

FINAL REPORT

ADB

Asian Development Bank



National Capital Region Planning Board

Capacity Development of the
National Capital Region Planning Board
Package 2 Component B
TA No. 7055-IND

Volume IV-A: Main Report
Detailed Project Report for
Improvement of Solid Waste Management in Ghaziabad



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ASSOCIATES

July 2010

NCR Planning Board
Asian Development Bank

Capacity Development of the National Capital Region Planning Board (NCRPB) – Component B (TA No. 7055-IND)

FINAL REPORT

Volume IV-A: Detailed Project Report for Improvement of Solid
Waste Management in Ghaziabad

Main Report

July 2010



Abbreviations

BOT	:	Built Operate Transfer
BPL	:	Below Poverty Line
CAGR	:	Compounded Annual Growth Rate
CDP	:	City Development Plan
CLBS	:	City Level Baseline Survey
ID&IP	:	City Level Investment Plan
CPHEEO	:	Central Public Health and Environmental Engineering Organization
DTP	:	Directorate of Town Planning
FOP	:	Financial Operating Plan
G.O.	:	Government Order
GoK	:	Government of Karnataka
KSCB	:	Karnataka Slum Clearance Board
KUWSDB	:	Karnataka Urban Water Supply and Drainage Board
LCS	:	Low Cost Sanitation
LPA	:	Local Planning Area
MDR	:	Major District Road
ML	:	Million Liter
MLD	:	Million Liters Per Day
MSL	:	Mean Sea Level
O&M	:	Operation and Maintenance
PCU	:	Passenger Car Unit
PWD	:	Public Works Department
ROB	:	Rail Over Bridge
RTO	:	Regional Transport Office
SC	:	Schedule Caste
SH	:	State Highway
SLBS	:	Slum Level Baseline Survey
ST	:	Schedule Tribe
SWD	:	Storm Water Drainage
SWM	:	Solid Waste Management
TMC	:	Town Municipal Council
UGD	:	Underground Drainage
ULB	:	Urban Local Body
V/C Ratio	:	Volume Count Ratio
VAMBAY	:	Valmiky Ambedkar Awas Yojana
WGTP	:	Willingness to Pay
WSC	:	Water Service Connection
WTP	:	Water Treatment Plant

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Compendium Volumes

Besides this Volume IV-A, the DPR for Improvement of SWM in Ghaziabad, has following Volumes appended separately.

- Volume IV-B: Drawings
- Volume IV-C: Economic & Financial Analysis
- Volume IV-D: Generic Environmental Management Plan

1. INTRODUCTION

A. Background

1. The National Capital Region Planning Board, constituted in 1985 under the provisions of NCRPB Act, 1985, is a statutory body functioning under the Ministry of Urban Development, Government of India. NCRPB has a mandate to systematically develop the National Capital Region (NCR) of India. It is one of the functions of the Board to arrange and oversee the financing of selected development projects in the NCR through Central and State Plan funds and other sources of revenue.
2. On Government of India's request, Asian Development Bank (ADB) has formulated the technical assistance (TA) to enhance the capacities of National Capital Region Planning Board and its associated implementing agencies. The TA has been designed in three components: Component A relates to improving the business processes in NCRPB; Component B relates to improving the capacity of the implementing agencies in project identification, feasibility studies and preparing detailed engineering design; and Component C relates to urban planning and other activities.
3. ADB has appointed M/s Wilbur Smith Associates to perform consultancy services envisaged under Component B. In the context of this contract, the first deliverable – Inception Report, was submitted in October 2008. The second deliverable – Interim Report comprising Master Plan for sewerage in Hapur, Master Plan for Water Supply for Panipat, Master Plan for Drainage for Hapur, Master Plan for Solid Waste management for Ghaziabad, Traffic and Transport analysis for Ghaziabad, Socio-Economic base line survey result in 3 sample project towns and proceedings of workshop 1 was submitted in January 2009. The four Master Plans as stated above are also made available on NCRPB web site for use of the implementing agencies.
4. The third deliverable Draft Final Report (DFR) comprising Detailed Project Report (DPR) for water supply in Panipat, DPR for sewerage in Hapur, DPR for drainage in Hapur, DPR for drainage in Sonipat, DPR for solid waste management in Ghaziabad, DPR for four selected transport components (Flyover, Road widening, Multi-level Parking and Bus Terminal) in Ghaziabad, and a Report on Capacity Building Activities were submitted.
5. Now, this is the Final Report (FR) and is the fourth and final deliverable. The comments/feedback on Draft Final Report received from ADB, NCRPB and respective implementing agencies were duly incorporated and final DPRs for components of Water Supply, Sewerage, Drainage, Solid Waste Management, and Transport are submitted as part of this Final Report. This is the Detailed Project Report of Sewerage System Improvement in Hapur.

B. Overview of this ADB TA

6. *Objectives.* The objective of this Technical Assistance (TA) is to strengthen the capacity at NCRPB, state-level NCR cells, and other implementing agencies in the area of planning for urban infrastructure and to impart necessary skills to conceive, design, develop, appraise and implement good quality infrastructure projects for planned development of NCR. The increased institutional capacity of the NCRPB and the implementing agencies will lead to effective and time scaling-up of urban infrastructure to (i) improve quality of basic urban services in the NCR; (ii) develop counter magnet towns; (iii) reduce in migration into Delhi and orderly development of NCR; and (iv) accelerate economic growth in the NCR.
7. The TA – Capacity Development of the NCRPB, Component B focuses on strengthening the capacities of NCRPB and implementing agencies relating to project feasibility studies and preparation, and detailed engineering design in the implementing agencies. Specifically this component B of the TA will support the project preparation efforts of the implementing agencies by preparing demonstration feasibility studies that include all due diligence documentation required for processing of the project in accordance with best practices, including ADB’s policies and guidelines.
8. *Scope of Work.* According to the terms of reference of the TA assignment, the following activities are envisaged in component B of the TA:
 - (i) Conduct technical, institutional, economic and financial feasibility analysis of identified subprojects in the six sample implementing agencies;
 - (ii) Conduct safeguards due diligence on the subprojects, including environmental assessment report and resettlement plan for all subprojects covered in the sample implementing agencies;
 - (iii) Prepare environmental assessment framework and resettlement framework; and
 - (iv) Develop a capacity building and policy reform program for the implementing agencies, including governance strengthening, institutional development and financial management.
9. Besides, this component of the TA will also:
 - (i) help in assessing the current practices and procedures of project identification and preparation of detailed project reports including technical, financial, economic and social safeguard due diligence;
 - (ii) support preparation of standard procedure manuals for project identification and preparation of detailed project reports including technical, financial, economic and social safeguard due diligence;
 - (iii) train the implementing agencies in the preparation of detailed project reports by using the sample subprojects, reports on deficiency of current practices and standard protocol manuals; and
 - (iv) help in developing a user-friendly web-page where different manuals and guidelines for preparation of DPRs will be made available for the implementing agencies.

C. About the Final Report

10. At Interim Report stage of the TA, the Master Plans for Water Supply in Panipat, Sewerage system in Hapur, Drainage for Hapur and Municipal Solid Waste Management for Ghaziabad were prepared. The Master Plans provided 100 percent coverage of population and the area likely to be in planning horizon year 2031/2041. All works required up to planning horizon year were conceptualized, broadly designed and block cost was estimated. The Master Plans also provided phasing of investment such that under phase 1 works required to cover present spread of city were proposed.
11. At draft final report stage of the TA the Detailed Project Reports (DPRs) were prepared for Phase 1 works as suggested in the Master Plans. For preparation of DPRs, engineering surveys and investigations were conducted and various possible and feasible alternatives evaluated. Finally for the selected options the DPRs prepared with detailed designs, item wise detailed cost estimate, work specifications, implementation process and proposed implementation arrangements. Further, according to ADB procedures these DPRs in addition to technical analysis included institutional, financial and economic feasibility analysis and environmental and social safeguards due diligence – environmental assessment and resettlement plans.
12. The DPR's submitted as part of Draft Final Report was reviewed by the implementing agencies, NCRPB and the ADB. Now this Final Report comprising DPR's modified in light of comments of IA's is being submitted. The draft DPR for water supply in Panipat was reviewed by PHED Haryana. Detailed discussions were held with Superintending Engineer (Urban), Executive Engineer (Urban), Superintending Engineer (Karnal) and Executive Engineer Panipat. The comments made by PHED have been suitably incorporated in this Final Report.
13. These DPRs are proposed to be made available to the ULBs and other implementing agencies of the state governments as model DPRs so that they may replicate the methodology/approach in the future DPRs prepared by them for obtaining finances from the NCRPB.
14. *Other Activities.* As part of the capacity development activities under this TA component B, two workshops were conducted during DFR stage. Workshop II on Master Plan Preparation Process for Urban Infrastructure was conducted on 9th April 2009 and workshop III on Municipal Solid Waste Management was conducted on 22nd May 2009 for capacity development of NCRPB and Implementing Agencies. A national tour also organized to best practice urban infrastructure facilities in various places in India. The participants include elected representatives and officials from NCR implementing agencies.

15. *Organization of this Final Report.* The Final Report of the TA Component B is organized in following Seven Volumes:

Volume I: Detailed Project Report for Water Supply System in Panipat

Volume II: Detailed Project Report for Rehabilitation and Augmentation of Sewerage System in Hapur

Volume III: Detailed Project Report for Rehabilitation of Major Drains in Hapur

Volume IV: Detailed Project Report for Improvement of Solid Waste Management System in Ghaziabad

Volume V: Detailed Project Reports for Four Transport Components in Ghaziabad

Volume VI: Detailed Project Reports Rehabilitation of Drainage in Sonipat

Volume VII: Capacity Building Activities

D. Structure of this Volume IV Report

16. This is Volume III Detailed Project Report (DPR) for Improvement of Solid Waste Management in Ghaziabad. This DPR is volume is further organized four sub-volumes (Volumes IIIA to IIID) as given below:

Volume IV-A: DPR Main Report: This report is organized into following **eight** sections:

Section 1 - Introduction

Section 2 presents an overview of municipal solid waste management in India;

Section 3 presents profile of Ghaziabad City

Section 4 presents Town planning and Population Forecast

Section 5 describes and assesses the existing solid waste management system in Ghaziabad;

Section 6 presents Planning and Design Criteria

Section 7 presents SWM Master Plan findings of January, 2009

Section 8 presents detail design for DPR works

Volume IV-B: Drawings

Volume IV-C: Economic & Financial Analysis

Volume IV-D: Generic Environmental Management Plan

2. SOLID WASTE MANAGEMENT OVERVIEW

A. Introduction

17. Solid waste is defined as discarded solid fractions, arising from domestic, trade, commercial, industrial, agricultural, institutional, public services and mining activities. The term waste refers to useless, unwanted or discarded material. This discarded material is very heterogeneous in nature and its characteristics vary from place to place and season to season. Refuse comprises of all the solid waste of the community.
18. American Public Works Association (APWA, 1975) has classified refuse materials in twelve categories. These include garbage, rubbish, ashes, street sweepings, dead animals, abandoned vehicles, construction/demolition waste, industrial refuse special waste such as hospital waste, bulky waste, animal and agricultural waste & sewage treatment residues.
19. Problem associated with solid waste began with the dawn of civilization when humans started congregating in communities. Prior to this period waste from primitive societies could be conventionally and unobtrusively disposed off by taking the advantage of the natural self-cleansing capacity of the environment. During this period the population density was low and plenty of land was available. Moreover, since the population was nomadic in habit, it was common for the tribe to move away from waste bodies. As villages grew into towns and gradually into cities, the waste was commonly thrown away into waterways, vacant lands and approach roads, where it was mixed with the other waste of the community and of the domestic animals.
20. The appalling conditions of the cities of ancient civilizations and during the middle ages are well documented. Such conditions resulted in epidemics like the Bubonic Plague, and then called the “Black Death” which in the 14th century destroyed half the population of Europe. During the last decade of the 19th century as well as during the five initial years of 20th century, millions of people died due to Bubonic Plague in India. In recent years, no city in the world with modern sanitation has reported a plague epidemic. Environmental impact due to gaseous and liquid discharges has received greater attention than that by solid waste. Progress in improving solid waste management is not yet satisfactory.
21. A study by the United States Public Health Service has demonstrated the relationship of 22 human diseases to improper solid waste management. With the advent of industrialization and urbanization the problem of waste disposal increased. High population density, intensive land use for residential, commercial and industrial activities led to adverse impact on the environment.

B. Status of Solid Waste Management in India

22. India is still considered to be a so-called developing country and an enormous gap exists between the rich elite and the poor masses. Over the years, there has been a continuous migration of people from rural and semi-urban areas to towns and cities. The number of class I cities has increased from 212 to 300 during 1981-1991 and further to 393, while class II cities have increased from 270 to 345 during 1981-1991 and to 401 now; as indicated in **Table 2-1**.
23. The increase in the population in class I cities is very high as compared to that in class II cities. In India out of the total population of 1027 million as on 1st March, 2001, about 742 million live in rural areas and 285 million in urban areas. The percentage of urban population to the total population of the country stands at 27.8. The net addition of population in rural areas during 1991-2001 has been to the tune of 113 million while in urban areas it is 68 million. The percentage decadal growth of population in rural and urban areas during the decade is 17.9 and 31.2 percent respectively. By 2011 and 2021, the urban population is likely to be increased by 81 million and 174 million respectively. The percentage of urban population to total population in the 1991 Census (including interpolated population of Ghaziabad & Kashmir where Census could not be conducted in 1991) was 25.7 percent. Thus, there has been an increase on 2.1 percentage points in the proportion of urban population in the country during 1991 – 2001. The uncontrolled growth in urban areas has left many Indian cities deficient in infrastructure services such as water supply, sewerage and municipal solid waste management. Urban sanitation and environmental issues are clearly contributors to basic health conditions in urban areas but Municipal Solid Waste (MSW) Management has a lower priority than water supply and sanitation. Although incidents such as the plague episode in Surat suggest that there are important health aspects to MSW, it is basically an environmental issue rather than a health one and certainly the recent pressures in India for improved MSW have had an environmental focus.
24. Solid Waste Management is a part of public health and sanitation, and according to the Indian Constitution, falls within the purview of the State List. Since this activity is non-exclusive, non-rival and essential, the responsibility for providing the service lies within the public domain. The activity being of a local nature is entrusted to the Urban Local Bodies (ULB). The Urban Local Body undertakes the task of solid waste service delivery with its own staff, equipment and funds. In this sector, very large numbers of people are involved, whether as “Scavengers” or “Rag pickers” or Municipal workers. Thus the numbers of people and their roles are important in any effort to improve the management of MSW. MSW is normally the single biggest activity that a municipality undertakes. Though there is widespread public concern about the poor level of MSW management in most urban centers but there are some good examples and some relatively well managed systems. A number of cities like Surat, Ahmedabad, Bangalore, Hyderabad and smaller towns like Suryapet have taken important initiatives and the State governments are giving this issue more attention and providing increased resources.

Table 2-1: Urban Local Bodies- Class and Numbers

Population	Class	No. of Cities
1,000,000 and above (metro only)		35
100,000 and above	Class I	358
50,000 – 99,999	Class II	401
20,000 – 49,999	Class III	1,151
10,000 – 19,999	Class IV	1,344
5,000 – 9,999	Class V	888
>5000	Class VI	191
Unclassified		10
Total		4,378

Source: Information from web site of CPCB.

C. Waste Generation Quantities in India

25. There is no reliable national data on waste management, covering either the technical or the financial aspects and therefore any overview figures represent approximations. A background report prepared by NEERI summarizes the readily available information and provides an indication of the scale of problem. It is estimated that in year 2000, the major urban centers in India generated about 1, 00,000 tons per day of Municipal Solid Waste. On an annual level, therefore, approximately 35 million tons of MSW is generated. An analysis of data available with the CPCB shows that waste generation has been found to be a function of consumption and production activity and thus strongly affected by household income and local production of goods and services. Therefore, the scale of task at the level of individual cities is more relevant. For example Mumbai, generates about 7,000 MT per day, Delhi about 6,000 MT per day. Smaller cities tend to generate smaller per capita loads and therefore less waste. Ghaziabad produces about 600 MT per day. The average waste quantities vary between 250 gm to 500 gm/capita/day depending on the type of local body. In general all Indian cities face similar problems with regards to solid waste management.

Table 2-2: Projected Municipal Waste Generations for Urban Population in India

Year	Projected population (in thousands)	Waste Generation Rate gm/ Capita/ Day	Total MSW Generation (million Tons)
2000	281,255	327	33.7
2005	315,276	391	45.0
2010	355,205	471	61.0
2015	401,898	571	83.8
2020	455,823	696	115.8
2025	517,178	848	160.1
2030	586,052	1,032	220.7

Source: Information from web site of CPCB

D. Problems Faced by Urban Local Bodies

26. In general all Indian cities face similar problems about their solid waste management. Amount and contents of generated solid waste may differ among different cities but problems related to collection, transport and disposal are same. Major parts of generated solid waste remain uncollected at the streets, road side, open places, etc. which pollute the environment. In many cities nearly 50% of generated solid waste remains unattended, giving rise to unsanitary conditions especially in thickly populated areas (slums etc.) which results in an increase in morbidity especially due to microbial and parasitic infections and infestations in all segments of population, with the urban slum dwellers and the waste handlers being the worst affected.
27. Solid waste is collected and transported in an inefficient way using outdated equipment and techniques. Collected municipal solid waste is indiscriminately dumped at the outskirts of the city and/or at road sides or at crude dumping sites. Availability of appropriate site for landfill is another crucial factor. Most of the urban local bodies including Ghaziabad Nagar Nigam are suffering with the acute problem of non-availability of suitable land.
28. The local bodies, which are fortunate to have got the land, are using these merely as crude dumping sites not even as controlled landfill site. The objective of maintaining a Sanitary landfill site is still like a distant dream for most of the ULB's. Personnel from sweeper to manager share a lack of motivation, working in an unpopular public sector with a dirty image.
29. It is estimated that 30% to 40% of the total budget of ULB's is allocated to solid waste management. Despite this, there has been a progressive decline in the standards of services with respect to collection and disposal of municipal solid waste, bio-medical waste and industrial wastes, as well as measures for ensuring adequacy of environmental, sanitation and public hygiene.
30. Little work is performed and little information is recorded and / or available. Municipal authorities do not have records of secondary data on solid waste management.
31. None of the Indian class – I/II cities has the details of the quantity of industrial waste generated and collected by them. Industries are supposed to take care of their own solid waste treatment and disposal. They are ordered to report how much waste they generate or what they do with it. How much of this is mixed with MSW is not known either.
32. In most Indian cities bio-medical waste is mixed with Municipal Solid Waste and disposed off along with it, without considering the implication of consequences of these activities. Now after, Bio medical waste (Management & Handling) rules, 1998 & 2000 and Municipal Solid Waste (Management & Handling) rules, 2000 have come to the force, it is expected that these rules will be followed strictly.

33. The local bodies generally do not get much financial support from State or central Government. They are supposed to generate their own financial resources. However, the elected bodies do not muster the courage to levy taxes under their powers, which may be commensurate with the level of services they wish to provide. Inadequate taxation and inefficient management both together render the municipal services far from satisfactory.
34. The smaller municipalities have hardly any funds to meet their day-to-day requirements and have no capabilities to take measures for improving the level of service. Growing costs, shortage of funds, indiscipline among the work force, etc. is making the situation worse with the passage of time. In large cities the situation is rather complicated and difficult. The infrastructural development is not in a position to keep pace with the population growth of such cities resulting in serious inadequacies in service.
35. Except for a few progressive Municipal Corporations in the country, all other local bodies suffer due to non-availability of adequate expertise, experience and resources. Hence the solid waste is not properly handled resulting in creation of environmental pollution and health hazards. These local bodies lack in technical, managerial, administrative, financial resources, adequate institutional arrangement and the technical knowhow of managing urban solid waste. The main reason of institutional deficiencies is that there is no system of accountability so the duties are not discharged efficiently. The institutional arrangement for Solid Waste Management is extremely poor in most urban areas. Most of the city fathers and senior decision making officials do not consider this subject worth their personal attention. At some places unqualified and untrained persons are promoted from the post of sweepers to supervisor, which results in deterioration of services.
36. It is, therefore, very essential to provide proper guidance and training to the personnel in the Urban Local Bodies to make them efficient in managing the solid waste generated in their respective areas/cities/towns.
37. As will be seen in subsequent Chapters, Ghaziabad faces problems similar to the ones discussed above.

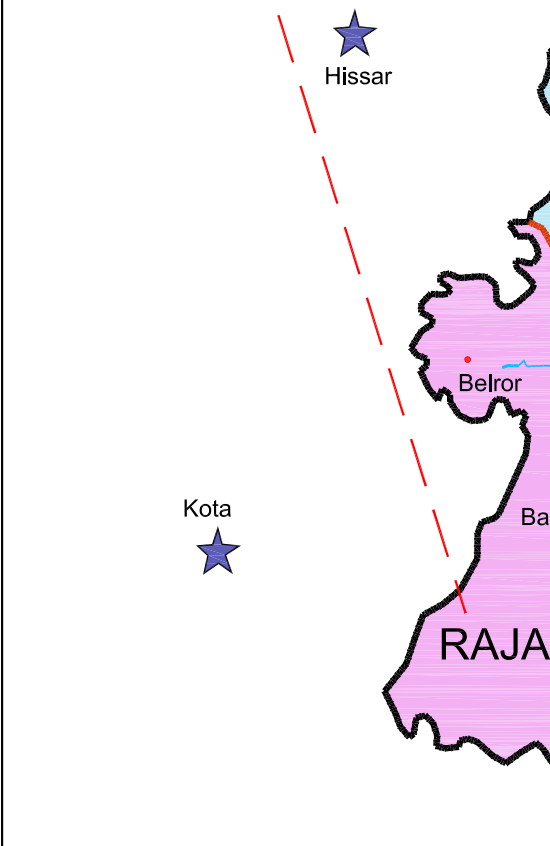
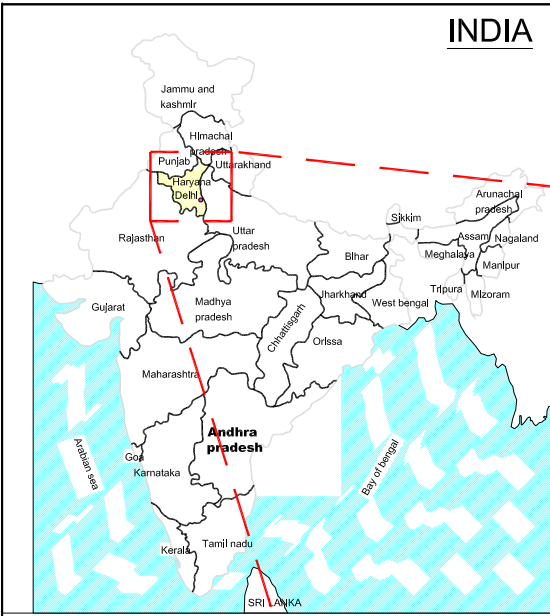
3. PROFILE OF GHAZIABAD TOWN

A. Overview

38. Ghaziabad is located in the northeastern part of National Capital Region, about 20 km east of Delhi. Ghaziabad City is an important City in Uttar Pradesh State and it is headquarter of Ghaziabad District. The City is spread and developed on both the sides of River Hindan, an important tributary of River Yamuna. Location of Ghaziabad in NCR is presented in **Map 3-1**.
39. Ghaziabad, the headquarter of the district of the same name, lies on the Grand Trunk road about a mile east of the Hindan river at Latitude 28° 40' North and Longitude 77° 25' East. It is 20 km east of Delhi and 46 km southwest of Meerut which it is connected by a metallic road. Other roads lead northwest to Loni and Baghpat and east to Hapur and Garhmukteshwar. Buses run at frequent intervals from this town to Delhi, Meerut, Aligarh, Bulandshahar, Moradabad, Lucknow and other cities. It is an important station on the Northern Railway where railway lines from Delhi, Calcutta, Moradabad and Saharanpur meet, connecting it with many important cities of India. The City has a boundary adjacent to Delhi, acts as the main entrance of Uttar Pradesh and is also called the “Gateway of Uttar Pradesh”.
40. Ghaziabad town is situated adjacent to the National Capital, Delhi towards North East. Thus over the years, it has experienced very rapid development and urbanization. The town is spread on both the banks of the river Hindan, an important tributary of Yamuna, merging in to Yamuna at Gharbara in Bulandshahar district, after flowing for a distance of about 200 km through Saharanpur, Muzaffarnagar, Meerut, Ghaziabad and Bulandshahar districts. The confluence is located about 40 Km downstream of Okhla barrage. A short cut canal called the Hindan Cut joins the river Yamuna at Okhla barrage from where the Agra canal takes off. The Hindan Cut thus serves to make the Hindan river water, including the supplemental discharge from the upper Ganga canal, available for diversion to the Agra canal for irrigational use. The river stretch remains dry in winter and summer seasons from Dehradun to Saharanpur receiving the effluents of agro-based industries in the basin including distilleries, sugar mills, pulp and paper mills, vanaspati factories, textiles mills and domestic effluents of Saharanpur.

B. History of Project Town

41. The City was founded in 1740 by the emperor, Ghazi-ud-din, who called it Ghaziuddin Nagar after himself and built a spacious structure consisting of 120 rooms of masonry with pointed arches. Only the gate, a few portions of the boundary wall and a massive pillar about fourteen feet high remain now, the precincts now being inhabited. His mausoleum still stands in the city but is in a bad state of preservation.



Capacity Development of the NCRPB: Component B (ADB TA 7055-IND)

Regional Setting of Ghaziabad

Legend

- NCR
- State Boundary
- District Boundary
- District Hq.
- Counter Magnet Areas
- River / Stream

Client:
**Asian Development Bank
 National Capital Region Planning Board**

Consultant:
Wilbur Smith Associates Pvt. Ltd.

Drawn: Roopa	Checked:
Date:	Approved:
Scale: Not to scale	

42. The city was the scene of fighting during the Indian Freedom Struggle, 1857–58, a revolt that began with Indian soldiers in the Bengal army of the British East India Company but developed into a widespread uprising against British rule in India. In an encounter between the freedom fighters and a small British force, the former were defeated while trying to hold the Hindan. This was the first war of independence and it brought Ghaziabad much of its glory.
43. From historical, cultural, mythological and archaeological point of view, Ghaziabad has been a prosperous city. This has been proved from the research work and excavations undertaken in the district. The excavation work carried out at the mound of Kaseri situated on the bank of river Hindan, 2 km north from Mohan Nagar, shows that civilization existed here even in 2500 B.C.
44. On 14th November 1976, Ghaziabad became the district. From then Ghaziabad has moved forward leaps and bounds on the social, economic, agriculture and individual fronts.

C. Climatic Condition

45. The climate of the city is dry and healthy; intensely hot during summer and quite cold during winter. The temperature is highest in May – June. The minimum temperature generally ranges from 7 degree C (January) to 26 degree C (May) and the maximum temperature from around 23 degree C (January) to 42 degree C (May). Westerly hot winds blow with great intensity in these months. The average rainfall is 732 mm and is generally limited to the months during June to September. Dust and thunderstorms occur frequently in summer season while occasionally fog occurs in the winter. Geologically, the town forms a part of the Indo-Gangetic alluvium.

D. Urban Economy

46. The economy of the town has been bi-functional – industries cum services since 1971. Industries form an important component of the economic base of the city. Ghaziabad is one of the largest industrial cities, next to Kanpur, in Uttar Pradesh. It is also an important centre for trade and commerce in western UP sub-region. Various products and equipments are supplied to the regional, national and international markets. The workforce participation rate and percentage workers in secondary sector are marginally declining but the size of work force in the city has maintained its increasing trend.
47. In terms of occupational structure, the Ghaziabad Nagar Nigam area is dominated by the tertiary (services) sector (59% in 1991) in general and specifically the other services sector (30% in 1991). Less than one third of workers are engaged in the secondary sector of which 30% workers were engaged in manufacturing sector. The household industries showed a decline in 1991, but improved in 2001. The percentage of workers engaged in primary sector has declined across the Ghaziabad Nagar Nigam area.

48. A number of famous major industries like Bharat Electronics Limited (a public sector unit of Central Government), UPTRON (a public sector unit of Uttar Pradesh Government), Dabur, Mohan Meakins, Gagan Vanaspati, Sri Ram Piston, Bhushan Steel and Weston Television are located in Ghaziabad. According to the statistics of the District Industrial Centre, 106 units of medium and large industries employed 24,595 workers in 2001. In percentage terms factories in the chemical and allied distillery sections (33%) dominate the Ghaziabad industrial scene. While in terms of workers, the electrical and electronic goods industries employ 29% of workers.

E. Urban Development

49. The city is growing at a very high pace and the population base has increased from 0.5 to 1.0 million during 1991-2001. During the last twenty years the population concentration has been on the periphery of the municipal board boundary. The city is growing spatially. Private developers promoted by Public – Private Partnership policy (PPP) are now supporting the urban development. The quality and quantity of housing is improving and reflecting the contribution of the private sector. There is no single city level agency, which maintains the integrated picture of the city housing status.
50. The city development till 1995, undertaken by the Ghaziabad Authority had declined in terms of the quality of residential development when compared with that of Noida, Greater Noida and Gurgaon in the DMA towns. The shabby look of the housing built by GDA got face uplift and its aesthetic value improved once GDA entered into PPP with private developers. The Commonwealth Games 2010, to be held in East Delhi are leading to a great deal of action in infrastructure development, hospitality as well as in the retail segment, as a result of which the population has increased many fold. Indirapuram and Kaushambi have been witnessing a lot of development in the wake of the upcoming event. To compete in the housing market, the development effort has been shifted from the public sector to the private sector through a partnership approach. Shipra, Ansals, Omaxe, Parshvanath and similar real estate giants of the private sector in housing development, have contributed to the city development.

4. TOWN PLANNING AND POPULATION FORECAST

A. Planning Horizon and Project Area

51. Planning horizon for Ghaziabad Solid Waste Management Project is kept as 20 years. The project area is entire GNN (Ghaziabad Nagar Nigam) area.

B. Ghaziabad Master Plan 2021

52. The Ghaziabad Master Plan report 2021 was prepared in year 2005. Total waste generation was envisaged as 558 MT @ 554 gm/capita per day with waste composition as – biodegradable 55%; inorganic /inert 28%; recyclable 13% and infectious 4%. The moisture component was estimated as 33-40%; volatile as 30-50% and inert material 45-60%.
53. 1,246 MT waste was projected to be generated from Ghaziabad Nagar Nigam in year 2021, out of that 750 MT was assessed to be available for final disposal with 365 MT for sequential anaerobic composting and 200 MT for composting.

C. NCR Regional Plan 2021

54. The NCR regional plan was approved on 9th July 2005. It was proposed that solid waste disposal and management should be planned for a minimum 20 years and at least controlled tipping should be adopted in the disposal of the solid waste. Areas should be identified in all the towns for sanitary landfill and all the towns above one lakh population should have arrangements to properly manage the waste disposal.
55. Studies have revealed that none of the towns in the region were disposing off solid waste in environmental friendly manner. The landfill sites were not lined to protect the ground water from leachate percolating into it. No other disposal system had been adopted by the local bodies.
56. Following deficiencies were observed :
- (i) Lack of knowledge of the local bodies
 - (ii) Non-availability of suitable land for SWM
 - (iii) Lack of public awareness
 - (iv) Non-availability of funds
 - (v) Piecemeal approach for handling of solid waste
 - (vi) Dependence on departmental staff

- (vii) Lack of coverage, shortage of staff, vehicles and funds
- (viii) Organizational inadequacies and non involvement of NGO/informal sectors and private agencies
- (ix) Shortcomings at landfill site
- (x) Mixed variety of organic and inorganic solid waste.

57. Following policies and strategies were proposed:

- (i) All the towns in NCR should prepare Solid Waste Management (SWM) plan in order to handle the waste generated in respective towns on the basis of guidelines provided by CPHEEO manual. It would be appropriate that the local bodies plan for the whole city and decentralization should be done for disposal of solid waste for reducing the transportation cost.
- (ii) Norms and standards provided in the CPHEEO manual for SWM which provides guidelines for collection, transfer, transport and disposal of solid waste in environmentally friendly manner should be followed.
- (iii) While preparing the Master/Development plan for various towns/cities, town planning departments of respective sub-regions should earmark the land for treatment/disposal of solid waste. The acquisition of the sites by development authorities/municipalities should form a compulsory element of the development programme and properly budgeted for in their plan documents. Sanitary landfill sites should be designed and engineered properly to collect and treat leachate and biogas should be collected and utilized in a phased manner.
- (iv) The segregation of biodegradable waste from non-biodegradable waste such as plastics, glass, metal paper etc at the source should be made compulsory in all towns/cities. Not more than 50% of the total solid waste generated should be disposed off through sanitary landfill.
- (v) Public awareness and trainings need to be carried out through public awareness campaigns and publicity through mass media.
- (vi) Institutional capacity building measures are required to be taken in order to improve the efficiency and effectiveness of SWM. The combination of private and public sector in proportionate ratios should be right option.
- (vii) Local bodies should improve financial positions through better financial management and by improving revenue generation capacities.
- (viii) Adoption of closed bins and covered transportation vehicles, safe and separate storage and source collection, community participation and modification of building byelaws to ensure provision of refuse storage were some other recommendations.

58. It was suggested to have a phase wise implementation and investment plan.

D. Population Projections as per SWM Master Plan, 2009

59. Area of Ghaziabad Nagar Nigam was confined to the core area of the city i.e. only 63.94 sq km till 1991 with population of 5, 11,759 but by 2001, area increased to 171.43 sq km

with census population as 9, 68,521.

60. The projection of the year wise population is made for the purpose of DPR till 2041 and same is attached at **Appendix 1**. Population projections were carried out based on appropriate methods, considering the population growth from 1971-2001 and of 2011 and 2021 as projected in Ghaziabad Master Plan. Average of three methods (arithmetic increase, incremental increase and curve fitting) was considered. Population projections were made separately for Ghaziabad and other towns in the GDA area. As presented in the following Table, estimated population of GNN and GDA in 2041 is 4.4 million and 6.1 million respectively. The total estimated waste generation in GNN and GDA area is given below. The projection population for 2010, 2011, 2016, 2021, 2026, 2031 and 2041 are given in the **Table 4-1**.

Table 4-1: Projected populations in GNN and GDA area up to 2041

Year	GNN	Dasna	Modi Nagar	Murad Nagar	Loni	Total GDA area
2001	968,521	24,428	139,642	74,080	120,659	1,327,330
2009	1,359,383	31,186	165,700	96,810	200,683	1,855,159
2011	1,479,619	33,150	172,941	103,508	227,902	2,017,120
2016	1,835,963	40,342	197,097	125,786	282,227	2,482,077
2021	2,278,126	49,095	224,628	152,859	349,501	3,054,209
2026	2,720,455	61,923	289,252	192,810	421,201	3,686,650
2031	3,248,668	78,103	372,468	243,202	507,610	4,450,051
2041	4,423,355	113,470	556,271	363,828	677,600	6,134,525

Source Up to 2021, as per Ghaziabad Master Plan 2021; and beyond that consultant's analysis

61. Ward wise population in GNN area has been collected from social economic profile survey report of Ghaziabad. The ward wise projections have been worked out and shown in following table.

Table 4-2 : Projected Ward Wise Population of GNN area

Ward Number	Area Sq. km	Population projections (in number)					
		2001	2009	2011	2021	2031	2041
01	0.69	12341	17665	19228	29604	42216	57481
02	0.57	11175	15996	17411	26807	38228	52051
03	1.38	11926	17071	18581	28609	40797	55549
04	1.97	10301	14745	16049	24711	35238	47980
05	0.20	10306	14752	16057	24723	35255	48003
06	2.24	12631	18080	19679	30300	43208	58832
07	1.65	12713	18198	19807	30497	43489	59214
08	0.24	12863	18412	20041	30856	44002	59913
09	0.77	12536	17944	19531	30072	42883	58390
10	3.16	13399	19180	20876	32142	45836	62409
11	0.54	12282	17581	19136	29463	42015	57207
12	0.47	12554	17970	19560	30115	42945	58474
13	0.53	13353	19114	20804	32032	45678	62195
14	0.33	11852	16965	18466	28431	40544	55204
15	0.72	13448	19250	20952	32260	46003	62638

Ward Number	Area Sq. km	Population projections (in number)					
		2001	2009	2011	2021	2031	2041
16	8.51	13145	18816	20480	31533	44967	61226
17	4.51	12245	17528	19078	29374	41888	57034
18	1.22	10675	15280	16632	25608	36517	49722
19	0.26	12181	17436	18978	29220	41669	56736
20	7.05	11062	15834	17235	26536	37841	51524
21	0.30	13515	19346	21057	32420	46232	62950
22	11.29	11337	16228	17663	27196	38782	52805
23	4.33	12542	17953	19541	30086	42904	58418
24	3.82	13300	19038	20722	31905	45497	61948
25	0.58	10734	15365	16724	25749	36719	49996
26	.52	10765	15409	16772	25824	36825	50141
27	0.29	12039	17233	18757	28880	41183	56075
28	4.57	12946	18531	20170	31056	44286	60299
29	4.95	11529	16503	17963	27656	39439	53699
30	7.01	11687	16729	18209	28035	39979	54435
31	0.80	12501	17894	19477	29988	42764	58227
32	1.54	10429	14928	16249	25018	35676	48576
33	1.88	10386	14867	16182	24914	35529	48376
34	8.91	10768	15414	16777	25831	36835	50155
35	5.62	10493	15020	16348	25171	35895	48874
36	3.34	13193	18885	20555	31648	45131	61450
37	1.20	10707	15326	16682	25685	36627	49871
38	4.52	12974	18571	20214	31123	44382	60430
39	0.87	10550	15102	16437	25308	36090	49139
40	1.60	12474	17856	19435	29923	42671	58101
41	1.54	12520	17921	19507	30034	42829	58315
42	6.76	10571	15132	16470	25358	36162	49237
43	0.84	12671	18138	19742	30396	43345	59019
44	0.73	12968	18563	20205	31108	44361	60402
45	0.24	11994	17168	18687	28772	41029	55865
46	2.57	12596	18030	19625	30216	43089	58669
47	0.65	11746	16813	18301	28177	40181	54710
48	0.57	12785	18301	19919	30669	43735	59550
49	10.57	10100	14457	15736	24228	34550	47043
50	0.63	10486	15010	16338	25154	35871	48841
51	0.34	11093	15879	17283	26610	37947	51669
52	0.26	10802	15462	16830	25912	36952	50313
53	3.39	10569	15129	16467	25353	36155	49228
54	7.77	13540	19381	21096	32480	46318	63066
55	0.43	10317	14768	16074	24749	35293	48054
56	0.80	10776	15425	16789	25850	36863	50192
57	0.20	11527	16500	17959	27652	39432	53690
58	4.34	13438	19235	20937	32236	45969	62591
59	0.98	10300	14744	16048	24708	35235	47975
60	1.10	10605	15180	16523	25440	36278	49396
61	0.72	13923	19930	21692	33399	47628	64850
62	0.87	11067	15842	17243	26548	37858	51548
63	0.79	11140	15946	17356	26723	38108	51888
64	0.91	11469	16417	17869	27512	39233	53420
65	0.48	10765	15409	16772	25824	36825	50141
66	5.68	12776	18288	19905	30648	43704	59508

Ward Number	Area Sq. km	Population projections (in number)					
		2001	2009	2011	2021	2031	2041
67	1.69	13758	19694	21435	33003	47064	64082
68	1.68	11955	17113	18626	28678	40896	55684
69	0.58	10619	15200	16545	25473	36326	49461
70	0.61	11557	16543	18006	27724	39535	53830
71	0.25	10952	15677	17064	26272	37465	51012
72	1.13	13614	19487	21211	32658	46571	63411
73	0.38	12508	17904	19488	30005	42788	58259
74	0.11	10512	15047	16378	25217	35960	48962
75	2.05	11062	15834	17235	26536	37841	51524
76	0.30	11272	16135	17562	27040	38560	52502
77	0.54	13359	19122	20814	32046	45699	62223
78	1.63	13857	19835	21590	33241	47402	64543
79	1.25	12907	18475	20109	30962	44153	60118
80	1.95	11340	16232	17668	27203	38792	52819

Source: Ward wise population in year 2001 from Socio economic profile of Ghaziabad, January 2009; projections made by the consultant

5. EXISTING SOLID WASTE MANAGEMENT SYSTEM AT GHAZIABAD

A. Overview

62. As per 2001 census the population of Ghaziabad city is 9, 68,256. The Municipal administration has been decentralized in five zones namely Mohan Nagar, Kabir Nagar, Vijay Nagar, Vasundhara and City zone. **Table 5-1**

Table 5-1 : Details of Solid Waste Management Zones and Wards

Zone Name	Total Wards	Ward Numbers
Mohan Nagar	14	9,14,17,24,44,46,48,57,60,63,69,70,73,75
Kabir Nagar	17	16,20,21,22,33,34,35,38,42,53,59,64,65,67,68,71,79
Vijay Nagar	14	2,3,6,8,12,13,15,18,23,26,45,51,52,66
Vasundhara	11	25,28,29,36,37,40,41,49,58,72,78
City Zone	24	1,4,5,7,10,11,19,27,30,31,32,39,43,47,50,54,55,56,61,62,74,76,77,80

Source: Ghaziabad Nagar Nigam

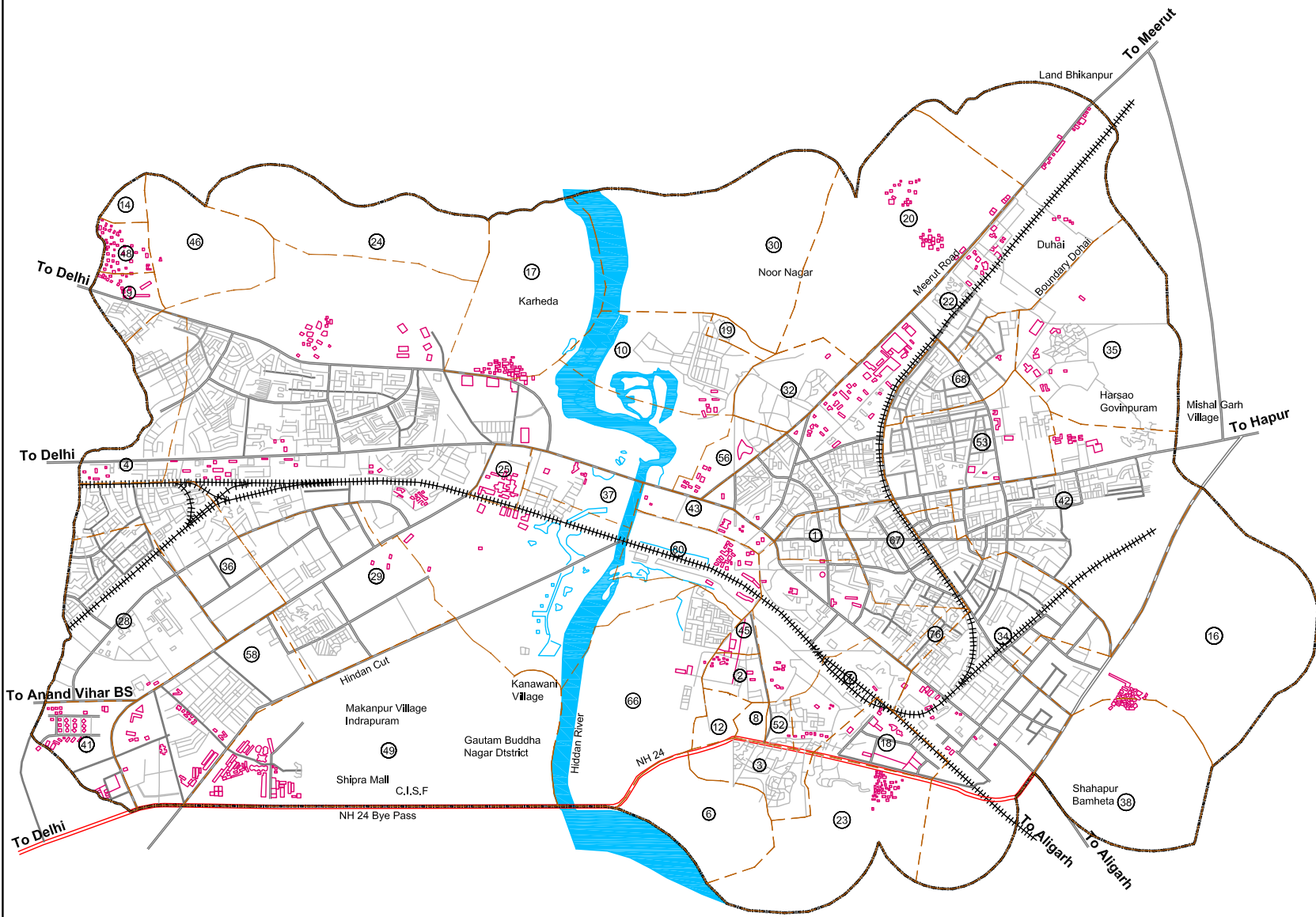
63. The entire GNN area has been divided in 80 wards. A map showing wards is presented in **Map 5-1**.

B. Waste Generation and Composition








64. The main solid waste generation sources are residential, commercial and market, slum, slaughterhouses, institutional organization like hospitals, hotels and restaurants, small and big scale industries, construction and demolition waste (debris) etc. but their quantity and quality data were not available with the Municipal authorities.
65. The essential primary data has been generated by Quantification and Characterization (Q&C) survey undertaken by a private agency called M/s ECOPRO Environmental services during sample survey carried out during 27 to 29 th December 2008. To assess the waste quantity disposed at the disposal ground, all the transport vehicles carrying waste were weighed on 29th December prior to taking for disposal. Detail analysis is presented in **Chapter 3**.

**Capacity Development of
the NCRPB: Component B
(ADB TA-7055)**

**Ghaziabad
Municipal Ward Map**



Legend

-  Municipal Boundary
-  Ward Boundary
-  Ward Number
-  National Highway
-  Other Roads
-  Buildings
-  River, Stream

Client
**Asian Development Bank
National Capital Region Planning Board**

Consultant
Wilbur Smith Associates

Drawn:SK	Checked: SKG
Date: August, 2009	Approved: NSS
Scale: NTS	

Map 5-1



C. Street Sweeping and Drain Cleaning

1. Existing System

66. Each zone is under charge of one sanitary and food inspector. The Zone office is the authorized place in every zone from where the sanitation activities are controlled. The tools and equipments are also stored here. The roll call of the sweepers/operators and their work allocation is done here. General public can interact with sanitary staff or can report a complaint for any deficiency at this office. Normally all works related to sanitation are handled at the zone office including parking of vehicle, allotment of duties, record keeping etc. every zone office has the facility of puncture repairing but for all other minor/major repairing, vehicle/equipment is sent to city garage which not only controls sanitation related activities of the city zone but controls all repairing, maintenance and fuel distribution to operators. In some zones, one-two room ward offices are also established which are manned by ward supervisors with staff for attending the ward level complaints.
67. Ward supervisors look after sanitation work at ward level but in most of the wards, Pucca (permanent) office/Seva Kendra does not exist. A picture view showing pucca and kutchha (temporary) ward office:

Picture 1: Existing SWM Ward Offices in Ghaziabad



68. GNN has total strength of 4,072 including temporary workers. Few of them are also working as supervisors and drivers. The workers are working in three categories depending upon the length of service. 1,037 are permanent workers; 458 are daily wages workers; 1421 are working through contractor and 1,156 are on contract basis. On an average there are 3 sweepers for every 1,000 population.
69. There are 165 supervisors for sanitation work; out of which; only 25 are regular and remaining 140 are officiating from the workers. The day to day responsibility of sanitation work of respective area is on the sanitary supervisor.

70. Normal working hours for sweepers and vehicle operators are 8 AM to 4 PM with a lunch period of 1 hour during 1-2 PM. Attendance of sweeping staff is taken two times in a day, in morning and after lunch. Normally, beats in morning shift are almost fixed but in afternoon shift, workers are made to sweep/clean specific area in collective manner as per the directions of supervisors.
71. The primary collection of solid waste is carried out through street and road sweeping because all kind of solid waste is thrown from windows/doors and put in open places. The sweeping and cleaning of city is done on the basis of a Single-tier system by forming “beats”. In each beat there is one sanitation worker. For waste collection from narrow roads, 24 number of three wheeler tempos are provided.
72. Every permanent worker is issued one uniform and gloves every year for summer seasons and one uniform for winter season once in three years but workers normally do not wear the uniform and gloves during work. Sanitation workers are using long coconut broom. Workers are also supplied spade, pick axe, shovel, pan, gumboot and other tools as per the requirement. The sanitation worker sweeps the stretch of street (beat) and heaps it on the road / street side with the help of coconut broom (Photo a). Drain cleaning is done by separate group of workers. Size of group depends upon nature and quantum of work. The sanitation worker after sweeping/drain cleaning collects these waste heaps in handcart and carries either to the nearby dust bin or to open collection point and unloads on the ground (Photo c, d, e, and f).
73. About 1,400 metallic un-containerized handcarts are distributed among 4,072 sanitation workers thus all the workers are not provided with equipment. The capacity of wheelbarrow is approximate 40-50 kg. Normally, each sanitation worker is making three-four trips per day. There is no fix norm for providing the carts. All the push carts are uncontainerized (Photo b).

Picture 2: Existing Sweeping and Collection System



a (worker, sweeping)

b (worker with push cart)

c (waste unloading)



d (stray animal)



e (waste scattered near bin)



f (dumper placer bin)

74. The shops / markets and other establishments normally start business after 9:30 – 10:00 AM. These timing do not synchronize with the work schedule of the sweepers, as by this time most of the collection procedure is over. The waste from these business communities again accumulates on streets and road. The same is true in the case of hotels, restaurants and vegetable market waste. The city does not appear clean.
75. Ghaziabad city has a large number of Nursing homes, pathology centers and hospitals over 3000 bed facility. Expected generation is about 3 MT of biomedical waste daily; two agencies are available for collection, processing and disposal of hazardous medical waste in a common bio-medical waste processing facility centre. One called M/S Medicare incineration Private limited, Masuri has entered into agreement with 85 medical institutions and other agency called M/S Synergie Private limited, Noida has agreement with 118 medical institutions.
76. Industrial waste generated by Industries situated in Industrial areas/Estates is supposed to recycle/process within the industrial area and no waste from industries should be allowed to mix with Municipal Solid Waste; however waste generated by most of the industries is getting mixed with MSW, because - firstly, the industrial area is almost merging with residential and commercial areas of the city and secondly, there is no check or control over the industrial waste disposal system. There are 10 industrial areas but details about waste generation from various industries are not available. Waste from Industries is of hazardous nature hence suitable provision for disposal separately as per Hazardous Waste Rules 1989 amended in 2000 is required.

2. *Deficiencies in Existing System*

77. Following deficiencies are observed in SWM primary collection system of Ghaziabad:
- (i) Amount spent per MT is much on higher side due to large work force.
 - (ii) Each of the zones is keeping records pertaining to respective activities but a written document pertaining to available resources and zone map showing boundaries is not readily available.
 - (iii) No work norm for the staff and vehicle movement is available. Area and number of beats in the area for each worker and vehicle is decided as per the practice. There is no system of sending the attendance to the senior officers on daily basis, thus

ensuring the presence and taking the work from the sanitation workers is left entirely on to the supervisors.

- (iv) In absence of the proper permanent ward offices, there are no secure places to keep the sanitary implements after the days work in most of the wards.
- (v) The handcart is left along the roadside or street side after the work is over, handcarts lying on the road give unpleasant sight, hindrance to the free flow of traffic and sense of insecurity in the mind of worker.
- (vi) The solid waste is neither stored, neither segregated nor collected at source. It is thrown on streets, footpaths, open spaces, open drains or water bodies, back yard lanes etc. Pushcart/tempo workers have to collect the street waste from the streets and public places.
- (vii) Only few important roads and markets are swept on daily basis, while other roads and markets; considered less important by GNN staff, are not swept regularly. Sweeping is not carried out on Sundays and worker's holidays.
- (viii) All type of solid waste generated is mixed with municipal solid waste including hazardous industrial waste, demolition waste, highly putrisciable waste and inert waste.
- (ix). Due to lot of encroachment on roads, covered drains, unauthorized parking, lot of traffic and kutcha shoulders on both sides of streets; area looks unclean even after sweeping.
- (x) Large work force is available but productivity is very less.
- (xi) The workers have been deputed in each zone according to past practice without working out the need based requirement.
- (xii) Safai Karamchari's beats are not decided as per any work norms. They are working according to past practices.
- (xiii) Road sweepers only sweep the streets and transport the waste up to collection points but drains abutting streets are not cleaned by the sweeper. Separate group of workers are deployed for drain cleaning but work distribution is without any norms.
- (ix) The tools and equipment are insufficient and improper. The design of equipment mainly uncontainerized push carts and tempos are required to be unloaded near the bins on the ground, therefore one additional worker is needed to transfer the waste from the ground into the bin again ,this has reduced the manpower productivity and necessitated for additional workers.
- (xv) It is observed that workers are mentally prepared for only 3-4 trips per day, which makes efficiency level very low.
- (xvi) Handcarts are not properly distributed, nor are in sufficient numbers (only 1400 for 4072 workers), which is one of the main reasons for reduced efficiency and productivity.
- (xvii) Sweepers and supervisors are mostly unskilled and have not been provided training. They have no exposure of good practices, proper use of tools and are not aware about health and hygiene related issues.
- (xviii) Primary collection of solid waste in Ghaziabad city is primitive and inefficient

D. Storage System

78. Zone/ ward Maps and list showing location of collection points is not available with Ghaziabad Nagar Nigam. Sanitation supervisors decide location of open/closed depot on their own without any norms in adhoc manner on the basis of availability of equipment and space. In some wards, number of collection points/bins is much more than required whereas many wards have only few collection points.
79. Out of total 675 collection points in entire area; 250 (35 % of total) are without containers and remaining has dumper placer bins. At 300 locations, 4.5 cum size bins; at 115 locations, 2 cum size bins and at 10 locations, refuse collector bins are provided in different wards.
80. All of 250 storage points which are on open land; develops unhygienic condition and cause of smell, odor, proliferation of flies, mosquitoes and other diseased vectors. These places are treated as receptacles of solid waste. In addition to regular points, many more number of irregular collection points exist for which no authentic information is available. The respective field staff collect the waste at temporary points and get the waste removed. At every closed collection point, one sanitation worker is deputed for transferring waste from the ground into the bin.
81. There are inadequate numbers of community dustbins of multiple size and design. These are not located and distributed properly. Positioning of the bins is decided on availability of space, past practice and personal preferences. There is lot of pressure against positioning of the bins as most of the bins are not cleared in time ; more waste remain scattered around the bin rather than inside the bin, attracting rag pickers and stray animals scurrying through the waste in search of recyclable/eatable.

E. Transport System

1. Existing System

82. Transportation is the second important stage of solid waste management system. Transportation stage can be defined as transportation of stored solid waste from various places in specially designed vehicles to the disposal site in the most hygienic way. This being very important element as it involves a large proportion of the capital and operating cost, which cause an impact on both- primary collection and processing. Objective of the system is transportation of collected refuse from specific collection points to the disposal site at minimum cost and removal of the waste at regular intervals from all collection points. Transport of solid waste is carried out entirely by Ghaziabad Nagar Nigam from all 80 wards without any private sector participation.

83. It is observed that entire quantity of generated waste is not transported. A substantial quantity of waste is either left on streets, deposited in open plots, low lying areas and drains or burnt in open. Ghaziabad Nagar Nigam is carrying out transportation with its own fleet of equipment. Presently GNN is using Front end loader / Excavator cum loader with truck and tractor tippers for removal of waste from open collection points and dumper placer carriers for closed collection points (dumper placer containers).
84. GNN have five zones. Vehicle of each zone are parked in the respective zone office and moves to pre decided route along with labour. Sanitary supervisors of zone are responsible for collecting the waste and ensuring that maximum waste gets lifted from their wards. Zonal officer fix the traveling routes of vehicles based on the basis of experience. Vehicle operation, management and fuel allotment of vehicles related to specific zone is under control of the zonal officer but the maintenance of vehicles is handled from city zone garage.
85. There is no record of with authorities on the route followed by collection vehicles and weight carried by each vehicle on each trip but fuel to each vehicle operator is issued as per past experience and assumed number of trips. Most of 125 vehicles (zone wise list given below) of Ghaziabad Nagar Nigam, like tempos, tippers and tractor trolleys are not covered though few of these are covered by tarpaulin sheet (**Table 5-2**).

Table 5-2: Zone Wise Distribution of SWM Vehicles

Type	Name of Zones					Total
	City	Kabir Nagar	Vijay Nagar	Mohan Nagar	Vasundara	
Loader	4	2	1	1	2	10
Excavator Cum loader	2	2	1	2	2	9
Tractor trolley	13	5	5	5	1	29
Truck tipper	9	10	4	7	5	35
DP carrier 2 cum	-	2	1	-	1	4
DP container 2 cum	-	72	36	-	35	143
DP carrier 4.5 cum	6	3	1	2	3	15
DP container 4.5 cum	90	87	20	34	43	274
Tempo	6	5	7	3	3	24
RC	1	-	-	-	-	1
Tractor carrier	1	-	-	-	-	1

Source: Ghaziabad Nagar Nigam

86. GNN has 19 DP carriers for about 450 containers. The ratio of DP carrier to Container is 1: 24. Ratio of 1 excavator cum loader to tipper is 1:3 and 1 loader to tractor trolley is 1: 2.
87. Vehicles work in one shift but as per the understanding the drivers are expected to complete the minimum number of trips every day. Each Refuse collector is expected to make 1 trip; open tipper and tractor cum trolley 3-4 trips and DP carrier 5-6 trips each day

per shift. Majority vehicles of Ghaziabad Nagar Nigam transport the waste to trenching ground at the banks of Sai Upvan Nallah. Vehicles of Vijay Nagar area go to other trenching ground of that area.

88. Trip record is maintained at the disposal yard. About 200 trips are made by all vehicles at the disposal place. Chief Health officer, GNN holds overall responsibility of management of operation and maintenance of about 130 vehicles. Each zone has puncture repairing and air filling arrangement but for any other maintenance work, vehicles are required to be sent to city garage which controls maintenance of entire fleet of vehicles of GNN. Financial power for minor repairing up to Rs 25,000 vests with Additional commissioner; up to Rs. 1 million with Commissioner; Rs. 1-1.5 million with Mayor; Rs. 1.5-2.0 million with the Executive committee; 2.0-3.0 with the Board and beyond Rs 3.0 million with the Government of Uttar Pradesh (GoUP).
89. Total number of operators is 162 but regular operators is only 10. The deficiency is met out with sanitation workers /daily wage/contract workers holding driving license to run the vehicles. There are 152 temporary operators arranged for SWM operation work.
90. Following Table shows the expenditure incurred on solid waste transportation in Ghaziabad. Average cost of transportation per ton of waste transported is about Rs 409/MT (**Table 5-3**).

Table 5-3 : Expenditure on Transport

S. No	Item	Cost (Rs. Million)
1	Amount sanctioned towards workshop head (transportation of waste) (2008-09)	83.00
i	Salaries of workshop and vehicle operator staff	7.00
ii	Vehicle repair and maintenance	25.00
iii	Fuel charges	45.00
iv	Drain cleaning	6.00
2	Population served (per ay) (year 2009)	1,359,383
3	Waste generated (ton/day) (expected)	748 MT
4	Waste transported(ton/day)(as per weighment on 29.12.08)	676 MT
5	Waste transported(ton/year)	202,800 MT
6	Cost of Transportation (per ton)	Rs 409 /MT

Source: Ghaziabad Nagar Nigam

2. *Deficiencies in Existing System*

91. Following deficiencies are observed in the existing municipal solid waste transport system in Ghaziabad.

- (i) Number of major collection points in each ward is fixed by the supervisors in ad hoc manner according to practice and convenience.
- (ii) In some wards, population and generation of waste is less but the collection points are more whereas in many others, situation is just reverse. To set up a new point is very difficult for GNN. There is lot of pressure for shifting or abolishing of existing points.
- (iii) In addition to identified points, several temporary points are also created for collection at the ward level for which no record is available.
- (iv) In absence of any weigh bridge for weighment; exact information about actual waste transportation is not available. Only guess work prevails while giving account of waste removed on particular day.
- (v) The milometer/hour meter of any vehicle is not in working condition. The quantity of waste transported as well as the operation hours of each vehicle can not be measured. Fuel distribution which ought to be on the basis of milometer reading is done on the basis of assumed number of trips.
- (vi) Transport system is dependent on manual labour attached with each vehicle as well as on mechanized means.
- (vii) Major drains are first filled with waste from the streets and later on are required to be cleaned under annual desilting program.
- (viii) Number of regular operators is much less than required. Most of the requirement is met from temporary staff from worker's category having driving license.
- (ix) Ratio of one dumper placer carrier to container is 1:24, which is on much higher side. The ideal ratio is 1:15 per day, depending upon the distance of disposal point.
- (x) Transport system is not fully synchronized with the system of community waste storage facility.
- (xi) Transport vehicles are not covered which is against the guidelines of Supreme Court.
- (xii) Vehicles of Ghaziabad Nagar Nigam are repaired regularly and no vehicles are grounded for want of minor maintenance work that is in spite of the fact that the garages do not have qualified mechanics and GNN is fully dependent on outside agencies for repairing of vehicles. Even minor repairs cannot be carried out by GNN.
- (xiii) GNN does not have own fuel pump and for daily needs, there is an arrangement with private fuel stations. The zonal officer is authorized to issue the fuel slip to each driver according to some assumptions, which are decided through past experience. Though record for fuel allotment is maintained but records for the exact distance traveled and the quantity transported are not maintained.
- (xiii) In the old city day time lifting of solid waste has always been problematic. The width of main lanes of old city not fit for two way traffic. Tempos are used to transfer waste from narrow areas up to community bins requiring for multiple

handling and duplication of efforts.

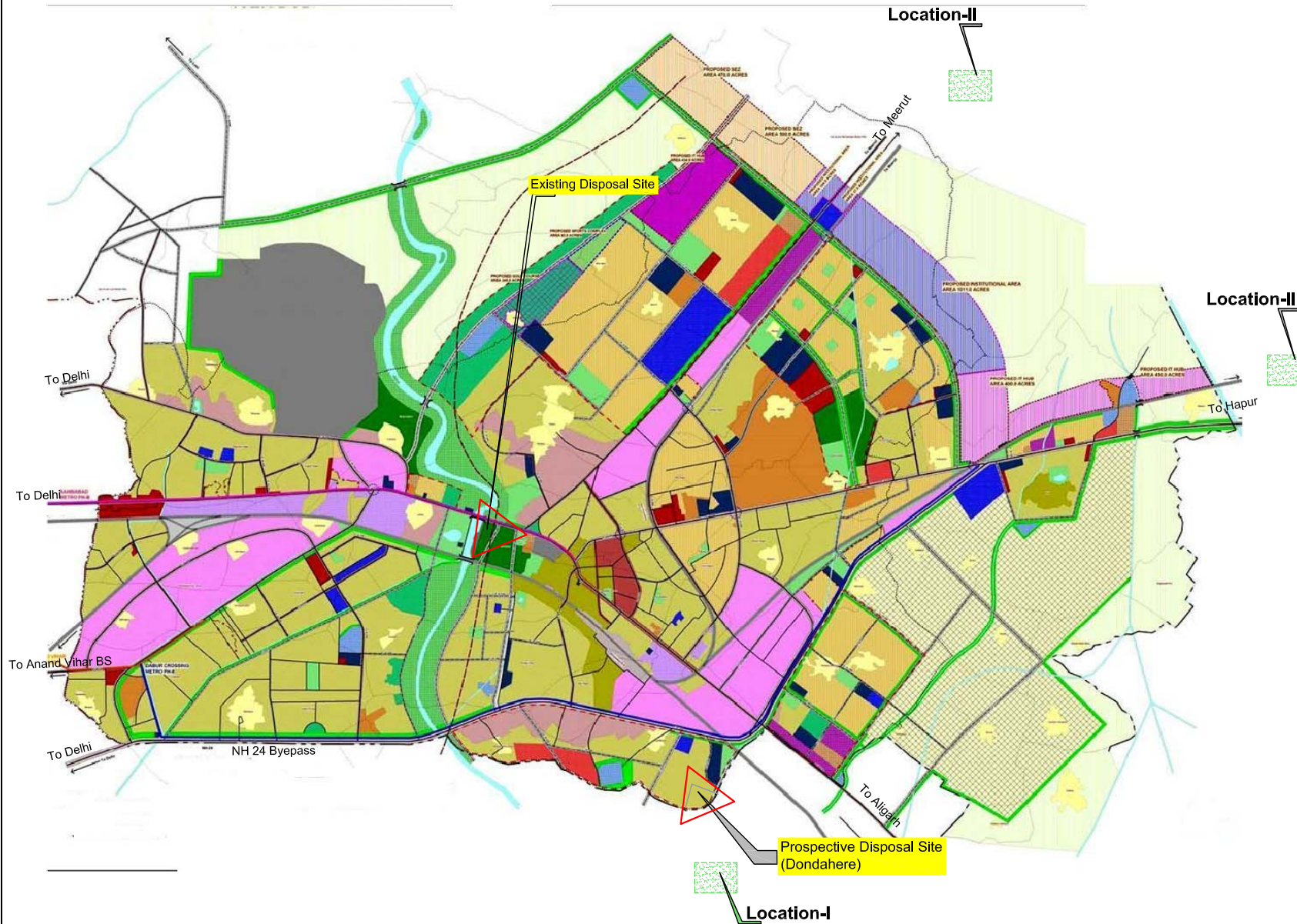
- (xiii) Mostly transport vehicles have to travel on major highway which remains very much congested due to long route traffic passing through Ghaziabad. On going construction of the flyover is also causing obstruction in easy movement of the vehicles.
- (xiv) Encroachments across the lanes also pose a problem. Transportation from the inner lanes of the city is found very difficult. Though there exists a legal provision for removal of construction waste and onus of removal is on generator but the debris etc is being removed by the GNN.
- (xv) Condition of roads is not very good and shoulders are kutcha, causing lot of inconvenience to transport vehicles.
- (xvi) All types of mixed waste including hazardous and construction material are removed by transport vehicles.

F. Solid Waste Disposal System

- 92. At present, there is no processing plant and properly designed sanitary land fill site at Ghaziabad. Waste is disposed off at an existing site located near Sai Upvan Nallah by cured open dumping method. Location of existing and prospective sites are shown in **Map 5-2**.

**Capacity Development of
the NCRPB: Component B
(ADB TA-7055)**

**Ghaziabad
Existing and Prospective Disposal Site**



Legend

- Rural Builtup
- Residential, Urban Builtup (High Density)
- Residential (Medium Density)
- Residential (Low Density)
- Main Commercial Area
- Commercial
- Whole Sale Commercial
- Industrial (Light & Small)
- Industry (Medium)
- Office
- Community Facilities
- Institutional Area
- Institutional Green
- Regional / Local Recreations
- Park, Open Spaces, Sport Center
- City Forest
- Green Buffer, Belt
- Area Reserve for River /
- Transport Nagar / Bus Station
- Defence Land
- STP/WTP/SWD
- Agricultural Land
- River, Canal, Drains, Water Bodies
- Graveyard / Cremation Ground
- Railway Land
- Non Conforming Use (Unauthorised Settlements)
- Area for Proposed HI-Tech City Urban Expansion
- Industrial Dev. Authority Area
- Existing Road
- Proposed Expressway Tentative Alignment
- Proposed Road
- Railway Line
- Urban Expansion
- State Boundary
- Dev, Authority Boundary
- Nagar Nigam Boundary
- Village Boundary
- Area Upgraded From MP-2001

Client:
**Aslan Development Bank
National Capital Region Planning Board**

Consultant:
Wilbur Smith Associates

Drawn: SK	Checked: SKG
Date: August, 2009	Approved: NSS
Scale: NTS	

Map 5-2



93. At present, most of the waste in mixed form is taken to Sai Upvan site with little quantity at carcass site near highway for Vijay Nagar zone for disposal in crude open dumping method. The following are the deficiencies the observation of waste disposal practices in Ghaziabad:

- (i) The disposal sites are neither demarcated nor fenced.
- (ii) Site is surrounded by Sai Upvan Nallah which ultimately connects to Hindan River at the downstream through RCC Hume pipes. The entire nallah remains choked and starts overflowing during monsoon season damaging the kutcha approach road and obstructing the smooth movement of the vehicles.
- (iii) A large quantity of waste ultimately finds access to Hindan River through nallah thus acts as a major source of environmental pollution. During monsoon, leachate directly enters into nallah and Hindan River.
- (iv) Present method of operation of the sanitary landfill is very crude and unscientific. The waste in mixed form is dumped without any processing and covering by daily cover.
- (v) Waste is only spread and leveled that too not done on regular basis. One hired Bulldozer, one Poclain and one Excavator cum loader are deployed at site for leveling and dozing but due to poor supervision and control; lot of waste heaps is visible on all corners of the site.
- (vi) Rules regarding site safety, environment and health are not followed. There is no control at the existing sites on the entry of the rag pickers, who while attempting to recover useful recyclable material, spread the waste all around spoiling the site and in turn are exposed to serious diseases.
- (vii) No studies have been carried out to determine the effect of the landfill operations on the environment and ground water. No EIA Studies have been carried out.
- (viii) Hospital waste, industrial waste, construction waste and all kinds of waste are currently getting access along with other waste.
- (ix) No weigh bridge exists at landfill sites. The record is kept by measuring the quantity on per trip basis. The total waste reaching at the dumping site is worked out by multiplying number of trips with average waste carrying capacity of vehicle. In absence of proper supervision and monitoring, this is handled by untrained workers/guards who do not understand the importance of this exercise and operators also consider this as a routine matter. Record of hired bulldozer is not kept by the guard.
- (x) No attempts for leachate control or recovery of biogas is being made at the site. There is a tendency to burn the waste at the site
- (xi) Condition of internal roads is very poor, due to which there is a tendency to dump at wrong places which either create obstruction or helps in deposition of waste in heaps at certain points.
- (xii) The existing site does not fulfill requirements according to MSW (M&H) Rules, 2000.

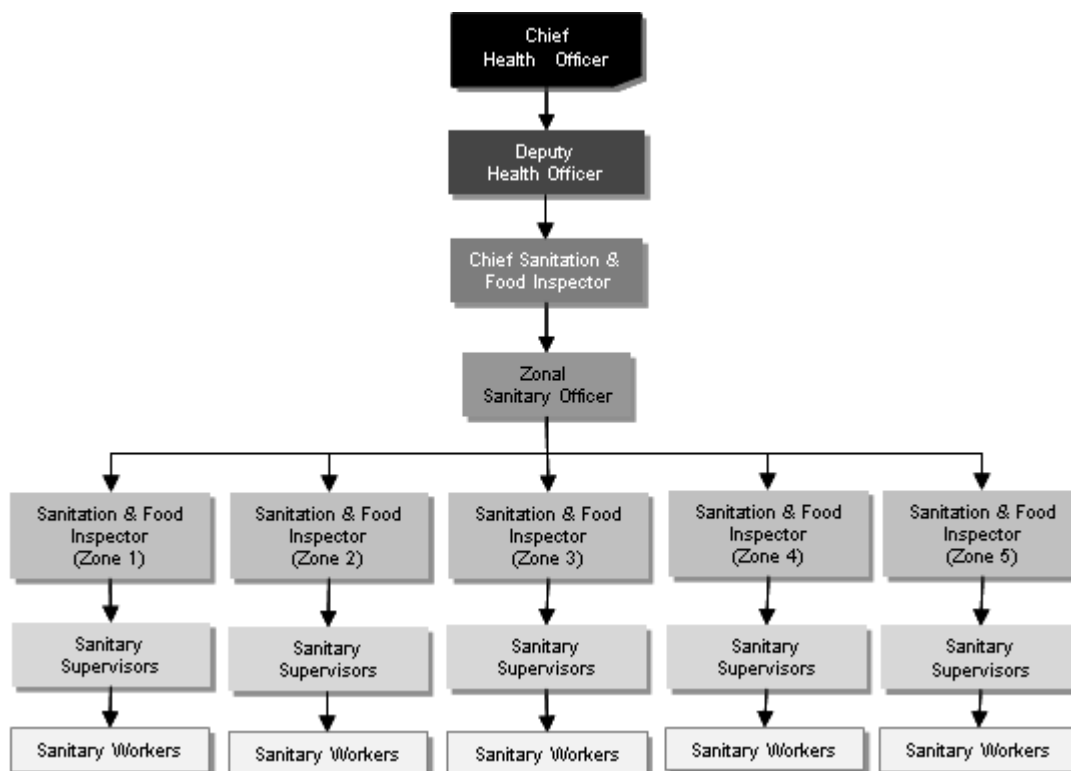
G. Institutional and Policy Aspects

94. The establishment, roles and responsibilities of Municipal Corporations in Uttar Pradesh are mainly derived from (i) the UP Municipal Corporation Act, 1956 and (ii) 74th Constitutional Amendment. Municipal Solid Waste Management is one of the activities of the ULB and is defined as an obligatory function. Specifically, this activity in India is guided by the national level legislation, the Municipal Solid Waste (Management and Handling) Rules, 2000.
95. The Municipal Solid Wastes (Management and Handling) Rules, 2000. Every municipal authority is responsible for the implementation of the provisions under these rules. The Rules outline the guidelines and principles for collection of wastes, segregation of wastes, storage of municipal wastes, transportation of municipal solid wastes, processing and disposal of wastes. The rules specify the criteria for selection of landfill sites and monitoring activities to be carried out before and after commissioning of the landfill sites. As per this legislation, the municipal authority is required to make an application for grant of authorization to set up waste processing and disposal facility from State Pollution Control Board (SPCB). The municipal authority shall also furnish its annual report to the SPCB on or before 30th June every year with respect to the solid waste management systems.
96. In Ghaziabad, the following institutions are involved in solid waste management.
- (i) Ghaziabad Nagar Nigam (GNN): GNN is responsible for solid waste management in Ghaziabad. Its Health Department is headed by Chief Health Officer is responsible for day-to-day solid waste management activities.
 - (ii) Uttar Pradesh Jal Nigam (UPJN): UPJN is a line department of the Government of Uttar Pradesh, mandated with provision of water supply and sewerage systems in the entire state. Although it is the responsibility of ULBs to prepare and execute the SWM projects, due to lack of its capacity, the preparation and execution of capital works is carried out by UPJN. In 2004, UPJN has prepared a project for SWM in Ghaziabad under a GoI Scheme. GoI approved this project with a cost of Rs. 135.1 million in 2004. The project comprised collection and transport equipment, construction of dhalaos (secondary waste storage depots) and platforms for bins, construction of processing plant and sanitary land fill site. UP Jal Nigam is the executing agency on behalf of GNN.
 - (iv) Uttar Pradesh State Pollution Control Board (UPPCB): As per the MSW Rules, 2000, UPPCB is the monitoring agency for implementation of MSW Rules, 2000 in UP. Its role is mainly to ensure implementation of MSW Rules, 2000, in terms of issuing consent for establishment and operation of waste treatment and landfill facility and also scrutinize the annual reports on SWM submitted by ULBs to ensure their compliance with the MSW Rules, 2000. The UPPCB also monitors the environmental compliance of the facilities during development, operation and closure as per the MSW Rules, 2000.

H. Administrative and Financial Arrangements in GNN

97. Overall in-charge of the city for sanitation and health is the Chief Health Officer, who is assisted by one Deputy Health officer, one Zonal Sanitation officer, one Chief Food Inspectors, three Sanitary and Food Inspectors, 130 Supervisor and over 4000 Sweepers. The Sanitary inspector through the staff deployed at the zone level looks after the cleaning work. Ward supervisors are responsible for sanitation at the ward level under overall control of zonal inspectors. The health section is entirely responsible for road sweeping, collection of waste, transportation of waste, operation and maintenance of all vehicles of GNN and management of land fill site as a part of Sanitation and Solid waste management. In addition to this, health section is responsible for issuance of death and birth certificates, issuing of licenses under Municipal byelaws and for fogging. Organization set-up of the Health Department is shown in **Figure 5-1**

Figure 5-1: Organizational Set-up of GNN Health Department



98. The solid waste management activity has received scanty attention from the civic authorities, though the GNN spends a large amount of funds. As per available data; the annual budget of GNN for year (2008-09) is 1663.3 million. 70% of total revenue is from government grant and remaining amount is generated by GNN from own resources. There is no separate head for any tax in lieu of solid waste services; however the GNN recovers house tax, water tax and sewer tax from the approved colonies. The house tax, water tax and sewer tax is recovered @10%; 10% & 4% of the rental value respectively (the rental value is assessed @ Rs 0.60 per sq ft built up area).

99. The expenditure on solid waste services is met by other revenue heads. GNN is incurring an amount of Rs. 331.2 million is spent on health sector (related with Solid Waste Management activities), which is about 20 percent of the annual budget of the Corporation. About Rs.255.2 million or Rs 1,258 per MT is spent on primary collection (mainly on account of salary of sanitation workers; this includes Rs 130.0 million for regular workers, Rs. 5.2 million on supervisors, and 120.0 million on daily wage workers) and Rs.83.0 million or Rs. 409 per MT on transportation, nallah cleaning and vehicle maintenance (Rs.45.0 million on fuel expenses, Rs 25.0 million on procurement and maintenance of vehicle/materials, Rs. 6.0 million on nallah cleaning and Rs 7.0 million on salaries). 676 MT of waste collection and transportation by GNN every day for 300 working days in a year. Overall cost on SWM is Rs 1,667 per MT.

100. Following are the observation on administrative arrangements of SWM in Ghaziabad:

- (i) Basic information is not available; each of the zones is keeping records pertaining to their activities; but there is no recorded information pertaining to available resources, and maps of zone/area of operation/beats/location of collection points etc are also not available.
- (ii) No work norms for the staff and vehicle movement are available; area and number of beats in the area for each worker and vehicle is decided as per the practice.
- (iii) There is no proper reporting mechanism is followed from ward/zone level to GNN head quarters; there is no system of sending the attendance to the senior officers on daily basis, thus ensuring the presence and taking the work from the sanitation workers is left entirely on to the supervisors.
- (iv) Present scenario of SWM Ghaziabad is described in a picture gallery below:

Picture 3: Present Scenario of SWM in Ghaziabad



(1) Solid waste lying in open



(2) Waste transport in open is common



(3) Worker sweeping the road



(4) Stray animals at open depot



(5) Inappropriate equipment



(6) Overfull Dumper placer container



(7) Overfull & broken container



(8) Manual loading of Solid Waste



(9) Burning of waste quite common



(10) Rag pickers at land fill site



(11) Construction waste On roadside



(12) Crude dumping at disposal site

I. Initiatives for Improvement of SWM in Ghaziabad

101. Solid waste management system has always been a serious concern for all urban local bodies. Being close to national capital and an important city of the State, Ghaziabad happens to be in limelight for sanitation and other infrastructure facilities. People often tend to compare the level of facilities of Ghaziabad city with Delhi. Due to poor financial situation, technical and managerial handicaps, it is not generally possible to keep the pace of infrastructure services with growth level but in case of SWM, GNN was fortunate to have got the funds from Government of India (GOI) under Special Scheme to control accidents at selected 10 cities having Air force Station on account of possible damages of aircrafts by bird hitting due to ill managed disposal sites. Apart from special scheme funds, GNN also gets funds from 11 th finance commission and state sponsored Ambedkar Yojna.
102. Ghaziabad city is one of the 10 Air force towns, selected for SWM improvement scheme sanctioned by GOI with the objective to mitigate the bird hit menace for the aircraft's of Hindan Indian Air Force station situated at Ghaziabad. The solid waste management project of the city was approved by the Ministry of Urban Development, GOI for Rs 13.51 crores in year 2005. The scheme is 100% financed by the GOI and being implemented by UP Jal Nigam on actual + 10% administrative charge basis.
103. Few salient features of approved project are given below:
- (i) The project report was prepared to cater the SWM related need of GNN for 5 years in general (2005-10) and 3 years for sanitary landfill site.
 - (ii) Equipment was proposed to augment the system for next 5 year period. Main focus was to provide supplementary number of equipment to meet the shortfall of equipment at particular time keeping consideration of financial limits.
 - (iii) As sufficient land was not available at the time of project preparation, it was decided to develop SLF site for 3 year life period.
 - (iv) MSW handling unit has been designed to handle up to 400 MT /day of MSW up to 2010 (5 years from design period). It has lately been decided to set up the plant on BOOT basis for 30 year period for which bidding process is already complete and firm called M/S Hollofix Urban infrastructure Pvt. Limited, Noida has been awarded the LOI. Agreement has not been signed as the proposed land is under legal dispute.
 - (v) Eight components were identified in the project report about which brief description and progress update is shown in Table below.
 - (vi) UP Jal Nigam is the executing agency on behalf of GNN.
104. The components of approved scheme and progress update are shown in following **Table 5-4**.

Table 5-4 : Cost Estimate of Government of India (GoI) Approved SWM Project (2005-10)

S. No	Component	Approved Cost	Progress	
		Rs. (Crore)	Financial	Physical
1	Solid waste collection	1.58	1.69	(i) 2000 bins of LLDPE of 50 liter (ii)109 dumper placer containers of 4.5 cum capacity (iii)143 dumper placer containers of 2 cum capacity (iv) 13 tractor container carriers (v)11 <i>Dhalaos</i> and 192 platforms of two different sizes were constructed
2	Solid waste transportation and handling	0.53	0.48	(i) 298 heavy duty tricycles (ii)1 servicing equipment with all accessories (iii) 4 DP carriers (iv) 1 tipper
3	Sanitary Landfill Unit (for 3 years)	3.66	0.37	*Only compound wall is constructed and some leveling work is executed but other work is held up because SLF development is under litigation
4	Compost plant (100 TPD)	2.69	0.19	Agency has been identified for execution on BOOT basis but due to non-clearance of land, work is held up.
5	Infrastructure facilities at solid waste disposal facility	1.78	0.88	Same as under item 4
6	Vermi Compost unit (20 TPD)	0.58	-	---do---
7	Sewerage/drainage facility near sensitive zone	2.05	2.20	
8	Public awareness, capacity building and training	0.25	0.25	
9	Contingency (3% on 1 to 7 above)	0.39		
10	Total basic cost	13.51	6.06	
11	UP Jal Nigam Project Management Charges	1.35		
12	Grand Total	14.87		

Source: SWM DPR prepared by UPJN

105. The picture gallery below shows some works executed/equipment supplied under a Centrally Sponsored Scheme (CSS):

Picture 4: Equipment & Works Implemented under CSS

	
LLDPE bins	Tricycle
	
DP with 2 nos 2 cum capacity bins	Tractor container carrier system
	
Platform for Dumper Placers	<i>Dhalao</i>

J. Critical Issues

106. It is obvious from the progress update given in table above that out of eight items, progress of four items is quite satisfactory but the progress related to compost plant and sanitary landfill site development is not satisfactory. The delay is caused due to land dispute and legal stricture of Honorable High Court on the identified land for Compost plant and sanitary landfill site at Doonda Hera. The progress was hampered in last two years due to legal interventions about which a brief narration is given below.

107. A site measuring 14 Acre area in Doonda Hera (belonging to Ghaziabad Nagar Nigam) was selected for setting up of compost plant and sanitary land fill under the CSS of GOI. UP Jal Nigam constructed compound wall around the 14 acre land in year 2004, which was under possession of GNN at that time .No Objection Certificates were also granted by Air force station Hindan and UP state pollution control board, Lucknow for the proposed site in year 2004.
108. The Master Plan, 2021 for Ghaziabad prepared by Ghaziabad Development Authority (GDA) became applicable from July, 2005. Unfortunately, the land under reference was shown as part of residential land use in the Master Plan which has become the bone of contention later on; as the Hon'ble High court, Allahabad granted Stay on carrying out any activity related to SWM on the petition of Mr Anil Tyagi in March, 2006.
109. Subsequently, after lot of persuasion and representations both at government and court level, it has now been decided by the Hon'ble High Court allowing, using the site for SWM purposes, provided land use is suitably amended by GDA. Since then, GDA have already recommended change of land use and matter has been sent to Government for final approval. It is expected that in couple of months from now, the change of land use would be effective and the work at the site could be started again by the UP Jal Nigam. The allotment of additional land of 29 acres (out of 33 acre) in village chipiyana , which is abutting the Doondahera site is also under consideration to extend the life of SLF site ,though even with this additional land, the SWM requirement for Ghaziabad will not be fulfilled beyond 7-8 years .
110. One site of 45 Hectare area will be required by GNN in for setting up processing plant and SLF site for 20 years of waste disposal in consultation with GDA, Hindan Air force Authority and UP State Pollution Control Board.
111. At new prospective site, apart from NOC from regulating agencies, topographical, geo-technical, environmental and social survey shall also be required to adjudge the suitability of the site according to MSW (M&H) Rules, 2000.

6. PLANNING AND DESIGNING CRITERION

A. Guidelines for Quantification and Characterization survey

112. The information on the quantity of waste generation and disposal, nature of wastes, its composition, physical and chemical characteristics are the basic needs for planning and designing of solid waste management system.
113. For quantification of waste, weighment exercise should be carried out for seven consecutive days by collecting representative samples from various waste generating sources. For assessing the collection and transportation efficiency, weighing of waste reaching at the intermediate points and disposal point is also important.
114. Characterization of waste is required to be carried out to know the physical and chemical characteristics of the waste. One sample per day for a particular type of location should be collected for physical and chemical parameters. The process should be repeated for seven consecutive days.
115. Quantification and characterization survey and analysis should be carried out at regular intervals according to guidelines given in CPHEEO manual, ideally, after an interval of 3 years.

B. Work Norms for Sweepers

(Source: CPHEEO Manual)

116. Sweeping should be done on all seven days of week. To ensure this, an additional staff of 17% of required staff should be added to work out the total strength of workers.
117. The sweepers should be given “Pin point” individual work assignments according to the density of the area to be swept. Following yardsticks should be adopted.

Table 6-1 : Work Norms for workers:

Norms of work for street sweepers	Length
High density area & Markets (Population above 60000 per sq. km.)	250 to 350 Running Meter
Medium density area (Population from 20000 to 60000 per sq. km.)	351 to 600 Running Meter
Low Density area (Population less than 20000 per sq. km.)	601 to 750 Running Meter

Note:

- (i) Each sweeper should have about 200 to 250 houses/ commercial/ institutional wastes in the beats to the extent possible.
- (ii) The above sweeping norms are for cleaning the streets in the first 4 hours of the working day
- (iii) The roads which have a central verge or divider should be considered as two roads.
- (iv) A sweeper should clean 30000 sqft of open space per day
- (v) Shallow drain up to 60 cm depth should be cleaned along with the street sweeping

C. Work Norms for Supervisors

(Source: CPHEEO Manual)

118. The first level supervisors could be asked to inspect the work of all the sweepers every day. All temporary waste storage depots must also be inspected by the same level of supervisors with the same frequency.
119. All Supervisory Officers right from Sanitary Sub Inspector to in – charge of Solid Waste Management department must remain on the field for 4 hours in the morning during the time of street sweeping.
120. Towns below 1, 00,000 Populations
 - (i) One qualified sanitation diploma holder as sanitary officer (S.O.) if the population is more than 50000.
 - (ii) One qualified Sanitary Inspector (S.I.) @ 50000 populations.
 - (iii) One qualified Sanitary Sub-Inspector (S.S.I) @ 25000 populations.
 - (iv) One Sanitary Supervisor (S.S.) @ 12,500 populations.

121. Cities between 1 and 2 lac Population

- (i) Public Health/Environmental Engineer /or Civil Engineer having training in environmental/ public health engineering in the grade of Assistant Engineer to be in charge of SWM department.
- (ii) Qualified Sanitation Diploma holder/Sanitation Officer @ one S.O. per 1 lac population or part thereof to look-after the collection, transportation, processing and disposal of waste or @ 1 per 2 sanitary inspectors, whichever is less.
- (iii) Qualified Sanitation Diploma holder Sanitary Inspector (S.I.) @ one S.I. per 50,000 population or part thereof or @ 1 per 80 sweepers, whichever is less.
- (iv) Qualified sanitation diploma holder Sanitary Sub-inspector (S.S.I.) @ one S.S.I. per 25,000 population or part thereof or @ 1 per 40 sweepers, whichever is less.
- (v) Sanitary Supervisors (a person who can read, write and report) @ one S. S. per 12,500 population or part thereof, or 1 per 20 sweepers, whichever is less.

122. Cities having population between 2-5 lacs

- (i) Public Health/Environmental Engineer/or Civil Engineer having training in environmental or public health engineering in the Grade of Assistant Executive Engineer to be in charge of SWM department.
- (ii) Public Health/Environmental Engineer in the grade of Assistant Engineer to look after the transportation, processing and disposal of waste.
- (iii) Sanitary Officer, Sanitary Inspectors, Sanitary Sub-inspectors, Sanitary Supervisors should be as per the yardstick indicated above.

123. Cities having Population between 5 and 20 lacs

- (i) Public Health/Environmental Engineer/or Civil Engineer having training in environmental or public health engineering of the level of Executive Engineer to be in-charge of the SWM department.
- (ii) Public Health/Environmental Engineers/or Civil Engineer having training in environmental or public health engineering of the level of Assistant Executive Engineer per 5 lacs population.
- (iii) Public Health/Environmental Engineers/or Civil Engineer having training in environmental or public health engineering of the level of Assistant Engineer per 2.5 lac population.
- (iv) Sanitary Officers, Sanitary Inspectors, Sanitary Sub-inspectors and Sanitary Supervisors as per yardstick indicated above.

D. Criteria for Door to Door Collection

124. Criteria are given below :

- (i) 4/6 containerized handcart / 8 containerized tricycle/ 3 containerized motorized four

wheeler mini garbage collector could be used for door to door collections.

- (ii) Each sweeper has to collect waste from 200/250 households.
- (iii) One mini garbage collector is suitable to collect about 7 MT waste per day from 13000 persons. One operator and one worker should be provided with each vehicle.

E. Criteria for Community Collection System

125. Criteria are given below :

- (i) Community collection points shall be created at central point by considering quantities of waste generated on that particular location. Different capacity community bins made of mild steel of size 2.5/3.0/3.5/4.5/7 cum sizes could be considered.
- (ii) These should be fully covered, must be placed at short distance and properly visible and advertised.
- (iii) Number of containers should be 100% more than the actual requirement. Such depots should not be more than 250 m from the work place of the workers. The distance between two bins should not be more than 500 m.
- (iv) In highly congested areas where keeping the bins is not possible, direct unloading of waste into mini waste transporting vehicles should be practiced.
- (v) The container/containers of at least twice the capacity may be placed at the storage locations to prevent overflow and to provide freedom of lifting at the convenience.

F. Criteria for Transport Vehicles

126. Criteria are given below :

- (i) Any Covered vehicle i.e. Trucks, Tippers, Tractor trolleys, Compactors, Dumper Placer carriers of compatible sizes could be used for transportation of waste from the community places. An additional spare fleet of 25-30% should be maintained.
- (ii) Transporting mixed waste and traveling through zigzag movement should be avoided.
- (iii) Normally one dumper placer vehicle should made 7-8 trips per day and shall be designed @ one carrier for 15 bins because all the bins are not going to be full on every day.
- (iv) One compactor of 14 cum size should be sufficient for 5 mini waste collectors or for 35 MT waste per day.
- (v) If processing plant/ disposal site is beyond 10 Km, Transfer Station should be set up. Bulk carriers of 20-25 cum capacity should be used for transporting the waste from the transfer station.

G. Site/Process selection criteria for Processing Plant

127. Criteria are given below :

- (i) Selection of suitable processing technology depends on physical and chemical composition of waste, capital cost, land availability, operation and maintenance cost, economical viability and sustainability.
- (ii) The ideal technology is one which requires minimum space, minimum rejects requiring further disposal, demands least operation and maintenance cost and manpower, causes least adverse impact on environment, recovers maximum net energy/useful products and requires least initial capital investment.
- (iii) The Indian waste normally contains high biodegradable fraction, high moisture and high inert fraction which is suitable for composting/ vermi- composting/ palletization etc but not considered for any thermal technology like incineration/ pyrolysis due to obvious reasons.
- (iv) Site for processing plant should be sufficient for 20-30 years.
- (v) As it would be difficult to find one location for entire city waste, therefore more than one site should be selected for setting up of the processing plant in directions of sanitary land fill sites. Ideally, transfer station cum recycling unit and processing plant should be established within one premise near the generation points.

H. Site Selection criteria for Sanitary Landfill (SLF) Site

(Source; CPHEEO manual and MSW (M&H) Rules, 2000)

128. Criteria are given below :

- (i) Land area should be large enough to last for minimum 20-25 years. If sufficient land area is not available, two three locations in different direction of the city should be selected.
- (ii) The site should be away from habitation clusters, forest areas, water bodies monuments, National parks, wetlands and places of important cultural, historical or religious interest.
- (iii) While selecting any new site, guidelines given in MSW (M&H) Rules, 2000 and CPHEEO manual should be followed:
- (iv) No landfill should be allowed within 200 m of any lake or pond; 100 m of river or stream; 100 year flood plain; 200 m of right of way; 300 m of public park; 500 m water supply well.
- (v) Landfill should not be 2 m below ground water surface; should be away from airfields at least by 20 KM; should not be part of 10-year ground water recharge area; should be free from underground mines; should be away from habitation, critical habitat area, and seismic risk zone and should have buffer zone.
- (vi) if site for processing plants are available near the city, then SLF sites could be away otherwise, processing plant and SLF site should be setup near to each other which would save transportation, operation & maintenance and supervision cost.
- (vii) The prospective sites should be analyzed from social & settlement, environmental

and geotechnical aspects according to ADB policy and State rules.

I. Design Criteria for SLF site

(Source: CPHEEO manual)

129. Criteria are given below :

- (i) It should be designed for “active” period and “closure” / “post closure” period. Active period could be 10-25 years depending upon availability of land. Closure period should be 25 years.
- (ii) Active cells should be designed considering compacted density as 850 kg/cum.
- (iii) The total landfill area should be approximately 15% more than the area required for land filling to accommodate all infrastructure and support facilities as well as to allow the formation of a green belt around the landfill.

130. The construction and operation of SLF consists of following steps :

- i. Site Development
- ii. Phase Development
- iii. Phase Operation
- iv. Phase Closure
- v. Landfill Closure

131. Following construction activities are required to be taken up during site development:

- (i) Construction of perimeter fence and entrance gate
- (ii) Construction of main access road near the entrance gate with parking area
- (iii.) Construction of main access road along the perimeter of the site as well as arterial road to tipping area of the first phase
- (iv). Acquisition and installation of weighbridges
- (v). Construction of weighbridge room/office; administrative office and site Control office
- (vi). Construction of waste inspection facility, equipment workshop , garage and vehicle cleaning area
- (vii). Installation of direction signs, site lighting, fire fighting facilities, communication facilities
- (viii). Construction of water supply and waste water/sewage disposal system
- (ix) Construction of surface water drainage system
- (x). Construction of main leachate pipe, tank and treatment facility
- (xi). Installation of environmental monitoring facilities
- (xii). Construction of gas collection pipe and treatment facility.

132. In preliminary design of a landfill section, the following slopes may be adopted:
- (i) Excavated soil slopes (2.5 Horizontal: 1 Vertical)
 - (ii). Temporary waste slopes (3.0 Horizontal: 1 Vertical)
 - (iii) Final cover slopes (4.0 Horizontal: 1 Vertical)

7. MASTER PLAN FINDINGS

A. Introduction

133. Master Plan Report (MPR) of Ghaziabad SWM was prepared in January 2009 with the objective to design a suitable integrated solid waste management system, by assessing the resource requirement for next 20 years and suggesting suitable measures for improvement of system.
134. MPR contains XI chapters. A brief description about the chapters of Master plan report is given in subsequent paragraph:
- (i) Chapter I Introduction, details out the background about the ADB TA project, and outline about the Master Plan Report.
 - (ii) Chapter II Solid waste Management – Country Overview, deals with actual situation of Municipal Solid Waste Management in India and general problems being faced by urban local Bodies.
 - (iii) Chapter III Profile of Ghaziabad City describes History of the project town, Climate condition, Urban Economy and Development and Administrative and Financial aspects about Ghaziabad city SWM.
 - (iv) Chapter IV Existing SWM system in Ghaziabad presents general description and present scenario of Municipal SWM system in Ghaziabad city, deficiencies in the system and initiatives taken for improvement of SWM in Ghaziabad .
 - (v) Chapter V Quantification and Characteristics - results of quantification and characterization survey and analysis of solid waste have been evaluated in this chapter.
 - (vi) Chapter VI Various Processing Options and disposal system describes various options available for processing and disposal of solid waste management system.
 - (vii) Chapter VII Planning for Integrated SWM describes suggestions for improvement of various elements of solid waste system i.e collection, storage, transportation, processing and disposal system. In this chapter, Involvement of Private Sector Participation (PSP), merits and Demerits with the private sector, existing level of participation in the city is discussed.
 - (viii) Chapter VIII Design of integrated SWM system deals with design parameters, design based on criteria, requirement of equipment and infrastructure for efficient SWM system for 20 years and capital investment requirement.
 - (ix) Chapter IX Operation and Management Guidelines is about operation and management guidelines of solid waste management activities.
 - (x) Chapter X ISWM Development – Implementation measures, deals with optimal design of system and suggestions for implementation. The suggestions have been categorized as short term, medium term and long term measures.

- (xi) Chapter XI Institutional Strengthening, Training and Mass Awareness Programmes- in this chapter, issues of Institutional strengthening and capacity building requirement of the line agency vis-à-vis present Organizational set up, Ideal set up for effective implementation of MSW Rules 2000, human resource development, training and Mass awareness programmes, promotional opportunities, Inter departmental coordination, encouragement to NGO/rag pickers etc. are covered in brief.

B. Situation Analysis

135. Situation Assessment of SWM is dealt in Chapter IV of MPR and V of this report- sweeping & waste storage system; collection and transport system; processing plant; disposal site; institutional and regulatory framework and financial /economic aspects is described in detail. Some major deficiencies are highlighted in subsequent clauses.

1. Deficiencies in Existing System

136. General

- (i) In many wards, ward offices are functioning from temporary spaces.
- (ii) SWM services not available on Sunday and other holidays
- (iii) SWM services not provided uniformly to all areas.
- (iv) Some new areas are without any service.
- (v) Non availability of primary data and basic information
- (vi) Absence of proper work distribution and delegation of duties
- (vii) Shortage of staff
- (viii) Low productivity of workers and equipment
- (ix) No work norm for workers and work plan for vehicle operators

137. Storage

- (i) Less numbers.
- (ii) About 35 % storage is on open ground.
- (iii) Size and location not decided appropriately
- (iv) Open burning in community bins/pits quite common
- (v) No prompt repairing arrangement for damaged bins and equipment

138. Collection and Transport

- (i) Absence of source collection and segregation
- (ii) Street littering in open plots, drains, water body and along road side is quite common as people throw their waste on streets instead of depositing in community

bins

- (iii) Collection and transportation system is incompatible, therefore manual and multiple handling becomes inevitable
- (iv) Waste through open vehicles and mixed form is transported
- (v) Ratio of 1 dumper carrier to container is too high i.e. 1:24
- (vi) The quantity of waste transported as well as the operation hours of each vehicle is not measured

139. Street sweeping and drain cleaning

- (i) Sweeping is done on very few roads that too without drain cleaning
- (ii) No work on Sundays and holidays
- (iii) Pushcart is ill designed and in insufficient numbers
- (iv) Street sweeping affected due to encroachment, unpaved edges, unauthorized parking, congestion and lot of vehicular traffic movement.
- (v) Workers do not use any safety equipment/tools
- (vi) Lack of motivation and training facilities
- (vii) Manual and multiple handling unavoidable

140. Processing and disposal

- a. No processing facility available
- b. Raw waste without processing is disposed off
- c. Existing site is used as open dump without proper disposal method
- d. Existing site is functioning without any authorization
- e. Mixing of all kinds of waste including construction.bio-medical and industrial and disposal at disposal site.

141. Institutional

- (i) Dependence on government for financial, legal , policy and land matters
- (ii) Poor institutional arrangement at GNN level. CHO and other health officer are working as head of the sanitation section but they do not have any experience and knowledge about solid waste management. These officers are entirely dependent on subordinate staff with very less initiative and exposure to the new technologies in the SWM sector.
- (iii) Less importance to SWM section
- (iv) No information about existing resources, deficiencies
- (v) Lack of interdepartmental cooperation
- (vi) Absence of qualified and trained staff
- (vii) Lack of supervision and absence of monitoring system
- (viii) Limited supervisory staff remains over occupied with multifarious activities

- (ix) Issues regarding proposed land at Doonda Hera and allotment of other land are critical issues.
- (x) Lack of workshop and training plan for staff

142. Financial

- (i) 20% of total budget is spent on SWM, Rs 254 is spent per capita per annum
- (ii) Estimated per MT expenditure on SWM service i.e. Rs 1667 is quite high
- (iii) Revenue is recovered under the head of property tax only with no direct collection for solid waste services.

143. Public participation and mass awareness

- (i) Absence of mass awareness
- (ii) Lack of public private participation
- (iii) Absence of private sector participation

C. Solid Waste Quantification and Characterization

144. Information about quantity of waste generated, collected and composition of waste was not available with GNN. Quantification and Characterization survey was carried out during 27 th to 29 th December 2008 through an experienced private agency. The detail findings of the survey are attached at **Appendix 2 to Appendix 6**.

145. Solid waste samples were collected from 88 points from residential, commercial, fruit & vegetable market, hotel & restaurants, horticulture, construction waste, waste from collection points and disposal place. The samples were collected both from generation points as well as from the disposal site to ascertain the extent of recyclable, organic, volatile, inorganic and inert components.

146. It has been estimated that average waste generation from GNN areas is 546. 49 grams per capita per day. Average density is analyzed as 470 kg/cum. The breakup of category wise waste generation is given in table below (**Table 7-1**).

Table 7-1 : Category wise waste generation per capita per day

Category of average per capita waste	Per day (gms)
Households	325 .29
Commercial	97.59
Road sweeping	65.06
Industrial and institutional	58.55
Total	546.49

147. The total waste from Nagar Nigam area is estimated to be 748 MT per day in 2009. The table showing projected solid waste generation quantities is given below (**Table 7-2**).

Table 7-2 : Projected Solid Waste Generation

Year	GNN	Other areas	Total GDA	Per capita waste/day	Waste from GNN area	From outer area	Total GDA
	Nos			Kg	MT/day		
2001	968521	358809	1327330	-	-	-	-
2009	1359383	495776	1855159	0.55	748	273	1020
2011	1479619	537501	2017120	0.57	837	304	1141
2016	1835963	646114	2482077	0.61	1114	392	1506
2021	2278126	776083	3054209	0.65	1482	505	1987
2026	2721455	966195	3686650	0.70	1898	674	2573
2031	3248668	1201383	4450051	0.75	2431	899	3330
2041	4423355	1711170	6134525	0.86	3808	1473	5281

Source: Analysis: population figures of 2011 and 2021 are from Ghaziabad Master Plan

148. The samples were analyzed for various physico-chemical parameters by using standard procedures. Composition of waste at source and at trenching ground is shown in table below:

Table 7-3 : Waste Composition Details at Source and Trenching Ground

S. No.	Category wise fraction	At source	At trenching ground
		Percentage (%)	
A. Biodegradable			
1.	Green waste and kitchen waste	55.94	58.09
B. Non biodegradable and inert			
1.	Wooden pieces	3.28	1.44
2.	Textiles	2.94	0.55
3.	Rubber/leather	0.98	0.48
4.	Inert	15.90	29.38
Total (B)		23.10	31.85
C. Recyclable			
1.	Paper and cardboard	9.71	2.72
2.	Glass	1.39	0.20
3.	Metal	0.64	0.10
4.	Polythene and plastics	9.12	6.93
5.	Others	0.10	0.11
Total ©		20.96	10.06
Grand Total		100	100
D. Moisture		38.10	41.63
E. Calorific value (Kcal/Kg)		1097.39	796.26

Source: Analysis: Quantification and characterization survey report Ghaziabad SWM Master Plan

149. The Ghaziabad waste contains high inert percentage, low calorific value, low recyclable and high moisture percentage, therefore unsuitable for processing by using any thermal treatment.
150. The biodegradable component at source and trenching ground is found as 56% and 58 % respectively, which indicates that the waste of Ghaziabad city is suitable for Composting.

D. Integrated Solid Waste Management (ISWM) System

151. Nagar Nigam is considered responsible for providing arrangement for road sweeping, collection of waste, transportation facility; processing and disposal of waste. Nigam has limited technical, managerial and financial resources, insufficient to manage the increased waste quantity. Nigam does not have land for setting up transfer station, processing plant and SLF site.
152. GNN is largely dependent on Government for all financial, legal, policy and land related matters. Public participation and private sector participation is also important for success of the system. Thus, an integrated solid waste management system (ISWM) involving all the stakeholders is required.
153. The ISWM is described in detail in chapter X of the MPR with improvement measures under categories of short term implementable within one year, medium term implementable within 1-3 years and long term measures which might require more than 3 year period. Few important measures are detailed out below:
154. Short Term Measures
 - (i) Sufficient importance to SWM sector
 - (ii) Proper work distribution of staff as per work norms
 - (iii) Decentralization of duty and authority
 - (iv) Ensure interdepartmental coordination
 - (v) Introduction of containerized push carts
 - (vi) Appreciate the work. Motivate by calling, sanitation guard/conservator instead of sweeper
 - (vii) Assess the utility of each community point and replace if required
 - (viii) Improve repairing system of vehicles and equipment
 - (ix) Replacement of open collection points and vehicles in phases
 - (x) 3 trips for heavy vehicles and 8 for dumper placers to be ensured.
 - (xi) Identification and allotment of land for ward offices, Transfer Station, Processing plant and SLF site.
 - (xii) Rehabilitation of existing disposal site
 - (xiii) Resolving Doonda Hera related issues and start functioning

- (xiv) Regular monitoring and supervision
- (xv) Mass awareness and training programme

155. Medium Term Measures

- (i) More autonomy and authority should be available to GNN
- (ii) SWM services on all seven days under independent section for SWM with senior engineer as head of the section
- (iii) More funds allotment for SWM activities
- (iv) Procurement of equipment for sweepers, collection and transport
- (v) Sweeper training, cash award/regularization etc for motivation.
- (vi) 100% covered storage/collection and transport system in place
- (vii) Deciding areas and activities for Private Sector Participation (PSP)
- (viii) Finalization of terms and conditions for PSP operations and begin in few areas
- (ix) Initiating door to door collection and segregation at source
- (x) Full operation of compost plant
- (xi) Setting up of ward offices, Recycling centre cum Transfer Station
- (xii) Initiating process for development of new SLF site
- (xiii) Continuous mass awareness and training programme
- (xiv) Beginning of imposition of user/tariff collection charges
- (xv) Use of containerized push carts in place of uncontainerized push carts
- (xvi) Use of compactors in place of existing equipments/vehicles.

156. Long Term Measures

- (i) 100% sweeping/ covered storage facility/ door to door collection with source segregation/ and transport facility
- (ii) Separate collection system for every category of waste
- (iii) Involvement of Private Sector Participation and NGO/CBO/RWAs in all sectors of SWM to provide service to 100% population and area.
- (iv) Extensive Mass awareness through Media and IEC material
- (v) Strict Monitoring and Supervision
- (vi) Implementation of user/tariff charges and legal provisions against defaulters
- (vii) Setting and operationalization of ward offices, Transfer Stations, Processing cum SLF sites

E. Design Criteria

157. The chapter VII & VIII deals with planning and design parameters, work norms, requirement on the basis of design criteria and identification of subproject and components for 20 year projections with base year as 2011 and design year as 2031.
158. Important design criteria considered are given below:
- (i) One pucca ward office with 1-2 room and one store in every ward
 - (ii) One Transfer Station cum Recycling centre in each of the five zones
 - (iii) SWM services to be available on all seven days of a week
 - (iv) 100% covered storage facility for entire population
 - (v) 100% covered transport facility for entire waste generation
 - (vi) Compatible collection and transport vehicle with least requirement of manual and multiple handling
 - (vii) Primary collection, road sweeping and drain cleaning services to be provided in a phased manner. Design is based on 50 % population coverage in base year i.e. 2011; and expected increase up to 60% by 2016; 70% by 2021; 80% by 2026 and 100% by 2031.
 - (viii) Compost plant and SLF are designed for 20 years requirement.
159. Sweeper's norms are already fixed by the State Government, which has been adopted as given below:
- (i) 28 sweepers on 10000 population
 - (ii) 1 pushcart for two sweepers
 - (iii) 1 operator and 1 helper for each motorized collection and transportation vehicle
160. Number of equipment/vehicle is proposed with following criteria:
- (i) One 4.5 cum bin for 2000 persons (100% more storage space than requirement)
 - (ii) One dumper placer carrier for 15 bins
 - (iii) One mini garbage collector for 7 MT waste quantities per day
 - (iv) One compactor for five mini garbage collectors or 35 MT waste quantities
 - (v) One compactor /tipper to make minimum 3 trips per shift
 - (vi) One dumper placer to make minimum 8 trips per shift
 - (vii) Tipper to be used for transport of construction/horticulture waste
 - (viii) One loader and two tippers to make one unit

161. Operation and maintenance cost per annum for various activities are considered as given below:
- (i) Collection equipment 10% of capital cost
 - (ii) Transport Equipment 30% of capital cost
 - (iii) Processing plant 20% of capital cost
 - (iv) SLF site 20% of capital cost
162. To ensure seven day working, number of workers has been increased by adding 17% for providing rotational off to staff. Total number of equipment and vehicles are increased by 25%, considering spare requirement demand on account of repairing.
163. Design of processing plant is based on following criteria :
- (i) 10/20 year design period
 - (ii) For biodegradable fraction 56% from entire population assuming 100% collection efficiency
 - (iii) To be designed as integrated plant which will produce compost/vermin compost from wet biodegradable components, pallets from dry biodegradable component and construction tiles/bricks from inert residual waste thus contributing only 10 % as residual from the total received quantity.
164. Design of SLF site has been done by considering following criteria:
- (i) 20 years design period
 - (ii) Residual from integrated processing plant @ 10% and 16% non-biodegradable component
 - (iii) Compacted density at SLF site @ 850 Kg/cum
 - (iv) Infrastructure facilities @ 15% of cell area
 - (v) Waste height 10 m including 16% inert material layer
 - (vi) Post closure period 25 years
 - (vii) Buffer area 6/10 m all around depending upon availability of land
165. Presently, a large chunk of the waste is disposed off at Sai Upvan Nallah site, which is not suitable environmentally, technically and also does not meet the criterion of MSW (M&H) Rules, 2000. The site cannot be termed as Sanitary Landfill (SLF) but may at the best be termed as a rudimentary tipping/ dumping site, used for want of a better option.
166. It is mandatory to develop Sanitary Land Fill site (SLF) for minimum 20 years life. GNN has not been able to select and acquire a suitable site. It is estimated that total space of about 44/60 hectares is necessary for 20 years life period for GNN and GDA region respectively, comprising of landfill cells, compost plant, buffer zone and all infrastructure

facilities as per the requirement.

167. It has been suggested to establish processing plant and SLF site on Design Build Operate Maintain and Transfer of land (DBOMT) basis by private experienced entrepreneur. Normally, these plants are not economically viable therefore some gap funding may be required to be provided by GNN by way of tipping fee but in some cases the firm may be willing to install and operate the plant without charging tipping fee if some concession like cheap land, road and electricity facility, tax concessions and freedom of technology selection and marketing of useful product etc are provided by the executing agency.
168. At present, no processing system exists at Ghaziabad. For any processing system, physical-chemical characteristics of solid waste and its quantity are the two key factors which decide the various options to be considered for various processing system. While evaluating the composite average value, it is found that the biodegradable fraction at source in wet condition is 55.94 %; recyclable 28% and Non biodegradable + inert percentage is 16 % while the MSW characteristics at disposal site which is likely to be processed in wet condition has 58.09% biodegradable fraction; recyclable material is 13% while Non-biodegradable + inert is 29 % .The variation is on account of the rag pickers who collect the recyclable fraction during collection, transportation and at disposal site.
169. With this characteristic of Ghaziabad waste, a suitable, viable option is possible in from of processing plant, comprising of Composting for wet waste/ Vermi composting for pure biodegradable waste/ Palletization for dry biodegradable waste or combination of more than one options. A substantial quantity can be processed while the remaining may be about 20% is to be disposed off by sanitary land filling method. While practicing composting sufficient safeguard should be taken so that the prescribed standards laid down in schedule IV of the MSW rules, 2000 for composting must be strictly followed. Contaminated compost is also a pollutant and has to be disposed off. In order to minimize the chances of contamination, strict segregation must be followed.

F. Equipment and Land Requirement

170. Design of Collection and Transportation equipment at base year of 2011 and design year of 2031 are given in the following **Table 7-4**.

Table 7-4 : SWM Equipments and Vehicles Requirement

Item	Criteria	2011	2016	2021	2026	2031
Population	Master plan	1,479,619	1,835,963	2,278,126	2,720,455	3,248,668
Number of sweepers	28/10000 + 17% extra	4847	6015	7463	8912	10643
Push cart workers	1 for 2 sweepers	2071	2570	3189	3809	4548
Push carts	1 for each worker + 25 % extra	2589	3213	3987	4761	5685
Storage bins	1 for 2000	925	1147	1424	1700	2030

Item	Criteria	2011	2016	2021	2026	2031
4.5 cum	persons+ 25 % extra					
Bin carriers	1 for 15 containers + 25 % extra	77	96	119	142	169
Coverage for primary collection (%)	As per master plan assumptions	50%	60%	70%	80%	100%
Population covered	--do--	739810	1101578	1594688	2176364	3248668
Waste generation (Mt/d)	--do--	419	668	1037	1518	2431
Mini waste collector (Nos)	1 for 7 MT/d+ 25% extra	75	120	188	276	441
Compactors (Nos)	1 for 35 MT/d + 25 % extra	15	24	38	55	88

171. Following **Table 7-5** shows design of compost plant and SLF site on base year as 2011 and design year as 2031.

Table 7-5: Design of Compost Plant and SLF

S. No.	Item	Criterion/ Assumptions	2011	2016	2021	2026	2031
I	Compost Plant (for GNN Area)						
<i>A</i>	<i>Size of Plant</i>						
1	Expected waste generated (MT)	As per master plan report	837	1,114	1,482	1,898	2,431
2	Biodegradable waste quantity (MT)	56 % (as per field survey and master plan report)	469	624	830	1063	1361
3	Capacity of plant required (MT/day)	10 years/20 years(as per MSW rules)		650		900	
4	Land requirement (ha)	As per master plan report		6			
<i>B</i>	<i>Compost Plant Equipment (for 3 sites)</i>						
6	Unit & size to be provided (units, MT)	As per design of master plan report		3x200		3x300	
7	Plant & machinery	--do--		3 sets		3 sets	
8	Loader backhoe	--do--	3	-	3	-	3
9	Tipper 8 cum	---do--	6	-	6	-	6

S. No.	Item	Criterion/ Assumptions	2011	2016	2021	2026	2031
10	Tractor with tipper	---do--	3	-	3	-	3
11	Water tanker (3000 liter capacity)	---do---	3	-	3	-	3
12	Computerized Weigh bridge (30 MT)	--do--	3	-			
13	Other Infrastructure works	As per the site requirement		Yes		Yes	
B	Sanitary Land Fill Site						
1	Expected waste generation MT/d	As per sample survey and master plan report	837	1114	1482	1898	2431
2	Net Compostable quantity (MT/day)	56% biodegradable	469	624	830	1063	1361
3	Residual from compost plant and non biodegradable (MT/day)	10 % from compost plant + 16 % of total waste (inert and non-biodegradable)	181	241	320	410	525
4	Capacity of SLF required for 20 years (MT/d)	As per master plan report	335				
5	Total volume of landfill required, m ³	Assume density as 850 Kg/cum	2,879,793				
6	Total land area required for landfill include facilities, infrastructure & buffer (ha)	As per master plan report	38				
7	Total land area required for compost plant +SLF (ha)	--do---	44				
8	SLF equipment (for 3 sites)	---do--					
	Loader backhoe		3		3		3
	Tipper		6	-	6	-	6
	Bull dozer		3	-	-	-	-
	Landfill Compactor		3	-	-	-	-
13	SLF infrastructure	-	As required	-	-	-	-
14	Number of active years	20 years or more	-	-	-	-	-
15	Closure and post closure period	25 years	-	-	-	-	-
16	Operation and	10% of capital cost	-	-	-	-	-

S. No.	Item	Criterion/ Assumptions	2011	2016	2021	2026	2031
	maintenance of primary collection equipment (per annum)						
17	Operation and maintenance of transportation equipment with transfer station (per annum)	30% of capital cost	-	-	-	-	-

172. Requirement for Equipment and land is assessed for entire waste management from GNN, Dasna, Murad Nagar, Modi Nagar, Loni Nagar and entire GDA area at base year 2011: **Table 7-6**

Table 7-6 : Resource Requirement at base year 2011

S. No.	Name of equipment	Nos.					
		GNN	Dasna	Murad Nagar	Modi Nagar	Loni Nagar	GDA
1	Containerized pushcart	2589	58	303	181	426	3530
2	Dumper placer container 4.5 cum	925	21	108	65	142	1261
3	Dumper placer carrier	77	1	7	4	9	105
4	Mechanized Mini waste collector	75	2	9	5	12	102
5	Transport compactor 14 cum	15	-	2	1	2	20
6	Loader Backhoe	6	-	-	-	-	6
7	Tipper 8 cum	12	-	-	-	-	12
8	Tractor with tipper	3	-				3
9	Water tanker	3	-	-	-	-	3
10	Weigh bridge 30 MT	3					3
11	Bull dozer	3					3
12	Landfill Compactors	3					3
13	Compost plant capacity (MT/d)	650/900*					900/1200
14	Space for compost plant (In Ha)	6					8
15	SLF site requirement (MT)	335 MT per day					455 MT Per day
16	Space for SLF site (Ha)	38 Ha					52 Ha
17	Total space for processing plant and SLF site (3 nos) (in Ha)	44 Ha (15 Ha each)					60 (20 Ha each)

173. Compost plant of 650/900 MT per day plant capacity is assessed for processing of entire waste for 10/20 years from GNN area. The size of the plant would be required as 900/1200 MT for 10/20 years of waste from GDA area.
174. Total land requirement for compost plant and SLF site has been worked out as 44 hectare for GNN area and 60 hectare for waste from GDA area.
175. Hoping that the land dispute of Doonda Hera would be soon resolved and the site would be found suitable from every respect, two other new sites should be selected, preferably in North (near Meerut road) and East side of the Ghaziabad (near Dasna/ Hapur road). The existing Sai Upvan site also needs to be rehabilitated as controlled dumping site.

G. Capital Investment Requirement

176. Phase wise capital investment requirement for GDA area is shown in table below (Table 7-7).

Table 7-7 : Capital investment Requirement for GDA area (on present market rate)

S.No.	Item	Amount (In lakh Rs)				
		2011	2016	2021	2026	Total
A	Collection and Transport Equipment					
1	Push cart @ Rs 7000	249 (3557)	304 (4344)	374 (5345)	452 (6452)	1377 (19671)
2	DP container @ Rs 40000	504 (1260)	620 (1551)	764 (1909)	922 (2304)	2810 (7025)
3	DP carriers @ Rs 12 lakh	1260 (105)	288 (24)	1620 (135)	684 (57)	3852 (321)
4	Mini waste Collector @ Rs 5 lakh	510 (102)	805 (161)	1240 (248)	1840 (368)	4395 (879)
5	Compactors @ Rs 26 lakh	520 (20)	312 (12)	988 (38)	676 (26)	2496 (96)
A	Total	3041	2329	4986	4574	14930
B	Processing Plant					
1	Loader cum excavator @ Rs 20 lakh	60 (3)		60 (3)		120 (6)
2	Tipper @ Rs 12 lakh	72 (6)		72 (6)		144 (12)
3	Tractor tipper @ Rs 8 lakh	24 (3)		24 (3)		48 (6)
4	Water tanker @ Rs 3 lakh	9 (3)		9 (3)		18 (6)
5	Weigh bridge 3 nos 30 MT	45 (3)				45 (3)

S.No.	Item	Amount (In lakh Rs)				
		2011	2016	2021	2026	Total
	@ Rs 15 lakh					
6	Other plant & machinery 3 units @ Rs 200 lakh	600 (3)				600 (3)
7	Infrastructure Facilities 3 unit @ Rs 200 lakh	600 (3)				600 (3)
C	Sanitary Land Fill Site					
1	Loader cum excavator	60 (3)		60 (3)		120 (6)
2	Bull Dozer 3 nos. @ Rs 60 lakh each	180 (3)				180 (3)
3	Compactor 3 nos @ Rs 35 lakh each	105 (3)				105 (3)
4	Tippers 6 nos @ Rs 12 lakh	72 (6)		72 (6)		144 (12)
5	SLF infrastructure facilities (Lump sum)	6495 (52 Ha)				6495 (52 Ha)
6	Ward offices 80 nos @ Rs 5 lakh	400 (80)				400 (80)
7	Transfer station 5 nos @ Rs 100 lakh	500 (5)				500 (5)
A+B+C	Total	12263		5283		24449

Note: Values shown in parentheses indicate numbers of respective equipments

H. Socio- Economic Profile of Ghaziabad – Salient features

177. Socio-Economic profile of Ghaziabad is prepared in context of solid waste management by following stratified random sample survey method. The findings have given insight about the existing status of urban services, expectation by the users and “willingness to pay”, if service standards are improved. The detail findings including base line questionnaire are presented in a separate volume.
178. Total 1030 households comprising of 5741 population was surveyed. Out of that, 820 Households (4581 persons) were from non-slum and 210 households (1160 persons) from slum areas. The average family size in non-slum and slum areas was 5.58 and 5.52 respectively.

179. 39.0 percent non-slum and 59 % slum households throw the garbage outside and dump; whereas 56.6% non-slums and 37% slum households store the garbage for collection. 69.4% non-slum and 52.4 % slum households felt that the distance of disposal site is less than 100 m. 76.7% non-slum and 69% slum households dispose the household waste daily but 17% non-slum and 26.7% slum household dispose waste every alternate day. 40.4% non-slums and 22.4 slum dwellers spend money for disposal of garbage. 79.15% of non slum household spend Rs 16-30 per month for disposal; whereas 78.72% slum households spend less than Rs 15 per month for disposal. 49% non-slums and 35.9% households are willing to pay if quality of services on waste disposal improves. 36.6% of non-slum and 59.4% of slum areas are willing to pay less than Rs 25. 35.2% non-slum households and 26.6% of slum households are willing to pay Rs 25-50 per month for waste disposal.

I. Other Critical Works

180. Present situation calls for significant improvements in order to comply with MSW, improve environmental condition and to protect public health. The existing situation of SWM can not be changed overnight. Presently, the work is done without any laid guidelines. In Chapter IX of MPR, operation and management guidelines and monitoring procedure is described which should be useful for overall supervision of SWM.
181. It requires consistent effort from all stakeholders. In Chapter X of MPR various measures along with duration for implementation have been suggested. It has been stressed to use Private sector participation in SWM activities on the basis of available successful models in Chapter VII of MPR.
182. In Chapter XI, of MPR, Institutional and Training aspects are described. It is suggested to strengthen ward level administration, making an experienced engineer as SWM head with sufficient power and authority and also to provide training to GNN officials. It is strongly recommended to construct one pucca ward office in every ward and one transfer station in every zone. Mass awareness is another important activity required to be performed in regular manner.
183. Land identification and allotment for SWM activities is very crucial for success of solid waste system. In the Master Plan Development Plan 2021 of Ghaziabad, about 10 sites were indicates for Sewage Treatment Plant (STP)/Water Treatment Plant (WTP)/ Solid Waste Disposal ground (SWD) but after review of these sites as detailed out in Chapter VIII, of MPR, it is mentioned that STP and WTP existed at few sites, whereas some other sites were not acceptable to Hindan Airport Authority as they were falling within flight zone of aircrafts. No Objection Certificate (NOC) from airport authority and UP State Pollution Control Board (UPSPCB) are critical therefore any new site is required to be selected after informal/formal discussions with the concerned authorities.
184. It is mentioned in the Master Plan Report that the proposed land at Doonda Hera (presently under legal dispute) is not sufficient for 20 years requirement, even after considering additional land of 29 acre at Chipiyana village. It has been suggested to set up

processing plant and SLF sites at three locations (including Doonda Hera, if found suitable from environmental, social and geotechnical aspects). Each site should be of about 20 Hectare each.

185. As GNN does not own any land bank, therefore State Government/GDA should provide suitable land for Transfer Station, Processing Plant and development as Sanitary Land fill Site free of cost, on priority.
186. It is suggested to keep land reserved for ward offices, zone office, collection centre, Transfer Station, processing plant and sanitary land fill site in every new colony/area developed/to be developed by GDA and other Institutions on mandatory basis.

8. DETAIL DESIGN FOR DPR WORKS

A. Salient Features of Detailed Project Report

187. Following are the salient features of the Detailed Project Report.

- (i) DPR on Ghaziabad Solid Waste Management (SWM) system is primarily based on the SWM Master Plan report of Ghaziabad prepared in January 2009.
- (ii) Design criteria are mostly adopted from the Master Plan report with few exceptions.
- (iii) The financial estimates of DPR has been prepared for fulfilling SWM requirement of GNN for next 5 years, however the cost provision for permanent assets like procurement of land, buildings and some of the infrastructure requirements have been included of 20 year requirement .
- (iv) While preparing DPR, the base year and design year have been taken as 2013 & 2018 respectively; as per the implementation schedule.
- (v) DPR is prepared for GNN area for collection and transportation of waste but setting up of processing plant and sanitary land fill site has been suggested to be on “Regional concept”. The regional concept means that the high capital intensive facilities would be developed and used by a group of ULBs as a common facility through a small administrative core group comprising of all the stakeholders, representative of State government and members of regulatory departments. The group could be in form of SPV (Special Purpose Vehicle) for this purpose.

B. Salient Features

188. DPR Design is based with prime objective of overcoming the deficiencies in existing system. The salient features of the design are mentioned below:

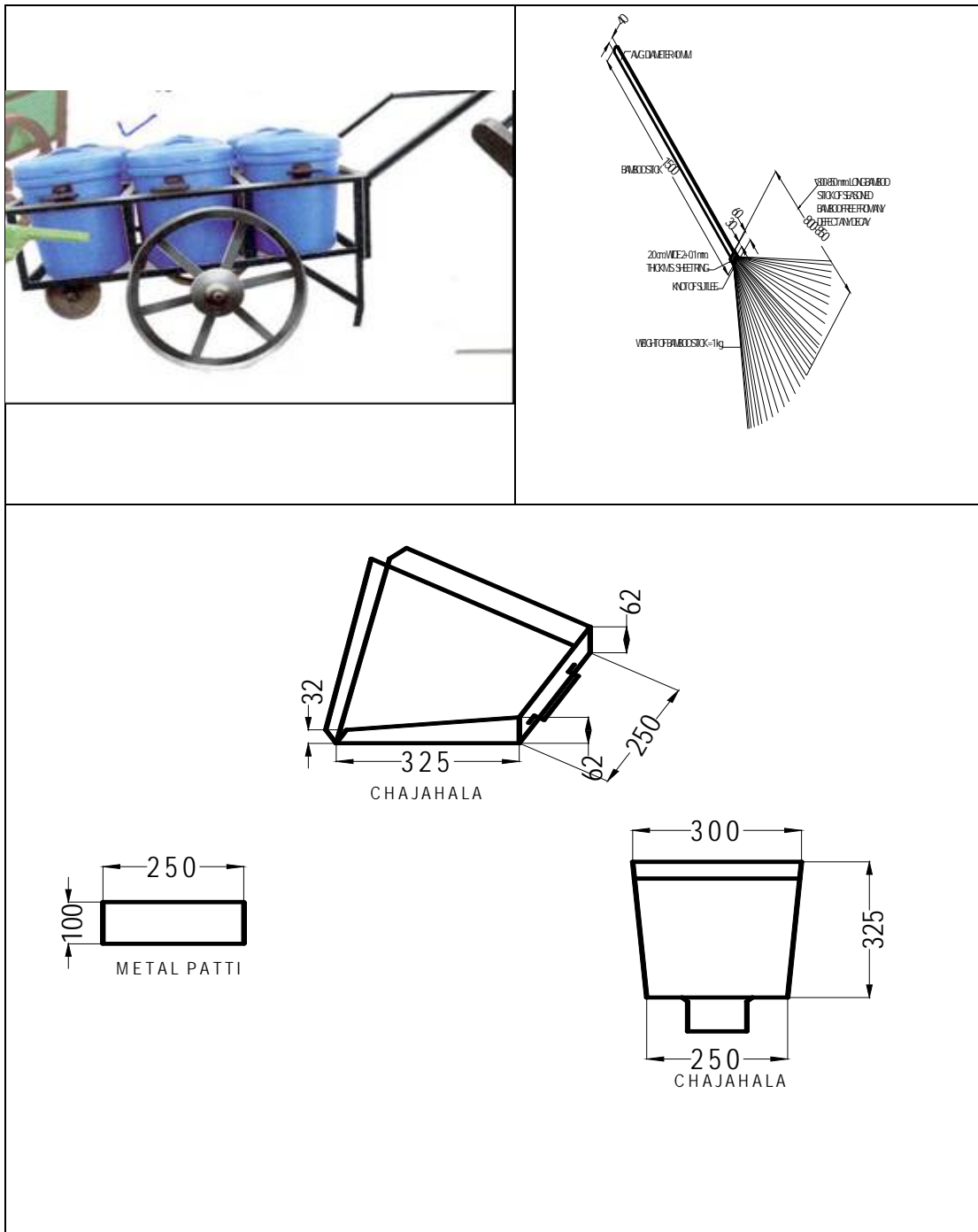
- (i) SWM facilities are designed, considering the requirement for all seven days of a week.
- (ii) Collection system is designed covering entire area, proposing the mixed system-Door to door collection in phased manner starting with 50% coverage and achieving 100% by the end of design year. The provision of covered storage by dumper placer containers is taken for remaining area starting with 50% and reducing to 0% by end of the design year.
- (iii) Compatible motorized vehicles and implements have been suggested for collection and transportation. In 50 % of area, where DTDC system is proposed, Motorized mini waste collectors of 1.8 cum (1.5 cum for biodegradable and 0.3 cum for recyclable) and compactors of 14 cum capacity are proposed. In remaining area, dumper placer containers of 4.0 cum capacity on twin carrier dumper placer vehicles are proposed up to transfer station, thereafter hook loader are proposed for bulk carrier bins of 20 cum capacity.

- (iv) Separate system should be used for bulk quantity special type of waste. For example, construction waste should be collected separately through heavy vehicles like open trucks etc by recovering collection charges from the generator. Such waste should not be disposed in landfill site but be used as sub base layer in road construction/ filling the plinth & low lying areas or as inert material for daily cover in SLF sites. Likewise, the Pure Biodegradable waste from Hotels/ Restaurants/ gardens/ Marriage houses/ vegetable yards etc should be collected through separate vehicles by recovering user charges and shall be processed in a centralized vermin-composting unit if mass is small and homogeneous or for composting if in large quantity and non-homogeneous nature. Biomedical waste and industrial waste should be collected and processed as per respective rules and should not be allowed to get mixed with MSW.
- (v) One Transfer Station with High hook lifter vehicles, compaction units and high capacity bulk containers have been proposed near/within city limits , for which an area of 1 hectare is proposed.
- (vi) One site is proposed to be developed as “Regional landfill site” for setting up of Processing plant and Sanitary Landfill Site. The site is yet to be selected, for which CPCB is playing active role in association with BISAG and NCRPB.
- (vii) Ward office is proposed in each ward for assembly of workers, storage of tools and grievance redressal at the ward level.
- (viii) Cost effective SWM system using suitable private sector participation/ public private participation models.

C. Proposed Works – Concept and Brief Description

189. Number of Sweepers and Tools: Presently, GoUP have prescribed norms for sweepers as 28 numbers per 10000 persons i.e. 1 sweeper for 357 persons., with family size as 5.58, it comes out to be 1 worker for only 64 Households, which is very less as compared to recommendation of manual i.e. one worker for 200-250 HH. The number of workers required as per the CPHEEO manual at 2009 population level (for 13,59,383 or 246265 HHs , @ 200 per HH) shall be only 1331 but as the existing workers can not be removed from the service, the existing strength is considered for providing tools etc.
190. Presently, the workers are using un-containerized pushcart, which are non-compatible with the storage community bins. It is suggested to use 6 containerized pushcarts for 1 out of every two sweepers. Accessories such as long handled broom, collection plate, plate, Chajahala, bell with locking arrangement shall be provided as per the standard specifications. It would be better if a small quantity of new tools are procured initially and used on pilot basis. If workers are satisfied then the bulk procurement could take place. A picture profile of proposed tools is shown below:

Picture 5: Street Sweeping & House Collection Equipment



191. Door to Door Collection (DTDC) system in phased manner: At present waste is collected from the road, drains, community bins, and open collection points, as DTDC does not exist in organized manner. The entire collection work is performed by the workers through non-compatible equipment requiring manual and multiple handling. It is informed that some house to house collection system exists in few colonies in an informal manner (especially in societies/new areas, where regular solid waste management system by GNN is not in practice) but any documentary evidence of these activities is not available.

192. Two pronged collection system is proposed in the SWM Master Plan Report. It has been recommended to initiate DTDC system in a phased manner beginning with 50 % coverage in first five year; to be increased in phased manner after every 5 year during design period.
193. Mini waste collectors of 1.8 cum capacity, compatible to compactors of 14 cum capacity are suggested for DTDC system. The mini waste collectors shall transport and unload the category wise waste (biodegradable/non-biodegradable) into respective Compactors, parked at centrally approachable locations, known as movable/temporary transfer stations within 3 Kms of coverage area of mini waste collectors. All recyclables shall be separated out for processing /resale/removal by rag-pickers before unloading into compactors. The compactors shall be transported to processing plant site/ sanitary land fill according to the nature of waste i.e. biodegradable/non biodegradable.
194. For remaining area, where no DTDC is proposed, provision for community storage through Dumper placer containers has been suggested. The number of community bins would be phased out gradually after settling down of DTDC system. The Dumper placer carriers shall transport the waste up to stationary TS site and unload the containers into hoppers as described in following subsection.

Picture 5: Type of Vehicles Proposed for Collection and Transportation

	
<p>Mini Waste Collector 1.8 cum capacity</p>	<p>14 cum Compactor</p>
	
<p>Compatible Equipment</p>	<p>Twin bin Dumper Placer Carrier</p>

195. **Transfer Station (TS):** It has been recommended to establish one stationary transfer station in GNN. It is a place having two levels containing arrangement for waste dropping through a hopper from higher level into a stationary compactor which shall be mounted on the floor of the lower level of the transfer station. The compactor contains a hydraulically driven ram which pushes the waste from the compactor's receiving chamber into the body of the transfer vehicle. The body of the transfer vehicle must be adequately reinforced to take the force of the ram. Such place of about 1 hectare area is proposed at centrally located place/near the city area. All the heavy vehicles like Hook lift carriers of 20 cum capacity and bins of 20 cum capacity should be provided at this place. If no other suitable place is identified, Sai Upvan site may be considered for TS.

Picture 6: Type of Equipment /Vehicle for Transfer Station



196. *Setting up of Processing Plant and Sanitary landfill Site.* The characteristic of Ghaziabad waste indicates Composting as a suitable, viable option. The equipment and plant for processing plant & equipment for SLF site shall be procured along with civil work and both the facilities should be adjoining to each other.
197. *Permanent Ward Office:* In many wards, some small temporary shed is used for assembly of workers, storing the tools and taking attendance. There is no place for receiving ward level complaints, and mechanism for attending to public grievances. Construction of permanent ward offices in each GNN ward is strongly recommended in the master plan report. The proposed ward office would be a permanent building with sufficient space; for office of ward officer, one common room for assistant and workers and place for storage of workers equipment and material. Such ward offices would be used as grievance redressal centre for identified services, meant to be solved at the ward level. A land strip of 100-200 sqm in each ward may be identified and acquired for this purpose. There cannot be any formal allotment at this juncture, because the wards are already fully developed and were developed by some other agencies initially and later on transferred to GNN for upkeep. The site for new ward offices will have to be identified in consultation with local citizens and representatives. The possible locations could be any idle government strip/corner of some park/ under some water tank/public property etc.

D. Surveys and Investigations

198. In order to execute the suggested works, some surveys and investigations shall be required, which are described in subsequent paragraphs.

1. Transfer Station (TS)

199. It is suggested to construct one centralized transfer station for entire GNN, which should be of about 1 Hectare, within/near the city boundaries, preferably on the way of the prospective new SLF site. After locating suitable land for the TS, topographical survey shall be carried out. Planning and structural designing of the proposed TS shall be done before actual execution

2. Processing Plant and Sanitary Landfill Site

200. Instead of selecting 3 sites, an independent site of 45 Ha area is proposed for GNN solid waste disposal but as indicated in previous subsections, it would be better to follow “Regional landfill site” approach. Accordingly an indicative layout plan for 8 lakh MT waste processing and disposal has been prepared on 20 ha site area. The site would be sufficient for 8 years, if only GNN waste shall be used but be sufficient for 5-6 years if used as common site for entire GDA area. Once land is identified, it has to fulfill specific criteria as given in subsequent clauses.

201. Topographical survey is required for gathering information about the site dimensions, area, and physical features of site under consideration and about adjacent land. Geo-technical survey and investigations are required to assess the water table level, soil characteristics, porosity, density etc. Environmental survey and investigations are required for assessing air, water monitoring.

202. NOC from Hindan Air force, Ground water department, SPCB, District administration, urban development department and other statutory agencies shall be required.

3. Ward Office

203. A suitable land space of about 100-200 sqm should be identified in each ward (If permanent ward office exists; then that ward may be excluded). Normally, the space in the ward is not easily available as earmarking any space for this purpose has not been in practice; therefore, some suitable space will have to be identified in consultation with public representatives, community and municipal officials jointly. The matter was discussed with public representatives of three zones of Ghaziabad Nagar Nigam on dated 30.06.09/1.07.09 & 3.07.09. It was informed that some corner of public parks, space under service water reservoir or any vacant government land could be used for this purpose in absence of any designated place.

204. After locating suitable land for the ward office, topographical survey of the site should be carried out. Planning and structural designing of the proposed ward office shall be required before actual execution.

E. Detailed Design

1. Design of Collection and Transportation Equipment for GNN Area

205. Following design criteria are used:

- (i) Number of sweepers is kept same as per the present strength of workers.
- (ii) One containerized pushcart is provided against 2 workers.
- (iii) Pushcarts and other equipments to be taken 25 % as spare, taking provision for spares against repairing & maintenance.
- (iv) Dumper placer bins of 4.0 cum capacity with twin bin compatible carrier are recommended for 50% area, likely to remain without Door to Door Collection (DTDC) system.
- (v) One DP carrier shall make 8 trips each day; therefore one vehicle is sufficient for 16 containers.
- (vi) Mini waste collector on four wheeler shall be used for DTDC and street sweeping collection from 50 % area, covered by DTDC system.
- (vii) The mini waste collector is supposed shall able to transport 700 kg waste in one trip, up to temporary transfer station (location of compactor). In entire day, total waste transportation is expected to be 7 MT /vehicle.
- (viii) The 14 cum capacity Compactor shall able to transport 10 MT waste in single trip, considering compacted density as 1.6 times of loose density, i.e. 750 kg/cum.
- (ix) The compactor shall transport the waste upto processing plant/ SLF site, which is expected to be about 20 km away from the city centre. It is assumed that each compactor shall transport about 60 MT waste in each day.
- (x) One bulk carrier of 20 cum capacity shall be able to hold 15 MT waste, considering 750 kg/cum compacted density.
- (xi) One hook lifter shall perform 8 trips in entire day, thus transporting 120 MT per day.

206. Requirement for collection, transportation equipment is shown in following **Table 8-1**.

Table 8-1 : Design for Collection and Transport Equipment for DPR

Item	Criteria	2013	2018
Population	Master plan	1,613,004	2,001,471
Number of HH	5.58 persons/HH as per socio-economic profile report	278104	345081
Number of sweepers required	1 per 200 HH + 17% as extra	1,627	2,019

Item	Criteria	2013	2018
Number of sweepers working at present	As per present strength (presuming that entire strength shall be filled either by permanent or temporary workers)	3,500	3,500
Push cart workers (nos.)	1 against 2 sweepers	1,750	1,750
(a) Push carts and other accessories for workers			
(1)Push carts -6 containerized	1 for each worker + 25 % extra	2,200	2,200
Waste generation kg/pc/d	As per SWM Master Plan Report,2009	0.59	0.64
Expected generation MT/d from entire population	--do--	952	1,281
(b) Equipment for DTDC area			
Coverage for DTDC (%)	As per SWM Master plan assumptions	50%	60%
Population covered (nos.) for primary collection/DTDC	--do--	806,502	1,200,883
Waste generation from DTDC (Mt/d)	--do--	476	768
(2)Mini waste collector 1.8 cum capacity (Nos)	1 for 7 MT/d+ 25% extra	85	137
(3)Compactors 14 cum (Nos)	1 for 60 MT/d + 25 % extra	10	16
(c) Equipment for Non- DTDC area			
(4)Storage bins of 4.0 cum capacity (nos.) (for 50 % area)	1 for 2000 persons+ 25 % extra	504	625
(5)Dumper placer twin bin carriers (nos.)	1 for 16 containers + 25 % extra	31	40
(d) Equipment for Transfer station			
(6)Hook lifters of 20 cum capacity	8 trips a day , each of 15 MT capacity + 25 % extra	5	6
(7)Bins of 20 cum capacity	1 for each lifter + 2 standby + 25 % extra	8	10

207. *Procurement of Equipment for Primary Collection, Sweeping, Community Storage and Transportation.* The list of equipment required for GNN at base year 2013 is provided in the following **Table 8-2**.

Table 8-2 : Showing List of Equipment Proposed for Procurement in DPR

S. No	Details	Nos.
1	6 Containerized Pushcart	2200
2	Dumper Placer container 4.0 cum	504
3	Dumper Placer carrier	31
4	Mechanized Mini waste collector	85
5	Transport Compactor 14 cum	10

S. No	Details	Nos.
6	Hook Lifter 20 cum	5
7	Bulk bins	8

Source: Design as per DPR

208. Technical Specifications of Collection, Transportation and disposal (except TS equipment) are attached at **Appendix 7**.

2. *Design of Transfer Station*

209. Transfer Station of 1 ha area consisting of following civil works and equipments/ machines has to be selected. Actual area is not identified but a schematic layout, section and plan showing operation of machines of TS is enclosed as drawing number NCRPB-GZD-SWM-01, 02 and 03 respectively.

210. Civil works shall consist of following:

- (i) One Administrative office, one toilet block
- (ii) Weighbridge control room
- (iii) Compound wall on all sides with gates and security arrangements
- (iv) Workshop
- (v) Parking facilities with cement concrete pavement
- (vi) RCC Ramps with separate arrangement for movement of loading and unloading vehicles
- (vii) Deck slab for unloading the waste
- (viii) Security cabin

211. Equipment /Machine works shall include :

- (i) Two number of compaction units
- (ii) Two Stainless Steel hoppers with hydraulic shut gate
- (iii) 5 hook lifters and 8 bulk containers
- (iv) Weighbridge of 30 MT capacity
- (v) One tubewell, Street lighting, drainage and other utilities
- (vi) Emergency devices, first aid box etc.

212. A concept note on TS, drawing and specifications of equipment is enclosed as **Appendix 8**.

3. Design of Processing Plant and SLF Site

213. Landfill size Requirement for Waste Processing plant and Sanitary land fill site Table 8-3

Table 8-3 Land size requirement for SLF

S. No	Item	Criterion/ Assumptions	2013	2017	2018	2023	2028	2033
I. Size of Compost plant Site								
1	Expected waste from primary collection (%)	As per assumptions of master plan report	50%	50%	60%	70%	80%	100%
a.	--do--(MT/d)	---do---	476	604	769	1147	1682	2661
b.	Biodegradable Waste qty from primary collection 56% (MT/d)	As per field survey and master plan report	267	338	431	642	942	1490
c.	Recyclable (21 %)	--do--	100	127	161	241	353	559
d.	Non-biodegradable (7%)	--do--	33	42	54	80	118	186
e.	Inert (16%)	--do--	76	97	123	184	269	426
2.	Expected waste from secondary collection (%)	--do---	50%	50%	40%	30%	20%	0
a.	--do--(MT/d)	---do--	467	604	512	492	421	0
b.	Biodegradable Waste qty from secondary collection (MT/d) (58%)	---do--	271	350	297	285	244	0
c.	Recyclable (10 %)	---do--	47	60	51	49	42	0
d.	Non-biodegradable (3%)	---do---	14	18	15	15	13	0
e.	Inert (29%)	---do---	135	175	149	143	122	0
3.	Total Biodegradable qty for compost plant (1b +2 b)	---do---	537	688	728	928	1186	1490
4.	Total Recyclable (1 c + 2 c)	--do--	147	187	213	290	395	559
5.	Total Non biodegradable (1 d + 2d)	--do--	47	60	69	95	130	186
6.	Total inert (1e + 2 e)	--do--	212	272	272	326	391	426
7.	Unit & size to be provided (units, MT)	As per design of master plan report	537+688/2= 600 MT i.e. provide 1 unit of 600 MT with provision for future expansion					
8.	Size of land		2 ha					
8.	Plant & machinery	--do--	1 set					
a.	Loader backhoe	--do--		1	-	1	-	1

S. No	Item	Criterion/ Assumptions	2013	2017	2018	2023	2028	2033
b.	Tipper 8 MT	---do--		3	-	3	-	3
c.	Tractor with tipper	---do--		1	-	1	-	1
d.	Water tanker (4000 liter capacity)	---do---		1	-	1	-	1
e.	Computerized Weigh bridge (30 MT)	--do--		1	-			
f.	Other Infrastructure works	As per the site requirement			Yes		Yes	
II	Sanitary Land Fill Site							
1	Expected waste generation MT/d	As per master plan report	952	1208	1281	1639	2103	2661
2	Net Compostable quantity (MT/day)	As per calculations above	537	688	728	928	1186	1490
3	Residual from compost plant and non biodegradable (MT/day)	20 % residual from compost plant + 100% non-biodegradable + 30% inert material)	217	279	296	390	497	612
4	Capacity of SLF required for 20 years (MT/d)		Average residual for 20 years from GNN area = $217+279+296+390+497+612/6 = 335$ MT or 2445500 MT for 20 years					
5	Total volume of landfill required, m ³	Assume density as 850 Kg/cum	2877059 Cum					
6	Volume of landfill including soil cover	10% of waste qty.	3164765 Cum for entire waste, for that, a total site area of 43 ha shall be required and 33 ha as cell area.					
7	Waste generation from entire GDA area		2013			2018		
			2191620@0.59=1293 MT			2696800@ 0.64 = 1726 MT		
8	Average waste in next five years		=1293+ 1726/2=1564 MT					
9	Expected residual for SLF site	30 % of waste qty.	450 MT per year or say 8.15 lakh MT in next five year					
10	Total land area required for landfill include facilities, infrastructure & buffer (ha)	As per master plan report	43 ha (for GNN area). This area shall be sufficient for GNN waste. Infrastructure facilities shall be common for entire quantity as required for first phase, say about 7 years for GNN and 5 years for waste from entire GDA area. In next phases, only cell areas shall have to be added by using same facilities.					
11	---do---for GDA area	---do--	60 Ha with area for compost plant as 5 Ha					
12	Total land area required for compost plant +SLF	--do---	45 Ha (for GNN area)					

S. No	Item	Criterion/ Assumptions	2013	2017	2018	2023	2028	2033
	(ha)							
13	SLF equipment (for 1 site)	---do---						
	Loader backhoe			1		1		1
	Tipper			3	-	3	-	3
	Bull dozer			1	-	-	-	-
	Landfill Compactor			1	-	-	-	-
14	SLF infrastructure	-		As required	-	-	-	-
15	Number of active years	20 years or more		-	-	-	-	-
16	Closure and post closure period	25 years		-	-	-	-	-
17	Operation and maintenance of primary collection equipment (per annum)	10% of capital cost		-	-	-	-	-
18	Operation and maintenance of transportation equipment with transfer station (per annum)	30% of capital cost		-	-	-	-	-

4. Design of Sanitary landfill Site

214. Total land requirement for entire waste disposal for 20 years project period is worked out as 45 Ha. The site is proposed to be developed in phases. In the first phase, 20 Ha site area shall be developed, which would be sufficient for a waste quantity of GNN area for over 7 years, or for 5 years if entire waste from GDA area (including Dasna, Muradnagar, Modinagar, Loni and Ghaziabad) is considered. Following is tentative breakup for first phase area.

- | | | |
|-------|--|-------|
| (i) | land filling cell area including bund area etc | 11 Ha |
| (ii) | Green belt | 2 Ha |
| (iii) | Buffer zone | 3 Ha |
| (iv) | Processing plant etc | 2 Ha |
| (v) | Infrastructure facilities | 2 Ha |

215. The second and subsequent phases could be developed, depending upon the availability of the site and pooling of other nearby towns willing to utilize the same site for their use.
216. *Identification and Selection of Site for Sanitary Landfill Site –Regional SLF Site.*
 Identification and selection of new site is a very critical activity. Ideally, suitable site shall be selected and reserved at the time of finalizing the Master Plan of the region itself but this is normally not done. Generally, no area is earmarked for activities related to SWM. As the SWM related activities are not properly maintained, therefore public perception is also against the setting up of any facility near the neighborhood (NIMB – Not In My Backyard syndrome), hence lot of public resistance is faced even for putting a community bin, leave apart the setting up a full-fledged processing plant/SLF site. Once the area is fully developed then it becomes more and more difficult to find a suitable land in sufficient size in a fast growing city on account of rising market rates of the land cost. Moreover, it is not easy to develop, operate and maintain the engineering landfill site in true sense, as it requires heavy investment and high technical and managerial capabilities. For smaller towns, where such expertise and funds are not available, it is an uphill task to develop and maintain SLF sites at their own.
217. In order to cope up with this situation, it is suggested to develop common/regional SLF sites, instead of individual site for each town. The regional SLF site shall cater the waste from nearby towns/cities falling within 25-50 Km radius, for which land, development and operation & maintenance cost shall be jointly shared by all the stakeholders on the basis of size, waste qty, financial condition or any other specific criteria. A small group of representatives of all stakeholders, department concerned, SPCB and other regulatory authorities could be formed as SPV (Special Purpose Vehicle) to oversee the identification, development and maintenance of the SLF site. These days, identification of common landfill sites is being done by using remote sensing and GIS techniques. The Bhasaracharya institute of Space Application and Geo-informatics (BISAG), Government of Gujarat have recently used this technique for identification of regional sites for entire State of Gujarat. It is learnt that NCRPB has already initiated suitable action for identification of regional SLF site for entire NCR region in association with CPCB, BISAG and all the stakeholders. It is hoped that suitable sites shall be identified by concerned agency shortly.
218. The size of the proposed site shall be sufficient to receive about 8.15 lakh MT quantity, expected to be obtained from GDA area in next 5 years.
219. *Landfill Cell Area and Capacity.* Considering the natural profile of the ground is flat and the landfill is designed to be above the ground level.

Area used for landfill cell	= 400 x 270 Sq.m
Area used for landfill (c/c of Embankment)	= 379 x 249 Sq. m
Lining System used	= Single Composite Lining
Thickness of Bottom Lining system	= 1.2 m
Thickness of Side Lining system	= 0.9 m

Thickness of Top Lining system	= 1.2 m
Total Height of landfill	= 22.40 m
Application Height of landfill	= 20.00 m
Landfill height above ground level	= 21.20 m
Embankment top width	= 9 m
Embankment Slope (Inner)	= 1V:3H
Embankment Slope (Outer)	= 1V:2H
Waste Filling Slope (above ground level)	= 1V:4H
No of Benches	= 6
Ht of each bench	= 3 m

220. The layout Plan and cross section of Proposed SWM disposal site is enclosed as Drawing number NCRPB-GZD-SWM-04 & 05 respectively. The drawings of side bund anchor are enclosed as NCRPB-GZD-SWM 06. Drawings related to compound wall, Entrance gate, Roads, Watchman cabin, Weigh bridge, administrative building,, Vehicle shed, Leach ate collection sump ,water tank and compost Plant are also attached as NCRPB-GZD-SWM 07 to 19.

221. Following infrastructure facilities are proposed

Compound wall 1790 RM and two main gates of 8 m width
Security cabin 3m × 3m
Weigh bridge 3m × 12m (2 platforms)
Scale room 3m × 3m
Approach Road 795 m , 7 m wide black topped road with shoulder of 1 m wide
Office building 9m × 10m
Parking shed 26 m × 8m
Visual inspection area 24 m × 44 m
Wheel wash area 18 m × 5 m
Worker's rest room and toilet block 11.5 m × 8 m
Fill soil area 30m × 30m
Storm water drain 2535 RM
Outer side of bund 1V : 2 H (6 M)
Top of Bund 9 m
Inner side of Bund 1V : 3 H (9 M)
Trench Inner side 1V : 3 H (3.60 M)
Landfill cell 400× 270m=108000 sqm
Green belt 10 m wide
Buffer zone 30 m wide
Space for future expansion 25 Ha
Leachate Pond
Water Tank

Compost plant area 2 Ha

222. Following Civil works are proposed in compost plant area:

Tipping area	10 M × 20 M
Pre-processing area	10 M × 50 M
Over size rejection area	10 M × 10 M
Monsoon shed	20 M × 20 M
Machine shed	40 M × 20 M
Curing shed	20 M × 20 M
Refinement section	20 M × 20 M
Sewing and bagging section	20 M × 20 M
Store	40 M × 20 M
Vermi-composting section	80 M × 20 M
Maintenance & other utilities	10 M × 30 M
Laboratories	10 M × 16 M
Office	10 M × 9 M
Compost pad section	9,000 Sq. m
Future expansion	50 × 25 Sq m
Cement Concrete Road	5 m wide 630 M
Drain	1400 M
Water supply, street lighting and other utilities	

223. The above facilities shall be constructed with the following specifications:

- (i) Compost pad, tipping area, monsoon shed and Cement concrete road shall be constructed with 250 mm 1 : 1.5 :3 cement concrete over 150 mm 1:4:8 cement concrete base and moorum sub base of 300 mm thickness as per Drawing Number NCRPB-GZD-SWM-09.
- (ii) Compound wall shall be constructed with Brick masonry in 1:6 mortar with plaster in 1: 4 cement mortar as per Drawing number NCRPB-GZD-SWM-07.
- (iii) Office, laboratories and other building works shall be constructed in brick masonry with RCC roofing and 1” marble flooring over 3” cement concrete 1:6:12 with painting etc complete as per standard specifications.
- (iv) A concept note on various options of processing technology, merits of compost plant and specifications is attached as **Appendix 9**.

5. *Design of Ward Office*

224. One Ward office is proposed in each ward of Ghaziabad Nagar Nigam. Though, in few wards, pucca ward office exists but in order to provide a proper facility centre at the ward level, construction of new ward office in all 80 wards has been recommended. The ward office shall consist of one office cum meeting hall for ward in-charge, one room for staff, one store for storing perishable material and tools, open space for assembly and tools with toilet facilities. Every office shall be equipped with one computer unit and furniture and well protected by compound wall and lockable gate.
225. A schematic plan showing an indicative ward office is attached as drawing number NCRPB-GZD-SWM-20.

6. *Technical Specifications of Various Components*

226. Technical specifications of Primary and Secondary Collection, Transport, Processing and disposal equipment are enclosed at **Appendix 7**. Concept note and technical specifications on Transfer Station are enclosed at **Appendix 8**. Concept note on processing technology options and specifications on Composting is enclosed at **Appendix 9**. Specifications of SLF site are attached as **Appendix 10**.
227. The work in general shall be carried out as per UP Lok Nirman Vibhag (UPLNV) or CPWD specifications, 1996 updated with correction slips issued up to latest date for all works related to civil, mechanical and electrical items.
228. All electrical installation shall comply with the requirements of Indian Electricity Rules, 1956 and Indian electricity Act 1910 as amended up to date and byelaws of authority of State Government or any other department.
229. All mechanical works related to Public Health Engineering will confirm to the requirements of manuals of water supply/sewerage/solid waste by the Ministry of Urban Development and various Indian Standards.

F. Importance of PSP in Implementation

230. Implementation of solid waste management project requires an appropriate decision by the policy makers and administration of the concerned urban local body. Decision is not only regarding the suitable process but also about the methodology of implementation. Many ULBs have been successful in implementing exemplary practices by involving private sector participation at various levels; whereas at some places, good work has been done with help of municipal staff, community and informal sector. Role and importance of PSP is described in detail attached as **Appendix 11**.

G. Capacity Building of Municipal Staff

231. Solid Waste Management has been a neglected subject for the past several decades. Systems have, therefore, not developed to improve the service. Knowledge of new technology and methods coupled with training at all levels is necessary. Institutional issues of Local bodies, essentials for good administration, importance of ward level decentralization, capacity building of workers, training requirements at various levels etc are discussed in detail at **Appendix 12**.

H. Role of Community and Importance of Awareness Campaigns

232. While, there is no substitution for system improvement but involvement of community before, during and after project implementation, would not only increase the possibility of successful implementation but also ensure that various activities remain sustainable even after the facilitating organizations are no more associated with the project. It is important to involve community by carrying out Mass Awareness campaigns. The issues for mass awareness campaigns and strategy are discussed in detail attached as **Appendix 12**.

233. Role of community is discussed in detail as attached at **Appendix 13**.

I. Setting Up, Operation and Maintenance (O&M) guidelines

234. Solid waste management system is a unique blend of man and machine. In all the activities like collection, transportation, processing and disposal, a proper mix of machine and manpower is required. For handling new SWM techniques, some trained persons with positive attitude and motivation would be required; unfortunately, the large work force is illiterate, untrained, lacks motivation and reluctant to adopt new techniques. The situation is further aggravated by unionism and political involvement in day to day administrative matters. It is found that the per capita cost on some activity is much higher as compared to the situation if same activity is performed by private sector.

235. Designing and setting up of the proper facilities with appropriate operation and maintenance mechanism is important for successful outcome. In absence of suitable O & M system, even the best designed system might prove to be inefficient and uneconomical. The O&M guidelines for SWM are described in detail at **Appendix 14**.

236. Looking to the higher cost and inefficiency, there has been a paradigm shift from in- house management to outsourcing and from manual to mechanization.

237. Suitable mechanism as suggested below may be adopted:

- (i) 50% of the area should be handled by municipal staff for which sufficient resources should be arranged by the GNN.

- (ii) 50 % of the remaining area should be handed over to private sector experienced entrepreneur for source segregated collection ,transportation up to transfer station and performing all SWM related activities in that area by mobilizing own resources. The private entity should be allowed to retain recyclable waste for separate income. The GNN could pay on per household /MT of garbage collection basis.
- (iii) Dumper placers and carriers should be procured, operated and maintained by the GNN.
- (iv) Setting up of new Transfer Station and subsequent operation and maintenance should be done by private sector on DBOMT (Design, Build, Operate, Maintenance and Transfer of land) basis by mobilizing own resources. The GNN should provide suitable land, ensure supply of minimum waste quantity free of cost and pay against the handled waste quantity on per ton basis.
- (v) Setting up of processing plant and sanitary landfill site should be entrusted to private sector on DBOMT (Design, Build, Operate, Maintenance and Transfer of land) basis by mobilizing own resources. The GNN should provide suitable land, ensure supply of minimum waste quantity free of cost and pay against the handled waste quantity on per ton basis.
- (vi) New ward offices should be constructed and maintained by GNN.

238. Following life span may be considered for various equipment of SWM services:

(i)	Mechanized mini waste collector	5 years
(ii)	Dumper placer bins	5 years
(iii)	Dumper Placer carrier	10 years
(iv)	Compactors	10 years
(v)	Bulldozer, Landfill compactors, WB	20 years
(vi)	Excavator cum loader	10 years
(vii)	Tippers, Tractors	10 years

239. Following Operation and Maintenance % shall be considered against capital cost :

(i)	Primary collection equipments	25 %
(ii)	Transport equipment	45 %
(iii)	Processing Plant and Machinery	10%
(iv)	Transfer station plant & m/c	10%
(v)	SLF infrastructure	2%
(vi)	SLF plant & machinery	20%
(vii)	Infrastructure of ward offices	2%
(viii)	infrastructure of TS	2%
(ix)	Infrastructure of Processing plant	2%

J. Cost Estimates

240. The Estimated cost of SWM DPR for GNN area is Rs 11,28.4 million. Abstract cost estimated is presented in **Table 8-5** and the detailed cost estimate is presented in **Appendix 15**.

K. Contract Packaging

241. Indicating contract packages are shown the following table.

Table 8-4 : List of Contract packages

S. No	Contract package/lot number	Detail	Estimated Capital cost (Rs Lakhs)	Remarks
1	1	Procurement of Equipment		
	Lot 1	Supply of 2200 numbers, 6 containerized push carts with accessories	198.00	To be procured by GNN
	Lot 2	504 Dumper placer bins of 4.0 cum capacity, compatible to twin bin 31 number Dumper placer carrier	661.00	
2	2	Door to Door Collection from 40 wards by procuring suitable equipment and deploying necessary manpower.	632.00	Through PSP
3	3	Design, Build, Operate, Maintain Transfer station for 500 MT per day waste transportation facilities from 40 wards at the place allotted by the GNN for a period of 7 years.	552.00	Through PSP
4	4	Design, Build, Operate, Maintain processing plant for 600 MT per day waste and disposal of about 8 lakh MT residual at the place allotted by the GNN for a period of 7 years.	2789.00	Through PSP
5	5	Construction of 80 Ward offices	826.00	GNN
		Total Capital Cost (In Lakh Rs)	5660.00	

Table 8-5 : Abstract Cost Estimate

S. No.	Particulars	Qty.	Unit	Rate Rs./Unit)	Ref	Amount (Rs)
A	For Primary and Secondary Collection of Waste					
1	Push cart 6 containerized with accessories	2,200	No.	9,000	Market Rate (MR)	19,800,000
2	Mechanized Waste Collector	85	No.	450,000	MR	38,250,000
3	Dumper Placer Container	504	No.	45,000	MR	22,680,000
	<i>Sub Total of A</i>					<i>80,730,000</i>
B	Transportation of Waste					
1	Dumper Placer Carrier	31		1,400,000	MR	43,400,000
2	Truck Mounted Refuse Compactor (14 Cum)	10	No	2,500,000	MR	25,000,000
	<i>Sub Total of B</i>					<i>68,400,000</i>
C	For Processing of Waste					
1	Cost of land	2	Ha	10,000,000	MR	20,000,000
2	Development of processing plant site	1	Nos.	68,177,692	As per estimate	68,177,692
3	Plant and Machinery	1	Set	20,000,000	MR	20,000,000
4	Weigh bridge 30 MT	1	No	1,000,000	MR	1,000,000
5	Loader backhoe machine	1	No	2,300,000	MR	230,0000
6	Dumper/Tippers 8 MT	3	No	1,200,000	MR	3,600,000
7	Tractor with Tipper	1	No	700,000	MR	700,000
8	Water tanker 4000 liter	1	No	500,000	MR	500,000
	<i>Sub Total of C</i>					<i>116,277,692</i>
D	For Transfer Station					
1	Cost of land	1	Ha	10,000,000	MR	10,000,000
2	Development of Transfer Station	1	No.	30,894,881	As per estimate	30,894,881
3	Heavy duty Compaction units	2	Nos	4,500,000	MR	9,000,000
4	Hook lifters 20 cum capacity	5	Nos	2,500,000	MR	12,500,000
5	Bulk Containers 15 MT	8	Nos	350,000	MR	2,800,000
	<i>Sub Total of D</i>					<i>65,194,881</i>
E	For Sanitary Land Fill Site					
1	Cost of land	43	Ha	10,000,000	MR	430,000,000

S. No.	Particulars	Qty.	Unit	Rate Rs./Unit)	Ref	Amount (Rs)
2	Development of SLF site	1st phase		161,689,666		161,689,666
3	loader Backhoe	1	No	2,300,000	MR	2,300,000
4	Tippers/Dumpers 8 MT	3	Nos.	1,200,000	MR	3,600,000
5	Bulldozer	1	No	6,000,000	MR	6,000,000
6	Landfill Compactors	1	No	8,000,000	MR	8,000,000
7	Weigh bridge 30 MT	1	No	1,000,000	MR	1,000,000
	<i>Sub Total of E</i>					<i>612,589,666</i>
F	Ward Offices					
1	Cost of land (government land)					
2	Development cost	80	Nos	1,033,000	As per estimate	82,640,000
	<i>Sub Total of F</i>					<i>82,640,000</i>
G	Total Estimate (A+B+C+D+E+F)					1,025,832,239
1	Add @ 3% for Physical contingency & quality control etc					30,774,967
2	Add 3% for DSC and TPI					30,774,967
3	Add 1 % for IEC					10,258,322
4	Add 1 % for Social Development					10,258,322
5	Add 1 % for Environmental Mitigation					10,258,322
6	Add 1 % for capacity building					10,258,322
H	Grand Total					1,128,415,463
					Say	Rs.1,128 million

Notes

1. Estimates are based on SOR of UP Lok Vikas Nirman Vibhag , June 2008
2. Few items, not available in UP SOR, have been taken from DSR 2007 or as per Market rate for special items
3. Rates of machines, equipments are obtained from renowned manufacturers/ suppliers
4. Estimate is updated by adding annual increment @ 5% till year 2010

Appendices

Appendix 1

Appendix 1

Projected Population of GDA region

Year	Ghaziabad	Dasna	Muradnagar	Modinagar	Loni	Total
2001	968,521	24,428	139,642	74,080	120,659	1,327,330
2002	1,010,446	25,185	142,661	76,600	128,582	1,384,058
2003	1,054,186	25,966	145,745	79,206	137,024	1,443,210
2004	1,099,819	26,771	148,895	81,900	146,021	1,504,890
2005	1,147,428	27,601	152,114	84,686	155,609	1,569,206
2006	1,197,097	28,457	155,402	87,566	165,827	1,636,271
2007	1,248,917	29,339	158,762	90,545	176,715	1,706,203
2008	1,302,980	30,249	162,194	93,625	188,318	1,779,123
2009	1,359,383	31,186	165,700	96,810	200,683	1,855,159
2010	1,418,227	32,153	169,282	100,103	213,860	1,934,445
2011	1,479,619	33,150	172,941	103,508	227,902	2,017,120
2012	1,544,873	34,478	177,523	107,623	237,858	2,102,560
2013	1,613,004	35,859	182,226	111,902	248,249	2,191,620
2014	1,684,140	37,295	187,054	116,351	259,095	2,284,451
2015	1,758,414	38,789	192,010	120,976	270,413	2,381,215
2016	1,835,963	40,342	197,097	125,786	282,227	2,482,077
2017	1,916,932	41,958	202,319	130,787	294,556	2,587,212
2018	2,001,471	43,639	207,680	135,987	307,424	2,696,800
2019	2,089,740	45,386	213,182	141,393	320,855	2,811,029
2020	2,181,901	47,204	218,830	147,014	334,872	2,930,098
2021	2,278,126	49,095	224,628	152,859	349,501	3,054,209
2022	2,360,427	51,428	236,280	160,125	362,791	3,171,359
2023	2,445,700	53,872	248,536	167,736	376,587	3,293,002
2024	2,534,055	56,432	261,428	175,709	390,907	3,419,311
2025	2,625,601	59,114	274,988	184,061	405,771	3,550,465
2026	2,720,455	61,923	289,252	192,810	421,201	3,686,650
2027	2,818,735	64,866	304,256	201,975	437,217	3,828,058
2028	2,920,566	67,948	320,038	211,575	453,843	3,974,890
2029	3,026,076	71,177	336,639	221,632	471,101	4,127,354
2030	3,135,397	74,560	354,101	232,167	489,015	4,285,666
2031	3,248,668	78,103	372,468	243,202	507,610	4,450,051
2032	3,350,503	81,075	387,712	253,198	522,486	4,595,223
2033	3,455,530	84,161	403,579	263,605	537,797	4,745,130
2034	3,563,849	87,364	420,096	274,439	553,558	4,899,929
2035	3,675,563	90,689	437,289	285,719	569,780	5,059,777
2036	3,790,780	94,140	455,185	297,462	586,478	5,224,839
2037	3,909,608	97,723	473,814	309,688	603,665	5,395,287
2038	4,032,161	101,442	493,205	322,417	621,356	5,571,295
2039	4,158,556	105,302	513,390	335,668	639,565	5,753,045
2040	4,288,912	109,310	534,401	349,465	658,308	5,940,723
2041	4,423,355	113,470	556,271	363,828	677,600	6,134,525

Appendix 2

Appendix 2
Per Capita Waste Generation Analysis

Calculation of Per Capita Waste Generation of Municipal Solid Waste Per Day

			27.12.2008	28.12.2008	29.12.2008	(3DAYS)
Sample	Type	Family size	1 st day	2 nd day	3 rd day	Total
Code		in	weight in	weight in	weight in	weight in
		numbers	Grams	Grams	Grams	Grams
SL 01	SLUM	6	1690	1180	1290	4160
SL 02	SLUM	6	2250	1190	1320	4760
SL 03	SLUM	8	3820	2010	4020	9850
SL 04	SLUM	7	2810	1890	2110	6810
SUB TOTAL		27	10570	6270	8740	25580
LIG 01	LIG	5	2010	2910	830	5750
LIG 02	LIG	7	2100	990	1210	4300
LIG 03	LIG	8	1970	2610	2890	7470
LIG 04	LIG	6	1710	2230	1200	5140
LIG 05	LIG	4	1210	210	490	1910
LIG 06	LIG	5	2410	4210	2610	9230
LIG 07	LIG	4	1320	1190	1010	3520
LIG 08	LIG	5	210	210	1300	1720
SUB TOTAL		44	12940	14560	11540	39040
HIG 01	HIG	4	1250	1560	1240	4050
HIG 02	HIG	6	1240	550	1560	3350
HIG 03	HIG	2	1310	430	580	2320
HIG 04	HIG	2	250	430	510	1190
HIG 05	HIG	6	3560	2450	2980	8990
HIG 06	HIG	4	3050	3510	4620	11180
SUB TOTAL		24	10660	8930	11490	31080
MIG 01	MIG	4	510	2920	540	3970
MIG 02	MIG	6	2520	1100	1410	5030
MIG 03	MIG	6	1490	1620	1480	4590
MIG 04	MIG	4	620	1750	2540	4910
MIG 05	MIG	6	1520	1345	2010	4875
MIG 06	MIG	4	740	1080	1090	2910
SUB TOTAL		30	7400	9815	9070	26285
GRAND Total		125.00	41570.00	39575.00	40840.00	121985.00
Per capita MSW from house holds			332.56	316.60		326.72

Average per capita from house holds (from actual survey conducted)	325.29 Grams
add 30% for commercial waste (page 483.3.6.2 manual on MSW CPHEEO)	97.59 Grams
add 20% for road sweeping waste (page 483.3.6.2 manual on MSW CPHEEO)	65.06 Grams

Appendix 3

Appendix 3
Density of Waste in Samples

S.NO	Type	27.12.2008	28.12.2008	29.12.2008	AVERAGE
		in Kg/Cu m	in Kg/Cu m	in Kg/Cu m	in Kg/Cu m
1	SLUM	414.60	381.40	347.50	381.17
2	LIG	330.40	325.20	413.50	356.37
3	MIG	341.40	365.50	425.30	377.40
4	HIG	362.50	311.50	345.50	339.83
5	COMMERCIAL	344.20	410.40	355.40	370.00
6	MARKET	315.60	351.20	410.80	359.20
7	FRIUT VEGETABLE MAR	312.80	364.40	302.80	326.67
8	HORTICULTURE	298.30	314.70	277.60	296.87
9	HOTEL	415.80	422.40	453.80	430.67
10	RESTAURANT	444.70	478.60	428.40	450.57
11	CONSTRUCTION	1524.80	1825.40	1640.20	1663.47
12	ROAD SIDE BIN	312.80	328.40	341.40	327.53
	AVERAGE DENSITY AT SOURCE				334.69
13	TRENCHING GROUND FRESH GARBAGE	422.80	364.80	370.40	386.00
14	TRENCHING GROUND OLD GARBAGE	498.80	510.10	530.60	513.17
	Total	452.82	482.43	474.51	469.92

Appendix 4

Appendix 4

Average Composition of Waste In Percentage

TYPE	FUEL%	ORGANICS%	INERTS%	RECYCLABLES%	OTHERS%
SLUM	7.84	68.93	16.3	6.31	0.62
LIG	6.69	60.44	27.45	5.12	0.30
MIG	9.95	50.26	34.45	5.35	0.00
HIG	5.14	58.01	30.3	6.48	0.07
COMMERCIAL	37.45	26.54	13.45	20.58	1.98
MARKET	63.68	6.47	0.90	28.96	0.00
FRUIT AND VEGETABLE MARKET	23.31	68.07	1.63	6.99	0.00
HORTICULTURE	22.37	68.08	3.72	5.83	0.00
HOTEL	12.35	68.74	8.78	10.13	0.00
RESTAURANT	5.33	79.77	7.48	7.22	0.00
CONSTRUCTION	2.81	1.26	88.05	7.89	0.00
ROAD SIDE BINS	5.27	59.80	30.42	4.13	0.38
AT SOURCE	17.5	51.36	21.91	9.58	0.28
TRENCHING GROUND FRESH GARBAGE	4.71	58.09	29.38	7.41	0.41
TRENCHING GROUND OLD GARBAGE	7.34	22.31	66.19	3.03	1.14
AVERAGE PERCENTAGE	15.30	49.77	25.61	8.51	0.35

Percentage Moisture in Samples

TYPE	27.12.2008	28.12.2008	29.12.2008	Average
SLUM	46.10	35.14	34.16	38.47
LIG	34.16	30.49	35.61	33.42
MIG	40.06	32.88	33.54	35.49
HIG	34.34	42.36	35.15	37.28
COMMERCIAL	21.60	18.40	15.30	18.43
MARKET	23.40	22.10	15.50	20.33
FRUIT AND VEGETABLE MARKET	55.50	58.60	43.2	52.43
HORTICULTURE	45.30	42.20	45.8	44.43
HOTEL	42.60	41.10	48.70	44.13
RESTAURANT	52.60	45.5	46.8	48.30
ROAD SIDE BINS	45.30	41.10	52.60	46.33
CONSTRUCTION	5.20	4.10	3.20	4.17
Moisture at source		38.10%		
TRENCHING GROUND FRESH GARBAGE	41.60	38.4	44.90	41.63
TRENCHING GROUND OLD GARBAGE	32.60	31.10	38.90	34.20
AVERAGE	37.17	34.53	35.24	35.65

Appendix 5

Appendix 5
Calorific Value of Waste in Samples

S.NO	Type	27.12.2008	2812.2008	29.12.2008	AVERAGE
		Kcal/Kg	Kcal/Kg	Kcal/Kg	Kcal/Kg
1	SLUM	1008.56	958.46	947.65	971.56
2	LIG	952.48	1045.87	956.32	984.89
3	MIG	1012.47	1147.8	912.45	1024.24
4	HIG	852.47	945.23	785.14	860.95
5	COMMERCIAL	1856.54	1985.41	2257.36	2033.10
6	MARKET	1875.65	1645.23	1745.88	1755.59
7	FRIUT VEGETABLE MARKET	871.24	756.45	656.22	761.30
8	HORTICULTURE	856.25	785.86	779.85	807.32
9	HOTEL	954.45	887.46	957.42	933.11
10	RESTAURANT	756.85	847.42	921.14	841.80
11	CONSTRUCTION	87.47	107.45	124.23	106.38
12	ROAD SIDE BIN	1045.25	958.45	965.41	989.70
13	TRENCHING GROUND FRESH GARBAGE	828.45	845.78	714.54	796.26
14	TRENCHING GROUND OLD GARBAGE	658.24	553.45	458.74	556.81
	AVERAGE	994.03	976.45	955.88	975.45

CALORIFIC VALUE OF WASTE IN SAMPLES

S.NO	Type	27.12.2008	2812.2008	29.12.2008	AVERAGE
		Kcal/Kg	Kcal/Kg	Kcal/Kg	Kcal/Kg
A	AVERAGE CALORIFIC VALUE AT SOURCE	1099.696	1100.519	1091.943	1097.386

CALORIFIC VALUE OF WASTE IN SAMPLES

S.NO	Type	27.12.2008	2812.2008	29.12.2008	AVERAGE
		Kcal/Kg	Kcal/Kg	Kcal/Kg	Kcal/Kg
B	CALORIFIC VALUE OF FRESH GARBAGE AT TRENCHING GROUND	828.45	845.78	714.54	796.26

Appendix 6

Appendix 6: Optimum Analysis (PERCENTAGE BY WEIGHT (DRY BASIS))

CODE	Carbon%	Hydrogen%	Oxygen%	Nitrogen%	Sulphur%	Phospho%	Potash%	Ash%	C/N ratio
Slum 27	32.17	6.51	41.56	1.15	0.65	0.69	0.56	16.71	27.97
Slum 28	27.41	5.21	51.21	1.25	0.69	0.35	0.44	13.44	21.93
Slum 29	31.37	5.35	50.52	1.08	0.49	0.76	0.74	9.69	29.05
LIG 27	28.73	6.26	52.07	0.92	0.48	0.7	0.82	10.02	31.23
LIG 28	32.09	5.64	43.68	1.15	0.88	0.64	0.55	15.37	27.90
LIG 29	30.78	5.67	45.57	0.87	0.54	0.72	0.57	15.28	35.38
MIG 27	28.93	5.43	47.51	1.38	0.87	0.73	0.69	14.46	20.96
MIG 28	29.14	6.24	48.91	0.91	0.84	0.77	0.83	12.36	32.02
MIG 29	27.19	7.82	45.65	1.25	0.56	0.74	0.93	15.86	21.75
HIG 27	31.18	6.37	45.42	1.08	0.24	0.84	0.81	14.06	28.87
HIG 28	27.12	6.82	50.92	0.93	0.82	0.75	0.85	11.73	29.16
HIG 29	25.51	5.43	52.50	1.15	0.65	0.69	0.84	13.23	22.18
COM 27	41.21	5.70	31.07	1.34	0.36	0.86	0.83	18.63	30.75
COM 28	45.74	6.20	22.11	1.20	0.87	0.84	0.87	22.17	38.12
COM 29	32.16	8.60	26.11	0.89	0.82	0.84	1.14	29.44	36.13
MARKET 27	44.11	5.10	15.17	1.01	0.55	0.73	1.26	32.07	43.67
MARKET28	56.82	6.28	17.70	1.35	0.46	0.93	0.86	15.60	42.09
MARKET29	59.92	6.61	18.61	1.06	0.55	0.72	0.86	11.67	56.53
FVM 27	28.41	5.23	48.81	1.36	0.29	0.86	0.83	14.21	20.89
FVM 28	18.32	5.84	51.23	0.89	0.91	0.71	0.92	21.53	20.58
FVM 29	25.61	8.30	46.09	1.13	0.63	0.72	0.73	16.99	22.66
HORT 27	30.45	5.40	43.08	1.27	0.67	0.85	0.96	17.32	23.98
HORT28	31.24	7.39	46.03	1.39	0.86	0.84	0.93	11.32	22.48
HORT29	31.23	6.25	39.04	1.56	0.40	1.01	1.08	19.43	19.99
HTL27	34.43	6.56	23.68	1.43	0.44	0.94	0.94	31.57	24.09
HTL 28	31.59	9.62	23.63	1.34	0.74	0.86	0.90	31.31	23.54
HTL 29	37.84	9.23	28.21	1.03	0.87	0.93	1.23	20.67	36.92
REST 27	34.91	8.56	32.97	1.29	1.04	0.98	1.12	19.14	27.06
REST 28	39.35	6.80	32.58	1.49	0.49	1.02	0.94	17.33	26.48
REST 29	40.51	7.64	23.73	1.68	0.58	1.11	1.14	23.61	24.07
RSB 27	28.42	3.91	45.09	1.15	0.18	0.72	0.66	19.88	24.76
RSB 28	31.36	6.38	55.54	1.02	0.98	0.80	1.02	2.917	30.84
RSB 29	32.86	9.87	30.69	1.58	1.13	1.17	1.31	21.40	20.85
FW 27	22.67	8.73	29.31	1.09	0.64	1.19	1.12	35.25	20.80
FW 28	29.08	9.49	28.40	1.25	0.75	1.30	1.38	28.36	23.26
FW 29	32.41	5.62	34.40	1.37	0.39	0.91	0.88	24.02	23.66
OW 27	47.18	5.31	15.87	0.95	0.36	0.74	0.73	28.86	49.66
OW 28	31.96	8.56	13.08	0.88	1.24	1.39	1.53	41.35	36.32
OW 29	44.35	9.51	8.33	0.96	0.67	1.33	1.26	33.59	46.20
Average	33.74	6.81	36.05	1.18	0.66	0.86	0.92	19.79	29.35
Average source	33.58	6.61	38.69	1.20	0.65	0.81	0.88	17.59	28.63

Average Trenching	28.05	7.94	30.70	1.24	0.59	1.13	1.13	29.21	22.57
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Results of Proximate Analysis

Proximate Analysis includes four tests

Loss of moisture when heated to 105o deg C for 1 hour

Volatile Combustible matter (loss on ignition)

Fixed carbon

Ash (weight of residue after combustion)

PERCENTAGE BY WEIGHT (DRY BASIS)

CODE	Moisture% 1	Volatile Matter% 2	Fixed Carbon% 3	Ash% 4
Slum 27	40.1	36.18	9.49	14.23
Slum 28	35.14	38.14	15.46	11.26
Slum 29	34.1	36.33	12.17	17.40
LIG 27	34.16	35.63	13.53	16.68
LIG 28	30.48	34.80	15.27	19.45
LIG 29	35.61	33.19	18.66	12.54
MIG 27	40.06	32.58	15.73	11.63
MIG 28	32.88	38.63	16.18	12.31
MIG 29	33.54	39.05	15.79	11.62
HIG 27	34.34	36.14	17.00	12.52
HIG 28	42.36	26.86	17.33	13.45
HIG 29	35.15	36.38	16.84	11.63
COM 27	21.60	41.69	21.07	15.64
COM 28	18.40	44.16	21.16	16.28
COM 29	15.30	50.74	19.33	14.63
MARKET 27	23.4	44.96	17.53	14.11
MARKET28	22.1	54.11	13.53	10.26
MARKET29	15.5	51.11	23.57	9.82

CODE	Moisture %1	Volatile Matter% 2	Fixed Carbon% 3	Ash% 4
FVM 27	55.5	18.37	14.87	11.26
FVM 28	58.6	20.92	9.66	10.82
FVM 29	43.2	23.69	18.59	14.52
HORT 27	45.3	25.45	17.05	12.20
HORT28	42.20	23.26	19.98	14.56
HORT29	45.80	23.25	14.70	16.25
HTL27	42.60	25.39	15.66	16.35
HTL 28	41.10	30.36	13.84	14.70
HTL 29	48.70	19.50	17.62	14.18
REST 27	52.60	23.44	13.63	10.33
REST 28	45.50	30.94	13.67	9.89

CODE	Moisture %1	Volatile Matter% 2	Fixed Carbon% 3	Ash% 4
REST 29	46.80	25.49	16.38	11.33
RSB 27	45.30	18.76	20.78	15.16
RSB 28	41.10	20.36	21.69	16.85
RSB 29	52.60	17.83	15.05	14.52
FW 27	41.60	22.87	20.23	15.30
FW 28	38.40	28.40	18.42	14.78
FW 29	44.90	29.74	14.43	10.93
OW 27	32.60	42.44	14.47	10.49
OW 28	31.10	39.79	17.18	11.93
OW 29	38.90	29.04	16.30	15.76
Average	37.91	32.05	16.51	13.53

Appendix 7

Contract Packages, & Specifications for Collection, Transportation and Landfill Equipment

A. LIST OF GOODS AND RELATED SERVICES

Lot No. : 1		
Lot Name : NCRPB-GZD/SWM/LOT-1		
Item No.	Name of Goods and Related Services	Quantity (in no.)
1	Supply of and Delivery of 6 Containerized Pushcarts with Essential accessories	2200
Lot No. : 2		
Lot Name : NCRPB-GZD/SWM/ LOT-2		
Item No.	Name of Goods and Related Services	Quantity (in no.)
1	Supply and Delivery of twin container Dumper Placer Vehicle of 4.0 cum capacity	504
2	Compatible Containers of 4.0 cum. capacity	31
Lot No. : 3		
Lot Name : NCRPB-GZD/SWM/LOT-3		
Item No.	Name of Goods and Related Services	Quantity (in no.)
1	Supply and Delivery of Mechanized Mini Garbage Collectors	85
Lot No. : 4		
Lot Name : NCRPB-GZD/SWM/01 LOT-4		
Item No.	Name of Goods and Related Services	Quantity (in no.)
1	Supply and Delivery of 14 Cum Capacity Truck Mounted Refuse Compactor Vehicle	10
Lot No. : 5		
Lot Name : NCRPB-GZD/SWM/01 LOT-5		
Item No.	Name of Goods and Related Services	Quantity (in no.)

1	Supply and Delivery of Excavator cum Loader	2
Lot No. : 6		
Lot Name : NCRPB-GZD/SWM/01 LOT-6		
Item No.	Name of Goods and Related Services	Quantity (in no.)
1	Supply and Delivery of 8 MT Capacity Tippers	6
Lot No. 7		
Lot Name : NCRPB-GZD/SWM/01 LOT-7		
Item No.	Name of Goods and Related Services	Quantity (in no.)
1	Supply and Delivery of Tractor Cum Tipper Trolley	1
Lot No. 8		
Lot Name : NCRPB-GZD/SWM/01 Lot -8		
Item No.	Name of Goods and Related Services	Quantity (in no.)
1.	Supply and Delivery of Water Tanker 4000 liter capacity	2
Lot No. 9		
Lot Name : NCRPB-GZD/SWM/01 Lot -9		
Item No.	Name of Goods and Related Services	
1.	Supply and Delivery of Bull Dozer 90 HP	
Lot No. 10		
Lot Name : NCRPB-GZD/SWM/01 Lot -10		
Item No.	Name of Goods and Related Services	
1.	Supply and Delivery of Landfill Compactor 450 HP	
Lot No. 11		
Lot Name : NCRPB-GZD/SWM/01 Lot -11		
Item No.	Name of Goods and Related Services	
1.	Supply and installation of 30 MT Electronic Weighing Bridge	

Delivery and Completion Schedule

The purpose of the Delivery and Completion Schedule (DCS) is to specify the delivery dates and places for each of the Goods and the delivery places and completion dates for each of the Related Services as listed in the List of Goods and Related Services. The DCS, as part of the Schedule of Supply, constitutes a Contract document and, therefore, it will be a part of the Contract.

Item No.	Description of goods and related services	Delivery Place	Contract Completion period
LOT-1	Supply and Delivery of 2200 hand carts/pushcarts with essential accessories	Office/store of GNN	Three Months
LOT-2	Supply and Delivery of 31Nos. Dumper Placer twin bin Carrier with 504 nos. compatible containers of 4.0 Cum. capacity	---do--	Six Months
LOT-3	Supply and Delivery of 85 nos. Mechanized Mini Garbage Collector	---do--	Six Months
LOT-4	Supply and Delivery of 10 Nos. Compactors of 14 cum Capacity	---do--	Six Months
LOT-5	Supply and Delivery of 2 No. Excavator cum Loader	---do--	Three Months
LOT-6	Supply and Delivery of 6 Nos. Truck Mounted Tippers	---do--	Three months
Lot -7	Supply and Delivery of 1 No. Tractor Cum Tipper Trolley	---do--	Three months
Lot -8	Supply and Delivery of 1 No. Water tanker 4000 liter	---do--	Three months
Lot-9	Supply and Delivery of 1 no. Bulldozer	--do-	Three months
Lot-10	Supply and Delivery of 1 no. Landfill Compactor	--do--	Three months
Lot-11	Supply and installation of 2 nos 30 MT Electronic Weigh Bridge	--do--	Three months

The date specified in the Contract for the start of the Purchaser's obligations should be the Notice of Award

Technical Specifications

The technical specifications of the equipment required are indicated in the following table. The Bidders provide technical specifications for the Goods and Equipment to be procured in their entirety so as to demonstrate their compliance with the requirements of the bidding documents.

Table 1: Containerized Hand Cart/Push Cart with Accessories

Specification
1. Make Of Mild Steel Wheel Barrows:
2. Make Of HDPE Containers:
3. General Specifications:
Containerized Hand cart/Push cart fabricated out of MS angles and flats suitable to accommodate minimum of 06 waste containers ideal for solid waste management. The equipment should be quite strong & sturdy and suitable to satisfy the critical needs of waste collection and transport.
4. Application:
To accommodate 6 nos.HDPE waste containers and push it by hand for collection and transport of garbage.
5. Type:
Push type Hand Cart with raised Handle of the same width of Cart at about 890 mm height from the base at maximum angle of 45°. The Cart to contain 6 waste containers (strong, sturdy and durable) of not less than 25 Ltrs capacity each.
6. Dimension (approximately):
Length: 1010 mm. Width: 700 mm. Height: 250 mm.
7. Specifications: Specifications and sizes of various components should be as under:
<ul style="list-style-type: none"> • M.S. Angles of size 25x25x3 mm for top frame, bottom frame, standing support, bottom frame section and 25x25x5 mm for handle. • M.S. Tee of size 40x40x6 mm for wheel. • M.S. Flat of size 40x6 mm for support wheel & hub, 20x5 mm for axle bracket & barrow section flat and 50x6 mm for front wheel clamp. • M.S. square bar of size 25x25 mm for axle. • Round head rivet of size 32x10 mm and 25x8 mm for riveting for 2 wheels and 20x6 mm for joint frame & handle of 2 sides. • Hexagonal Bolt of size 40x10mm for axle & bracket of 2 sides. • M.S. washer of size 21x46 mm x 6 gauge (4.12 mm) thick for inside & outside hub. • Cotter pin of size 6x50 mm length to joint and for fixing pin other side. • C.I. Hub (complete with axle hole 20 mm support hole 6 No's with turning etc. The weight of each hub 3.5 Kg) on each side. • Bearing SKF or equivalent standard make 6204 ZZ for wheels. • MS pipe (20 mm 16 gauge) for handle with rounded rubber grip. • M.S. Bush for two sides of the wheel. • M.S. Pin with washer 16 gauge for front wheel & for fixing one side pin. • Hard rubber lining of size 40x5 mm (It should be fixed on MS wheel). • All M.S. material used for fabrication of wheel barrow and accessories should be conforming to IS: 2062 / 99 (Updated) or equivalent. <p>Every wheel barrow should be equipped with 1500 mm long 5 mm dia. galvanized chain and 7 levers lock of standard manufacturer.</p>
8. Wheels:
Two numbers of strong and sturdy wheels fabricated out of MS Tee. Wheels to be provided with rubber on circumference should be of about 500 mm dia with support of MS flat of 25x5 mm with sealed bearing provided on two sides. One HMHDPE wheel of 200mm dia and width 75 mm should be provided at front with proper MS hub, shaft etc.
9. Handle:
Special rounded Rubber grip of about 150mm length should be provided on the handle for easy holding.
10. Waste Container: of HDPE
(a)General Specifications:
Moulded in one piece from virgin grade of Polyethylene Material, absolutely smooth, strong and sturdy

fabricated & integrated with round handle of Mild Steel provided with one Lid/ Cover to prevent the smell/ infection, ideal for collection and transportation of Solid Waste.

(b) Application:

For collection and transportation of solid waste and suitable for being lifted by hand into Containerized Wheel Barrows

(c) Capacity:

Container of 25 liter capacity should adequately handle solid waste of at least 20 Kg.

(d) Material:

Virgin Grade of Polyethylene material confirming to the requirement of IS 10146-1982 or equivalent, non toxic, free from any contamination, chemical resistant, blended with stabilizers, Anti Corrosive and Anti Acidic.

(e) Dimensions: circular in shape with

Top Diameter – 315 sq.mm

Bottom Diameter – 265 sq. mm

Height - 400 mm

Tolerance +/- 5%

(f) Basic Qualities:

Moulded from special UV stabilized grades of polyethylene.

100% rust free and maintenance free.

Safe in handling as no corrosion, cracking, blistering etc.

Colourful and elegant.

Light weight and easy to handle.

Hygienic and easy to clean.

Strong and durable.

(g) Design:

Circular in shape, designed to prevent the sticking of wet waste and for easy and faster cleaning. Thickness of not less than 3 mm. It should have 2 No's moulded inverted projection or inverted all around projection for comfortable and safe lifting provided at bottom of the container. Each container should be covered with a lid of same material & same process of moulding having a thickness of 3 mm with moulded handle/ knob to lift it easily.

Manufactured from Injection/ Blow moulding Process.

Moulded with strengthening projection of not more than 40 mm height on the circumference.

Four holes of 10 mm diameter each provided at bottom.

(h) Colour:

As per purchaser's choice.

(i) Handle:

Strong & Durable Round Handle, fabricated out of 8 mm MS rod with MS strip on two sides. The lifting handles to be integrated with the strips. MS rod and strips to be powder coated. Should be strong enough to lift the load of 20 Kg. up to the height of 1 mtr.

(j) Durability:

The container should be 100% seamless, without any joints or welding hence no possibility of corrosion or contamination; Moulded in one tough piece, non toxic, strong and sturdy, absolutely smooth; Easy & safe to be handled, liftable by hand to satisfy the critical needs of waste handling.

(k) Locking:

Locking arrangements to be provided to lock the container with push cart.

(l) Printing:

To be provided as per the requirement of purchaser.

(m) Drawing:

GA drawing to be enclosed by bidder for reference.

(n) Properties: High density polyethylene grade suitable for injection/blow moulding applications with good mechanical properties, gloss, dimensional stability and good ESCR.

11. M.S. Plate (Name Plate):

For identification of containerized wheel barrow M.S. Plate (Name Plate) to be provided in the front of push cart for easy readability and to be welded firmly with the frame of the equipment as per dimensions mentioned below :

a) Length should not be more than 310 mm

b) Width should not be more than 205 mm

Approx. 20 letters to be written / painted on the Name Plate, which should be minimum of 38 mm in size as

per the colour shade approved by the authority.
12. Accessories:
Provision should be made for following additional accessories: (one with each push cart).
a) Long Handle Broom : The broom to be long handled with bamboo stick secured to the handle. The bamboo handle should have a length of 1350 mm with a diameter of not less than 30 mm. The weight of the handle to be about 900 gms. It should have a solid smooth structure with a pointed edge at one end for proper fixing of broom. 800-850 mm long bamboo /coconut /local material (as desired by purchaser) sticks weighing about 1 Kg should be secured to the stick using 20 mm wide, 2 mm thick mild steel ring in a trapezoidal pattern. The sticks should be free from rust, insects and be of good quality.
b) Collection Plate/ Chajjala : It should be made of 18 gauge (1.02 mm) mild steel sheet of size 325 mm length and width of 300 mm & 250 mm in tapered shape with rugged handle of MS Rod of 10 mm dia and length not less than 100 mm welded on side.
c) Metal Plate/Chajjala : It should be fabricated from 18 gauge (1.02 mm) MS Sheet in a Rectangular type traditional shape with one edge hardened by folding. It should be 100 mm X 250 mm MS Plate of 18 gauge thickness.
d) Bell : Standard chrome plated metal bell of diameter 100 mm and height of 70 mm should be mounted suitably on the wheel barrow as per purchaser's requirement.
13. Locking:
Locking arrangements to be provided for the push cart, containers and accessories. 7 lever lock of standard manufacturer to be provided with two keys alongwith 500 mm long 5 mm MS chain.
14. Painting:
The equipment should be painted with two coats of superior quality anti-corrosive primer with two coats of approved quality paint. The bidder should get the paints and shades approved from the purchaser.
15. Drawing:
B. The drawing of equipment should be submitted by the bidder, which should be approved by the purchaser.
16. Guarantee
The bidder should provide drawings of the Goods/Equipment proposed with the bid and the selected bidder would be required to submit the working drawing for approval of the Purchaser at time of Contract execution.

Table 2: Dumper Placer Vehicle (Side Loading Type) For Lifting Of Twin Bins Of 4.0 Cum Capacity

SPECIFICATION	
1	a) Make and Model
	b) Country of Origin
	c) Year of manufacture
2	Basic specifications
	The Dumper Placer Vehicle shall be of side loading type suitable for lifting two numbers of 4.0 cum MSW storage bins (Chassis and Cab) to be rugged and durable, should incorporate the latest technological features offered by the manufacturer/supplier and should be suitable to be used as a hydraulically operated hoisting mechanism to load, offload and tip demountable containers of 4.0 cum capacity up to transfer station/ disposal site. The machine comprises of a pair of lift arms actuated by double acting high pressure rams, hydraulically operated tipping hooks for operation of lifting, lowering and unloading of garbage container/bin, hydraulic roller stabilizers and complete hydraulic system with control valve and duly mounted on chassis of standard make with cab & PTO. The components are to be mounted on all steel welded sub-frames. Unit should conform to the best practice known to the body fabrication trade in design, quality of material and workmanship. Assemblies, sub-assemblies, components and accessories should be standard and interchangeable. Unit should be side loading type with loading height not more than 1.20 metres from ground level. The equipment should confirm to the following specifications:
3	General Description
	MMV chassis of either Eicher/ TATA/Ashoka Leyland with Company fitted Cabin which should meet the following specifications:
a)	Pay load: Minimum 8000 kg
b)	ULW-Cab Chassis : Maximum 3000 kg
c)	Engine: Fuel efficient, 4-stroke, 4-cylinder water cooled BS II direct injection diesel engine delivering minimum 80 BHP at manufacturer's duty point.
d)	Clutch: Single plate dry friction type
e)	Gear Box Type: Synchromesh
f)	No. of gears: 5 forward and 1 reverse
g)	Front Axle: Heavy duty forged I-Beam reverse Elliot or manufacturer's specifications
h)	Rear Axle: Single speed fully floating or manufacturer's specifications
i)	Brakes: Service and parking brakes: Dual circuit full air brakes on rear as per ARAI certificate.
j)	Frame: Ladder type heavy duty frame made out of suitably thick pressed steel channels with riveted/bolted cross members, side members of channel sections
k)	Suspension: Semi elliptical leaf spring at front and rear. Shock absorber: Hydraulic double acting telescopic type at front and rear.
4.	Wheels & Tyres: No. of wheels: Front : 2, Rear : 4, Spare : 1 (lockable) Wheel base: Minimum 3800 mm Tyres: 8.25 x 20 – 14/16 PR Minimum with diagonal ply as per manufacturer's specifications
5.	Fuel Tank Capacity: Minimum 190 liters.
6.	Driver' Cabin: Company fitted all steel semi/fully - forward control driver's cab with tilting arrangement & with torsion bar assistance. Cabin should have minimum two nos. foam padded adjustable seats having seat belts. Cab should have all standard accessories like openable side windows, rear view door mirrors, laminated windscreen, two speed wind shield wipers, fuel gauge, multiple warning lamps and buzzer for low oil pressure, coolant level etc.

7.	<p>Electric System: Voltage: 12 volts Battery capacity: 12 volts, 90 Amps/hr. Alternator capacity: minimum 35 amps/hr. Head lights: 2 nos. with head light protection frame Brake light: 2 nos. Turn signal: front and rear Reverse alarm: 1</p>
8.	Hazard Flashers: It should have rear and cab mounted “flashing beacons” for use when loading.
9.	Steering- Power Steering with hydraulic power assistance, self centering type: as per ARAI certificate.
10.	<p>Hydraulic Tank and Filters: The Hydraulic Tank should have 1.5 times capacity then the fluid required by the hydraulic system and includes a sight fluid level indicator, return line filter, suction line shut-off cock and filter cap with chain.</p>
11.	Hydraulically – operated hoisting mechanism: The system should able to lift two nos. containers of 3.0 cum capacity each of approved design. The test load should be 2750 Kgs for each container including dead weight.
	<p>a) Main frame: Main frame should be box type, made of cold form pressed steel sections 5 mm thick plate mounted on vehicle chassis through rolled mild steel channel sub- frame consisting of long runner made by ISMC 100, Cross Member by ISMC 75 & ISA 35 and Box support by ISMC 125 Boxed. The frame should be properly strengthened with cross members for proper load distribution and to avoid point loading during operations. Frame should be covered with the help of floor sheet of 4 mm thickness and should have stoppers in the front and at the sides so that the containers do not move during transportation and donot hit the boom cyclinders.</p>
	b) Rear end: It should be aesthetically pleasing and provide greater ground clearance using fix geometry for stabilizing arm movement.
	c) Bed: The bed should be made with adequate number of horizontal and longitudinal ISMC sections. A 3-mm HR chequered sheet should be welded on the top of the frame.
	d) Tipping hooks: The machine should be provided with 2 nos tipping hooks at the rear end which should be operated manually for unloading of the garbage from the refuse bin. The equipment shall have tested MS chain of 5/8 “ or lifting and ½’ for tipping confirming to IS-5616 & IS 2429 (part II)
	e) Boom arms and outrigger: Two sets of two heavy-duty booms. Each boom set should be joined together with help of Boom cross bar made of M.S. pipe C class of 88 mm outer diameter. The boom should be fabricated with the help of sheet made channels of 5 mm thickness which are joined together to make a box section of size 145 mm×80 mm× 5 mm with the help of MIG welding. The boom arms should be lifted with M.S. bushes having self-lubricating bushes for mounting with the frame. The boom length shall be such that it can lift the bin horizontally even from the unlevelled ground without jerks. 2 nos inclined outriggers shall be provided.
	f) Cylinder Guards: Cylinder guards should be provided along the chassis length to protect the lifting cum tipping cylinders on either side of the chassis. For this minimum of 5-mm MS plates with adequate height should be welded on either side of chassis, internally and externally to guard lifting cylinders
	g) Stabilizers: Two shoe mounted through hydraulic cylinder should be provided to relieve rear axle of excessive loads during lifting of loaded containers. The stabilizer should be strong enough to provide continued stability and should not take undue time. The stabilizer should have locking arrangement so that no malfunction operation is possible. Hydraulic control Valve lever to b provided for stabilizer.
	h) Hydraulic Cylinders: The following specifications of raw materials should be used in hydraulic cylinders.
	(i) Boom cyclinders – Each boom set should be operatable with the help of two double acting single stage hydraulic cylinders having a bore diameter of 110 mm and shaft diameter of 56 mm. Total nos. of cylinders should be 4 nos. the cylinder tube should be imported prehnoned type and the shaft be grinded and hard chrome plated. The stroke of the cylinders should be suitably adjusted so that the machine can lift the container from the ground without any difficulty.
	j) Piston rod- 2 numbers- EN- 8 preciously honed dia of 63 mm minimum

	k) Gland Piston
	EN8
	l) Seal
	Bushak + Shamban & NOK
	Control Valve
	The system should have pilot operated overload protection valve, load holding valves in the boom cylinders circuit as well as the stabilizer jack circuit so that the cylinders donot collapse on load or on hose failure.
12.	Painting and lettering
	All members of hydraulically operated mechanism like main frame, bed boom rams, boom arms, cylinder guards, rear end stabilizer, etc. should be first cleaned either by sand blasting or any other appropriate method and given a coat of anti-corrosive primer and finished with two or more coats of synthetic enamel paint in approved colour with Poly Urethane process and painting for better life and for finish. Lettering to be done as approved by purchaser.
13.	Standard Accessories:
	<p>(A)Following accessories as a part of the machine should be provided (if not already provided along with vehicle):</p> <ul style="list-style-type: none"> a Mud Flaps- 04 b Mud Guards- 02 c Lockable tool box 01 d Rotating Beacon with Cabling- 01 e Flash lamp with cabling- 01 f Reverse audio visual horn 01 g Grease gun with flexible Nozzle 01 h Fire extinguisher 2 litre Pump type 01 i First aid kit 01 <p>(B) Manufacturer should provide following with each vehicle;</p> <ul style="list-style-type: none"> • Two sets of certified net torque, horsepower and fuel consumption curves. • Two copies of technical details, drawings, operator’s manual and standard tools/part’s book • Two copies of workshop and service manual • Two copies of spare parts catalogue • Warranty card for one year • Battery warranty card for one year
14.	After Sales Support:
	<ul style="list-style-type: none"> • Free service in the first year with a warranty for the machine for I year from the date of commissioning • To demonstrate capabilities of giving proper service and spare parts after the expiry of warranty period • Should be capable of proposing maintenance contract for subsequent years at respective cities of Corporation
15.	Drawings:
	The drawings of vehicle should be submitted by the bidder which should be approved by the purchaser.

Table 3: Metallic Garbage Collection Closed Bins - 4.0 cum. Capacity

SPECIFICATION	
1	a) Make and Model
	b) Country of Origin
	c) Year of manufacture
2	Basic specifications:
	The container having compatibility with the Dumper Placer Vehicle should be closed type with minimum capacity of 4.0-cum with side loading arrangement.
3	General Description:
	The container would be used for storage of Municipal solid waste/ occasional storage of constructions wastes, debris, silt etc. The containers should be made of reinforced steel frame clad with sheets. The lifting hooks to be integrated into the frame capable of taking the specified load.
4	Type :
	The container having compatibility with the Dumper placer carrier vehicle should be closed type having capacity of 4000 litres with adequate strength to handle a weight of about 2500 kg (excluding self weight). A drain plug/hole would be provided to drain the leachate or for cleaning. The bins would have a top hinged door with locking arrangement with provision for tipping of the wastes. The loading height should be 1100 mm.
5	Material:
	The material for the container should be steel conforming to IS 2062 (updated) or equivalent. Bottom plate to be 4.0 mm or above. Side and top M.S. sheets should be above 3.10 mm thickness and tail gate shall be of CRC sheet of minimum 2 mm thickness. The support channel to be of 100 x 50 mm ISMC channel of minimum 5 mm thickness. Top door hinges, tail gate hinges top flap support, Top & bottom frame supports, angels 50 x 50 x 5 mm ISA and should have continuous welding channels, Tees, anchor pins, locking arrangement of tail gate should be heavy duty of rugged steel.
6	Openings and covers:
	The top of the container would be closed with flap type two nos. on each side (total four opening). The opening should be covered with 2 mm MS sheet with suitable size angles. The tail gate / hinged door of the container for closing can be kept in open position in general. The gate with hinges at top to open automatically while unloading the garbage from container. It should be closed at the time of transportation and placement.
7	Lifting Hooks:
	The hooks for lifting the bins to be integrated to the structure of the bin to enable lifting of bins from side.. 4 numbers of lifting hooks of shall be provided in the frame after making a hole of the same diameter, it should be continuously welded on outer side and one additional place of 100 x 100 x 5 mm to be provided on inner side to strengthen it and to handle the design weight for lifting with adequate factor of safety. The shape and size would be as per design of the lifting tackle. The hook pin should be minimum 40 mm diameter.
8.	Painting and Lettering:
	Container should be first cleaned either by sand blasting or any other appropriate method and given a coat of anti-corrosive primer and finished with two or more coats of synthetic enamel paint in approved colour with Poly Urethane process and painting for better life and for finish at the inside surface of the container, whereas outside surface to be finished with two or more coats of synthetic enamel paint of approved colour. The bidder should get the colouring paint/ name & slogan writing approved from the purchaser.
9	Reflectors:
	Minimum 8 number of reflectors 65 to 75 mm diameter to be provided on all sides of the container at suitable locations for operation during night time.
10.	Drawings:
	The drawing along with detail specifications of container should be submitted by the bidder which should be approved by the purchaser.
11.	Guarantee:
	The bidder should provide drawings of the Goods/Equipment proposed with the bid and the selected bidder would be required to submit the working drawing for approval of the Purchaser at time of Contract execution.

Table 3: Mini Garbage High Lift Waste Collector and Tipper

C. Purchaser's Specification	
1. Make and Model Machine & Chassis 2. Year of Manufacture 3. Country of Origin	
4. General	
<p>The four wheeler Mini Truck Closed Garbage High Lift Tipper should be useful for transportation of refuse, silt, grit or any other waste from the collection point to its disposal point/directly unloading into the compactor/ container. The body capacity should be minimum 1.8 Cum (comprising of 1.5 cum for garbage with hydraulically unloading arrangement into compactor/bin and 0.3 cum capacity for storage of recyclable waste for manual/gravitational unloading). The garbage container of 1.5 cum capacity should be hydraulically operatable and compatible with bins/compactor.</p> <p>The unit should consist of:</p> <ul style="list-style-type: none"> • The hydraulic System should operate by battery operated via 12 V Power Pack/ engine driven hydraulically pump • Fully Enclosed Tipper with two openable lids at the top for collection of waste. • Hydraulic arrangement for unloading • Under body Hydraulic System • Pendant switch/DC valve for tipping operation as per requirement <p>The complete tipping system should be designed to suit chassis units, which consists of a body with suitable frame. The tipper body should be supplied along with the complete hydraulic system with under body tipping mechanism. The hydraulic system should comprise of 12V power pack unit/ engine driven hydraulic pump with DC control valve and hydraulic oil tank (Capacity : 15L) Controls for power pack unit which is pendant switch (remote control) fitted in the cabin as red and green push buttons for tipping and lowering operations.</p>	
5. Chassis	
G.V.W:	Minimum 1600 Kgs.
Front Axle Weight :	590 Kg (approx.)
Rear Axle Weight :	540 Kg (approx.)
Container Capacity:	1.8 Cum.
Wheel Base :	Minimum 2100 mm
Max output :	Minimum 16 Hp @ 3200 rpm
Torque:	Min. 3.5 mtr. / kg @ 2000 rpm
Displacement :	Minimum 700 cc
Suspension :	Parabolic leaf spring At both front and rear.
Fuel Tank :	30 litre
Overall Dimension :	Minimum 3800 x 1500 x 1800 mm
Gear box :	Synchromesh (4 forward) and sliding mesh (one reverse)
Clutch :	Single plate dry friction diaphragm type
6. Prime Mover	
The source of supply to be from the battery operated by Power Pack (150 Amp 12 V)/ engine driven hydraulic pump	
7. Unloading arrangement	
Hydraulic cylinder with scissor/any other suitable mechanism. Tipping angle 60 degree (flat floor)	
8. Frame	
The sub frame should be all welded construction of rectangular hollow section, reinforced adequately on the load members, mounted on chassis with nuts and bolts.	
9. Tipper Body (Container)	
Tipper Body should be all welded construction of sheet metal adequately reinforced by the stiffeners having formed ribs on the floor of the container. Dimension : Length = 2750 mm Width = 1500 mm	

<p>Height : 1000 mm Total Height from the ground – 1500 mm Loading Height – 1250 mm Unloading Height – 1100 mm</p>
<p>10. Driver’s Cabin:</p> <p>The machine should be provided with company fitted all weather Steel Driver’s Cabin with excellent operator all around visibility.</p>
<p>11. Body Prop</p> <p>Body Prop should be provided to support the body for servicing purpose and safety purpose</p> <p>The Hydraulic System should operate on the Power Pack/ engine driven hydraulic pump, which should source the supply from the vehicle battery itself i.e. 12V or by engine.</p>
<p>12. Hydraulic Valves</p> <p>A suitable Relief Valve should be provided for the protection of overloading.</p>
<p>13. Hydraulic Cylinders</p> <p>All cylinders must be tested at 1.5 times the rated working pressures. Cylinder rods of all cylinders should be constructed of high strength hardened steel rods and should be hard chrome plated. Where necessary, pin mounting connections of cylinders should incorporate hardened spherical bushings on hardened pins. The cylinders should be of reputed make and should adhere to dimension given in technical schedule.</p>
<p>14. Hydraulic Tank and Filters</p> <p>The Hydraulic Tank should be fitted with Suction Strainer to ensure the supply of clean hydraulic oil, Air Breather, Oil Filter and Oil level indicator.</p>
<p>15. Accessories (if not provided by manufacturer)</p> <p>MUD GUARD – 04 nos. MUD FLAP - 04 nos.</p>
<p>16. The Manufacturer/Supplier should provide following with each vehicle:</p> <ol style="list-style-type: none"> i. Two copies of Operator’s manual ii. Two copies of Workshop & service manual iii. Two copies of Spare parts catalogue operation manual iv. Warranty card for one year. v. Battery warranty card for 1 year vi. Manufacturer’s standard tools for maintenance with lockable security box
<p>17. Warning System and Essential Accessories</p> <ol style="list-style-type: none"> a Speedometer b Engine oil pressure gauge or warning light c Fuel level gauge d Water temperature gauge e Ammeter or warning light f Horn – 2 pieces g External rear view mirrors h Radiator protection grill i Head and tail lights, cabin lights, j Reversing alarm/beeper system k Spare wheel with tyre and inner tube with wheel carrier. l Jack and wheel wrench m Anti- theft steering lock
<p>18. Painting and writing</p> <p>The entire unit should be painted with two coats of superior quality anti-corrosive primer with two coats of approved quality paint. The bidder should get the colouring paint/ name & slogan writing approved from the client.</p>
<p>19. After Sales Support:</p> <ol style="list-style-type: none"> 1. Free service in the first year with a warranty for the equipment for one year from the date of commissioning. 2. To demonstrate capabilities of giving proper service and spares after the expiry of warranty period. 3. Should be capable of proposing maintenance contract for subsequent years with Thimphu City Corporation.

20. Drawings:

The bidder should provide drawings of the Goods/Equipment proposed with the bid and the selected bidder would be required to submit the working drawing for approval of the Purchaser at time of Contract execution.

Table 5: Truck Mounted Refuse Compactor-14 cu.m. Capacity

Specification
a. Make and Model(Machine and Chassis) b. Year of manufacture c. Country of origin
1. General: The Refuse Compactor Vehicle should be robust in construction and be able to collect garbage from different spots/ mini garbage collectors and transport to dumping ground. It should be easy to handle and allow the loading personnel to operate the vehicle with minimum physical effort and maximum safety. The unit should be run on the power transmitted from vehicle's engine through Power Take off unit. The PTO should be sturdy design of reputed make and should be able to provide sufficient power to run the system. The unit should be operated by hydraulic systems. The positive compaction against the ejector plate should be used to enable desired compaction to be achieved at all times for even loading. Proper distribution of load on front and rear axles should be achieved without overloading the axles in any circumstances. Collection of garbage should be done by emptying/ unloading the garbage into the hopper of the compactor from the garbage collectors. The Loading Height should not be more than 1.1 Mtrs from the ground level. The unit should have suitable Power Take off arrangement from the truck Chassis which should be used for driving various components such as: Refuse collection body, Ejector Plate, Tailgate with hopper, slide plate, packer plate, Controls, Valves, and Cylinders etc.
2. Rear Loader: The rear loader unit and its hydraulically assisted packer body should be designed in conformation to the best practice known to the body fabrication trade in design, quality of material and workmanship. All assemblies, subassemblies, components and accessories should be of standard type and interchangeable. All necessary accessories not specifically mentioned herein but necessary for making complete unit ready for use should be included. The unit should be rear loading type with loading height not more than 1.1 meter from ground level. The operation of compaction, ejection of refuse should be of hydraulic system. The hydraulic cylinders, hydraulic pump, control valves, seamless pipes, hoses, couplings etc. should be of high quality and standards to withstand high pressures. The pipe ends should be flared to ensure perfect seal and prevent leakage even at high pressure.
3. Refuse Collection Body: The body should be of 14 cum capacity, torsion free, fabricated from IS 2062 updated or equivalent steel sheets and reinforced ribbed so as to withstand continuous operation at maximum imposed loads and without harmful deformation or excessive wear. The bottom group, the sidewalls and the top must form a box-type design. The sidewalls as well as the top should be in reinforced frame steel construction. The body floor should be equipped with extra heavy structural steel wide flanges that will guide and support the ejector panel. The tailgate bearing and automatic tailgate locking should be integrated into the rear frame of the body. At its front, a traversing bar should be welded to the bottom and top, which serves as a bearing for the telescopic ejection cylinder. <ul style="list-style-type: none"> • Roof panelling thickness-minimum 2 mm • Side panelling thickness-minimum 3 mm • Floor thickness-minimum 4 mm • Rear cross bar thickness-minimum 6 mm • Superstructure member thickness-Box section minimum 4mm • Base frame member thickness-minimum 6 mm
4. Ejection Panel: The ejection panel should run on a synthetic guide block within the lateral longitudinal guides of the boat-type bottom group of the refuse collection body and must be operated by a telescopic hydraulic ram. It must serve during loading as a resistance for the refuse compaction process. The ejection plate should be of steel plate of suitable grade to meet the operational requirements. A hydraulic control unit should regulate the withdrawal of the ejection panel during the loading process, so that the compaction is optimised. The mechanism should consist of a profile-reinforced, wear-resisting plate of great sturdiness and the guide frame with the guide blocks.

Ejection panel should be fabricated from high strength mild steel of minimum 3 mm. thickness.

5. Tailgate:

The tailgate should form the main part of the refuse collection vehicle. The tailgate should unlock automatically and raise to permit ejection of the refuse when hydraulic valve is manually actuated. There should be manually operated tailgate turnbuckle locks at rear end. Tailgate should be provided with sturdy arrangement for raising and controlling of descent. The valve that operates the tailgate lift action should be located at such location so that to prevent any harm to the operator. The Tailgate should be made up by three main groups:

- (i) Tailgate with Hopper: The tailgate with hopper should form the basic structure to which the functional parts, slide plate and packer plate should be attached. It should be equipped with Automatic-locking system through long hole and hooks. This locking-system should be completely liquid-proofed between tailgate and body by using double lips rubber seal.

The hopper should be able to take the refuse from the bins manually/mini garbage collector vehicle. The hopper should have a capacity of minimum 1.75 cum. At its top, it should be fixed to the refuse collection body by means of two slotted hinges and should be supported by two hydraulic rams and two locking hooks mounted to the rear frame of the body. These bearing points and the locking hook should take up the compression forces. The profile-reinforced side walls of the frame should constitute the bearing for the two hydraulic rams which automatically release the locking mechanism and then lift the loading system for refuse discharge up to the final stop.

The hopper used to take in the refuse should be permanently welded in between the side walls and should consist of highly solid fine-grained constructional steel made of High resistance steel.

- (ii) Slide Plate: The carriage plate should be robust profile-reinforced steel construction Supplied with a wear-resistant cover plate made of high resistant Steel. The thickness of side plate should be of suitable grade material. It should be actuated by two hydraulic rams, and must run on suitable number of sliding blocks. At the bottom end of the slide plate a moveable packer plate should be embedded.
- (iii) The packer plate should consist of highly solid steel and the strongly Reinforced lateral bearing arms for the attachment of the hydraulic rams. It should clear the hopper and initiate the primary compaction within the hopper. On completion of the swivel movement the compaction of the refuse and its transportation into the refuse collection body should begin. The packer plate should be made of special High resistance steel of suitable grade.
- (iv) Side panelling thickness-minimum 3 mm
- (v) Rear side of hopper plate thickness-minimum 6 mm
- (vi) Hopper bottom plate thickness-minimum 6 mm
- (vii) Other member thickness-minimum 6 mm

6. Hydraulic Valves:

All the valves provided should be of reputed make and of international standard. The valves should be of rated 140 kg/sq cm. pressure.

7. Chassis:

Standard Make TATA / Ashok Leyland/ equivalent

Model-Euro-III

GVW-Minimum 16000 Kg

Wheel Base-Minimum 4200mm

Maximum Engine output 125 HP @2400 RPM

Maximum Torque 40 Kgm @ 1400-1700RPM

Front Axle capacity 6MT

Rear Axle capacity 10 MT

Power Steering

8. Operator's Cabin:

Company fitted/fabricated all steel semi/fully - forward control driver's cab with tilting arrangement & with torsion bar assistance. Cabin should have minimum two nos. foam padded adjustable seats having seat belts. Cab should have all standard accessories like openable side windows, rear view door mirrors, laminated windscreen, two speed wind shield wipers, fuel gauge, multiple warning lamps and buzzer for low oil pressure, coolant level etc.

<p>9. Control Operation:</p> <p>Power take off controls mounted in the cabin should be conveniently located by chassis manufacturer.</p> <p><u>Tailgate Operation</u></p> <ul style="list-style-type: none"> ◆ Tailgate opening and closing for dumping should be controlled from driver's cabin ◆ Optional hand lever for manual operation should also be provided. ◆ The tailgate hydraulic valves should be electro pneumatic / electro hydraulic for rugged operation <p><u>Ejector Plate operation</u></p> <ul style="list-style-type: none"> ◆ This operation should be controlled from driver's cabin ◆ Optional hand lever for manual operation ◆ The ejector plate hydraulic valve should be electro-pneumatic/electro hydraulic.
<p>10. Actuation:</p> <p>Hydraulic actuation via hydraulic pump should be driven by the P.T.O. of the vehicle chassis.</p>
<p>11. Pump:</p> <p>The hydraulic system should be driven through a dual-pump</p> <ul style="list-style-type: none"> ● Large circuit for the compaction ● Small circuit for ejection plate and lifter <p>The large pump circuit should feed the hydraulic rams of the compaction unit. The small pump circuit should feed the lifting rams of the tailgate (the lifting rams should also be used for the locking mechanism), the telescopic ram of the ejection panels and the lifting device of the system.</p>
<p>12. Rams/ Cylinders:</p> <p>All cylinders must be tested 1.5 times the rated working pressures. Following cylinders may be provided:</p> <ul style="list-style-type: none"> 1 three-stage telescopic ram, double-acting for the ejection panel. 2 hydraulic rams, double-acting for the slide plate <p>Double acting Slide-cylinders (for compacting) should be located outside of the sidewalls. The cylinders are mounted in pushing position.</p> <ul style="list-style-type: none"> 2 hydraulic rams, double-acting for the packer plate 2 hydraulic rams, double-acting for the tailgate (lifting/lowering and automatic locking) <p>There should be minimum 7 Nos. Hydraulic Cylinders. Cylinders should be equipped with lubricating bearing. All cylinders should be of reputed make from Organization duly accredited and approved by International Certification Agencies. Cylinder rods of all cylinders should be constructed of high strength hardened steel rods, centreless ground to an RMS smoothness rating of 8 and should be hard chrome plate to a minimum thickness of 0.13 mm. All cylinder rod seals should be able to field tightened to compensate for normal wear of seals. Pin mounting connections of packer and compaction cylinders should incorporate hardened spherical bushings on hardened pins wherever necessary.</p>
<p>13. Control blocks:</p> <ul style="list-style-type: none"> 1 control block for the compaction system 1 control block for lifting/lowering the tailgate and refuse ejection
<p>14. Tank:</p> <p>Hydraulic fluid tank; capacity approx. 160 Litres</p>
<p>15. Filters:</p> <ul style="list-style-type: none"> Return line filter with steel cartridge. Filter for hydraulic tank.
<p>16. Electric:</p> <p>Automatic operation (continuous cycle) by pushing electric operated push-button, compacting mechanism should be running till you switch off through the push button.</p> <p>Optional Manual operation by hand lever facility to be provided.</p> <p>The automatic cycles should be controlled with 4 proximity switches together with the hydraulic integrated control-group. Further 2 emergency stop switches should be provided.</p> <p>The control system should be only operated by hydraulic and electric.</p> <p>Optionally one should also be able to operate the whole compactor with a hand-lever, which comes</p>

<p>out directly from the main-control-block. Emergency electric stops to be provided. Signal-system to the driver's cab to be provided. On each side there should also be 1 switch for the signal system to the driver's cab. The system should encompass all installations relevant for the functioning of the entire bodywork and the distribution voltage should be tapped from the electrical system of the chassis vehicle. Lights: Double light-system at the rear are provided :</p> <ul style="list-style-type: none"> Working light Rotation light. Parking Light Stop Light Direction Indicator Number Plate Light 																		
<p>17. Selector switch:</p> <ul style="list-style-type: none"> Single/continuous-cycle (right hand)- One Main Switch – One Working Light (Cab) – One Finishing [Rotating Light] (Cab) – One 																		
<p>18. Push button:</p> <ul style="list-style-type: none"> Engine Accelerator – One Emergency Stop (Right Hand) – One 																		
<p>19. Safety features:</p> <p>Hose burst valve should be fitted to the system to prevent the tailgate descending in the event of the hydraulic failure. Emergency stop switch should be provided to stop all the operation instantaneously in case of emergency. The switch should be provided on either side of the vehicle and in the driver's cabin. There should be a body prop provided on the tailgate to hold the tailgate in the open position for safety of workshop personnel when entering the body for maintenance or repair.</p>																		
<p>20. Painting and Lettering:</p> <p>The entire unit should be painted with two coats of superior quality anti-corrosive primer with two coats of approved quality paint to ensure long lasting, resistance to rust, weathering and breakage. The color shade should be purchaser's choice selected from the standard colors offered by the supplier. The bidder should get the colouring paint/ name & slogan writing approved from the client.</p>																		
<p>21. Standard Accessories:</p> <p>(A) Following accessories ,if not provided as as a part of the machine should be provided:</p> <table border="0"> <tr> <td>i. Mud Flaps-</td> <td>04nos.</td> </tr> <tr> <td>ii. Mud Guard-</td> <td>02 nos.</td> </tr> <tr> <td>iii. Lockable tool box-</td> <td>01 no.</td> </tr> <tr> <td>iv. Rotating Beacon with cabling-</td> <td>01 no.</td> </tr> <tr> <td>v. Flash lamp with cabling-</td> <td>01 no.</td> </tr> <tr> <td>vi. Reverse audio visual horn</td> <td>01 no.</td> </tr> <tr> <td>vii. Grease gun with flexible nozzle</td> <td>01 no.</td> </tr> <tr> <td>viii. Fire extinguisher 2 litre pump type</td> <td>01 no.</td> </tr> <tr> <td>ix. First aid kit</td> <td>01 no.</td> </tr> </table> <p>(B) Manufacturer should provide following with each vehicle;</p> <ul style="list-style-type: none"> i Two sets of certified net torque, horsepower and fuel consumption curves. ii Two copies of technical details, drawings, operator's manual and standard tools/part's book iii Two copies of workshop and service manual iv Two copies of spare parts catalogue v Warranty card for one year vi Battery warranty card for one year 	i. Mud Flaps-	04nos.	ii. Mud Guard-	02 nos.	iii. Lockable tool box-	01 no.	iv. Rotating Beacon with cabling-	01 no.	v. Flash lamp with cabling-	01 no.	vi. Reverse audio visual horn	01 no.	vii. Grease gun with flexible nozzle	01 no.	viii. Fire extinguisher 2 litre pump type	01 no.	ix. First aid kit	01 no.
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vii. Grease gun with flexible nozzle	01 no.																	
viii. Fire extinguisher 2 litre pump type	01 no.																	
ix. First aid kit	01 no.																	

22. After Sales Support:
<ul style="list-style-type: none"> • Free service in the first year with a warranty for the machine for 1 year from the date of commissioning • To demonstrate capabilities of giving proper service and spare parts after the expiry of warranty period • Should be capable of proposing maintenance contract for subsequent years at respective cities of Corporation
23. Drawings:
The bidder should provide drawings of the Goods/Equipment proposed with the bid and the selected bidder would be required to submit the working drawing for approval of the Purchaser at time of Contract execution.

Table 6: Technical Specification for Excavator Cum Loader

Specifications	
1.0	a. Make and Model b. Year of Manufacture c. Country of Origin
2.0	General Descriptions
	General: The Excavator Cum loader should be rugged and durable, and designed for ease of manoeuvrability and proper distribution of loader, and axle induced stresses. The frame/chassis should be either fully welded or rigidly bolted to achieve this, in accordance with the manufacturer's standard procedures. It should be suitable for working under adverse site conditions, and the power train should be designed for this purpose as 4 wheel drive.
3.0	Basic Specification
a)	Type: Loader complete with 1.0m ³ front end loader bucket rear backhoe excavator with preferably 0.3 m ³ bucket and minimum dump height of 2.6 m.
b)	Structure: Rugged, durable and designed for durability and proper distribution of induced stresses.
c)	Engine: Fuel efficient, 4 stroke, 4-cylinder, water cooled diesel engine. Minimum Gross Horsepower Rating : 76 HP (54 KW) at manufacturer's rated RPM
d)	Drive Train: 4 wheel drive.
e)	Transmission: Compact, fully synchromesh, with 4 speeds forward and 2 speed reverse.
f)	Differential and Axles: The differential should be heavy duty, designed for use under severe operating conditions. The axles should be designed to withstand severe duty conditions at loading sites, and to perform continuous loading cycles with excellent manoeuvrability. The rear axle should be a rigidly mounted heavy duty drive axle, with torque proportioning differential for 2 wheel drive units. The front axle should be a heavy duty oscillating steer axle.
g)	Steering: Full power, front wheel hydrostatic power steering with manual capability in the event of engine or hydraulic power failure.
h)	Brakes: Main brakes. Self adjusting, oil immersed, multi-disk, hydraulically actuated with independent left and right brake pedals. Parking brake: Hand operated.
i)	Hydraulic system: Engine driven hydraulic pump with hydraulic tank mounted so as to ensure constant oil flow to the pump. System should be equipped with easily visible level read-out gauge and replaceable filter cartridge elements. System should operate at adequate pressure and flow at 2200 RPM.
j)	Electrical System : 12 volt system with battery and alternator. Weather Protection, Water Proof and dust proof with heavy duty harness head Lights. Front Working Lights: 2 halogen lamps. Rear Working Lights: 2 halogen lamps. Tail Light/Brake Lights: 2 each at rear end. Turn Signal Lights: 2 front 2 rear. D. Emergency Signal Flasher: 4-way.

	<p>Reverse Alarm : 1</p> <p>Number Plate Illuminators: Front and rear.</p>
(k)	Tyres: Heavy duty for earth moving machines of suitable size as per manufacturer's standard.
(l)	<p>Operator's Cabin: All steel welded safety cab conforming to Roll Over Protection (ROP) and Fall Over Object Protection (FOP) with safety glass mounted on rubber pads to eliminate machine vibrations. Accessible from both sides.</p> <p>Interior: Designed for ease of operation without undue fatigue. Features should include suspension seats, all-round visibility, easy-to-reach controls, rear view mirror, interior light, front windshield wiper and horn.</p> <p>Controls: Throttle, independent left and right foot brake pedals, parking brake, transmission disconnect pedal, hydraulic control levers, steering wheel, gear shift lever, turn signals, flasher, etc.</p> <p>Instruments : Bright read-out front and back consoles which include tachometer, hour meter, engine oil pressure gauge, fuel gauge, water temperature gauge, parking brake indicator, headlight indicator, alternator "no-charge" condition, etc. Audio-visual alarms for oil pressure, oil temperature, transmission oil temperature, transmission oil pressure, main battery etc</p>
m)	Loader Bucket: Standard bottom dump clam 6 in one bucket suitable for dozing, digging, grading, filling, grabbing and loading capacity should be nominal 1.0 m ³ .
n)	Backhoe Bucket: Standard excavator type backhoe bucket suitable for digging, loading, dozing, grading, filling and grabbing. Size shall be nominal 750 mm width with preferably 0.3m ³ capacity.
o)	<p>Capacity :</p> <ul style="list-style-type: none"> ▪ Max Digging depth (not less than 4.50M.) ▪ Break out forces from excavator bucket cylinder (not less than 5500 kg.) ▪ Break out forces from excavator Arm cylinder (not less than 3000 kg.) ▪ Breakout forces from loader bucket cylinder (not less than 6000kgf.) ▪ Breakout forces from loader Arm (not less than 5000 kg.)
p)	<p>Painting and Lettering: Paint Process and Paint should be superior quality to ensure long lasting structure resistance to rust, weathering and breakage.</p> <p>Color shade should be the Purchaser's choice selected from the standard colors offered by the Supplier. The bidder should get the colouring paint/ name & slogan writing approved from the purchaser.</p>
q)	<p>After Sales Support :</p> <ul style="list-style-type: none"> ▪ Free service in the first year with a warranty for the machine for 1 year from the date of Commissioning. ▪ To demonstrate capabilities of giving proper service and spaces after the expiry of warranty period. ▪ Should be capable of proposing maintenance contract for subsequent years
4.	<p>The Manufacturer/Supplier should provide following with each vehicle :</p> <ul style="list-style-type: none"> (a) Manufacturer's standard tools for maintenance with lockable security box. (b) Operator's manual (c) Workshop and service manual (d) Spare parts catalogue (e) Technical details, drawing and operation manual (f) Warranty card for one year (g) Battery warranty card for 1 year.
5.	<p>Warning System and Essential Accessories:</p> <ul style="list-style-type: none"> (a) Digital Hour meter (b) tachometer (c) Fuel gauge (d) water temperature gauge (e) Engine oil pressure gauge with warning light (f) Ammeter supported with warning light (g) Horn- 2 pieces (h) External rear view mirrors (I) Radiator protection grill (j) Head and tail lights, cabin lights, reversing light and traffic indicator (k) Spare front & rear (one each) wheel with tyre and inner tube

	(l) Jack and wheel wrench (m) Anti-theft steering lock (n) Full power front wheel hydrostatic power steering with manual capability also (o) Seat belt, front screen wiper, hazard warning system and helper seat (p) Speedometer (q) Radio of standard make
6.	Drawings: The bidder should provide drawings of the Goods/Equipment proposed with the bid and the selected bidder would be required to submit the working drawing for approval of the Purchaser at time of Contract execution.

Table 6: Technical Specification for Dumper 8 Mt Capacity

Specifications	
1	a. Make and Model b. Year of Manufacture c. Country of Origin
2	General Descriptions
	The Dumper Tipper Vehicles (Chassis, Body and cabin) Should be rugged and durable and should incorporate the latest technologies and feature offered by the manufacturer/supplier and should be suitable to be used as Hydraulically operated tipping mechanism for dumping or unloading with body built on chassis for Transporting with minimum 8.0 cum volume and minimum 8 MT. payload of waste of constructing and demolition debris, Garden and Horticultural waste. The truck body to be designed accordingly. The hydraulic system with control valve and PTO should be suitably designed. The vehicle should confirm to the following specification:
3	Basic Specifications
	Any heavy vehicles chassis with factory installed cabin and Tipper body should meet the following specification
a	Complete chassis with cabin and Tipper body with spare wheel, tyre and tools should be as per latest IS or ISO specification. Payload: Minimum 8000 kg(8MT).
b	Engine: Fuel efficient turbo charged diesel engine having bore and stroke and cylinder, inter water cooled, direct injection diesel engine delivering maximum output of 130 HP for minimum payload capacity of 8 MT at manufacturers rating equipped with air cleaner suitable for dusty conditions, satisfying latest BS norms of emission standards.
c	Clutch : Dry friction Type – Single plate
d	Gear box: Synchromesh on all forward gears and Constant mesh on reverse gear. No. of gears : 5 forward & 1 reverse
e	Rear and front Axle: Heavy duty forged and fully floating single speed I section spiral bertel gear suitable for Minimum 8 MT. Payload.
f	Steering: Right hand drive Power steering with manual capability in event of hydraulic/ engine failure.
g	Brakes : Service brakes: Dual circuit full air brakes. Parking brakes: Spring actuated parking brake acting on rear wheels with graduated hand brake valve.
h	Frame: Ladder type heavy duty frame with riveted/bolted cross members, side members of

Specifications	
	channel sections.
i	Suspension: Semi elliptical leaf spring at front and rear with auxiliary springs at rear only.
j	Shock Absorber: Hydraulic double acting Telescopic type at front.
k	<p>Wheels and Tyres :</p> <p>No. of wheels – Front : 2</p> <p style="text-align: center;">Rear : 4</p> <p>Radial Tyres (maximum size)- 10.00x20-16 PR nylon</p> <p>Wheel base : Minimum 3600 mm.</p>
l	<p>Tipper Body: High quality company fitted steel sheets of 4 mm. thickness and to be lined by 0.30 mm stainless steel coating inside the bucket. All steel welded construction to withstand the corrosive nature and heavy impact due to loading of construction and demolition waste with volume capacity of 8.0 cum.to hold minimum 8 MT pay load. The load body is to be operated by hydraulic hoist activated by PTO drive system. The body of tipper has to be completely closed with top cover suitable for SWM operations in conjunction with Front End loader. The top cover should be hydraulically operatable made of 2 mm thick mild steel sheet with epoxy coating inside (design of cover should be as approved by the purchaser). The rear gate of load body is to be mechanically automatic in opening while in unloading position and closed in normal position. The inside surfaces of the garbage load body are to be lined by anticorrosive stainless steel panels to make it leak proof to protect the vehicle and its equipment. Adequate safety measures are to be ensured for safe dumping system.</p>
m	<p>Electric system: Minimum 75 AMP Hr. with suitable alternator capacity.</p> <p>Head and tail lights: 2 head & 2 tell with headlight protection frame.</p> <p>Cabin lights</p> <p>Brake light: 2 nos.</p> <p>Turn signal: Front and rear.</p> <p>Reserve Alarm : 1</p> <p>Hazard Flashers: It should have rear and cabin mounted flashing beacons for use when loading.</p>
n	<p>Painting: Painting Process and paint should be superior quality to ensure anti corrosive and long lasting structure resistance to rust, weathering and breakage.</p> <p>Color Shade should be the Purchaser's choice selected from the standard colors offered by the supplier.The bidder should get the colouring paint/ name & slogan writing approved from the purchaser.</p>
o	<p>Hydraulically Operating Tipping Operation (twin ram hydraulic).</p> <ul style="list-style-type: none"> ▪ To be suitable for unloading of minimum 8 MT payload with minimum tipping angle of 40° and maximum tipping time 25 seconds. ▪ The cylinders, piston rod etc.should be of corrosion resistance satisfying latest (ISO standard) ▪ The Hydraulic unit system should be painted with synthetic enamel paint of color in golden fellow.
4.0	<p>After Sales Support:</p> <ul style="list-style-type: none"> ▪ Free service in the first year with a warranty for the machine for 1 year from the date of commissioning. ▪ To demonstrate capabilities of giving proper service and spaces after the expiry of warranty period. <p>Should be capable of proposing maintenance contract for subsequent years.</p>
5.0	The Manufacturer/Supplier should provide following with each vehicle:

Specifications	
	a) Manufacturer's standard tools for maintenance with lockable security box. (b) Operator's manual (c) Workshop and service manual (d) Spare parts catalogue (e) Technical details, drawing and operation manual (f) Warranty card for 1 year (g) Battery warranty card for one year.
6.0.	Warning System and Essential Accessories: (a) Speedometer (b) Engine oil pressure gauge or warning light (c) Fuel level gauge (d) Water temperature gauge (e) Ammeter or warning light (f) Horn- 2 pieces (g) External rear view mirrors (h) Radiator protection grill (i) Head and tail lights, cabin lights, reversing light and traffic indicator (j) Reversing alarm/beeper system (k) Spare wheel with tyre and inner tube with wheel carrier. (l) Jack and wheel wrench (m) Anti- theft steering lock
7.0.	Mandatory Tools and Spare Parts The following genuine obligatory spares are to be supplied along with each equipment: <ol style="list-style-type: none"> 1) Oil Filter - 3 no. 2) Diesel Filter Primary - 3 no. 3) Diesel Filter Secondary - 3 no. 4) Hub, Packing - 4 no. 5) Rear Wheel Oil seal - 4 no. 6) Split Pin - 4 no. 7) Fuse - 3 no. 8) Bulb - 2 no. 9) Wheel Nut - 4 no. 10) Tapper covers packing -2 no. 11) Air cleaner rubber - 2 no. 12) F.I.P. packing - 1no. 13) Air Breather - 1no. 14) Gaskit elbow -1no. 15) Bolt prop. Shaft -6 no.
8.0	Drawings : The bidder should provide drawings of the Goods/Equipment (including openable cover) proposed with his bid and the selected bidder should submit the working drawing for approval of the Purchaser during Contract execution.

Table 7: Technical Specification for Tractor

Purchaser's Specifications	
1.0	a. Make and Model b. Year of Manufacture c. Country of Origin
2.0	General Descriptions
	General: The Tractor should be rugged and durable, and designed for ease of manoeuvrability and proper distribution of tractor, and axle induced stresses. The frame/chassis should be either fully welded or rigidly bolted to achieve this, in accordance with the manufacturer's standard procedures. It should be suitable for working under adverse site conditions, and the power train should be designed for this purpose.
3.0	Basic Specification
a)	Type: tractor complete with trolley attachment provision.
b)	Structure: Rugged, fully welded, durable and designed for durability and proper distribution of induced stresses.
c)	Engine: Fuel efficient, 4 stroke OHV direct injection diesel engine. Minimum Gross Horsepower Rating : 35 HP (27 KW) at manufacturer's rated RPM
d)	Cylinder: Minimum three cylinders vertical in line – 3 Cylinder DI Engine with Integral cylinder head
e)	Fuel Injection: In line fuel injection pump with variable speed mechanical governor.- Mechanical
f)	Fuel System : Gravity and forced feed, Fuel tank capacity not less than 30 liters and fuel filtration should be dual stage
g)	Air Cleaner: should be of oil bath type with cyclone type transparent pre-cleaner.
h)	Lubrication: Forced feed and splash type with full flow filter paper element
i)	Cooling: Impeller type water pump, fan and radiator, forced feed water circulation.
j)	Compression Ratio: More than 17;1
k)	Transmission : 8 forward and 2 reverse gears
l)	Clutch: Single/Double plate dry friction type
m)	Steering: Worm and nut type with re-circulating balls
n)	Brakes : Shoe/Disk Type Emergency brakes: hand brake with parking latch
o)	Electric System : Voltage: 12 volts, Battery capacity: 12 volts, 60 Amps/hr @ 5 hr rating, Alternator capacity: minimum 12 volts 13 Amp, Head lights: 2 nos. 12 V -36 W, Brake light: 2 nos. 12 V-21, Rear light: (Plough lamp) -01
p)	Instrument Panel: it should have tachometer and hour meter, water temperature gauge, oil pressure gauge, ampere meter, fuel gauge, high beam indicator, left and right turn indicators, hazard warning switch, hand and foot accelerator etc.
q)	Seat: longitudinal adjustable with back rest and hydraulic shock absorber.
r)	Wheel and Tyres: No. of wheels: Front: 2, Rear: 2.
s)	Hydraulics: Hydraulic system with ADDC, single acting cylinder position and mixed Control, provision for external circuit for double acting cylinders.
t)	Painting: Paint process and paint should be superior quality to ensure long lasting structure resistant to rust, weathering and breakage. The bidder should get the colouring paint/ name & slogan writing approved from the purchaser.

u)	<p>After Sales Support :</p> <ul style="list-style-type: none"> ▪ Free service in the first year with a warranty for the machine for 1 year from the date of Commissioning. ▪ To demonstrate capabilities of giving proper service and spaces after the expiry of warranty period. ▪ Should be capable of proposing maintenance contract for subsequent years at respective cities of Corporation.
4.	<p>The Manufacturer/Supplier should provide following with each vehicle :</p> <ul style="list-style-type: none"> (h) Manufacturer’s standard tools for maintenance with lockable security box. (i) Operator’s manual (j) Workshop and service manual (k) Spare parts catalogue (l) Technical details, drawing and operation manual (m) Warranty card for one year (n) Battery warranty card for 1 year.
5.	<p>Warning System and Essential Accessories:</p> <ul style="list-style-type: none"> (a) Digital Hour mete (c) Fuel gauge (d) water temperature gauge (e) Engine oil pressure gauge with warning light (f) Ammeter supported with warning light (g) Horn- 2 pieces (h) External rear view mirrors (I) Radiator protection grill (j) Head and tail lights, cabin lights, reversing light and traffic indicator (k) Spare wheel with tyre and inner tube (l) Jack and wheel wrench (m) Anti-theft steering lock (p)Speedometer
6.	<p>The following genuine obligatory spares to be supplied along with each equipment:</p> <ul style="list-style-type: none"> Oil Filter - 3 no. Diesel Filter Primary - 3 no. Diesel Filter Secondary - 3 no. Hub, Packing - 4 no. Rear Wheel Oil seal - 4 no. Split Pin - 4 no. Fuse - 3 no. Bulb - 2 no. Wheel Nut - 4 no. Tapper covers packing -2 no. Air cleaner rubber - 2 no. F.I.P. packing - 1no. Air Breather - 1no. Gaskit elbow -1no.
7	<p>Drawings:</p>
	<p>The bidder should provide drawings of the Goods/Equipment proposed with the bid and the selected bidder should submit the working drawing for approval of the Purchaser during Contract execution.</p>

Table 7: Technical Specification for Tractor Trolley

Specifications	
1.0	a. Make and Model b. Year of Manufacture c. Country of Origin
2.0	General Descriptions
	General: The Tractor trolley should be rugged and durable, and designed for ease of manoeuvrability and proper distribution of tractor, and axle induced stresses. Tractor drawn Tipping Trolley should have box type load body having minimum 3 cum capacity, suitable to transport and unload up to 3 tones for all types of road gradient.
3.0	Basic Specification
a)	Type: Trolley complete with proper attachment provision with tractor.
b)	Structure: Rugged, fully welded, durable and designed for durability and proper distribution of induced stresses.
c)	Main Chassis: I SMC 150x75 mm channel - 1 set.
d)	Sub Frame: ISMC 125x65 mm - 2 Nos.
e)	Hitch Beam: Fabricated from MS plate- press formed and welded I SMC channel – 1 No.
f)	Cross Member: I SMC 75x40 mm channel -10 Nos.
g)	Eye Hitch: Forged steel and heat treated– 1 No.
h)	Rear Doors: 3.00 MM HR sheet with reinforcement of 75x40 ISMC
i)	Axle: EN -8 – 63 mm sq.
j)	Wheels: Ring Type – 8mm thick – 2 Nos.
l)	Breaks: Parking breaks – 1 set
m)	Tyres: 900x20-16 ply – 2 Nos. of standard make (approved by purchaser)
n)	Hydraulic Jacks: Single ram 5 - ton capacity hydraulic jack with minimum tipping angle of 50 degree
4.0	Painting and Lettering: The entire surface should be first cleaned by sand blasting or any other appropriate method and given a coat of anti corrosive primer. Bituminous or any other anti-corrosive paint shall be applied to the inside surface of the body, whereas outside surface shall be finished with two or more coats of Air drying enamel paint of desired shade and color as approved by purchaser. The bidder should get the colouring paint/ name & slogan writing approved from the purchaser.
5.0	After Sales Support : <ul style="list-style-type: none"> ▪ Free service in the first year with a warranty for the machine for 1 year from the date of Commissioning. ▪ To demonstrate capabilities of giving proper service and spaces after the expiry of warranty period. ▪ Should be capable of proposing maintenance contract.
6.0.	Drawing:
	The bidder should provide drawings of the Goods/Equipment (including openable cover) proposed by them with his bid and the selected bidder should submit the working drawing for approval of the Purchaser during Contract execution.

Table 8: Technical Specification for Water Tank 4000 Liter Capacity

Purchaser's Specifications	
1.0	a.Make and Model b.Year of Manufacture c.Country of Origin
2.0	General Descriptions
	General: The chassis of the carrier vehicle shall be diesel Engine Driven Euro – II and above norms of appropriate capacity suitable for carrying the water tanker of capacity 4000 liters and compatible with the water tank. It shall be rugged, durable and shall incorporate latest technological features.
3.0	Basic Specification
	The Chassis should be perfectly capable and suitable for mounting water tank of capacity 4000 liters, diesel engine operated water pump and hosepipe and hose reel etc. Turning radius of vehicle should not be more than 6 meters. The chassis shall be Light commercial vehicle.
a)	Engine: Minimum Euro 2 fuel efficient Turbo charged 4 stroke, 4/6 cylinders water cooled direct injection delivering required BHP to pull mounted load.
b)	Number of Gears : 5 forward and 1 reverse
c)	Steering : Power steering
d)	Suspension : Semi elliptical leaf spring at front and rear with auxiliary springs
e)	Shock absorber : Hydraulic double acting telescopic type
f)	Wheel base (Max) : 3400 mm
g)	Py load (Minimum) : 5700 Kg
h)	Number of wheels : Front: 2, Rear: 2, spare:1(Lockable)
i)	Cabin: All steel fully forward driver's cabin having minimum two numbers foam padded adjustable seats with seat belts. It should have all standard accessories like two doors, openable side windows, rear view door mirrors, laminated wind screen, three speed windshield wipers, fuel gauge, multiple warning lamps and buzzers for low oil pressure, coolant level etc. Locking arrangement from inside and outside should be provided. The cabin shall be painted with one coat of steel primer and two coats of good quality paint internally & externally, of approved colour and shade.
j)	Electrical system : <ul style="list-style-type: none"> • Voltage: 12/24 Volts • Battery capacity: 12/24 Volts, 100 Amps per hour • Alternator: Minimum 35 Amps • Head light: 2 with head light protection • Brake light: 3 numbers • Light on Tank side: 1 number • Turn signal: Front and rear • Reverse alarm: 1 No. • Hazard flasher : Rear and cab mounted “flashing beacons” for use when loading
k)	Water Tank: Water Tank shall be fabricated out of 3.15 mm thick M.S. Sheet elliptical in shape of suitable dimension compatible with cabin and chassis to be supplied by the bidder over which the tank is to be mounted. The tank shall have 2 compartments of equal capacity. Both compartments will be interconnected at bottom. Each compartment shall be provided with air

	vent pipe of size 50 mm and a 450 mm size manhole with hinged coverlid and locking arrangements. Internal partitions shall be made of 3.15 mm thick M.S. sheet reinforced by 35 X 35 X 5 mm thick angles. The tank shall have dished faces at both the ends. Ladders made of 16 SWG conduit pipe will be provided to have access to the manhole and to get into the tank. Water level indicator of vertical conduit type with vertical slit opening containing a float indicator will be provided in the tank. Two outlets one number of 3” size and another of 2” size fitted with Gunmetal gate valve for connecting with the pump suction shall be provided.
l)	Diesel Engine driven Pump: 5 HP diesel engine driven water pump shall be installed at each water tanker. Engine shall be single cylinder water-cooled with manual crank start system. Diesel Engine shall be of reputed make ISI marked as approved by the Engineer.
m)	Hose Pipe: Hose pipe shall be of good quality canvas hose of reputed make of size equal to diameter of pump delivery and 30 meters long ISI marked suitable for connecting to the delivery of water pump
4.0	Standard Accessories as part of equipment : <ul style="list-style-type: none"> • Toolbox • First aid box • Safety kit
5.0	Painting and Lettering: The entire frame to be painted with powder coating of color approved by purchaser. Lettering /slogan writing as approved by purchaser.
6.0	After sales support : <ul style="list-style-type: none"> ▪ Free service in the first year with a warranty for the machine for 1 year from the date of Commissioning. ▪ To demonstrate capabilities of giving proper service and spaces after the expiry of warranty period. ▪ Should be capable of proposing maintenance contract.

Table 9: Technical Specification For Bull Dozer 90 HP

Purchaser's Specification	
1.	a. Make and Model b. Year of Manufacture c. Country of Origin
2.	General Description
a)	The Bull Dozer (track type tractor) shall be designed for general purposes. It shall have a maximum operating weight of 11000 Kg. to include full fuel tank, lubricants, coolant, hydraulic controls, Bulldozer track, shoes, and operator cabin etc. and shall have minimum draw bar pull of 10,000 Kg. It shall be powered by water cooled, 4 – cycle overhead valve, and direct injection diesel engine with a minimum Flywheel Horsepower of 90 HP at manufacture's rating. The engine fuel shall be direct injected with variable timing, adjustment free and individual fuel injection pumps and fuel nozzle valve. The unit shall be equipped with the manufacturer's standard specification as to the type of transmission, hydraulic system, type of cooling system. etc.
3.	Basic Specification
A.	Engine
a)	“Fly wheel Horsepower shall not be less than 90 HP at manufacture's rating”
b)	Cylinders shall be 4 or 6 in line”
c)	It shall be diesel fuel feed with direct injection fuel system, individual and adjustment free fuel injection pumps and fuel nozzles.
d)	Water – cooled cooling system.
e)	Voltage and capacity of alternator shall be 24 V, 30 amp minimum.

Purchaser's Specification	
B. Power Transmisison	
a)	The transmission shall be of selective gear type comprising 3 gear shafts – main shaft, counter shaft and intermediate shaft, all supported by roller bearings, whose gears are so selected as to provide a total 7 speeds, 4 forward and 3 reverse speeds. It should have a splash type lubrication to ensure that oil lubricates all running and sliding parts within the transmission. The speed shall be 0-2.5 km/h minimum and 0-9.0 km/ h maximum for forward and 0-3.0 km/h minimum and 0-8.0 km/h maximum for reverse.
C. Final Drive	
	Shall be spur gear, double reduction drive.
D. Steering and Braking	
	Steering clutches should be of dry, multiple discs, spring type with spring booster and interconnected to dry externally contracting band type steering breaks. Steering clutch control to be hand operated with spring booster.
E. Undercarriage	
a.	Suspension to be semi-rigid, equalizer bar type.
b.	Track frame to be box – section, high tensile strength steel construction.
c.	Track rollers – minimum 5 on each side.
d.	Carrier rollers – minimum 2 each side.
e.	Track shoe assembled, single grouser type, minimum 38 in number, grouser height not less than 50 mm and shoes width not less than 400 mm.
f.	Minimum ground contact area shall be 16,000 cm ²
F. Hydraulic System	
a.	Hydraulic pump shall be of gear pump type; minimum capacity shall be 170 litre/ min @ 1750 rpm and relief pressure at 140 kg/cm ² .
b.	Hydraulic cylinders to be double acting, piston type having two cylinders for blade lift.
G.. Bull Dozer Blade	
a.	Straight Bull Dozer blade width and height shall be 2700 mm and 900 mm minimum. Its lift above ground level shall not be less than 900 mm and maximum drop below ground shall be 400 mm. The blade shall have minimum tilt adjustment of 250 mm and digging angle as 55°. The weight of blade shall not be less than 1,450 Kg.
b.	Cutting edge shall be made to extra hard carbon steel.
c.	The bull dozer blade to be with C frame built up with steel channels and plates by welding.
H. Driver's Cabin	
	An all-weather, all-steel enclosed type with lock having minimum length of 1,800 mm, width of 1,600 mm and height of 1,500 mm to be fitted on the machine. Three wipers to be provided on front wind screen and one wiper on the rear glass. Cabin must be provided with minimum one lamp.
I. Painting	
	Paint Process and Paint shall be superior quality to ensure long lasting structure resistance to rust, weathering and breakage. Colour shade shall be the Purchaser's choice selected from the standard colours offered by the Supplier.
4. Warning System and Essential Accessories- Following accessories shall be provided -	
	1 Radiator with blower fan 2 Muffler with rain cap 3 Starter motor, 4 Hydraulic track adjusters,

Purchaser's Specification	
	5 Rigid drawbar, 6 Electronic monitoring system, 7 Hinged extreme service crankcase guard, engine compartment guarding hydraulic tilt hose guard, final drive seal guard, idler seal guard, fuel tank guard, 8 Hydraulic oil cooler, 9 Replaceable bolt-on sprocket segment, 10 Warning horn, back-up alarm, lighting system, 11 Adjustable seat with seatbelt, 12 Gauge instrumentations like- Engine oil pressure gauge, Fuel pressure gauge; Water temperature gauge, High water temperature indicator, Low engine oil pressure indicator etc. 13 Lighted instrument panel, 14 Rear view mirror, 15 Electric service hour-meter, 16 Front pull hook, 17 Engine enclosures, 18 Radiator core protector grid, radiator heavy – duty hinged guard, radiator bottom guard, 19 Sealed and lubricated track group with 400 mm minimum shoe width, 20 Centre track guiding guard. 21 A tool set for minor repair and maintenance, 22 Grease gun with flexible nozzle, and fire extinguisher 2 – litre pump type 23 First aid kit. 24 24 V, 30 A alternators with built in regulator. 25 Key switch, Back up switch, Neutral switch, Charge indicator etc.
(A) The Manufacturer/Supplier shall provide following with each vehicle-	
a.	Two sets of certified net torque, horsepower and fuel consumption curves.
b.	Two copies of technical details, drawings, operator's Manual and standard tools/ parts book.
c.	Two copies of driver's manual.
d.	Two copies of Workshop and service manual.
e.	Two copies of spare parts catalogue.
f.	Warranty card for one year.
g.	Battery warranty card for one year.
(B)	After Sales Support : <ul style="list-style-type: none"> • Free service in the first year with a warranty for the machine for 1 year from the date of commissioning. • To demonstrate capabilities of giving proper service and spares after the expiry of warranty period. • Shall be capable of proposing maintenance contract for subsequent years at respective cities of Corporation.

Table 10: Technical Specification for Land Fill Compactor 450 HP

Specification	
1.	<ul style="list-style-type: none"> a. Make and Model b. Year of Manufacture c. Country of Origin
2. General Description	
a)	<p>General : The Land fill compactor should be designed for general purposes. It shall have a minimum operating weight of 40000 Kg to include full fuel tank, lubricants, coolant, hydraulic controls and operator cabin etc. and shall have a minimum Flywheel Horsepower of 450 HP at manufacture's rating. The engine fuel shall be direct injected with variable timing, adjustment free and individual fuel injection pumps and fuel nozzle valve. The unit shall be equipped with the manufacturer's standard specification as to the type of transmission, hydraulic system, type of cooling system. etc.</p>
(b)	<p>Basic Dimensions (Minimum) : Overall length : 9 m Overall width at wheel : 4 m Overall height : 4 m Wheel base : 3.5 m Inside turning radius : 3 m Ground clearance : 0.75 m Articulation +/- : 35 degree Oscillation +/- : 6 degree</p>
(c)	<p>Wheels : Standard wheel should be 48" wide with 1" thick outer drums and 8" tall one piece steel cleats with minimum overall diameter as 70". Cleats should be arranged to provide effective traction and demolition and to prevent material plugging without the use of cleaner bar.</p>
3. Basic Specification	
A. Engine	
a)	Cylinders shall be turbo charged after-cooled 6 in line"
b)	It shall be diesel fuel feed with direct injection fuel system, individual and adjustment free fuel injection pumps and fuel nozzles.
c)	Water – Cooled cooling system.
d)	1500 Watt engine block heater, 24 Volt electrical system with master switch. Maintenance free 4 number heavy duty batteries each with 100-140 Amp alternator.
B. Power Transmisison	
a)	<p>The transmission shall be of selective gear type comprising 3 gear shafts – main shaft, counter shaft and intermediate shaft, all supported by roller bearings, whose gears are so selected as to provide a total 8 speeds, 4 forward and 4 reverse speeds. It should have a splash type lubrication to ensure that oil lubricates all running and sliding parts within the transmission.</p> <p>The speed shall be 0-2.5 km/h minimum and 0-9.0 km/ h maximum for forward and 0-3.0 km/h minimum and 0-8.0 km/h maximum for reverse.</p>
C. Final Drive	
	Dependable all wheel hydrostatic drive with each wheel driven by its own independent system consisting of PC –controlled variable displacement pump, motor and planetary reduction final drive. No torque converter, no clutch, no differentials or axle shafts.
D. Steering and Braking	
a.	MC 400 electronic control system continuously calibrates all four wheels with the angle of the centre joint to improve steering, reduce component wear and increase operator comfort.
b	Joystick steering with horn button, blade control with blade, speed and directional control.

Specification	
c.	All wheel hydrodynamic braking, independent spring applied hydraulic release fail/safe parking/emergency brakes on front wheels.
E.. Undercarriage	
a.	Extra heavy duty steel construction and sealed undercarriage to make the compactor perfectly suited to rugged condition of land fill conditions.
b.	No components shall be located under the machine
F. Filtration/Cooling System	
a.	Closed/loop hydraulic drive system for each wheel with 10 micron filtration. Hydraulic circuit includes 5 micron return filtration.
b.	Oversized radiator, oil cooler and change air cooler with slide –out pre-screens for easy access and cleaning.
G.. Compactor Blade	
a.	Cutting edge shall be made to extra hard carbon steel.
b.	The compactor blade to be with C frame built up with steel channels and plates by welding.
H. Driver's Cabin	
a.	Ergonomically designed insulated and sound suppressed. Six way adjustable air ride seat, head rest and 3” wide seat belt.
b.	Illuminated analog styled gauges, MC 400 digital display screen and warning indicators.
c.	40000 BTU front and rear A/C system and 30000 BTU front and rear heat/defrost system.
d.	AM/FM radio system, MP 3 port, four speaker stereo
e.	Rear vision camera with full colour display
f.	Four exterior west coast mirrors and four front and rear two side halogen exterior lights.
I Painting	
	Paint Process and Paint shall be superior quality to ensure long lasting structure resistance to rust, weathering and breakage. Colour shade shall be the Purchaser's choice selected from the standard colours offered by the Supplier.
4.Warning system and essential accessories- Following accessories shall be provided -	
.	<ol style="list-style-type: none"> 1. Warning horn, back-up alarm, lighting system, 2. Adjustable seat with seatbelt, 3. Gauge instrumentations like- Engine oil pressure gauge, Fuel pressure gauge; Water temperature gauge, High water temperature indicator, Low engine oil pressure indicator etc. 4. Lighted instrument panel 5. Rear view mirror 6. Electric service hour-meter 7. Engine enclosures 8. Radiator core protector grid, radiator heavy – duty hinged guard, radiator bottom guard. 9. A tool set for minor repair and maintenance, 10. Grease gun with flexible nozzle, and fire extinguisher 2 – litre pump type 11. First aid kit. 12. 24 V, 30 A alternators with built in regulator. 13. Key switch, Back up switch, Neutral switch, Change indicator etc.
(A) The Manufacturer/Supplier shall provide following with each vehicle-	
a.	Two sets of certified net torque, horsepower and fuel consumption curves.
b.	Two copies of technical details, drawings, operator's Manual and standard tools/ parts book.
c.	Two copies of Driver's manual.
d.	Two copies of Workshop and service manual.

Specification	
e.	Two copies of spare parts catalogue.
f.	Warranty card for one year.
g.	Battery warranty card for one year.
(B)	<p>After Sales Support :</p> <ul style="list-style-type: none"> • Free service in the first year with a warranty for the machine for 1 year from the date of commissioning. • To demonstrate capabilities of giving proper service and spares after the expiry of warranty period. • Shall be capable of proposing maintenance contract for subsequent years

Table 11: Technical Specification for Weighbridge 30 MT Capacity

S. No.	Purchaser's Specifications
1.0	Machine :
a)	Type: Static, fully electronic, load cell based. pit less fully floating design
b)	Capacity : 30 MT with least count of 5 Kg
c)	Platform size : 9000 × 3000 mm with necessary ramps
d)	Steel Structure: The steel structure should be based on bidders own design. Top of the structure should be of 12 mm thick MS sheet with adequate design having anti-skid surface.
2.0	Load Cells Details :
a)	No. of Load Cells : 06
b)	Type : GD Rocker Pin Design with Hexagonal end Counterforce (Load Pin) for Anti-rotation
c)	Output : digital with response time of digitizer 0.1 second
d)	Accuracy : OIML, 10000d Class III –L, viz; 0.010% of Rated Capacity
e)	Rated Output Sensitivity: 2 mV/V
f)	Output Update : 10 reading per second
g)	Non Linearity : < +/- 0.017 % of Rated Output
h)	No Repeatability : < +/- 0.010% of Rated Output
i)	Overload Rating : > 300% of Rated Capacity
j)	Protection Class: Min. IP 68 (submerged in water at 1.5m. depth for 10,000 hrs.
3.0	Electronic Display Unit :
a)	Type of Display : Min. Dual Display, Vacuum Fluorescent, 7 digits
b)	<p>Key Board : 24 Position Membrane type, Tactile Feel</p> <ul style="list-style-type: none"> • 0 – 9 Keys • Scale Function Keys • Vehicle Management Software Function Keys
c)	Heights of Display : 24 mm
d)	Date and Time : Automatic calendar clock should be provided with the indicator with battery backup so that the time, date etc does not change in case of failure of power
e)	Tare : 100%
f)	Indicator : 8142PRO+ Terminal
g)	<p>Standard Interface: 2 Nos. RS232,</p> <ul style="list-style-type: none"> • 1No Rs422/485 • 1No. CL 0-20 ma • 1 No. Parallel Centronics Interface

	<ul style="list-style-type: none"> • Host Interface
h)	Password Protection : should be available
i)	Inbuilt Vehicle Management Software : <ul style="list-style-type: none"> • Stores Min.1000 transaction & 500 Trucks ID • Daily Report • Min.4 Print Ticket Format • Truck ID, Client ID, Cargo ID
j)	Memory Capacity : <ul style="list-style-type: none"> • Min. Program Memory 64K • Min. Data Memory 32K
k)	Scale Functions : <ul style="list-style-type: none"> • Push Button Tare • Keyboard Tare • Tare interlock, Automatic Tare & Clear Function • Centre of Zero indications • Auto Zero maintenance • Motion Detection & indication • Expanded Weight Display • Real-time Clock by Battery Backup
l)	Calibration: Through software only with Hardware & Software Protection facility.
4.0	General: Fully electronic with P IV computer, coloured monitor 15", 80 column matrix printer, communication, necessary software as per the requirement, additional remote display unit, 5 KVA UPS with 8 hour battery back up.
5.0	Civil Works: All civil works for installation of weighbridge such as foundation, ramps etc except weighing record room shall be done by the supplier within the quoted price.
6.0	Warranty: The equipment should have a minimum warranty of one year including the warranty for load cells.
7.0	Stamping: The supplier will get the stamping done of the weighbridge from Weights & Measure department of Government of Bhutan, initially as well as every year during warranty period.
8.0	Drawings: Drawings should be submitted by the bidder.
9.0	Trainings: Supplier should have to provide training to purchaser's staff during commissioning of the equipment and also for trouble free operation and maintenance free of cost.

4. Services For Registration and Licensing Of Vehicle

The supplier will be responsible to arrange for insurance of all equipments/vehicles in the name of the Ghaziabad Nagar Nigam before final acceptance by the purchaser. The supplier should arrange Basic Comprehensive Insurance covering at least Theft, Fire, Riots and Road accidents for one year. The price for such expenses of insurance & final registration (wherever applicable) will be quoted under schedule of services.

5. Training of Operating Personnel

All personnel designated by the Purchaser to be responsible for the operation and maintenance/repair of the equipment should be provided with practical training in the use and maintenance of the Goods, at the offices of the Ghaziabad Nagar Nigam . For this purpose, the Supplier should provide a training program for the Purchaser's personnel immediately after the delivery of the equipment. The Supplier should submit separately, with his bid documents, details of his proposed training program, the facilities required, and the training personnel to be provided. All costs for the Suppliers' personnel

involved in the training and any incidental expenses should be included in the tendered rate. All costs of the Purchasers' personnel and provision of training facilities should be borne by the Purchaser.

6. Optional Tools and Spare Parts

In addition to the obligatory tools and spare parts listed, the Purchaser, at his sole option and without any obligation to do so, may procure additional maintenance/repair tools, equipment and spare parts up to a maximum of 10% of the price of the goods. To facilitate selection of tools, equipment and spare parts, the Supplier should submit with his tender separate lists and the cost of:

- (i) Fast moving and maintenance genuine spare parts with their corresponding prices along with original technical brochures and parts catalogues; and
- (ii) All standard and specialized tools and equipment required for maintenance and repairs of the supplied equipment along with their corresponding prices.
- (iii) The lists submitted by the supplier should be comprehensive and should include all items which may reasonably be required for repair and maintenance after one year of service period. Such lists should include the Serial Number of the recommended item, description, manufacturer's catalogue number, unit price of each item, recommended quantity, and total price. The estimated cost and time of delivery should be provided separately in the Tender Schedule and this will not be considered in bid evaluation.
- (iv) Selection of the particular items and quantities to be supplied within the 10% allowance should be done by the Purchaser, in consultation with the Supplier, from the lists provided. The tools, equipment and spare parts so selected should be delivered by the Supplier at the same time as for delivery of the Goods, or as may otherwise be mutually agreed.

Appendix 8

**Appendix 8:
Transfer Station – Concept Note & Specifications**

1. Concept:

1. In large cities where disposal sites are more than 10 km away from the city boundary and smaller vehicles are used for transportation of waste, it may prove economical to set up transfer stations to save transportation time and fuel provided such cities have a good performance record of vehicle maintenance and adequate facilities to maintain large size vehicles and containers. Large size 15 to 20 cu. m. containers could be kept at transfer stations to receive waste from small vehicles. A ramp facility may be provided to facilitate unloading of vehicles or dumper places containers, directly into large containers at transfer station. Construction of complicated and expensive transfer stations must be avoided. The requirements of large containers and vehicles may be worked out on the basis of the total quantity of waste expected to be brought to the transfer station and the number of trips the vehicles will be able to make in two shifts each day.

2. Transfer System- Various stages

- (i) Unloading – unloading of collection vehicles and temporary storage of wastes, if needed.
- (ii) Loading – loading systems for transfer vehicles at the transfer station
- (iii) Transport- Bulk haulage in transfer vehicles
- (iv) Discharge- Unloading of transfer vehicles at the disposal site

3. Unloading -Two types :

- (i) Direct unloading
- (ii) Unloading to storage

4. Direct Unloading

2. It involves collection vehicles discharging directly into transfer vehicles or their loading systems. A two level arrangement is required. Wherein the collection vehicles drive up a ramp to the upper level in order to discharge into a transfer vehicle parked or loading system (conveyors and/or stationary compactors)

Advantages	Disadvantages
Least investment- as no storage of wastes, therefore building size, area for circulation etc is minimized.	Size of the transfer fleet has to be large as vehicles will be engaged in direct unloading
No storage of waste therefore odour and insect nuisance would be less	Short period of transfer operations as collection vehicles arrive within 1-2 peak hours per shift.

5. ***Unloading –to- Storage system***

3. In this system collection vehicles discharges into a storage area, which may be a platform on the same level/ pit below the level/ above the level; from where the waste is subsequently reloaded into transfer vehicles with help of separate equipment like poclain/loader. This system requires civil works for storage of waste, movement of vehicles and equipment for loading and transportation. The storage area is commonly designed to hold the peak quantity of waste generated in one day.

Advantages	Disadvantages
Long duration available for transfer operations	More investment is required
Collection operation is possible with relatively small fleet size	Odor and insect problem due to longer duration of waste storage

6. ***Loading Design concepts***

4. There are various systems for loading waste into transfer vehicles. The most common loading systems are outlined below:

Direct Loading to Transfer Vehicle

5. Waste discharged from collection vehicles or from the storage area drops by gravity through a hopper directly into an open-top transfer vehicle. A knuckle-boom crane may be mounted at the mouth of the hopper and used to distribute the load evenly within the transfer vehicle.

Loading by Stationary compactor

6. Waste drops through a hopper into a stationary compactor which is mounted on the floor of the lower level of the transfer station. The compactor contains a hydraulically driven ram which pushes the waste from the compactor’s receiving chamber into the body of the transfer vehicle. The body of the transfer vehicle must be adequately reinforced to take force of the ram.

Loading by Pre-load Compactor

7. Waste drops through a hopper into a preload compactor which is mounted on the floor of the lower level of the transfer station. The pre-load compactor contains a hydraulically driven ram which pushes the waste from the compactor’s receiving chamber into a compaction chamber. The compaction chamber is reinforced to take the force of the ram and sized to make a compacted unit which would readily fit within the body of the transfer vehicle. Once the compacted unit of waste is fully formed, it is extruded from the compaction chamber into the transfer vehicle. Because the transfer vehicle does not receive compaction forces, it does need not be reinforced to take the force of the ram.

Direct loading to self-contained compaction vehicle

8. Waste drops through a hopper into a self-contained compaction vehicle. A movable bulkhead mounted at the front of the body of the vehicle pushes the waste toward the back doors of the body. Compaction is achieved as the waste's void spaces are reduced and forces from the bulkhead are applied. The same movable bulkhead which compresses the waste is also used to push it from the vehicle at the disposal site. The body of the vehicle must be reinforced to take the force of the ram.

7. *Transport Design Concepts*

Few of the transfer vehicles are discussed below

9. **Open Top Trailers.** These trailers are open at top and have doors at the back. After filling, the waste is covered (i.e. by tarpaulin) so that it doesn't blow out during transport. Open top trailers are loaded from the top by gravity feed through a tipper. They also can be loaded from the back by the pre-load compaction loading system.
10. **Closed Top Trailers.** These trailers have side walls and roofing and doors at the back. Closed top trailers are loaded by pre-load compactors. The untied bale of waste is extruded from the compactor into the body of the trailer.
11. **Compactor-Compatible Closed Top Trailers.** These trailers have side walls and roofing and doors at the back. Compactor-compatible closed top trailers are loaded by stationary ram compactors. Unlike the light weight trailer described above, the sides and roofing is reinforced to be able to receive the forces of the ram.
12. **Self-contained Compaction Trailers.** These trailers are closed at the top except for an opening to receive waste near the front of the top. They have side walls and roofing and doors at the back. The movable bulkhead is mounted at the front of the trailer and pushes from the front toward the closed back doors. The side walls, roofing and back doors are reinforced to be able to receive the forces of the movable bulkhead. The movable bulkhead is also used for discharging the waste at the disposal site and operates by pushing the waste out the back when the doors are opened.

8. *Discharge Design Concepts*

13. A discharge system may be either self-contained (mounted on the transfer vehicle) or external (located at the disposal site). The main discharge systems are discussed below:
14. **Push-blade.** The push-blade discharge system is a single tilted blade sized to fit within the full cross-sectional area of the trailer body and pushed from front to back, in order to push waste out the back. The blade is pushed by one or two hydraulic cylinders mounted between the blade and front of the trailer. To discharge its load, the transfer vehicle is driven onto the landfill area, backed up to the working face, its back doors are opened and the load is pushed out backward by the push-blade. The push-blade system is compatible with closed top trailers which have been loaded by stationary compactor or pre-load compactor systems.

15. **Live floor.** The live-floor discharge system is a series of slats mounted on tracks which run from front to back along the trailer floor. These tracks move sequentially to walk or shuttle the load out of the trailer. Three hydraulic cylinders mounted below the floor actuate the walking motion. To discharge its load the transfer vehicle is driven onto the landfill area, backed up to the working face, its back doors are opened and the load is walked out the track by the live-floor. The live floor system is compatible with open top and closed top trailers and with loading by direct, stationary compactor or pre-load compactor systems.

16. **Frame – Mounted Tipper.** The frame-mounted tipper discharge system involves two hydraulic cylinders mounted on the frame of the trailer. These cylinders lift the front of the trailer body so that the tilt angle of the body and the weight of the load under gravity cause the load to fall out from the back. To discharge its load, the transfer vehicle is backed up to the working face, its back doors are opened and the trailer body is tipped and the load falls out the back opening. The tipping system is compatible with open top trailers which have been loaded by direct dumping from collection vehicles into the trailers and with closed top trailers which have been loaded by pre-load compactor.

17. **Mobile- Tipper.** The mobile tipper is not a self contained discharge system, unlike the systems mentioned above. The mobile tipper is a track mounted machine which is located at the working face of the landfill for the purpose of lifting transfer vehicles and discharging their loads. A transfer vehicle is driven onto the mobile-tipper and the vehicle's back doors are opened. Two hydraulic cylinders lift the front of the tipper's platform and the weight of the load causes it to fall out the back of the trailer. A bulldozer at the back of the mobile –tipper pushes the discharged load away, making room for discharge of the next load. The mobile-tipping system is compatible with open top trailers which have been loaded by direct dumping from collection vehicles and with closed top trailers which have been loaded by pre-load compactors.

9. *Factors considered before designing*

18. Following are the important factors considered before designing transfer station facility:
 - (i) Quantification and characterization of waste to be handled
 - (ii) Site location, distance from city centre and access from main road. Preferably within 10 km from the city centre and near to the highway on the way to disposal site.
 - (iii) Site should be away from residential, educational activity
 - (iv) Need for Environmental Impact Assessment
 - (v) Zone and wards identification from where MSW could be brought for transfer and transportation
 - (vi) Infrastructure facilities to be available like access road, water supply, electricity, drain outlet etc
 - (vii) Ideal system with justification
 - (viii) Investigation and analysis exercise
 - (ix) Selection of appropriate equipment and transporting vehicles for efficient operation

- (x) Workshop and parking facilities
- (xi) Transportation operation and Manpower management

10. *Infrastructure Facilities required*

19. Following minimum infrastructure facilities are required for an ideal Transfer Station:

- (i) Administrative office, toilet , water supply etc
- (ii) Weighbridge of 30 MT capacity with control room
- (iii) Compound wall on all sides with gates and security arrangements
- (iv) Workshop
- (v) Parking facilities with cement concrete pavement
- (vi) RCC Ramps with separate arrangement for movement of loading and unloading vehicles
- (vii) Deck slab for unloading the waste, 2 number S.S. hopper with hydraulic shut gate
- (viii) Two number of compaction units, sufficient numbers of hook lifters and large capacity containers
- (ix) Street lighting, drainage and other utilities
- (x) Emergency devices, first aid box etc.

11. *Specifications for equipments*

a) Transfer Station Compactor

20. **Bottom Frame :** The bottom frame shall comprise two longitudinal Domex™ steel runners with a yield-strength of 690MPa and key traverse reinforcements of the same material. To the rear of the system the pivot point of the tipping frame shall be attached using one chromed steel axle carried in bronze bearings. The pivot point shall be situated as low as possible into the bottom frame, well beneath the separate axle carrying the rear rollers, which will support a container's lower frame, so that the tipping capacity of the cylinders is augmented. To the front of the frame the cylinder bridge construction shall be located providing a strong and solid attachment for the main cylinders, while channelling the tipping forces to the truck's chassis via the bottom frame. The tipping frame shall automatically locks onto the bottom frame during the unloading procedure into clasps located on the inner side of the bottom frame runners.
21. **Tipping Frame :**The tipping function shall enable the system to empty containers with rear doors. The tipping frame shall pivot at the rear of the system's bottom frame and support the rear rollers made from steel or high grade cast iron, which shall rotate in bronze bearings. To the front of the tipping frame a steel locking plate shall be welded, which shall catch a spring activated locking bolt extending from the main frame when tipping frame and main frame shall be locked jointly for tipping.
22. **Main Frame:** The main frame shall house the hook mast sliding arm and enable the

dismounting process. This frame shall pivot around an axle which should rotate in bronze bearings, situated to the front of the tipping frame. During the dismounting process the rotation of the pivot axle shall lock the tipping frame onto the bottom frame. A double action hydraulic cylinder placed in the sliding arm shall provide a forward and reverse movement. The main cylinders shall be connected to the main frame at the cylinder joke.

23. **Sliding arm** :-The sliding arm shall provide the possibility to transport containers of various lengths. To enhance the sliding, maintenance and lubrication free PA6G oil filled polyamide synthetics shall be utilized. To enable the dismounting operation, the locking bolt that links main frame and tipping frame during tipping must be disengaged. Sliding into the main frame at the end, the sliding arm shall reach the locking bolt and open it. Sliding out towards the front, the spring shall move the locking bolt back into place.
24. **Hook Mast** The hook height shall be standard at 1570 mm. Other hook heights shall be available on request. Task into consideration that lower hook heights shall reduce the capacity of the Hook loader. On request a mechanical (2 positions) height adjustment shall be available.
25. **Knuckle arm:-** At the bottom the hook mast shall be attached to the sliding arm by means of an elbow-like construction thus enabling the mast to pivot from a vertical position to an oblique of 60 degrees. Hence the radius the hook mast travels during (dis.) mounting operations shall be reduced. The advantage is a decreased inclination of the container during this phase essential for loose goods and placing containers on railway carts, when height restrictions need to be adhered to. The standard removable hook on top of the mast shall be fabricated from low wear WELDOX™ steel with yield strength of 700MPa and features a self-locking mechanism using an ex-center weight.
26. **Container Locking** :-System will be delivered standard with combi-lock (in-and outside). (Except type 300 KN)
27. **Short blasting and painting** ;-Every component of the Hook loader shall be separately short blasted and thoroughly painted with a durable primer previous to final assembly, thus assuring superior corrosive protection and an extensive life span.

Hydraulic System

28. **Features:-**The hydraulic system shall comprise two double action high-pressure main cylinders, one sliding cylinder, valve block and all necessary piping, hoses and connectors. Further a Hyva oil tank shall be separately provided including return filters. Standard every Hook loader is provided with hose-burst protection and an automatically hydraulic blocking of the sliding function during tipping operation.
29. **Hydraulic pipes / Valve block** :-The hydraulic piping shall go trough the under frame of the hook loader. The connection of the hydraulic pipes to the valve block shall be with using hydraulic hoses.

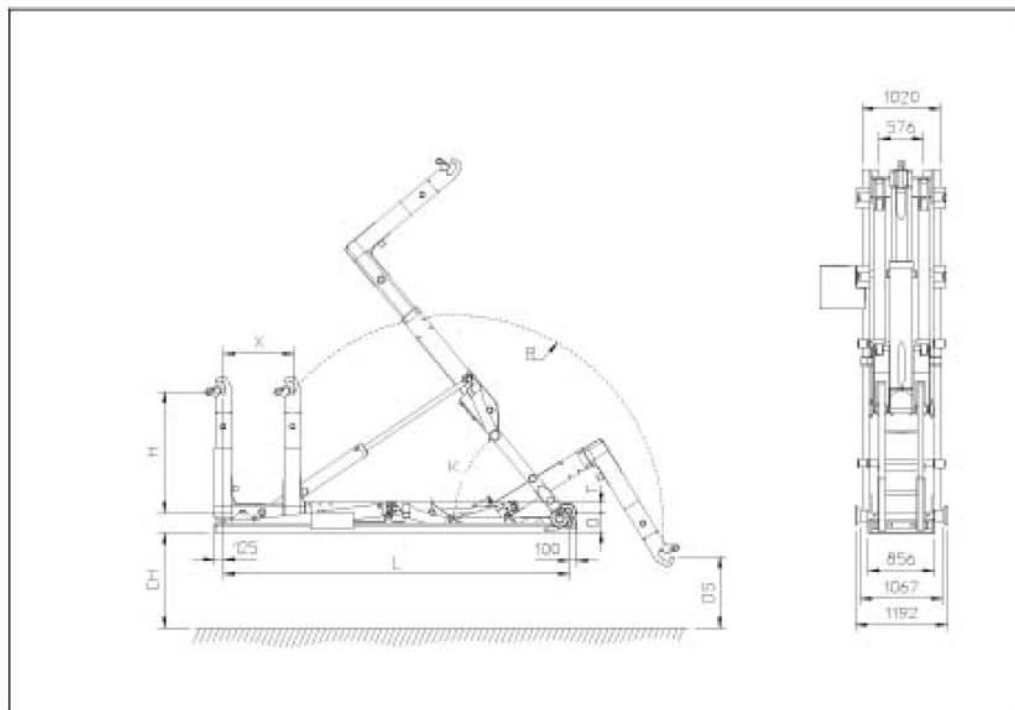
30. **Pump:-** No pump shall be provided standard as several kinds can be selected or a pump already available on the truck. The pump can be selected from the General Options price list.
31. **Adapters:-**In most cases an adapter shall be necessary to fit the pump on the P. T. O. The P. T. O. is fitted on the truck prior to mounting the Hook loader.
32. **Extra functions**For additional applications extra hydraulic functions shall be integrated in the main valve block ex-works. However, this must be ordered with the Hook loader.
33. **Main Controls** The Hook loader equipped with pneumatic in cab controls. The main cylinders shall be activated through proportional operation.

Emergency Controls
34. **Emergency Controls** The main valve block shall be located to the left side of the truck and shall be operated with an emergency handle in case of a malfunction of the in-cab controls.

General
35. **General:-**Hook loaders shall be fabricated in accordance to the EG machine directives and display the CE sign. The CE sign warrants optimal safety for the user. Further detailed technical shall be furnished on separate specification sheets.

Further variations and adaptations are possible on requests. Please contact the engineering department for details.

Capacity 220 kN (-S) H = 1570 mm Ch = 1050 mm

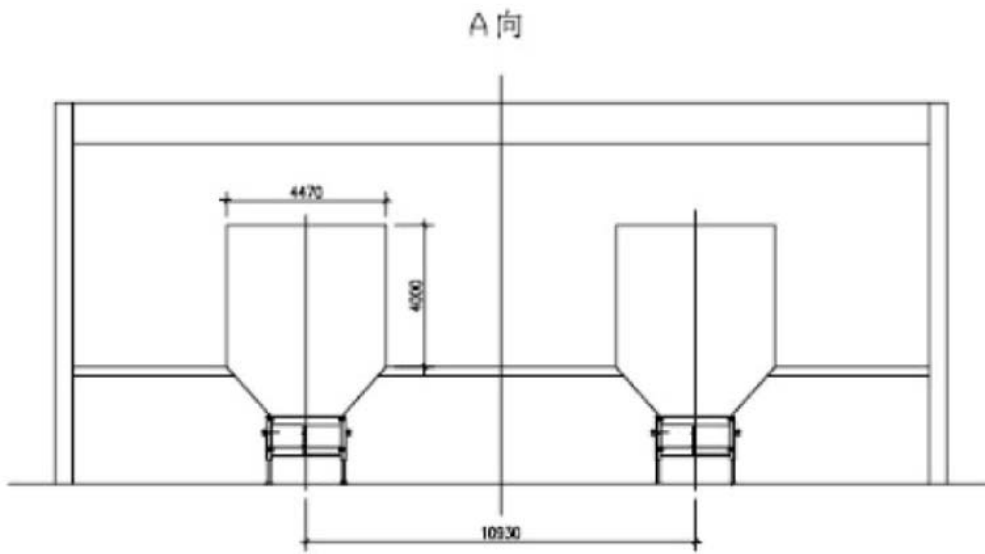


TYPE:	22-45-S	22-47-S	22-49-S	22-51-S	22-53-S	22-55-S	22-57-S	22-58-S	22-60-S	22-62-S	22-65-S
X (mm)	800	1000	1000	1000	1000	1200	1200	1200	1400	1400	1500
L (mm)	4500	4700	4900	5100	5350	5550	5700	5900	6000	6200	6500
O (mm)	290	290	290	290	290	290	290	290	290	290	290
K	50°	57°	53°	53°	49°	49°	47°	49°	49°	47°	48°
R (mm)	2725	2980	2980	3045	3045	3045	3045	3125	3125	3125	3340
T (mm)	130	130	130	130	130	130	130	130	130	130	130
Weight ¹ (kg)	2300	2375	2400	2425	2450	2475	2500	2550	2600	2625	2800
DS (mm)	951	1054	1054	1167	1167	1167	1167	1120	1120	1120	1137
Min./max. container length (mm)	3650-5800	3750-5800	3850-6000	4200-6200	4400-6450	4400-6550	4550-6800	4650-6900	4650-7100	4850-7300	5060-7600
Loading (time) ² (s)	38	37	37	42	42	43	43	45	46	46	55
Unloading (time) ² (s)	47	49	49	54	54	56	56	58	59	59	70
Tipping (time) ² (s)	42	43	43	49	49	49	49	51	51	51	61
Fast unloading (time) ² (s)	17	19	19	19	19	21	21	21	22	22	24

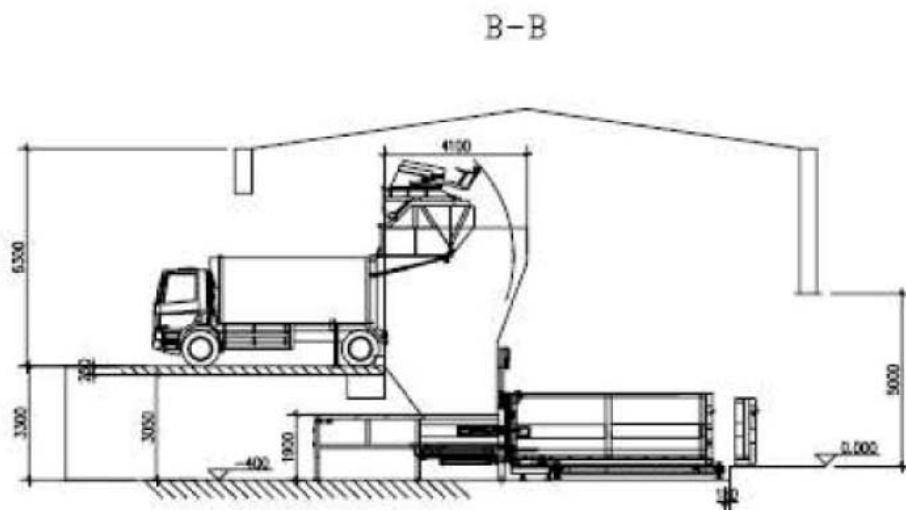
H = Hook height, CH = Chassis height, DS = Lowest tipping point (depending on hook- and chassis height)

¹ Rough estimation based on a standard system, filled with oil and without mounting kit accessories.

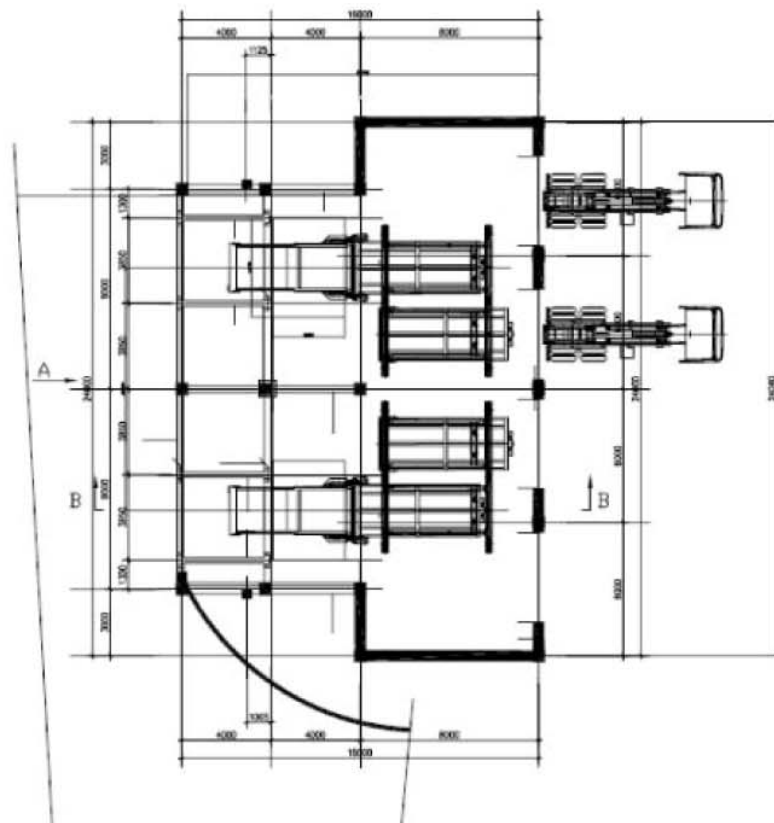
² Rough estimation based on PTO type C, pump 80 l/min., motor 1200rpm, PTO transmission i = 1.0 and dependent on cylinder thickness.



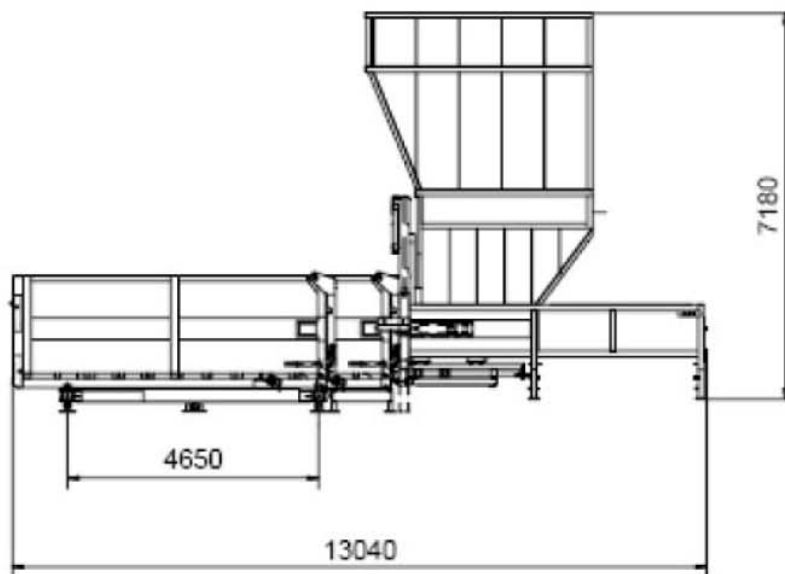
ROOF & RAMP LAY-OUT OF MACHINE HM 35 / 35



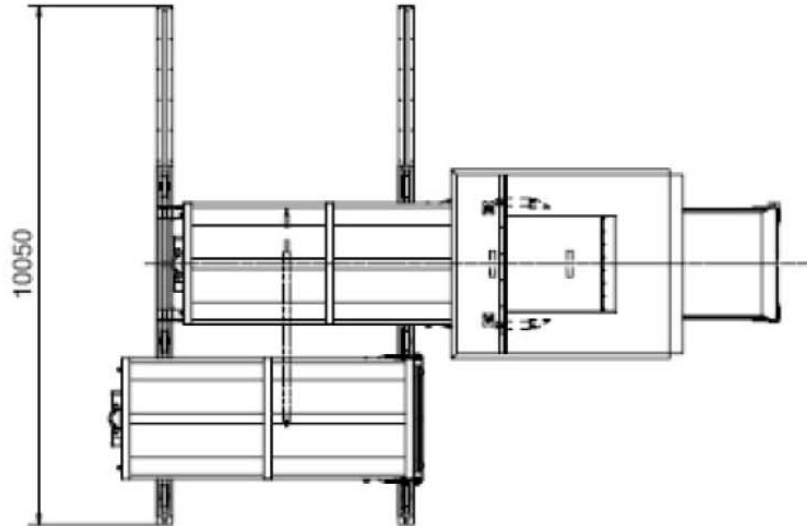
PLAN LAYOUT FOR TWO MACHINES OF MODEL HM 35 / 35



OVERALL DIMENSIONS OF MACHINE MODEL HM 35 / 35



PLAN-LAYOUT OF MACHINE HM 35 / 35



General Lay-out Waste Transfer Station,



Illumination of project configuration

1. The maximum daily managing volume is 6000; the building is a two-floor construction. The dumping way is ramp top loading.
2. The total area of the transfer station is 2000 square meters (not including ramp way) building area is 2500 square meters.
3. The layout of control center is double floor. (Between two equipments) Use translucent glass. The room area is more than 25 square meters.
4. The electricity is 380V, 50Hz. Three phase five lines, total power is 1000KW.
5. Surfaces, ventilation, fire control, construction strength level must accord with national standard.

b) Hook Lifters

Product Description:

36. Truck Mounted Hook Loader, suitable for lifting 20 M3 capacity container – Payload capacity of 15,000 Kgs (waste only), shall be designed to pick up the loaded or empty skip containers, transport, dumping of material and thereafter unload the skip containers safely and faster. The telescopic Jib enables proper load distribution on the chassis.

Technical Features:

37. Designed to handle containers of 20 M3 capacity. The dumping mode shall be achieved by operating the main rams, actuating arm and tilting frame, with jib extended, pivoting around the rear shaft.
- (i) A sub-frame made out of bend steel plates and cross members shall be mounted on the truck chassis frame.
 - (ii) A tilting frame hinged to the sub frame with a steel shaft shall carry the rear cantering rollers.
 - (iii) A main arm hinged on the tilting frame with a mechanical locking mechanism shall allow the dumping mode.
 - (iv) A telescopic jib, sliding in the arm, supporting a wide-open lifting hook shall enable loading of container.

Technical Specifications:

- (i) Payload Capacity : 15,000 Kg. (Excluding Skip container Dead Weight)
 - (ii) Hydraulic Specifications:
 - Pump-Axial piston
 - Controls- Hydraulic Control Valves – Manual
 - Hydraulic Tank – 100 Liters
 - Filter-10 micron, return line with replaceable cartridge
 - Arm cylinders (lift cylinders) 2 Nos., double acting, equipped with counter balance valves and built in by pass valves.
 - Jib cylinder (slide cylinders) – 1 No. Double acting, equipped with built in counter balance valve Hoses, tubes & fittings.
 - (iii) Safety Devices:
 - Safety valve prevents jib operation during dump mode
 - Automatic locks on arm
 - Slide through container catches
- . Specifications for containers of 20 cum capacity, compatible to hook lifters

c) Technical specifications:

General Description :

38. The closed top type containers shall be compatible with Hook loader as well as stationary compactor to be installed at transfer stations. The container shall have rear door opening for unloading the collected refuse at processing site. They shall also have locking arrangement to lock them with stationery compactor while loading the refuse.

39. Specific Specifications:

Volumetric Capacity	20 CuM
Base	6 MM
Floor Plate	As per ISMB 180
Rollers	2 Nos. rear side
Material	As per BIS 2062

40. Other Parameters:

- (i) The design of container should be compatible to the Hook Loader with all safety arrangements.
- (ii) Proper sealing arrangement shall be provided in the container to avoid spillage of garbage & leachate during transportation.
- (iii) The container shall have arrangement to drain the leachate formed during compaction in the drain.
- (iv) The container shall be painted with anti-corrosive paint from inside & outside.
- (v) All the containers shall be numbered for an identification & record purpose.

Appendix 9

Concept Note on Processing & Treatment & Specifications for Compost Plant

a. Introduction:

1. The decomposition of organic matter in municipal solid waste causes environmental pollution. Adoption of various treatment methods not only reduces the pollution potential of solid waste but also renders suitable options thereby avoiding its adverse impact on environment. Some of the treatment methods yield a recyclable product from solid waste. These products have re-sale value and thereby reduce the expenditure on processing and disposal.
2. Treatability for the processing of the solid waste depends on the Physico-Chemical characteristics of the waste. Organic matter primarily due to its nutrient level and biodegradable component is one of the factors influencing the treatability.

b. Processing of Solid Waste:

3. Processing of solid waste, besides reducing its pollution potential, also reduces the quantity for disposal (filling etc.). Considering the limited availability of space, methods which result in a product or by product that can be used, should be preferred. Several methods are being adopted for utilization of organic matter. As the organic fraction generates odour, invites flies & stray animals and decomposes under natural conditions, more emphasis is laid on utilization of organic fraction.
4. The biodegradable waste can be processed by composting, vermi composting, anaerobic digestion or any other appropriate biological processing for stabilization of wastes. It should not be directly sent for disposal. Regarding Solid waste to energy, it should be either thermally treated or biologically treated.

c. Description of Technologies

5. Two types of technologies are available- (1) Biological (2) Thermal

(1) Biological Treatments

The various biological treatment alternatives are as follow:

- (i) Composting (ii) Vermi composting (iii) Anaerobic digestion

6. **Composting**

Composting is a controlled process by which biodegradable waste get decomposed through micro-organisms. All organic matter can be composted. Animal excreta especially cow dung; bird droppings, dung of horses, goats, pigs, dogs and cats added to the decomposing organic matter hastens composting. Biological matters that can be composted are shown in Table 1 below:

Table 1 showing compostable waste components

Kitchen wastes	Peels Food remains Egg shells Coffee dregs Tea leaves Meat , crushed bones Rotten vegetables and fruits
Garden wastes	Fallen leaves Dead leaves Weeds(dry) Harvest residues Fallen fruits and flowers
Unsanitary wastes	Uninfected sanitary napkins & diapers(without plastic shield)

7. Composting can be carried out at the local level through compost pits and heaps and at the central level through composting plants, when the quantities are more. Biological treatment of waste is opted when the organic fraction of solid waste is high, the inorganic content is low and toxic components are absent. For optimum composting, an initial C/N ratio of 25-35 is desirable. In case it is too low, carbon will have to be added in the form of paper, straw, saw dust and in case of too high a C/N ratio addition of source of N in the form of blood, slaughter house waste, fish scraps, night soil, sewage sludge etc.
8. **Mechanical compost plant** consists of various processes unit each serving a specific purpose. The mechanical compost plant should be installed after market survey and proper propaganda amongst the farmers. Moreover there should be demonstration plot where compost effect on yield and soil productivity could be demonstrated. This may be done in association with State Agriculture Department.
9. **Merits of Composting**
 1. The process involves conversion of the waste into useful and marketable materials and thus reduces the load on disposal sites and ultimately reduces cost of disposal.
 2. The product contains essential plant nutrients, NPK as well as some of the trace metals which are important from the plant growth point of view. Compost improves soil quality.
 3. The process is quite rugged and simple to operate.
 4. The process does not require highly skilled personnel to operate it.
 5. When compared with other technologies, the capital cost as well as the operating cost is the least.
10. **De-merits of Composting**
 1. If the plant is not operated properly, the smell and odour problems as well as leachate from the pre-fermentation yard may pose environmental problems.
 2. The inorganic which can not be recycled have still to be disposed off at land fill.

3. The compost produced has a larger volume for the same nutrient content and hence poses problems in transport and marketing
4. As the process is carried out in the open, it is adversely affected by heavy rains etc.
5. Due to non-segregated waste, quality of waste sometimes is not very good.
6. Lack of marketability due to fixed notion in the minds of farmers in favour of chemical fertilizers, which is provided on subsidized rates also.

11. **Vermi Composting:**

“Vermi” stands for process facilitated by worms. Earthworms eat soil and various kinds of organic matter which undergo complex biochemical changes in the intestines which are then excreted out in the form of granular castes of earthy smell. Earthworm excreta together with their cocoons and undigested food are called vermi-castings. Some earthworm species which live close to the surface and have greater preference for organic matter than soil can be isolated and used to produce vermin-castings. Application of vermi-castings to plants is similar as in the case of compost or organic manure. This process is only suitable for small quantities.

12. **Anaerobic Digestion (Biomethanation):**

In anaerobic digestion, organic fraction of solid waste is separated, the particle size is reduced by grinding and this separated material is anaerobically digested at temperatures ranging in 24-31^o C. Anaerobic digestion involves bioconversion of organic matter to a gaseous mixture containing mainly methane & CO₂ and solid and liquid residues. The gas has a low calorific value and the residue stabilized solids have good fertilizer value and can be used as manure.

13. **Merits of Biomethanation**

1. The process results in the generation of Bio-gas which can either be directly used or converted to electricity. Use of the gas also helps reduce green house gas emissions.
2. The digested residue can be used as compost.
3. The land required for the plant is comparatively less.
4. Power requirement is less.
5. As the process is enclosed, environmental problems are less.

14. **Demerits of Biomethanation**

- 1 The capital cost for setting up of the plants is comparatively higher.
2. The operation of the plant requires trained personnel.
- 3 The liquid discharges coming out of the plant have still to be treated in a waste water treatment plant to satisfy the pollution control board standards.
- 4 Due to the comparatively lower temperature to the digester the digested residue may still contain pathogens, parasites and weed seeds. This also poses problems in the sale and use.
- 5 The process is not suitable for waste containing less organic matters

15. **Thermal Treatments**

There are three types of thermal treatments in practice known as:

(I) Refuse Derived Fuel (II) Pyrolysis (III) Incineration

16. **Refuse Derived Fuel (RDF) or Palletisation:**

The municipal solid waste (MSW) is initially dried to reduce the moisture content. It is then screened to remove sand, silt and soil. It is then processed to remove and separate glass, metal and other contraries. Sometimes the waste is further subjected to air separation and then shredded. The size reduced material can be directly used in boilers on site. If the material is to be used offsite, it is usually densified into pellets and then transported to the place where it is to be used. The pellets are normally used as a substitute to the traditional fuel like coal.

17. The process of pallet manufacturing is described below:

MSW in raw form is taken to the plant site, where sorting of large stones, tyres etc takes place, iron pieces get separated out with help of magnetic separators, after primary size reduction the waste is dried under Sun or hot air dryers for moisture reduction. In the screening section, the waste is passed through various sized screens, after which it is taken to the Air classification unit for separation of rubber, glass, woody bye mass and leather. At this stage, plastic is separated out and the product is in form of RDF (fluff). The fluff is taken to the secondary size reduction section, from where stone and inert material get separated out and volume of final product is reduced substantially. For converting fluffs into dense form of Pallets, product is taken to densification unit for ultimately conversion into Pallets as shown in picture below. By this time, the calorific value of waste gets increased up to 4000-5000 Kcal/kg suitable for being used as substitute to traditional fuel like coal. It is obvious that there would be a marginal drop in % carbon di oxide & Suspended particle emission by using pallets as compared to coal. Thus using of fuel pallets shall not only help in reduction of cost but also be more environmental friendly as compared to traditional fuel.

18. **Merits of Palletization**

1. the process is quite simple and easy to operate
- 2 It results in production of useful material which can be used either in industries or households or even burnt in incinerator or pyrolysis plants.

19. **De-Merits of Palletization**

1. If the material has to be used as an industrial fuel, it requires modification in the design of the burners and boilers.
2. it does not require skilled staff for operation
3. The capital cost of the plant is low
4. The RDF is known to contain heavy metals and when burnt it may lead to air pollution problems.
5. The operation of the plant poses aesthetic problems.
6. The inorganic are still to be disposed off and a land fill has also to be operated.

20. **Pyrolysis**

The process of pyrolysis or destructive distillation has been used for the production of charcoal and is also used in many industrial applications. However, the adoption of this technology for the processing of Municipal Solid waste is of recent origin and only a very few such plants have been set up in developed countries.

21. Pyrolysis is an irreversible chemical change brought about by the action of heat in an atmosphere devoid of oxygen. Gasification involves thermal decomposition of organic matter at high temperature in the presence of limited amount of air/oxygen. The processes are carried out at a temperature between 500-1000°C to produce three streams-

1. Gas- It is a mixture of combustible gases
2. Liquid- it contains tar, pitch, light oil and low boiling organic chemicals like acetic acid, acetone, methanol etc.
3. Char- it consists of elemental carbon along with the inert materials in the incoming waste. It is observed that out of the heat contained in the waste 67-75% is recovered but when the heat recovered is compared to that provided as input, there is a heat loss due to endothermic nature of reaction.

22. **Merits of Pyrolysis**

1. it requires the least land space for equal capacity
2. it does not result in any air pollution
3. the products of the process all have a heat value and can be utilized

23. **De-merits of Pyrolysis**

1. the process performance is not established so far.
2. The products will require extensive marketing efforts
3. the plant requires skilled operation
4. the process is costly
5. the use of products such as oil require modification of burners and other equipment
6. The generated waste water is highly polluting and needs chemical, biological as well as tertiary treatment.

24. **Incineration**

This is suitable for wastes having high calorific value, low moisture and less inorganic waste, which can have self sustained combustion. In this process, the waste is burnt in an excess amount of oxygen under controlled manner in specially designed machines. The ash from the burnt waste often contains lead and cadmium among other heavy metals, which are dumped into land fills from where, they may leak out, contaminating water and environment.

25. **Merits of Incineration**

1. It requires less land.
2. Burning at high temperature causes killing of pathogens.
3. Hygienic operation.
4. Large volume reduction (up to 90%).
5. Recovery of waste heat is possible if incinerated in large quantity

26. **Demerits of Incineration**

1. Incineration is not suitable for waste having low calorific value and high moisture. Chemical composition is essential before taking final decision.
2. Incineration is carried out in excess amount of oxygen and the resultant emission contains highly troublesome gases and particulates, therefore proper incinerators need proper air pollution control devices and prove to be very expensive. The gaseous emissions include Carbon Di Oxide, Sulphur Di Oxide, Oxides of Nitrogen, Dioxins and Foran. The last two are said to be responsible for health hazard. Dioxin and Foran are generic terms referring to special family of chlorinated benzene ring compounds. Though 210 compounds of Dioxin and Foran exist, but mainly, tetra series containing 4 chlorine atoms are considered as the most toxic compound.
3. Air pollution control equipment has to be provided which increases the capital cost of incineration.
4. The ash from the burnt waste also contains toxic elements like, arsenic, lead, mercury and cadmium, (neuron toxins and nephro-toxins, respectively) among other heavy metals, which when leaked out from the dumping place may harm water and environment. Treating the ash containing toxic elements beyond limits is also a costly affair.
5. Due to rapid increase in fuel cost, the operation and maintenance cost is also high. Additional cost is also required to solve the problem due to fouling and slagging in the furnace.
6. The system requires high technical skill to manage the operations.

B. Critical Review of Various Technological Options

27. Every technology is required to be examined according to suitability as per the quality and quantity of waste, merits and demerits, the environmental requirements, operation and maintenance requirements, economic aspects, land and traditional man-power requirement, stage of development, applicability in local context and past success record.
28. A comparative assessment of various options is shown in the table 2 below :

Table 2: Comparison of various options

Processing options	Technology	Capital cost	O&M cost	Need For High Skilled operators	Land requirement
Compost	Proven	low	low	Not much	medium
Vermi compost	--do--	low	low	--do---	---do--

Anaerobic digestion	Not proven	large	high	required	--do---
RDF	Proven	high	high	--do--	large
Pyrolysis	Complicated	high	high	--do--	less
Incineration	---do---	high	high	--do--	less

29. **Conclusion :**

At present, no processing system exists at Ghaziabad. For any processing system, physical-chemical characteristics of solid waste and its quantity are the two key factors which decide the various options to be considered for various processing system. Chemical composition for Ghaziabad waste has been carried out during solid waste survey conducted during 27-29 th December 2008. While evaluating the composite average value, it is found that the biodegradable fraction at source in wet condition is 55.94 %; recyclable 28% and Non biodegradable + inert percentage is 16 % while the MSW characteristics at disposal site which is likely to be processed in wet condition has 58.09% biodegradable fraction; recyclable material is 13% while Non-biodegradable + inert is 29 % .The variation is on account of the rag pickers who collect the recyclable fraction during collection, transportation and at disposal site. With this characteristic of Ghaziabad waste, a suitable, viable option is possible in from of integrated processing plant, comprising of **Composting** for wet waste, **Vermi composting** for pure biodegradable waste. A substantial quantity can be processed while the remaining may be about 20% is to be disposed off by sanitary land filling method.

C. **Composting:**

Composting is controlled, natural safe method of decomposition of biodegradable material by bacteria and micro-organisms. Composting is of two types: (1) Anaerobic (2) Aerobic

30. **Anaerobic:** This is conventionally carried out in pits where alternate layers of waste and night soil are laid under anaerobic condition. The pit is completely filled and a final soil layer is laid to prevent fly breeding, entry of rain water and for conservation of the released energy. The material is allowed to decompose for 4-6 months, after which the stabilised material should be taken out and used as compost. This method requires longer time for stabilisation needs large land surface and generates lot of smell and odour, therefore is not considered suitable for Ghaziabad.

31. **Aerobic:** Aerobic composting is the breaking of biodegradable material by micro organisms and fungi under aerobic, moist conditions. The naturally elevated temperatures foster microbial growth, kill weed seeds, encourage pathogen die off, kill helminths and cysts and avoid generation of noxious gases. During composting, the readily biodegradable material is oxidized (converted to carbon di oxide, heat and water), leaving an organic residue (humus). The metabolic heat generated by the micro organisms elevates the temperature of the mixture. The heat, if not too high (< 60° C), promotes rapid decomposition as a result of the built up microbial biomass. Temperatures in excess of 55° C for 3 days are effective in killing weed seeds. Success with composting depends on providing

the conducive conditions to the preferential conditions of desirable microbes. Anaerobic conditions, noxious odours, changes in the pH, moisture content, and temperature can hamper microbial activities; therefore a high degree of control of temperature and moisture is required to achieve a satisfactory product. The final material must have a relatively high void ratio, warranting the use of low density blending agents.

32. In this process, organic matter is stabilised, moisture also changes, non compostable are rejected, and thus the volume of final product is reduced by 50 % of input. Further, this method requires lesser time for stabilisation, needs less land space and does not generate any odorous gases, therefore is recommended for Ghaziabad.
33. **Windrow Composting:** In areas/regions where high ambient temperature is available, windrow composting is preferred. In this method, refuse is delivered on open paved surface on sufficient space for storing the waste of about 20 days. The waste shall be kept in form of windrows, with each of size 5m long × 2 m wide ×2.5 m height. The size of the windrow shall depend upon the volume of each day's waste.
34. Each windrow would be turned on 6th, 11th, 16th and 20th day to destroy insects, larvae and to provide aeration. On 24th day windrow would be broken down and passed through screens of about 25 mm size to remove oversize contrary material. The screened material should be stored for 20-30 days in heap of 2 m wide ×1.5 m height to ensure further stabilisation. The material should be further screened through 4 mm size, mixed with additives for improving the quality and packed in small packages as per the requirement of the market.
35. **Factors Affecting the composting process**
 - (1) **Organisms:** Aerobic composting is a dynamic system wherein bacteria, actinomycetes, fungi and other biological forms are actively involved. Majority of organisms responsible for composting are present in organic waste. Different organisms play predominant role in breaking down different constituents of municipal solid waste. Thermophilic bacteria are mainly responsible for breaking the proteins. Fungis and actinomycetes are responsible in decomposition of cellulose and lignin. The relative preponderance of one species over another depends upon the constantly changing food supply, temperature and substrate conditions. In the initial stages mesophilic forms predominate and thermophilic bacteria and fungi soon take over except final stage of composting. Except when the temperature drops, actinomycetes and fungi are confined to only 5-15 cm of outer surface layer. If the turning is not carried out frequently the actinomycetes and fungi in these layers register increased growth imparting it greyish white colour. Thermophilic, actinomycetes and fungi are known to grow well in the range of 50-60° C.
 - (2) **Moisture:** The moisture tends to occupy the free air space between particles. Hence when the moisture content is very high, anaerobic conditions set in. However, the composting mass should have certain minimum moisture content in it for the organisms to survive. The optimum moisture content is known to be between 50-60 %.

- (3) **Temperature:** Municipal solid waste is known to have good insulation properties and the released heat results in increase of temperature of the decomposing mass. As some heat loss occurs from the exposed surface, the actual rise will be slightly less. During turning of windrows, temperature drops. Under controlled conditions, temperature rises up to 70° C. the increased temperature results in increased activity of biological activity and hence results in faster stabilisation of the material. The high temperature also helps in destruction of pathogens and parasites. Activity of cellulose enzyme reduces above 70° C and the optimum range for nitrification is 30-50° C beyond which nitrogen loss is known to occur. Thus temperature range of 50-60° C is optimum for nitrification and cellulose degradation.
- (4) **Carbon/ Nitrogen (C/N) Ratio:** C/N ratio shows available carbon and nitrogen in MSW. The organisms involved in stabilisation of organic matter utilise about 30 parts of carbon for each part of nitrogen and hence initial C/N ration of 30 is considered most favourable for composting. The optimum value to be ranged as 25-30. In case it is too low, carbon shall have to be added in the from of paper, straw, saw dust and in case of too high a C/N ratio, addition of source of N in the from of blood, slaughter house waste, fish scraps, night soil, sewage sludge etc shall be required.
- (5) **Aeration:** it is necessary to ensure that oxygen is supplied throughout the mass and aerobic activity is maintained. During the decomposition, the oxygen gets depleted and has to be replenished. This can be achieved by turning the windrows or by supplying compressed air at 1-2 cum/day/kg of volatile solids. Artificial air supply requires enclosing decomposing mass in containers which is very costly.
- (6) **pH: Compost** should have a pH to be between range of 5 - 8 to be compatible with plant growth and to avoid odour. A pH within range of 5.5-6.5 is desirable if the compost is to be used as the sole component in a general potting medium, because within this range Nutrients are most available to plants. Both saline and acidic conditions are not conducive to good composting and ameliorants such as sulphur and lime are occasionally added to correct pH.

36. **Control of Composting Process**

Compost quality is ensured by controlling composting process .Following parameters as given below should be controlled:

- ❖ Moisture content
- ❖ Nutrient content
- ❖ Particle size distribution
- ❖ Stability
- ❖ Content of other elements (e.g. heavy metals)
- ❖ Product consistency over time
- ❖ Pathogen levels
- ❖ Odour control
- ❖ Leachate control
- ❖ Disposal of rejects

37. **Moisture Content:**

The moisture content of the compost product is controlled by storing the product so as to avoid significant moisture addition by rainfall. The product must be dry enough to allow hauling with conventional loading, hauling, and spreading equipment / methods. The 50 percent moisture content criterion for efficient screening also provides a dry enough product to meet these needs. Care must also be taken not to over-dry the product as well. When compost is too dry, it will generate dust when handled, and dry compost can be difficult to re-wet.

38. **Nutrient Content:**

The Nutrient content of compost is also a quality component. The major plant Nutrients supplied by compost are nitrogen, phosphorus, and potassium. Most minor plant Nutrients are also contained in compost and these also contribute to its quality. The level of Nutrients in compost is controlled by the chemical composition of the material. While not a fertilizer, compost is often used as a fertilizer supplement.

39. **Particle Size Distribution:**

This quality parameter is primarily a function of the screen size used. Different end-users of compost will have different requirements for particle size distribution of the compost. The most demanding user in this regard will be horticulturists that will use the material in potting mixtures. The specifications for particle size distribution requirements can be ascertained from users. Those who will use the compost to amend field soils (e.g., landscapers, orchardists, field crop growers) will have less stringent requirements, but still should be provided samples of the product to test prior to deciding on an appropriate particle size specification.

40. **Stability:**

The term "stability" as used here means a product that will not undergo rapid decomposition or produce nuisance odours when applied by users. If the compost has undergone the adequate composting and curing procedures, there should be no problem in achieving a stable product. Assuring a minimum curing period of 20-30 days is important to producing a stable compost product.

41. **Content of Other Elements:**

The content of undesirable elements in compost, such as heavy metals, (e.g. cadmium, copper, zinc, lead, mercury, nickel, and chromium) is generally at very low levels in yard debris and the final compost product. Weed seeds are controlled by maintaining temperatures suitable to meet **PFRP** (*process to further reduce pathogens*) requirements.

42. **Product Consistency over Time:**

This quality parameter is one of the most important to users. In order to incorporate compost into their operating practices, users must be certain that each batch of materials has the same properties, within relatively narrow limits. Inconsistency in product quality will result in reduced consumer confidence and will jeopardize future marketing efforts.

43. **Pathogen Reduction Criteria:**

Agricultural waste compost is not required by regulation to comply with the pathogen reduction criteria that are stipulated for municipal sludge (bio-solids) compost. However it is good practice and may be required if a site permit is

required for non-farm organic waste material. The compost product should fulfil the following criteria:

- The compost product should be brought to a minimum temperature of 131°F (55°C) for three consecutive days (or 15 days with 5 turns for turned windrow) in order to fulfil the requirements of a bio-solids stabilization.
- In addition to stabilization, these elevated temperatures are effective at killing weed seeds, which is a very important product quality concern.
- The compost product should be exposed to a minimum composting period of 28 calendar days and a minimum curing period of 20 calendar days prior to distribution.
- Monitoring of the compost product for pH, percent total solids, volatile solids reduction, nutrients, and heavy metals concentration should be done on a regular basis.

44. **Odour control:**

During the process of decomposition, aerobic conditions should be maintained so that the smell & odour and fly problem do not arise. During turning, dust problem should be controlled.

45. **Leachate control:**

The windrow should be located over impervious surface so that surface water from the windrows which may contain entrant particulates and pollutants could be properly collected and disposed off. By this way, leachate can also be reused in composting operation.

46. **Disposal of rejects:**

The rejects from the process should be disposed off at properly designated and operated sanitary landfill sites. The MSW should be diverted to monsoon shed during monsoon.

47. **Properties of Compost**

The compost produced from the MSW should be black brown or at least black in colour. It should be crumbly in nature with an earthy odour. The compost should neither be completely dry nor should the water come out on squeezing. The Nitrogen, Phosphorous and Potassium (N, P, and K) should be 1 % each. The nitrogen should be in the form of Nitrates. The C/N ratio should be in range of 15-20. Other standards are given in following table:

Table 3: Compost Standards

Parameters	Maximum acceptable concentration parts per million (ppm)
Arsenic	20
Cadmium	20
Chromium	300
Copper	500
Lead	500
Mercury	10
Nickel	100
Zinc	2500

48. **Major Tasks for Successful Composting :**

Four tasks are central to the design of a modern MSW composting system: **collection, contaminant separation, sizing and mixing, and biological decomposition.**

49. The first of the pre-processing tasks, collection, largely determines the processing requirements of the remaining tasks because they must be tailored to the characteristics of the incoming waste. Separation processes at the composting facility generate recyclable and reject streams, usually at several places in the process. Size reduction increases the surface area of the organic wastes, enhancing opportunities for biological activity, while mixing ensures that nutrients, moisture and oxygen are adequate throughout the material.

50. **Collection**

Composting is a manufacturing process, for which the ideal input material is a consistent and clean organic waste. This ideal is rarely reached, and even leaf composting facilities receive cardboard, sacks, bamboo baskets, wooden boxes, plastic bags, and street sweepings which can contain a variety of contaminants. Moving across the collection spectrum from leaves and grass to "biowaste" (such as food scraps, yard trimmings, and selected other organics like soiled paper) to totally mixed MSW, the types and volumes of non-compostable contaminants increase. These include visible materials such as plastic and glass, and chemical contaminants, such as **Household Hazardous Wastes (HHW)**. Both physical and chemical contaminants can have a negative impact on the marketability of the finished product, and their removal forms a large part of the expense of modern MSW composting facilities.

51. Some composting programs require source separation of organic compostables by participating residents and businesses, while others accept a mixed stream and separate non-compostables at a centralized facility. Separate collection of compostable materials programs can include everything from yard and food waste to soiled paper products, and in some cases have recovered 45 to 50 percent of the entire solid waste stream for composting. However, even when organic compostables are separately collected, a small fraction of non-compostable wastes will need to be removed at the composting facility. Educational programs are a critical aspect of source separated composting systems, since such programs depend on residents to accomplish much of the separation.

52. Composting programs which accept a mixed waste stream accept material more or less as it is currently collected, relying on the facility separation techniques described below. One important modification to traditional collection techniques is the establishment of a HHW collection program. To be effective at reducing the contaminants of concern in MSW compost, such programs must emphasize heavy metal sources such as batteries and consumer electronics. The remaining mixed waste (less any separately collected recyclables and HHW) then serves as feedstock for the composting facility, where centralized separation of non-compostable materials will occur. With this approach, 60 to 70 percent of the solid waste stream is typically processed into compost. The

remaining 30 to 40 percent includes recyclables as well as rejects destined for the landfill or an incinerator and landfill.

53. There are several trade-offs between source separation and centralized separation of compostables. It is clear that source separation can produce a higher quality, less contaminated compost, as well as maximize the recycling of glass and paper. And while source separation is generally less convenient for the waste generator, pilot programs are finding that many generators like to do it. However, two other important factors, the overall system cost and the quantities of materials recovered for recycling and composting, have to be adequately researched and evaluated.

54. **Centralized Separation**

In composting systems there are three objectives for materials separation:

- 1) Recover recyclable or combustible materials as marketable by-products
- 2) Reduce the levels of visible inert materials (e.g., plastics and glass)
- 3) Reduce the levels of chemical contaminants (e.g., heavy metals and HHW).

A wide range of technologies are available (see Table 4), and many facilities use a sequence of steps employing different processes.

Table 4: MSW Composting - Centralized Separation Technologies

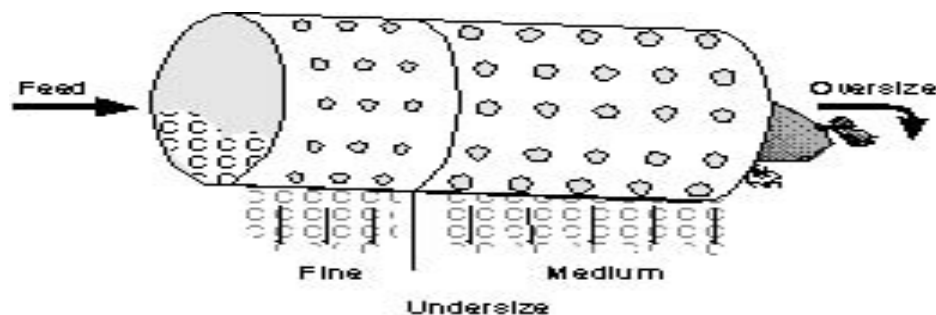
<u>TECHNOLOGY</u>	<u>MATERIALS TARGETED</u>
Screening	Large: film plastics, large paper, cardboard, misc. Mid-sized: recyclables, organics, misc. Fines: organics, metal fragments, misc.
Hand Picking	Recyclables, inerts and chemical contaminants
Magnetic Separation	Ferrous plus contaminants associated with ferrous met.
Eddy Current Separation	Non-ferrous metals
Air Classification	Lights: paper, plastic Heavies: metals, glass, organics
Wet Separation	Floats: organics, misc. Sinks: metals, glass, gravel, misc.
Ballistic Separation	Light: plastic, undecomposed paper Medium: compost Heavy: metals, glass, gravel, misc.

Many of these technologies are mechanically sophisticated, but for the reduction of chemical contaminants the most effective systems use human beings. While machines can do a reasonably good job of separating by size, density, or electromagnetic characteristics but manual separation is quite successful for small quantity of waste.

55. **Screening:**

Most MSW composting facilities first convey the waste into a bag-opener and screen or trommel to separate different sizes of waste (Figure 1). Fine materials, including soil, grit, and much of the organic wastes, fall through the screen as "unders". Plastic films and large paper products are retained on the screen as "overs". But the main purpose of size segregation in a composting plant is to facilitate further separation. It is much easier for either people or machines to further separate materials of a similar size, as small items are not buried under large ones. Size fractionation also takes advantage of the size distribution properties of different waste components, generating streams in which certain recyclables or contaminants are concentrated.

Figure 1: Trommel



56. **Manual Separation:**

With materials segregated to a relatively uniform size, it becomes much more practical to hand separate recyclables and contaminants as they move along conveyor lines. As manual separation of MSW can be an unpleasant task, worker comfort and safety are very important. Ergonomic design can help workers function at their best, and issues such as conveyor speed, reach, and placement of containers, flooring material, lighting, ventilation and dust control should all be considered. Here, as throughout the plant, it is recommended that workers wear safety glasses, gloves and adequate clothing to protect against injury from sharp objects, and hearing and respiratory protection wherever appropriate.

Conveyors and other materials handling machinery are critical to the operation of a plant. While this equipment may seem mundane, proper materials handling can minimize downtime and cleanup, and contribute to the overall efficiency of the facility. Steady materials flow will improve the efficiency of all the separation devices described below:

57. **Magnetic Separation:**

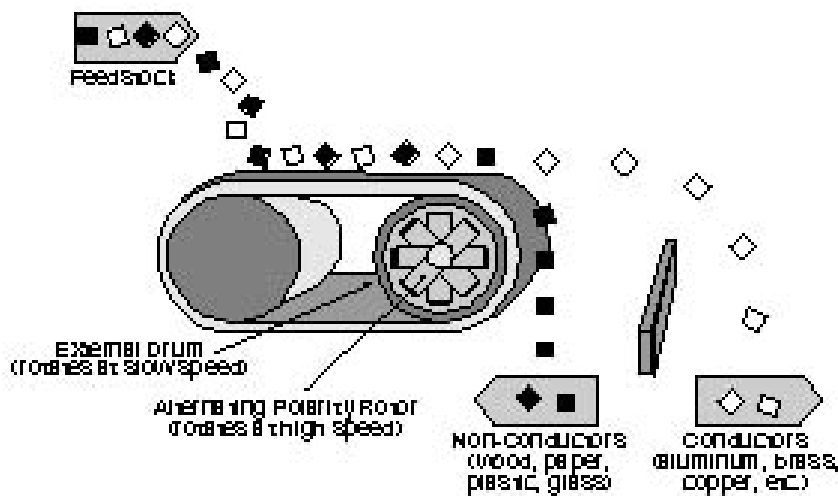
As materials are conveyed from one separation system to another, the conveyors can utilize magnetic belts, rollers or overhead magnets to separate the ferrous metals from the rest of the stream (not mandatory, only to be provided if required). Magnetic separation efficiency is sensitive to the depth of waste, as small ferrous items will not stick to the magnet if they are buried in non-ferrous materials, while larger ferrous items can drag non-ferrous items like

paper and plastic along. Air classification to remove the light paper and plastic fractions prior to magnetic separation minimizes the contaminants in the scrap ferrous. Pre-shredding and screening can also enhance ferrous recovery. Because magnetic separation is relatively inexpensive, it can sometimes be found at several locations in the composting facility. A minimum of two stages of magnetic separation are usually needed to achieve efficient ferrous recovery. Magnetic separation is effective with iron and most steel, but does not separate aluminium, copper, and other non-ferrous metals. Consumer electronics can be difficult to separate magnetically, depending on the ratio of ferrous to non-ferrous materials.

58. **Eddy current separation**

These systems have been developed to separate non-ferrous metals. This technology works by exerting repulsive forces on electrically conductive materials. These systems should be located after magnetic separation to minimize contamination by ferrous materials. Aluminum is the primary metal recovered from MSW, although some copper and brass will also be separated. Cans literally jump off the conveyor into a waiting bin (Figure 2). Eddy separators, while they do not achieve perfect removal of aluminum, do produce a relatively marketable aluminum by-product.

Figure 2: Eddy Current Separator



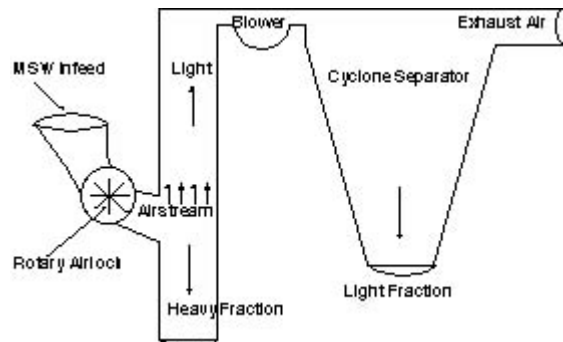
Adapted with permission from Eriez Magnetics

59. **Air classification**

This is an additional separation technology used in some MSW composting facilities, and is commonly used to generate a marketable Refuse Derived Fuel (RDF). This technology has been used in the combustion industry for many years. The heart of an air classification system is an air column or "throat", into which the waste stream is fed at a gradual rate. The air column is usually oriented vertically. A large blower sucks air up through the throat, carrying light materials such as paper and plastic, which then enter a cyclone separator where they lose velocity and drop out of the air stream. Heavier materials, such as metal, glass, and food waste, fall directly out of the throat (Figure 3). These two streams tend to be different sizes as well as densities, facilitating further separation. Glass and

metal can be sorted out of the heavy fraction by systems such as the wet separator described below. The light fraction can be marketed directly as an RDF, or sorted for recyclable paper or plastic prior to composting.

Figure 3: Air Classification



60. **Wet separation technologies**

While taking advantage of the same sorts of density differences as air classifiers use water rather than air as the floating medium. These units are usually used to separate particles of glass, sand, and other heavy particles from organic materials prior to composting. A hammer mill or other size reducer is needed prior to wet separation to minimize the potential for air pockets in the heavy fraction. After entrainment in a circulating water stream, the heavy fraction drops into a sloped (and sometimes vibrating) tank where it moves to a removal zone. This heavy fraction may be marketable as an aggregate substitute in construction applications. The less dense organic matter floats and is removed from the recirculating water using screening systems similar to those employed by wastewater treatment facilities. Wet separation is particularly effective at removing glass fragments and other sharp objects, which tend to be heavier than organic materials.

61. **Ballistic separation** takes advantage of both density and elasticity differences to separate inert and organic constituents. This method can be used in either initial processing or in the refinement of the final compost product. Compost is dropped on a rotating drum or spinning cone, and the resulting trajectory differences bounce glass, metal and stones away from the compost.

Compost refining refers to separation processes which occur after biological processing. These can include screening, ballistic, and/or magnetic separation, and are important in preparing a visually attractive product. Contaminant separation at this late stage has a limited effect of chemical contaminants but can significantly reduce inert materials like plastics, glass, and stones.

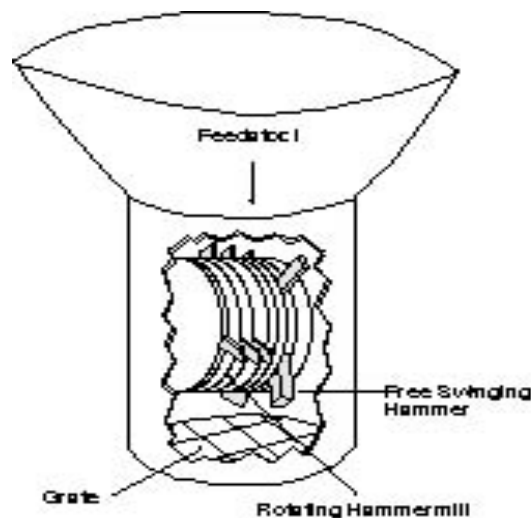
62. **Size Reduction and Homogenization**

Even after the removal of much of the non-compostable material, municipal solid waste needs further processing before composting. Large pieces of paper, cardboard, food and yard waste will break down slowly if not reduced to a smaller size. Reducing particle size increases surface area, enhancing composting rates because the optimum conditions for decomposition occur on

the surfaces of organic materials. However, reducing particle size also reduces the pore size, limiting the movement of oxygen required for composting. Thus for any composting system and material there is an optimum range of particle sizes, and for MSW this is usually between two inch to four inch diameters (5 - 10 cm).

63. Size reduction and mixing processes usually occur after initial separation and removal of non-compostables. However, some separation processes, including wet separation, air classification and magnetic separation can achieve greater levels of removal after size reduction. Proper sequencing of these materials preparation processes can have a significant impact on system performance.
64. There are three major types of size reducing devices available for municipal waste processing: hammer mills, shear shredders, and rotating drums. **Hammer mills** consist of rotating sets of swinging steel hammers through which the waste is fed (Figure 4). Tub grinders use a rotating tub to feed a horizontal hammer mill, and are common item at large yard wastes composting facilities. Hammer mills are energy and maintenance intensive, with hammers requiring frequent resurfacing or replacement. In MSW processing applications they must be housed in specially designed chambers as propane tanks and other flammable materials can cause serious explosions. And once batteries or other contaminants pass through a hammer mill, they are pulverized and much more difficult to separate.

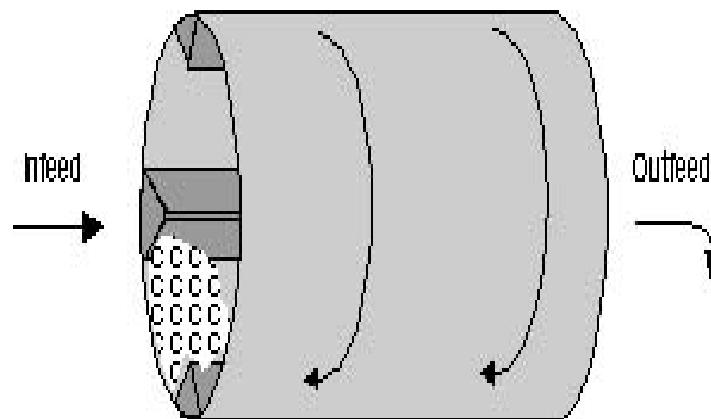
Figure 4: Hammer mill



65. **Shear shredders** usually consist of a pair of counter-rotating knives or hooks (each of which is several centimetres thick), which rotate at a slow speed with high torque. The shearing action tears or cuts most materials, although thin flexible items like film plastic may slip through the gaps between the knives. This tearing may help open up the internal structure of the particles, enhancing opportunities for decomposition. Shear shredders consume less energy and are less destructive than hammer mills, but still can break apart contaminants and make subsequent recovery difficult.

66. **Rotating drums** mix materials by tumbling them in a rotating cylinder (Figure 5). Internal flights or vanes lift material up the sides of the rotating drum where they fall to the base by gravity. Drums may be set on a slight incline from horizontal, although this is not always necessary to carry the material through the drum from the feed end to the outlet. While some of these drums can also function as biological reactors, typical residence times of less than 36 hours allow only the beginnings of microbial decomposition. To the extent that decomposition does occur in a rotating drum, it is important that aeration is adequate. Excessive anaerobic activity can lead to low pH (<5.0), which may result in ammonia volatilization, corrosion of the drum, and leaching of metal contaminants.

Figure 5: Rotating Drum



Drums take advantage of gravity to tumble, mix, and homogenize the wastes. Dense, abrasive items such as glass or metal will pulp the softer materials, resulting in considerable size reduction of paper and other cellulose materials. Rotating drums are the least destructive size reduction technology, and many solid contaminants can more readily be separated after passing through the drum. While it is not known how much abrasion and leaching in the drum will affect the effectiveness of subsequent contaminant removal, even in this relatively gentle size reduction technology some cross contamination of compostable materials is likely to occur.

67. **Mixing:** The last stage of processing before the active composting stage is usually the incorporation of water. If it includes a large paper fraction (with a high carbon to nitrogen ratio), MSW also benefits from mixing with nitrogen-rich materials such as sewage sludge or septage. Size reduction and blending homogenizes the compostable materials, achieving greater uniformity of moisture and nutrients. Thorough mixing is important for rapid decomposition, and a variety of devices are available. The drum-type wet pulverizers described above commonly serve as a mixing and blending device. Some mixers have been adapted from agricultural feed mixer designs, and may contain counter-rotating augers or a reel. Pug mills can also be used, which blend by means of slowly counter-rotating hammers.
68. Separation, size reduction and mixing/homogenization are all prerequisites to the biological process of composting. The individual physical processes described above must be selected and linked together with biological processing

technology to form a complete composting system. In evaluating a system design, several criteria stand out as particularly important to these physical processing steps, including **cost** (capital, operations and maintenance), **market specifications** for compost and recyclable by-products, and the **flexibility** of the system to respond to a changing MSW feedstock.

69. **Cost** is clearly an important criterion for any solid waste management option. While complex systems that separate many recyclable by-products and reduce contaminants may appear attractive, their overall costs may not be competitive. The economic analysis of a composting facility must not only evaluate other competitive options such as land filling or incineration, but must also examine different ways of achieving the same goal with a composting program. The economic trade-offs between source separation and centralized separation for recyclable recovery and contaminant removal are not well defined, but need to be examined on a case by case basis to develop the best system for a particular community.
70. Part of that economic analysis must include a market assessment, both for recyclable by-product streams as well as the compost product itself. A composting facility must function as a manufacturing facility, where quality control and product specifications determine the facility operation and design. If markets require a higher grade recyclable product than a particular technology will produce, then the facility will be in serious trouble. Designing for product quality is difficult, in part because information on the effects of combining technologies is scarce. But this critical challenge must be met if an MSW composting facility is to succeed.
71. **Flexibility:** MSW composting facilities must be designed for flexibility. Changes in the regulatory environment, in market specifications, and in the waste stream itself are likely to be significant in the coming years. As with any new technology, "state of the art" is likely to have ephemeral meaning for MSW composting facilities. This is particularly true with the physical processing steps, where changes in the amount and type of waste collected and the product quality required are likely to significantly impact optimal facility design. An MSW composting facility must be able to adapt if it is to play a long term role in responsible waste management.
72. Total 2 Ha area is proposed for a compost plant of 600 MT capacity.
73. Civil Works :Following Civil works are proposed
- | | |
|---------------------------------|-------------|
| • Tipping area | 10 × 20 sqm |
| • Pre-processing area | 10 × 50 sqm |
| • Over size rejection area | 10 × 10 sqm |
| • Monsoon shed | 20 × 20 sqm |
| • Machine shed | 40 × 20 sqm |
| • Curing shed | 20 × 20 sqm |
| • Refinement section | 20 × 20 sqm |
| • Sewing and bagging section | 20 × 20 sqm |
| • Store | 40 × 20 sqm |
| • Vermi-composting section | 80 × 20 sqm |
| • Maintenance & other utilities | 10 × 30 sqm |

- Laboratories 10 × 16 sq m
- Office 10 × 9 sq m
- Compost pad section 9000 sqm
- Future expansion 50 × 25sq m
- Cement Concrete Road 5 m wide 630m
- Drain 1400 m
- Water supply, street lighting and other utilities

74. Compost pad, tipping area, monsoon shed etc shall be constructed with 250 mm 1 : 1.5 :3 cement concrete over 150 mm 1:4:8 cement concrete base and moorum sub base of 300 mm thickness.

75. Compound wall shall be constructed with Brick masonry in 1:6 mortar with plaster in 1: 4 cement mortar as per approved section.

76. Office, laboratories and other building works shall be constructed in brick masonry with RCC roofing and 1” marble flooring over 3” cement concrete 1:6:12 with painting etc complete as per standard specifications.

77. **Equipment Specifications for 600 MT capacity**

(A) List of Equipment:

(a) Plant and machinery related with composting

Following plant and machineries would be required:

(I) Preparatory section:

- i. Feeder Conveyor
- ii. Dual Trommel -25/4 mm

(II) Refinement section:

- iii. Feeder Conveyor
- iv. Gravity Separator
- v. Aspirator Separator

(b) Loading and other equipment

- vi. Excavator cum loader 1
- vii. Digital Weighing Machine 1 30 MT
- viii. Dumper 3
- ix. Tractor tipper 1
- x. Water tanker 4000 liter 1

(c) Others

- xi. Plastic water tank of 10000 litre capacity with HDPE pipe line of 25 mm diameter
- xii. Windrow composting thermometer
- xiii. Power requirement
- xiv. Office, yard and plant lighting etc.

(B) Technical Specifications

Figure 6: Conveyor with Dual Trommel



Feeder Conveyor (Preparatory Section):

Type : Chain Belt “Z” type conveyor with UHMW liners
Input : Digested organic waste
Output : Digested organic waste
Purpose : Feeding of digested city garbage
Power : Through Hydraulic power pack
Chain : Heavy duty steel fabricated roller chain
Belt : Heavy duty NR belt M 24 grade 3 ply 8 mm
Drive : Through hydraulic motor
Support : Steel fabricated
Fabrication: Out of heavy rolled sections as ISMC 100, 75, ISA 50, 45 along with 12 & 14 SWG sections etc.
Dimension: 900×8000

Dual Trommel:

Type : Shaft less Rotary Screen
Input : Digested organic waste
Output : Material having oversize < 4 mm
Purpose : To screen out oversized inert & undigested materials
Power : Through Hydraulic power pack
Drive : Friction drive
Support : Steel fabricated
Fabrication: Main drum with lifters fabricated out of 10 mm thick HRC sheet with heavy duty angular reinforcement. Perforated screen with 25 mm holes fabricated out of 3 mm plate.
Dimension: 2000×5800

Figure 7: Elevator and Vibro screen for refinement section



Feeder Conveyor of Refinement section:

Type : Chain Belt “Z” type conveyor with UHMW liners
Input : Fully digested and cured material having -16 mm size
Output : Fully digested and cured material having -16 mm size
Purpose : Feeding of semi finished compost for refinement
Power : Through electric power
Chain : Heavy duty steel fabricated roller chain
Belt : Heavy duty NR belt M 24 grade 3 ply 8 mm
Drive : Through electric motor, 2 HP, TEFC
Support : Steel fabricated
Fabrication: Out of heavy rolled sections as ISMC 100, 75, ISA 50, 45 along with 12 & 14 SWG sections etc.
Dimension: 900×8000

Gravity Separator:

Type : Gravity Separator
Capacity : Matching
Input : Digested screened material below 4 mm size
Output : Digested screened material below 4 mm size and free from heavy impurities such as sand, gravel etc.
Purpose : To remove out heavy impurities such as sand, gravel etc
Power : Through electric power
Drive : Through electric motor, 3 HP & 2 HP, TEFC
Support : Steel fabricated
Fabrication: Heavy base plate & links, out of heavy rolled sections as ISMC 75, ISA 50, 45 along with 12 & 14 SWG sections etc.

Dimension: 1500× 900×1600

Aspirator Separator:

Type : Centrifugal flow type with high efficiency cyclone
Capacity : Matching
Input : Fine dusty material from gravity separator
Output : Fine dusty material
Purpose : To entrap dusty material from gravity separator
Power : Through electric power
Drive : Through electric motor, 3 HP & 2 HP, TEFC
Support : Steel fabricated
Fabrication: sheet 12 & 14 SWG, out of heavy rolled sections as ISMC 75,
ISA 50. Fan casing with anti corrosion liners.

- ❑ Shovels, spades, pans etc

Figure 8: Fork and Shovel



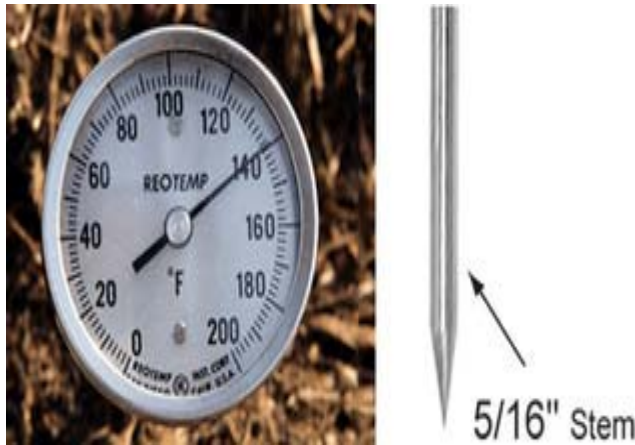
Square Nose Shovels

Made of premium quality metal, our square nose shovels have a polished aluminium head for minimum soil adhesion. Their large fork head is useful for weeding and digging around larger plants. This range of shovels has wooden handles, which are interchangeable and have hanging hole for convenient storage

- ❑ Water tank of 4000 litre capacity with pipe/sprinkling system
- ❑ Compost Windrow Thermometer

Heavy duty windrow thermometer made of rugged all stainless steel construction, unbreakable plastic crystal, hermetically sealed, easy to read 3” diameter dial with external reset adjustments, 5/16 “ diameter pointed stem for easy insertion of length 36 “.

Fig 9: Compost Thermometer - Heavy Duty Windrow - 36 inches (91.5 cm)



The Heavy Duty Windrow Compost Thermometer is ideal for monitoring interior temperatures of large compost bins or windrows. The heavy duty construction means this thermometer should stand the test of time. The dial on this thermometer should be in degrees Celsius (not Fahrenheit as is pictured).

FEATURES:

- Stem:** 36" (91.5 cm) long, 5/16" (7.9 mm) diameter, pointed tip.
- Accuracy:** +/- 1% full scale. Temperature range is minus 20 to 95 degrees Celsius.
- Dial Size:** 3" (7.6 mm) diameter. The dial case is hermetically sealed, so it should not fog.
- Dial Face:** Unbreakable plastic crystal.
- Workmanship:** All welded stainless steel design. This product should be capable to be left inside the compost pile and should not be needed to be stored inside. It should withstand the chemical and biological weathering of the compost pile over time.
- Warranty:** One year from supply date

- Weighing machine (Plat form scale)of 100 kg capacity with 10 gm accuracy

Fig 10: Platform scale



Common Features:

- Should incorporate international quality standard load cells.
 - Advanced microcomputer based design
 - Battery backup option.
 - Overload and shock load protection.
 - 100% subtractive tarring range.
 - Bright LED display. ZERO, TARE, NET/ GROSS function.
 - Audio-visual overload indication.
 - Stainless steel platform.
 - Standard bidirectional computer (RS - 232) interface.
 - Following additional multiple functions:
 - a. Parts counting,
 - b. Accumulation of weights in memory,
 - c. Printing of weight data,
 - d. Selection of baud rate,
 - e. Filling mode,
 - f. Variable integration time to suit weighing atmosphere.
- Needle machine for packaging

Appendix 10

Appendix 10
Specifications for Sanitary Landfill Site

1. Development of processing plant and Sanitary landfill site –on DBOMT basis

The scope of the work covered under this section includes development of Processing plant and Sanitary landfill site on Design, Build, Operate, Maintain and Transfer of land (DBOMT) basis, in accordance with the guidelines provided in MSW (M&H) rules, 2000, and CPHEEO Manual, 2000 including all required infrastructure works.

Scope of work shall include following:

- System design and layout of the MSW treatment and disposal site and facilities.
- Detailed design and specifications for all components, including civil, mechanical and electrical works.
- Establishing and maintaining a Quality Control System during construction.
- Construction of Civil works for all components and services.
- Manufacture, supply and installation of all mechanical and electrical equipment.
- Procurement and supply of material handling equipment.
- Start-up and commissioning of the system, including integration, tuning and testing performance.
- Providing supervisory personnel for start-up and commissioning, and training operating personnel.
- Providing as-built drawings for the completed facilities.
- Management and operation of the site for three full years/or as decided by the client, after commissioning.

Before commencing development, it will be required to undertake various investigations as mentioned in following subsections.

2. Sub soil/geological investigations-

- (i) to determine strata of underlying soil
- (ii) permeability of various strata beneath the landfill
- (iii) extent of availability of liner material, drainage material, top soil and protective soil in adjacent /selected borrow area
- (iv) sub soil properties and bearing capacities along circulation roads
- (v) seismic data collection

3. Ground water/Hydrological investigations-

- (i) depth to ground water table with seasonal variations
- (ii) analysis of ground water with all drinking water quality parameters
- (iii) estimation of quantity of surface runoff required for designing of drainage facility
- (iv) possibility of flooding of the site

4. Leachate investigations

This is required for finalizing leachate treatment strategy.

5. Waste characterization

Waste to be received at the land fill site shall be tested for the following properties:

- (i) composition
- (ii) physical properties
- (iii) chemical properties
- (iv) biological properties
- (v) thermal properties
- (vi) toxic properties
- (vii) geo-technical properties

6. **Project Location & Topography of the Area**

The project is proposed to be implemented for waste of Ghaziabad Nagar Nigam at the new waste disposal site. The site to be developed as “**Regional Landfill Site**” is yet to be identified. The proposed site shall not only be suitable for GNN waste but also for the entire GDA area covering nearby small towns. The site area requirement for GNN waste is assessed as 45 Ha but additional area will be required for entire GDA waste quantities. The task for identification of suitable land has been entrusted to BISAG, an institute of Government of Gujarat.

7. **Facilities at Site**

The Following facilities shall be provided at site:

- 2 Main gates of 8 m width
- Security cabin 3.0 × 3.0 m
- Parking shed 26 m × 8.0 m
- Office building 9 × 10m
- Two 30 Tonne capacity weighbridge (computerized) at the site entry / exit of 3m × 12 m each and one scale room of size 3.0 × 3.0 m
- BT Approach road of 9 m width (7 m black topped and 1 m shoulder on both side) of length 800 m
- Visual inspection area 24m × 44 m
- Wheel Wash facility 18m × 5 m
- Compost plant/ Processing plant 2 ha
- Workers rest room and toilet block 11.5 × 8 m
- Fill soil area 30 m × 30 m
- Ramp (slope 1 : 10) 81 m
- Outer side of bund 1V : 2H (6 M)
- Top of bund 9.0 m
- Inner side of bund 1V : 3 H (9 m)
- Trench inner side 1V : 3 H (3.60 m)
- Landfill cell area 270m × 400 m= 108000 sqm
- Monitoring wells 4 nos
- Green belt 10 m wide
- Leachate pond 3 m × 3 m

- Signs and directions
- Surface water drainage system along the approach road and internal road in the campus, rehabilitation of existing drains along approach road
- Gas holding & flaring facility.
- Surface water sedimentation tank
- Liner System: The liner system shall comprise of the following layers below the waste:
 - 0.3 m thick drainage layer comprising of coarse sand or gravel (stone dust with no fines)/Geocomposite Drain (Layer of Geonet covered by Woven Geotextile)
 - 0.2 m thick of protective layer of sandy silt/Non Woven Geotextile of 300 gsm
 - 1.5 mm thick Flat Cast Extruded HDPE geomembrane.
 - 0.9 m thick clay layer/amended soil layer
- Cover System: Cover system shall comprise the following above the waste:
 - 0.30 m thick gas collection layer comprising of gravel (stone dust with no fines)
 - 0.9 m Thick Clay Liner/Geosynthetic Clay Liner of 6.0 mm thickness
 - 0.3 mm Drainage layer of permeability >10-2 cm/sec/Geocomposite Drain (layer of geonet covered with woven geotextile on top)
 - 0.45 m thick barrier layer (Sandy silt+ 5% bentonite)
 - 0.25 m thick surface layer of local top soil for vegetative growth.
- Mechanical equipment for segregation, compacting and pest repellent sprays and disinfection. Following equipment shall be required
 - Excavator cum loader 1 no.
 - Tipper 3 no.
 - Bulldozer 1 no,
 - Landfill Compactor 1 no.
- Tree plantation in landfill site within 10m width all along the site edge proposed to be developed as green belt (Green belt of appropriate shrubs and trees)
- Fire control management facility
- Communication facilities
- Electrification, (Internal and External)
- Buffer zone 30 m wide all around

8. **Development of Landfill Site and Processing plant :**

A sanitary landfill site will comprise of the area in which the waste will be filled as well as additional area for support facilities. It is proposed to develop a compost plant unit and SLF site within same premises. The site shall be developed on the basis of DBOMT, in which entire site shall have to be designed, built, operate and maintain by the experienced private entrepreneur. For this land shall have to be provided by the client i.e GNN and other towns (in case of regional land fill site) on concessional rate along with guaranteed minimum waste quantity at the plant/SLF site at free of cost. Within the area to be filled, work may proceed in

phases with only a part of the area under active operation. A typical site layout is shown in the attached drawing no. NCRPB-GZD-SWM 04. The sanitary land fill site shall be designed incorporating all the components mentioned in clause 7 of this section. Landfill should be a combination of above and below ground level and slope landfills. A typical cross section of landfill is also shown in the attached drawing NCRPB-GZD-SWM 05.

9. **Operating methodology :**

Before the main design of the landfill can be undertaken it is important to develop the operating methodology. Operation of landfill should be designed by the successful private entrepreneur in phases. Each phase should be designed for 12 months. Phase plan should be drawn as soon as the landfill layout and section are finalised.

10. The **Stability of the landfill** should be checked for the following cases

- Stability of excavated slopes.
- Stability of liner system along excavated slopes.
- Stability of temporary waste slopes constructed to their full height.
- Stability of slopes of above ground portion of completed landfill.
- Stability of cover systems of above ground landfills.

11. In preliminary design of a landfill section, the following slopes have been adopted.

- Excavated soil slopes (2.5 H:1 Vertical)
- Temporary waste slopes (3.0 H:1 Vertical)
- Final cover slopes (4.0 H: 1V)

Slopes can be made steeper, if found stable by stability analysis results. Acceptable factor of safety may be taken as 1.3 for temporary slopes and 1.5 for permanent slopes.

12. The same entrepreneur, who shall develop and operate SLF shall have to operate the composting unit/any suitable processing unit as decided by the client; document his findings on operation, marketability and other aspects to enable a decision on the suitable technology, process, marketable product, and whether to scale up the unit. The final useful product shall be the property of the developer. The income from sale / disposal of compost will accrue solely to the developer.

13. **Site Security Compound wall**

Compound wall should be built all along the land fill site area. Compound wall of 2 m height in table moulded brick masonry 230 mm thick in CM 1:6, shall be constructed all along the land fill site. Pillars of 2.65 m height shall be constructed at main gate. The depth of excavation for compound wall shall be at least 0.90 m. The foundation shall be of CC 1:4:8 of 15 cm thickness. 25 mm thick CC coping in ratio of 1:1.5:3 (cast in situ) shall be laid above the entire length of wall. A Mild Steel entrance gate of 5m width and 2.65 m height of approved design and specifications shall be provided for access to the work force and the vehicles into the Land fill site. A well designed cow catcher also shall be provided at main gate to prevent entry of animals.

14. **Weigh bridge**

A weighbridge of 30 tonne capacity shall be installed as shown in the layout plan. The scope of this item will include all related civil, electrical and mechanical works.

Bidder will supply the weigh bridge as per the specifications laid down and will install as per the manufacturer's standards and specifications. The required civil works for installation of weigh bridges including its foundation and providing connection for digital display in the office premises shall be carried out by the contractor under the lump sum item of Weigh Bridge. After installation of the bridge, commissioning and performance test shall also be carried out by the contractor. Sufficient length/ parking space inside the entrance gate till the weighbridge, to prevent queuing of vehicles outside the entrance gate, will be provided.

15. **Site office with toilet and bathing facilities**

The site office building of 90 sqm shall be one storied with front portion utilised as site office and the rear portion to be utilised as store and toilet block. The unit shall be a RCC framed structure with individual foundation. The drawing is attached as NCRPB-GZD-SWM-13. The doors, windows, ventilators and shelves shall be in accordance with drawing. The office building shall also be provided with 2 numbers of open steel racks and two steel almirah of size 3'x6'.

16. The office should have provisions for internal water supply, electrification etc with all the necessary fixture and items required to complete the work, and to terminate the connections suitably outside of the building. The general arrangement drawing for office cum workshop building is attached for bidder's reference (NCRPB-GZD-SWM-14).

17. **Internal Roads**

Internal roads of SLF site shall be black topped road surface and of compost plant, cement concrete roads including hard shoulders in accordance with relevant standards MORTH specifications. The design shall be made using CBR method. Necessary drainage including surface/sub surface drainage shall be provided. The design of pavement shall be for a minimum period of 15 years. The internal BT n roads should be 7 m carriage width with overall road width including shoulder as 9 m BT road all around the compound wall in approximate length of 800 meters. Road profile and typical cross section of internal roads are shown in the drawing No. NCRPB-GZD-SWM-09.

18. **Leachate collection**

The leachate drainage layer should not be designed less than 30 cm thick, with the minimum slope of 2% and a permeability of greater than 0.01 cm/sec. A system of perforated pipes and sumps should be within the drainage layer. The pipe spacing should be governed by the requirement that the leachate head should not be greater than the drainage layer thickness. The material of pipe should be HDPE. The leachate shall be collected in a sump of sufficient capacity. The leachate collection sump shall be lined with HDPE on the wall as well as base with HDPE Concrete Connection strips.

19. **Surface water drainage system**

The Contractor shall design and construct adequate storm water drainage facilitates in the present layout portion of the landfill site. The drains shall be designed considering the storm run-off as 0.032 cum/sec and to facilitate sub surface drainage from roads and platforms. Rectangular section storm water drains of 1.2 m width and 1.2 m depth shall be constructed in with brick masonry 1:6 & plaster of 12 mm thickness with mortar of 1: 4. They shall be constructed on both sides of the road. The storm water collected shall be connected with the final discharge body, i.e. existing storm water drain flowing near the landfill site.

20. **Liner System**

The following composite liner system shall be adopted as the minimum requirement:

- A leachate drainage layer 30 cm thick made of granular soil having permeability (K) greater than 10^{-2} cm/sec/Geocomposite Drain
- A protection layer (of sandy silt) 20 cm /Non Woven Geotextile of 300 gsm
- A HDPE geomembrane (flat cast extruded) of thickness 1.5 mm.
- A compacted clay barrier or amended soil barrier of 0.9 m thickness having permeability (K) of less than 10^{-7} cm/sec.

The liner adopted at landfill site must satisfy the minimum requirements published by regulatory agencies (MOEF/CPCB). The material to be used for liner system should be approved by the regulatory agencies and the use of such materials has been demonstrated over a 10 year period.

21. **SPECIFICATIONS OF HDPE GEO-MEMBRANES**

A. High Density Polyethylene (Hdpe)-1.5 mm minimum thickness

22. The lining material shall be of highest quality high density polyethylene (HDPE) sheeting, manufactured in using virgin high density polyethylene resin entirely free of plasticizers or other filler materials. Only 10% of the resin may be from edge cut-offs.
23. The HDPE sheet shall be manufactured through Flat Cast extrusion technology.
24. The HDPE sheet shall have minimum length of 150 m and minimum width of 9 m to reduce the no of welding/seaming points.
25. 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.
26. The overlapping and welding area shall be marked with a white line to assure an optimum welding.
27. The welding area on the outside edge of the liner shall be smooth.
28. The thickness of the HDPE geomembrane shall not vary across the roll by more than 5%.
29. The HDPE liner shall meet the following physical property values. The manufactured sheet shall have values not less than that is mentioned in the table given below.

Property	Test Method	Unit	Value
Thickness Nominal	ASTM D 5199	Mm	1.50
Density	ASTM D 1505	Gm/cc	0.942
Melt Flow Index	ASTM D 1238-190/2.16	Gm/10 min	<1.0
Tensile Strength at Yield	ASTM D 6693	N/mm	25
Tensile Strength at break	ASTM D 6693	N/mm	45
Elongation at Yield	ASTM D 6693	%	12%
Elongation at Break	ASTM D 6693	%	700
Tear Resistance	ASTM D 1004	N	215
Puncture Resistance	ASTM D 4833	N	550

Carbon Black Content	ASTM D 1603	%	>2
Carbon Black Dispersion	ASTM D 5596	Cat	1-2
ESCR	ASTM D 1693	Hrs	2000
Dimensional Stability	ASTM D 1204	%	+/- 2
NCTL Test	ASTM D 5397	Hr	300
OIT	ASTM D 3895	Min	100

Tolerance: -5% from the mentioned values

B. Specifications of Geo-synthetic Clay Liner

30. The Geosynthetic Clay Liner (GCL) shall consist of a continuous layer of natural sodium bentonite powder, sandwiched between a needle-punched polypropylene (PP) geotextile as a cover layer and a slit film PP woven geotextile as the carrier layer. The components shall be needle-punched uniformly together across the entire GCL and then thermally treated on the woven side. Additional bentonite with the same quality as the core bentonite shall be impregnated into the outer 500 mm of the cover non woven geotextile during the manufacturing process to facilitate longitudinal impermeable overlaps.

31. Properties

Property	Test Method	Unit	Value
Geotextile Layer			
Cover layer			
Geotextile Type			Polypropylene non woven
Mass per Unit area	EN 965	Gsm	220
Carrier layer			
Geotextile Type			Polypropylene woven
Mass per Unit area	EN 965	Gsm	110
Bentonite layer			
Type			Natural sodium Bentonite (Powder)
Mass per unit area	EN 965	Gsm	3670
Swell index	ASTM D 5890	MI/2g	24
Fluid Loss	ASTM D 5891	MI	<18
Water Content	DIN 18121	%	Approx.10
Geosynthetic Clay Liner			
Mass per Unit area	EN 965	Gsm	5000
Thickness	EN-964-1	Mm	6.0
Max tensile Strength	ASTM D 4595	KN/m	12.0/12.0
Elongation at break	ASTM D 4595	%	10.0/6.0

Peel strength	ASTM D 6496	N/10 cm	>60
Permeability	ASTM D 5887	N/m	>360
Index flux	ASTM D 5887	Cm/sec	2*10 ⁻⁹
Roll Dimension			
Width/Length/Dia		M/m/m	4.85/40/0.65 m

* md = machine direction, cmd = cross machine direction

Values without the symbol \geq or \leq can vary up to 10 % in the worse direction.

C. Non Woven Geotextile

32. This shall be a polypropylene (PP), staple fiber; needle punched nonwoven geotextile manufactured by any reputed ISO 9000 series certified company. The fibers shall be needed to form a stable network that retains dimensional stability relative to each other. This shall be resistant to UV degradation and to biological and chemical environments normally found in soils. This shall conform to the following properties values:

33. Properties.

Property	Test Method	Units	Value
Mass per unit Area	EN 965	g/m ²	300
Thickness	EN 964	mm	1.6
Tensile Strength(md/cmd)	EN ISO 10319	N	14/22
Elongation at Break(md/cmd)		%	50/30
Puncture Strength	EN ISO 12236	N	3890
Pore Size (O95)	EN ISO 12956	mm	0.07
Permeability	EN ISO 11058	Per sec.	0.05
Water Flow Rate		L/sm ²	50
Width	--	M	5.9
Length	--	M	100
Area	--	sqm	590

Note: Tolerance +/-5% from the stated values

D. Geonet

34. Single layered three dimensional and high compression resistance drainage consisting of two extruded strands, capacity, also under pressure and at very low gradients.
35. **Properties:**

Technical Data	Test method	Unit	Values
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Water flow rate at 20 kpa 50 kpa 200 kpa 500 kpa	ENISO 12958	L	1.62 1.50 1.17 0.83
Raw Material			HDPE
Mass/Area	EN 965	Gsm	500
Thickness At load 20 kpa At load 200 kpa	EN 964	Mm	4.2 3.8
Density		g/cc	0.94
Tensile Strength (Max) Md/cmd	ENISO 10319	KN/m	6.0/2.0
Elongation at maximum tensile strength Md/cmd	ENISO 10319	%	20/80
Roll Dim		M/m	4.0/50

Note: Tolerance +/-5% from the stated values

E. Woven Geotextile

36. GWF 26 - 130 is a woven polypropylene multifilament geotextile. The individual multifilament yarns are woven together into a stable fabric structure with a superior combination of mechanical and hydraulic properties. The product shall have excellent resistance to biological and chemical environments normally found in soils and should be stable against short-term exposure to ultraviolet radiation.
37. GWF 26 - 130 shall be suitable for applications involving the functions of separation, stabilization and filtration.
38. GWF 26 - 130 shall conform to the property values listed below:
39. **Properties:**

S.No	Property	Test Method	Value
I	Polymer Composition, Structure and Physical Properties		
1	Polymer	Polypropylene	
2	Structure	Woven with multifilament yarn in both warp and weft directions	
3	Mass per unit area	ASTM D 3776	130 g/m ²

II	<i>Mechanical Properties</i>			
1	Tensile strength	Warp	IS 1969	28 kN/m
		Weft		26 kN/m
2	Elongation at designated peak tensile load	Warp		25 %
		Weft		25 %
3	Trapezoid tearing strength	Warp	ASTM D 4533	300 N
		Weft		300 N
4	Puncture strength	ASTM D 4833		250 N
III	<i>Hydraulic Properties</i>			
1	Apparent opening size	ASTM D 4751		75 microns
2	Water flow rate normal to the plane	ASTM D 4491		10 l/m ² /s
Roll Dimensions		Standard roll length : 100m Standard roll width : 5m		

E. Quality Assurance of Geosynthetics

40. Installation of HDPE Liner

The HDPE liner shall be installed in according to an approved installation procedure method statement and specifications described herein. The Contractor shall submit to the engineer-in-charge requirements for liner installation seam welding, inspection and testing requirements, and all quality control procedures.

41. Preparation

Before lining work begins, the foundation surfaces to be lined shall have been prepared as described in the specification, contract Drawings and to the satisfaction of the installation supervisor. The surface shall be compacted, free from undulations and any stones, or other sharp or hard objects. The sufficient provisions be made for placement in position and preparation for welding of the HDPE liner as follows:

- Provision of a good firm access to and from the working area.
- Provision of suitable equipment for liner placement, seam welding and seam testing.

42. Liner Installation

- No equipment or tools shall cause damage to the geomembrane by handling, trafficking or other means;
- No personnel working on the geomembrane shall smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane;
- The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the sub grade or geotextile protection layer on adjacent panels;

43. Panel Placement

Panels shall be arranged so as to minimize handling and field seaming. Panels shall be placed in a relaxed condition, free of tension or stress upon completion of the installation. Stretching of the liner is not permissible.

44. **Panel Inspection**

After deployment the panel shall be numbered. The liner material shall be inspected for physical defects, streaks, particles of foreign material, undispersed constituents, cracks, blisters, pinholes, surface divots or evidence of cold flow.

The surface of the geomembrane shall be clean at the time of inspection. The geomembrane shall be brushed, blown or washed by the Contractor if the amount of dust or mud inhibits inspection. The engineer-in-charge shall determine whether cleaning of the geomembrane is needed to facilitate inspection.

Any disruption in the geomembrane surface due to irregularities in the subgrade shall be marked for cut-out removal and for repair.

45. **Weather Conditions**

46. **Temperature :** Geomembrane deployment shall only proceed between ambient temperatures of 5 degrees centigrade to 40 degrees centigrade. Placement shall proceed above 40 degrees only after the engineer-in-charge has verified that the material can be seamed according to the specification. Deployment shall not be made in the presence of excessive moisture (eg. fog, rain, and dew) or in the presence of excessive winds.

47. **Humidity:** Geomembrane seaming shall only proceed when the humidity is less than 83 % for extrusion welding and less than 90% for hot wedge welding. When the humidity exceeds these values, seaming shall only proceed after the engineer-in-charge has verified that the material can be seamed according to the specifications.

48. **Welding Of Seams :**Seam welding shall be carried out by the Contractor using hot wedge and extrusion welding techniques according to the liner manufacturer's specifications. Double hot wedge welding techniques shall be preferred for all main longitudinal seams.

49. Liner sheets shall be positioned prior to welding as directed by the manufacturer recommendations but shall provide for a minimum of 100mm overlap for extrusion welding, and 100mm for hot wedge welding. Prior to welding, liner surfaces, which are to be welded, shall be cleaned and prepared according to the liner manufacturer's specifications and procedures.

50. Welding and jointing shall not take place during any period of precipitation, high relative humidity or during dusty conditions. Extrusion welding shall not take place unless the ambient temperature is above 5⁰C and below 45⁰C or as directed by the engineer-in-charge.

51. Location and orientation of sheets, overlaps, welds and any repairs; and Supporting documentation,, identifying seam sampling (with test pieces), testing and repairing, and all related quality assurance/quality control documentation.

52. **Extrusion Welding**

Where extrusion welds are proposed, field joints shall be made by overlapping adjacent panels a minimum of 100mm and extruding a ribbon of extrusion joining resin no less than 25mm in width between the overlapped panels or over the seam between the panels where hand welds are required. To avoid movement of adjacent pieces of the geomembrane, the pieces shall be welded together using hot air welder.

- 53. Prior to extrusion welding of the seams, all areas, which are to become seam interfaced, shall be cleaned of dust and dirt. The slick surfaces of the HDPE panel which are to become seam interfaces shall be roughened with a grinder, before extrudate is placed between the overlapping seams or over a lapped seam. All roughed surfaces shall be covered with extrudate.
- 54. Extrusion joining shall not take place unless the sheet is dry and shall not take place unless the ambient temperature is above 5⁰ centigrade and below 45⁰ centigrade. The engineer-in-charge shall make the decision whether to continue or to halt the Extrusion welding based on trial seaming and testing.

E. Minimum Requirements For Inspection & Testing Of Welds, Joints And Repairs

- 55. A Construction Quality Control and Quality Assurance (CQA/CQC) Plan written by a Qualified HDPE geomembrane specialist should be prepared. The CQA/CQC plan shall describe field seam quality assurance/quality control procedures for the inspection of each seam, repair procedures and daily welding machine testing.
- 56. Trial test welds shall be conducted, prior to liner welding, for each welding machine; part samples shall be field tested; remaining samples shall be retained for subsequent testing if necessary and as required by the engineer-in-charge and in according to liner manufacturer’s specifications.
- 57. Field seams shall meet the following specifications.

Seam Property		Test Method	Requirements
a)	Shear strength	Manual testing devise or Tensiometer	Film Tear Bond (FTB) where the break is in the sheet, not the weld
b)	Peel strength	Manual testing devise or Tensiometer	Film Tear Bond (FTB) where the break is in the sheet, not the weld

- 58. Peel seam specimens shall be 25mm wide. Peel tests shall be carried out on one specimens. A break through the weld shall be considered a Non-FTB (failure) in peel strength tests.
- 59. Approved field seaming processes are double hot wedge fusion welding and extrusion welding. Welding rods or beads used for extrusion welding shall be HDPE and the physical properties shall be same as those of the resin used in the manufacture of the HDPE liner.
- 60. All seams shall be fully tested by non-destructive methods. These methods shall be either by pressurized air for the double fusion welds and vacuum box for the extrusion welds. Spark testing is only acceptable in locations where air and vacuum box testing are not applicable.
- 61. All welded joints shall be inspected in accordance with the quality control plan. During the welding process one samples per day or one for every 200 m of seam length whichever gives the greater number of samples shall be taken (perpendicular to the direction of the extrusion). Two specimens should be tested for peel tensile strength test. The samples shall be taken at the ends of the rolls.
- 62. Faulty work, determined by inspection or testing, shall be repaired with extruder, where approved by the engineer-in-charge as follows:

63. Large faults shall be cut back to give clean and dry interfaces, free from imperfections. They shall then be covered with appropriate shaped pieces of the same material as the liner to give a minimum 150mm overlap which shall then be welded by extrusion welding, as specified previously. Repairs for making good areas removed from random samples for destructive testing shall be carried out by this method.

64. **Landfill Gas Management**

65. A controlled passive venting system should be designed and provided including but not limited to the following features.

66. A containment system which encloses the gas within the site and prevents migration outside the landfill.

67. A system for collecting and removing landfill gas from within and particular from the perimeter from the landfill. Passive gas vents to be provided at 75mx75m spacing and extended 1m above the landfill / ground (whichever is higher) surface.

68. **Cover System:** The final cover system must enhance surface drainage, minimise infiltration, vegetation and control the release of landfill gases. The landfill cover system to be adopted should in tune with the gas management plan and must satisfy the minimum requirements of published by regulatory agencies (MOEF/CPCB). The final cover should be provided at a slope of 3 to 5% for proper surface drainage.

69. **Green belt –Plantation at landfill site**

A green belt of suitable shrubs and trees, 10m minimum width, along the three sides of the landfill site shall be developed. The Plantation of Trees in the land fill site shall be done along with maintenance contract.

70. Plants should be installed in the beginning of the project. Only 50 % of eligible payment shall be allowed on installation of plants and remaining 50% will be allowed on completion of contract. Payment should be made for finally available survival trees. The payment of dead trees shall be recovered from the contractor at the end of contract.

71. The choice of plant species shall be done on the basis of site conditions like topography, climatic conditions and ecology of the area. The plant species will be from the tree group of the plants only. At least 10 meter wide strip all around the compound wall shall be converted to a green belt.

Pits dug a few days in advance of actual planting shall be allowed to weather and be filled with good/ suitable fertile soil mixed with manure. Size of the pit shall be as per standard requirement. Only one tree shall be planted in each pit. Spacing between the two rows of trees shall be 5 m centre to centre. Trees in consecutive rows shall be staggered. Normally seven rows of plants shall be planted in the area earmarked within the landfill site unless otherwise directed.

72. The tree species like Rubinia, Horsechessnut, Alenthus, poplars etc are recommended for plantation. Contractor shall be responsible to manure, watering plant and to maintain without any extra cost to Employer during construction and maintenance period of 12 months. The contractor will start this activity in the first month of the contract and will install all plants in initial two months period of the contract.

73. The plantation for the green belt should be done as per the following guidelines.

- Selection of locally adopted perennial plants that are resistant to drought and extreme

temperature.

- Root of the plant shall not disrupt the low-permeability layer.
- Selected plants shall have ability to thrive on low nutrient soil with minimum nutrient addition.
- Plantation shall be made in sufficient density to minimize soil erosion.

74. **Fire control management facility**

Fire fighting Equipment's like fire extinguishers of suitable capacity and fire buckets with sand and necessary stand, as per the standard specifications shall be provided in all the installations such as near the gas management system, workshop and office building. Necessary safety charts and board shall also be provided in the various units as per the direction of the department.

75. **Communication facilities**

- One telephone connection from telecom department with 3 telephone instrument for income facility along with the cable network, one each at administration office, entrance security gate cabin and weighbridge (telephone connection fees shall be paid under provisional sums)
- Two computers in the administration office. These should be connected to weigh bridge to enable recording of garbage transport vehicle number and weight.

76. During trial run followed by operation and maintenance period the contractor shall ensure compliance of MSW rules 2000 by meeting following requirements:

- a) To formalize and document the record keeping procedure as well as waste acceptance and processing procedures to be followed
- b) To provide sign boards showing purpose, owner/operator of the site, hours of operation, relevant record about the quantity of waste etc.
- c) Keeping all records like investigation, design and construction details, permission/licenses from concerned authorities, EIA& EMP reports etc.
- d) Maintaining site reports like:
 - ✓ Weigh bridge data(daily inflow and outflow for each vehicle)
 - ✓ Waste inspection data(daily)
 - ✓ Materials, sources etc. (daily)
 - ✓ Site personnel records (daily attendance etc.)
 - ✓ Bills/accounts
 - ✓ Visitors record
 - ✓ Complaint record
 - ✓ Topographic survey at operating phase
 - ✓ Photographic record at operating phase
 - ✓ EMP data
 - ✓ Waste filling plan and actual progress i.e. cell construction and review
 - ✓ Leachate generation and gas generation
 - ✓ Weather/climate data
 - ✓ Accidents etc.
 - ✓ Others
- e) Ensuring no open burning of waste
- f) To keep access of persons limited
- g) Spreading and compaction of waste in layers not more than 60cm thick
- h) Daily cover of at least 15cm at end of each working day
- i) Final cover minimum 60cm at end of final lift

- j) All precautions for protection of environment and as required for compliance of EMP and design criterion
- k) Control of blowing of litter
- l) Control of salvaging at the operational face of the site
- m) Maintenance of all infrastructure services
- n) Maintenance of all equipments
- o) Ensuring adequate competent work force
- p) No unloading at unauthorized place
- q) Ensuring vector and dust control
- r) Arrangement for coping up with accident hazards, fire etc.
- s) Ensure entry and inspection of only appropriate waste. No handling of special waste other than MSW
- t) Ensuring complete compliance of MSW Rules 2000.

77. **Safety measures**

Adequate safety measures required for the construction without any hindrance to public, material, property, etc. should be maintained, some of them include:

- Barricading all sides of the open trenches.
- Round the clock watch and ward maintaining all safety regulations at the site of work and protecting the site from unauthorized intrusions

78. **Civil Specifications**

The following civil specifications shall be applicable for providing and executing all such items, which are not mentioned in foregoing sections but are necessary to be provided and for the items, which are mentioned above but require some elaboration. No extra cost shall be paid for such items. All civil specifications mentioned here below shall be treated as part of the technical specifications already mentioned. The specific requirement of different items of work involved in the construction, completion and commissioning of the plant as a whole, shall be provided in accordance with the requirement given in these civil specifications. The superstructure and substructure of all building works shall be as specified, for which prior approval from the Engineer is to be obtained before setting out the work.

79. **Design of structures**

The design of all structures shall take into account the weight of equipment, wind forces and seismic forces and shall be designed as per relevant, latest IS codes. The platforms shall be designed to take the requisite vehicle load and/or the machinery load as applicable.

80. **Materials**

All materials used in the work shall be subjected to mandatory tests in accordance with relevant IS codes, and before using them on the work, the test reports shall be submitted to the Engineer.

81. **Form Work**

Form work, shuttering, centring, scaffolding etc., shall be of steel plates or plywood, lined with MS-sheets and for scaffolding steel tubular shall be used. Joints should be sufficiently tied to prevent loss of cement slurry from the concrete. All forms, shuttering shall be levelled, aligned, and thoroughly cleaned, before they are used for concreting. Form work shall be removed after specified days of curing. The surface of RCC after removal of form work / shuttering shall be smooth, even and without honeycombing or undulations.

82. **Finishing of RCC Surfaces**

To give an even finish to the concrete surfaces, unless otherwise specified, the outside faces of walls and inside surfaces of ceiling shall be of form work finish, smoothly rendered and

other inside faces shall be finished with cement plaster 12 mm thick in 1:4 cement mortar. All concrete surfaces coming in contact with liquid shall be provided with cement plaster 20 mm thick in 1:3 cement mortar with approved quality water proofing compound in requisite proportion.

83. **Minimum clear cover over Reinforcement**

Minimum clear cover over the steel reinforcement shall be in conformity with IS: 3370 in the case of water retaining structures. For other structures the clear cover over the reinforcement shall be as per IS: 456.

84. **Minimum Reinforcement**

For all civil structures, the minimum reinforcement shall be based on IS: 456.

85. **Minimum Thickness of RCC**

The minimum thickness of all RCC members' viz., walls, roofs, floors etc., shall not be less than 150mm.

86. **Tested Steel**

Only tested steel reinforcement shall be used on the work, and the Contractor shall produce the test certificate of the manufacturer to the Engineer. The grade of steel shall be Fe: 415 conforming to IS: 1786.

87. **Cement Concrete**

For all other concrete structures, unless otherwise specified, cement concrete mix of minimum M20 grade shall be used.

88. **Lean Concrete**

Lean concrete mix of 1:4: 8, 150 mm thick shall be provided under all foundations and floors of structures and other buildings.

89. **Earth Work**

While carrying out earthwork in excavation in foundation and trenches in all kinds of soil, including boulders, soft and hard rock etc., the work shall be carried out as per the directions of Engineer. Wherever necessary, shoring and strutting as specified in the above mentioned specifications shall be provided.

90. **Excavated earth in trenches shall not be dumped within 1.5 m distance from both sides of the trench from the top. Barricading on the sides of the trenches shall be provided with caution sign boards and sufficient red light arrangement during night.**

Earthwork in backfilling the trenches with selected earth and with the earth taken from borrow pits shall be done in layers of 150 mm, watered and well consolidated.

91. **Disposal of surplus excavated material**

The surplus excavated material from the site shall be disposed off to the place decided by the Engineer with all lead and lift upto a distance of 5 kms from the site of work.

92. **Brick Work**

All brick work in foundation, substructure or superstructure, including partition walls shall be done with table moulded bricks of standard size, with necessary centring, scaffolding and curing, in accordance with the Standard Practices. Nothing extra would be paid for any lift and minor architectural work required to be done as per Drawings / directions of the Engineer. All Partition walls shall be built in 115 mm brick masonry, in 1:4 cement mortar

with two numbers of 6 mm diameter MS bars at every third course embedded in cement mortar. The outer walls of room shall be built in 230 mm brick walls, in cement mortar 1:6.

93. **Cement Plaster over Brick Work**

Cement mortar plastering shall be done on all brickwork at any height or depth. The thickness of cement plaster shall be 12 mm. The mix of cement mortar for plastering shall be 1:4. The work shall include providing and removing necessary scaffolding, curing, and rounding of corners etc., complete.

94. **Plinth Protection**

Plinth protection shall be provided for all the structures. The plinth protection shall be 1m wide 25 mm thick in CC (1:1.5:3) overlaid on a compacted base of CC (1:4:8), 100 mm thick. The outer edge shall be lined with brick laid on edge and joined with CM1:3.

95. **Flooring and Finishing**

The flooring of all the buildings, unless otherwise specified, shall be Granolithic marble flooring 2.5 cm (1") thick consisting of 2 cm (3/4") thick layer of 1 part cement, 2 parts of approved coarse sand and 4 parts of 2 cm (3/4") graded approved stone chips including 5 mm (1/4") thick surface coat with white cement, black and white or grey or mixed marble chips passing 3 mm (1/8") but retained on 1.5 mm (1/16") mesh screen in proportion of 1:2 as specified or directed by the Engineer-in-charge and polished by hand or machine and finally finished with french mansion polish or any other approved polish and including 8 cm (3") 1:6:12, concrete base, including supply of all material, labour, tools and plants etc. required for proper completion of the work.

96. **Filling below flooring**

The portion below the flooring should be provided with approved earth filling including watering and compacting in layers of 150 mm thick, for a depth of 450 mm minimum.

97. **Skirting**

Wherever the flooring is provided, it should be accompanied with the skirting of same material as that of flooring, 125 mm high for walls set in CM 1:3 and pointed with CM 1:3, flush with wall surface.

98. **Doors, Windows and Ventilators**

The Contractor shall submit the drawings for approval and upon approval shall provide and fix the doors, windows and ventilators. The work shall include cost of cartage, manufacturing, all skilled and unskilled labour, tools and plants, all fittings including painting with enamel paint of approved quality with two coats over the primer coat. The area of windows and ventilators shall be 20 % of ceiling area of the building units.

99. **Doors**

The wood door shall be fixed with 65 mm x 125 mm frame fixed in the masonry with 40 mm x 5 mm flat mild steel iron hold fasts 40 cm long embedded in CC 1:3:6 with granite metal of 20 mm and down size, 150 mm thick with fully panelled shutters with styles and rails of 40 mm thick with 25 mm thick panels. The iron oxidised fixtures for each door shall be one aldop, two tower bolts, one overhead closure and two door handles. For external doors in addition to these, one aldop and one steel latch shall be provided. Equivalent metal doors are also acceptable.

100. **Windows**

The wood windows shall be fixed with 65 mm x 125 mm frame fixed in the masonry with 40 mm x 5 mm flat mild steel hold fasts 40 cm long embedded in CC 1:3:6, 150 mm thick mullions wherever necessary with half glazed and half panelled shutters 30 mm thick with 25 mm thick panels and glass 4 mm thick, MS rods 12 mm dia at 60 mm and 120 mm apart alternately and MS flats 6 mm x 40 mm vertically at top of glazed shutters. The iron oxidised fixtures for each window panel shall be one set of hook and eyes, one rubber bushing per end panel and two butt strap hinges. Equivalent metal / glass windows are also acceptable

101. **MS Rolling Shutters**

MS Rolling Shutters shall be provided and fixed as per relevant Indian Standard specification. The rolling shutter shall be of pull and push type made out of 18 gauge x 7.50 cm MS lathers of convex corrugations complete with side guides and bottom rails with inter locking arrangements for steel lathers by means of alternate and clips. The suspension shafts shall be provided with high tension coil type springs. The rolling shutters shall be provided with top cover, locking arrangements, pulling hooks, handles with all fittings and other accessories. The rolling shutter shall be painted with two coats of red oxide factory finish and two coats of synthetic enamel painting over shop painting etc., complete.

102. **Chajjas and Canopies**

RCC chejjas as shown in the GA drawing, of inclined type shall be provided over the external windows and ventilators, projecting 600 mm wide all round, unless otherwise specified. The RCC canopies over the main entrance door shall have a minimum projection of 2 m over the full width of the door + 500 mm.

103. **Painting Wood Work and Steel Work**

All steel doors, windows, ventilators, rolling shutters, pipe railing, MS grills etc., shall be painted with two or more coats of superior quality enamel paint of approved shade and make over a priming coat of superior quality primer. The surface shall be cleaned, rubbed and made smooth evenly, before applying a priming coat and enamel paint.

This painting will include cost of all material, skilled and unskilled labour, cartage and applying wherever required as mentioned above.

104. **Distempering**

On the inner faces of the walls and ceiling of the buildings, two coats of washable oil bound distemper of approved quality, manufacture and shade shall be provided. Before distempering, the surface shall be rubbed, cleaned and made smooth and even. This will include cost of material, skilled and unskilled labour, transportation etc.

105. **Water Proofing Cement Paint**

The external faces of all walls, chejjas and parapets of all structures and buildings from ground level to the top of the structure shall be provided with two coats of water proofing cement paint of approved make, quality and shade. This cement painting shall be done over one coat of primer of approved make, quality and shade. Before applying primer coat, the surface shall be rubbed, cleaned and made even. Any paint stains wherever not necessary shall be cleaned. The work shall include cost of all material, necessary centring, scaffolding, skilled and unskilled labour, tools, brushes, transportation etc.

106. **Rain water pipes**

For draining rain water, all roofs shall be provided with 100 mm dia. CI down water pipes of ISI brand. These shall be provided with necessary bends and shoes wherever required.

Necessary iron clamps shall be fixed to hold the pipe tightly to the wall. The work includes cost of all materials and skilled and unskilled labour.

107. **Protection against Floatation due to Uplift Pressure**

The Contractor shall ensure that all structures constructed underground by lowering sub soil water level, shall be protected against uplift and consequent floatation and tilting. Adequate measures including non stop dewatering shall be taken as per relevant IS codes.

108. **Water for Drinking and Construction work**

The Contractor shall have to make all arrangements at his own cost for water fit for construction purposes and also water fit for drinking purposes as per norms of IS codes and nothing extra will be paid.

109. **Power for Construction Work**

The Contractor shall make all arrangements at his own cost for providing power supply to the site of work, site office and for construction activities.

110. **Plumbing Works**

GI pipes of class B shall be used for internal and external plumbing works. The service connection from the main pipe to the building shall be of GI, with necessary CI T-ferrule.

For the pipes within the building, GI pipes of class B bearing IS mark shall be used. These pipes shall be concealed within the walls as directed, before the plastering to the walls. The exposed portions of the pipes for the purpose of internal plumbing, shall be of GI, class B. Jointing in GI pipes shall also be of collar joints. Necessary valves, bends, tees, stoppers and jointing material etc., shall be provided by the Contractor. All material used and workmanship shall conform to relevant standards & specifications.

111. **Internal and External Lighting and Street Lighting**

Internal and External Lighting of all the buildings / units of the landfill site, including workshop & office etc, should in concealed steel conduits with suitable sizes of PVC copper conductor wires, including fixtures and fittings to give the level of illumination given below including providing Ceiling / Exhaust fans etc in each room/toilet. Street Lighting with 300 W flood light / 125 W HPMV lamp fittings on 7 m long steel swaged tubular poles to give required level of illumination. All electrical fixtures and cable, wire etc shall be ISI brand of reputed makes.

112. The internal lighting shall be in recessed conduit system using 2.5 sq mm / PVC copper conductor wires drawn in 3/4"/1" (19 mm / 25 mm) 16 gauge stove enamelled steel conduit. 15 Amps plug points wiring shall be done with 2.5 sq mm wires as per state PWD specifications / IER. Wiring should be carried out by providing 8 to 10 fitting per circuit, each controlled with 10 A S.P switch for lighting and 15 amps. S.P. switches for power points. 3 phase industrial socket points 32 A shall be provided in the main plant and sub-station.

113. Distribution / Sub distribution boards to be provided at various locations. On some of the locations, spare switch units / MCBs shall be provided. It may be noted that the capacity of such fuses etc. will be taken into account while designing the size of the cable / bus-bars as if it was a connected load.

114. The tenderer shall quote for the supply and erection of all fixtures falling under his sub-head so as to complete the installation including wiring. The actual position of the fittings, poles, switches etc. and the wiring layout cable routes shall however be submitted by the

tenderer along with the tender. The drawing shall also show the position of sub-main distribution board, recessed conduit route in case of internal lighting and cable routes for external electrification. All conduit fittings and accessories shall be painted with weather proof paint of original shade. Cables for power and lighting should not be done or carried out together in the same conduits. The unit rate of each fitting shall be indicated so that the payment can be made as per actuals depending / actuals execution of contract. The tenderer should give detailed description of fixtures and fittings they are offering along with manufactures leaflets etc. The approval for the type of fitting shall be given by the Engineer. The internal lighting shall conform to the illumination level as per the specification enclosed. The internal / external lighting in and around all the buildings shall be done by the tenderer who shall also lay suitable size cables with necessary power margins from the respective control switches adopting loop in, loop out system of wiring.

115. **Lighting System Specification**

116. The lighting system shall consist of lighting switches, power receptacles, distribution boards, sub-distribution boards, complete with switch fuses, junction boxes, pull boxes, terminal blocks, glands, conduits and accessories (elbows, tees, crosses, bends, etc.) and supporting and anchoring materials, lighting fixtures complete with fluorescent tubes / incandescent lamps / mercury vapour lamps and lighting cables. All materials, fittings and appliances used in the electrical installation shall conform to the relevant IS specifications and shall be anticorrosive painted for plant area.

117. It shall be the responsibility of the Contractor to work out a detailed layout for the lighting fixtures offered by him in order to provide the specified level of illumination. The Bidder shall be responsible for measuring the levels of illumination after installation and establish compliance with the Enquiry Specification. The number and type of fixtures offered by Tenderer shall be indicated in his Tender. The final layout of the lighting fixtures shall be furnished for the approval of the Engineer, before commencement of installation. Control of lighting switches should be with maintainer circuit breaker.

118. **Lighting Equipment**

a) **Scope**

Equipment shall include lighting distribution boards, lighting fixtures, poles, switches, receptacles, conduits, wires cables and miscellaneous hardware necessary for complete lighting work.

b) **Illumination Levels**

The following minimum levels of illumination shall be provided in the respective areas:

	Area	Illumination level
a)	Land fill Area	50 lux
b)	Offices	150 lux
c)	Workshop	150 lux
d)	Toilet & Bathrooms	100 lux
f)	Outdoor area, Road	10 lux
g)	At the entrance of site	100 lux

119. **Lighting Fixtures**

a) The lighting fixtures offered shall comply with the following requirements:

- The fixtures shall be suitable for operation on a nominal supply of 240 volts, single phase,

50 c/s, AC with a voltage variation of $\pm 10\%$.

- All fixtures shall be designed for minimum glare. The finish of all parts of the fixtures shall be such that no bright spots are produced, either by direct light source or by reflection.
 - For multi lamp fluorescent fittings, the circuit should be designed in such a manner as to reduce the stroboscopic effect to the minimum.
- b) The lighting fixture ballasts shall comply with the following requirements :
- The ballasts shall have a long service life and low power loss.
 - The ballasts shall be of the inductive and heavy duty type, filled with polyester or equivalent. They shall be free from hum and protected from the atmosphere. HPMV lamp ballasts shall be provided with taps.
 - For multi lamp fittings, a separate choke shall be provided for each lamp.
- c) Lighting fixture starters shall be of the safety type (i.e. if the lamps fail to ignite at the first start, no further starting must be possible without attending to the tube light). Starters shall have bimetal electrodes and high mechanical strength.
- d) Lighting fixture for outdoor lighting shall be of the flood light type or mercury vapour lamp. Street lighting shall be carried out with pole mounted mercury vapour lamp fixtures. All other tube fixtures complete with reflectors. Office areas shall have decorative type and others shall have industrial type fixtures.
- e) All lighting fixtures shall be supplied complete with lamps and all necessary accessories for their satisfactory operation.
- f) Lighting fixtures shall also comply with the following requirements:
- Incandescent lamp fixture shall be of the well glass type, complete with a cast housing and reflector both of which shall be vitreous enamelled. The lighting fixture shall be suitable for satisfactory use in mildly acidic atmosphere.
 - Outdoor lighting fixtures shall be of dust proof and weather proof, decorative, post top lantern type, suitable for accommodating a colour corrected high pressure mercury vapour lamp and shall be complete with stove enamelled aluminium canopy, opal acrylic Perspex bowl and all necessary accessories.
- g) The fixture capacitors shall comply with the following requirements:
- Each capacitor shall be suitable for operation at 240 Volts $\pm 10\%$ single phase 50 Hz, with a suitable value of capacitance so as to correct the power factor of its corresponding lamp circuit to the extent 0.98 lag.
 - The capacitors shall be hermetically sealed preferably in a metal container to prevent seepage of impregnating material and ingress of moisture.
- h) The lamp-holders shall comply with the following requirements.
- Lamp-holders for fluorescent tubes shall be of the spring loaded, low contact resistance, bi-pin rotor type, resistant to wear and suitable for operation at the specified temperature, without deterioration in insulation value, contact resistance or lamp holding quality.
 - Lamp-holders for incandescent and HPMV lamps shall be of the G.L.S. type.
- i) Lighting fixture reflectors shall generally be manufactured from sheet steel of aluminium of not less than 20 SWG. They shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools.
- j) Polystyrene egg-box type louvers shall be provided. Appropriate captive type fixing devices shall be incorporated for securing these.

- k) Each fixture shall be complete with a four way terminal block for the connection and looping of incoming and outgoing supply cables. Each terminal shall be able to accept two 2.5 sqm. solid copper conductors.
- l) Each lighting fixture shall be provided with a grounding terminal suitable for connecting 12 SWG G.I. wires.
- m) All metal or metal enclosed parts of the housing shall be so bonded and connected to the ground terminal so as to ensure satisfactory grounding continuity throughout the fixture.
- n) On completion of manufacture, all surfaces of the fixtures shall be thoroughly cleaned and degreased. The fixtures shall be free from scale, rust, sharp edges and burrs.
- o) The enamel finish shall have a minimum thickness of 2 mils for outside surfaces and 1.5 mils for inside surfaces. The finish shall be non-porous and free from blemishes, blisters and fading.
- p) The surfaces shall be scratch resistant and shall show no signs of cracking or flaking when bent through 90 degrees over a 12 mm diameter mandrel.
- q) All light reflecting surfaces shall have optimum light reflecting co-efficient such as to ensure the overall light output as specified.
- r) All reflectors and louvers shall be finished to the same standard as the fixture housing.

120. **Ceiling Fans**

Adequate numbers of ceiling fans of 1200 mm sweep in office/workshops and exhaust fan 375 mm sweep with louvers in the toilets. Fans shall be of reputed brand.

121. **Earthing**

Earthing at all establishments shall be provided as per latest IS 3043 and IE Rules and as per tender specifications and requirements.

122. **Road and Bridges**

123. **General Specifications:** The General Technical Specifications for the Roads and Bridge Works shall be the "SPECIFICATIONS FOR ROAD AND BRIDGE WORKS (FOURTH REVISION - 2001)", as corrected in the original issued by the Ministry of Road Transport and Highways, Government of India and published by the Indian Roads Congress (IRC), hereinafter referred to as MORT&H Specifications, with a cross reference to relevant Bureau of Indian Standards (BIS) for materials and other aspects not covered by the IRC.

Appendix 11

A. Introduction :

1. SWM services are highly labour intensive. On account of increased wage structure of the Government and Municipal employees, this service is becoming more and more expensive. Besides, the efficiency of the labour force employed in the urban local bodies is far from satisfactory. High wage structure and Inefficiency of the work force results into steep rise in the cost of service and yet the people at large are not satisfied (as visible from the result of socio-economic survey) with the level of service being provided by the urban local bodies.
2. At the same time due to rapid urbanization, the cities are expanding at a very fast rate; the boundaries of cities are crumbling with addition of more and more new colonies in the city. With increase in the demand for infrastructure facilities in new colonies and areas, there is hardly any supply of services in commensurate to the requirement mainly due to restrictive government policies (there is hardly any new appointments) and poor financial condition of the departments. Efforts to increase the efficiency by Human Resource Development and institutional strengthening will, to some extent improve the performance but that may not be enough. It is, therefore, necessary that the local bodies seriously consider voluntary organizations / NGO / private sector participation in solid waste management.
3. Several factors play a role in the increasing interest of urban authorities in privatization of utilities such as:
 - (i) Performance failure of their departments.
 - (ii) Rapid urban growth and escalating demands from citizens
 - (iii) Lack of resources & financial reorientation to private sector
 - (iv) Encouraging popular or individual participation in economic development

B. Advantages and Disadvantages:

4. Innovative technologies have been employed in many cities where the private sector has been allowed in the management of waste. These need to be replicated in other cities. The need for such participation from the private sector has been recognized, both by the Committee appointed by the Supreme Court and also by the 12th Finance Commission. The later has prescribed that 50% of the funds flowing to the Municipal Bodies would have to be spent for solid waste management activities through public private partnerships during the next 5 years.
5. Such participation of private sector would have to be based on options such as ‘Build, Own and Operate’ (BOO) and ‘Build, Own, Operate and Transfer’ (BOOT) basis depending upon the situation. Another option for the municipal bodies is to procure the “Hardware” and engage the private sector to “Operate” the same. This option however, has a number of pitfalls and may be sparingly used. There seems to be a wide variety of contracts in place with unclear deliverables and even more unclear methods of evaluation, penalty and reward for the service providers.
6. Advantages and disadvantages of private sector participation is shown in following table :

Table: 1 Review of Private Sector Participation in SWM

Advantages	Disadvantages
1. Brings technical and managerial expertise to the sector.	1. A government organization unlike private will provide services to as many citizens as possible, regardless of financial
2. Improves operating efficiency and	

<p>3. reduce the needs for subsidies. For long term contracts it can result in large scale capital investments and greater efficiency in the use of that capital.</p> <p>4. The inhabitants can benefit by an increase in response to their needs and preferences.</p> <p>5. Privatization results in increased labor productivity & efficiency due to less job securities, incentives, flexible use of staff as per tasks, and linkages between productivity and salary. The entire process is guided by profits, while in government sector, apart from decision making delays, attempts are to avoid public criticism.</p>	<p>feasibility in a particular area.</p> <p>2. There is always a risk of failure because of different interests. The Private entrepreneur's main objective is of course to maximize profit and/ or acquire a bigger market share.</p> <p>3. Generally, private sector chooses activities with a specific objective ensuring certain return on investment therefore it is obvious that a private firm evaluates its ventures for the commercial viability and investment decisions are taken selectively ignoring less paying areas.</p> <p>4. Poor operation and maintenance of the facilities by the operators lead to failure of contract.</p> <p>5. Unsustainable operations of the facilities owe to high capital and O& M expenses.</p> <p>6. Poor monitoring and supervision by the local bodies lead to inefficiencies.</p> <p>7. In case of some dispute, situation in area may deteriorate if work is discontinued and there is no alternative arrangement for tackling the situation. In such situation, there may be blackmailing or exploitation of management.</p>
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7. Private Sector Participation or Public Private Partnerships may be considered by urban local bodies keeping merits and demerits into considerations. This will check growth in the establishment costs, bring in economy in expenditure and introduce an element of healthy competition between the private sector and the public sector in solid waste management services. There should be a right mix of private sector and public sector participation to ensure that there is no exploitation of labour as well as of the management.

C. Areas where private sector participation could be possible

8. Prospective areas for privatization could be any/many of following:
- (i) Door to door collection of domestic waste/ collection and transportation up to transfer station or processing plant or to sanitary land fill site.
 - (ii) Door to door collection of commercial waste/ collection and transportation up to transfer station or to processing plant or to sanitary land fill site.
 - (iii) Collection, processing and disposal of hotel and restaurant waste on cost recovery basis or on (Built Own Operate) BOO basis.
 - (iv) Door to door collection of hospital waste, processing and disposal on BOO basis.
 - (v) Collection and disposal of construction waste on cost recovery basis.
 - (vi) Setting up, operation and maintenance of waste treatment and/ or disposal facility on tipping fee basis or on BOO basis.
 - (vii) Supplying vehicles on rent.

- (viii) Supplying vehicles on lease along with repairs and maintenance of vehicles at a private garage.
- (ix) Transportation of waste on contractual basis, etc.

D. Important principles of PSP

a separate agency for bulk waste producers on cost recovery basis

- 9. The appointment of an agency for the collection of waste from bulk producers is an ideal way to tackle this type of waste. Municipal Bodies can award the rights for collection and transportation of debris / bulk waste like waste from hotels/restaurants etc to contractors who can be allowed to charge the generators at a predetermined rate. The contractors can also be allowed to “sell” such debris to other construction sites that require land filling or process the biodegradable waste for producing compost, as the case may be.
- 10. Various models can be tried for fixing the basis of payment. However, payment on the basis of actual waste generated may be avoided till such time a very dependable system is in place to ensure that no waste finds its way into the normal municipal stream. Payments on the basis of number of trips in case of debris / number of rooms for hotels/ area etc are simpler to enforce and do not provide any incentive for manipulation.
- 11. It would be also advisable to involve the association of the affected generator groups in the process of appointment of an agency, fixing the rates and in monitoring its performance.

b. priority to comprehensive contract

- 12. Such contracts should be comprehensive in nature. They should ideally require the contractor to collect waste from each household, transport the same to the processing site, and sweep the roads as well as keep clean the gutters, nallahs, and other public places in a given locality. The contractor can also be given the right of enforcement of rules.
- 13. The contractor, in such cases, ensures that households hand over waste to his staff directly. When this is done he is required to deploy less staff to clean roads and public places.
- 14. In case an agency is responsible only for door-to-door collection, but not its transportation, no incentive can be provided for reduction / segregation of waste. It can dump whatever it wants into the community bins.
- 15. A comprehensive contract has another major advantage. It allows the community bins to be eliminated.
- 16. This also reduces the managerial burden on the municipal body considerably. Instead of handling a plethora of small contracts, the local body has to monitor only one contract. Also this monitoring is directly related to the final objective with which the contracts were given- i.e. to keep the city clean.

c. Contracts to be Performance Oriented. Pay for outputs and not for inputs

- 17. With a view to make sure that the system works efficiently, it is essential that contracts be performance oriented, or be output based. For example, it could be on the basis of households covered, or in case of comprehensive contract, on keeping a given part of the city free of garbage.
- 18. The payment to the operator should not be on weight basis. Here the private operator has no

incentive to reduce the waste through segregation. In fact it would provide an incentive to discourage segregation, and even bring debris, etc to the processing point to get more payment. The ideal system would be to pay a fixed amount for a certain specified job (of clearing all the garbage from a given locality and house to house collection, with or without road sweeping,). However, payment on weight basis can be adopted when differential payments for mixed and segregated waste have been prescribed. Here the operator is allowed to bring unlimited quantity of segregated waste, but only a limited quantity of mixed waste to the processing site.

19. Payment on house hold basis seems to be an acceptable method, especially when the operator is allowed to collect a part of the charge directly from households. This is ideal for self help groups, etc where only house to house collection is done. The payments could be linked to the fulfillment of the overall objective of maintaining cleanliness in a given area. This is ideal for comprehensive contracts. The reporting on parameters of quality of services may be entrusted to local citizens groups. This would also keep a tab on performance of the operators.
- d. Give more freedom to private entrepreneur*
20. Many cities have given contracts which require a certain number of labor or vehicles to be provided, trips to be made between certain hours, submission of daily attendance of labor etc. This is an incorrect practice. Freedom should be given to the contractor to decide how to do the assigned work. This would give him scope to improve efficiency and thus bring down costs (which finally get passed on to the local body).
21. Municipal bodies should avoid recommending for specific equipment to the contractor. Rather than prescribing particular vehicles/ handing over own vehicles, it would be better to allow the contractor to buy his own vehicle but they should follow the provisions of MSW (M&H) rules, 2000 i.e. covered and compatible vehicles fulfilling criteria. If municipality has bought new vehicles which are suitable for SWM management, these can be contracted out for operation and maintenance by the private contractor.
22. The period of the contract should be such that it provides adequate time for the contractor to recover the investment made. Usually, where vehicles are provided by the municipal body contracts could be for 1-3 years, while those where the contractor has to get his own equipment the contracts could be for 5-7 years (with a provision for annual review).
23. The municipal bodies may engage only registered contractors. It should be binding on the Contractor to provide necessary facilities to the workers as per the Contract Labor Act, 1970 and other labor legislation. The contractor also should ensure payment as per the Minimum Wages Act. The contractor cannot employ people under-18 years of age. The workers must be given identity cards, as well as two sets of uniforms, gloves, mask, boot, raincoats, etc. He also must carry out mandatory annual medical check up for all the workers. The contractor should keep the Corporation indemnified in respect of all claims and should insure all the workers as well as equipments.
24. Except for low cost technologies like vermi-composting and biogas plants, municipal bodies should avoid getting attached/recommend the particular technology to the private entrepreneur. This is especially so for expensive technologies for converting waste to power. The technology keeps on evolving. What is acceptable today may soon become outdated tomorrow.
25. The municipal bodies can select the agency on the basis of the least cost option to manage the waste. This is best determined by the per tonne cost of managing waste (tipping fee model). The agency should accept the minimum agreed quantity of waste every day, otherwise suitable penalty for non-acceptance of minimum quantity should be levied, as per the penalty clause.

26. The agency undertaking waste collection and transportation could be paid an incentive for bringing segregated waste. Another option to reduce the amount of mixed waste coming on the processing plant could be allowing the contractor to bring unlimited quantity of segregated waste but only a certain maximum quantity of mixed waste free of cost. The agency would be liable to a “tipping fee” for the quantity over and above the free limit. This free quantity of mixed waste could gradually be reduced on a month-to-month basis. This would encourage the contractor to educate the public and his staff to segregate the waste.
27. The responsibility of mutually resolving the quality of garbage may be between the two operators – one transporting waste at the processing site, and the other processing the received waste. Disputes could be resolved by the municipal body.
28. There must be built in incentives to ensure proper processing of waste and minimum rejects being generated in the processing plant. Thus the responsibility of land filling the rejects could be that of the operator. However, where the land fill site is managed separately from the processing plant, a tipping charge could be charged for the rejects beyond a maximum permissible quantity. Similarly, transportation of rejects could be the contractor’s responsibility. This will help to achieve a self-monitoring system of ensuring that all bio-degradable are efficiently processed.
29. As it may be difficult for the operator to find a scientific site for the landfill of the ash/rejects from the treatment plant and he may resort to unscrupulous dumping. To prevent this, municipal bodies could allow land fill of treated waste on its landfill site on collection of suitable tipping charges. A part of the sanitary landfill could be reserved for the residue from biomedical waste treatment and its tipping charge should be higher.
30. The operator should be free to sell the power/compost/or any other material produced after processing. Selection of technology should be decided by the service provider in consultation with the state pollution control board. SPCB gives authorization after periodically inspecting the facility to ensure that it continues to remain within the rules. The municipal bodies can ensure the same by means of imposing suitable pre-agreed penalties for the failure to keep the licenses intact. The operator must also be made responsible for updating the technology as required by the rules from time to time.
31. Carbon credits may be a very attractive way to finance scientific processing of waste. This is specially so with the signing of the Kyoto Protocol under which tradable carbon credits have become available. The possibility of the Municipal Body being able to generate revenues in future from the processing and reduction of waste should be explored or the option kept open. It is advisable to retain a clause to share the rights in the future in case they become available.
32. The contractor could be allowed to prepare a detailed action plan within a broad parameters prescribed by the municipal body. It could finally approve the action plan.

E. Existing Private Sector Participation in Ghaziabad

33. Existing private sector participation level in Ghaziabad is almost nil except outsourcing of repairing of vehicles. Record of little private participation under practice is not available with GNN. The type of private participation is in form of customary services provided by sweepers as per the traditions and collection of waste from outer colonies, from where no arrangement is made by GNN.

F. Possible PSP Options for Ghaziabad

34. There is no single, ideal and absolute solution for Solid Waste Management in all cities. Even within the city, different methodology are required be adopted. For example- some areas could be given to PSP, whereas Ghaziabad Nagar Nigam could handle balance area. The selection of appropriate area would be based on the availability of manpower, equipment, and

type of area, quantity of generation and type of waste etc. As per the normal practice, the privatization can begin with 1/3 of city area with ultimate objective to cover 1/2 to 2/3 of total city area but minimum 1/3 area should definitely be remained with Nagar Nigam staff to avoid any possible exploitation by the private entrepreneurs and to keep the staff and machinery of Nagar Nigam operational zed.

G. Selection of executing agency for specific area:

35. Sanitation work on Public Private Participation (PPP) or Public Private People Participation (PPPP) basis (some nominal service charges say Rs.20/25 be contributed by each household) has been tried successfully in various parts of the country. The PPP or PPPP model should be tried out in Ghaziabad.
36. After selection of suitable model for particular area of the city, terms and conditions of bid document could be prepared to get the work executed in true spirit of MSW (M&H) Rules 2000 with focus on people's satisfaction in true sense. The bidding system should be transparent and balanced in nature with provision of penalty and timely payment and prompt complaint redressal system. In order to attract resourceful and experienced firms, it is suggested to keep minimum period of operation as three years for collection and transportation and ten years for processing plant /SLF site with provision of termination and extension for another 2-3 years with mutual consent, as the case may be.
37. It is essential that the GNN while giving a contract to private sector make an enabling provision in the contract to inspect the performance of the private contractor from time to time and as a matter of rule should inspect the performance of the private contractors to maintain the quality of the services, prevent corrupt practices and take remedial measures.
38. The formats should be prescribed for such inspections and results of inspections should be reported to the higher authorities at regular intervals. The contracts should carry a provision of penalty for failure to perform the contractual obligation.
39. Some specific areas and modals could be as follows:

Table 2: Proposed SWM System and Recommendation for PSP

Proposed System	Recommendation for PSP
A. Collection System	

Proposed System	Recommendation for PSP
<ul style="list-style-type: none"> • SK should collect waste from different localities using different type of equipment as explained. • Separate collection system for various category of wastes such as commercial, Hotel and restaurants, marriage halls /community halls, horticulture, bio medical waste, etc. 	<ul style="list-style-type: none"> • Areas which do not have Municipal workers or have insufficient numbers should be considered for services by NGOs/privatization, which may include either complete sanitation work from source collection to transportation for totally unmanned area or comprehensive sanitation work for manned area (activities done by sanitation staff be excluded but all other activities be included). Precaution should be taken to keep the interest of existing sanitation staff intact; otherwise there may be resistance from the union. • House-to-House (HTH) collection by some NGO (Non Governmental Organization)/ RWA (Resident Welfare Organization) /CBO (Community Based Organization) by recovering service charges and sweeping, transportation by Corporation staff. • Source collection with phased segregation at source should definitely be the part of duty. • NGO should supervise work of their staff and try to train individual house holders for collection in two bins and for source segregation. • The work norms should be on the basis of standard yardsticks. • Provide implements along with O&M responsibility to NGOs or allow NGOs to deploy own equipments. • Well documented terms and conditions with timely payment schedule is the essence for success, hence should be followed in letter and spirit.
Transportation	
<ul style="list-style-type: none"> • Transportation through a fleet of dumper placers, & Compactor vehicles with transfer station 	<ul style="list-style-type: none"> • Stabilize transportation allocation to private contractors up to maximum ceiling of 50% of total transported waste quantity to prevent monopoly and cartelling. • Provide necessary vehicles as recommended to private contractors on a cost recoverable basis • Provide a contract period long enough to contractor to recover costs in purchasing own vehicles. • Provide necessary vehicles to private entrepreneurs for operation and maintenance on monthly payment basis. • Building & O&M of transfer stations, when decided, could be with private contractors on BOT basis against recovery of tipping fees.
Processing & Disposal	

Proposed System	Recommendation for PSP
<ul style="list-style-type: none"> The waste of Ghaziabad is suitable for Composting, hence Compost Plant is proposed. 	<ul style="list-style-type: none"> Encouragement should be given to small entrepreneurs for manual composting /vermiculture along with source segregation near their working areas. Success of composting plant lies in economic design, source segregation and proper marketing. All this can be managed by some experienced private entrepreneur. Processing plant should be set up on BOOT basis but sometime the processing plants are not economically viable under BOOT basis but with gap funding /subsidy /tipping fee arrangement, the plant can be operated viably but in any case operation, maintenance and sale of compost should necessarily be in private hands.
<p>Sanitary Landfill</p>	<ul style="list-style-type: none"> The proposed SLF at Ghaziabad should be given out to private entrepreneur for operation and maintenance at some pre-decided tipping fees arrangement. In case, both compost plant and SLF are located at same place, it would be better if both the activities are entrusted to one operator.

40. Privatization, however, is not the total solution for the successful provision of Solid Waste Management services. Privatizing some aspects of the service or the entire system will not reduce or eliminate the responsibility of Ghaziabad Nagar Nigam for the service. Furthermore, privatization of services should not be interpreted as the weakening of local government. On the contrary, in order for local government to effectively privatize some of its services, some of the government institutions must be strengthened. Only a local government institution having competent and qualified professional staff would be able to develop, negotiate, manage, monitor, and enforce a contract with a private entity.

Door to Door Collection (DTDC) System

41. Door to Door Collection System is considered as backbone of the effective solid waste management system. The thrust of this initiative is to ensure at source segregation of waste and make a self-sustainable model for door-to-door waste collection by working together with the Municipalities, communities and unorganized waste collectors.
42. The Municipal bodies should give priority to groups/ cooperatives of rag pickers / women groups under SJSRY while awarding such contracts. There is a deficiency of trained people to handle house to house collection accompanied by segregation of waste. Hence, there is all the more reason to utilize the expertise of rag pickers for this work.
43. The need of the hour is to put the informal sector at the beginning of the collection chain rather being at its fag end. These very rag pickers can be “employed” to carry out house to house collection of segregated waste so that they do not need to rummage for recyclables through mixed waste at community bins and processing sites. They should be allowed to sell the recyclables. They should be allowed to collect a part of their “remuneration” directly from the generators whom they are servicing. Such payments could even be on a voluntary basis. The municipal body may pay them a small amount per household covered (say Rs 10 for collection without transportation, and Rs 20 along with transportation).
44. They could be allowed to convert biodegradable waste into manure at a suitable place in neighborhood gardens and allowed sell the same.

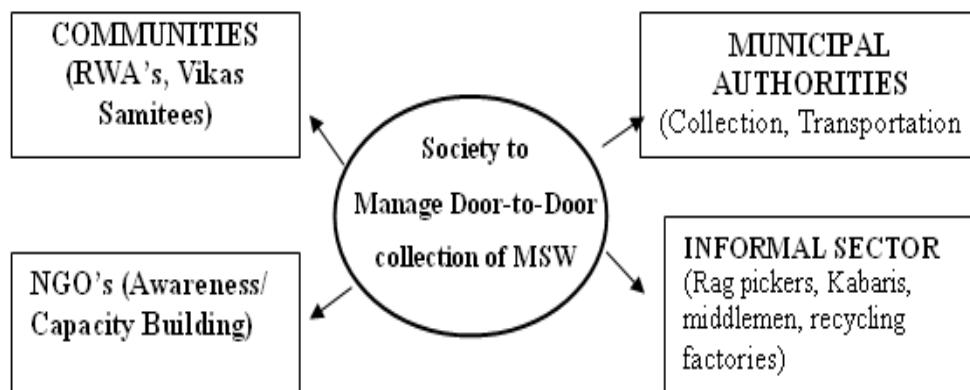
45. Conditions to wear specified uniforms, carrying identity cards and giving them attractive designations (for example ‘*Swathata Doot*’ in Nagpur) helps in giving them the requisite status and place in the society. They can thus earn a livelihood in a much more hygienic manner and can get dignity of labor as opposed to their current status of being a social outcast.
46. Formation of larger groups could be encouraged by giving contracts to NGO’s which employ such deprived sections of the city population (as was done by Nanded and Nagpur). This enables comprehensive contracts for waste management to be given. Another way is to provide equipments from Municipal funds (or cash advance) which can be recovered from amounts payable to them.
47. There can be several models for DTDC. Two models are described below for reference.
48. **Model 1 - by Privatization:** Tenders could be invited by the local body for private sector participation ~ doorstep collection of waste. The private entrepreneur getting contract should be allowed to select his own team of workers; give them containerized tricycles or handcarts or other vehicles, tools and equipments necessary for door step collection of waste. He may allot 200 to 300 houses, or adequate no. of shops, hotels, restaurants, etc., depending on the distances to be traveled and garbage/waste to be collected and manageable for day to day collection of waste from such premises. He may collect the user charge as per the rates fixed by the local body per unit per month for door step collection of waste in consultation with officials of Nagar Nigam. He should have his own supervisors to ensure that door to door collection service is given efficiently and Nagar Nigam officials should just over see by occasional inspection to see that services are adequately being provided in the given areas through private sector and no over charging is done. The persons, engaged by the private sector for door step collection should be allowed to take away recyclable material and also be allowed to dispose of other waste into the municipal system/municipal bins in tile city in tile manner as may be prescribed by the GNN. The Nagar Nigam employees should provide all possible legal and administrative help to the private entrepreneur for making the activity successful. Mass awareness programme and publicity through Media should be regularly carried out by the Nagar Nigam. The Corporation should provide financial support to the private entrepreneur, as in beginning many people may be reluctant in giving user charges.
49. **Model - 2 : by involving informal sector**
- In compliance with MSW (Management and Handling) Rules 2000, aim is to reuse, recycle and reduce waste so that minimal amount goes to landfill site .The objective of any SWM project should be to provide overall benefits to the society by creating better and healthy environment. There are various stakeholders from informal sector, involved in solid waste management including “Rag-pickers” and “Domestic sweepers (waste-lifters)”. These people work under hazardous conditions without any protective gears. Under the DTDC project, these informal sector persons should be brought under the umbrella of formal “Waste hierarchy” providing them suitable honorarium, training and health related services, thereby improving their social, health and financial status. The management facility should also create additional employment opportunities at multiple levels for these people. This should also result in lowered crime rate and better educational opportunities to their families.
50. Features of Model
- In addition of sharing the responsibilities, the required two types of costs may be shared with Municipalities.

- a) Soft costs towards the salary of sanitary workers, their uniforms, protective gears such as hand-gloves, etc, maintenance cost of rickshaws/equipments, costs towards supervising and monitoring could be borne by facilitator and
- b) Hard cost: Municipality may provide cost towards the containerized rickshaws/other tools. In addition, ULB also ensures to provide and daily lifting of roadside containers at the designated storage depots.

The following could be the details of the model:

- An area of about 2000 households should be selected based on discussion with the ULB and survey of the city.
- Organization of separate awareness programme to the community, sanitary workers & ULB workers highlighting the need and importance of the activity.
- Selecting suitable workers from the rag-picker community available in that area/city and imparting training to them.
- Initiating the door-to-door collection activity.
- Requesting ULB to inform public for their participation, eligible collection fee and also implications of non-cooperation (issue of defaulter notice, etc)
- Differential collection fee based on the income levels (LIG, MIG, HIG) for households and higher fee for commercial establishments such as shops, restaurants, hotels, market areas.
- Continuous supervision and monitoring to ensure the progress.
- The model is to attain self-sufficiency – to meet its operational expenses- in a span of 6-8 months and subsequently to be expanded into other areas of the city. Upon successful demonstration in selected area of a particular city, it is easier to expand in subsequent areas and cover entire city.
- Formation of a society, at an appropriate time, involving Residential Welfare Associations, women groups/associations, elected representative of the local body, Administrative head of local body and other known personalities of the city and the society to take over the monitoring/ supervision of MSW door-to-door collection activity of the city.

51. Proposed Society for Managing MSW Collection



Appendix 12

Appendix 12
Institutional, Training and Mass Awareness Aspects

A. Introduction

- 1) The Municipal Solid waste (M&H) Rules, 2000 addresses collection, transportation and disposal of Municipal solid waste in detail. For dealing with Biomedical and industrial hazardous waste, separate legal provisions exist other than MSW rules, therefore classification of waste and responsibility of different authorities should be understood properly. Scope of this report is limited to Municipal solid waste only.
- 2) There is a long chain of responsibilities for handling of waste under the rules. At the top of the chain lies Central pollution Control Board (CPCB) and at the bottom lies the Municipal authority.
- 3) The distribution of jobs and responsibilities of authorities at different levels can be understood by the flow diagram below:

(a) CPCB: At the central level

- To coordinate with the State Board's
- To monitor the implementation of guidelines and standards
- Review of standards and guidelines
- Compilation of monitoring data
- To prepare a consolidated annual review report based on State Pollution Control Board (SPCB) reports ,for the central government before 15th December every year



(b) SPCB: The State level Pollution Control Board and Committees

- To monitor the compliance with standards regarding ground water ,ambient air, leachate quality, compost quality and incineration standards,
- To consider the grant of authorization for setting up waste processing and disposal facilities and landfills to either municipal authority or a private operator of a facility, after considering the views of other agencies like the State Urban Development Authority, Ground Water department, Airport or Airbase authority or any such regulatory agency as required. The request for authorization should be in Form I.
- The State Government or the committee shall issue authorization in Form- III to the municipal authority or private operator within 45 days stipulating compliance criteria and standards as specified and including such other conditions, as specified.
- To consider the issue of fresh authorization after the validity of existing authorization expires.
- To coordinate with CPCB
- To prepare annual report for CPCB



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- The Secretary in charge of the State Urban Development Department will have the overall responsibility of the implementation of MSW (M&H) Rules, 2000.
- In the case of metropolitan cities the Secretary in charge of the urban development will receive from the Municipal Authority report of any accidents in Form V.



(d) **District level**

- The overall responsibility for the implementation of the MSW (M&H) Rules, 2000 at the district level lies with the District Magistrate (DM) or The Deputy Commissioner (DC), who must oversee the working of the department under him/her.
- The DM/DC will receive from the Municipal Authority reports of any accidents in Form V.



(e) **Municipal level**

The municipal Authority will be responsible for implementation of MSW (M&H) Rules, 2000 at municipality level including:

- Infrastructural development for collection, storage, segregation, transportation, processing and disposal of MSW.
 - Apply for grant of authorization for setting up of waste processing and disposal facilities including landfills from the State Board or Committee. The application should be in Form I. A private operator of a facility should also apply in a similar manner.
 - Notify the waste collection and segregation schedule to generators of these wastes to help them comply.
 - Organize awareness programmes with citizens to promote reuse or recycling of segregated materials and community participation in waste segregation.
 - Write an annual report and submit to :
 - ❖ Secretary-in-charge of the Department of Urban Development of the State or Union Territory in case of Metropolitan Cities.
 - ❖ The District Magistrate or the Divisional Commissioner in case of non-metropolitan cities.
 - ❖ The State Pollution Control Board or Committee on or before 30th June of every year.
- 4) In order to make city's solid waste management successful, involvement & efforts of line agencies becomes very important. Institutional strengthening should be done by adequately decentralizing the administration, delegating adequate powers at the decentralized level, inducting professional into the administration and providing adequate training to the existing staff.
- 5) It is also necessary to fix work norms for the work force as well as for supervisory staff to maintain the manpower productivity and optimum output expected from the vehicles and machinery utilized. It is therefore, necessary that local body adopt adequate measures for institutional strengthening as mentioned above.

B. Strengthening of Ward level administration

- 6) Authority and responsibility should go hand in hand. For fixing accountability there should be adequate delegation of fiscal and disciplinary powers to the officers and the supervisory staff responsible for managing solid waste and carrying out all day-to-day functions smoothly. The ideal situation is one, in which most of the SWM related activities are dealt and disposed off at the ward level. To make the ward office self sufficient, the utmost requirement is to establish a pucca ward office in centrally located and convenient place in each ward with posting of an active ward officer. In Ghaziabad, ward offices are functioning from temporary huts or public places like park/water tank etc. The ward office should have sufficient space for minimum two to three rooms. One room for ward officer and other for storage is must. Following activities could be undertaken at the ward office:
- (i) All sanitation related works like street sweeping, collection and transportation of garbage
 - (ii) Dead animal removal from the streets
 - (iii) Nabbing of stray animals
 - (iv) Fogging spraying, anti larva spraying
 - (v) Cleaning and maintaining of public toilets and urinals of the ward
 - (vi) Cleaning of drains
 - (vii) Special sweeping and painting *Rangoly* on demand and special occasions
 - (viii) Cleaning of septic tanks/ choke removal of sewage lines
 - (ix) Maintenance of street lights
 - (x) Maintenance of minor repairing works of street, drain, parks etc
 - (xi) Deposition of license/registration fees
 - (xii) Issuance of death and birth certificate
 - (xiii) Arrangement of Public redressal system for all municipal related activities
- 7) **Essentialities for successful management:**
- (i) For efficient administration, there should be regular timings for opening and closing of ward offices.
 - (ii) In each ward, communication system should be available with linking of the office with other offices, workshop and head office of GNN through Networking.
 - (iii) One responsible officer with positive aptitude and tendency to solve the public grievances should always be available at the office for entire office hours.
 - (iv) Strong monitoring at Zonal and City level should take place.
 - (v) Good inter-departmental coordination within each department of GNN should be ensured.
 - (vi) Top priority should be given to solving of public redressal
- 8) The Head of the Solid Waste Management department should also have the power to punish subordinates including supervisory staff. Adequate in-built checks may be introduced to

ensure that the delegated powers are not misused. The ward level administration should be fully responsible for ensuring primary collection of waste, street sweeping, storage of segregated waste at source and taking the waste to waste storage depots, clearing debris and cleaning surface drains and public space and should be regularly supervised by the ward-level supervisors. The presence of all Solid Waste Management officers in the field during morning hours should be compulsory. A grievance redressal system of the ward should be put in place in each ward.

- 9) *Involvement of Ward committees.* The 74th Constitutional amendment envisages formation of Ward Committees in each city above 0.3 million population. This is also applicable to Ghaziabad City. These Ward Committees, as and when formed, will be very useful in improving Solid Waste Management services at the ward level. These Committees should be motivated to help in the following areas:-
- (i) Creating public awareness regarding Solid Waste Management at the ward level;
 - (ii) Formation of Resident welfare Association / Neighborhood committees to ensure public participation in source segregation of recyclable waste and deposition of domestic waste in the handcarts at fixed time during primary collection;
 - (iii) Involving school children to be watch dogs in preventing littering of streets by the people;
 - (iv) Interfacing with the people and officials and help in reducing public grievances on Solid Waste Management at the ward level;
 - (v) Supporting the effort of cost recovery for the services rendered;
 - (vi) Encouraging NGO participation in Solid Waste Management.

D. Proposed Organizational Setup

- 10) *Exclusive SWM In charge from engineering background.* Although, there is one Health officer to look after and coordinate the SWM activities in an exclusive manner but implementation is in traditional manner and not according to MSW (M &H) Rules, 2000. The health officers are practitioner Medical Officers and have opted for the posting as GNN may be in charm of staying at Ghaziabad but have no experience and aptitude for SWM activities. Apart from this, administrative officers and health officers are not experts in bidding procedures which compels them to continue with traditional style of working but for implementing good practices in SWM preparation of bid documents, tendering, formulation of specifications etc are required, which are related to engineering section but due to lack of coordination, lack of authority and personal conflict among officers most of the tender related activities have not been initiated.
- 11) A senior officer of Executive Engineer (X.EN) rank should be made the in charge of central SWM department. He should be responsible for entire implementation of SWM according to MSW (M&H) rules, 2000. The central Solid Waste Management Department should be responsible for procurement and upkeep of vehicles, construction of transfer stations, setting up and maintenance of processing plants as well as for managing the disposal sites in an environmentally acceptable manner. It should make policy for House to House collection, decide the tax imposition, prepare a module for awareness and public private participation, contract document and suitable terms and conditions for various activities under SWM sector etc. It should monitor the manpower deployed, waste collection carried at ward level, waste quantity transported at the dumping sites, progress of complaint redressal, costs incurred on various activities on daily basis.
- 12) The central Solid Waste Management department should also be responsible for the

procurement of land for processing and disposal of waste. As Head Quarter in charge he should take policy decisions and co-ordinate the activities of all the wards and be answerable to the Municipal Commissioner and elected body for the efficient functioning of the department. He should look after the recruitment of manpower, human resources development, training etc. He should also coordinate for processing of waste, establishment of processing plant, transfer station, slaughter house, land fill site, carcass utility center, bio medical plant etc. He should be the officer in charge for all works related to SWM activities and have the complete authority and confidence of Commissioner.

- 13) **City Level Administration.** The city level administration should be directly under the control of Municipal commissioner. He should supervise and support the XEN (SWM) and should approve the policy and guidelines for successful implementation of SWM. He should delegate sufficient authority and powers to department head of the SWM section. The Municipal Commissioner should build up good rapport with State Government and arrange financial resources as well as physical resources such as land allotment, approval of policies requiring State Government approval.
- 14) The subject of solid waste management, proposed to be handled by Environmental engineers /public health engineers or civil engineer of Executive Engineer level with the support of mechanical/automobile engineers to handle the workshop facilities and various processing plants. Qualified engineers should, therefore, be regularly inducted in handling Solid Waste Management.
 - (i) Public Health/Environmental Engineer in the grade of XEN should be made in charge of Solid Waste Management section with sufficient authority and responsibility. He would report directly to Commissioner.
 - (ii) To avoid the problem of coordination and passing of responsibility to others, overall control in relation to sweeping, drain cleaning, collection, transportation, processing and disposal of all wastes including vehicle maintenance facilities should lie with in charge of SWM section.
 - (iii) In charge should be assisted by two Assistant Engineers-one Civil Engineer and one Mechanical Engineer for technical matters and one Chief sanitary officer for supervision, monitoring, mass awareness and record keeping.
 - (iv) The AEN Civil Engineer should exclusively be made responsible for solid waste related activities like construction and maintenance of; buildings, storage points, processing plants and sanitary land fill sites.
 - (v) The AEN Mechanical Engineer should be made responsible for entire transportation system, procurement & maintenance of vehicles, operation and maintenance of processing plant and sanitary land fill site.
 - (vi) The Chief sanitation officer should be responsible for supervision and monitoring of solid waste related activities, planning, record keeping and conducting mass cleaning drives and publishing IEC material.
 - (vii) Sanitary Inspectors to assist Chief Sanitation Officer in supervision of sweeping, drain cleaning, transportation, door to door collection, processing, disposal systems, planning and monitoring. Supervisors to assist in supervision work.

E. Work norms for workers, supervisors and vehicles

- 15) The sweepers should be given "Pin point" individual work assignments according to the density of the area to be swept.
- 16) The sweepers may be directed to sweep the roads and footpaths in the area allotted to them as well as to collect the domestic, trade and institutional waste in their handcart from the

households, shops and establishments situated on the road / street.

- 17) The above sweeping norms are for cleaning the streets in the first 4 hours of the working day. In the remaining hours of the day, if there is broken duty, the sweepers should be assigned pin point work for cleaning the streets in slums and unauthorized settlements to ensure hygienic conditions in the city and prevent the problems of health and sanitation arising in such areas.
- 18) The roads, which have a central verge or divider, should be considered as two roads. In such cases, the length of the road allotted for sweeping should be reduced to half or alternatively separate sweepers may be engaged for sweeping two sides of the road.
- 19) The yardstick for cleaning open spaces should be prescribed looking to the local situation. However, 30,000 sq.ft. of open space can be given to a sweeper for cleaning per day.
- 20) Similarly work norms can be prescribed for variety of vehicles used depending upon the distance to be traveled and the places to be covered. These norms may be prescribed after conducting time and motion study.
- 21) Normally one Dumper Placer vehicle could make 7-8 trips to the processing and disposal site depending on the distance to be traveled.
- 22) Norms of work for supervisors maybe prescribed and monitored by the local body for inspection of sweeping done, clearance of waste storage depots, transportation of waste carried out, etc. inspection of processing and disposal sites by various levels of supervisors may also be prescribed to ensure adequate output of all the supervisory staff.
- 23) The first level supervisors could be asked to inspect the work of all the sweepers every day. All temporary waste storage depots must also be inspected by the same level of supervisors with the same frequency.
- 24) All Supervisory Officers right from Sanitary Sub Inspector to in – charge of Solid Waste Management department must remain on the field for 4 hours in the morning during the time of street sweeping. The timings for the lower and middle level supervisor should extend beyond the duty hours of the sanitation workers in the afternoon/evening to verify whether work has been done properly. This supervision will have a direct impact on the quality of service.
- 25) For capacity building of the department, senior officials should be frequently exposed to developments taking place in various parts of the state / country by sending them out of city visits and for attending seminars, workshops and training courses. They should be also involved in all decision making processes.

F. Human Resources Development

- 26) Human resources development is very essential for internal capacity building for any organization. Training, motivation, incentives for outstanding service and disincentives for those who fail to perform are essential for human resources development. Concerted efforts should be made by the local body to inculcate among its officers and staff a sense of pride in the work they do and to motivate them to perform and give their optimum output to improve the level of services of the city and the image of the local body.

G. Training

- 27) No specialized courses have so far been designed to meet need of different levels of staff. Short and medium term courses should therefore, be designed for the sanitation workers and supervisory staff. Special training and refresher courses may also be conducted as described below:
- 28) *Special Training to Unqualified Staff.* Unqualified supervisory staff should be given service training to qualify for supervising sanitation works. They may be sent out for training to the

All India Institute of Local Self-Government or such similar institutions with signs special course of sanitation supervisors.

- 29) *Refresher Courses for All Levels of Staff.* Refresher courses should be conducted for the sanitation workers as well as supervisory staff at least once in every 5 years, or they should be sent for training to get exposure to advance in this field.
- 30) *Issues for training of sanitation workers*
- Importance of sanitation in urban areas
 - Present scenario of solid waste management system in the urban areas, deficiency in the system etc.
 - Impact of inefficient Solid Waste Management services on health and environment.
 - Inefficiency of tools and equipments used and loss of manpower productivity.
 - Need for modernization of solid waste management practices.
 - Options available for improving the system
 - Advantages of using improved tools and equipments for primary collection of waste and street sweepings
 - Need for synchronization of storage of waste at source, primary collection of waste and waste storage depots
 - Proper upkeep of tools and equipments and waste storage depots
- 31) *Issues for training to sanitation supervisors*
- Need for synchronization of transportation of waste with waste storage depots
 - Transportation of waste on day to day basis
 - Waste processing and disposal options, advantages and disadvantages of various technologies.
 - Sanitary land filling and related technologies
 - Public and NGO participation in waste management
 - Building public awareness
 - Enforcement of the various rules
- 32) *Issues for training to officers directly responsible for SWM department*
- Solid Waste Management good practices prevalent in other parts of the country and in the developed countries
 - Institutional strengthening, internal capacity building and human resource development
 - Private sector participation in Solid Waste Management and cost benefits accrued on account of PSP.
 - Management information systems
 - Financial aspects
 - Health Aspects
 - Legal Aspects
- 33) *Exposure to Chief Executive Officer/ Municipal Commissioner.* It is necessary to give an orientation to the Chief Executive officer of the local bodies and make them aware of this important aspect of Urban Management. They may therefore be given exposure to Solid Waste Management through short training programs or seminars conducted by the departmental officers.

- 34) *Exposure to Elected Members.* Whereas the Municipal Commissioners or the Chief Executives are responsible for day-to-day affairs of the urban local bodies, the elected members are the policy makers and their sanctions are essential for any major investments or improvements in Solid Waste Management services. It is, therefore, necessary that the members of the elected wing such as the Mayors of the Corporation and other important office bearers, are given appropriate orientation towards the need of modernization of solid waste management practices in the urban areas and the importance of the same in terms of health and sanitation in the cities/towns. If these members are given an appropriate exposure, they would automatically support adequate financing for solid waste management services and strengthen the hands of chief executives in the implementation of modern methods of waste management and they would also help in getting public support through their network of field workers.
- 35) It is suggested to organize sponsored trip for officials of Municipal Corporations to places where considerable success has been achieved in the field of SWM. Few places for such visits could be-*Chennai, Bangalore, Hyderabad, Surat or Ahmedabad.*

H. Promotional Opportunities

- 36) Adequate promotional opportunities should be available in the decentralized Solid Waste Management hierarchy to maintain the interest of the supervisory staff to remain in the department.
- 37) *Inter Departmental Co-ordination.* Since the SWM department depends largely upon the support of various departments of the local body, more particularly the Engineering department, the Chief Executive of the local body should hold regular monthly co-ordination meetings to Sort out problems faced by the SWM department such as expeditious repairs of roads, drains, water-supply pipe-lines etc. which cause hindrance to street and city cleaning. The reinstatement of roads dug up by utility services should also be given priority. Apart from infrastructure works, the engineering department should give priority to specific works related to SWM section, such as- construction/repairing of ward offices, garage, store buildings, pucca floor under all collection points, identification of suitable land and construction of transfer station, SLF, Processing plant etc.
- 38) The procurement procedures for the SWM equipment also need to be expedited and simplified in such meetings. A Rate-contract system should replace time consuming tendering procedures. It should be ensured that none of SWM activity should get affected for want of repairing of equipment. Sanitary workers should have usable implements. About 25 % more equipment shall be purchased to take care of repairing and maintenance.
- 39) There should be an Apex Committee comprised of representatives of various utility services, headed by the Municipal Commissioner of the Corporation, to co-ordinate the laying of underground services in the city by various utilities and the reinstatement of the roads as soon as the underground services are laid. The Apex Committee should ensure that repeated digging of road is avoided for laying of services by various utilities at time. The works to be carried out by various utilities on a particular road should be coordinated to prevent frequent digging of roads, laying and maintaining of services in slums, provision of public health engineering services and water supply for public toilets and road construction in the slums to improve overall health and sanitation in the city may also be regularly reviewed in the co-ordination committee meetings.

I. Involvement of informal sector and NGO

- 40) *Encouragement to NGOS and Waste Collector Co-operatives.* NGOs should be fully involved in creating public awareness and encouraging public participation in SWM planning and

practice. The local body may also encourage NGOs or co-operative of rag pickers to enter this field and organize rag pickers in doorstep collection of waste and, provide them an opportunity to improve their working conditions and income. The local body can give incentives to NGOs in their effort of organizing rag pickers in primary collection of recyclable and/or organic waste, and provide financial and logistic support to the extent possible.

J. Mass Awareness Campaigns

- 41) For effective implementation of SWM practices, multi pronged action is required in association with all stake holders- Municipal corporation employees, Public representatives, State Government, NGOs and waste generators.
- 42) On one side, training & refresher courses are essential for Municipal employees; the other important side is conducting Mass awareness programmes for waste generators. It is experienced that even after setting up of a good system, it is not always necessary to obtain desired results, in absence of people’s cooperation and awareness. No city can remain clean, if sanitation work is left entirely on civic body with no cooperation or very little cooperation of people. Thus Public Participation is key to the success for SWM.
- 43) People need to know about the duties of Nagar Nigam; rules and regulations / obligatory functions of GNN; as well as their participatory role towards city’s cleanliness. Information, Education and Communication (IEC) mechanisms should be used to ensure effective public participation.
- 44) Following could be some useful points for mass awareness:

Table: Target group for Mass awareness

S.No.	Target group	Points for Mass awareness
1.	Households	<ul style="list-style-type: none"> 1. Not to throw any solid waste in the neighborhood, on the streets, open spaces, and vacant lands, into the drains or water bodies. 2. Keep food waste/biodegradable waste in a non-corrosive container with a cover (lid) 3. Keep, dry/recyclable waste in a bin/bag or a sack. 4. Keep domestic hazardous waste if and when generated separately for disposal at specially notified locations.
2.	Multistoried buildings, commercial complexes, private societies, etc.	<ul style="list-style-type: none"> 1 to 4 as above 5. Provide separate community bin/bins large enough to hold food/biodegradable waste and recyclable waste generated in the building/society. 6. Direct the member of the association/society to deposit their waste in community bin on day to day basis before the hour of clearance.
3.	Slums	<ul style="list-style-type: none"> 1 to 4 as above 5. Use community bins provided by GNN for deposition of food and biodegradable waste.

4.	Shops, offices, institutions, etc.	1 to 4 as above 5. If situated in a commercial complex, deposit the waste so stored as per 2 and 3 above in community bins provided by the association.
5.	Hotels & Restaurants	1 to 4 as above. However, the container used should be strong and with lid.
6.	Vegetables & Fruit Markets	1. Provide large containers, which match with transportation system of the local body. 2. Shop keepers not to dispose of the waste in front of their shops or open spaces. 3. Deposit the waste as and when generated into the large container placed in the market.
7.	Meat & Fish Markets	1. Not to throw any waste in front of their shops or open spaces around. 2. Keep non-corrosive container/containers with lid handle and deposit the waste in the said containers as and when generated. 3. Transfer the contents of this container into a large container provided by the association of the market or local body on day to day basis before the hour of clearance.
8.	Street Food Vendors	1. Not to throw any waste on the street, pavement or open spaces. 2. Keep bin or bag for the storage of waste that generates during street vending activity. 3. Preferably have an arrangement to affix the bin or bag with the hand-cart used for vending.
9.	Marriage Halls, Community Halls, etc.	1. Not to throw any solid waste in their neighborhood, on the streets, open spaces, and vacant lands, into the drains or water bodies. 2. Provide a large container with lid which may match with the transportation system of the local body and deposit all the waste generated in the premises in such containers.
10.	Hospitals, Nursing Homes etc.	1. Not to throw any solid waste in their neighborhood, on the streets, open spaces, and vacant land, into the drains or water bodies. 2. Not to dispose off the biomedical waste in the municipal dust bins or other waste collection or storage site meant for municipal solid waste. 3. Store the waste as per the directions contained in the Government of India, Ministry of Environment Biomedical Waste (Management & Handling) Rules 1998 and modified in 2003.

11.	Construction & Demolition Waste	<ol style="list-style-type: none"> 1. Not to deposit construction waste or debris on the streets, footpaths, pavements, open spaces, water bodies, etc. 2. Store the waste within the premises or with permission of the authorities just outside the premises without obstructing the traffic
12.	Garden Waste	<ol style="list-style-type: none"> 1. Compost the waste within the garden, if possible. 2. Trim the garden waste once in a week on the days notified by the local body. 3. Store the waste into large bags or bins for handing over to the municipal authorities or contractors appointed for the purpose on the day of collection notified.

(a) Methodology:

- 45) The overall objective is to achieve People's participation in SWM activities in collaboration with the Municipal Corporation. In order to achieve the objective, following methodology has been suggested.
- 46) Situational analysis about existing deficiencies should be made like; no segregation and storage at source, no house to house collection, littering and open burning quite common, improper collection and disposal mechanism etc .
- 47) Design and implement a suitable mechanism for source segregation, collection, transportation and proper disposal on pilot basis through NGO.
- 48) Capacity building of different stakeholders involved viz. NGOs, CBOs, Volunteers, line agencies, etc. for development of proper mechanism for adopting best practices of solid waste management.
- 49) Dissemination of information to community regarding best practices of Solid Waste management through print, electronic media and unconventional media.
- 50) Production of relevant IEC for replication at their end

(b) Strategies and approaches:

- 51) Identification of major issues of concern in respective area-such as,
 - i. Need and urgency of waste disposal
 - ii. Obligatory functions of ULB and legal provisions for People's participation
 - iii. Present scenario of SWM and need for active role of community participation
 - iv. Need of formation of Community Based Organizations (CBO), Neighborhood committees (NCs) for timely disposal and collection of waste; recycling, reusing and reduction of waste at source; segregated storage at source; deposition of waste at proper place in proper containers; no littering on streets and public places; paying user charges regularly and cooperation to Municipal corporation employees
 - v. Role of N.G.Os in city/Mohalla/ward cleanliness drive, street sweeping
 - vi. organizing awareness camps, skill enhancement of the people/communities as well as develop coordination with the ULB
- 52) Development of IEC for replication and distribution
- 53) Awareness generation through electronic media:
 - i. Scroll on message

- ii. Ad spots
 - iii. Songs with drama
 - iv. Interactive sessions
 - v. Quiz competitions
- 54) Awareness generation through print media:
- i. Appeals
 - ii. Advertisements
 - iii. Articles
 - iv. Distribution of pamphlets
 - v. Stickers
 - vi. Posters
- 55) Awareness generation through unconventional and traditional media:
- i. Street plays
 - ii. Advertisement through Uttar Pradesh State Road Transport Corporation (UPSRTC) buses/private buses
 - iii. Organization of workshops on 'best out of waste' during hobby classes and in schools
 - iv. Organization of public meetings, door to door campaigns etc.
 - v. Ensure facilitating awareness generation campaign in a series.
 - vi. Facilitate having associating partners, like NGOs, line agencies, media to implement joint venture for awareness generation campaign
 - vii. Capacity building of municipal personnel, NGOs, CBOs for development of effective mechanism for adopting best practices
 - viii. Formation of committees at local level to sustain the initiative undertaken and incorporating related capacity building initiatives
- 56) It would be better if a pilot project is implemented through NGO.
- 57) Target group: House wives, members of selected commercial houses, grass root workers of GNN
- 58) Number of camps: 20 (with recapitulation 3 times for each camp=80) for Ghaziabad city.

© ***Process of implementation***

- i. Coordination by NGO
- ii. Involvement of CBOs/ Mohalla Samities (where ever available), members of local small business enterprises, GNN grass root representatives, school teachers and the communities.
- iii. Equipment input such as LPCD projector, video clippings
- iv. Involving local media for publication of activities
- v. Follow up activities

(d) ***Expected outputs:*** Behavioral changes in practices

Appendix 13

Appendix 13 Community Participation

A. Introduction:

1. “Community participation” plays a very crucial role in successful solid waste management projects. This means that communities should be viewed as partners in all phases of the project cycle i.e. identification, planning, designing, implementation, monitoring and evaluation.
2. Implementation of any solid waste management related project is not possible without involvement of the community. Even for minor matters like keeping temporary community bins there can be public resistance. Generally, community people have a fixed notion about any SWM related place - a nuisance point with full of scattered garbage responsible for spreading bad odour, flies and scrambling place for rag pickers and stray animals. This image is on the basis of improper SWM operations at present.
3. Community participation has several benefits, which can be divided in benefits for the community and benefits for the project. On one hand, community participation can be seen as an end in itself and a way to strengthen the community. On the other hand, community participation can be seen as a means to execute project in a more efficient way with a surety of sustainability.

B. Specific Role and Benefits:

4. The success of community participation in SWM depends on other stakeholders’ involvement, especially the local municipality; Community based organization (CBO), Resident welfare associations (RWAs), trading/housing associations /societies, local public representatives, micro-enterprises, Non government organizations (NGOs) and informal sectors. In particular, the municipality plays a vital role as in most of the areas basic responsibility for delivery of basic services lies with them. If, the municipality does not have segregated collection and processing system, there is hardly any purpose for source segregation.
5. Possible benefits of common nature:
 - Improvement of project design , effectiveness and efficiency
 - Cost minimization
 - Enhancement of impact and sustainability of project
 - Help in preventing conflicts and to stimulate cooperation and agreement
 - Builds awareness, local capacities and capabilities
 - Helps in decision making
6. Community may play important role in many ways specifically, as shown in following table :

Table : Possible Role of community in SWM

S.No.	Activity	Expected Role	Benefits	Target group
A.	Planning and Designing			
a.	Data collection	<ul style="list-style-type: none"> • Information about waste generators, number of 	<ul style="list-style-type: none"> • Information are mostly not available nor 	All waste generator groups,

		<p>households/shops etc, waste quantities generation,</p> <ul style="list-style-type: none"> • Any suitable site for ward office, community collection points, micro processing centre etc could be known • Social economic status of the community ,paying capacity and willingness to pay could be found • Are for privatization could be agreed upon 	<p>updated but community may give correct and updated data</p> <ul style="list-style-type: none"> • Land identified by municipality may not be agreed by the community but site suggested after consultation may be agreeable • Scope about privatization and user charges could be ascertained. 	<p>local public representatives, professionals, various associations and informal/formal groups</p>
b.	Door to Door collection and Road sweeping	<ul style="list-style-type: none"> • Decision about Mode, timings, privatization, user charges on differential rate basis • Community supervision 	<ul style="list-style-type: none"> • Littering could be controlled • Source segregation could be possible • Involvement of NGO /CBO/RWAs and Rag pickers • Introduction of privatization on user charge basis • SWM on all seven days a week • Public satisfaction • Cost savings 	<p>All waste generators – individual as well as part of society</p>
c.	Community Storage	<ul style="list-style-type: none"> • Decision about location, type and size of litter bin, community bins, ward office etc 	<ul style="list-style-type: none"> • No dispute or resistance about the locations • Control on littering • Segregated storage • Scattering of waste near the bins and scrambling by rag pickers/ stray animals shall be 	<p>--do---</p>

			<ul style="list-style-type: none"> reduced • SWM on all days • High people's satisfaction • Cost saving 	
d.	Transportation	<ul style="list-style-type: none"> • Decision about Mode, timings, privatization, user charges • Community supervision 	<ul style="list-style-type: none"> • Involvement of NGO /CBO/RWAs • Introduction of privatization on user charge basis • SWM on all days 	Concerned ULB/ Private entrepreneur (in case of privatization)
e.	Processing	<ul style="list-style-type: none"> • Decision about type, mode ,location of unit in consultation with experts • Local people could be involved in processing, selling, management and supervision 	<ul style="list-style-type: none"> • Increased scope for decentralized small scale processing plants • Opportunity for local employment • Motivation for source segregation • Involvement of NGO /CBO/RWAs • Cost saving 	---do---and all waste generators
f.	Institutional strengthening	<ul style="list-style-type: none"> • Concept of decentralization • Community ownership • Involvement in supervision and monitoring could be decided 	<ul style="list-style-type: none"> • Local institutional system shall be strengthened • Decentralization will not only reduce cost but result in more public satisfaction • Dependency on government shall reduce 	Community as a whole, local public representatives, associations, formal and informal groups

Appendix 14

Appendix 14 Operation and Maintenance Requirements

1.0 Introduction

There are following important elements of the solid waste management system, namely:

- Primary collection and Road sweeping
- Secondary collection
- Transportation vehicles
- Transfer station
- Treatment facilities
- Landfill site

All elements require appropriate operation and maintenance system.

1.1 Primary Collection

Component	Operation Requirement	Maintenance Requirement
Broom, basket, plate, spade and other tools	Used by sweepers/sanitary workers. Proper storage and locking facility is needed to keep the tools	Theft is a major problem; otherwise tools should be able to function till their designated life span.
Wheel barrows	--do--	Theft of bucket/wheel barrow is a major problem. Frequent repairing of wheel barrows may be required if manhandled/ handled by many people. Normal defects are – breaking of welding/ wear and tear of wheels/ corrosion of body etc
<p>Suggestions :</p> <ul style="list-style-type: none"> • Regular upkeep and rotation of the wheelbarrows. • Proper record keeping of number of equipment in use/under repairing at ward level/zone level • Equipment should be formally allotted to worker/s as per the availability and requirement • Specifications should be finalized after proper discussions with end users. It should be ensured that the equipment procured confirms to the Bureau of Indian Standard Specifications, if available. In case the BIS specifications are not available, the equipment should be of standard specifications with commitment from suppliers for providing after sales service and preventive maintenance and which could be easily maintained in Ghaziabad. • It is preferable to use new equipment on pilot basis before procuring bulk quantity. • Wheels should be sturdy and have double ball bearings • Buckets should be painted with anticorrosive paint, bottom holes for drain off , easily removable and appropriate capacity • Specified place should be designated for storing of wheel barrows 		

- Daily cleaning and greasing at regular interval should be ensured
- It is better to allow some minor amount i.e. Rs 50 per month for monthly upkeep of equipment to end user ,which would ensure timely repairing as well as motivate to keep the equipment in order.

1.2 Secondary Collection Equipment

Component	Operation Requirement	Maintenance Requirement
Containers	<p>(a)Used by sanitary workers. Proper location, pucca base and raised platform are needed to keep the containers.</p> <p>(b) To decide proper location is a major problem as most property owners do not want community containers near their premises.</p> <p>© Container of sufficient size should be placed on wide roads so neither spilling takes place nor they cause obstruction to the traffic.</p>	<p>(a)The containers get damaged during unloading and lowering on the ground.</p> <p>(b)When platform is not raised and pucca, then bottom of container may be damaged due to corrosion</p> <p>(c) Sometimes containers get damaged due to accident.</p> <p>(d)Containers should be compatible with waste carrying equipments.</p>
<p>Suggestions :</p> <ul style="list-style-type: none"> • Specify location and size on need based, waste receiving quantity, • Regular upkeep and maintenance mechanism to be in place. • Proper record keeping of number of containers in use/under repairing/spare at ward level/zone level • Containers should be formally allotted to vehicle as per the availability and requirement • Specifications should be finalized after proper discussions. It is preferable to use new equipment on pilot basis. • It is better to allow some minor amount i.e. Rs 500 per month for monthly upkeep of equipment to workshop in charge, which would ensure timely repairing. 		

1.3 Transportation Vehicles

Component	Operation Requirement	Maintenance Requirement
Transportation vehicles	<p>(a)Vehicle operated by operators which could be either municipal employees or provided by private operators if operation is given on contract.</p> <p>(b)Proper routing to be decided to avoid zigzag</p>	<p>a) Regular maintenance is required as suggested by the manufacturer.</p> <p>b) Vehicle maintenance checklist should be prepared for preventive maintenance.</p> <p>c) Proper inventory level should be maintained or if</p>

	<p>movement and congested areas.</p> <p>© Separate vehicles for biodegradable and non-biodegradable/bulk waste</p>	<p>maintenance to be contracted out, then annual maintenance contract should be in force.</p> <p>d) A training and health check schedule should be prepared and adhered for the staff.</p>
<p>Suggestions :</p> <ul style="list-style-type: none"> • Regular upkeep and maintenance mechanism of the vehicles should be in place. • Proper record keeping of number of vehicle in use/under repairing at ward level/zone/city level. • Vehicle should be formally allotted to operator/s as per the availability and requirement • Specifications should be finalized after proper discussions with end users. It is preferable to use new equipment on pilot basis. • New vehicle should be purchased after ensuring proper operation and maintenance system in place. • It is better to allow some minor amount i.e. Rs 5000 per month for monthly upkeep of vehicle to workshop in charge, which would ensure timely repairing. 		

1.4 Transfer Station

Component	Operation Requirement	Maintenance Requirement
Transfer Station	Transfer station may be operated upon either by municipal staff or by private agency depending upon the contract conditions.	<p>a) Regular maintenance of equipment, compaction unit and civil works is required.</p> <p>b) Vehicle maintenance checklist should be prepared for preventive maintenance.</p> <p>c) Proper inventory level should be maintained or if maintenance to be contracted out, then annual maintenance contract should be in force.</p> <p>d) A training and health check schedule should be prepared and adhered for the staff.</p>
<p>Suggestions :</p> <ul style="list-style-type: none"> • Regular upkeep and maintenance mechanism of the vehicles should be in place. If the entire system is in private hands, only supervision will be required at municipal level. • Proper record keeping of number of vehicle arrived for unloading and bulk carriers 		

<p>dispatched from transfer station.</p> <ul style="list-style-type: none"> • Specifications should be finalized after proper discussions with end users. It is preferable to use new equipment on pilot basis. • New vehicle should be purchased after ensuring proper operation and maintenance system in place. • It is better to allow disposal of some minimum amount per month for upkeep of transfer station to workshop in charge, which would ensure timely repairing, if it is maintained by municipality otherwise responsibility will be of private entrepreneur.
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1.5 Processing Plant

Component	Operation Requirement	Maintenance Requirement
Processing Plant	(a) Processing plant may be operated upon either by municipal staff or by private agency depending upon the contract conditions. (b) During monsoon period, processing will be required to be carried out in monsoon shed. © Proper arrangement for storage of useful material and transport of residual to landfill site has to be ensured.	a) Regular maintenance of vehicle, equipment, and civil works is required. b) Vehicle and equipment maintenance checklist should be prepared for preventive maintenance.
<p>Suggestions :</p> <ul style="list-style-type: none"> • Regular upkeep and maintenance mechanism of the plant should be in place. If the entire system is in private hands, proper supervision will be required at municipal level. • Proper record keeping of number of vehicle arrived, quantity and nature of waste, processed quantity, quantity of useful product and residual should be ensured. • Specifications should be finalized after proper discussions with end users if to be maintained by municipality otherwise private entrepreneur will be held responsible. • It is better to allow disposal of some minimum amount per month for upkeep of transfer station to workshop in charge, which would ensure timely repairing, if it is maintained by municipality otherwise responsibility will be of private entrepreneur. 		

1.6 Sanitary landfill site

Component	Operation Requirement	Maintenance Requirement
Sanitary Landfill Site	(a) SLF site should be fully secured and developed according to MSW (M&H)	(a) Monitoring of air quality and water quality on periodical basis.

	<p>Rules, 2000.</p> <p>(b)Waste subjected to land filling should be non-biodegradable nature.</p> <p>(c) Waste should be covered and well compacted at the day end with minimum 10-15 cm of soil or inert material.</p> <p>(d) Prior to commencement of monsoon season, an intermediate cover of 40-60 cm thickness of soil should be placed with proper compaction and grading.</p> <p>(e) Proper arrangement for drainage, leachate and landfill gas management should be made.</p> <p>(f) After completion of landfill site, a final cover should be provided before closure of the site.</p>	<p>(b) A vegetation cover shall be provided and maintained over the completed site.</p> <p>(c) Post closure care should be conducted for at least 15 years and long term monitoring shall consist of followings :</p> <p>i. Maintaining the integrity and effectiveness of the final cover.</p> <p>ii.Monitoring leachate collection system</p> <p>iii.Monitoring of ground water</p> <p>iv.Maintaining and operating the landfill gas collection system</p>
<p>Suggestions :</p> <ul style="list-style-type: none"> • SLF site should be given to experienced private entrepreneur on Design, Build, Operate, Maintain and Transfer (DBOMT) basis. • Regular upkeep and maintenance mechanism of the SLF site should be in place. If the entire system is in private hands, proper supervision will be required at municipal level. • Proper record keeping of number of vehicle arrived; quantity and nature of waste should be maintained. 		

Appendix 15: Detailed Cost Estimates - SWM Ghaziabad

Table 1: Abstract Cost Estimate

Table 2: Estimate for Ward Office

Table 3: Abstract Cost for Elevated Transfer Station

Table 4: Detailed Estimate of Transfer Station

Table 5: Detailed Estimate for Sanitary landfill site

Table 6: Abstract Estimate for Processing Plant site

Table 7: Detailed Estimate for Boundary Wall

Table 8: Detailed Estimate for construction of BT Road (1 Km long & 5 m carriage way)

Table 9: Detailed Estimate for construction of CT Road (1 Km long & 5 m carriage way)

Table 10: Detailed Estimate for Storm Water Drain (1.20 m wide & 1.20 m deep)

Table 1: Abstract Cost Estimate

S. No.	Particulars	Qty.	Unit	Rate/Unit	Ref	Amount
				<i>Rs</i>		<i>Rs</i>
A	For Primary and Secondary Collection of Waste					
1	Push cart 6 containerized with accessories	2,200	No.	9,000	Market Rate (MR)	19,800,000
2	Mechanized Waste Collector	85	No.	450,000	MR	38,250,000
3	Dumper Placer Container	504	No.	45,000	MR	22,680,000
	<i>Sub Total of A</i>					<i>80,730,000</i>
B	Transportation of Waste					
1	Dumper Placer Carrier	31		1,400,000	MR	43,400,000
2	Truck Mounted Refuse Compactor (14 Cum)	10	No	2,500,000	MR	25,000,000
	<i>Sub Total of B</i>					<i>68,400,000</i>
C	For Processing of Waste					
1	Cost of land	2	Ha	10,000,000	MR	20,000,000
2	Development of processing plant site	1	Nos.	68,177,692	As per estimate	68,177,692
3	Plant and Machinery	1	Set	20,000,000	MR	20,000,000
4	Weigh bridge 30 MT	1	No	1,000,000	MR	1,000,000
5	Loader backhoe machine	1	No	2,300,000	MR	2,300,000
6	Dumper/Tippers 8 MT	3	No	1,200,000	MR	3,600,000
7	Tractor with Tipper	1	No	700,000	MR	700,000
8	Water tanker 4000 liter	1	No	500,000	MR	500,000
	<i>Sub Total of C</i>					<i>116,277,692</i>
D	For Transfer Station					
1	Cost of land	1	Ha	10,000,000	MR	10,000,000
2	Development of Transfer Station	1	No.	30,894,881	As per estimate	30,894,881
3	Heavy duty Compaction units	2	Nos	4,500,000	MR	9,000,000
4	Hook lifters 20 cum capacity	5	Nos	2,500,000	MR	12,500,000
5	Bulk Containers 15 MT	8	Nos	350,000	MR	2,800,000
	<i>Sub Total of D</i>					<i>65,194,881</i>
E	For Sanitary Land Fill Site					
1	Cost of land	43	Ha	10,000,000	MR	430,000,000
2	Development of SLF site	1st phase		161,689,666		161,689,666
3	loader Backhoe	1	No	2,300,000	MR	2,300,000
4	Tippers/Dumpers 8 MT	3	Nos.	1,200,000	MR	3,600,000

S. No.	Particulars	Qty.	Unit	Rate/Unit	Ref	Amount
				Rs		Rs
5	Bulldozer	1	No	6,000,000	MR	6,000,000
6	Landfill Compactors	1	No	8,000,000	MR	8,000,000
7	Weigh bridge 30 MT	1	No	1,000,000	MR	1,000,000
	<i>Sub Total of E</i>					<i>612,589,666</i>
F	Ward Offices					
1	Cost of land (government land)					
2	Development cost	80	Nos	1,033,000	As per estimate	82,640,000
	<i>Sub Total of F</i>					<i>82,640,000</i>
G	Total Estimate (A+B+C+D+E+F)					1,025,832,239
1	Add @ 3% for Physical contingency & quality control etc					30,774,967
2	Add 3% for DSC and TPI					30,774,967
3	Add 1 % for IEC					10,258,322
4	Add 1 % for Social Development					10,258,322
5	Add 1 % for Environmental Mitigation					10,258,322
6	Add 1 % for capacity building					10,258,322
H	Grand Total					1,128,415,463

Table 2: Estimate for Ward Office

S. No	Perticulars	Qty.	Unit	Rate	Amount	Reference/ schedule item number
Part A: Building Works				<i>Rs</i>	<i>Rs</i>	
1	Excavation in foundation in ordinary soil (loam,clay or sand) including lift upto 1.50 m and lead up to 30 m and including filling watering and ramming of excavated earth into the trenches or into the space between the building and the sides of foundation trenches or into the plinth and removal and disposal of surplus earth as directed by the Engineer-in-charge upto a distance of 30 m from the foundation trenches.	53.30	cum	38.00	2,025.21	UPLNV 251 (a) page 15
2	Concrete with 4 cm gauge brick ballast,fine sand of 1.25 F.M. and cement in proportion 8:4:1 in foundations and under floors, including supply of all materials, labour ,tools and plants etc required for proper completion of the work.	19.84	cum	1,800.00	35,703.18	UPLNV 275 page 18
3	M-150 Brick Work in 1:6 one cement and six fine sand 1.25 F.M. mortar in foundation and plinth including supply of all materials, labour, tools and plants etc. required for proper completion of the work.	74.97	cum	1,900.00	142,443.00	UPLNV+A73k 303 page 21
4	2.5 cm thick Damp Proof Course of cement concrete consisting of 1 part cement, 11/2 parts approved course sand and 3 parts approved 10 mm graded stone grit and including water proofing material as ordered by the Engineer incharge in the proportion as specified by the manufacturer including supply of all materials, labour,tools & plants etc. required for proper completion of the work and including proper curing & shutterings as necessary.	31	sqm	180.00	5,580.00	UPLNV 361 page 23
5	M-150 Brick Work in 1:4 one cement and four fine sand 1.25 F.M. mortar in superstructure for walls of one brick thick including supply of all materials, labour, tools and plants etc. required for proper completion of the work.	32.46	cum	2,285.00	74,171.10	UPLNV 309 page 21
6	M-150 Brick Work in 1:4 one cement and four fine sand 1.25 F.M. mortar in superstructure for walls of half brick thick including supply of all materials, labour, tools and plants etc. required for proper completion of the work.	0.06	cum	2,325.00	139.50	UPLNV 310 (A) page 21
7	12 mm thick cement plaster with cement and fine sand of 1.25 fineness modules in 1:4 over brick work minimum thickness not to be less than 1 cm including supply of all materials,labour,tools & plants etc. required for proper completion of the work.	315.66	sqm	62.00	19,570.92	UPLNV 582 page 33

S. No	Particulars	Qty.	Unit	Rate	Amount	Reference/ schedule item number
8	Earth work in cutting or in embankment in ordinary soil excavation to be in the form of regular pits not exceeding 0.50 m in depth and earth work in embankment to be in 20 cm layers including ramming and dressing the surface to required levels and slopes and also including 1.50 m lift and 30 m lead. The earth from cutting to be used in making embankment or to be deposited as spoil banks with-in 30 m distance as directed by engineer incharge, including Royalty.	51.66	cum	39.00	2,014.74	UPLNV 253(a) page 15
9	Granolithic marble flooring 2.5 cm (1") thick consisting of 2 cm (3/4") thick layer of 1 part cement,2 parts of approved coarse sand and 4 parts of 2 cm (3/4") graded approved stone chips including 5 mm (1/4") thick surface coat with white cement , black and white or gray or mixed marble chips passing 3 mm(1/8") but retained on 1.5 mm (1/16") mesh screen in proportion of 1:2 as specified or directed by the Engineer-incharge and polished by hand or machine and finally finished with french mansion polish or any other approved polish and including 8 cm (3") 1:6:12,concrete base, including supply of all material,labour ,tools and plants etc. required for proper completion of the work.	64.5	sqm	570.00	36,765.00	UPLNV 621 page 38
10	Same as above but 12 mm thick dado	16.66	sqm	530.00	8,827.68	UPLVN 625 (a) page 38
11	Providing and fixing glass strip of 4.0 mm (1/8 ") thickness in joints of floor and skirting at the time of laying labour,tools and plants etc. complete of 2.2 cm depth and of 5 mm thickness	55.2	rm	14.00	772.80	
12	Centering and shuttering including strutting, propping etc. and removal of form for :					
(a)	Suspended floors, roofs, landings, balconies and access platform	97.44	sqm	187.35	18,255.38	
(b)	Lintels,beams,,plinth,beams, girders, bressumers and cantilevers	5.41	sqm	162.65	879.94	
13	RCC work with cement approved coarse sand & 2 cm gauge approved stone grit in proportions of 1:2:4 in slabs excluding supply of reinforcement and its bending, but including its fixing and binding the same with 24 B.W.GGI. Binding wire and including necessary centering and shuttering etc. and supply of all materials,labour,tools and plants etc required for proper completion of the work including cost of binding wire. The rates excludes making of drip course which shall be paid extra	0.81	cum	4,450.00	3,604.50	UPLNV 283 page 19

S. No	Particulars	Qty.	Unit	Rate	Amount	Reference/ schedule item number
14	RCC work with cement approved coarse sand & 2 cm gauge approved stone grit in proportions of 1:2:4 in slabs excluding supply of reinforcement and its bending, but including its fixing and binding the same with 24 B.W.GGI. Binding wire and including necessary centering and shuttering etc. and supply of all materials,labour,tools and plants etc required for proper completion of the work including cost of binding wire. The rates excludes making of drip course which shall be paid extra.	14.62	cum	5,000.00	73,100.00	UPLNV 284 page 19
16	M.S (tor steel or plain) in plain work such as RCC or RB work including bending for proper shape and including supply of steel & its wastage,bend,hooks and authorised overlapping shall be measured and including cost of binding wire. Assuming 1 % steel of RCC quantity , for 15.43 cum = 15.43 qtl.	15.43	qtl.	4,900.00	75,607.00	UPLNV 504 page 27
17	Providing and fixing on wall face Unplasticised Rigid PVC rain water pipes conforming to IS : 13592 Type A including jointing with seal ring conforming to IS : 5382 leaving 10 mm gap for thermal expansion. (i) Single socketed pipes (110 mm diameter)	12	m	170.00	2,040.00	
18	Providing and fixing 1 mm thick M.S. sheet garage door with frame of 40 ×40 ×6 mm angle iron 3.15 mm thick M.S. gusset plate at the junction and corners including supply and fixing of necessary fittings. Lock rail of 15" length of oxidised iron and including pintels hooks at the top and applying priming coat of red lead paint on all sides complete using M.S. angles 40×40×6 mm for diagonal bracings	9.5	sqm	2,200.00	20,900.00	UPLNV 517 (a) page 28
19	M.S. or Iron work of small sizes and sections but steel Z sections windows including holding down bolts,hold fast,tie rods grating etc, wrought to required form including supply of steel bolts,nuts, wastage etc and their fixing required for proper completion of the work.	6.01	qtl.	6,100.00	36,661.00	UPLNV 502 (B) page 27
20	Finishing wall with water proof cement paint of approved make and quality on new work with two coat to give an even shade including supply of all materials, labour,tools and plant etc required for proper completion of the work.	122.5	sqm	25.00	3,062.50	UPLNV 660 page 44
21	Painting roofs or other iron work in large areas with one coat priming and one coat of approved (above one sq.metre) paint (british antesol or equivalent) including supply of all materials, labour, tools & plants etc. required for proper completion of the work. paint to be used should confirm to ISI no. 103-109	24.69	sqm	22.00	543.18	

S. No	Perticulars	Qty.	Unit	Rate	Amount	Reference/ schedule item number
22	Distemping (first coat) with oil bound distemper of approved brand and manufacture of required shade on undecorated wall surface to give an even shade over and including a priming coat with cement primer of approved brand and manufacture such as Berger, J&N, shalimar, Asian paint after thoroughly brushing the surface free from mortat dropping and other foreign matters and also including the surface even with plaster of paris or approved synthetic materials and sand papered smooth industry supply of all materials, labour, tools & plants etc required for proper completion of the work.	262.98	sqm	24.00	6,311.52	UPLNV 649 page 42
	Total				568,938.23	
	Add 15% for electrification,water supply, sewerage and miscelleneous like signboards etc				85,340.73	
	Add for furniture, computer etc				80,000.00	
	Total				734,278.96	
	Total (Add 10%) TP			Say	800,000.00	
	Total					
Part B: Cost of compound wall of 32.5 m length including main gate						
1	Excavation in foundation in ordinary soil (loam,clay or sand) including lift upto 1.50 m and lead up to 30 m and including filling watering and ramming of excavated earth into the trenches or into the space between the building and the sides of foundation trenches or into the plinth and removal and disposal of surplus earth as directed by the Engineer-in-charge upto a distance of 30 m from the foundation trenches.	32.18	cum	38.00	1,222.65	UPLNV 251 (a) page 15
2	Concrete with 4 cm gauge brick ballast,fine sand of 1.25 F.M. and cement in proportion 8:4:1 in foundations and under floors, including supply of all materials, labour ,tools and plants etc required for proper completion of the work.	5.36	cum	1,800.00	9,652.50	UPLNV 275 page 18
3	M-150 Brick Work in 1:6 one cement and six fine sand 1.25 F.M. mortar in foundation and plinth including supply of all materials, labour, tools and plants etc. required for proper completion of the work.	37.54	cum	1,900.00	71,321.25	UPLNV 303 page 21

S. No	Particulars	Qty.	Unit	Rate	Amount	Reference/ schedule item number
4	2.5 cm thick Damp Proof Course of cement concrete consisting of 1 part cement, 1 1/2 parts approved course sand and 3 parts approved 10 mm graded stone grit and including water proofing material as ordered by the Engineer incharge in the proportion as specified by the manufacturer including supply of all materials, labour, tools & plants etc. required for proper completion of the work and including proper curing & shutterings as necessary.	24.75	sqm	180.00	4,455.00	UPLNV 361 page 23
5	M-150 Brick Work in 1:4 one cement and four fine sand 1.25 F.M. mortar in superstructure for walls of one brick thick including supply of all materials, labour, tools and plants etc. required for proper completion of the work.	20.63	cum	2,195.00	45,271.88	UPLNV 305 page 21
6	12 mm thick cement plaster with cement and fine sand of 1.25 fineness modules in 1:4 over brick work minimum thickness not to be less than 1 cm including supply of all materials, labour, tools & plants etc. required for proper completion of the work.	145.75		62.00	9,036.50	UPLNV 584 page 33
7	M.S. or iron work in heavy sizes such as trusses, built up gates, record racks, roof works, gates etc. including rivetting or welding where necessary.	500	kg	54.00	27,000.00	UPLNV 503 page 27
8	Painting roofs or other iron work in large areas with one coat priming and one coat of approved (above one sq meter) paint (British antesol or equivalent) including supply of all materials , labour, tools & plants etc. required for proper completion of the work. Paint to be used should confirm to IS no. 103-109	13.25		22.00	291.50	UPLNV 644 page 41
9	Finishing wall with water proof cement paint of approved make and quality on new work with two coat to give an even shade including supply of all materials, labour, tools & plants etc required for proper completion of the work.	145.75		25.00	3,643.75	UPLNV 660 page 44
	Total				156,896.90	
	Say					
Part C Cement Concrete Pavement						

S. No	Particulars	Qty.	Unit	Rate	Amount	Reference/ schedule item number
1	Cleaning Jungle including up rooting of rank, vegetations grass, push, wood trees and samplings of grith upto 30 cms measured at a height of 1 m above ground level and removal of rubbish up to a distance of 50 m outside the periphery of area cleared.	66.81	100 sq	180.00	120.26	UPLNV 259(i) page 16
2	Earth work in foundation in ordinary soil (Loam, Clay or sand) including lift upto 1.5 m and lead upto 30 m and including filling watering and ramming of excavated earth into the trenches or into the space between the building and the sides of foundation trenches or into the plinth and removal and disposal of surplus earth as directed by the Engineer-in-charge upto a distance of 30 M from the foundation trenches.	13.36	cum	38.00	507.76	UPLNV 251 (a) page 15
3	Concrete with 4 cm gauge brick ballast, fine sand of 1.25 F.M. and cement in proportion 8:4:1 in foundations and under floors, including supply of all materials, labour, tools and plants etc required for proper completion of the work.	6.68	cum	1,800.00	12,025.80	UPLNV 275 page 18
4	Construction of Unreinforced, dowel jointed at expansion and construction joint only, plain cement concrete pavement, thickness as per design, over a prepared sub base with 43 grade cement or any other type as per clause 1501.2.2 M30 grade (1:11/2;3) coarse and fine aggregates confirming to IS 383 maximum size of coarse aggregate not exceeding 25 mm, mixed in a concrete mixer of not less than 0.2 cum capacity and appropriate weight batcher using approved mix design, laid in approved fixed side form work (steel channel, laying and fixing of 125 micron thick polythene film, wedges, steel plates including levelling the formwork as per drawing), spreading the concrete with shovels, rakes, compacted using needle, screed and plate vibrators and finished in continuous operation including provision of contraction and expansion, construction joints, applying debonding strips primer, sealant, dowel bars, near approaches to bridge/culvert and construction joints admixtures as approved curing of concrete slabs for 14-days, curing compound (where specified) and water finishing to lines and grade as per drawing and technical specifications clause 1501 of MoRT&H.	6.68	cum	5,000.00	33,405.00	UPLNV 20.39 new Item (a) page 58

S. No	Perticulars	Qty.	Unit	Rate	Amount	Reference/ schedule item number
5	Providing & laying hot applied thermo plastic compound 2.5 mm thick including refetrising glass beads @ 250 gm/sqm area, thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC 35. The finish surface to be level uniform and free from streaks and holes. Composition of thermo plastic material shall be as per table 800-3 of clause 803 of MoRT& H including cost of all material,labour , T& P etc. required for proper completion of work as per direction by Engineer-in -charge	12.18	sqm	650.00	7,913.75	UPLNV 20.40 new item page 59
					53,852.31	
				say	Rs 0.54 lakhs	
	Grand Total Part A + Part B + Part C =				945,028.17	
					9.46 lakhs	

Table 3: Abstract Cost for Elevated Trasfer Station

S. No	Item	Amount (Rs)
1	PART A: Elevated Platform & Ramp	7,650,661.00
2	PART B: Cement Concrete Pavement	10,530,054.00
3	PART C: Boundary Wall Including Two Gates	2,009,600.00
4	PART D: Greeary	100,000.00
5	PART E: Building for Office, Workshop Etc	5,718,277.00
	Total Civil Works	26,008,592.00
6	PART F: Weigh Bridge 30 MT	1,000,000.00
7	PART G: Tube Well, Electrificaion and Street Lighting (15% of Civil Works)	3,901,288.80
	Total	30,909,880.80
		say Rs 309 lakh

Table 4: Detailed Estimate of Transfer Station

S. No.	Description of Item	No.	L	B	H	Qty.	Unit	Rate	Unit	Amount	Add T.P.	Revised Amount	Ref
			<i>m</i>	<i>m</i>	<i>m</i>			<i>Rs</i>		<i>Rs</i>		<i>Rs</i>	
PART "A" - Ramp Portion													
1	Excavation in foundation in ordinary soil (Loam, Clay or sand) Including lift upto 1.50 M. and lead upto 30 m. and including filling watering and ramming of excavated earth into the trenches or into the space between the building and sides of foundation trenches or into the plinth and removal and disposal of surplus earth as directed by the engineer-in-charge upto a distance of 30 M. from the foundation trenches.												UPLNV 251 (a)page 15
	Earth retaining foundation RE-1	1	11.50	0.30	0.60	2.07							
	Earth retaining foundation RE-2	4	60.00	0.30	4.00	288.00							
	Column foundation	10	2.20	2.20	0.60	29.04							
	Total					319.11	cum	38.00	cum	12,126	10%	13,339	
2	Earth work in cutting or in embankment in ordinary soil excavation to be in the form of regular pits not exceeding 0.50 M. in depth and earth work in embankment to be in 20 cm. layers including remming and dressing the surface to required levels and slopes and also including 1.50 M. lift and 30 M. lead. The earth from cutting to be used in making embankment or to be deposited as spoil banks with-in 30 M. distance as directed by the Engineer incharge. Including Royallity.												UPLNV 253 (a) page 15
		1	60.00	4.00	20.00	4,800.00	cum	39.00	cum	187,200	10%	205,920	
3	2.5 cm thick Damp Proof Course of cement concrete consisting of 1 part cement, 11/2 parts approved course sand and 3 parts approved 10 mm graded stone grit and including water proofing material as ordered by the Engineer incharge in the proportion as specified by the manufacturer including supply of all materials, labour,tools & plants etc. required for proper completion of the work and including proper curing & shutterings as necessary.					20.70	sqm	180.00		3,726	10%	4,099	UPLNV 361page 23

S. No.	Description of Item	No.	L	B	H	Qty.	Unit	Rate	Unit	Amount	Add T.P.	Revised Amount	Ref
			m	m	m			Rs		Rs		Rs	
4	Cement Concrete with 4 cm gauge brick ballast, Fine sand of 1.25 F.M. and cement in the proportion of 8:4:1 in foundations and under floors including supply of all materials, labour, Tools & plants etc. required for proper completion of the work.												UPLNV 275 page 18
	C.C. concrete at bottom of RE wall-1	1	11.50	0.30	0.15	0.52	cum						
	C.C. concrete at bottom of RE wall-2	4	60.00	0.30	0.15	10.80	cum						
	C.C. concrete at bottom of column	10	2.00	2.00	0.15	6.00	cum						
	Total					17.32	cum	1,800.00	cum	31,176	10%	34,294	
5	R.C.C. work with cement, approved coarse sand & 2 cm gauge approved stone grit in proportions of 1:11/2:3 in position excluding supply of reinforcement and its bending, but including its fixing and binding the same with 24 B.W.G.I. binding wire and including necessary centering and shuttering etc. and supply of all materials,labour,tools and plants etc required for proper completion of the work including cost of binding wire. The rate excludes making of drip course which shall be paid extra												UPLNV 283 new item page 19
	For deck slab	1	11.50	7.80	0.25	22.43	cum						
	For pier	10	0.50	0.40	4.00	8.00	cum						
	For longitudinal girders	2	11.50	-	0.45	0.05	cum						
	For cross girders	5	7.80	0.30	0.45	5.27	cum						
	Concrete for ramp	1	60.13	20.00	0.25	300.67	cum						
	Total					336.40	cum	5,000.00	cum	1,682,000	10%	1,850,200	
6	M-150 Brick Work in one cement & four (1:6) fine sand of 1.25 F.M. mortar in foundation and plinth including supply of all materials, labour, Tools & plants etc. required for proper completion of the work.												UPLNV 303 of page 21
		1	11.50	4.30	0.35	17.31	cum						
		1	11.50	3.50	0.88	17.61	cum						
		1	11.50	0.80	0.88	8.05	cum						
		4	60.00	4.00	0.35	168.00	cum						
	Total					193.66	cum	1,900.00	cum	367,954	10%	404,749	

S. No.	Description of Item	No.	L	B	H	Qty.	Unit	Rate	Unit	Amount	Add T.P.	Revised Amount	Ref
			m	m	m			Rs		Rs		Rs	
7	M-150 Brick Work in 1:6 one cement and four fine sand 1.25 F.M. mortar in superstructure including necessary cutting & moulding of bricks as required thickness of walls not to be less than 1 1/2 brick including supply of all materials,labour,tools & plants etc required for proper completion of the work.												UPLNV 303 & 309 of page 21
	Parapet wall at side of ramp	4	60.00	1.20	1.00	288.00	cum	1,995.00	cum	574,560	10%	632,016	
8	12 cm thick plaster with cement and fine sand of 1.25 fineness modules in 1:4 over brick work minimum thickness not to be less than 1 cm. including supply of all materials, labour, tools & plants etc. required for proper completion of the work.												UPLNV 582 page 33
	RE Wall-1	1	11.50		4.00	46.00							
	RE Wall-2	4	60.00		4.00	960.00							
	Piers	10	10.00	0.80	4.00	72.00							
	Total					1,078.00	sqm	62.00	sqm	66,836	10%	73,520	
9	M.S (tor steel or plain) in plain work such as RCC or RB work including bending for proper shape and including supply of steel & its wastage,bend,hooks and authorised overlapping shall be measured and including cost of binding wire.												UPLNV 504 page 27
			Length	Diameter	Unit wt (Kg)	Total wt.	Unit						
	For deck slab (along span)	2	403.55	16 mm	1.58	1,275.20	kgs						
	For deck slab (along width)	2	41.36	16 mm	1.58	130.69	kgs						
	For longitudinal girders	2	46.00	20 mm	2.47	227.24	kgs						
	For longitudinal girders (stirrups)	2	15.00	8 mm	0.39	11.70	kgs						
	For cross girders	5	30.00	16 mm	1.58	237.00	kgs						
	For cross girders (stirrups)	5	20.00	8 mm	0.39	39.00	kgs						
	For piers	10	1.04	20 mm	2.47	25.69	kgs						
	For piers (ties)	10	1.80	8 mm	0.39	7.02	kgs						
	For footing of piers (along span)	10	38.00	12 mm	0.89	338.20	kgs						
	For footing of piers (along width)	10	46.00	12.00	0.89	409.40	kgs						
						2,701.14	kgs						
						2701.14 kg or		4,900.00	Qtl	132,349	10%	145,584	
10	Centering and shuttering including strutting, propping etc. and removal of form for :												
(a)	For columns,piers,pillars,abutments,posts and struts etc												DSR 5.9.6 page 93

S. No.	Description of Item	No.	L	B	H	Qty.	Unit	Rate	Unit	Amount	Add T.P.	Revised Amount	Ref
			m	m	m			Rs		Rs		Rs	
	For deck slab	2	11.50		0.25	5.75	sqm						
		4	7.50		0.25	7.50	sqm						
	For RCC piers					5.75	sqm						
	Total					19.00	sqm	238.40	sqm	4,530	15%	5,209	
(b)	Suspended floors, roofs, landings, balconies and access platform												DSR 5.9.3 page 93
	Deck slab	1	11.50	7.50		86.25	sqm	187.35	sqm	16,159	15%	18,583	
11	Cast cement concrete door sills, chaukhats,boudary posts,shelves and similar small work with cement,approved coarse sand and 2 cm gauge stone grit in proportions of 1;2:4 excluding its fixing and binding wire,moulds,all materials,labour,tools & plants etc. required for proper completion of the work. The rate excludes making of drip course which shall be paid extra.												UPLNV 282 page 19
	coping above RE wall-1	1	11.50	0.35	0.15	0.60							
	coping above RE wall-2	4	60.00	0.35	0.15	12.60							
	Total					13.20	cum	3,700.00	cum	48,854	10%	53,739	
12	Earth work in excavation by mechanical means (hydraulic excavator)/ by mechanical means over areas (exceeding 30 cm in depth 1.5 m width and 10 sqm in plan) including disposal of excavated earth,lead up to 50 m and lift up to 1.5 m, disposed earth to be levelled neatly and neatly dressed for all kinds of soil as per MoRT&H specifications.												Code 2.6.1 DSR 2007
	For pavement on ramp	1	120.00	8.00	0.70	672.00							
	For outer periphery of road	1	140.00	8.50	0.70	833.00							
	Total					1,505.00	cum	101.85	cum	153,284	15%	176,277	
13	Supplying and laying water bound macadam sub base with brick aggregate and binding material, earth etc including screening,sorting and spreading to tempelate and consolidation with light power road roller etc complete including cost of moorum etc.												Code 16.5.1 & 16.3.10 of DSR 2007
	For pavement on ramp	1	120.00	8.00	0.30	288.00							
	For outer periphery of road	1	140.00	8.50	0.30	357.00							
	Total					645.00	cum	558.05	cum	359,942	15%	413,934	

S. No.	Description of Item	No.	L	B	H	Qty.	Unit	Rate	Unit	Amount	Add T.P.	Revised Amount	Ref
			<i>m</i>	<i>m</i>	<i>m</i>			<i>Rs</i>		<i>Rs</i>		<i>Rs</i>	
14	Concrete with 4 cm gauge brick ballast, fine sand of 1.25 F.M. and cement in proportion 8:4:1 in foundations and under floors, including supply of all materials, labour, tools and plants etc required for proper completion of the work.												UPLNV 275 page 18
	For pavement on ramp	1	120.00	8.00	0.15	144.00							
	For outer periphery of road	1	140.00	8.50	0.15	178.50							
						322.50	cum	1,800.00	cum	580,500	10%	638,550	
15	Construction of Unreinforced, dowel jointed at expansion and construction joint only, plain cement concrete pavement, thickness as per design, over a prepared sub base with 43 grade cement or any other type as per clause 1501.2.2 M30 grade (1:11/2;3) coarse and fine aggregates conforming to IS 383 maximum size of coarse aggregate not exceeding 25 mm, mixed in a concrete mixer of not less than 0.2 cum capacity and appropriate weight batcher using approved mix design, laid in approved fixed side form work (steel channel, laying and fixing of 125 micron thick polythene film, wedges, steel plates including levelling the formwork as per drawing), spreading the concrete with shovels, rakes, compacted using needle, screed and plate vibrators and finished in continuous operation including provision of contraction and expansion, construction joints, applying debonding strips primer, sealant, dowel bars, near approaches to bridge/culvert and construction joints admixtures as approved curing of concrete slabs for 14-days, curing compound (where specified) and water finishing to lines and grade as per drawing and technical specifications.												UPLNV 20.39 new Item (a) page 58
	For pavement on ramp	1	120.00	8.00	0.25	240.00							
	For outer periphery of road	1	140.00	8.50	0.25	297.50							
						537.50	cum	5,000.00	cum	2,687,500	10%	2,956,250	

S. No.	Description of Item	No.	L	B	H	Qty.	Unit	Rate	Unit	Amount	Add T.P.	Revised Amount	Ref
			<i>m</i>	<i>m</i>	<i>m</i>			<i>Rs</i>		<i>Rs</i>		<i>Rs</i>	
16	Providing & laying hot applied thermo plastic compound 2.5 mm thick including refretorising glass beads @ 250 gm/sqm area, thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC 35. The finish surface to be level uniform and free from streaks and holes. Composition of thermo plastic material shall be as per table 800-3 of clause 803 of MoRT&H including cost of all material,labour , T& P etc. required for proper completion of work as per direction by Engineer-in - charge												UPLNV 20.40 new item page 59
	For pavement on ramp	25	8.00	0.08		15.00							
	For outer periphery of road	30	8.50	0.08		19.13							
						34.13	sqm	650.00	sqm	22,181	10%	24,399	
	Total									6,930,877		7,650,661	
PART "B" Cement Concrete Pavement													
	CC Pavement other than Ramp portion					5,367.00	sqm	1,962.00	sqm			10,530,054	
PART "C" Compound wall													
	Compound wall 400 m length with two gates					400.00	m	5,024.00	Rm			2,009,600	
PART "D" Greenary													
	Lump sum											100,000	
PART "E" Building works													
	Office, workshop, staff room etc					595.00	sqm	Rs 8357	sqm			4,972,415	
	Add 15 % for electricity, sanitation and other miscellaneous											745,862	
PART "F" Weigh Bridge													
	30 MT capacity											1,000,000	
PART "G" Tube Well ,Electrification and Street Lighting													
	15 % of Civil works											3,886,289	
	Grand Total after adding expected T.P.											30,894,881	
	Say Rs											309 lakh	

Table 5: Detailed Estimate for Sanitary landfill site

S. No.	Item	Unit	Quantity	Rate/ Unit	Amount, Rs	Expected T.P.	Revised amount	Ref
				<i>Rs</i>	<i>Rs</i>		<i>Rs.</i>	
A	SECURED LANDFILL FACILITY							
1	Site clearance sorting & strutting if necessary slinging & propping of pipes electrical cables etc. including levelling & dressing of sides and ramming of bottoms, disposal of surplus excavated soil as directed within a lead of 8Km. Disposed earth to be levelled & neatly dressed complete as per direction of enginner in charge.	Sq. m.	75,000	3	197,925	15%	227,614	Code 2.63 DSR 2007
2	Earthwork in filling for embankment: Earthwork in filling with good quality morrum/yellow earth brought from outside for embankment in loose layers of 200mm thickness,compacting to 95% proctor density including water sprinkling, dressing/trimming slopes etc. as directed at all leads and lifts.	Cu. M.	61,831	99	6,149,093	15%	7,071,457	Code 2.3.1 DSR 2007
3	Providing and laying clay liner: Providing and laying clay liner on bottom with natural soil material mixed with prescribed percentage of sand, commercially available Bentonite of specified grade, water tested in laboratory, free from all deleterious material, pebbles etc. with all lead and lifts including laying in layers of compacted thickness of 150 mm each for a minimum thickness of 900 mm.	Cu. M.	68,026	356	24,217,256		24,217,256	MR
4	Supplying and laying 1.5 mm thick Flat Cast Extruded HDPE geomembrane: Supplying and laying 1.5 mm thick Flat Cast Extruded HDPE geomembrane liner smooth on both sides including providing overlaps, electrowelding of joints, anchoring, etc. complete as per manufacturer's specifications and as directed by engineer-in-charge.	Sq. m.	97,635	285	27,825,975		27,825,975	MR
5	Providing and Laying of 200 gsm Non-Woven GeoTextile: Providing and laying needle punched non woven geotextile of 200 gsm made of continuous filaments extracted from polymers comprising 70% polypropylene and 30% polyethylene geotextile including wastages, overlap, stitching,anchoring etc. complete as per drg.Payment shall be made for net laid area.	Sq. m.	97,635	75	7,322,625		7,322,625	MR
6	Supplying and laying gravel: Supplying and laying sand/ gravel in layers on the bed of the SLF as part of Bottom Liner System,well compacted ,etc. as directed over NWGT as per drawing etc. complete.	Cu. M.	23,289	785	18,281,865	15%	21,024,145	Code number 2910/11 DSR
7	Providing and Laying of Geo-Net: Providing, laying, welding and testing of Geo-net liners of 550 gsm at the side slopes of the landfill as directed by the Project Engineer, anchoring the layer suitably as per the directions, developing panel layout, carrying out seaming of the liner, testing of seams throughout the entire length as per the quality assurance and quality control procedures and as per the drawings, specifications and instructions of Project Engineer.	Sq. m.	19,519	265	5,172,535		5,172,535	MR

S. No.	Item	Unit	Quantity	Rate/ Unit	Amount, Rs	Expected T.P.	Revised amount	Ref
				Rs	Rs		Rs.	
8	Providing and laying of 6 mm thick Geosynthetic Clay Liner: Providing and laying Geo Synthetic Clay Liner, 6 mm thick consisting of Layer Of natural Sodium Bentonite between woven and non woven Geo Textile needle punched together on the inner slopes of embankment and anchor trench including wastages, overlaps, etc as per drawing. Only net area shall be measured and paid.	Sq. m.	19,898	275	5,471,950		5,471,950	MR
9	Providing and Laying of 140 gsm Woven GeoTextile: Providing and laying multifilament Polypropylene woven geotextile of 140 gsm including wastages, overlap, stitching,anchoring etc. complete as per drg.Payment shall be made for net laid area.	Sq. m.	19,898	75	1,492,350		1,492,350	MR
10	Earthwork in Excavation for Anchor Trench: Excavation for anchor trench as necessary & disposing off excavated stuff as directed in all types sand gravel soft murum etc including dewatering.	Cu. M.	310	102	31,574	15	36,310	DSR 2007
11	Supplying and Filling Murrum and Cement in Anchor Trench: Supplying and filling murrum and cement in trench,well compacted, rammed,etc. as directed as per drawing etc. complete from up to 10 km lead.	Cu. M.	310	85	26,350	15	30,303	DSR 2007 1,1,1
12	Providing vegetative facia: Providing Geomat comprising a layer of bio-degradable mulching material sandwiched between and mechanically bonded to two layers of polymer netting on the outer slope of the embankment as directed.	Sq. m.	11,339	125	1,417,375		1,417,375	MR
					97,606,872		101,309,893	
B	LEACHATE COLLECTION AND LEAK DETECTION PIPES							
13	Providing and laying 315 mm OD HDPE pipe: Providing and laying 315 mm OD HDPE pipe,approved make to be laid with all required fittings including stub ends reducers bends etc. and flanges as per drawing and as directed. The rate shall include loading, unloading material of jointing, etc. as directed.	Rm.	1,093	2,100	2,295,300		2,295,300	MR
14	Providing and laying 200 mm OD HDPE pipe: Providing and laying 200 mm OD HDPE pipe,approved made to be laid with all required fittings including stub ends reducers bends etc. and flanges as per drawing and as directed. The rate shall include loading, unloading material of jointing, etc. as directed.	Rm.	833	1,300	1,082,900		1,082,900	MR
15	Providing and laying 160 mm OD HDPE pipe: Providing and laying 160 mm OD HDPE pipe,approved made to be laid with all required fittings including stub ends reducers bends etc. and flanges as per drawing and as directed. The rate shall include loading, unloading material of jointing, etc. as directed.	Rm.	1,328	750	996,000		996,000	MR

S. No.	Item	Unit	Quantity	Rate/ Unit	Amount, Rs	Expected T.P.	Revised amount	Ref
				Rs	Rs		Rs.	
16	Providing & laying 450 mm OD cement concrete pipe: Providing & laying cement concrete pipe of 450 mm diameter in proper line level & slope including providing fixing collers in cement mortar 1:2 curing etc complete as per the drawing.	Rm.	109	750	81,750		81,750	MR
17	Wrapping with 150 gsm Non-Woven Geotextile: Wrapping with nonwoven geotextile of 150 gsm around the Gravel Mound including wastages, overlap, stitching,anchoring etc. complete as per drg.	Sq. m.	10,250	70	717,500		717,500	MR
					5,173,450		5,173,450	
C	LEACHATE COLLECTION SUMPS							
18	Construction of Leachate collection sump: Construction of Leachate collection sump of inner dimensions 8m x 5m and Height 4m including excavation, RCC work suitably designed with reinforcement and foundation, cover slab for the sump using all contractors materials as directed by Engineer in charge.	Nos	2	1,000,000	2,000,000		2,000,000	Lump Sum
19	Supplying and laying 1.5 mm thick Flat Cast Extruded HDPE geomembrane: Supplying and laying 1.5 mm thick Flat Cast Extruded HDPE geomembrane liner on the base and wall surface of the sump complete as per manufacturer's specifications and as directed by engineer-in-charge.	Sq. m.	150	285	42,750		42,750	MR
20	Providing Carbolock concrete connection strips: Providing Carbolock concrete connection strips on the base and surface of the sump.	Rm.	78	900	70,200		70,200	MR
					2,112,950		2,112,950	
D	MISCELLANEOUS							
21	Storm Water Drain: Storm Water Drain around the periphery of the SLF	Rm	2,535	4,659	11,810,565	4659	11,810,565	As per unit rate
22	Construction of compound wall and gates	Rm	1,790	5,024	8,992,960	5024	8,992,960	As per unit rate
23	Greenery: Digging holes in ordinary soil and refilling the same with excavated earth mixed with manure or sludge in the ratio 2:1 by volume, flooding with water, dressing including removal of rubbish and surplus earth if any with all lead and lifts (Holes 60 cm dia and 60 cm deep) and planting trees in a spacing of 3 m from centre to centre, watering etc complete.	Nos	2,387	195	465,465	195	465,465	MR
24	Approach road	Sq. m.	5,600			727	4,071,200	
25	Office	Sq. m.	90			8357	752,130	Rate analysis
26	Parking shed	sqm	188			6000	1,128,000	MR
27	Visual inspection area	sqm	1,056			1962	2,071,872	Rate analysis
28	Wheel wash area	sqm	90			1962	176,580	Rate analysis
29	Workers rest room and toilet	sqm	92			8357	768,844	Rate analysis
30	fill soil area	sqm	900			1962	1,765,800	Rate analysis
							32,003,416	
							140,599,709	
31	Other utilities water supply,electricity and street lighting etc						21,089,956	15% of Civil work cost

S. No.	Item	Unit	Quantity	Rate/ Unit	Amount, Rs	Expected T.P.	Revised amount	Ref
				<i>Rs</i>	<i>Rs</i>		<i>Rs.</i>	
	Grand Total (A+B+C+D)						161,689,666	

Table 6: Abstract Estimate for Processing Plant site

S.No.	Item	Qty	Rate	Amount (In Rs)	Rate Reference
		<i>Sq. m</i>	<i>Rs</i>	<i>Rs</i>	
1	Cement Concrete road	3,150.00	1,962.00	6,180,300.00	Unit rate of CC Pavement
2	Tipping area	200.00	1,962.00	392,400.00	Rate Analysis
3	Over size rejection area	100.00	1,962.00	196,200.00	Rate Analysis
4	Monsoon shed	400.00	6,000.00	2,400,000.00	Rate Analysis
5	Curing shed	400.00	6,000.00	2,400,000.00	Rate Analysis
6	Sewing and bagging	400.00	6,000.00	2,400,000.00	Rate Analysis
7	Store	800.00	8,357.00	6,685,600.00	Rate analysis
8	Vermi composting and other	1,600.00	1,962.00	3,139,200.00	Rate Analysis
9	Maintenance and other	300.00	1,962.00	588,600.00	Rate Analysis
10	Laboratory	160.00	8,357.00	1,337,120.00	Rate analysis
11	Office	90.00	8,357.00	752,130.00	Rate analysis
12	Future expansion	1,250.00	1,962.00	2,452,500.00	Rate analysis
13	Compost pad	9,000.00	1,962.00	17,658,000.00	Rate Analysis
14	Cement concrete road	3,150.00	1,962.00	6,180,300.00	Rate Analysis
15	U-shape drain 1.2m wide and 1.2 m depth (Rm)	1,400.00	4,659.00	6,522,600.00	Rate Analysis
	Total			59,284,950.00	
16	Add 15% for water supply, electricity. Road light etc			8,892,742.50	
	Grand Total			68,177,692.50	
			Say	Rs 682.00 lakh	

Table 7: Detailed Estimate for Boundary Wall

S. No	Item	No.	L	B	H	Qty.	Unit	Rate	Amount	Ref
			<i>m</i>	<i>m</i>	<i>m</i>			<i>Rs</i>	<i>Rs</i>	
1	Excavation in foundation in ordinary soil (loam,clay or sand) including lift upto 1.50 m and lead up to 30 m and including filling watering and ramming of excavated earth into the trenches or into the space between the building and the sides of foundation trenches or into the plinth and removal and disposal of surplus earth as directed by the Engineer-in-charge upto a distance of 30 m from the foundation trenches.	1	100.00	1.10	0.90	99.00	Cum	38.00	3,762.00	UPLNV 251 A page 15
2	Concrete with 4 cm gauge brick ballast, fine sand of 1.25 F.M. and cement in proportion 8:4:1 in foundations and under floors, including supply of all materials, labour ,tools and plants etc required for proper completion of the work.	1	100.00	1.10	0.15	16.50	Cum	1,800.00	29,700.00	UPLNV 275 page 18
3	M-150 Brick Work in 1:6 one cement and six fine sand 1.25 F.M. mortar in foundation and plinth including supply of all materials, labour, tools and plants etc. required for proper completion of the work.									UPLNV+A 73k 303 page 21
	Boundary Wall 1st step	1	100.00	0.90	0.30	27.00	Cum			
	Boundary Wall 2nd step	1	100.00	0.75	0.45	33.75	Cum			
	Boundary Wall 3rd step	1	95.00	0.60	0.60	34.20	Cum			
	Total					94.95	Cum	1,900.00	180,405.00	
4	2.5 cm thick Damp Proof Course of cement concrete consisting of 1 part cement, 1 1/2 parts approved course sand and 3 parts approved 10 mm graded stone grit and including water proofing material as ordered by the Engineer incharge in the proportion as specified by the manufacturer including supply of all materials, labour,tools & plants etc. required for proper completion of the work and including proper curing & shutterings as necessary.								-	UPLNV 361 page 23
	Plinth level	1	95.00	0.60		57.00	sqm			
	Top level	1	95.00	0.30		28.50	sqm			
	Total					85.50	sqm	180.00	15,390.00	
5	M-150 Brick Work in 1:4 one cement and four fine sand 1.25 F.M. mortar in superstructure including necessary cutting & moulding of bricks as required thickness of walls not to be less than 11/2 brick including supply of all materials,labour,tools & plants etc required for proper completion of the work.									UPLNV 309 page 21
	Boundary Wall 4th step	1	95.00	0.45	1.00	42.75	Cum			
	Boundary wall 5th step	1	95.00	0.30	1.00	28.50	Cum			
	Total					71.25	Cum	2,195.00	156,393.75	
6	12 mm thick cement plaster with cement and fine sand of 1.25 fineness modules in 1:4 over brick work minimum thickness not to be less than 1 cm including supply of all materials,labour,tools & plants etc. required for proper completion of the work.	2	95.00	2.65		503.50	Sqm	62.00	31,217.00	UPLNV 582 page 33

S. No	Item	No.	L	B	H	Qty.	Unit	Rate	Amount	Ref
			<i>m</i>	<i>m</i>	<i>m</i>			<i>Rs</i>	<i>Rs</i>	
7	M.S. or iron work in heavy sizes such as trusses,built up gates,record racks,roof works,gates etc.including rivetting or welding where necessary.	1	5.00	2.65		Say 500	kg	54.00	27,000.00	UPLNV 503 page 27
8	Painting roofs or other iron work in large areas with one coat priming and one coat of approved (above one sq meter) paint (British antesol or equivalent) including supply of all materials , labour,tools & plants etc. required for proper completion of the work. Paint to be used should confirm to IS no. 103-109	1	5.00	2.65		13.25	sqm	22.00	291.50	UPLNV 644 page 41
9	Finishing wall with water proof cement paint of approved make and quality on new work with two coat to give an even shade including supply of all materials, labour,tools & plants etc required for proper completion of the work.	2	95.00	2.65		503.50	sqm	25.00	12,587.50	UPLNV 660 page 44
									456,746.75	
									502,421.43	
								or say	5024/RM	

Table 8: Deatiled Estimate for construction of BT Road (1 Km long & 5 m carriage way)

S. No	Item	No.	L	B	H	Qty.	Unit	Rate	Amount	Ref
			<i>m</i>	<i>m</i>	<i>m</i>			<i>Rs</i>	<i>Rs</i>	
1	Cleaning Jungle including up rooting of rank,vegetations grass,push,wood trees and samplings of grith upto 30 cms measured at a height of 1 m above ground level and removal of rubbish up to a distance of 50 m outside the periphery of area cleared.	1	1,000.00	9.00		9,000.00	100 sqm	180.00	16,200.00	UPLNV 259 (i) page 16
2	Earth work in excavation by mechanical means (hydraulic excavator)/ by mechanical means over areas (exceeding 30 cm in depth 1.5 m width and 10 sqm in plan) including disposal of excavated earth,lead up to 50 m and lift up to 1.5 m, disposed earth to be levelled neatly and neatly dressed for all kinds of soil as per MoRT&H specifications.	1	1,000.00	9.00	0.47	4,230.00	cum	101.85	430,825.50	Code 2.6.1 DSR 2007
3	Banking excavated earth in layers not exceeding 20 cm in depth, breaking clods,watering,rolling each layer with 1/2 tonne roller or wooden or steel rammers and rolling every 3rd and top most layer with power roller of minimum 8 tonnes and dressing up, in embankments for road,flood bamks, marginal banks and guide banks etc lead up to 50 m and lift up to 1.5 m as per MoRT&H specifications for all kinds of soil.	1	1,000.00	9.00	0.50	4,500.00	cum	99.45	447,525.00	Code 2.3.1 DSR 2007
4	Supplying and laying water bound macadam sub base (GSB) with brick aggregate and binding material, earth etc including screening,sorting and spreading to tempelate and consolidation with light power road roller etc complete including cost of moorum etc.									Code 16.5.1 & 16.3.10 of DSR 2007
	Carriage way	1	1,000.00	7.00	0.20	1,400.00	cum			
	Shoulders	1	1,000.00	2.00	0.20	400.00	cum			
	Total					1,800.00	cum	558.05	1,004,490.00	
5	Providing ,laying ,spreading and compacting stone aggregate of specified sizes to WBM specifications including spreading in uniform thickness, hand picking, rolling with 3 wheeled road/vibratory roller 8-10 tonne in stages to proper grade and camber, applying and brooming requisite type of screening/binding material to fill up interstices of coarse aggregate watering and compacting to the required density. wooden or steel rammers and rolling over 3rd and top most layer with power roller of minimum 8 tonnes and dressing up, in embankments for roads, flood banks, marginalbanks and guide banks etc lead upto 50 m and lift upto 1.5 m as per table 400-7 of MoRT&H specifications for all kinds of soil.									Code 16.4 of DSR 2007
	Hand broken - Grade-I (90-45mm)	1	1,000.00	7.00	0.10	700.00	cum	934.85	654,395.00	Code 16.3.1 of DSR 2007

S. No	Item	No.	L	B	H	Qty.	Unit	Rate	Amount	Ref
			<i>m</i>	<i>m</i>	<i>m</i>			<i>Rs</i>	<i>Rs</i>	
	Hand broken - Grade-II (63-45mm)	1	1,000.00	7.00	0.08	525.00	cum	961.00	504,525.00	Code 16.3.2
	Crusher broken - Grade-III (53-22.4mm)	1	1,000.00	7.00	0.08	525.00	cum	1,003.10	526,627.50	Code 16.3.3
6	Providing and applying tack coat using hot straight run bitumen of grade 80/100 including heating the bitumen, spraying the bitumen with mechanically operated spray unit fitted on bitumen boiler, cleaning and preparing the existing road surface as per MoRT&H specifications on WBM new surface @ 0.75 kg/sqm	1	1,000.00	7.00		7,000.00	sqm	23.90	167,300.00	Code 16.30 of DSR 2007
7	2 cm premix xarpet surfacing with 1.8 cum and 0.9 cum of stone chippings of 13.2 mm size and 11.2 mm size respectively per 100 sqm and 52 kg and 56 kg of hot bitumen per cum of stone chippings of 13.2 mm and 11.2 mm size respectively including a tack coat with hot straight run bitumen including consolidation with road roller of 6-9 tonne capacity etc. complete (tack coat to be paid separately) with paving asphalt 80/100 heated and then mixed with solvent at the rate of 70 gms per kg of asphalt.	1	1,000.00	7.00		5,000.00	sqm	81.95	409,750.00	Code 16.32.1 of DSR 2007
8	Providing and laying seal coat over prepared surface of road with bitumen heated in bitumen boiler fitted with the spray set spraying using 98 kg of bitumen of grade 80/100 and binding surface with 0.90 cum of stone aggregate of 6.7 mm size (passing 11.2 mm sieve and retained on 2.36 mm sieve) per 100 sqm of road surface including rolling and finishing with power road roller all complete.	1	1,000.00	7.00		5,000.00	sqm	50.00	250,000.00	Code 16.41 of DSR 2007
9	Painting road surface marking with adequate number of coats to give uniform finish with ready mixed road marking paint confirming to IS: 164, on bituminuous surface in white/yellow shade including cleaning the surface of all dirt, scales, oil, grease and foreign material etc. complete. New work (two or more coats)	2	1,000.00	0.10		200.00	sqm	58.10	11,620.00	Code 16.48 (1) of DSR 2007
	Total								4,423,258.00	
	Grand Total (Add 10% for TP)								5,086,746.70	
								Or say	727/sqm	

Table 9: Deatiled Estimate for construction of CT Road (1 Km long & 5 m carraige way)

S. No	Item	No.	L	B	H	Qty.	Unit	Rate	Amount	Add TP	Revised amount	Ref
			<i>m</i>	<i>m</i>	<i>m</i>			<i>Rs</i>	<i>Rs</i>		<i>Rs.</i>	
1	Cleaning Jungle including up rooting of rank, vegetations grass, push, wood trees and samplings of grith upto 30 cms measured at a height of 1 m above ground level and removal of rubbish up to a distance of 50 m outside the periphery of area cleared.	1	1,000	5		5,000	100 sqm	180	9,000	10%	9,900	UPLNV 259 (i) page 16
2	Earth work in excavation by mechanical means (hydraulic excavator)/ by mechanical means over areas (exceeding 30 cm in depth 1.5 m width and 10 sqm in plan) including disposal of excavated earth, lead up to 50 m and lift up to 1.5 m, disposed earth to be levelled neatly and neatly dressed for all kinds of soil as per MoRT&H specifications.	1	1,000	5	0.70	3,500	cum	102	356,475	15%	409,946	Code 2.6.1 DSR 2007
3	Supplying and laying water bound macadam sub base with brick aggregate and binding material, earth etc including screening, sorting and spreading to tempelate and consolidation with light power road roller etc complete including cost of moorum etc.	1	1,000	5	0.30	1,500	cum	558	837,075	15%	962,636	Code 16.5.1 & 16.3.10 of DSR 2007
4	Concrete with 4 cm gauge brick ballast, fine sand of 1.25 F.M. and cement in proportion 8:4:1 in foundations and under floors, including supply of all materials, labour ,tools and plants etc required for proper completion of the work.	1	1,000	5	0.15	750	cum	1,800	1,350,000	10%	1,485,000	UPLNV 275 page 18

S. No	Item	No.	L	B	H	Qty.	Unit	Rate	Amount	Add TP	Revised amount	Ref
			m	m	m			Rs	Rs		Rs.	
5	Construction of Unreinforced, dowel jointed at expansion and construction joint only, plain cement concrete pavement, thickness as per design, over a prepared sub base with 43 grade cement or any other type as per clause 1501.2.2 M30 grade (1:1 1/2:3) coarse and fine aggregates conforming to IS 383 maximum size of coarse aggregate not exceeding 25 mm, mixed in a concrete mixer of not less than 0.2 cum capacity and appropriate weight batcher using approved mix design, laid in approved fixed side form work (steel channel, laying and fixing of 125 micron thick polythene film, wedges, steel plates including levelling the formwork as per drawing), spreading the concrete with shovels, rakes, compacted using needle, screed and plate vibrators and finished in continuous operation including provision of contraction and expansion, construction joints, applying debonding strips primer, sealant, dowel bars, near approaches to bridge/culvert and construction joints admixtures as approved curing of concrete slabs for 14-days, curing compound (where specified) and water finishing to lines and grade as per drawing and technical specifications clause 1501 of MoRT&H.	1	1,000	5	0.25	1,250	cum	5,000	6,250,000	10%	6,875,000	UPLNV 20.39 new Item (a) page 58
6	Providing & laying hot applied thermo plastic compound 2.5 mm thick including refretorising glass beads @ 250 gm/sqm area, thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC 35. The finish surface to be level uniform and free from streaks and holes. Composition of thermo plastic material shall be as per table 800-3 of clause 803 of MoRT& H including cost of all material, labour, T& P etc. required for proper completion of work as per direction by Engineer-in -charge	250	5		0.08	94	sqm	650	60,938	10%	67,031	UPLNV 20.40 new item page 59
									8,863,488		9,809,514	
										say Rs/sd	1,962	

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