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SECTION 3.0
INTEGRATED MSW-RDF AND POWER PLANT

Guwahati Municipal Corporation (GMC) is the municipal corporation for Guwahati responsible for providing municipal and allied civic services, which encompasses the collection, transportation, processing and disposal of Municipal Solid Waste (MSW) generated in the city. GMC currently disposes the collected Municipal Solid Waste at Boragaon site by open dumping, which is, however, unscientific way of disposal of waste.

The Ministry of Environment and Forests (MoEF) under the aegis of Government of India (GoI), has formulated the Municipal Solid Wastes (Management and Handling) Rules 2000 ("MSW Rules"), which makes it mandatory for every civic body to implement a scientific solid waste management system through which Municipal Solid Waste is duly processed and only waste that are not suitable either for recycling or for processing are disposed in an Engineered Sanitary Landfill .

GMC is desirous of establishing a suitable mechanism to manage the collection, transportation, processing and disposal of (MSW) generated from the residential and other areas within municipal limits of Guwahati by utilizing the scientific advancements in this field with a view to meet environmental regulations and to improve public health & hygiene.

With a vision to improve MSW management in the City of Guwahati, GMC has also got a Grants approval to the extent of Rs. 3516.71 Lakhs .The Grant approval is under "Jawahar Lal Nehru National Urban Renewal Mission (JNNURM)" by the Ministry of Urban Development, Govt of India and is for the purpose of MSW Management in the city of Guwahati.

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Infrastructure Development Corporation of Assam Limited (IDCAL) is a Joint Venture Company incorporated by Government of Assam through Guwahati Metropolitan Development Authority (GMDA) and Infrastructure Leasing and Financial ServicesLimited (IL&FS) for development of urban infrastructure projects in Guwahati and other areas of Assam. IL&FS group has significant experience and expertise to render advice, develop projects, facilitate formulation of policy and related aspects for catalyzing Public Private Partnership. IL&FS through its subsidiaries have been actively working in the MSW sector in various States of India including Delhi, Rajasthan, Uttar Pradesh, Maharashtra and Tamil Nadu.

In view of above, GMC entered into a Memorandum of Agreement dated 3rd August 2007 ("MOA") with IDCAL, to evaluate suitable waste management solution and to develop and bid out a project for enabling the collection, transportation, processing and disposal of MSW under PPP framework. Under the MoA, it is envisaged that a Special Purpose Company (SPV) shall be set up by IDCAL to develop the project and to obtain requisite clearances necessary for implementing an integrated waste management facility including an integrated waste processing facility at Boragaon in Guwahati. It is also envisaged under MoA that IDCAL shall select a suitable private Party through competitive bidding process that shall implement the Project after taking over entire equity shareholding in SPV, along with all the rights and responsibilities vested therein.

Accordingly, a SPV with the name Guwahati Waste Management Company Private Limited (GWMCL) has been set up to develop the project and to obtain requisite clearances necessary for implementing an integrated waste management facility including an integrated waste processing facility at Boragaon in Guwahati.

By going into PPP through competitive bidding route, GMC will get benefited by way of successfully implementing the Project, which results in reduction of air,

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water and land pollution and savings in expenses and also helps in improvement of cleanliness in Guwahati Municipal Area.

To improve the project viability, GMC agrees to allow development of an integrated waste-processing project consisting of Composting, Refuse Derived Fuel (RDF) as well Power Generation from MSW. The selected Private Partner shall be obliged to adopt an integrated concept for waste processing so that flow of waste to the landfill is as less as possible. However, GMC also specifically mentions that the grant component towards capital investment may not be available for processing technologies other than those approved under DPR submitted for Grants under JNNURM.

The integrated municipal waste-processing complex at Boragaon is proposed to include

a) Composting Plant to process organic waste.
b) MSW processing plant (RDF Plant) based on DST-TIFAC technology for RDF preparation at Boragaon.
c) Power Plant of 5MW capacity, which will use the RDF as a fuel for generating steam in the boiler.

The following is the list of consultants involved who have provided their expertise in making the DPR for the integrated complex

S. No	Organisation	Scope of consultancy
01	IL&FS Infrastructure Development Corporation, New Delhi	Project Consultant
02	Avant-Garde Engineers and Consultants (P) Ltd., Chennai.	Review of Techno- economic feasibility Power Plant Prepared by Project Consultant.

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S. No	Organisation	Scope of consultancy
03	APTDC, Hyderabad	Techno- economic feasibility report of RDF section
04	IL&FS Ecosmart, New Delhi	EIA Consultant
05	Legal consultant, New Delhi	Concession agreement, Land lease agreement, Sewage supply agreement
06	MSW Characterization	Delhi Test House, Delhi

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SECTION 4

PROJECT AREA & ITS MANAGEMENT

4.1 Introduction

This section covers the regional setting, physical growth, demographic and socio-economic profile of the Guwahati City. The profile is based on the information collected from the various government agencies and the Guwahati Municipal Corporation. The salient features of the city are based on the discussions with the concerned officials, stake holders and field surveys.

Secondary information from various earlier studies and other resource persons was collected for this purpose. Sections below summarise the analysis of the information collected.

4.2 Regional Setting

Guwahati city, the capital of Assam is located on the south bank of river Brahamaputra towards the south eastern side of Kamrup district. The city area is located in $26^0 5'$ N to $26^0 12'$ N Latitudes and $91^0 34'$ E to $91^0 51'$ E Longitudes. The metropolitan area of the city is 264 sq km of which an area of about 216 sq km is within the municipal corporation's limit.

4.3 Significance of The City

Guwahati experienced phenomenal growth after becoming the state capital in the year 1972. Establishment of the Guwahati Oil Refinery, opening of major institutions of higher education like the Guwahati University, Engineering College, Medical College etc., construction of Saraighat bridge, has been some of the major factors to make Guwahati one of the most developed cities in the North Eastern states. It is also the central hub for all the commercial activities in the North East. It is at the junction of National Highways 31, 37 & 40. A broad guage railway line connects Guwahati with

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the rest of the country. Super fast trains including Rajdhani Express connect Delhi, Kolkata and Chennai to Guwahati. It has the biggest airport in the entire North East region. It provides link to all the other state capitals. Recently, it has been upgraded to an international airport by the Ministry of Civil Aviation, Government of India. It is the service centre for the oil industry and tea plantations; the world's largest tea auctions are held here.

Guwahati has a population of around 8.2 lakhs based on the Census 2001. The population has grown manifold in the past few years.

4.4 Climate And Weather

Climate of the Guwahati city is sub tropical humid. Climatically the whole year can be divided into three periods. From February to May, the weather is dry and moisture less. In the month of March, the North East wind carries dry sand from the river and makes the atmosphere very cloudy.

The wind direction is predominantly from the North-East to South-West during winter season and South-West to North-East during summers. The temperature varies from 31°C to 22°C in this region.

In April and May local rain along with thunderstorm are common features. The monsoon period is from June to October, with maximum rainy months being June and July. The average rainfall in Guwahati is 166.22 cm. From November to January, the weather is cool and foggy, with minimum temperature during the month of December.

4.5 Project Area – Guwahati Municipal Corporation

Guwahati city achieved its municipal corporation status in the year 1974. The metropolitan area of the city is 264 sq km of which an area of about 216 sq km is within the municipal corporation's limit. Table below presents the main features

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of the GMC Area. The figures in the table have been taken from the data of Census Board 2001.

Parameter	Description
Area, in km2	216
Population - 2001 Census	809,895
No.of Households	184454
No of Municipal Zones	20
No.of Wards	60
Population Density, persons/km^2	3750
Number of Slums	26
Slum Population	160371
Percentage Slum Population to total Population	19.8 %

Source: Comprehensive Master Plan for Guwahati Matropolitan Area: Data Base Report (Draft)

4.6 Population Growth

Guwahati is the largest urban centre in Assam comprising of 24% of the total urban population of the state. The maximum growth in the population of Guwahati has been registered during the period 1971-2001, after it became the state capital in 1972. The city has the status of Class I town in Assam, as per Census of India, 2001. It contributes to 55% of the combined population of the Class I towns of Assam. The geometric growth rate (Compounded Annual Growth Rate) model has been used to estimate the future population in Guwahati, since the population has a tendency to grow in Geometric Progression.

The population within GMC area is 809,895 as per 2001 census, projected to be 946,487 for the year 2005 based on geometric progression model. Table 4.1 given below provides the population growth trends of GMC area

Table 4.1 Population Growth Trends of GMC Area

Year	Guwahati Municipality	Decadal Growth (%)
1961	100,707	130.90
1971	123,783	22.91
1981*	No census	-
1991	584,342	117.27
2001	809,895	38.60

Source: Census of India; Modified Final Master Plan and Zoning Regulations for Guwahati

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The following table gives the Compounded Annual Growth Rates (CAGR) of population of GMC area with respect to 2001 population.

Table 4.2 Compounded Annual Growth Rates (%) of Population of GMC Area

Year	Guwahati Municipality
1961-2001	4.038
1971-2001	3.973
	3.318

Comprehensive Master Plan for Guwahati Metropolitan Area: Data Base Report (Draft)

Based on CAGR, the low, medium and high projections of population of GMC area are as follows:

Table 4.3: The Future Population Estimate in GMCA

Year	Estimate		
	Low	Medium	High
2005	922,855	946,487	948,832
2010	1,086,461	1,150,065	1,156,486
2015	1,279,072	1,397,430	1,409,585
2020	1,505.829	1,698,000	1,718,075
2025	1,772,787	2,063,218	2,094,078

Source: Comprehensive Master Plan for Guwahati Metropolitan Area: Data Base Report (Draft)

In the master plan for Guwahati (Draft report), the medium projection of 20.63 lakhs has been adapted for the year 2065. This value has been used for population distribution in the area in the master plan and this report too.

4.7 Sex Ratio

As compared to the overall sex ratio of 932 of Assam, the Guwahati city has slightly lower sex ratio of 839 in 2001. From Table 4.4, it can be observed that in 1901, the city had a very low sex- ratio of 500, which actually started increasing after 1971, when the city became the state capital. Since then, there has been continuous rise in the sex ratio with the highest 839 in 2001.

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Table 4.4: Change in Sex Ratio in GMC Area

Year	Guwahati City
1901	500
1911	534
1921	528
1931	503
1941	567
1951	558
1961	497
1971	638
1991	783
2001	839

Source Comprehensive Master Plan for Guwahati Metropolitan Area: Data Base Report (Draft)

4.8 Land Use

Water bodies: The water bodies include all the rivers, lakes and reservoirs, and ponds in Guwahati City.

Open and barren land: The land devoid of vegetation is included in this category. This includes the rocky surfaces. The areas that have been stripped of vegetation are included in this class.

Vegetation: Vegetation includes forests as per the Forest Conservation Act and non forest areas with close tree cover. For the analysis, the vegetation has been considered under three categories of crown cover density, namely, < 10% (low density vegetation), 10-40% (medium density vegetation) and > 40% (high density vegetation).

The landuse categories and the area of each category within the municipal limits are given in the Table below.

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Table 4.4: Land use Categories and Area of Each Category

S. No.	Landuse Categories	Area (sq km)	Percentage of Total Area
1	Water Bodies	1.3	0.6
2	Open /Barren land	8.64	4
3	Agriculture land	8.6	4
4	Barren Land	8.6	4
5	Vegetation Low Density	64.8	30
6	Vegetation Medium Density	8.64	4
7	Vegetation High Density	4.32	2
9	River bed	0.54	0.25
10	Built Up Area	79.92	37
11	Marshy Vegetation	23.76	11
12	Marshy Land	4.32	2
13	Miscellaneous (unclassified)	2.48	1.15
	Total	216	100

It can be seen that the major development in the Guwahati city has taken place in a concentrated cluster. The area of the city was only 1.68 sq km in 1951 and 14 sq km in 1961 and now extends up to 216 sq km.

4.9 Administration & Management

The Guwahati Municipal Corporation is the creation of the Guwahati Municipal Corporation Act, 1971. The Corporation was duly constituted in 1974 in the first meeting of the elected councilors as per provision of Sec. 45 of this Act.

The Corporation has the following major branches:

1. Conservancy
2. Water Works Tax Division
3. Public Works
4. Building Permission
5. Street light and Electrical Section
6. Municipal Markets

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7. Sanitation & Health
8. Veterinary
9. Enforcement
10. Property Tax
11. Mutation Branch
12. Trade License
13. Advertisement
14. Slow Moving Vehicle Branch
15. Dead body and Night Soil Removal Branch
16. Poverty Alleviation
17. Birth and Death Registration
18. Garage Branch
19. Accounts Branch

The Corporation is headed by a Council of 60 elected Ward Commissioners. The council is headed by a Mayor and then a Deputy Mayor. There are five standing committees of the council to supervise various works.

The Commissioner is the executive head of the corporation. He is assisted by Additional and Joint Commissioners.

The water and public works divisions are headed by a Chief Engineer. The garage branch is headed by a Superintending Engineer. The accounts branch is headed by a Financial Advisor and Chief Accounts and an Audit Officer. Each revenue zone is headed by a Deputy Commissioner. Each Public works division is headed by an Executive Engineer.

The Engineering Department of GMC is responsible for collection and transportation of Solid Waste generated in the GMC Area. For operational purposes the entire area of the corporation is divided into 20 zones (23 Engineering zones out of which 20 zones have SWM responsibilities) consisting of 60 wards, with each zone having 3 to 5 wards. Each zone is headed by a Zonal

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Engineer (Assistance Engineer) Inspectors and supervisors who oversee the daily activities assist the Zonal engineers. The Zonal Engineers work under Divisional engineers, each division having 4-5 zones. The Engineering Department address major programmes such as - construction and maintenance, building licensing, and SWM activities including drain cleaning.

4.9.1 Staffing Details

The Engineering Department of Guwahati Municipal Corporation has at present total employee strength of 2800 out of which 1173 are working on solid waste management. The Chief Engineer is assisted by five Executive Engineers each in charge of one division. Organogram of GMC staff involved in SWM activities is shown in Figure 2.1.

Table 4.6: Staffing – GMC–Engineering. & Conservancy Departments

Designation	No. of posts	Duties
Chief Engineer	1	Responsible for management of all engineering & sanitation.
Superintending Engineer	1	Overall engineering and sanitation operations
Executive Engineer	5	Construction & maintenance of roads, drains, municipal buildings and SWM
Zonal Engineers	20	Supervision of the construction works, street sweeping, collection, transportation
Supervisors	60	Supervision & monitoring of SWM
Workers	800	Street sweeping, nalla cleaning, assisting
Drain Cleaners	270	Cleaning of drains
Drivers	16	Operation of collection drain cleaning

Source : GMC

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SECTION 5.0
PRESENT STATUS OF MSW MANAGEMENT AND WASTE CHARACTERISTICS

5.1 Review Of Existing MSW Management

Subsequent to detailed review of existing MSW Management, it is observed that the existing system in the city is not in compliance with the MSW Rules, 2000. Health & Environmental aspects are not integrated as can be seen from the Table 5.1 below:

Table 5.1 Salient Features of Solid Waste Management in the GMC Area

Elements		Features
Generation	Generators	Households, Hotels, Restaurants, Commercial Establishments, Markets, Temples, Institutions, Drain Silt, Street
Segregation & storage at source	Generators	Generally absent. News papers, cartons, glass are segregatedat source.
Collection	Primary Collection	Collect from households and bring to GMC collection points, drains/ road margins/ river; Limited private initiative for door to door collection.
	Drain cleaning	270 workers engaged. Material removed by GMC vehicles.
	Street sweeping	Approximately 800 sweepers and workers engaged for sweeping and collection of sweepings in the streets.
	Collection Points	RCC / Metallic/Masonry Enclosures - 318 nos., size - 0.3, 0.5, 1.0, 1.2, 1.5,

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Elements		Features
		2, 3, 5 m3 Open ground level points - 460 nos.
	Average spacing of collection points	Highly varying (200 m - 1000 m)
	Transfer	Manual, by scraping from ground
Transport		Private transporters contracted by GMC through trucks (47 private and 16 GMC owned trucks)
Frequency of waste removal		Scheduled daily, from city centre, occasionally from other places- Nigh time Lifting, 2 trips on an average per truck per day from GMC collection points.
Processing		No processing at city or local level except a 50 Tons per month private vermi compost initiative at Panikheti.
Disposal	Land Fill Site	Crude unsafe dumping at Sachhal, Express Highway VIP Road, Size – 9
Recycling		Separation by rag pickers for non- organic matter / recyclables including plastics, paper, metals, bottles, etc. at generation and collection points and the land fill site.

It would be prudent to mention that there is no sewerage and drainage system in the Guwahati city.

It is observed that GMC provides services in only 70% of the area under their jurisdiction. No services are available on Sundays and holidays. Detailed analysis of the present system is carried out in this chapter to assess the component wise service levels and deficiencies. The overall city looks dirty with rampant disposal of waste all over the streets and river Brahmaputra.

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5.2 Sources Of Municipal Solid Waste

The primary generators of solid waste generation in the Municipal area are the local households, markets and commercial establishments such as hotels, restaurants, shops etc. As Guwahati is a centre of commercial activity not only in Assam but also in the entire North East, there is a considerable floating population in Guwahati. Inventory of sources and source wise assessment of generation is not available with GMC. Based on preliminary observations and GMC records the following major groups of waste generators were identified. Table 5.2 below shows the major sources of MSW and the number of corresponding units:

Table 5.2 Sources of MSW

S. No	Source	No of units
1.	Domestic Sources (Households)-200 l	1,84,454
2.	Commercial Establishments	38,871
3.	Hotels & Restaurants	596
4.	Markets	14
5.	Temples (major)	06

Source: GMC

5.3 Collection And Transportation

5.3.1 Primary Collection

In some of the housing societies, door to door collection systems exist mainly through private initiatives of the Resident Welfare Associations. For example, few of the colonies where such an initiative is being taken are: Rehawari, Uzan Bazaar, Chandmari, Silpukhri and Pan Bazaar. Residents pay Rs. 20 – 40 per house for door to door collection of the waste.

The MSW strewn around is mainly collected through street sweepings. The municipal sweeper collects the waste in heaps along the road sides and the cartman deposits the waste in secondary collection points.

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5.3.2 Secondary Collection Points / Waste Storage Depots / Waste Receptacle /

GMC presently has 778 secondary waste storage collection points as reported by the GMC. Majority of these points are open ground sites. The break up of varieties of waste storage depots in the city is as below:

Type of waste storage depot	No.
Open waste storage depots	460
Masonry/RCC/Metallic waste collection points	318

GMC has let out the transportation of the solid waste to 20 private contractors. They collect the waste from the secondary collection points and dispose off at the dumping sites. These transporters have annual contracts with the GMC and are paid according to the clearing of the waste from the area assigned. If the GMC supervisors find that the area allocated to the contractor has not been cleared then he has to pay a fine of 3 times of the fee he gets. The trucks make on an average 1-2 trips to clear the waste from their respective allocated areas. GMC has its own fleet of 16 trucks, which are being used for drain cleaning and on special occasions e.g. during festivals of Diwali, Durga Puja, Ambu Basi Mela and Dignitary Visits.

The vehicles involved in the solid waste transportation are ordinary uncovered non tipping type trucks. They are manually loaded by scraping waste from the ground into conical shaped bamboo basket (thapa) and tilting the same to the truck holding the bottom handle. The workers are not using any personal protection equipments for this job.

Recently, GMC has restricted the collection and transportation of the waste during the night time. The lifting of the waste starts at 7.00 pm in the evening.

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It was reported that in 2004, there was public protest against the generation of odour and the insect menace in this site. To combat this problem GMC is doing some remediation exercise. Insect repellent and de-odouriser is sprayed at regular intervals at the site. This job has been awarded to a private contractor.

5.5 Quantity & Characteristics of MSW Generated

5.5.1 MSW Characterization

Physical characterization of MSW has been done at Boragaon landfill site and for chemical characterizations, samples were collected and analysed by a reputed and accredited lab (Delhi Test House). The methodology adopted for the sampling of municipal solid waste and physical & chemical test results obtained are tabulated in subsequent pages:

5.5.2 Waste Characterization Methodology

Physical testing of municipal waste carried out by Delhi Test House (DTH) at Boragaon Landfill site. From general experiences and during study it was observed that large amount of mixing of MSW occurs with the inert and other waste during collection of waste at Dhalaos point and transportation of waste to landfill site. So landfill was selected to carry out the physical characterization of waste in order to know the true picture of the waste coming at the receipt point (at landfill site in present and hence in the proposed complex in future). Waste reaching at the landfill site constitutes the lesser quantity of recyclables as most of these has picked up by the rag pickers at the Dhalaos or at the source generation point. MSW arriving at landfill site from selected locations was segregated into the different categories.

The laboratory appointed for MSW Characterization along with the GMC & IL&FS officials identified the trucks in order to have indicative sampling of the wastes reaching the landfill site from the identified zones for the physical characterization of waste. The selection of sample was done taking help of GMC

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and carries on till 8.00 am in the morning. The GMC supervisors and engineers go for supervision during these hours. However, the street sweeping is done during the day time.

Table 5.6 Solid Waste Collection and Transportation Infrastructure with GMC

Vehicle	GMC
Hand Carts	104
Trucks	16
Brooms	700 brooms in a month

5.4 Processing & Disposal Of Municipal Solid Waste

At present, GMC is not practicing any scientific and safe solid waste processing and disposal methods. However, there is a small successful private initiative of 50 Tons / month for vermi compo sting in the outskirts of the city at Panikheti. This unit is owned by M/s North East Green Tech.

GMC has no sanitary landfill site per say. Organised dumping in Guwahati started with the disposal site at Versapada. After a Public Interest Litigation (PIL) this site was abandoned and disposal was shifted to Amin Gaon. After that it was shifted to Adebari and then finally at Sachhal, the current disposal site. This site was developed nearly 2 years back.

The disposal site at Sachhal, 10 km away from city centre, is a low-lying area. This site is a government owned land and was transferred to the GMC. Only a part of this site is being used. It is a developing area and many new constructions have come up in recent years. Few of these are close to the site. Being low-lying area, during monsoon flooding occurs and landfill operations become difficult in the absence of properly developed roads and the approach gets flooded. The disposal is crude dumping where the waste is not covered and no specific steps are taken for controlled filling. A dozer is used to compact the waste. Bird, cattle nuisance, burning of waste, water logging and leachate contamination are the major issues of the site.

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staff and officials at the landfill site based on socioeconomic conditions of area Due consideration was given to the information regarding vehicle number of the trucks loading and carrying the waste to landfill site from each of the identified locations. A random sampling was done to select a truck from the identified zone reaching the landfill site. From amongst 3-4 vehicles coming to the landfill site from each of the identified locations, one vehicle has been chosen for the physical characterization of waste.

The conventional method of gravimetric profiling has been adopted by emptying out the entire trucks contents of the truck on a Plastic Sheet/suitable surface so that there occurs no mixing of underneath waste/soil. The entire truck contents were then physically separated by rag pickers arranged by laboratory into different categories. Considering wet nature of kitchen waste and due to intermixing with inerts it was found out that there is still some contents of inerts and other material in the kitchen waste so further analysis was carried out, to arrive out the actual fractions of the kitchen waste. Accordingly the kitchen waste was further segregated after drying for at least one hour. Each of these fractions was weighed individually using weighing machine.

By quartering & coning method, representative sample of around 2-3 kg was prepared and samples of mixed waste, kitchen waste components of Physical segregation were taken in separate plastic envelopes (to ensure minimum loss of moisture etc.). The collected samples from mixed waste & kitchen waste were also analyzed for its proximate analysis in addition to other chemical characteristics. Calorific value has been determined for four fractions separated after physical segregation i.e for mixed waste, Kitchen waste, Fuels & Organic matter.

5.3.2 Waste Characterization Results

5.3.2.1 Physical Sampling of waste

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The physical test results of MSW sampling, done by Delhi Test House at the Boragaon landfill site for the trucks carrying waste from the identified/selected locations based on socioeconomic characteristics of population of project area is tabulated below:

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A. Physical Characteristics:

Physical Characterization of MSW carried out by Delhi Test House, Lab at Boragaon landfill site in Gauwahati in the month of Oct-Nov 2007

1	Net weight (Kg)	2710	2150	3580	3270	1890	3260	3380	2980	2900.00
2	Density of Total Waste(Kg/m3)	405	378	488	432	378	406	432	378	411.75
3	Moisture Content (Mixed Waste)	23.6	21.09	23.4	19.2	41.2	18.1	33.2	24.8	25.57
4	Moisture Content (Kitchen Waste)	33.2	34.2	34.6	33.2	44.3	28.4	44.6	35.2	35.96
5	Calorific Value-Mixed	1442	1622	1462	1422	1399	1208	1110	1542	1400.88
6	Calorific Value-Kitchen	1874	2122	1882	1821	1622	2016	1309	1896	1817.75
7	Calorific Value-Fuel/Recyclables	3937	4908	3937	4097	3768	3992	3708	3997	4043.00
8	Calorific Value-Organics	2236	2306	2236	2212	2278	2124	2006	2128	2190.75
1a.	Wooden Pieces	0.26	0.28	0.25	0.15	0.5	0.61	0.24	0.27	0.32
1b.	Paper	4.3	4.6	5.08	7.09	4.12	6.84	7.08	9.36	6.06
1c.	Textiles	7.12	12.18	12.15	14.67	15.08	12.42	14.07	10.67	12.30
1d.	Thermocole	0.15	0.28	0.06	0.09	0.1	0.09	0.09	0.1	0.12
1e.	Straw/Hay	3.95	1.02	0.92	1.25	1.16	2.98	4.14	4.13	2.44
1f.	Coconut Shell	1.73	6.32	5.3	8.07	8.14	1.71	6.07	4.83	5.27
1g.	Polythene	5.2	12.65	6.48	7.4	13.54	7.82	9.19	9.9	9.02
1h.	Plastic	0.81	1.54	0.69	1.16	2.17	0.85	1.76	1.2	1.27
1i	School Bag	-	0.47	0.64	0.46	-	0.55	0.77	0.87	0.47
1j.	Dry Leaves/Dry Matter	2.91	4.32	2.96	2.72	4.92	6.01	5.47	3.38	4.09
1k.	Sugar Cane Straw/Husk	-	0.84	-	-	1.11	1.78	4.61	4.76	1.84
	Total	26.43	44.50	34.53	43.06	50.84	41.66	53.49	49.47	43.00

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Physical Characterization of MSW carried out by Delhi Test House, Lab at Boragaon landfill site in Gauwahati in the month of Oct-Nov 2007

2a.	Green Leaves	7.2	7.53	2.23	2.87	7.94	8.31	6.54	6.84	6.18
2b.	Kitchen Waste	33.28	24.23	31.62	26.42	21.53	25.39	18.18	20.5	25.14
2c.	Green Matter	5.53	1.02	3.9	5.01	2.22	7.73	7.88	6.65	4.99
2d.	Vegetables	0.92	1.49	0.47	0.48	1.79	0.92	1.37	1.34	1.10
2e.	Flower	0.48	0.28	0.14	0.15	0.16	0.24	0.2	-	0.21
	Total	47.41	34.55	38.36	34.93	33.64	42.59	34.17	35.33	37.62
3a	Concrete/Stone/Bricks	0.44	1.86	1.36	1.44	2.34	0.8	0.65	2.55	1.43
3b.	Sand/Soil/Earth	24.94	16.28	23.96	18.5	11.64	12.91	9.52	10.73	16.06
3c.	Cement	-	-	-	-	-	1.34	-	-	0.17
3e.	Lime	-	1.95	1.28	1.4	0.74	-	1.66	1.37	1.05
	Total	25.38	20.09	26.60	21.34	14.72	15.05	11.83	14.65	18.71
4a.	Glass	-	0.23	0.05	0.15	-	-	0.09	0.26	0.10
4b.	Rubber/Leather/Tyre	0.77	0.56	0.33	0.43	0.79	0.64	0.41	0.17	0.81
4c.	Metal	-	-	0.05	-	-	-	-	0.03	0.01
	Total	0.77	0.79	0.43	0.58	0.79	0.64	0.50	0.46	0.92
5a.	Dead Animals	-	-	-	-	-	-	-	-	0.00
5b.	Hazardous Waste/Human Hair	-	0.05	0.03	0.03	-	-	-	0.03	0.02
5c.	Batteries	-	-	0.05	-	-	-	-	-	0.01
	Total	0.00	0.05	0.08	0.03	0.00	0.00	0.00	0.03	0.02

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B. Chemical Analysis:

The Average results of latest MSW sampling done by laboratory for the project area is tabulated below:

Chemical Characterisation of Waste , Sample collected by DTH LAB from Boragaon Landfill site at Guwahati

1	Moisture content, % by mass	IS: 9235-1979	23.6	21.09	23.4	19.2	41.2	25.9	42.4	24.8	27.70
2	Total Volatile Substance, % by mass	IS: 10185-1982	14.2	17.6	19.6	18.1	20.4	16.1	13.8	18.2	17.25
3	Ash Content, % by mass	IS: 1350 Guideline	32.5	33.1	32.8	30.6	31.1	31.6	29.5	31.4	31.58
4	Fixed Carbon, % by mass	Lanze's Book Method	29.7	27.4	24.2	32.1	7.3	34.2	23.5	25.6	25.50
5	Calorific Value (Kcal /kg)	Bomb Calorimeter	1442	1622	1462	1422	1399	1208	1016	1542	1389.13
1	Moisture content, % by mass	IS: 9235-1979	33.2	34.2	34.6	33.2	44.3	28.04	54.28	35.2	37.13
2	Total Volatile Substance, % by mass	IS: 10185-1982	13.6	17.5	17.4	15.4	17.4	15.2	14.8	16.1	15.93
3	Ash Content, % by mass	IS: 1350 Guideline	35.3	32.9	77.5	35.1	33.2	29.8	30.4	34.1	38.54
4	Fixed Carbon, % by mass	Lanze's Book Method	17.9	15.4	13.8	16.3	5.1	26.6	10.2	14.6	14.99
5	Calorific Value (Kcal /kg)	Bomb Calorimeter	1874	2122	1882	1821	1622	2016	3010	1896	2030.38
6	Total Solid, % by mass	IS:9235-1979	54.8	63.8	49.6	69.8	72.8	72.2	61.2	62.8	63.38
7	Organic carbon, % by mass	USDA Guideline	6.2	5.2	6.4	5.2	4.9	5.6	4.9	6.2	5.58
8	Nitrogen, % by mass	Kjeldahl Method	0.42	0.25	0.32	0.32	0.33	0.3	0.29	0.3	0.32
9	C/N Ratio	By Calculation	14.76	20.8	20	16.25	14.84	18.6	16.89	20.6	17.84
10	Phosphorus, % by mass	USDA Guideline	0.008	0.002	0.009	0.006	0.008	0.007	0.009	0.007	0.01
11	Chloride, % by mass	Titrimetric	0.25	0.23	0.25	0.23	0.24	0.26	0.19	0.21	0.23
12	Sulphur, % by mass	IS: 1448 (P-33)-1991	0.12	0.19	0.15	0.21	0.17	0.22	0.11	0.16	0.17
13	Calorific Value (Cal/g)	Bomb Calorimeter	1442	1622	1462	1422	1399	1208	1016	1542	1389.13
14	Chemical Oxygen Demand, mg/kg	APHA 20th Edition	523294	543178	538160	462136	481908	430881	519812	525122	503061.38
15	Bio Chemical Oxygen Demand, (for 3 days at 27°C, mg/kg)	IS: 3025 (P-44)-1993	198852	206408	204500	175612	183125	163735	197529	199546	191163.38

15	Cadmium (as Cd), mg/kg	AAS	ND.(0.2)	ND.(0.2)	ND.(0.2)	ND.(0.2)	ND.(0.2)	ND.(0.2)	ND.(0.2)	ND.(0.2)	ND.(0.2)
16	Zinc (as Zn)mg/kg	AAS	11.3	23.6	10.2	9.2	73.7	9.5	6.4	7.2	18.89
17	Lead (as Pb), mg/kg	AAS	N.D.(5)	156.7	N.D.(5)	N.D.(5)	18.3	110.6	N.D.(5)	N.D.(5)	35.70
18	Nickel (as Ni), mg/kg	AAS	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	0.00
19	Chromium (as Cr), mg/kg	AAS	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	0.00
20	Arsenic (as As), mg/kg	AAS	N.D.(0.05)	N.D.(0.05)	N.D.(0.05)	N.D.(0.05)	N.D.(0.05)	N.D.(0.05)	N.D.(0.05)	N.D.(0.05)	0.00
21	Selenium (as Se), mg/kg	ASS	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	N.D.(5)	0.00
22	Manganese (as Mn), mg/kg	AAS	57.5	60.1	55.8	44.3	42.16	43.9	31.5	37.1	46.55
23	Mercury (as Hg), mg/kg	Mercury Analyzer	N.D.(0.01)	N.D.(0.01)	ND	N.D.(0.01)	N.D.(0.01)	N.D.(0.01)	N.D.(0.01)	N.D.(0.01)	0.00
24	Iron (as Fe), mg/kg	AAS	1233.9	1260.2	1169.85	1005.8	892.1	1014.05	991.3	1065.7	1079.11
25	Copper (as Cu), mg/kg	AAS	58.6	63.6	51.2	51.9	47.7	41.6	39.6	39.2	49.18

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SECTION 6.0

PROJECT DESCRIPTION

6.1 Broad Design Considerations & Process Descriptions (Overall)

The "Integrated Municipal Waste Complex" consists of MSW processing plant to convert MSW to RDF and a Power plant. There would also be a compost plant with a capacity of 50 TPD for processing of organic fraction of MSW and also a Sanitary Landfill Facility. However, this DPR will deal with only the RDF plant and Power Plant portions. The layout plan of the site showing all of the above facilities are included in Annexure I

The Integrated Municipal waste complex is being designed on the basis of following major parameters:

A. The plant will be designed to process MSW of capacity 500 TPD (Tons per Day) and in the initial period would be processing about 350 tons of MSW, which would generate around 180 TPD of Refuse Derived Fuel in the form of fluff. The fluff is expected to have a gross calorific value (GCV) of 2,500 kcal/kg to 3,000 Kcal/kg of fluff.

B. The plant is also being designed to use about 50 TPD of biomass having an average gross calorific value (GCV) of 2,500 kcal/kg to 3,000 Kcal/kg.

C. RDF fluff quantity of 180 TPD and Biomass quantity of 50 TPD is available for firing in a specially designed boiler to generate high pressure / high temperature steam. The steam generated from the boiler is expected to generate about 6,000 kW of power.

D. The RDF plant is expected to operate for 330 days in a year. The power plant will be operating throughout the year except for 15-20 days during which period the Boiler will be taken up for inspection and maintenance. This means that the power plant will be potentially available for power generation for about 345 to 350 days.

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E. Developer may also consider putting up a pelletizing unit taking some of the space of RDF Fluff storage area

F. The fuel feeding system will be designed for 15 TPH of RDF fluff flow for the worst-case scenario of GCV of RDF lowering to 2200 kcal/kg. The boiler will be able to accept additional fuel to compensate for this reduced quality of fuel.

G. The plant will be designed as **environmentally clean plant**, so that the liquid effluents, solid effluents and gaseous effluents from the plant will meet the Standard as applicable on date However in so far as the gaseous emissions are concerned the project envisages having standards better than what are applicable in India in view of Public Health.

H. The layout of the plant has been so designed that the material flow is smooth and any manual material handling is minimized.

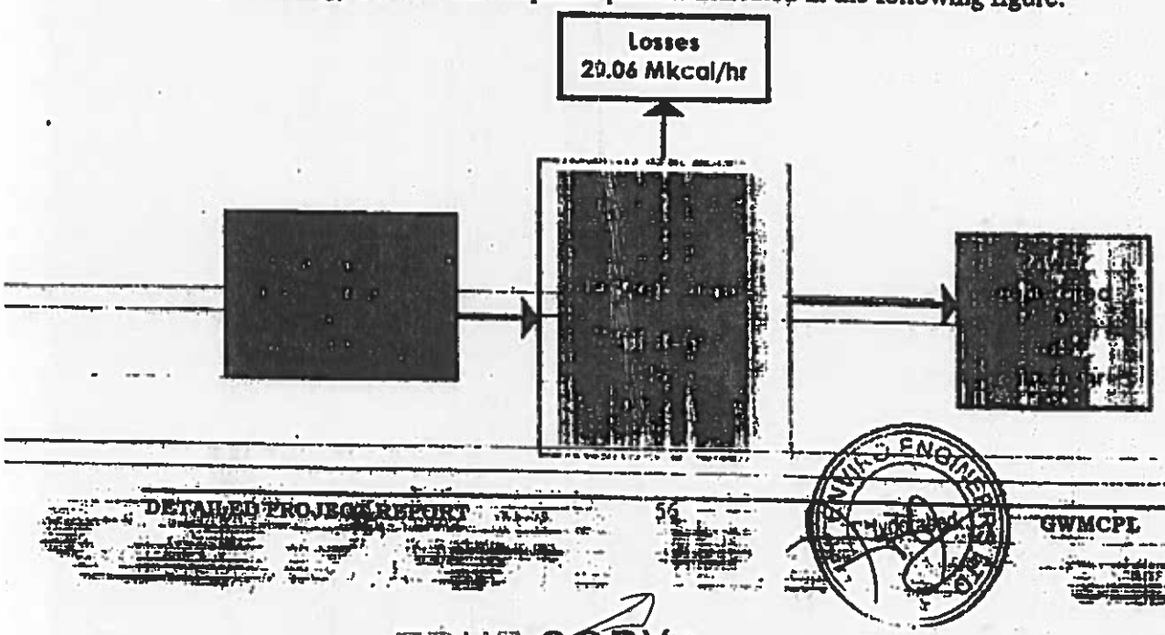
6.2 Material & Energy Balance (Overall)

The Energy balance for the integrated plant is indicated in drawing No. GWMCL-ME-SCH-001 and Material balance for the integrated plant is indicates in the drawing GWMCL-ME-SCH-003. These drawings are included in Annexure-I.

The brief energy balance for the power plant and RDF processing plant are given in the figures below:

6.2.1 Summarized Energy balance for Power Plant

The energy balance for the power plant is indicated in the following figure:



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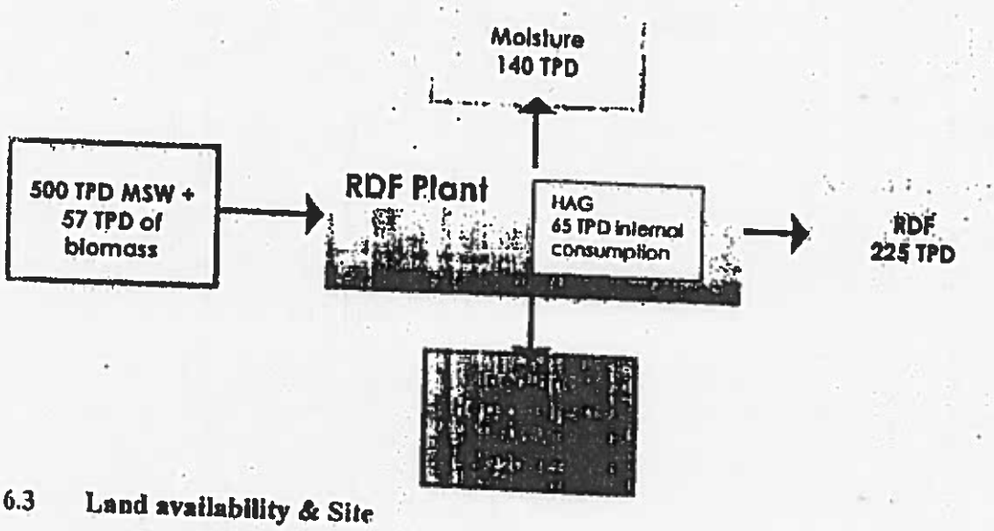
6.2.2 Summarized Material Balance for the RDF plant

The energy balance for the power plant is indicated in the following figure:



6.3 Land availability & Site

The proposed site for integrated facility development is located at Baragaon village in GMC limit area with survey numbers 1112, 1113, 1117, 704 and part of 1114. The site is observed to be open land with seasonal agricultural activities. It has also been observed that fishing activities are predominant in and around the site. The site is within the Brahamputra river flood plain. The site is located at a distance of around 15 km from the Guwahati City and is 1 km from the NH-37.

An approach road of length around 0.5 km originating from NH-37 provides access to the site. A railway track passes adjacent to the site on western side.

The land use around the site is observed to be agricultural and residential with a hill on north western side. No major trees have been observed within and around the site. Only aquatic flora has been observed within the site, as it is water logged throughout the year.

The type of soil in the site has been observed to be dark grey silt and clayey soils. The terrain is low lying plain with mild undulations. The ground water levels at the site are observed to be very shallow with ground water only few feet below the ground.

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Total area for the development of integrated facility for the management of MSW in Guwahati is about 24.12 Ha (180 Bigha). The features of the site are presented in Table 6.1.

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Table 6.1: Features of Proposed Site

Features	Details
Latitude & Longitude	Lat. 26'5'0" to 26'8'0", Long. 91'38'0" to 91' 41'0"
Land use	It is on Brahmaputra flood plain. The land is generally lies idle, but occasionally used for minor cultivation and for fishing
Major crops in the study area	Reported some occasionally paddy cultivation in around the site but often gets washed away in floods. However, there is no indication that the site is being cultivated.
Nearest Highway	National Highway-37 is 1 km away
Access Road detail	The road is metalled and paved upto IASST, while about 0.5 km road leading to the site is unpaved
Nearest Railway Station	Guwahati – ~15 km
Nearest Airport	Guwahati air port ~10 km
Nearest Town/City	Maligaon village towards North about 6 km from the site
Major Settlements	On the other side of NH-37 about 1.5 km and in Gorchug about 2.5 to 3 km from the proposed site settlements in Paschim Boragaon (houses as well as school) within the 1 km of the site including proposed
Minor settlements	Harapur (Harapara/Hirapara,~5km), Chakard (~3km), Devchatal (~1.5 to 1.75 km), Maghawpara (~ 1 to 1.25 km), Teteliya (~2.5km) Villages
Water bodies and dams, canals	Mora nalha which, originate from the Garchuk, passing right through the site and joining the dipar beel (within 200 to 300 m from the site).
Hills and Mountains (within or around the area)	Meghalaya Pahad behind the Maghuwapara about 1.5 to 2 km from the site; behind that Rani reserve forest starts while on the other side towards north Pharasil reserve forest about 4 km from the site
Reserve forests	Rani reserved forest about 1.5 km from the site
Ecologically sensitive zones(within 10 km)	Deepar beel about 1.5 km from the site
Monuments (within 10 km)	Not observed any
Sensitive Receptors	Shiv temple within 1 km from the site.
Socio-economic	Since the area remains waterlogged, some minor fishing activities have been observed. Occasional paddy farming has also been reported in some patches. No lands at and in the vicinity of site is used for residential purposes except the proposed lands of LIC and tea industry in between the compost and landfill Moreover, hardly any identify the site as of scenic
Major important industries within 10 km	There are tea warehouses, small-scale textile (weaving) mill, salt factory and stone crushing factory near the

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6.4 Water availability

The plant water requirements includes plant cooling water make up requirements, potable & service water requirements. The quantity of plant water requirement is about 2,500 m^3/day including the requirement for power plant & RDF Plant. This water will be taken from the groundwater sources. The plant potable requirement of about 20 m^3/day will be also met from groundwater. The effluent from the integrated plant will be treated as per the required standards before letting out in to a Nallah.

6.5 Fuel management

6.5.1 MSW & BIOMASS Management

A. No. of trucks of MSW for RDF and Compost plant

i) It is expected there will be 125 incoming trucks to bring in 500 TPD of Mixed MSW and about 12-15 trucks for bringing 50 TPD of biomass. Truck will normally enter the plant during the timings as approved by local authorities during day and night timings.

ii) Truck will enter the main gate through "entrance side" and proceed to the weighbridge.

B. Weighment of Trucks

Incoming trucks will be weighed with tare weight reference and net weight of material will be computed by electronic weighbridge. Tare weight inventory of all the trucks will be maintained.

C. Movement of Trucks

Depending upon the type of material, MSW or Biomass, each truck will be directed for unloading mixed MSW and biomass. Mixed MSW will be unloaded in RDF plant pit and biomass will be unloaded in the storage area earmarked for the same. After unloading, the truck will proceed to the "exit side" of the main gate on the basis of "weightment slip". It is expected that 15 trucks will get cleared per hour.

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6.5.2 RDF Plant fuel management

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The RDF plant has a capacity to produce more than 180 TPD of the fuel. While 180 TPD of RDF will be directly used (online) for power generation in the plant and any excess quantity of RDF will be stored for future purpose. In order to meet the regular requirement of fuel for the boiler, it is envisaged to have a main storage area for RDF. This storage capacity will meet the fuel requirements of the boiler for about 7 days, amounting to about 1,500 MT. The covered storage area will be 40m X 20m X 10m. The fluff from the main storage area can be transferred to the Boiler fluff storage by pneumatic conveying. The Boiler fluff storage house will have a dimension of 20 m X 14 m X 10 m and is located to the east of the boiler. The bottom floor of the boiler fluff storage house shall start from +6 m Elevation.

6.6 Integrated Plant Layout and flow of materials

As indicated earlier, the plant consists of MSW processing plant to convert MSW to RDF, and power plant to form an **"Integrated Municipal Waste complex".**

The equipment and systems of the integrated plant has been so laid out that the flow of materials is smooth and there are no hindrances for material movement and transportation.

The layout of the plant has been so designed that the material flow is smooth and any manual material handling is minimized

As visualized in the plant layout, trucks would bring in the Municipal Waste. The Trucks will be first weighed in a weighbridge to ascertain the quantity of MSW. The trucks will then be taken to unload the MSW (except the green waste) into the unloading pits. The MSW taken from the unloading pits will be segregated and treated for conversion to RDF fluff.

The RDF fluff generated from the RDF plant will be stored in a covered area adjacent to the boiler. The Boiler is located to the east of the RDF fluff storage area. The Fluff is transferred from this storage to a Belt feeder by a grab crane, which turn feed the

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boiler Receiving Hopper, through a belt conveyor. The Boiler, Electro Static Precipitator, Flue Gas treatment facilities, ID fan and 60 m high Chimney will be positioned such that they will be "in-line".

The turbo generator building is located towards the eastern side of boiler. The condenser and the TG auxiliaries like, lube oil system, gland steam condenser, boiler feed pumps, condensate pumps piping etc will be located on the ground floor of the TG building. The Electrical room will be located on the northern side of TG building and the power plant control room will be located in a floor above the electrical room.

The water treatment facilities such as filters, RO plant and MB (mixed bed) unit, DM water storage tank are located near boiler towards the north of the RDF plant.

The common monitoring basin is provided on the northern side of the RDF plant, where reject water from RO plant, DM plant and cooling tower blow down will be collected, neutralized and corrected as per required Standards.

Fly Ash from economizer hoppers and ESP hoppers will be pneumatically collected and conveyed to a fly ash silo, which is located on the western side of the boiler. Road access has been provided for the trucks to collect ash from the silo for disposal. Bottom ash will be collected in dry form. The ash generated from the boiler (bottom ash and fly ash) is proposed to be disposed off to agencies, which utilize them for manufacturing building materials.

6.7 Power Evacuation

The steam turbo generator will be generating Power at 11kV. The rating of the generator is 7.5 MVA. The generated power will be connected to one 11kV Switchgear through suitably sized generator breaker. The 11kV Switchgear will have two feeders connecting to the Garchug 11 kV grid substation, which distributes Power to the other areas.

During start-up of the plant, the power will be drawn from the 11 kV feeder in 11 kV switchgear of the plant, which is connected to the 11 kV Grid. The plant will be

started and brought up to synchronizing speed and voltage. Generator will be synchronized with the plant 11 kV switchgear and the generator breaker will be closed. After synchronizing of the power generated the excess power over and above the power consumption of Integrated Municipal waste complex will be exported. There will be an energy meter in the 11 kV feeders, which will measure the power exported as well as imported.

Power Import to the plant during the shutdown of the power plant will also be through the same 11 kV feeders.

The auxiliaries for the RDF / Power Plant will be fed from the 11kV Switchgear.

Suitable provisions in the PPA will have to be considered to include Netting of Power (ie, The power exported and power imported shall have the same tariff/cost) and that no minimum demand charges are applicable.

6.8 Major Plant Equipments-RDF processing Plant

MSW is processed to produce RDF based on appropriate, tested and proven technology developed by the Department of Science & Technology (DST), Govt. of India.

6.8.1 Design Considerations

Design of the RDF processing plant considers the following aspects:

A. Installed capacity of the plant is for handling around 500 TPD of MSW and to produce 180 TPD of RDF. There would be a provision of storage of RDF for 7 days duration.

B. MSW will be processed to produce RDF fluff. Production of RDF pellets is not envisaged. However, the option of pelletelization is open and an indicative layout

of the same attached in the annexure. In such case, some area of RDF fluff storage area will be used for pelletization plant.

C. Approximately 50% of MSW will be of particle size more than 150 mm and balance 50% of MSW will be of particle size less than 150 mm.

D. Fluff production has been considered for 330 days and balance 35 days fuel production will be less due to rains and/or other interruptions.

E. The plant will work normally for 20 hrs per day. However in case of availability of larger qty of MSW, the plant is capable of working for 24 hours per day.

F. Primarily Combustible fraction separated from MSW will be fired at the Hot Air Generator to produce hot air for Rotary Dryer.

G. Arrangement will be made to spray Herbal pesticide on the garbage to eliminate insects, flies & odour etc.

H. RDF Fluff produced will be first stored in the main fluff storage shed and then fed to the boiler fluff storage area from where it will be directly fed into the Boiler of Power Plant through suitable fluff handling arrangement.

I. The plant shall have a space provision for installing densification facility of surplus fluff.

J. Special Cutter Equipment will be installed to shred textiles.

K. Space provision for in-house utilization of rejects is considered.

L. The RDF processing plant will be maintained at negative pressure to avoid any foul smell in nearby areas and the air collected from the plant will be treated before discharge.

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6.8.2 MSW Quantity

Description	Unit	Qty
MSW to be delivered every day	TPD	500
Average working days in a year	Days	330
Average Quantity of MSW that can be processed in a year	TPA	165,000

6.8.2.1 MSW composition and quality

The latest analysis conducted by GWMCL indicates the following average composition for MSW. The composition is broadly classified as combustible, kitchen waste and inert.

	Result of Analysis
	Actual (Wet Basis)
Biomass/Wood/Paper/Textile	42 %
Kitchen / Organic waste	38 %
Plastic/Rubber/Leather/Metal	2 %
Sand/Grit/Earth/Others	15 %
Stones / Ceramic / Bricks	3 %
Total	100%
Moisture	* 28.43%

6.8.4 MSW composition considered for design

With the introduction of door-to-door collection system and improved waste management aspects envisaged during the initial term of the project, the waste characteristics are expected to change. In view of this, the following average composition has been considered for design:

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Constituents	Result of Analysis	Wet basis	Dry basis
	Actual (Wet Basis)	Design Parameters	
Biomass/Wood/Paper/Textile	42 %	15%	10%
Kitchen / Organic waste	38 %	50%	28%
Plastic/Rubber/Leather/Metal	2 %	10%	8%
Sand/Grit/Earth/Others	15 %	15%	12%
Stones / Ceramic / Bricks	3 %	10%	8%
Total	**100%**	**100%**	
Moisture	* 28.4%		35%

The design parameters considered above are safe with respect to the values obtained in actual sampling as it has assumed lower fuel content, higher moisture and high inert.

6.8.5 Refuse Derived Fuel (RDF)

A. MSW collected from different sources has differing calorific values. The MSW, after drying and separation of non-combustible fraction and after conversion to RDF, possesses an average GCV (gross calorific value) of 2,800 kcal / kg.

B. A description of the fluff and pellets produced from MSW combustibles, its proximate and ultimate analysis, ash analysis are indicated in the Table below:

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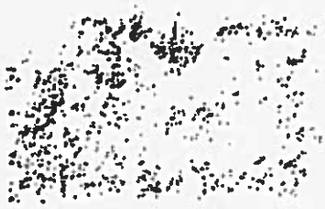
Description	Details
RDF type	Fluff 
Shape	Irregular
Size	150^{mm} X 150^{mm}
Bulk Density	100 kg/m^3
Moisture	10 % - 20 %
Ash content	10 % - 20 %
Volatile matter	40 % - 60 %
Fixed carbon	10 % - 20 %
Moisture	10 % - 20 %
Mineral matter	15 % - 25 %
Carbon	35 % - 40 %
Hydrogen	5 % - 8 %
Nitrogen	1 % - 1.5 %
Sulphur	0.2 % - 0.4 %
Oxygen	25 % - 30 %
Gross Calorific Value of RDF (Avg)	2,800 kcal / kg
Chloride Content	0.04%
Initial Deformation temperature	860 °C
Softening temperature	950 °C
Hemispherical temperature	1040 °C
Fluid temperature	1100 °C
Silica	53.10%

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Description	Details
Alumina	11.18%
Iron Oxide	4.87%
Titanium dioxide	0.89%
Calcium Oxide	13.15%
Magnesium oxide	2.90%
Sodium oxide	5.79%
Potassium oxide	1.56%
Sulphur trioxide	2.55%
Phosphorous pentoxide	1.43%

6.8.6 MSW to RDF conversion process description

A. The conversion process of Municipal Solid Waste (MSW) into Refuse Derived Fuel (RDF) involves the following operations:

i) Homogenization
ii) Size Reduction
iii) Drying
iv) Segregation
v) Densification (optional)

B. The schematic process flow diagram for conversion of MSW to RDF is given in Figure-6.1.

C. MSW is collected, transported to Plant site by the GWMCL. Primarily, following elements would not be mixed with MSW:

i) Construction waste
ii) Hospital Waste
iii) Slaughter House waste
iv) Drainage silt
v) Green Waste generated (in bulk quantity) vegetable-Fish markets / Big Hotels

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D. The Tipper Trucks or the Lorries would supply the garbage in two/three shifts. The Trucks are then weighed at the weighbridge station before they unload in the two MSW storage pits each having holding capacity of 600 MT.

E. One of the pits will be used for unloading the incoming material. After unloading the MSW will be sprayed with Herbal pesticide in the receiving pit. On the periphery of the pit a pipeline will be laid. This pipeline will have special devices, which will spray the herbal insecticide in the form of mist. Normally quantities sprayed will be 1.5 Liter/Ton of MSW with 1% concentration. The cost implication of this herbal insecticide will be Rs.2.50 to Rs.3 per MT of garbage.

F. As the raw MSW received at site is dumped into the storage pits, any yard segregation is not envisaged. The overhead crane with grab bucket picks up MSW and put it on the "Vibrating Feeders".

G. At this stage, as the garbage travels on the main conveyer belt, odd sized objects are picked up manually.

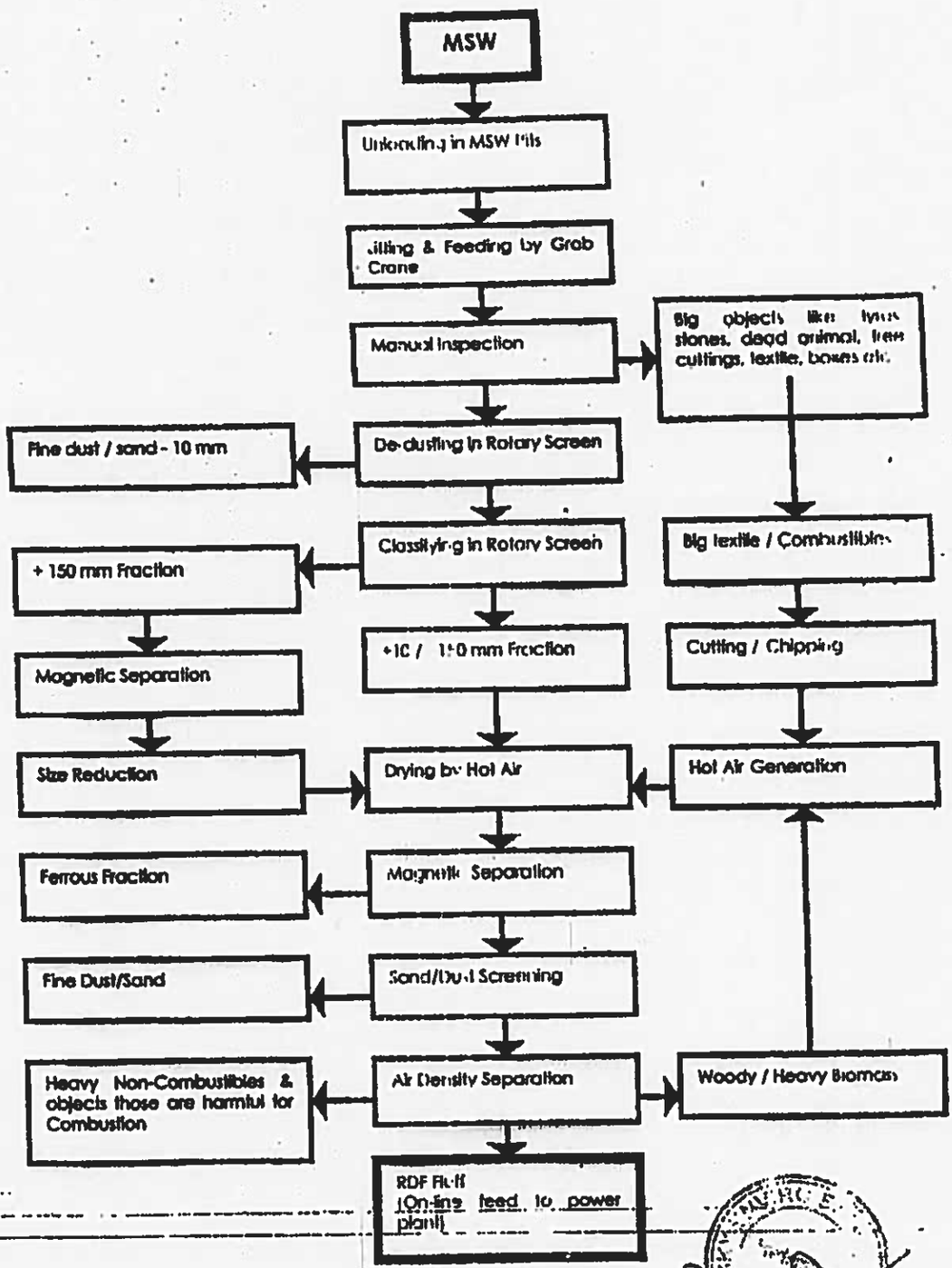
H. The constituents segregated at this stage are mostly lengthy textiles, large twigs and woody pieces, thermocol, any stray dead animal and consumer durables. The dead animal and consumer durables (hardly noticed in MSW) are put into trolleys and periodically taken out from the processing system and suitably disposed off.

I. The MSW after inspection is fed into a de-dusting cum pre-drying system to remove dust/sand/earth (10 mm particle size) in a **Fines Separation Rotary Screen** in which hot air is injected.

J. After the fines separation, MSW is fed into another **Rotary Screen** to classify the material into two fractions: Over size + 150 mm and Undersize –150 mm.

K. Undersize fraction (- 150 mm) will primarily contain organic matter and is directly fed through a belt conveyor in to the **Rotary Dryer**. The Oversize fraction (+ 150 mm) is fed into a **Primary Shredder through a Magnetic Seperator** (to separate ferrous material)

Fig 6.1 : Schematic Flow Diagram MSW conversion to RDF 3062 ~~340~~



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6.8.7 "MSW to RDF Plant" Equipments

The MSW to RDF process plant layout is indicated in Drawing No GWMCL-MI:-GA-007. The list of plant and machinery along with the broad dimensions is indicated in the Table below:

[illegible]	Description	Broad Dimensions (mm)
W	Electronic weigh bridge	9000 x 3000
P1	MSW storage pit (existing)	20,000 x 14,000
P2	MSW storage pit (additional)	20,000 x 14,000
SS	Chemical spray system (herbal insecticide)	Along the periphery of the unloading pits
1A	EOT crane with grab bucket	Span=15,200, Length = 50,000
1B	EOT crane with grab bucket	Span=15,200, Length = 50,000
1C	EOT crane with grab bucket	Span=15,200, Length = 50,000
VF1	Vibratory feeder	1500 X 2000
VF2	Vibratory feeder	1500 X 2000
VF3	Vibrating feeder	1500 X 2000
2	Sorting conveyor with mag. Separator	1500 x 42000
M	Manual pickup	
3	Fines separation rotary screen	DIA 2200 X 6000
3A	Fines extraction screw conveyor	DIA 300 x 8000
B1	Bin for dust collection	2500x 2000x3000
4	Rotary screen	DIA 2200 X 6000
5	Cutter chipper feeding conveyor	600 X 35000
6A	Cutter chipper	3000 x 6000
6B	Fluffing machine	600 x 400
7A	Primary shredder	L 4500, W 3500, H 4800
7B	Primary shredder (stand-by)	L 4500, W 3500, H 4800

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Sr. No.	Description	Broad Dimensions (mm)
8	Primary shredder discharge conveyor	1000 X 32000
9A	Rotary dryer with cyclone, fan, chimney	DIA 4000 X 28000
9B	Hot air generator (hag) with pa/sa fan, etc.	2500 X 7500
9C	Transfer conveyor between RDF and bio-methanation plant	600 x 35000
10	Rotary screen feeding conveyor	1000 X 22000
10A	Feed divertor	
11	Rotary screen	DIA 2200 X 6000
11A	Screw conveyor	DIA 300 X 8000
12	Dust transfer belt conveyor	600 x 6000
B2	Bin for dust collection	2500 x 2000 x 3000
13	Air classifier feeding conveyor	1000 x 26000
14	Vibratory feeder cum feed divertor	2000 x 200 x 3000
15A	Air classifier	2000 x 1500 x 5000
15B	Air classifier	2000 x 1500 x 5000
16	Heavy reject transfer conveyor	600 x 10000
17A	Cyclone with air lock & fan	DIA 1400
17B	Cyclone with air lock & fan	DIA 1400
17C	Cyclone with air lock & fan	DIA 1400
18	Fluff storage building for boiler	20,000 X 14,000 X 10.000 M

6.8.8 Equipment Details

The list of major equipment of RDF plant is given in the Table-4 of Annexure-II.

6.8.9 Specifications of Major Equipment

A. EOT Crane with Grab Bucket

Span : 15.2 meters

Lift height : 10.0 meters

Grab Bracket Volume $3m^3$

Lift Capacity : 10X kg

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Minimum Operations Per Hr 30

Normal operating time 1.5 minutes

It will be an electrically operated, overhead travelling crane. Long travel and cross travel will be electrically operated. Grab will be controlled Hydraulically.

Crane will be controlled from the 'control pulpit' in the control room

Drive Motor for the EOT crane will included the following:

Long travel	-	2 x 2 KW with normal speed control
Cross travel	-	1 x 2 KW with normal speed control
Hoist Motor	-	1x 3 KW
Hydraulic Panel	-	1 x 2 HP

Crane is to be designed to operate round the clock. Adequate focusing lights will be provided besides the General lighting of the crane area.

B. Rotary Screen

Technical Details

Multi Stage Rotary screen is a Rotary cylinder built up with steel section having supporting rollers at both the ends. Drive to screen separator is provided by motor and gearbox through girth gear and pinion. Support rollers are of rubber construction to give smooth drive to separator at a very low cost.

All the screening sections are covered with steel sheet. Material discharge from the separator is connected at different outlets.

Rotary Screen has wide entry gate at discharge end for inside inspection of screen. Cleaning of Jam can also be carried out through the gate. Material inlet to the screen is properly sealed to avoid dust coming out.

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Broad Specifications

Capacity		35 T/hr
Type of Construction		Fabricated
Length		6000 mm
Diameter	:	2200 mm
Speed	:	6 - 10 rpm
Drive		10 hp Motor

C. Primary Shredder

Technical Details

It is reversible, centrally fed, Hammer Mill, designed to disintegrate Municipal Solid Waste into small pieces and also homogenize the waste. Low speed, heavy hammers will have two-stage disintegration of the waste. First disintegration occurs at grinding bars. Material gets crushed between the gaps. Second disintegration occurs at grate bars. The Material is forced from the Gaps in between the grate bars.

Hammer Mill inlet chute is designed to accommodate incoming conveyor up to 1200 mm width. The drive arrangement consists of TEFC motor and transmission of power takes place through the V-Belts. Since the heavy weight hammers has high inertia, soft starter is provided.

Hammer Mill is designed to have large diameter, machined and balanced rotor for vibration free operation. Complete assembly is mounted on base frame with anti vibration mountings. Material fed into and discharged from the hammer mill is gravity assisted.

Hammers mounting and dismounting will be manual operation and as such weight of each hammer has to be restricted to 20 kgs. Maximum weight of all the hammers in one assembly is restricted to 1500 kgs. The direction of rotation of Hammer mill is reversible. It has been designed to use both sides of the hammers. Hardening of hammer tips is to be designed. It is also possible to hard-face the hammer's tip using hard facing electrodes.

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Similarly, grinding bars should be mounted in such a matrix so that it is possible to have repair of grinding bars at regular intervals. It should also be possible to have inspection and replacement of grate bars from the side opening.

Broad Specifications

Capacity:	25 Ton/Hour with operating Moisture of 35 %	
Grate Size	:	100 x 100 mm
Moisture	:	60 % maximum
Material Input :		Biomass, wooden pieces, paper, Textile, leather, glass, ceramic etc.
Input bulk density	:	0.4 to 0.6 Kg/M3
Input/Output	:	Gravity assisted
Size of Hammer mill	:	Length 4500 mm, width 3500 mm, height 4800 mm
Drive arrangement	:	Thru V - Belts
Motor HP	:	250
Motor Speed	:	1200 R.P.M

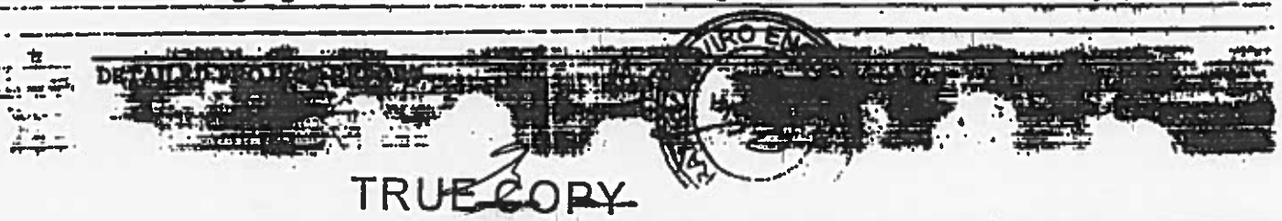
D. Rotary Dryer With Hot Air Generator

Broad specifications

Length	: 28 meter
Dia	: 4.0 meter
Input	: min 30 ton at 45 % moisture/max 35 ton at 35% moisture
Output	: 25 ton/hr. Minimum at 15% moisture

Rotary Cascade Dryer System

This is a rotating cylindrical shell provided with a set of lifting flights. The cylindrical shell will be in MS and the lifers will be in MS. During rotation of the cylindrical shell the wet material is lifted and made to shower across the cross section of the cylinder. The hot air that is introduced co-currently to the material flow, intimately contacts the wet solids undergoing showering action, resulting in drying. The material travels along the length of the dryer in a cascade manner by virtue of the lifting flights and the inclination of the rotating shell. The material is dried by the



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time it reaches discharge end. The material is discharged from the dryer via discharge port. Fixed end chambers are provided on both the ends of the rotating cylinder. The rotating cylinder is provided with two nos. tyre rings, externally fitted. These tyre rings rest on support rollers. The rollers & tyres will be provided with lubrication chamber, so that layer of oil is always covering the tyre/roller surfaces

Flow type	:	Co-current
Drive unit	:	Motor, reduction gear box and girth gear & pinion arrangement Final RPM of the dryer will be 5 RPM
Supports	:	Tyres supported on rollers. Thrust rollers are provided for preventing axial displacement.
Manhole	:	Suitable manhole is provided.

Double Flap Valve (Feed Side & Product Side)

This is an air lock valve having two flaps, mounted serially and working alternately The flap operation is carried out by means of pneumatics power cylinders. Timer and suitable pneumatic control system govern the actuation of the pneumatic cylinders. This will provide air locks at feed side as well as product side.

Hot Air Generator

This will be direct mixing type (direct fired) hot air generator consisting of a refractory chamber to which fuel is dozed continuously and uniformly. Helpers do this manually. The fuel gets ignited due to existence of flame inside. The flue gases formed are diluted with ambient air to give hot gases, at required temperature & flow rate. The ash formed during the combustion process falls below into ash collection chamber from where it is removed manually. The air required for combustion is provided by the air handling system of the dryer. Start up of the operation (in cold condition) is done employing a specially installed tempest burner. This pre-heating operation is carried out by using High Speed Diesel. After the fire chamber reaches the operating temperature, the burner is switched off.

Settling Chamber

The exhaust gases from the dryer are passed through the settling chamber The chamber is a vertical cylinder constructed in masonry. The entrained solids from the

dryer system are allowed to get in on the bottom floor of the chamber. A door provides access to the inside of the chamber from where the settled material is periodically removed. Chimney is required for exhausting the humid gases from the dryer system at suitable elevation.

FD Fan & ID Fans

FD fan sucks the air from the atmosphere and delivers into dryer. The ID fan sucks the air at the dryer outlet and delivers it into athnosphere. the impellers will be dynamically balanced. Material of Construction for fans is Mild Steel.

Type - Centrifugal type.

Drive arrangement – V belt driven.

Impeller – Dynamically balanced.

E. Rotary Screen

To separate out soil enricher (mixer of sand/grit and biomass) from dried msw, rotary screen is used. For effective dust separation, 6/10mm punched hole sieve is placed on rotating angle frame. Below this a screw conveyor is mounted for collection of fines. The fines are further shifted to a bin through belt conveyor.

Length	8000 mm
Dia	3000 mm
Speed	5 – 10 rpm
Drive mechanism	Through pinion mounted on gear box output shaft and gear on the body
Drive motor	20 hp
Angle of inclination	6 – 10 degree
Material of construction	Mild steel plate 6/10 mm thickness with punched holes
Hole size	6 mm
Capacity	35 ton/hr

H. General specifications pertaining to conveyor belts

For handling bulk material, belt conveyor has a vital application of its capability of handling high tonnage over long distances at lower cost than other type of conveyors.

These are in use extensively for small and big capacities as can handle wide variety of materials economically

i) **Idlers:** These greatly influence belt tensions, power requirements, belt life, capacity and operational success of a conveyor. These should be of heavy-duty design for continuous handling of coarse materials. Salient design features are given below

ii) **Frame:** These should be of sturdy and rigid design with self cleaning design with inverted angle base and slotted mounting holes.

iii) **Carrying Idlers:** 3 roll 30 degree troughing construction manufactured from suitable ERW pipe fitted with anti-seize grease packed bearings spaced at 1.2 m interval. The roller dimensions should be offered with overall idler assembly dimensions based on IS:8598-1977.

iv) **impact Idlers:** 3 roll 30 degree troughing construction manufactured from suitable ERW pipe fitted with OD rubber rings and antisieze grease packed bearings spaced at every 0.4 m up to a length of 1.2 m below the loading point. The roller dimensions with overall idler assembly should be based on is: 8598 – 1977.

v) **Return Idlers:** Single roll construction manufactured from suitable ERW pipe fitted with anti-seize grease packed bearings at spaced 3.0 m interval The roller dimensions should be as per IS: 8598-1977.

vi) **Self aligned carrying Idlers:** Specifications should be same as carrying idlers with swiveling arrangement and side guide rollers are provided at 15 meters intervals. The roller dimensions should be as per IS: 8598-1977.

vii) **Self aligned return Idlers:** Specifications are same as return idlers with swiveling arrangement and side guide rollers are provided at 30 m interval. The roller dimensions should be as per IS: 8598-1977.

viii) **Pulley assemblies (head end, tail end/take up, snub/bend):** The pulleys should be of heavy duty construction suitable for continuous operation. Minimum pulley diameters should be as per IS: 1891 (part 1) 1978. While other dimensions and tolerances should be as per IS: 8531-1977.

The pulley shells are either made from standard heavy-duty tubes or fabricated from ms plates. The pulleys should be fitted with precision machined hubs and shafts. The pulleys should also be crowned, rubber lagged and statically balanced.

Assembly of pulley and shaft should be usually accomplished through a bore and key way. Heavy duty, split type, plummer blocks equipped with self aligning double row ball/roller/taper roller bearings with adequate dust sealing arrangements are used. Take up shaft runs between standard take up. Blocks with antifriction, self-aligning, ball bearing sliding between parallel guides should be provided in the structure.

ix) **Deck plate:** Deck plate manufactured from 2 mm m.s. Sheet conforming to IS: 2062 should be provided with average length of 2500 mm.

x) **Belt scrappers:** A v- blade type internal belt scrapper should be provided at the feed end or tail pulley and a double bladed counter weight balanced scrapper should be provided at the discharge end of the conveyor or near the head end pulley.

xi) **Safety switches:** Zero speed switch – 1 no, pull card switch 1 no. And belt sway switch 1 pair should also be provided for safety measures.

xii) **Skirt board:** A shirt board should be manufactured from 5 mm ms plate and fitted with easy adjustable skirt rubber of 12 mm thick having a shore hardness of 40-50.

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6.10 Major Plant Equipment- Power Plant

6.10.1 Power Cycle selection

The power cycle selected is Rankine Cycle with one regenerative heating. Based on the optimum cycle efficiency that can be achieved and consideration of cost, metallurgy standard range of the turbine, operability, maintainability, taking into consideration the capacity of the power plant the following parameters are considered for the steam cycle:

a) The boiler superheated steam outlet pressure and temperature selected is 46 bar (a) & 435 °C. The Boiler can be designed to fire RDF and Biomass
b) The steam turbine inlet pressure and temperature is 45 bars and 430 °C.
c) The de-aerator pressure corresponds to the saturation pressure for 105 °C.
d) The feed water temperature to the inlet of the boiler is taken as 105 ° C.
e) The steam requirement for De-aerator is met by extraction from the steam turbine.
f) The condenser provided for in the steam cycle is water cooled condenser, which operates at a vacuum of 0.1 bar (a) and temperature of 45.80 °C

The boiler is designed to fire RDF and biogas. Considering the power generation of 6 MW, Gross Calorific Value (GCV) of RDF as 2,800 kcal/kg and Biogas as 4,500 kcal/Nm^3, and a combined boiler efficiency of 74.8%, the steam generation will be about 27.76 TPH and the RDF fired will be 8.68 TPH and biomass fired will be around 57 TPD.

Based on TG mechanical efficiency of 99%, Gear box efficiency 97.5%, Generator efficiency of 97% and turbine exhaust pressure at 0.1 bar, the expected power output at 11kV would be 6.00 MW.

The maximum cooling water requirement for the condenser would be around 1657 m^3/hr with a cooling water temperature range of 8 °C.

6.10.2 Energy Balance

The Energy Balance Diagram (Dwg. No. GWMCL-ME-SCH-001) is enclosed in Annexure -I

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