table-2. The minimum width of the roll shall be 8 m and the minimum length shall be 150 m.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Method</th>
<th>Minimum values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness, mm</td>
<td>ASTM D 5199</td>
<td>1.5 mm (-5% to +10%)</td>
</tr>
<tr>
<td>Color</td>
<td>-</td>
<td>Black</td>
</tr>
<tr>
<td>Permeability</td>
<td>ASTM E 96</td>
<td>2.3 x 10^{-14} cm/sec.</td>
</tr>
<tr>
<td>Density</td>
<td>ASTM D 1505</td>
<td>&gt;0.935 gm/cc</td>
</tr>
<tr>
<td>Coefficient of Linear</td>
<td>ASTM E 831</td>
<td>1.5 x 10^{-4} °C^{-1}</td>
</tr>
<tr>
<td>Thermal Expansion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile Strength at Yield</td>
<td>ASTM D 638, Type IV Dumbbell at 2 inch/min</td>
<td>245 N/cm width</td>
</tr>
<tr>
<td>Tensile Strength at Break</td>
<td>ASTM D 638, Type IV Dumbbell at 2 inch/min</td>
<td>420 N/cm width</td>
</tr>
<tr>
<td>Elongation at Yield</td>
<td>ASTM D 638, Type IV Dumbbell</td>
<td>12-13 %</td>
</tr>
<tr>
<td>Parameter</td>
<td>Test Method</td>
<td>Minimum values</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Elongation at Break</td>
<td>ASTM D 638, Type IV Dumbbell at 2 inch/min</td>
<td>700 %</td>
</tr>
<tr>
<td>Carbon Black</td>
<td>ASTM D 4218</td>
<td>2 to 2.5%</td>
</tr>
<tr>
<td>Ozone resistance</td>
<td>ASTM D 1149, 168 hrs</td>
<td>No crack</td>
</tr>
<tr>
<td>Water absorption</td>
<td>ASTM D 570, 23 °C</td>
<td>0.1%</td>
</tr>
<tr>
<td>Environmental Stress Cracking</td>
<td>ASTM D 1693</td>
<td>&gt; 2000 hrs</td>
</tr>
<tr>
<td>Volatile Losses</td>
<td>ASTM D 1203</td>
<td>0.1%</td>
</tr>
<tr>
<td>Tear Resistance</td>
<td>ASTM D 1004, A</td>
<td>131 N/mm</td>
</tr>
<tr>
<td>Water Vapor Transmission</td>
<td>ASTM E 96</td>
<td>0.024 g/day.m²</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>ASTM D 4833</td>
<td>3500 N/cm</td>
</tr>
<tr>
<td>Seam Properties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Shear Strength</td>
<td>ASTM D 4437 mod.</td>
<td>13.8 MPa</td>
</tr>
<tr>
<td>(b) Peel Strength (hot wedge fusion)</td>
<td></td>
<td>10.3 MPa</td>
</tr>
<tr>
<td>(c) Peel Strength (filled extrusion)</td>
<td></td>
<td>9.0 MPa</td>
</tr>
<tr>
<td>Change in weight (%)</td>
<td>EPA 9090A, Chemical Compatibility Test</td>
<td>≤10</td>
</tr>
<tr>
<td>Change in volume (%)</td>
<td>EPA 9090A, Chemical Compatibility Test</td>
<td>≤10</td>
</tr>
<tr>
<td>Change in tensile strength (%)</td>
<td>EPA 9090A, Chemical Compatibility Test</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Change in elongation at break (%)</td>
<td>EPA 9090A, Chemical Compatibility Test</td>
<td>&lt;30</td>
</tr>
<tr>
<td>Parameter</td>
<td>Test Method</td>
<td>Minimum values</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Change in modulus (%)</td>
<td>EPA 9090A, Chemical Compatibility Test</td>
<td>&lt;30</td>
</tr>
<tr>
<td>Change in hardness (%)</td>
<td>EPA 9090A, Chemical Compatibility Test</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>

15.3.0 QA/QC Requirements for Membrane Raw Materials

All raw material supplied to the manufacturer shall be delivered in rail car batches and must be supplied with test certification from the raw material supplier. The certification must state the results of tests, which confirm the quality of the resin. The raw material supplier must also confirm that each batch of resin is all of the same type and is 100% Virgin. Each batch of resin shall be given an identification (batch) number which shall be used and remain on file to keep track of all rolls manufactured from each batch.

The use of any off spec, recycled or blends of resins will not be considered. Prior to the production of the membrane, the membrane manufacturer shall test the raw material batches to certify the raw material suppliers test results and entity of the singular resin. The membrane manufacturer shall provide certification and all available test result for raw materials prior to the delivery of materials to site.

15.4.0 QA/QC Requirements for Membrane Manufacturing

The manufacturing process shall be a fully automated Flat-Cast extrusion process controlled by a fully computerized system. The control system shall provide for the continuous monitoring of the parameters like; Temperature, Pressure and Speed. The manufacturing process must also provide for the automated continuous monitoring of thickness and sheet quality.

15.4.1 Thickness: - Each roll shall be tested automatically and evenly over its entire surface area, the minimum parameters acceptable for testing each roll shall be 6,000 thickness point checks. The acceptable thickness for each roll shall not be greater than -5% to +10% of the specified material thickness.

15.4.2 Sheet Quality: - Each roll shall be tested automatically for High Voltage Test over its entire surface area for any point of Electrical Continuity through (across) the thickness of the sheet. The high voltage scanner shall be capable of detecting any pinhole, void or significant reduction of electrical resistance. Any roll detected to have holes or electrically conductive inclusions shall be rejected and not sent to the site.

Each roll delivered to site shall be provided with a roll test data report, these reports must provide the following information and test results as per the specified ASTM standards, reports must also carry the manufactures laboratory QA/QC approval seal.
The liner material shall be supplied with a 125mm-film sheet along the roll longitudinal edges in order to keep this zone clean and to stop oxidization. This film shall be removed immediately before welding.

The overlapping and welding area shall be marked to assure an optimum welding. The HDPE liner shall have a glossy smooth surface.

15.4.3 Roll Identification

1. Roll Number and dimensions
2. Production Date
3. Area of Sheet on Roll
4. Roll Length
5. Roll Width
6. Roll Weight

15.4.4 Resin Lot Information

1. Batch Number
2. Resin Type
3. Resin Test Results as per following ASTM Test methods.
   a. Density D792
   b. Moisture D570
   c. Brittleness D746
   d. Melt Index D1238
   e. O.I.T. D3895

15.4.5 Membrane Property

The implementing agency will arrange to carry out the following tests, at their cost, at a reputed and approved laboratory at the time of execution of work to ascertain and assure the quality of material received at project site. The tests shall be witnessed by client / consultant at their discretion. The frequency of tests for physical and mechanical properties and their conformity norms are indicated in following Table.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Property</th>
<th>Norms (ASTM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/5000 m²</td>
<td>Thickness</td>
<td>D-5199</td>
</tr>
<tr>
<td>1/5000 m²</td>
<td>Density</td>
<td>D-792</td>
</tr>
<tr>
<td>1/5000 m²</td>
<td>Carbon black content</td>
<td>D-1603</td>
</tr>
<tr>
<td>1/5000 m²</td>
<td>Carbon black dispersion</td>
<td>D-5596-94</td>
</tr>
<tr>
<td>1/1500 m²</td>
<td>Mechanical Properties Tensile resistance</td>
<td>D-638 Mod.NSF 43</td>
</tr>
<tr>
<td>1/2000 m²</td>
<td>Shear test (on seam)</td>
<td>D-4437, 6.3 NSF mod.</td>
</tr>
<tr>
<td>1/2000 m²</td>
<td>Peel test (on seam) Rupture test (on seam)</td>
<td>D-4437, 6.2 NSF mod. US-EPA.</td>
</tr>
</tbody>
</table>
### Preparation of Detailed Project Report for MSW Management

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Property</th>
<th>Norms (ASTM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every lot</td>
<td>ESCR</td>
<td>ASTM D 1693-B</td>
</tr>
<tr>
<td>1/5000 m²</td>
<td>Puncture Resistance</td>
<td>ASTM D 4833</td>
</tr>
<tr>
<td>1/5000 m²</td>
<td>Tear Resistance</td>
<td>ASTM D 1004</td>
</tr>
</tbody>
</table>

**Note**: Sample size for conformity test a meter of the entire width for the roll and must not be taken in the first thickness.

#### 15.5.0 QA/QC at site

The material shall be inspected after it is delivered at site as follows:

1. Rolls or portions of rolls that appear damaged shall be marked.
2. Verification shall be done to ensure that materials are stored in secure place and are protected against dirt, theft, vandalism, and passage of vehicles.
3. Rolls shall be properly labelled with date and roll size.

Any material rejected on site by the Engineer-in-charge shall be jointly inspected by the Engineer-in-Charge and the Manufacturer/Installer. If required, the material shall be tested and if the material is unable to meet the specification, it shall be replaced by the Manufacturer/Installer at his cost.

#### 15.6.0 Preparation for HDPE Liner Deployment:

Prior to commencement of HDPE liner deployment, layout drawings shall be prepared to indicate the panel configuration and general location of field seams for the project. The actual panel layout may vary, but shall have to be approved by the Engineer-in-charge, in order to accommodate field conditions. Each panel used for the installation will be given a number that will be correlated with a batch or roll number.

Overlap the panels of geo-membrane approximately six (6") inches prior to welding. Clean the seal area prior to seaming to assure the area is clean and free of moisture, dirt or debris of any kind. No grinding is required for fusion welding.

Adjust the panels so that the seams are aligned with the fewest possible number of wrinkles and “fish mouth”.

Grind seams overlap prior to welding within one (1) hour of the welding operation in a manner that does not damage the geo-membrane. Grind marks should be covered with extrude whenever possible. In all cases, grinding should not extend more than one quarter inch (1/4") past the edge of the area covered by the extrude welding.

#### 15.6.1 Special Instructions for Installation

Implementing agency shall protect the sub soil desiccation, flooding protection, if required may consist of a thin plastic protective cover (or other material as approved by Engineer-in-Charge installed over the completed sub-soil until such times as the placement of geo-membrane liner begins. Sub soil found to have desiccation cracks greater than half inch (1/2") in width or depth or which exhibit swelling, heaving or other
similar conditions shall be replaced or reworked by the implementing agency to remove these defects.

15.6.2 Sub-base Preparation

The sub-base must be properly prepared and compacted for installation of HDPE liner. The sub-base must not contain any particles. The sub-base must be checked for footprints or similar depressions before laying the liner. The seaming equipment tends to get caught in such small depressions, causing burnout and subsequent repair. A small piece of the synthetic membrane placed below the membranes that are being seamed (this piece is moved forward along with the seaming equipment) may reduce burnout due to small depressions.

15.7.0 Field Panel Placement

HDPE deployment will generally be not done during any precipitation, in the presence of excessive moisture, in an area of standing water, or during high winds.

Installation of field panels shall be done as indicated on the approved layout drawing keeping the provision for settlement of the soil. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location will be noted in the field. Information relating to HDPE panel placement including date, panel number, and panel dimensions may be maintained on a site-specific basis. If a portion of a roll is set aside to be used at another time, the roll number will be written on the reminder of the roll at several places.

The method and equipment used to deploy the panels must not damage the HDPE or the supporting sub grade surface. No personnel working on the HDPE engage in actions that could result in damage to the HDPE. Adequate temporary loading and/or anchoring, (i.e. sandbags, tires) which will not damage the HDPE, will be placed to prevent uplift of the HDPE by wind.

The HDPE will be deployed with adequate allowance for typical thermal expansion.

Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked and repaired as explained earlier in the chapter.

15.8.0 HDPE Field Seaming

In general, seams shall be oriented parallel to the slope, i.e. oriented along, not across the slope. Whenever possible, horizontal seams should be located on the base of the cell, not less than five (5’) feet from the toe of the slope. Each seam made in the field shall be numbered. Seaming information shall include seam number, welder ID, machine number, temperature setting and weather conditions.

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam as described earlier in this chapter.

15.9.0 Equipment

15.9.1 Fusion Welding
Fusion Welding consists of placing a heated wedge, mounted on a self-propelled vehicular unit, between two (2) over-lapped sheets such that the surfaces of both sheets are heated above the polyethylene’s melting point. After being heated by the wedge, the overlapped panels pass through a set of pre-set pressure wheels, which compress the two (2) panels together to form the weld. The fusion welder is equipped with a device, which continuously monitors the temperature of the wedge.

15.9.2 Extrusion Fillet Welding

Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the overlap of the two (2) HDPE sheets to be welded. A hot air pre heat and the addition of molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the overlapped sheets. The extrusion welder is equipped with gauges giving the temperature in the apparatus and a numerical setting for the pre-heating unit.

Factors such as the HDPE temperature, humidity, wind, precipitation, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed.

15.10.0 Seam Testing of HDPE

All field seams shall be non-destructively tested over their full length using test equipment and procedures described herein. Seam testing shall be performed as the seaming work progresses, not at the completion of the field seaming.

15.10.1 Air Pressure Testing

The welded seam is composed of a primary seam and a secondary track that creates an unwelded channel. The presence of an unwelded channel permits fusion seems to be tested by inflating the sealed channel with air to a predetermined pressure and observing the stability of the pressurized channel over time.

15.10.2 Equipment for Air Testing

The equipment required for air testing consists of following components:

1) An air pump (manual or motor driven) capable of generating and sustaining a pressure between 20 to 60 psi.
2) A rubber hose with fittings and connections.
3) A sharp hollow needle or other approved pressure feed device with a pressure gauge capable of reading and sustaining a pressure between 0 to 60 psi.

15.10.3 Procedure for Air Testing

Both the ends of the seam to be tested should be sealed. Needle or other approved pressure feed device should be inserted into the sealed channel created by the fusion weld.

Test channel should be inflated to a pressure of approximately 30 psi, and the pressure should be maintained within the range listed in Initial Pressure Schedule given below. Valve should be closed and the initial pressure should be observed and recorded.
INITIAL PRESSURE SCHEDULE *

<table>
<thead>
<tr>
<th>MATERIAL (MIL)</th>
<th>MIN. PSI</th>
<th>MAX. PSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>27</td>
<td>35</td>
</tr>
<tr>
<td>80</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>100</td>
<td>30</td>
<td>35</td>
</tr>
</tbody>
</table>

* Initial Pressure settings shall be recorded after an optional two (2) minute stabilization period. The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize. The initial pressure reading may be recorded once stabilization has taken place.

The air pressure should be observed and recorded five (5) minutes after the initial pressure setting is recorded. If loss of pressure exceeds the following or if the pressure does not stabilize, the suspect area should be located and repaired in accordance with para. 11.0.0 of this chapter.

MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL AFTER 5 MINUTES

<table>
<thead>
<tr>
<th>MATERIAL (MIL)</th>
<th>PRESSURE DIFF.</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>4 PSI</td>
</tr>
<tr>
<td>60</td>
<td>3 PSI</td>
</tr>
<tr>
<td>80</td>
<td>2 PSI</td>
</tr>
</tbody>
</table>

At the conclusion of all pressure tests, the end of the air-channel opposite the pressure gauge shall be cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated from the point of blockage. If the point of blockage cannot be found, air channel shall be cut in the middle of the seam shall be cut and each half shall be treated as a separate test. Pressure feed needle shall be removed and the resulting hole shall be sealed by extrusion welding.

15.10.4 Procedure for Non-Complying Test

In the event of a Non-complying Air Pressure Test, the following procedure shall be followed:
1. Seam end seals should be checked and seams should be retested.
2. If a seam does not maintain the specified pressure, the seam should be visually inspected to localize the flaw.
3. If no flaw is found, area to be vacuum tested should be marked. Entire length of the seam should be vacuum tested as explained in this chapter.
   a. If leak is located by the vacuum test, it should be repaired by extrusion fillet welding. Repair should be tested by vacuum testing.
   b. If no leak is discovered by vacuum testing, the seam will be considered to have passed non-destructive testing.
### 15.10.4 General Air Testing Procedures

1. The opposite end of the air channel will in all cases be pierced to assure that no blockages of the air channel have occurred.
2. Whenever possible, seams should be air-tested prior to completing butt seams to avoid having to cut into liner. All cuts through the liner as a result of testing will be repaired by extrusion welding.
3. All needle holes in air channels, within the boundaries of the active cell, will be repaired with an extrusion bead or repaired by patching at the discretion of the Engineer-in-Charge.

### 15.10.5 Air Pressure Testing Documentation

All information regarding air-pressure testing (date, initial time and pressure, final time and pressure, pass/fail designation, and Technicians number) will be written on one end of the seam, or portion of seam tested.

### 15.10.6 Vacuum Testing

This test is used on extrusion welds, or when the geometry of a fusion well makes air pressure testing impossible or impractical, or when attempting to locate the precise location of a defect believed to exist after air pressure testing.

### 15.10.7 Equipment for Vacuum Testing

The equipment required for vacuum testing shall consist of following components:

1. Vacuum box assembly consisting of rigid housing with a soft neoprene gasket attached to the open bottom, a transparent viewing window, port hole or valve assembly, and a vacuum gauge.
2. Vacuum pump or Ventura assembly equipped with a pressure controller and pipe connection.
3. A rubber pressure/vacuum hose with fittings and connections.
4. A bucket and means to apply a soapy solution.
5. A soapy solution.

### 15.10.8 Procedure for Vacuum Testing

1. Excess overlap from the seam should be trimmed, if any.
2. Vacuum pump/compressor should be turned on to reduce the vacuum Box to approximately 10 inches of mercury, i.e., 5-psi gauge.
3. A strong solution of liquid detergent and water should be applied to the area to be tested.
4. Vacuum box should be placed over the area to be tested and sufficient downward pressure should be applied to “seat” the seal strip against the liner.
5. Bleed valve should be closed and vacuum valve should be opened.
6. A minimum of 5-psi vacuum should be applied to the area as indicated by the gauge on the vacuum box.
7. It should be ensured that a leak tight seal is created.
8. The suction should be held for an adequate time to thoroughly examine the HDPE through the viewing window for the presence of soap bubbles.
9. After this period vacuum valve should be closed and bleed valve should be opened, the box should be moved over the next adjoining area with a minimum three inch (3”) overlap, and the process should be repeated.

15.10.9 Procedure for Non-Complying Test

1) All the areas where soap bubbles appear should be marked and repaired  
2) The repaired areas should be retested.

15.10.10 General Vacuum Testing Procedures

1) Vacuum box testing will be performed by qualified construction personnel. 
2) Overlap must be trimmed prior to vacuum boxing all seams. 
3) Special attention shall be exercised when vacuum testing “T” seams or patch intersections with seams.

Vacuum testing crew will use Mean Streak permanent markers to write online indicating tester’s ID number, date, and pass/fail designation on all areas tested. Records of vacuum testing shall be maintained on non-destructive testing form.

15.10.11 Destructive Testing

The purpose of destructive testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore, destructive testing should be held to a minimum to reduce the amount of repairs to the HDPE.

15.10.12 Procedure for Destructive Testing

1. Destructive test samples shall be marked and cut out randomly at a minimum average frequency of one (1) test location every 500 feet of seam length, unless otherwise specified or agreed.
2. Destructive samples should be taken and tested as soon as possible after the means are welded (the same day), in order to receive test results in a timely manner.
3. Qualified personnel will observe all field destructive testing and record date, time, seam number, location, and test results on Destructive Testing Form.
4. Sample Size
   (a) The sample should be twelve inches (12”) wide with a seam sixteen inches (16”) long centered length-wise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the Owner at the Owner’s request or by specific project specifications.
   (b) A one-inch (1”) specimen shall be cut from each end of the test seam for field-testing.
   (c) The two (2) one inch (1”) wide specimens shall be tested on a field tensiometer for peel strength. If either field specimen does not pass, it will be assumed the sample would also not pass laboratory destructive testing.

15.10.13 Procedure for Non-Complying Destructive Test

1. Additional field samples should be cut for peel testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the initial non-complying sample. A field test should be performed for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing.
(a) If the laboratory samples pass, the seam between the two (2) passing sample locations should be repaired according to procedures detailed in para 11.0.0 of this chapter.

(b) If either of the samples is still in non-compliance, then additional samples should be taken in accordance with the above procedure until two (2) passing samples are found to establish the zone in which the seam/seams should be reconstructed.

2. All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken.

3. In cases of repaired seams exceeding 150 consecutive feet, a sample must be taken and pass destructive testing from within the zone in which the seam has been reconstructed.

4. All destructive seam samples shall be numbered and recorded on Destructive Test Form.

15.10.13 Laboratory Testing of Destructive Seam Samples

1. Seam destructive samples may be sent to laboratory or tested on site when permitted by a site-specific quality control plan or in the event that third party laboratory destructive testing is not being performed.

2. Destructive samples will be tested for “Shear Strength” and “Peel Adhesion”. Five (5) specimens shall be tested for each test method. Four (4) out of the five (5) specimens must exhibit for each round of peel and shear testing. In addition, four (4) of the five (5) individual specimens must meet or exceed the strength requirements as listed in Material specification sheet in order for the seam to pass the destructive test.

15.11.0 Testing for Pinholes, Cuts

Laid HDPE sheet on liner shall be tested for cuts, pinholes, seam leakage’s etc. by using modern Geo-electrical leak detection/vacuum box on complete lining profiles before putting the next layer. The implementing agency shall give the detailed methodology for testing. Any defect remediation / repair modification as required by this test shall be carried out by the implementing agency.

15.12.0 Defects and Repairs

15.12.1 Repair Procedures

Any portion of the HDPE or HDPE seam shown a flaw, or having a destructive or non-destructive test in non-compliance shall be repaired. Procedures for repair include the following

15.12.2 Patching

Patching shall be used to repair large holes, tears and destructive sample locations. All patches shall extend at least three inches (3") beyond the edges of the defects and all corners of patches shall be rounded. The total area of patches in no case shall exceed 1.0% of the panel area

15.12.3 Grinding and Welding
Grinding and welding shall be used to repair sections of extruded fillet seams.

15.12.4 Spot Welding or Seaming
Spot welding or seaming shall be used to repair small tears, pinholes or other minor localized flaws.

15.12.5 Capping
Capping shall be used to repair lengths of extrusion or fusion welded seams.

15.13.0 Verification of Repairs
Every repair shall be non-destructively tested. Repairs, which pass the non-destructive test, shall be deemed acceptable. Repairs in excess of 150 consecutive feet of seem shall require a destructive test.

15.14.0 Control and Verification Tests on Geo-membrane Installation
These tests will verify the welds’ mechanical resistance to peel and shear. No assembling equipment will be used on site without a previous calibration test.

The Installer must prepare samples of a minimal length of one (1) metre by a width of 300mm, with the weld centered on the sample’s width. Two (2) specimens will be taken from each end of the samples of peel and shear. For each sample, two paired peel and shear results will thus be obtained.

Calibration of all welding equipment must be performed and documented by the installer for each instrument used, at the start of each work shift, following abrupt changes in weather conditions and as requested by the Engineer-in-Charge.

Calibration of equipment will be performed by tests on geo membrane samples under the same weather conditions as those expected on site during panel assembling.

Once removed, samples will be tested on site with a calibrated portable tensionmeter and must meet with the requirements of welds resistance to peel and shear as described in the Technical specification.

The Installer shall provide the Engineer-in-Charge with recent certificates of standardization for all control instruments (tensionmeter; speed, tensile level etc.). The Engineer-in-Charge reserves the right to demand any additional calibration test at any time.

All documentation on the calibration tests performed by the Installer shall be submitted to the Engineer-in-Charge. The installer will identify each calibration test with the following information;

- Date and time
- Identification of destructive test
- Identification of weld
- Welded panel’s identification number
- Quantified results of peel and shear test
- Identification of type of rupture
- Quality control technician’s identification
- Localization on “As-built” plan
The Quality Assurance technician shall perform small perforations in the lining in order to assess the efficiency of the Installer’s non-destructive testing program. The Quality Assurance technician shall perform those perforations with an approximate frequency of one (1) each 1000 meters of weld at least three (3) instances of the project.

The Quality Assurance technician shall document those punching or perforations by including at least the following information:

- Date and time of operation
- Identification of weld
- Exact location of perforation
- Quality Assurance technician’s identification
- Results of Installer’s non-destructive tests
- Date and time of repair.

If the Installer’s non-destructive testing program fails to find the punching or perforations made, the Installer will repeat non-destructive testing on the faulty weld, as well as on the welds before and after it.

The Quality Assurance technicians shall perform verification destructive tests at an approximate frequency of one (1) for each 1000 meter of weld.

A special testing frequency will be used at the Engineer-in-Charge discretion when visual observations indicate a potential occurrence of problems. Verification tests may be performed in the following cases:

- Variation on the thickness of the weld
- Doubtful cleanliness of overlapping
- Dirty equipment or in poor condition
- Different personnel than the one authorized
- Adverse weather conditions
- Welding equipment failure
- Visible variation in material’s quality
- Close confined or complex working space
- Beginning and end of panels
- On the Engineer-in-Charge request

### 15.15.0 Warranty

Written warranties addressing HDPE material and installation workmanship shall be submitted to and approved by Engineer-in-Charge. The manufacturer’s warranty shall state that the installed material meets all requirements of the contract drawings and specifications and that under typical local atmospheric conditions and weather aging, the sheet material is warranted for at least 20 years. The installer’s warranty shall state that the HDPE field and factory seams will not fail within at least 20 years of the installation under similar conditions.

### 16.0.0 CLAY LINER

#### 16.1.0 Scope

This section covers the specifications for the supply, laying and testing of clay liner as per the drawings and specifications mentioned herein to the satisfaction of the Engineer-in-Charge.
Composite Clay Liner serves as a hydraulic barrier to flow of leachate the properties required for compacted clay liner as per specs is as follows:

- Minimum thickness of each composite clay liner/layer (primary & Secondary) shall be 0.60 m (Total ≥ 0.9 m).
- Maximum hydraulic conductivity of 1 x 10^-7 cm/ sec. (k ≤ 1 x 10^-9 m/s).

The minimum requirements recommended to achieve above specified hydraulic conductivity:

16.2.0 General Requirements

The soil used in the liner shall meet the following minimum criteria:

1. Be classified under the Unified Soil Classification System CL, CH, SC and OH (IS 2720 Part IV/ASTM Standard D248769)
2. Allow greater than 20 - 30 percent (dry weight) passage through no. 200 sieve (75 μm) (grain size analysis as per IS:2720 Part IV/ ASTM Test D1140)
3. Plasticity index greater than or equal to 7 to 10% (IS 2720 Part V)/ Plasticity greater than or equal to 15 units (ASTM Test D424)
4. Gravel content shall not be exceeding more than 30 %
5. Maximum particle size shall be between 20 to 50 mm
6. Have a pH of 7.0 or higher
7. Have a liquid limit equal to or great than 30 units (IS 2720 Part V/ ASTM Test D423)
8. Moisture Density relationship as per IS: 2720 Part VIII
9. Permeability test as per IS: 2720 Part XXXVI.

16.3.0 Quality control aspects

General quality control aspects which shall be adhered to are as follows:

1. The material (soil) used for filling shall be free from boulders, lumps, tree roots, rubbish or any organic deleterious matter.
2. Pre-processing may be carried out for water content' adjustment, removal of oversized, materials, pulverization of any clumps, homogenization of the soils, and., introduction of additives such as bentonite.
3. Ensure that a sub-grade on which a compacted clay liner will be constructed is properly prepared by compacting and obtaining required firmness.
4. Proper compaction of liner materials is to be carried out to ensure compacted clay liner meets hydraulic conductivity specified above.
5. Determine the appropriate thickness (as measured before compaction) of each of the several lifts that will make up the clay liner. Also proper bonding between lifts is to be ensuring to avoid formation of preferential pathways.
6. Preventive measures to protect compacted layers from desiccation are to be provided during construction.

16.4.0 Laying of clay liner

This specification and the method of measurements described herein are applicable for construction of compact clay liner at the base and on the sides of the landfill.

1. The implementing agency has to identify the borrow soil (if required) area having the requisite properties as mentioned above and make his own approach and access roads (as required) from the borrow area to the demarcated landfill area. No claim shall also be admissible to the Implementing agency on account of his having to take
longer leads or routes for earth movement, than envisaged by him, either due to any road cuttings, non-availability of routes, or any other grounds whatsoever.

2. In case total filling required in any area consists of earth both from borrow areas and available approved excavated material from within site area or use of any amended soil to achieve the stipulated permeability. The necessary laboratory tests/demonstrations/calculations are to be furnished to Engineer-in-Charge for approval.

3. In the event of filling of soil material as mentioned above, joint levels shall be taken - before commencing the filling with earth from borrow areas.

4. Prior to the placement of the clay in the desired location, the sub grade under the clay liner shall be checked. This shall be usually performed by proof-rolling the sub grade. Any weak zones shall be removed and appropriately backfilled and all debris should be removed. The clay may then be placed above the sub grade in loose lift.

5. Compacted clay liners shall be constructed in a series of thin lifts for proper compaction and homogeneous bonding between lifts. The lift thickness of clay liner shall be 20 to 22.5 cm before compaction and 15 cm after compaction. The soil placed in a loose lift shall be no thicker than about 230 mm. After the soil is placed, a small amount of water may be added to offset evaporative losses, and the soil may be tilled one last time prior to compaction. Each lift of clay liner shall be bonded to the underlying and overlying lifts. The surface of a previously compacted lift must be rough so that the new and old lifts blend into one another.

6. Sheep foot rollers shall be used for compacting the clay liner. The roller with fully penetrating feet (of 22.5 cm shaft length) shall be used for compact the liner. The minimum weight of the roller shall be 10000 kg (10 Tonnes). The minimum foot length shall be between 180 to 200 mm and Minimum number of passes shall be 5. A pass shall be reckoned as one pass of the compactor, not just an axle, over a given area, and the recommended minimum of five passes is for a vehicle with front and rear drums. The compaction shall be continued till the specified hydraulic conductivity is obtained and verified by Engineer-in-Charge.

7. Each layer shall be tested in field for Moisture Content and Hydraulic Conductivity (Undisturbed Sample) before laying the next layer the next layer. A minimum of 1 rest for 500 sq. m for each layer shall be conducted.

8. Successive layers of clay shall not be placed until the layer below has been thoroughly compacted to satisfy the requirements laid down in specifications.

9. Prior to compaction, the moisture content of material shall be brought to within plus or minus 2 % of the Optimum Moisture Content as described in IS: 2720 Part VII. The moisture content shall preferably be on the wet side for potentially expansive soil.

10. After compaction of a lift, the soil must be protected from desiccation, which causes the cracking of the Clay liner. Desiccation shall be minimized by smooth rolling the surface to form a relative impermeable layer at the surface or the soil can be periodically moistened. The protective measures stipulated above shall apply to each lift as well as the completed liner or cover barrier.
11. The lifts shall be placed in horizontal layers. For liners to be constructed slopes, the lifts shall be placed parallel to the slope.

17.0.0 LEACHATE COLLECTION SYSTEM

17.1.0 Scope

The primary function of the leachate collection and removal system (LCRS) is to collect and convey leachate out of the landfill unit to control the depth of leachate above the liner. The leachate collection system is placed over the unit's liner system. The bottom line should have a minimum slope of 2 percent to allow the leachate collection system to gravity flow to a collection sump or alternate arrangements for pumping shall be made.

The implementing agency shall Design a leachate collection and removal system using adequate water balance equations or appropriate modes to estimate leachate generation for the landfill and to maintain less than 30 cm depth of leachate, or 'head', above the liner.

Leachate Collection and detection system should include a high-permeability drainage layer, perforated leachate collection pipes, a protective filter layer, and a leachate removal system. Design considerations for each of these elements are given below:

1. High permeability drainage layer:
   (a) Drainage materials are to be placed on the liner system at the same minimum 2 percent grade.
   (b) The drainage materials (sand and gravel) shall be provided as per specifications given in chapter 21 and chapter 22 of this document.
   (c) It should be demonstrated that the layer will have sufficient bearing capacity to withstand the weight load of full unit.
   (d) Geo-synthetic drainage materials may be used in addition to or in place of, soil materials.
   (e) The flow rate of geo-net can be evaluated by ASTM D-4716.

2. Perforated Leachate Collection Pipes.

3. Perforated piping system should be located in the drainage layer to rapidly transmit the leachate to the sump and removal system.
   (a) The design of perforated leachate collection pipes should consider necessary flow rates, pipe sizing and pipe structural strength.

4. Protective filter Layer
   (a) To protect the drainage layer and perforated leachate piping from clogging, a filter layer is to be placed over the high permeability drainage layer. As per the specifications given in chapter 18
   (b) The filter layer should consist of a material with smaller pore space than the drainage material or the perforation openings in the collection pipes.
   (c) Leachate Removal system
   (d) A leachate collection sump shall be designed and constructed of materials compatible with and impermeable to leachate formed in landfill. The final leachate collection sump shall be common for the total secure landfill area and shall be located and sized accordingly.
   (e) The sump should be accessible for removal of leachate if the pump becomes inoperative and the stand pipe becomes damaged.
(f) Pumps are to be provided to remove leachate that has collected.

(g) The pump should be placed at adequate depth to allow enough leachate collection to prevent the pump from running dry.

(h) A level control, standby pump and warming system is to be provided to ensure proper sump operation.

(i) Standpipes should also be provided to remove leachate from the sump.

(j) The leachate shall be pumped for treatment in the leachate treatment plant

The primary leachate collection system shall be placed over the primary liner in this project is a composite liner (geo-membrane with compacted clay beneath). The secondary leachate collection system also called leak detection system shall be placed over the secondary liner i.e. between two composite liners. The leachate, if any, shall be collected at low point (provision shall be made sufficiently) and periodically sampled so as to assess the adequacy of primary liner against leakage of leachate.

Material for Filter shall meet the following requirements:

The drainage and filter material shall be placed dry and may be lightly compacted with a vibratory roller. Care must be taken, to ensure that vehicles are up to driven over the naked HDPE liner.

Laying of Perforated Leachate Collection Pipes

The upper half of the pipe above the spring line shall be perforated, whereas the lower half of the pipe shall remain un-perforated. The bidder shall provide details of supplier of the HDPE pipes along with the three pipe parameters i.e. Compressive yield strength, wall crushing, wall buckling.

The perforated pipes shall be laid out in 'v' trenches and the trenches shall be backfilled. All care shall be taken to avoid digging the trench below the levels indicated in the drawing. All the perforated-pipes shall be connected to a solid HDPE header pipe, through a Standard "T’-joint”.

18.0.0 HDPE PIPES

18.1.0 Scope

This section covers the specifications for the supply, laying, jointing and testing of HDPE pipes as per the drawings and specifications mentioned herein to the satisfaction of the Engineer-in-charge.

18.2.0 Specifications

The pipe shall conform to the material grade PE-80 of latest edition of IS: 4984. The pressure rating shall be PN-6.

The pipe and fittings shall be chemically resistant and shall be suitable for all pH ranges i.e. 0 to 14.

These shall have smooth internal bore enhancing the hydraulic flow properties with low frictional losses.

The pipes and fittings shall be strong and resilient enough to withstand static and hydrodynamic both with regard to internal as well as external pressures.
The pipe shall have excellent elastic properties and can take sufficient curvature.

The pipes and fittings shall have the property that it can be joined conveniently with no leakage.

The pipe and fittings shall be UV rays resistant and shall also be resistant to wear and abrasion. The pipes flange should be provided wherever required with joints having HDPE long stub ends. The flange shall conform to DIN-PN-10 and drilling shall be to match with the counter flange of valves/pipes/pumps etc.

18.3.0 Piping System

All piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. The minimum thickness for pipes and fittings shall be adhered to higher thickness in equivalent material is acceptable. However, no credit will be given for higher thickness.

All the piping systems, fittings and accessories supplied under this package shall be designed to operate with normal maintenance for a plant service life of 20 years and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.

All piping system shall be properly laid to take care of hydraulic shocks and pressure surges, which may arise in the system during operation. Bidder should provide necessary protective arrangements like anchor blocks / anchor bolts, etc. for the safeguard of the piping system under above-mentioned conditions. External and internal attachments to piping shall be designed so as not cause flattering of pipes, excessive bending stresses or harmful thermal gradients of pipe walls.

Pipes and fittings shall be manufactured by an approved firm of repute. A list of approved manufacturers is given in the tender document. They should be truly cylindrical of clear internal diameter as specified in the IS code, of uniform thickness, smooth, and strong, free from dents, cracks and holes and other defects. They shall allow ready cutting, chipping or drilling, welding etc.

19.0.0 SAND LAYER

19.1.0 Scope

This section of the specification covers supplying and laying sand layer in the leachate collection and removal system and leak detection system as shown in the drawings and as mentioned herein.

19.2.0 General Requirements

The implementing agency shall furnish all labour and material required for the complete performance of the work in accordance with the drawings, schedule of item and as described herein.

19.3.0 Sand Layer

Graded sand filter of 100 mm thickness shall be laid as indicated in the drawing in the landfill area in the leachate collection and removal system and leak detection system.

19.4.0 Material
The material for sand layer shall consist of clean, sound and well graded coarse sand. The material shall be free from debris.

Above the gravel bed, clean sand (425 micron to 4.75 mm) shall be placed. The thickness of the sand layer shall be 100 mm. The effective size (d10) of the sand recommended is 0.4 mm with uniformity co-efficient of 1.5. The sand shall be laid on the top of the gravel layer manually and spread to the specified thickness. The minimum thickness of 100 mm shall be ensured after spreading water.

The sand layers shall be well watered and rammed. Care shall be taken that materials of different layers do not get mixed, both at the time of placing and during compaction. The sand material shall be clean, sound, durable and well graded. No debris, wood, deleterious material etc., shall be permitted.

20.0.0 GRAVEL LAYER

20.1.0 Scope

This section of the specifications covers supply and placement of the gravel in the leachate collection and removal system and leak detection system as indicated in the drawings released for the construction or as directed by the Engineer-in-Charge.

20.2.0 General requirements

The implementing agency shall furnish all labour, equipment and material required for the complete performance of the work in accordance with the drawings and as described herein.

20.3.0 Materials

1. Gravel layer in the leak detection system

   The gravel shall be rounded, cleaned and free from disintegrated and foreign material. The size of the gravel shall decrease upwards. The size of the gravel recommended is 4.75 - 65 mm. The gravel shall be stockpiled at site separately and shall be mixed as per the specifications and then laid on the ground. Average density of the gravel recommended is 1600 kg/m3. The gravel's shall be well graded as directed by the Engineer-in-Charge.

2. Gravel layer in the leachate Collection and Removal System

   The gravel shall be rounded, cleaned and free from disintegrated and foreign material. The size of the gravel shall be 4.75 - 80 mm. The gravel shall be stockpiled at site separately and shall be mixed as per the specifications and then laid to the ground. Average density of the gravel recommended is 1600 kg/m3. The gravel's shall be well graded as directed by the Engineer-in-Charge.

20.4.0 Placing

Graded gravel's shall be constructed as indicated in the drawings. The gravel's shall be placed in layers of uniform thickness as shown in the drawings and care shall be taken to avoid segregation of coarse and fine materials and formation of pockets.

21.0.0 VERTICAL CENTRIFUGAL PUMP
21.1.0 Scope

This specification covers the works of the design, manufacture, construction features, testing, and delivery to site, erection, commissioning, and performance of vertical centrifugal pumps. (Non-clog type)

21.2.0 Code and Standards

The design, manufacture and performance of the pump shall comply with all currently applicable statutes, regulation and safety codes in the locality where the equipment will be installed. The equipment shall also confirm to the latest applicable Indian or equivalent international standard.

21.3.0 Design Requirements

1. The pumps shall be capable of handling Liquid of pH 0 to 10. These pumps shall be designed for parameters specified in tender drawing and shall be suitable for continuous (normal) operation and intermittent operation.

2. The total head capacity curve shall be continuously rising towards the shut off with the highest at shut off. The pump speed shall not exceed 1500 rpm.

3. Pumps of particular category shall be identical pumps and shall be suitable for parallel operation with equal load division. Impellers shall preferably be of non-over loading type.

4. Pumps shall run smooth without undue noise and vibrations. The magnitude of peak-to-peak vibration at shop will be limited to 75 decibel at the bearing housing. After installation at site the magnitude of vibration shall be limited to 50 db.

5. The KW rating of the pump motor shall be:

   Sufficient to drive the pump through the entire range of head – capacity curve, and

   KW / HP rating of the drive shall be calculated for additional 20% reserve power to take care of over loading on entire operating range.

6. The pump shall be capable of developing the specified total head at the specified rated capacity while operating in parallel and be capable of operating continuously at run-out capacity condition.

7. Pump shall be supplied with level control as per manufactures standard.

21.4.0 Features of Construction

Pumps shall be of vertical centrifugal non-clog type with required number of stages suitable for the service conditions. Materials of construction offered by the Bidder for pumps, drives and accessories shall be as per Galigher standards. All wetted parts shall be inside and outside rubber lined and shall be suitable to handle liquid of pH 0 to 10.

Written guarantee addressing pump material shall be submitted to and approved by Engineer-in-Charge. The manufacturer’s guarantee shall state that the installed material
meets all requirements of the contract and specifications and that under typical local atmospheric/operating conditions and weather aging, the pump material is suitable.

21.4.1 Accessories

1. All accessories required for proper and safe operation shall be furnished with the pumps.
2. Each stage of pump, unless self-venting, shall be provided with a suitable vent connection, complete with valves.
3. Tapping suitably plugged for pressure gauges shall be provided on delivery flanges.

21.4.2 Drives

Drive motor shall be connected to the line shaft of the pump with the help of a V-belt and shall have maximum rpm of 1500. The pulley shall match the rpm of pump.

21.5.0 Testing at Manufacturers Works

Materials and performance of the pumps and its components shall be tested in accordance with the relevant standards. Test certificates for these shall be furnished for the Owner’s approval.

21.5.1 Noise and Vibration Measurement

Noise and vibration shall be measured during the performance testing at shop as well as during the site test. The Noise and vibration levels measured at shop test shall be furnished to the Owner for its acceptance. The noise and vibration test at site shall be done in presence of Engineer-in-Charge or his representative. Noise and vibration level measured and accepted as per applicable standards.

21.5.2 Visual Inspection

Pumps shall be offered for visual inspection to the Owner before dispatch. The components of the pumps shall not be painted before inspection.

21.5.3 No weld repair on cast iron shall be allowed

21.5.4 Field Testing

After installation, the pumps offered shall be subjected to mechanical run testing and trial operation at field. If the performance at field is found not to meet the requirements, then the equipment shall be rectified or replaced by the implementing agency, at no extra cost to the Owner. The procedure of the above testing will be mutually agreed between Owner and Implementing agency.

Based on observations of the trial operation, if modifications and repair are necessary the same shall be carried out by the Implementing agency to the full satisfaction of the Engineer-in-Charge.

21.6.0 Drawings to be submitted

The following drawings along with datasheet shall be submitted by the Bidders for Owners approval.

1. Outline dimensional drawings showing the details of pump and motor assembly
2. Performance curves, showing capacity Vs total head, efficiency, NPSH and power consumption ranging from maximum flow to shut-off head.
3. GA drawing of pump house showing mounting arrangements, sump details, center to center distance of pumps etc.
4. Necessary Catalogues

21.7.0 Name Plate

Each pump shall be provided with a name plate indicating the following details:

- Design capacity, total head, speed, motor rating, model number, tag number, etc., and manufacture serial number and weight of equipment.

22.0.0 VALVES

22.1.0 Scope

This specification covers the design, performance, manufacture, and construction features, testing, packing and forwarding to site erection, commissioning of the Butterfly Valve.

22.2.0 Code and Standards

The design, manufacture and performance of valves and specials shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable Indian / British / USA standards / or equivalent International standards.

22.3.0 Specification for Butterfly Valve

Butterfly valves shall be of double flanged confirming to AWWA-C-504 class or BS: 5155 Class 150. The Butterfly Valves shall be manually operated as well as motor operated as per the requirement of the system. The motor shall be suitable for 415 V, 3 phase, 50 Hz and outdoor service. The motorized operated valves shall also have the manual override.

The various components of butterfly valves shall be of the following material of construction. The specification mentioned below is the minimum requirement; however bidder shall confirm that these are suitable for handling the liquid having pH range of 0 to 10. If any lining etc. is required on the wetted part of the valves, the bidder has to provide.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Body</td>
<td>2% Ni Cast Iron - ASTM A 48 Cl. 40; BS: 1452 Gr 220;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SG Iron - BS: 2789, Neoprene rubber lined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cast Iron – ASTM A 216 Groundwater. WCB; BS: 1504 Eq. Gr, Neoprene rubber lined</td>
</tr>
<tr>
<td>2.</td>
<td>Disc</td>
<td>Cast Iron – ASTM A 48 Cl. 40; BS: 1452, Gr. 200,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SG Iron – BS : 2789, Neoprene rubber lined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cast Steel – ASTM A 216 Gr. WCB. BS: 1504 Eq. Gr, Neoprene rubber lined</td>
</tr>
</tbody>
</table>
3. Butterfly valves shall be fitted with sleeve type bearing such as PTFE. Valves of 350 NB and above shall be provided with one or two thrust bearing to hold the disc securely in the centre of valve seat without hydraulic or external axial shaft loads. Sleeve and other bearings fitted into the valves body shall be of self-lubricated materials that do not have any effect on the fluid handled and other components of the valves.

All the manually operated butterfly valves shall be provided with Hand wheel or Hand lever as per the requirements. For larger sizes i.e. 150 NB and above. Hand wheel shall be provided. For lever/wrench operated valves, means shall be provided for positively holding the disc is not less than three intermediate positions. Manually operated valves shall be provided with reduction gear unit for valves of size 200 NB and above. All the valves shall be equipped with adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the open and closed positions. The valve operators (Hand wheel, Gear reduction unit etc) shall be designed as per relevant International Standard.

All the butterfly valves shall be provided with an indicator to show the position of the disc. Flanges shall conform to ANSI B 16.5 C150.

22.4.0 Tests

All the valves shall be tested hydro-statically for strength, tightness of seats and tightness of back seating at the pressures specified in relevant code.

The procedure for testing the tightness of seats of valves shall be as follows. The valves shall be subjected to water pressure of a minimum 2.812 kg/cm. The pressure shall then be increased to the specified seat test pressure. Valves shall then be cracked open at this pressure to determine the tightness of the seat ring in the body. Butterfly valves shall be tested on both sides of disc. The testing in general shall confirm to the relevant IS standard.

Vendor shall furnish five sets of the following certificates for all types of valves.

Certified physical and chemical analysis certificates, metallurgical test reports of all components of the valves and specialties.

Certified hydrostatic test reports for all body castings.

22.5.0 Painting and Corrosion Protection

A shop coat of paint shall be applied to all steel and cast iron exposed surfaces as required to prevent corrosion, after release has been given for painting and before dispatch. All parts shall be adequately protected for rust prevention; grease shall not be used on mechanical surfaces.
22.6.0 **Drawings and Manuals**

Bidder shall furnish the following drawings along with datasheet for Owners approval:

- Dimensional outline drawings.
- Cross section drawing.
- Instruction manual.

22.7.0 **Name Plate**

All valves shall have permanent name plates indicating the service, type, size of the valves

23.0.0 **LEACHATE TREATMENT PLANT**

23.1.0 **Scope**

This specification covers the design, performance, manufacture, construction, site erection, commissioning and testing of the Leachate treatment plant.

23.2.0 **General requirements**

The capacity of leachate treatment plant shall be as per design documents. However the implementing agency shall review the site, collect rainfall and other relevant data and shall work out the capacity and design of the plant. All the drawings in this regards would be submitted to the Engineer-in-Charge for approval.

For designing the system the implementing agency shall account for

1. the anticipated flow rate which will require treatment;
2. the composition of the leachate at source;
3. the discharge composition required by the regulating authority.

From this information the technology needed to meet the discharge consent shall be selected. There are estimated to be approximately twenty principal technologies that can be employed for leachate treatment.

Each of which shall be combined in various modes with other standard chemical engineering unit processes to optimize the balance between cost and quality. Refer table 1 in this chapter

**Table-1: Principal Technologies for leachate treatment**

<table>
<thead>
<tr>
<th>Title</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermally driven ammonia strippers</td>
<td>Power generation from LFG</td>
</tr>
<tr>
<td>Sequencing batch reactors</td>
<td>Exhaust gas sampling equipment</td>
</tr>
<tr>
<td>Leachate heaters</td>
<td>Ambient air line-coolers</td>
</tr>
<tr>
<td>Equipment Type</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Eductor pump sets</td>
<td>Leachate evaporation</td>
</tr>
<tr>
<td>Pneumatic pumps</td>
<td>Odorgaard™ (Landfill gas odour control)</td>
</tr>
<tr>
<td>Borehole pumps</td>
<td>Pressure swing adsorption</td>
</tr>
<tr>
<td>Gas chillers</td>
<td>AC Range flares</td>
</tr>
<tr>
<td>Distributed monitoring systems</td>
<td>SC Range flares</td>
</tr>
<tr>
<td>Gas analysis packages</td>
<td>MC Range flares</td>
</tr>
<tr>
<td>SCADA control</td>
<td>RB Range flares</td>
</tr>
<tr>
<td><strong>LinkLand™ GUI</strong> (For use with SCADA system)</td>
<td>SMART flares</td>
</tr>
<tr>
<td>LHC Range flares (For the combustion of low calorific value gases)</td>
<td>Mobile ground flares</td>
</tr>
<tr>
<td>Spray-irrigation sets</td>
<td>pH driven ammonia stripper</td>
</tr>
<tr>
<td>Scrubbing columns</td>
<td>Aeration lagoons</td>
</tr>
<tr>
<td>Stripping towers</td>
<td>Aeration towers</td>
</tr>
<tr>
<td>Chemical dosing equipment</td>
<td>Sepsizer™ (Air classification system)</td>
</tr>
<tr>
<td>Cyclone water knockout pot</td>
<td>Activated carbon columns</td>
</tr>
<tr>
<td>VOC adsorption with activated carbon</td>
<td>Flare stack standard options</td>
</tr>
</tbody>
</table>
23.3.0 Specifications

The equipments, pipes, pumps, valves, filter material, civil works shall be provided in accordance with the specifications given in the relevant chapters of this tender document.

23.4.0 Painting and Corrosion Protection

A shop coat of paint shall be applied to all steel and cast iron exposed surfaces as required to prevent corrosion, after release has been given for painting and before dispatch. All parts shall be adequately protected for rust prevention; grease shall not be used on mechanical surfaces.

23.5.0 Drawings and Manuals

Bidder shall furnish the following drawings and documents for Owners approval:

- Dimensional outline drawings.
- P & ID
- Instruction manual.
- Operational Manual

23.6.0 Guarantee

Written guarantee addressing material shall be submitted to and approved by Engineer-in-Charge. The manufacturer’s guarantee shall state that the installed material meets all requirements of the contract and specifications and that under typical local atmospheric/operating conditions and weather aging, the material is suitable.

The bidder shall also submit a guarantee for treated water quality parameters. The treated water quality parameters shall be in accordance with the relevant IS code.

24.0.0 WEIGHBRIDGE

24.1.0 Scope

The Implementing agency shall procure electronic type weigh-bridge (road) as per this specification from an approved vendor (approved vendor list attached with the tender). Erection / installation, commissioning, performance testing and calibration of the weigh bridge at site shall be under the scope of supply of implementing agency.

24.2.0 General requirements

a) Supply one no. Electronic Weigh- Bridge (road) of 20 T capacity along with other accessories as per the technical requirements of this specification.

The weigh-bridge shall basically comprise of:

- Steel platform for the required size with approaches on both sides.
- Load cells with integral cables and mountings.
- All electrical parts:
  - junction boxes
  - Cable between junction box and weigh cabin (The weigh cabin shall be located at approx. 3m from, nearest edge of the weigh-bridge.)
  - Weighing console with a digital indicator.
24.3.0 Technical requirements

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weigh-bridge type</td>
<td>Electronic type with load cells</td>
</tr>
<tr>
<td>Material handled</td>
<td>Sulphur trucks, in general</td>
</tr>
<tr>
<td>Weigh-bridge capacity</td>
<td>20T</td>
</tr>
<tr>
<td>Weigh-bridge construction</td>
<td>Pit less with approach ramps on both sides and non-skid type steel plates</td>
</tr>
<tr>
<td>Platform size</td>
<td>6.1mx3-m</td>
</tr>
<tr>
<td>No. of load cells for weighing</td>
<td>4-nos. Min.</td>
</tr>
<tr>
<td>Weighing console</td>
<td>Microprocessor based with suitable memory device for storing data of 90days with 100 trucks/day transactions.</td>
</tr>
<tr>
<td>Area classification</td>
<td>Safe</td>
</tr>
<tr>
<td>Corrosion Allowance for fabricated items</td>
<td>3mm</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>IS 2062, for fabricated structure / component</td>
</tr>
<tr>
<td>Control Console Room</td>
<td>The console shall be provided on suitable table with the operator chair at a convenient location in the control room. The control room shall also be provided with window air-conditioner(s). UPS for 2 hr. rating, required for the system shall be supplied.</td>
</tr>
</tbody>
</table>

Refer standard specification no.6-27-0001 and for other technical requirements of weigh Bridge.

24.4.0 Vendor data requirements

i) GA drawing of the platform with details of MOC
ii) Foundation drawing with load details
iii) All electrical drawing with the specification/rating of the items as per the tender specification.
iv) Installation, operation and maintenance manuals

25.0.0 PIEZOMETERS

25.1.0 Scope

This section of the specifications covers supply and installation of piezometers as indicated in the basic design and engineering report and the drawings to be released for the construction or as directed by the Engineer-in-Charge.

25.2.0 General requirements

The implementing agency shall furnish all labour, equipment and material required for the complete performance of the work in accordance with the drawings and as described herein.

25.3.0 Specifications

Piezometer shall be constructed to monitor the quality of groundwater. Four piezometers shall be constructed on the downstream side of the Jarosite landfill i.e. on the eastern side. Two piezometers shall be constructed on the upstream side i.e. on the western side of the Jarosite landfill. The groundwater table varies from 1 m to 8 m depending upon the season; accordingly the depth of piezometer shall be 10m below ground level. The piezometer consist of a stand pipe made up of stainless steel which shall be screened along the entire aquifer depth i.e. the standpipe shall be screened from a depth of 1 m to 10m. The screened interval shall be encased in a filter zone made up of gravel and sand layer. The function of the filter zone is to allow free flow of groundwater into and out of standpipe and prevent fines from entering the standpipe. Immediately above the screened interval, a clay and bentonite seal shall be placed. The thickness of clay seal shall be 0.5 m. above the clay and bentonite seal, a grout seal consisting of cement and bentonite shall be constructed which provides a barrier for preventing surface water and ground water from elsewhere from migrating into the screened interval. At the ground level, a steel casing embedded in concrete pad shall be employed. A cap shall be placed on the top of steel casing to prevent rainwater and surface water from entering into the standpipe. The piezometer shall be constructed at a distance of 7 m from outside edge of the embankment. The location of piezometer is shown in drawing 0: 18009-P-O5 and schematic diagram of the piezometer is shown in Figure 1.

26.0.0 ELECTRICAL WORKS

26.1.0 Scope

The scope of electrical works shall cover Design, Engineering, Supply, Erection, Electrical Inspectorate Clearance, Testing & Commissioning of the complete equipment /system within the Battery Limits.

The electrical system selected shall confirm up to date statutory rules and regulations and due consideration has been given to general safety requirements for personnel and plant & machinery.

Any item or any provision/requirement if not included in this section, but is necessary to be provided for the completion of the project and for its functional necessity, the same shall be provided by the implementing agency.
26.2.0 The Electrical scope of work start from the supply of LT Panel (MCC) and further power distribution to Motors including incoming feeding cables to this proposed LT panel from the Purchaser’s existing panel.

The power at 415 V, 3 phases, 50Hz, 3-wire shall be brought to proposed LT panel from existing LT panel located at the nearest distance from Proposed LT panel placed in MCC room

The cable sizing shall be done as per the following Criteria:

1. Load of 20% higher of Full load of the proposed plant
2. Voltage Drop within 6% of the rated voltage
3. Voltage Drop within 15% of the rated voltage due to starting current effect.
4. Derating factors effect of Ambient temperature.
5. Derating factors effect of grouping of cables
6. Derating factors effect of depth of laying of cables

Incoming cables termination at both ends will be in scope of this work.

26.3.0 This LT Panel will have one number incoming feeder and will have required outgoing feeders for motors of the plant and also for lighting and control supply feeder with control transformers. Separate Lighting transformer shall be provided.

There will be two nos. control transformers of required capacity. One of two control transformers will be in operation and second will be standby. The standby should come into circuit automatically when operating transformer is stopped.

LT Panel will be located inside the MCC room. The motor feeder for motor up to 7.5HP will be with DOL feeder and above 7.5HP star-delta starter will be used.

20% spare feeders will be provided in LT panel.

There will be one number control panel placed near LT panel for the operation of plant. Only stop push button with mushroom headed and turn to release will be provided on LT panel for emergency stop only. In addition to above, local push button station will be place near all the main drives of plant for testing/maintenance and emergency stop purpose.

So all the motors will be started either from Control Panel or from local Push button stations.

The capacitor bank for improvement of power factor is not considered, as load of the plant is low.

26.4.0 One number Main LT Panel for complete Plant, which will feed power to individual drive/equipment as indicated in the enclosed SLD. This SLD is only for the reference of bidder.

Short circuit current level for LT panel shall be 30 KA for one second for bus bar selection.

For ease of maintenance, Local Push Button Stations are placed near the drives.

The drives shall be started either from Control Panel or from local push button station.

All the drives will be started in sequence as per system requirement. Local / remote selector switch are also provided on Control Panel for selection of control either from
Control Panel or from local push button station. In case of remoter selection, drives will be controlled from Control Panel and in case of local selection, drives will be controlled from local push button station.

26.5.0 AC MOTORS

All the motors in this scope of supply shall be energy efficient squirrel cage Induction type, TEFC having degree of protection IP 55. Motor shall be suitable for 415V+/-10%, 50Hz+/-5% and suitable for DOL/star-delta starting. The motors shall generally conform to IS: 325. All motor shall be with class F insulation. Motor rating shall be at least 20% higher than the driven equipment.

26.6.0 LT PANEL

This will be floor mounted fully drawn out type, single front type and shall be fabricated out of 2mm CRCA sheet with multi-tier compartmentalised design with enclosure protection IP-54. The doors and covers will be fabricated out of 1.6mm CRCA sheet. Panel shall be manufactured as per standard manufacturing practice.

Incoming feeder (1 no.) shall be equipped with MCCB, CT/Ammeter with SS. Voltmeter with SS, RYB Lights and Circuit Breaker ON/OFF lamps.

The outgoing feeders are with MPCB/DOL/Star Delta Starter as per motor rating.

The incoming feeder for LT Panel will comprise of the following:

- 1no. : 415V, TP, MCCB
- 1set : Phase indicating lamps
- 1no. : Ammeter with selector switch
- 1no. : Voltmeter with selector switch
- 1set : Control fuses
- 1set : CTs of suitable ratio for metering

The outgoing feeders for motor shall be equipped with MPCB, Power contactor.

Each DOL starter feeder will comprise of the following:

- 1no. : MPCB
- 1no. : Power Contactor
- 1no. : Ammeter
- 1set : Control DP MCB
- 1set : ON/OFF/TRIP Lamps
- 1set : Stop Button
- 1set : Test Button

Each RDOL starter feeder will comprise of the following: (for Motorised valves)
1no. : MPCB
1no. : Power Contactor
1no. : Ammeter
1set : Control DP MCB
1set : ON/OFF/TRIP Lamps
1set : Stop Button
1set : Test Button

Each Star-Delta starter feeder will comprise of the following:

1no. : MPCB
3nos. : Power Contactor
1no. : Timer
1no. : Ammeter with CT
1set : Control DP MCB
1set : ON/OFF/TRIP Lamps
1set : Stop Button
1set : Test Button

Each Control Transformer will be provided with primary and secondary MCB and required interlocking and sector switch.

The feeders will be provided with one number CT and one number ammeter along with other items for above 11KW motor rating on Y-phase.

Stop Push Button on LT Panel or Control panel or on Local Push Button Station will be with mushroom headed and turn to release type.

26.7.0 CONTROL PANEL

This will be floor mounted, single front type and shall be fabricated out of 2mm CRCA sheet with vertical type design. This will be with enclosure protection IP-54. Panel shall be manufactured as per standard manufacturing practice.

This will have mimic and fault enunciator on top portion. The mimic will depict the Equipment flow diagram. On each equipment of Mimic, ON lamp will be provided.

The following shall be provided for each motor:

1. Local/Remote Selector sw.
2. Start Push Button
3. Stop Push Button with mushroom and turn to release type.
4. ON lamp
5. OFF lamp
6. Annunciation window for trip indication.
Lamp will be provided for each level and pressure switches. In addition to this very high level will be also annunciated on enunciator window of Control panel.

26.8.0 POWER AND CONTROL CABLE:

Incoming LT cables shall be with 3.5 cores or higher, up to LT Panel based on load shall be provided.

26.8.1 L.T. Power Cable:

The power cable shall be PVC insulated, PVC sheathed, armoured type with 3.5 core for motors, with Aluminium conductor. For motors up to 5.5 KW, the power cable shall be 4Cx4. sq. mm Aluminium.

26.8.2 Control Cable:

The control cable shall be PVC insulated, PVC sheathed, armoured type with copper solid conductor suitable for 1100 V grade and of sizes mentioned below:

- 7C x 1.5 sq. mm
- 4C x 1.5 sq. mm
- 2C x 1.5 sq. mm for instruments

26.8.3 EARTHING SYSTEM

The earthing system will be limited to the earthing of equipment which are in this scope of supply.

Required number of GI Plate Electrode for earth pits will be provided for making over all earth resistance less than 1.0 Ohms. GI strips/wires of required size shall be provided. Earthing system shall be as per IS: 3043.

50x6 mm GI strip shall be laid from existing earthing grid and linked to proposed plate electrode. The existing point is 500 metre away from this proposed LT Panel.

Each electrical equipment shall be earthed at two distinct points.

The inter connection of earth pits, LT PANEL shall be done with 50x6 mm G.I Strips. 25x6mm, 25x3 mm G. I. Strip / 38 sq. mm GI Wire for motors and boards etc. shall be used. 10 SWG wire for auxiliary or miscellaneous items like Push Button Station etc.

26.9.0 LOCAL PUSH BUTTON STATION

The local push button Station shall be placed near the main drive. This will comprise of two nos. push buttons (one for Start and other for stop). Stop push button will be with mushroom headed and turn to release type. This will be fabricated with 1.6 mm steel sheet along with canopy.

26.10.0 LIGHTING SYSTEM

This lighting system shall be provided for the complete plant including office. The internal lighting will be done with the help of 2x40W Fluorescent Lamps for the room height upto 5 M and beyond above 5M, 250W HPSV lamp will be used.
The outdoor lighting will be with weather proof Street Lighting 70/125 W HPSV Lamps. For lighting the landfill area, 10M mast type flood light of 400W HPSV lamps shall be used.

Internal lighting will be done with industrial type lighting fitting with 2x40W Fluorescent Lamps. Office will have decorative type light fitting.

The illumination level for Indoor lighting for MCC room and office will be 250 Lux. Outdoor lighting illumination level will be 25-30 lux.

There will be one number Main Lighting Board and required sub lighting boards. Main Lighting Board will be fed from lighting transformer by 4core cable of required size and sub-lighting board will be fed from Main Lighting board by 4-core cable of required size.

26.11.0 MCC Room

One MCC room shall be provided to accommodate the LT panel, Main Lighting Board and control panel. There will be one office adjacent to MCC room.

26.12.0 Instrumentation System

26.12.1 Level Switches

Separate level switches shall be provided along with each pump for indication/annunciation. The level switches shall be float type.

26.12.2 Pressure Switches

This will be diaphragm sealed type and will be used on each Delivery Pipe of pumps.

26.12.3 Pressure Gauge

This will be diaphragm sealed type and will be used in each Delivery Pipe of pumps.

26.13.0 Safety Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber mat (2 M x 1Mx12 mm)</td>
<td>1 no.</td>
</tr>
<tr>
<td>Shock treatment chart</td>
<td>1no.</td>
</tr>
<tr>
<td>Caution board</td>
<td>As per requirement</td>
</tr>
</tbody>
</table>

26.14.0 Cable Tray & Cable Accessories

All cables shall be directly buried underground as per standard, outside the building and cable marker shall be provided. Cable shall be laid overhead cable try inside the building. All cables shall be neatly dressed and clamped on the trays. Cable shall be provided with the necessary cable gland, lugs Tags etc.

The cable tray will be ladder type hot dip galvanised to 80 micron and made by 2mm thick CRCA sheet steel.

The cable tray sizes will be of following sizes:

1. 40x150x40x2mm
2. 40x300x40x2mm
3. 40x450x40x2mm
4. 40x600x40x2mm
Note: Any item or any provision / requirement if not included in this section, but is necessary to be provided for the completion of the project and for its functional necessity, the same shall be provided by the Implementing agency. The decision of Engineer-in-Charge in this regard shall be final and binding on the implementing agency.

27.0.0 SCHEDULE OF MAKES

1) Pump

Warmen international india pvt.Ltd.
C-25 Aani street, Thinmaya Municipal Stage-II, Virugambakkam Chenni –600092
Tel: 24791691

2). Motors

Kirloskar Electric Co.Ltd.
Bharat Bijlee
Siemens Ltd.
Crompton NGEF

3). Valves (Butterfly)

Kirloskar Brothers Ltd.
Indian Valve Company
Upadhya
Keystone India (P) Ltd.
L&T

4) HDPE Pipes

EMCO General Plastic Industries (P) Ltd.
Pioneer pipes Ltd.
Polymould Products,
Shital Polyplast,
ORI-Plast Ltd.

4) HDPE Liner/ Geotextile/ Geonet/Liners

(a) Raven Industries

Flexible Film department
P.O.Box 5107
Sioux Falls, Sd 57117-5107
USA
Tel: 001-605-3350174
Fax: 001-605-3310333

(b) Environmental Protection, Inc.

9939 US-131, South-Mancelona
Michigan-49659
USA
Tel: 001-231-5879108
Fax: 001-231-5878020

(c) GSE Lining Technology
19103, Gundle Road
Houston, TX 77073
USA
Tel: 001-281-4438564
Fax: 001-281-8756010

(d) Naue Fasertechnik GmbH & Co. KG
Alter Bahudamm 12
D-49448 Lemförde
Germany
Tel: 0049-5443 20673
Fax: 0049-5443 20677

(e) Terram BBA Non-wovens Asia Pacific Ltd.
Lot P.T. 200 Persiaran Selangor
40000 Shah Alam
Selangor Darul Ehsan
Malaysia
Tel: 0060-35413766
Fax: 0060-35413799

5) Water Proofing Compound
CICO
SIKA
CERA-CHEM

6) L.T. Panel / Control panel
Control and Switchgear
L & T
Siemens
GEC Alsthom
Crompton

7) Lighting Fixtures
Philips
Crompton
Bajaj
Havels
GE
<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>8)</td>
<td>Pressure Gauges</td>
<td>Manometers India Ltd.</td>
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<tr>
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<td>H Guru Instruments Pvt Ltd.</td>
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<td>General Instruments Pvt. Ltd.</td>
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<td>Bells Control</td>
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<td>9)</td>
<td>CTs &amp; PTs</td>
<td>INDCOIL</td>
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<td>Kappa Electricals</td>
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<td>Siemens</td>
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<td>10)</td>
<td>Push Buttons &amp; Indicating Lamps</td>
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<td>Contactor</td>
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<td>Selector Switch</td>
<td>L&amp;T – Salzer</td>
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<td>MCBs</td>
<td>L&amp;T – Hager</td>
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<td>16)</td>
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<td>Terminal block</td>
<td>Elemex</td>
</tr>
</tbody>
</table>
28.0.0 QUALITY ASSURANCE CHECK LIST

This checklist is intended to be an aid to the Implementing agency and the Engineer-in-Charge in identifying aspects of testing materials and workmanship.

Results of all tests to be carried out by the Implementing agency shall be submitted to the Engineer-in-Charge promptly.

The following minimum checks/tests shall be carried out for soil, rock material, concrete, RCC works and other works. The implementing agency shall add the cost of all the tests and facilities to be provided by him to the Owner for his testing in the quoted rates for various rates for various items under the Schedule of Items.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Type of Test of Check</th>
<th>Frequency/Quantum</th>
<th>Ref. Document for testing</th>
<th>Accept</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
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<td></td>
<td></td>
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<tr>
<td>b</td>
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<td>c</td>
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<tr>
<td>d</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

1. EARTH FILLING AND COMPACTION

   i) Suitability of fill Material

   a) Grain size analysis
      Once in every 2000 cum. for each type and each source subject to a min. sample of two samples
      IS: 2720 (part IV) IS: 2720 (part IV)

   b) Liquid and Plastic limit
      -ditto-
      IS: 2720 (part V) IS: 2720 (part V)

   c) Shrinkage limit
      Once in every 5000 cum. for each type and each source subject to a min. sample of two samples
      IS: 2720 (part VI) IS: 2720 (part VI)

   d) Free swell Index
      -ditto-
      IS: 2720 (part XL) IS: 2720 (part XL)

   e) Chemical Analysis
      i) organic matter
      ii) Calcium carbonate
      Once in every 5000 cum. for each type and each source subject to a min. sample of two samples
      IS: 2720 Part XXII IS: 2720 Part XXII
### Preparation of Detailed Project Report for MSW Management

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Type of Test of Check</th>
<th>Frequency/Quantum Norms</th>
<th>Ref. Document for testing</th>
<th>Accept</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>pH</td>
<td></td>
<td>Part XXIII</td>
<td></td>
</tr>
<tr>
<td>ii)</td>
<td>Total soluble sulphate</td>
<td></td>
<td>Part XXVI</td>
<td></td>
</tr>
<tr>
<td>iii)</td>
<td></td>
<td></td>
<td>Part XXVII</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard Proctor Test</td>
<td>Once in every 2000 cum. for each type and each source subject to a min. sample of two samples</td>
<td>IS: 2720 (part VII)</td>
<td>IS: 2720 (part VII)</td>
</tr>
<tr>
<td>III)</td>
<td>Moisture content of fill before compaction</td>
<td>-ditto-</td>
<td>IS: 2720 (part II)</td>
<td>IS: 2720 (part II)</td>
</tr>
<tr>
<td>IV)</td>
<td>Degree of compaction of fill</td>
<td>-ditto-</td>
<td>IS: 2720 (part II)</td>
<td>IS: 2720 (part II)</td>
</tr>
<tr>
<td>a)</td>
<td>Dry density by core method Or</td>
<td>i) For foundation filling, one for every ten foundations for each layer. However, each layer for location of important and heavily loaded foundations resting on fill shall be tested. ii) For Area filling, one of every 1000 sqm area for each compacted layer.</td>
<td>IS : 2720 (Part XXIX, Part XXVIII)</td>
<td>IS : 2720 (Part XXIX, Part XXVIII)</td>
</tr>
<tr>
<td></td>
<td>Dry density in place by sand displacement method</td>
<td></td>
<td>IS: 2720 (Part XXIX, Part XXVIII)</td>
<td>IS: 2720 (Part XXIX, Part XXVIII)</td>
</tr>
<tr>
<td>b)</td>
<td>Relative density (density Index)</td>
<td>-ditto-</td>
<td>IS: 2720 (Part XIV)</td>
<td>IS: 2720 (Part XIV)</td>
</tr>
<tr>
<td>c)</td>
<td>Dry density by proctor needle penetration</td>
<td>Random check to be carried out for each compacted layer in addition to test mentioned under IV(a) above</td>
<td>Standard practice</td>
<td>Standard practice</td>
</tr>
</tbody>
</table>

#### 2. COARSE AGGREGATE FOR CONCRETE

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Type of Test of Check</th>
<th>Frequency/Quantum Norms</th>
<th>Ref. Document for testing</th>
<th>Accept</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Check for Gradation</td>
<td>Once per 100 cum. or part thereof or each change of source.</td>
<td>IS:2386 &amp; S:383</td>
<td>As per IS: 383 for concrete</td>
</tr>
<tr>
<td>b)</td>
<td>Specific Gravity</td>
<td>-ditto-</td>
<td>IS: 386 &amp; Minimum Sp. Gravity 2.60 for</td>
<td></td>
</tr>
<tr>
<td>Item No.</td>
<td>Type of Test of Check</td>
<td>Frequency/Quantum Norms</td>
<td>Ref. Document for testing</td>
<td>Accept</td>
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<tr>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IS:1122 concrete</td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Crushing Value</td>
<td>Once for each source</td>
<td>IS:2386 Part IV</td>
<td>As per IS:383</td>
</tr>
<tr>
<td></td>
<td>(for concrete only)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(ii) Max. 10% weight loss after five cycles for filter materials.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(for concrete only)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f)</td>
<td>Flakiness &amp; Petrographic Examination</td>
<td>-ditto-</td>
<td>IS:2386 Part-VIII &amp; IS:383</td>
<td>Flakiness Index Max. 15% Aggregate constituents which are known to cause deleterious chemical reaction with cement/lime should be avoided.</td>
</tr>
<tr>
<td></td>
<td>(for concrete only)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Impact Value</td>
<td>Once for every source</td>
<td>IS:2386</td>
<td>Maximum 30%</td>
<td></td>
</tr>
<tr>
<td>h) Water Absorption</td>
<td>-ditto-</td>
<td>IS:2386</td>
<td>Maximum 2%</td>
<td></td>
</tr>
<tr>
<td>i) Slake Durability</td>
<td>-ditto-</td>
<td>IS:10050</td>
<td>Percentage retained after two 10 minutes cycles shall be more than</td>
<td></td>
</tr>
<tr>
<td>Item No.</td>
<td>Type of Test of Check</td>
<td>Frequency/Quantum Norms</td>
<td>Ref. Document for testing</td>
<td>Accept</td>
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<tr>
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</tr>
<tr>
<td>3.</td>
<td>FINE AGGREGATE FOR CONCRETE &amp; SAND FOR MORTAR</td>
<td></td>
<td></td>
<td>85%.</td>
</tr>
<tr>
<td>a)</td>
<td>Bulkage (for concrete only)</td>
<td>Once per week</td>
<td>IS:2386 &amp; IS:383</td>
<td>As per IS:383</td>
</tr>
<tr>
<td>b)</td>
<td>Moisture Content (for concrete and mortar only)</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td>-ditto-</td>
</tr>
<tr>
<td>c)</td>
<td>Gradation</td>
<td>Once for every source</td>
<td>IS:2386 Part-I, IS:9429 &amp; IS:383</td>
<td>Same as in Sl.No.4a.</td>
</tr>
<tr>
<td>d)</td>
<td>Specific Gravity</td>
<td>-ditto-</td>
<td>IS:2386 Part-I</td>
<td>Minimum 2.40</td>
</tr>
<tr>
<td>e)</td>
<td>Water Absorption &amp; Density (for concrete and mortar only)</td>
<td>Once for every source</td>
<td>IS:2386</td>
<td>Maximum 2.5%</td>
</tr>
<tr>
<td>f)</td>
<td>Soundness (for concrete only)</td>
<td>-ditto-</td>
<td>IS:2386 Part-V</td>
<td>As per IS:383</td>
</tr>
<tr>
<td>g)</td>
<td>Visual Examination</td>
<td>100%</td>
<td>IS:2386 &amp; IS:383</td>
<td>-ditto-</td>
</tr>
<tr>
<td>4.</td>
<td>WATER FOR MORTAR AND CONCRETE MIXING &amp; CURING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>pH Value</td>
<td>Once for every source</td>
<td>IS:3025 &amp; IS:456</td>
<td>As per IS:456</td>
</tr>
<tr>
<td>b)</td>
<td>Turbidity</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td>-ditto-</td>
</tr>
<tr>
<td>c)</td>
<td>Sulphate Content</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td>-ditto-</td>
</tr>
<tr>
<td>5.</td>
<td>CEMENT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Fineness</td>
<td>Once for every source</td>
<td>IS:269 &amp; IS:4031</td>
<td></td>
</tr>
<tr>
<td>Item No.</td>
<td>Type of Test of Check</td>
<td>Frequency/Quantum</td>
<td>Ref. Document for testing</td>
<td>Accept</td>
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<td>---------------</td>
</tr>
<tr>
<td></td>
<td>b) Setting time</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Soundness</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) Specific Gravity</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e) Compressive Strength</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td>As per IS code</td>
</tr>
<tr>
<td>6.</td>
<td><strong>CONCRETE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Workability</td>
<td>Minimum 3 samples per batch.</td>
<td>IS:1199 &amp; IS:456</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Crushing Strength</td>
<td>One sample of 6 cubes per 150 cum. or part thereof.</td>
<td>IS:1199, IS:456, IS 516 &amp; spec.</td>
<td>As per IS code</td>
</tr>
<tr>
<td></td>
<td>c) Compacting Factor</td>
<td>Once per mix</td>
<td>-ditto-</td>
<td>-ditto-</td>
</tr>
<tr>
<td></td>
<td>d) Water Tightness</td>
<td>Each tank and reservoir</td>
<td>IS:3370</td>
<td>IS:3370</td>
</tr>
<tr>
<td></td>
<td>e) Finished Dimension</td>
<td>All Structures including embankment slopes</td>
<td>As per drgs.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td><strong>BRICK</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Visual Examination</td>
<td>At Random</td>
<td>IS:3495 &amp; IS:1077</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Compressive Strength</td>
<td>One set of samples per 10,000 bricks or part thereof.</td>
<td>IS:3495 &amp; IS:1077</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Efflorescence</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d) Water absorption</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e) Colour and Dimensional Conformity</td>
<td>One from each stack</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>f) Soundness</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td><strong>FORM WORK</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Staging</td>
<td>Each member</td>
<td>IS:456 &amp; approved</td>
<td></td>
</tr>
<tr>
<td>Item No.</td>
<td>Type of Test of Check</td>
<td>Frequency/Quantum Norms</td>
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<td>Accept</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>drawing &amp; specification.</td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Dimensions &amp; Plumb line</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Shape &amp; Alignment</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>Ground Support</td>
<td>Each member</td>
<td>IS:456 &amp; appd.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(drawings &amp; specifications)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e)</td>
<td>Cleaning &amp; Oiling</td>
<td>100%</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td>f)</td>
<td>Tightness for mortar</td>
<td>100%</td>
<td>-ditto-</td>
<td></td>
</tr>
</tbody>
</table>

9. **REINFORCEMENT**

<table>
<thead>
<tr>
<th>Item</th>
<th>Type of Test of Check</th>
<th>Frequency/Quantum Norms</th>
<th>Ref. Document for testing</th>
<th>Accept</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Bending</td>
<td>At random</td>
<td>Approved drgs.</td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Joints with right gauge of bending wire.</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Placement as per levels and covers</td>
<td>-ditto-</td>
<td>-ditto-</td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>Rust/loose scales</td>
<td>-ditto-</td>
<td>IS:456</td>
<td></td>
</tr>
</tbody>
</table>

29.0.0 **LIST OF MANDATORY SPARES**

1. For each Vertical Centrifugal pump
   - Impellers 1 set
   - Shaft and Shaft sleeve 1 set
   - Set of bearings 1 set
   - V-Belt 1 sets
   - Strainer 1 set

2. Butterfly valves motorized (for each size) 1 no.
3. Butterfly valves manual (for each size) 1 no.
4. Non Return valve (for each size) 1 no.
5. Pressure indicator (for each type) 1 no.
6. Pressure switch (for each type) 3 no.
7. Level switches (for each type) 2 no.
8. Voltmeter (for each type) 1 no.
9. Ammeter (for each type) 1 no.
10. Power contactor (for each rating) 1 no.
11. Switches (for each type) 1 no.
12. HRC fuses (for each type) 3 no.
13. Push button (green) 5 no.
14. Push button (red) 5 no.
15. Indicating Lamp (green) 5 no.
16. Indicating Lamp (red) 5 no.
17. Indicating Lamp (amber) 5 no.
18. Enunciator Channel PCB 50% of total channel
19. Power supply PCB 1 no.
ANNEXURE 6: Quotation for Sanitary Landfill

Ref : JMJS/IPEGPL/2015-2016/039
Dated : July 21, 2015

IPE Global Private Limited
IPE Global House
B-84 Defence Colony
New Delhi – 110 024
E.mail : ipeinfo@ipeglobal.com/thaikkann@ipeglobal.com

Kind Attn : Mr Ganesh Kumar Singh – Manager (Infrastructure)

Dear Sirs,

This is in reference to your email enquiry dated 18.07.2015 for supply and installation of HDPE geomembrane liner for secured landfill application - as such please find our prices for the same as under:

<table>
<thead>
<tr>
<th>SI #</th>
<th>Material Description</th>
<th>Quantity Offered</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>HDPE black geomembrane liner as per ASTM specification in 1500 microns or 1.5mm thick in width of 5/6 Meters x 50 Meters length</td>
<td>To be informed later</td>
<td>Rs 275.00 per Sq.meter</td>
</tr>
<tr>
<td>2.</td>
<td>Installation of HDPE black geomembrane liner of 1500 microns thick by fusion method with tools and tackles</td>
<td>To be informed later</td>
<td>Rs 60.00 per Sq.meter</td>
</tr>
<tr>
<td>3.</td>
<td>HDPE black pipe of 110 mm</td>
<td>Same</td>
<td>Rs 945.00 per R/M</td>
</tr>
<tr>
<td>4.</td>
<td>HDPE black pipe of 200 mm</td>
<td>Same</td>
<td>Rs 3,085.00 per R/M</td>
</tr>
</tbody>
</table>

**Terms**

Price : Prices offered are Ex- Kolkata – Way bill to be given by you.
CST : CST extra @ 2 % against ‘c’ form
Service Tax : Service Tax extra @ 14 %
Delivery : We can deliver the material within two weeks from the date of receipt of your order with advance.
Test Certificate : For : Liner CIPET Test certificate will be provided - testing takes 20 -25 days which Please note.
Inspection : If required to be carried out by your Representative / Third party before despatch at your cost.
Force majeure clause : Standard force majeure clause will be applicable.
Validity : This offer will remain valid till 28.07.2015.

**Payment terms for Supply** : 40 % advance along with order and balance before despatch against proforma invoice.

**Payment terms for Installation** : 40 % mobilisation advance with order 55 % against R/A bills submitted every 15 days to be cleared immediately and balance 5 % immediately upon completion of installation to the satisfaction of site in charge.

---

IPE GLOBAL
Expanding Horizons Enriching Lives.
The following facilities shall be provided to us free of any charges:

- Accommodation and feeding for our crew of technicians & supervisor at site.
- Office and store room for our machines and tools with water and electricity.
- Power connection with 100 meters cable lead (or a generator) and light (for night work) at the site of installation.
- Local labourers required to pull and spread the sheet in the pond to be arranged by you at your cost.
- Once the team is mobilised and the work front is no provided to them — any idle labour for no fault of ours — idle charges will be @ Rs 10,000/= per day for the delayed period thereof.
- Any protective work if required to be carried out — the same should be done in tandem with the pace of our installation team — any delay in doing so will hamper our progress — our team shall not wait for the follow on.

We trust you will find our offer in line with your requirements and shall provide us with the opportunity to offer our product and services.

Should you require any further clarification please find the undersigned at your disposal or contact on cell # 98300 82027 / 98307 90002.

Thanking you

Yours faithfully

For JMJ SHELTERS

PETER RAO
Chief Executive.
Details:
- Boundary Wall: 1210 M
- Surface Clearing: 25 Acres

Legend:
- IPE Global Limited
- IPE Global House, B-84, Defence Colony, New Delhi, India

Approved:
- Scale
- Designed:
- Checked:
- Drawn:
- Date:
- Rev.
- Sheet

This drawing is a property of IPE Global PVT. LTD. and must not be passed on to any person not authorised to receive it nor be copied or otherwise made use either in full or in part by such person or body without our prior permission in writing.

Preparation of DPR's for MSWM System in 23 ULBS under Zone-IV Andhra Pradesh Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC)

This site is for landfill and waste to energy plant.

SITE FOR LANDFILL AND WASTE TO ENERGY PLANT
NOTE / REMARKS
1. ALL LEVELS AND DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
2. ALL LEACHATE COLLECTION HDPE PIPES TO BE WRAPPED WITH NON-WOVEN GEOTEXTILE & SEALED AT FREE END.
3. SECTION AA AND BB

IPE GLOBAL PRIVATE LIMITED
IPE Global House, B-84, Defence Colony,
New Delhi, India

FILE No.:               A.P._DPR/MSWM/ZONE-4/13

ANDHRA PRADESH URBAN FINANCE & INFRASTRUCTURE DEVELOPMENT CORPORATION (APUFIDC)

GKS
AJ
GKS
AKB

28/7/2015
HDPE GEOMEMBRANE 1.5 mm

CLAY LAYER

PCC

DETAIL-Z (TYP.)

ANCHOR TRENCH

ROAD EL. 95.50
SLOPE 1:2
G.L. 92.50
EMBANKMENT

DETAIL OF SIDE LINER SYSTEM

EMBANKMENT

ANCHOR TRENCH

WASTE

2% SLOPE

SECTION AA

SECTION BB

DRAINAGE LAYER OF GRANULAR SOIL OF K>10 CM / SEC. >1.5 THICK HDPE MEMBRANE PROTECTIVE LAYER OF SILTY SOIL CLAY LAYER

LINER SYSTEM FOR BOTTOM DETAIL-Y (TYP.)

PASSIVE VENT T10 mm OD

HDPE PIPE

200 MM c/c

TYPICAL DETAILS OF STANDARD HDPE PIPE

TYPICAL DETAIL OF PIPE PERFORATION

SURFACE LAYER (TOP SOIL)

VEGETATIVE COVER

BARRIER LAYER (COMPACTED CLAY OR AMMENDED SOIL) K>10

GAS COLLECTION LAYER GRANULAR SOIL

WASTE

TOP COVER WITH GAS VENT FOR PASSIVE CONTROL OF LANDFILL GAS

DETAIL-X (TYP.)

NOTES / REMARKS:-

1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
2. ONLY WRITTEN DIMENSION SHALL BE FOLLOWED.

IPE GLOBAL PRIVATE LIMITED

IPE Global House, B-84, Defence Colony, New Delhi, India

FILE No.:               A.P._DPR/MSWM/ZONE-4/14

ANDHRA PRADESH URBAN FINANCE & INFRASTRUCTURE DEVELOPMENT CORPORATION (APUFIDC)

(GK S)

(AJ)

(GK S)

(FAK)

28/7/2015
NOTES / REMARK : -
1. ALL DIMENSIONS ARE IN MM AND LEVELS AND COORDINATES ARE IN METER.
2. ALL BRICK WORK SHALL BE IN CM 1:6 PLASTERED ON BOTH SIDES AS PER SPECS.
3. ALL CONCRETE SHALL BE IN M-20 (1:1.5:3) AS PER IS:456.
4. ALL PEDESTAL FOUNDATIONS SHALL REST ON ORIGINAL SOIL.

SECTION A-A
DETAILED ROLLER

SECTION B-B
DETAILED OF ROLLER

LEGEND:

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>TYPE</th>
<th>SIZE</th>
<th>DESCRIPTION</th>
<th>NOS</th>
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<td>1</td>
<td>W1</td>
<td>1000X2150</td>
<td>WINDOW FULLY GLAZED (D.F)</td>
<td>1</td>
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<tr>
<td>2</td>
<td>W1</td>
<td>2000X1200</td>
<td>WINDOW FULLY GLAZED (D.F)</td>
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<td>W2</td>
<td>900X1200</td>
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IPE GLOBAL PRIVATE LIMITED
IPE Global House B-84, Defence Colony, New Delhi, India

FILE No.:            A.P_DPR/MSWM/ZONE-4/01

ANDHRA PRADESH URBAN FINANCE & INFRASTRUCTURE DEVELOPMENT CORPORATION (APUFIDC)

GKS
AJ
DS
AKB

28/7/2015

PREPARATION OF DPR'S FOR MSWM SYSTEM IN 23 ULBS UNDER ZONE-IV ANDHRA PRADESH

IPE Global House B-84, Defence Colony, New Delhi, India
NOTES / REMARK:

1. ALL DIMENSIONS ARE IN MM AND LEVELS AND COORDINATES ARE IN METER.
2. THE WEIGH BRIDGE SHALL BE OF ELECTRONIC TYPE (CAPACITY-20 TONS PLUS 25% OVER LOAD) AND SHALL HAVE MICROPROCESSOR BASED WEIGHING CONSOLE.
3. THE WEIGHING PLATFORM SHALL HAVE NON SKID TYPE STEEL PLATFORM.
4. ALL BRICK WORK SHALL BE IN CM 1:6 PLASTERED ON BOTH SIDES AS PER SPECS.
5. ALL CONCRETE SHALL BE IN M-20 (1:1.5:3) AS PER IS:456.
6. ALL PEDESTAL FOUNDATIONS SHALL REST ON ORIGINAL SOIL.

PROJECT:
PREPARATION OF DPR'S FOR MSWM SYSTEM IN 23 ULBS UNDER ZONE-IV ANDHRA PRADESH

CLIENT:
ANDHRA PRADESH URBAN FINANCE & INFRASTRUCTURE DEVELOPMENT CORPORATION (APUFIDC)

FILE No.: A.P._DPR/MSWM/ZONE-4/04

IPE Global House  B-84, Defence Colony, New Delhi, India
1. ALL DIMENSIONS ARE IN MILLIMETER.
2. P.C.C. (1:4:8) IN BRICK BALLAST.
3. USE 1:4 CEMENT SAND FOR PLASTER.
4. BRICK MASONRY (1:6).

30 MM EXPANSION JOINT AFTER EVERY 9 PANELS

ELEVATION

COPING WITH BRICK TILES

SECTION - Y-Y

SECTION - Z-Z

NOTES / REMARK:

1. 1:1
2. IPE GLOBAL PRIVATE LIMITED
3. PROJECT: PREPARATION OF DPR'S FOR MSWM SYSTEM IN 23 ULBS UNDER ZONE-IV ANDHRA PRADESH
4. CLIENT: ANDHRA PRADESH URBAN FINANCE & INFRASTRUCTURE DEVELOPMENT CORPORATION (APUFIDC)
5. TITLE: DETAILS OF BOUNDARY WALL
6. FILE No.: A.P._DPR/MSWM/ZONE-4/05
7. DATE: 28/7/2015

IPE Global House  B-84, Defence Colony, New Delhi, India
NOTES / REMARK:

1. ALL DIMENSIONS ARE IN MM AND LEVELS AND COORDINATES ARE IN METER.
2. ALL CONCRETE SHALL BE IN M-20 (1:1.5:3) AS PER IS:456.
3. THE PIT SHALL BE MADE IN RCC 1:1.5:3 (TYPE-I, PAVEMENT 200 THK.)
CROSS SECTION OF PARKING AREA

- 150 mm THICK CEMENTED PLATFORM
- 75 mm THICK SAND FILLING
- 50 mm THICK C.C. FLOORING
- 75 mm THICK P.C.C. (1:4:8)
- 150 mm THICK SAND FILLING

CEMENT PLASTER
PCC M150 (1:2:4)
BRICK ON EDGE SOLING

CROSS SECTION OF CEMENTED PLATFORM
WORKSHOP SHED
AREA = 10000 x 30000
PLATFORM LVL. = +2.7 M (686.7 FT)

TOILET
DRINKING WATER

3.5M WIDE ROAD

NOTE:
MASONRY WALL UPTO 3.0M HEIGHT

LEGEND & ABBREVIATIONS

EXTERNAL WALL FINISHES: SNOWCEM OVER 25mm THK. PLASTER
INTERNAL WALL FINISHES: DRY DISTEMPER OVER 12mm THK. PLASTER.

NOTE: ALL THE EQUIPMENTS / MACHINES WILL BE MOUNTED ON THE RCC FLOOR WITH ANCHOR FASTENER.
SECTIONAL DETAILS
(N.T.S)

COMPACTED EARTH FILL

GEOSYNTHETIC SHEET

STONE METAL
22.5 mm TO 50mm

STONE METAL
SOLING 0 TO 63mm

M 25 R.C.C.

10Ø 250 c/c

12Ø 150 c/c

NOTES / REMARK:
1. ALL DIMENSIONS ARE IN MM.
1. ALL DIMENSIONS ARE IN MILLIMETER.

STONE METAL
22.5 TO 50mm SIZE

STONE SOLING
40 TO 63mm

COMPACTED SOIL

TIPPING FLOOR AND PRE-PROCESSING AREA
(N.T.S)

8 mm dia 200mm c/c
10mm dia 200mm c/c

10mm dia 150mm c/c

STONE METAL
22.5 TO 50mm SIZE

STONE SOLING
40 TO 63mm

COMPACTED SOIL

PAVEMENT DESIGN IN PROCESSING AREA & MACHINE SHED
EXCEPT FOR MACHINE FOUNDATION
(N.T.S)