

# **Background Information Document**

Design-Build- Operate & Transfer Municipal  
Solid Waste Management Project for the City  
of Berhampur Municipal Corporation

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## **1 The Project Area**

Berhampur is the oldest city of Ganjam district located in the state of Orissa. It is mainly a trading centre for southern Orissa having its influence over eight districts. The city was declared as a Municipality in the year 1867 and a Class-I Town category as per the 2001 census. Berhampur Municipal Corporation (BeMC) was established in the year 2008 having an area of 79.80 sq. km and is divided into 40 administrative wards.

The geographical scope of this study area as per the Terms of Reference (ToR) of this project is the existing municipal limits of Berhampur Municipal Corporation (Figure - 1) comprising of 40 wards with an area of 79.80 sq. km and population of 355,823 as per 2011 census. The town has witnessed widespread growth in its population over the years and is the fourth most populous town of Orissa.

### ***Location and Linkage***

Berhampur town is located at 19.32°N latitude and 84.78°E longitude having an average elevation of 26 meter above Mean Sea Level (MSL).

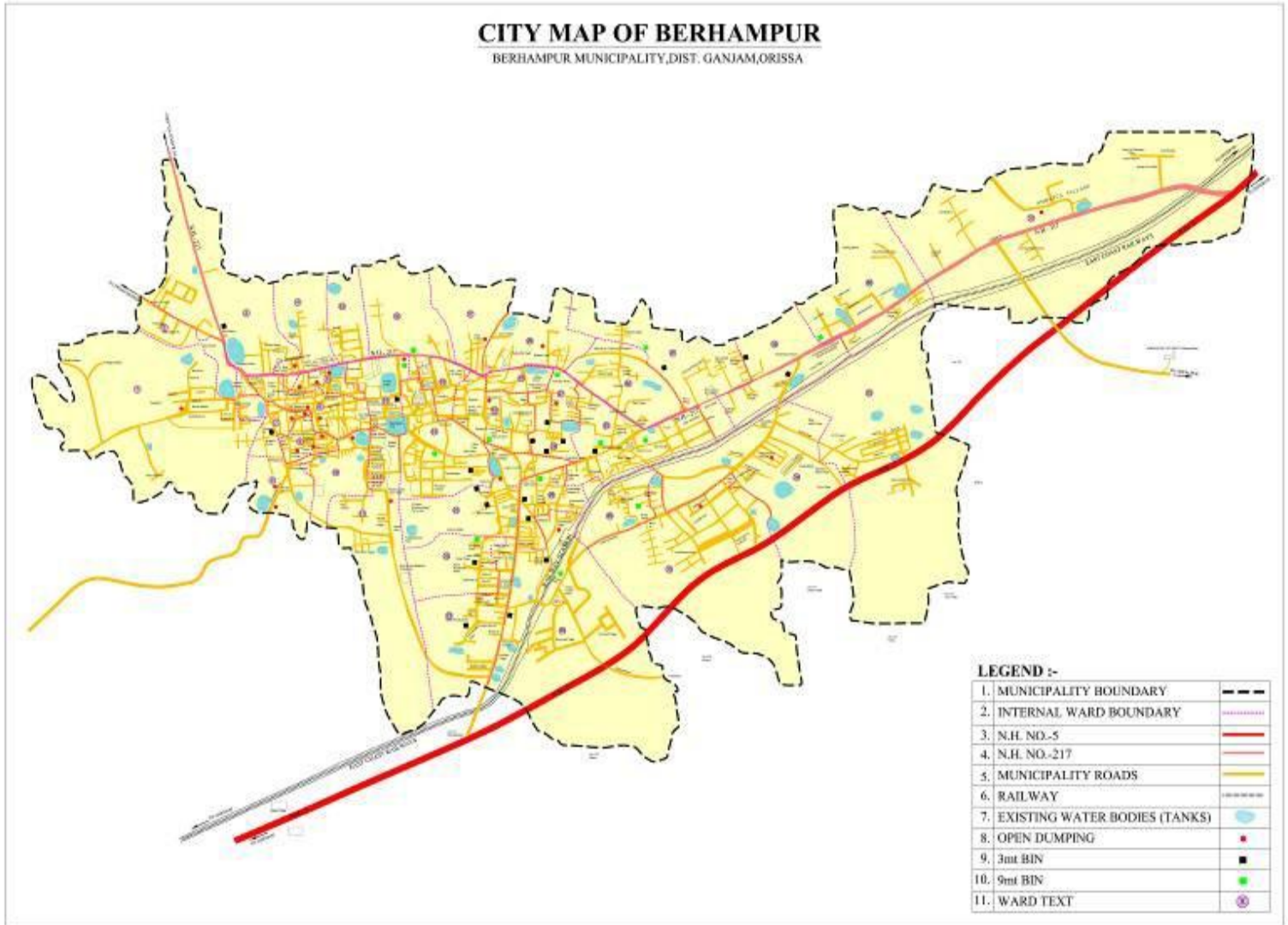
The city is well connected by road and rail network. The Howrah-Chennai railway line of South-Eastern Railway/ East Coast Railway passes through the city making Berhampur as the busiest station in this region. National Highway (NH-5) runs close to the city providing direct linkage to Kolkata, Vishakhapatnam and Chennai. Also, National Highway (NH-217) runs through this city connecting Raipur in Chhattisgarh with Gopalpur in Orissa. The city is well connected with districts through State Highways (SH-7, SH-17 & SH-65). The state capital, Bhubaneswar, is situated at a distance of 180 km from the city along NH-5. The nearest sea port is situated at Gopalpur at a distance of 15 km from the city and the port of Visakhapatnam is located at a distance of 250 km.

### ***Climate and Geology***

River Rushikulya also known as the “Ganga” of Ganjam flows at a distance of about 30 km from the city and discharges into the Bay of Bengal near Gopalpur port. The city has a good number of large tanks/ lakes and is bounded in the west and north by a range of hillocks having granite rocks of igneous origin.

The climate is pleasant and soothing due to its close proximity to the Bay of Bengal. Maximum summer temperature is 40 °C whereas minimum winter temperature is 22 °C. The mean daily temperature varies between remains at 33 °C to 38 °C. May is the hottest month of the year whereas December is the coldest. The period from June to September marks the south-west monsoon and 70% of annual precipitation is received during this period and the average annual rainfall is around 1250 mm. High humidity prevails in the atmosphere both in summer and rainy months. The general soil condition is clayey except in some places where hard soil and rocky beds are also found.

**Figure 1: City Map of Berhampur**



### 1.1 Socio Economic Settings

The sex ratio of Berhampur is 920 according to the 2011 census which is close to the state urban sex ratio of 932 and higher than the national urban sex ratio of 900.

The literacy rate of Berhampur city is 89.26 %, which is the highest in southern Orissa and is also higher than the literacy rate for urban Orissa. The female literacy rate is 85.39%, which is marginally lower than the male literacy rate with 92.83%. The female literacy rate of Berhampur is higher than that of national figure of 65.46% and that of state figure of 64.01%. The male literacy rate for the town is also higher

than that of national figure of 82.14% and the state figure of 81.59% respectively. The key socio-economic indicators for Berhampur town are provided in Table - 1.<sup>1</sup>

**Table 1: Key Socio Economic Indicators of Berhampur**

Indicators	Urban	Berhamp
Sex Ratio	932	920
Literacy Rate	85.75%	89.26%

## 1.2 Industrial and Economic Scenario

Ganjam has four medium scale industries, 8580 Small Scale Industrial (SSI) units and numerous food processing units. Orissa Industrial Infrastructure Development Corporation (IDCO) has developed industrial estates at Berhampur, Chatrapur and Bhanjnagar. It has also developed an Autonagar Complex at Haldiapadar and a large number of micro enterprises have also started in the area. Under micro and small enterprise sector food & allied sector, chemical & allied sector, forest & allied sector, engineering and metal sector and textile sector are being promoted for future development.

Berhampur is the most commercialised city and largest urban centre of Ganjam district and southern Orissa. Berhampur is known for its exquisite silver filigree works and silk sarees woven with gold and silver threads.

The industrial complex such as Indian Rare Earths Ltd. is located very near to the city and there is also a proposal in the pipe line for establishing a Titanium Dioxide Plant near Gopalpur, which is situated at about 15 kms from Berhampur city. Similarly, improvement and expansion of Gopalpur Port are also being done to meet the infrastructure requirements for the industries. An Air Defence College is located near the city, thereby making it strategically important.

The city has many educational institutions such as Medical College, Law College, Engineering Schools and Colleges. Berhampur University is also located nearby. It has got a number of recreation centres, two stadiums, cinema halls, libraries and other cultural centres.

## 1.3 Agricultural Scenario

The Ganjam District is known for its fertile soil and agricultural productivity. A variety of crops such as paddy, groundnut, sugar cane, oil seeds, ragi, mung and biri are grown in the district. Around 75% of the total work force of Ganjam district is involved in the agricultural sector. Among the gross cropped area of 718.80 hectare in the district, the net sown area is 409.20 hectare and the rest is the fallow land.

Agriculture sector occupies an important place in Ganjam District as a major source of income and employment opportunity. However, the agriculture is depended on the Monsoon and dry-land farming technology is absent among farmers. Inputs like quality seeds, fertilizer and bio-fertiliser; and pesticides are not available in sufficient quantity and in time of need.

<sup>1</sup> [www.census2011.co.in](http://www.census2011.co.in)

## 1.4 Demography

Berhampur has witnessed widespread growth in its population over the years and the current population is estimated to be around 356,598 as per the census data 2011. Table - 2 shows the population growth of Berhampur for the last five (5) decades.

**Table 2: Population Trend of Berhampur**

Census Year	Population	Decadal population variation	
		Absolute	Percentage (%)
1971	117,662	--	--
1981	162,550	44,888	38.15
1991	210,418	47,868	29.45
2001	307,792	97,374	46.28
2011	356,598	48,806	15.86

*Source: Census of India and Berhampur Municipal Corporation*

From the above table it can be seen that Berhampur has witnessed mixed growth rate of population over the decades with a sharp fall in the growth rate for the decade 2001-11 though jurisdictional boundary of the town increased from 37.09 sq. km (2001 census) to 79.80 sq. km (2011 census). The population growth rate for Berhampur for 2001-11 decade is higher than the overall population growth rate of Orissa (13.97%) and Ganjam district (11.37%) however is lower than the urban population growth rate of Orissa (26.80%). The population density and growth in jurisdictional area of the town for the last five (5) decades is presented in Table - 3. The trend shows that the population density almost doubled and increased to 8,299 person/ sq. km. in the year 2001 as compared to the previous year's i.e. 1971, 1981 and 1991. However, with the increase in the jurisdictional boundary, the population density is now stabilised to previous levels.

**Table 3: Area and Population Density Trend of Berhampur**

Census Year	Area (sq. km)	Population	Population Density
1971	29.27	117,662	4020
1981	37.09	162,550	4383
1991	37.09	210,418	5673
2001	37.09	307,792	8299
2011	79.80	355,823	4459

Berhampur city has a significant slum population both authorized and unauthorized spreading all over the city and are thickly populated. The total slum population of the city at present is 117,541 which is around 33% of the total population. The total number of households as of 2011 is 66,812 in which 26,270 are slum households. Ward wise break-up of total population, slum population, and household as of 2011 is provided in Table - 4.

**Table 4: Ward Wise Demographic Profile of Berhampur (2011)**

Ward No	Total Population	Total Households	Slum Population	Slum Population (%)	Slum Households	Slum Households (%)
1	11,35	1,420	4,845	43	1,160	82
2	8,819	2,061	4,382	50	929	45
3	8,502	1,765	6,559	77	1,360	77
4	11,28	1,850	4,683	42	969	52
5	7,091	1,915	3,434	48	690	36
6	8,957	1,867	1,724	19	387	21
7	10,63	1,743	8,553	80	1,794	103
8	7,567	1,810	6,568	87	1,430	79
9	11,30	1,867	7,365	65	1,545	83
10	12,06	1,895	2,600	22	555	29
11	9,557	1,758	904	9	236	13
12	12,46	1,631	7,106	57	1,294	79
13	8,980	1,851	5,821	65	1,373	74
14	13,48	2,177	3,225	24	774	36
15	8,153	1,622	1,158	14	278	17
16	11,94	2,030	1,250	10	346	17
17	10,05	1,954	5,086	51	1,329	68
18	8,895	1,883	907	10	222	12
19	7,522	1,667	2,921	39	676	41
20	10,53	2,175	1,429	14	307	14
21	11,46	2,193	2,757	24	646	29
22	8,524	1,622	3,821	45	846	52
23	9,585	1,660	3,536	37	737	44
24	8,833	2,092	2,822	32	592	28
25	10,16	1,798	1,508	15	351	20
26	6,542	1,893	583	9	132	7
27	9,142	1,494	165	2	45	3
28	13,50	1,934	741	5	160	8
29	11,59	1,893	2,472	21	613	32
30	8,575	1,648	1,153	13	277	17
31	10,99	2,240	0	0	0	0
32	7,213	1,492	627	9	135	9
33	8,446	1,595	4,515	53	994	62
34	10,52	1,815	6,208	59	1,499	83
35	9,964	1,589	3,631	36	1,003	63
36	6,079	1,032	1,060	17	240	23
37	5,500	1,881	1,422	26	346	18
<b>Tot</b>	<b>355,8</b>	<b>66,812</b>	<b>117,5</b>	<b>33</b>	<b>26,270</b>	<b>39</b>

Source: City Sanitation Plan, 2011



## 1.5 Population Growth & Projection

There are several standard methods of population projection such as arithmetical increase method, geometrical increase method, incremental increase method and graphical method. All these different methods have different scope of applicability, depending upon the size and age of the city, current population of the city, population growth pattern for last few decades and future anticipated growth. Different methods give different accuracy level for population projection and it is difficult to use one single method as accurate. Therefore, to project the future population of Berhampur city average values obtained from projecting population by the above three methods has been used for this study which is provided in Table - 5.

**Table 5: Population Projection of Berhampur**

Year	Population Projection			Average	CAGR
	<i>Arithmetical Progression Method</i>	<i>Geometrical Procession Method</i>	<i>Incremental Increase Method</i>		
20	415,363	462,612	427,371	435,1	2.03 %
20	474,904	601,451	510,927	529,0	2.00 %
20	534,444	781,959	606,490	640,9	1.98 %

## 1.6 Site Details, Topography and Contours

Berhampur Municipal Corporation (BMC) is in possession of a 33.62 acre land at Mahuda which would be proposed for Municipal Waste Treatment and Disposal Facility. The site is located on the outskirts of Berhampur city in a north eastern direction. It is at a distance of 15 km from the central part of Berhampur city. It is beyond the purview of BMC municipal limits but is within the Berhampur Development Authority (BDA) area. The site is immediately adjacent to the all-weather metalled road leading to Mohuda and Lathi village from Berhampur (SH 22).

The topographical survey of the existing land parcel indicates that the site has steep gradient and the RL contour level at the site ranges from 56.3 to 84.8 m. It means that the level difference on the site from one point to other is 28.5 m, which increases gradually from the southern edge of the site to the northern end of the site.

## 1.7 Site Geology and Hydrogeology

Major part of the district is underlain by the hard crystalline rocks of the Archaen Age. Sediments of recent to sub-recent age occur along the coastal tracts discontinued patches. Minor laterite also occurs in the area as capping over the older formations i.e. Granite Gneiss and its Khondalitic variant. The landfill site at Mohuda is located at the foothills of granite hillocks and may have rock fractures system which provides pathways to pollutants and contaminants to ground water regime and also alluvial sediments that may have easy accessibility.

Information on geological status of the site and surrounding areas collected from the Officials of Public Health Engineering Department (PHED) indicates that the overall soil strata around the site is rocky with initial 15 – 20 m of soft soil followed by hard rock strata.

Information on hydrogeology, ground water resource and water levels has been collected from the CGWB report for Ganjam district<sup>21</sup>. Granite and granite gneisses are the most prevalent rock types in the district. The weathered residuum ranging in thickness from 5m to 25m and the fractured Jones constitute the principal repository of ground water in the hard rocks. Groundwater occurs under water table conditions in the weathered residuum and circulates through fractures and fissures below. Groundwater occurs under unconfined to semi-confined conditions and can be developed through shallow tube wells and open wells.

## **2 Municipal Solid Waste Collection & Transportation – Existing System**

The responsibility for primary waste collection lies with Berhampur Municipal Corporation. BMC's own manpower accomplishes the work in 18 wards. BMC has engaged private contractor under annual contract in 18 wards. In ward no. 31, a Non-Governmental Organization (NGO) by the name of Vedic collects the waste from households, however BMC is responsible for street sweeping in this ward. Waste segregation at source is not practiced in Berhampur.

All the privatized wards and ward no. 31 are covered by door-to-door (DTD) waste collection at household level, using tricycles having capacity to hold 6 bins of 10 liters each. The waste collected from the households is transferred to the designated secondary collection points of the respective wards.

In the remaining 18 wards managed by BMC there is no door-to-door waste collection system and the residents of these wards throw their waste at any convenient point on the road or open drains or in community bins provided by BMC, from where it is collected as part of the municipal street sweeping service. Depositing waste in open drains is also very common in Berhampur. Street sweepers are responsible for not only cleaning roads and footpaths of dirt and silt, but also for collecting waste deposited by businesses and residents.

BMC also collects bulk waste from commercial sources such as shops, markets, hotels, restaurants and other business and services from secondary collection points. Vegetable and fruit markets represent the single largest source of waste within the commercial sources. A list of the major markets, hotels and restaurants in Berhampur is attached as Appendix X.

There are 3 types of Secondary Collection Points (SCPs) in the city. These are – 1) 3 MT containers, 2) 9 MT containers and 3) open dumps. Berhampur has twenty 3 MT containers, sixteen 9 MT containers and 27 open dumping points. Depending upon the location and filling status, the containers are lifted daily or every alternate day or once in three days. Facilities are not available to promote direct loading of large bins on transportation vehicles

### **2.1 Existing System for other types of Solid Waste**

All major medical establishments (hospitals and nursing homes) have separate biomedical waste collection and segregation system. Each establishment has made a contract agreement with MKCG medical college to send their respective medical waste to MKCG medical college for incineration. The biomedical waste is presently being managed in accordance with the Biomedical Waste (Management & Handling) Rules and management of this waste is not under the scope of BMC as per the Municipal Solid Waste (Management & Handling) Rules. Biomedical Waste is not part of the Project scope. However ashes resulting from the incineration process may be collected by the Concessionaire as part of its collection obligations.

There is no major process industry generating hazardous industrial waste in the area. The main industries consist of small handloom establishments and stone crushing plants. Industrial waste has to be managed in accordance with Hazardous Waste (Management and Handling) Rules and therefore is

not under the scope of BMC as per the Municipal Solid Waste (Management & Handling) Rules. It is therefore outside the scope of this Project.

## **2.2 Informal Sector**

Segregation of waste into bio-degradable and inert fractions is not being practiced at the household level in any part of Behrampur. However some partial segregation of waste is presently happening through informal recycling.

Currently, most of the recyclables from the households finds its way into the recycling process by three modes. The Kabariwallas buy the most valuable of recyclables at the household level and resell it to the waste traders. Most of the waste traders in Behrampur are located in Aska Road, Corporation Road and Gate Bazar. The rest of the recyclables are disposed of by the household along with waste. Secondly, rag pickers and those working at the secondary collection points remove the recyclables from the waste and sell it to the waste traders. The wastes along with remaining recyclables are then sent to the dumping site at Chandania Pahad by BMC for disposal. Lastly, rag pickers also collect recyclables from the dumping site. They sell it to the waste traders.

About 100 to 150 rag pickers are estimated to be presently operating in the city.

### 3 WASTE QUANTITY & CHARACTERISTICS

The major sources of municipal solid waste generation in Berhampur are primarily:

- Residential
- Fruits & Vegetable markets; and
- Hotels & Restaurants

#### List of Major Markets, Hotel and Restaurants in Berhampur

Major Markets	List of Major Hotels	List of major restaurant
<ul style="list-style-type: none"> <li>• Komapalli market</li> <li>• Madrajvending zone</li> <li>• Bijupur sabzi mandi</li> <li>• Bijupur fruit market</li> <li>• Giri market sabzi mandi</li> <li>• P Market</li> <li>• Gate bazaar sabzi mandi</li> </ul>	<ul style="list-style-type: none"> <li>• Hotel city palace</li> <li>• Hotel Kamasin</li> <li>• Satyasai lodge</li> <li>• Moonlite lodge</li> <li>• Moti hotel</li> <li>• Radha hotel</li> <li>• Mandan hotel</li> <li>• Jyoti hotel</li> </ul>	<ul style="list-style-type: none"> <li>• Satyasai restaurant</li> <li>• Nanadan restaurant</li> <li>• Samrat restaurant</li> <li>• Nisha restaurant</li> <li>• Bhubeneswari restau</li> <li>• Marrydine</li> <li>• Paradise</li> <li>• Shop at lake view</li> <li>• Shop at Girija Chowk</li> </ul>

#### 3.1 Quantification Methodology

Primary waste quantification survey has been carried out at all the major sources of generation. For this purpose, survey was conducted for three (3) consecutive days at selected residential wards representing High Income Group (HIG), Middle Income Group (MIG) and Low Income Group (LIG) i.e. slum population of the city, at bulk waste generating sources such as all major fruit & vegetable markets and at major commercial establishments such as hotel and restaurants/ eateries.

From the household level survey, respective waste generation factors (gm/capita/day) for different residents groups based on their economic profile such as HIG, MIG and LIG (slum) have been assessed based on weighted average and are used in this report to calculate the total residential waste generation in the city. To assess the overall municipal waste generation of Berhampur city, quantity of wastes generated from all major bulk generating sources and commercial establishments is added up with the residential waste generation to obtain the total MSW generation in the city for the year 2012.

Apart from this, the waste quantification has also been carried out by load count method at the Chandania Pahad disposal site. During this survey, the loaded and unloaded weight of all vehicles coming to the landfill for waste disposal was recorded for three consecutive days. By this exercise, the collection efficiency of the waste management system has been assessed. The details of the survey and its outcome are described below.

##### 3.1.1 Waste Quantification – Residential Waste

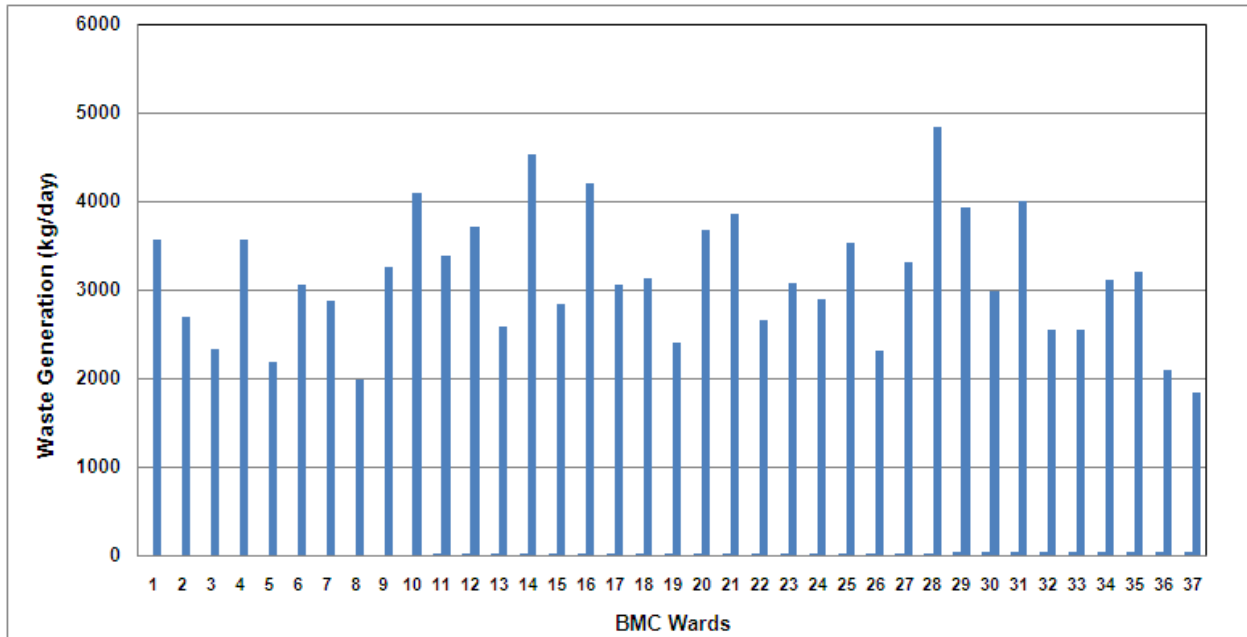
Primary waste quantification survey at household level was carried out in HIG area near Gazapati Nagar (WN 31), MIG area near Nilkantha Nagar Brit colony (WN 10) and in two slum areas at Dharmera Street

(WN 12) and Hareda Kandi (WN 1). At each ward representative numbers of household was surveyed for primary quantification and the waste generation factor was calculated. From primary survey, the waste generation factor based on weighted average for HIG, MIG and slum population has been assessed as 415, 316 and 247 gm/capita/day respectively. However, since information for HIG and MIG population is not available and is difficult to predict as there is no veritable research and report available for Berhampur, for estimating waste quantity generated by non-slum population, weighted average of per capita waste generation of HIG and MIG households i.e. 364 gm/capita/day has been used for this purpose. Based upon the waste generation factor and the population of year 2011 the overall waste quantification in all wards has been carried out and presented below:

**Figure 2: Household Waste Quantification for Berhampur**

Ward No.	Population (2011) <sup>4</sup>		Waste Quantity Estimated (kg/day)		
	Slum population	Non-slum population	Slum area	Non-slum area	Total
1	4845	6508	1197	2369	3566
2	4382	4437	1082	1615	2697
3	6559	1943	1620	707	2327
4	4683	6598	1157	2402	3559
5	3434	3657	848	1331	2179
6	1724	7233	426	2633	3059
7	8553	2083	2113	758	2871
8	6568	999	1622	364	1986
9	7365	3944	1819	1436	3255
10	2600	9460	642	3443	4085
11	904	8653	223	3150	3373
12	7106	5361	1755	1951	3706
13	5821	3159	1438	1150	2588
14	3225	10255	797	3733	4530
15	1158	6995	286	2546	2832
16	1250	10695	309	3893	4202
17	5086	4965	1256	1807	3063
18	907	7988	224	2908	3132
19	2921	4601	721	1675	2396
20	1429	9109	353	3316	3669
21	2757	8704	681	3168	3849
22	3821	4703	944	1712	2656
23	3536	6049	873	2202	3075
24	2822	6011	697	2188	2885
25	1508	8659	372	3152	3524
26	583	5959	144	2169	2313
27	165	8977	41	3268	3309
28	741	12768	183	4648	4831
29	2472	9126	611	3322	3933
30	1153	7422	285	2702	2987
31	0	10995	0	4002	4002
32	627	6586	155	2397	2552
33	4515	3931	1115	1431	2546
34	6208	4319	1533	1572	3105
35	3631	6333	897	2305	3202
36	1060	5019	262	1827	2089
37	1422	4078	351	1484	1835
<b>Total</b>	117541	238282	<b>29 TPD</b>	<b>87 TPD</b>	<b>116 TPD</b>

Figure 3 Comparative Waste Generation in each Ward in Berhampur

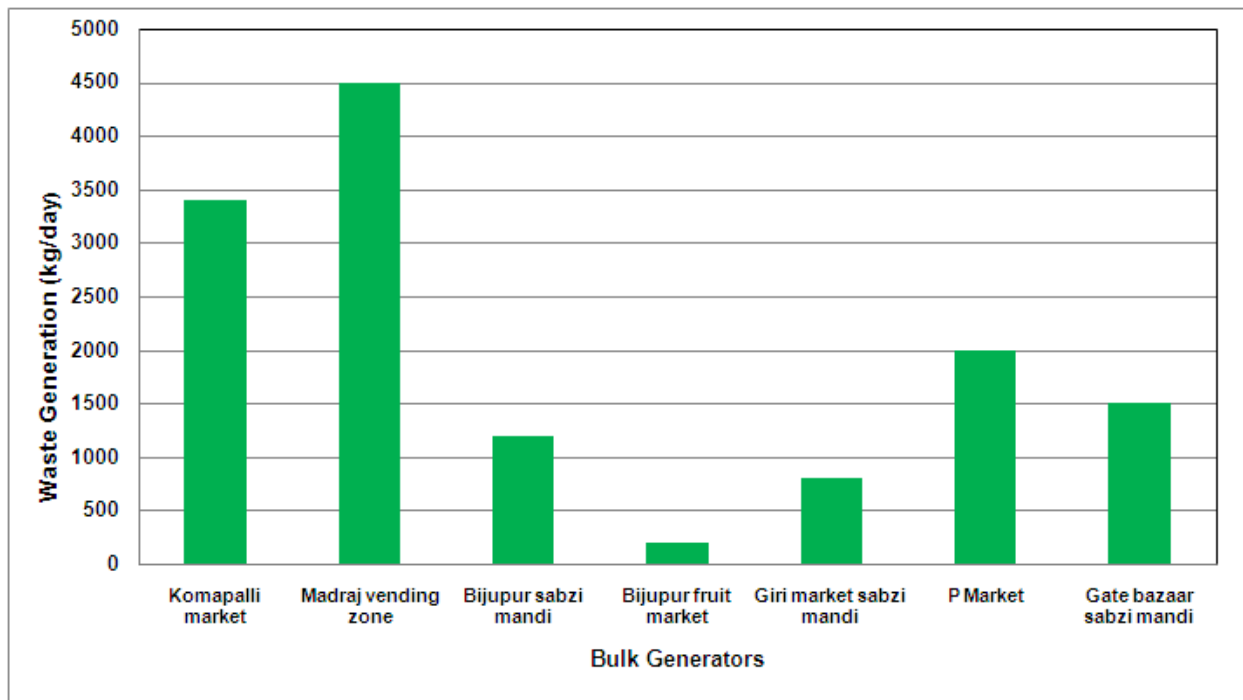


### 3.1.2 Waste Quantification - Bulk Waste Generating Sources

Primary waste quantification was carried out at all the bulk generation sources in Berhampur city such as vegetable markets, fruit markets, and vending zones. The survey was done through the visual observation and assessment on the percentage filled of the containers (SCPs) placed in those markets for consecutive three (3) days. In addition to the observation, consultation and discussion was also carried out with the market people to understand the lifting schedule and their assessment of the waste generation quantity from that specific market. The outcome of the survey is presented.

Figure 4 Waste Quantification from Bulk Generators

SN	Market Name	Ward	SCP	Waste lifting schedule	Waste Quantity (kg/day)
1	Komapalli market	28	9 MT & 3 MT	Alternate day (9 MT) Once in a week (3 MT)	3400
2	Madraj vending zone	28	9 MT	Alternate day	4500
3	Bijupur sabzi mandi	21	Open dump	Daily	1200
4	Bijupur fruit market	21	Open dump	Daily	200
5	Giri market sabzi mandi	13	3 MT	Daily	800
6	P Market	5	Open dump	Daily	2000
7	Gate bazaar sabzi mandi	20	Open dump	Daily	1500
<b>Total (approx. in tons per day)</b>					<b>14 TPD</b>



### 3.1.3 Waste Quantification - Commercial Establishments

To estimate the waste quantity generated from large commercial establishments, different hotels, restaurants, eateries in the city were surveyed. Discussions were carried out with the concerned person to understand the size of the establishments (such as number of beds for hotels and number of seats for restaurants), waste generation per day and also the waste collection & disposal systems. Tables below provide the waste quantification results of such commercial establishments:

SN	Hotel Name	Waste Quantity (kg/ day)
1	Hotel city palace	10
2	Hotel Kamasin	20
3	Satyasai lodge	30
4	Moonlite lodge	25
5	Moti hotel	5
6	Radha hotel	50
7	Mandan hotel	80
8	Jyoti hotel	100
<b>Total</b>		<b>320 kg</b>



SN	Restaurant name	Category or size	Waste Quantity as per survey (kg/ day)	Waste generation factor (kg/ estb./day)	No. of similar establishment as per BMC	Total waste (kg/day)
1	Satyasai restaurant	<b>Big &amp; medium size</b>	60	45	110	4950
2	Nanadan restaurant		50			
3	Samrat restaurant		30			
4	Nisha restaurant		30			
5	Bhubeneswari restau		50			
6	Marrydine	<b>Small tiffin restaurants</b>	15	15	166	2490
7	Paradise		15			
8	Shop at lake view road		20			
9	Shop at Girija Chowk		10			
<b>Total (approx tons per day)</b>						<b>7.5 TPD</b>

### 3.1.4 Waste Quantification at Disposal Site

Waste Quantification at (Chandania Pahad) was carried out for three (3) consecutive days to estimate the quantity of waste reaching the disposal site and also to estimate the waste collection efficiency of the SWM system in the Berhampur city based on "Load Count Method". The results of the waste quantification at disposal site are provided in the table below:

SN	In Entry	Vehicle No.	KG-Gross	Tare	Net	Vehicle Type	Time Exit
<b>Day 1</b>							
1	9:08	OR07E 3508	4125	3705	420	TATA-407	9:20
2	9:11	OR07T 1296	14860	9415	5445	Truck	9:25
3	9:12	OR07J 2843	4475	2695	1780	Tractor	9:24
4	9:13	OR07Q 7973	4605	3715	890	Tractor	9:28
5	9:14	OR07F 0772	5700	3560	2140	TATA-709	9:23
6	9:16	OR07T 1298	14345	9470	4875	Truck	9:35
7	9:17	OR07V 8669	4755	3155	1600	Tractor	9:29
8	9:22	OR07J 2839	4665	2765	1900	Tractor	9:35
9	9:26	OR07Q 7982	4460	3695	765	Tractor	9:43
10	9:28	OR07J 1895	3955	2585	1370	Tractor	9:37
11	9:33	OR07E 3506	4090	2645	1445	TATA-407	9:47
12	9:49	OR07J 1901	3730	2685	1045	Tractor	9:57
13	9:51	OR07D 7452	4395	2830	1565	Tractor	10:08
14	9:52	OR07D 1169	5585	2845	2740	Tractor	10:07
15	9:56	OR07Q 7983	5360	3695	1665	Tractor 3MT	10:26
16	10:01	OR07D 1167	3650	2595	1055	Tractor	10:21
17	10:09	OR07T 1297	15120	9590	5530	TATA 1613	10:25
18	10:12	OR07Q 7976	5145	3620	1525	Tractor 3MT	10:36
19	10:14	OR07V 8663	4470	3075	1395	Tractor	10:23
20	10:28	OR07T 1296	13330	9380	3950	TATA 1613	10:43
21			5190	3660	1530	Tractor 3MT	10:55
22	10:39	OR07J 1893	4470	2645	1825	Tractor	10:55
23	10:41	OR07E 3508	5230	3740	1490	Tractor 3MT	11:02
24	10:44	OR07V 8669	4665	3150	1515	Tractor	10:59
25	10:48	OR07J 2849	4335	2660	1675	Tractor	11:02
26	10:53	OR07F 0772	5520	3555	1965	TATA-407	11:05
27	10:58	OR07 0285	5230	2545	2685	Tractor	11:23

SN	In Entry	Vehicle No.	KG-Gross	Tare	Net	Vehicle Type	Time Exit
28	11:00	OR07D 7445	4105	2770	1335	Tractor	11:16
29	11:01	OR07T 1298	12935	9400	3535	TATA 1613	11:18
30	11:03	OR07J 1895	3840	2590	1250	Tractor	11:15
31	11:09	OR07E 7836	12760	8650	4110	TATA 1613	11:26
32	11:11	OR07J 2843	4485	2690	1795	Tractor	11:21
33	11:12	OR07Q 7973	4330	3665	665	Tractor 3MT	11:27
34	11:13	OR07D 1169	3525	2845	680	Tractor	11:29
35	11:14	OR07D 7452	3085	2760	325	Tractor	11:25
36	11:17	OR07J 1901	3815	2605	1210	Tractor	11:28
37	11:25	OR07V 8666	5310	3140	2170	Tractor	11:37
38	11:36	OR07Q 7983	4480	3670	810	Tractor 3MT	11:47
39	11:57	OR07V 8663	4165	3125	1040	Tractor	12:09
40	12:46	OR07Q 7984	5260	3570	1690	Tractor 3MT	13:18
41	15:43	OR07E 3508	4675	3685	990	TATA-407	16:02
42	15:46	OR07E 3506	4045	2715	1330	TATA-407	16:03
43	15:56	OR07V 8666	4950	3130	1820	Tractor	16:10
44	15:58	OR07Q 7973	4460	3695	765	Tractor 3MT	16:15
45	16:07	OR07F 0772	5935	3550	2385	TATA-709	16:16
46	16:11	OR07Q 7982	4155	3570	585	Tractor 3MT	16:27
47	16:22	OR07Q 7976	5025	3660	1365	Tractor 3MT	16:39
48	16:23	OR07Q 7984	4890	3660	1230	Tractor 3MT	16:44
49	17:21	OR07V 8669	4345	3215	1130	Tractor	17:32
<b>Total- Day 1</b>					<b>88 TPD</b>		

<b>Day 2</b>							
1	8:23	OR07E 3508	4490	3745	745	TATA-407	8:34
2	8:35	OR07J 2843	4145	2700	1445	Tractor	8:45
3	8:39	OR07T 1297	13995	9640	4355	TATA 1613	8:51
4	8:43	OR07T 1296	15160	9470	5690	TATA 1613	8:56
5	8:44	OR07Q 7973	4290	3580	710	Tractor 3MT	8:59
6	8:52	OR07V 8669	4405	3150	1255	Tractor	9:04
7	9:05	OR07Q 7984	4300	3660	640	Tractor 3MT	9:20
8	9:10	OR07D 1169	4685	2905	1780	Tractor	9:24
9	9:15	OR07F 0772	5190	3645	1545	TATA-709	9:25
10	9:16	OR07Q 7976	4910	3665	1245	Tractor 3MT	9:32
11	9:18	OR07Q 7983	4270	3695	575	Tractor 3MT	9:30
12	9:19	OR07D 7445	3855	2785	1070	Tractor	9:29
13	9:20	OR07J 1901	3570	2600	970	Tractor	9:30
14	9:22	OR07T 1298	13610	9480	4130	TATA 1613	9:36
15	9:27	OR07J 1893	4065	2660	1405	Tractor	9:34
16	9:31	OR07D 7452	3810	2495	1315	Tractor	9:46
17	9:33	OR07J 1895	3555	2580	975	Tractor	9:41
18	9:45	OR07T 1297	14820	9605	5215	TATA 1613	10:09
19	9:49	OR07Q 7982	4570	3695	875	Tractor 3MT	10:12
20	9:51	OR07E 3506	3620	2770	850	TATA-407	10:04
21	10:01	OR07V 8666	4470	3140	1330	Tractor	10:19
22	10:02	OR07V 8663	4240	3190	1050	Tractor	10:11
23	10:06	OR07E 7836	12060	8645	3415	TATA 1613	10:22
24	10:08	OR07E 3508	4825	3705	1120	TATA-407	10:19
25	10:13	OR07Q 7973	5155	3675	1480	Tractor 3MT	10:30
26	10:14	OR07Q 7983	4945	3675	1270	Tractor 3MT	10:27

SN	In Entry	Vehicle No.	KG-Gross	Tare	Net	Vehicle Type	Time Exit
27	10:33	OR07D 1169	3630	2845	785	Tractor	10:50
28	10:34	OR07T 1298	13490	9450	4040	TATA 1613	10:53
29	10:35	OR07F 0772	5155	3630	1525	TATA-709	10:41
30	10:36	OR07T 1296	14360	9450	4910	TATA 1613	10:51
31	10:37	OR07J 2843	4505	2680	1825	Tractor	10:48
32	10:48	OR07J 1901	3615	2650	965	Tractor	11:02
33	10:52	OR07J 2849	4110	2660	1450	Tractor	11:05
34	11:59	OR07 0285	4470	2525	1945	Tractor	11:24
35	11:01	OR07D 7452	4265	2810	1455	Tractor	11:18
36	11:04	OR07Q 7983	4325	3690	635	Tractor	11:20
37	11:08	OR07Q 7984	4610	3670	940	Tractor 3MT	11:31
38	11:12	OR07J 1893	3140	2660	480	Tractor	11:22
39	11:16	OR07J 1895	3620	2590	1030	Tractor	11:28
40	11:17	OR07Q 7976	4470	3605	865	Tractor 3MT	11:44
41	11:19	OR07V 8669	4820	3150	1670	Tractor	11:31
42	11:23	OR07D 7445	3430	2760	670	Tractor	11:34
43	11:35	OR07V 8663	3825	3130	695	Tractor	11:47
44	11:52	OR07Q 7982	3970	3670	300	Tractor 3MT	12:11
45	15:32	OR07E 3508	4290	3695	595	TATA-407	15:47
46	15:46	OR07Q 7982	3870	3585	285	Tractor 3MT	16:03
47	15:57	OR07F 0772	5750	3630	2120	TATA-709	16:09
48	16:04	OR07Q 8666	3950	3125	825	Tractor	16:17
49	16:18	OR07Q 7984	4475	3660	815	Tractor 3MT	16:31
50	16:57	OR07Q 7976	4210	3690	520	Tractor 3MT	17:13
<b>Total- Day 2</b>					<b>78 TPD</b>		

<b>Day 3</b>							
1	8:33	OR07Q 7983	4365	3690	675	Tractor 3MT	8:46
2	8:34	OR07J 2843	4350	2700	1650	Tractor	8:45
3	8:36	OR07E 3508	4495		2035	TATA-407	8:49
4	8:56	OR07D 7973	4190	3665	525	Tractor 3MT	9:13
5	8:58	OR07F 0772	5320	3630	1690	TATA-709	9:05
6	9:01	OR07T 1297	13410	9585	3825	TATA 1613	9:18
7	9:03	OR07Q 7976	4855	3670	1185	Tractor 3MT	9:23
8	9:06	OR07Q 7984	4025	3670	355	Tractor 3MT	9:24
9	9:08	OR07Q 7982	4300	3660	640	Tractor 3MT	9:29
10	9:09	OR07T 1296	14730	9445	5285	TATA 1613	9:28
11	9:10	OR07V 8669	4145	3160	985	Tractor	9:20
12	9:16	OR07T 1298	13100	9415	3685	TATA 1613	9:36
13	9:27	OR07Q 7983	4495	3665	830	Tractor 3MT	9:40
14	9:35	OR07Q 1893	3620	2660	960	Tractor	9:43
15	9:42	OR07D 7445	3560	2765	795	Tractor	9:50
16	9:47	OR07J 2839	3040	2810	230	Tractor	10:00
17	9:48	OR07J 1901	3400	2670	730	Tractor	10:00
18	9:49	OR07V 8663	3970	3130	840	Tractor	10:01
19	9:55	OR07E 3506	4175	2720	1455	TATA-407	10:10
20	10:02	OR07D 1169	4580	2850	1730	Tractor	10:19
21	10:07	OR07J 1895	3810	2620	1190	Tractor	10:16
22	10:11	OR07E 7836	11240	8700	2540	TATA 1613	10:34
23	10:13	OR07D 1167	4070	2745	1325	Tractor	10:56
24	10:15	OR07Q 7973	4070	3575	495	Tractor 3MT	10:31

SN	In Entry	Vehicle No.	KG-Gross	Tare	Net	Vehicle Type	Time Exit
25	10:22	OR07J 2843	4030	2630	1400	Tractor	10:38
26	10:23	OR07Q 7983	4520	3690	830	Tractor 3MT	10:32
27	10:24	OR07E 3508	4735	3840	895	TATA-407	10:37
28	10:27	OR07 0285	3375	2575	800	Tractor	10:45
29	10:30	OR07V 8669	4325	3145	1180	Tractor	10:45
30	10:32	OR07F 0772	5230	3625	1605	TATA-709	10:42
31	10:34	OR07J 2849	3905	2680	1225	Tractor	10:52
32	10:36	OR07T 1296	14590	9525	5065	TATA 1613	10:54
33	10:39	OR07T 1298	13950	9436	4514	TATA 1613	11:11
34	10:53	OR07J 1893	4220	2655	1565	Tractor	11:00
35	10:57	OR07Q 7976	4165	3685	480	Tractor 3MT	11:00
36	11:12	OR07J 1901	3640	2650	990	Tractor	11:21
37	11:13	OR07Q 7984	4530	3660	870	Tractor 3MT	11:29
38	11:14	OR07D 1169	3575	2850	725	Tractor	11:27
39	11:27	OR07J 1895	3190	2590	600	Tractor	11:35
40	11:36	OR07V 8663	3960	3130	830	Tractor	11:45
41	11:40	OR07Q 7982	4790	3690	1100	Tractor 3MT	11:59
42	11:44	OR07D 7445	3655	2800	855	Tractor	11:51
43	15:34	OR07Q 7973	4475	3700	775	Tractor 3MT	15:45
44	15:45	OR07F 0772	4240	3545	695	TATA-709	16:00
45	15:51	OR07E 3506	3395	2720	675	TATA-407	16:02
46	16:18	OR07Q 7982	4000	3680	320	Tractor 3MT	16:34
47	16:56	OR07D 1167	3105	2850	255	Tractor	17:06
48	16:57	OR07J 1901	3180	2640	540	Tractor	17:19
49	17:03	OR07Q 7976	4660	3610	1050	Tractor 3MT	17:31
50	17:00	OR07V 8669	4205	3225	980	Tractor	17:26
51	17:32	OR07J 1895	3880	2590	1290	Tractor	17:39
<b>Total - Day 3</b>					<b>68 TPD</b>		
<i>Average quantity of waste reaching disposal site</i>					<b>78 TPD</b>		

### 3.1.5 Summary of Waste Quantification at Berhampur

The approach used in establishing waste quantities is based on field survey and primary sampling by the technical consultants of the major waste generating sources in Berhampur supplemented with a comprehensive review of waste management practice in BMC. Waste sampling study at the waste disposal site was also conducted during field investigation. The per capital waste generation rate for Berhampur considering all the waste generation sources and year 2011 census population is 390 grams per person per day. The summary of primary waste quantification results is given below:

**Figure 5 Summary of Primary Waste Quantification**

S No.	Item	Quantity
<b>A</b>	<b>Primary Waste Quantification Results</b>	
1	Waste quantity estimated at residential household	116
2	Waste quantity estimated at bulk generators	14
3	Waste Quantity estimated from commercial establishments	
a	Hotels	0.32
b	Restaurants / Tiffin Corners	7.5
	<b>Total Waste Generation</b>	<b>138</b>
<b>B</b>	Average Waste quantity Reaching disposal site	78

C	Collection efficiency of SWM in the city	57%
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### 3.2 Waste Composition and Characterization of Berhampur

Figure 6 Summary of Physical Composition of the MSW of Berhampur City

Sampling Locations	Physical Composition (%)					
	Food / Organic Waste	Wood & wood product	Paper & Cardboard	Textile	Park & Garden Waste	Glass, Plastic and other inert
Residential Household	75.20	3.81	6.16	0.69	1.66	12.47
Secondary Collection Points	45.64	9.01	7.40	2.43	10.51	25.12
Vegetable and Fruit Markets	80.82	3.43	2.23	0.24	3.15	10.12
Landfill	24.76	15.66	2.53	3.70	6.83	46.52
<b>Overall Av.</b>	<b>56.61</b>	<b>7.98</b>	<b>4.58</b>	<b>1.77</b>	<b>5.54</b>	<b>23.56</b>

Figure 7 Summary of Chemical Characterization of the MSW of Berhampur City

Sampling Locations	Physical Composition (%)				
	Moisture Content (%)	Bulk Density (T/m <sup>3</sup> )	Organic Matter (%)	C/N Ratio	Net Calorific Value (kCal/Kg)
Residential Household	75.59	0.23	54.59	34.56	2264
Secondary Collection Points	39.17	0.17	34.85	36.50	1189
Vegetable and Fruit Markets	57.58	0.21	30.73	29.89	1231
Landfill	35	0.20	28	42	1031
<b>Overall Av.</b>	<b>52</b>	<b>0.20</b>	<b>36.96</b>	<b>35.70</b>	<b>1429</b>

### 3.3 Projection of Future Waste Generation at Berhmapur

Future waste generation is calculated for the project area based on expected population growth and applying the per-capita waste generation rate of 390 grams/person/day. The assumptions considered for projecting waste generation are:

- Population projection based on historical trend and average values obtained by projecting population using arithmetical increase method, geometrical increase method and incremental increase method; and
- Per capita waste generation rate is assumed to increase by about 1.3%7 per annum to account for economic growth in the project area.

**Figure 8 Future Waste Project of Berhampur**

SN	Year	Population	Waste Quantity (TPD)
1	2011	355,823	138
2	2012	363,167	142
3	2013	370,634	146
4	2014	378,228	151
5	2015	385,950	156
6	2016	393,803	162
7	2017	401,789	167
8	2018	409,911	173
9	2019	418,171	179
10	2020	426,571	184
11	2021	435,116	191
12	2022	443,806	197
13	2023	452,646	203
14	2024	461,637	210
15	2025	470,784	217
16	2026	480,088	224
17	2027	489,554	232
18	2028	499,184	239
19	2029	508,982	247
20	2030	518,951	255
21	2031	529,094	264
22	2032	539,415	272
23	2033	549,919	281
24	2034	560,608	290
25	2035	571,486	300
26	2036	582,558	310
27	2037	593,827	320

#### 4 Envisaged Solid Waste Management Components for the Project:

##### 1. Secondary Transfer Stations with Static Compactors:

Secondary Transfer Stations are envisaged at 5 optimum locations in Berhampur city so as to cover the entire geographical area of the city. Each site is under the possession of Berhampur Municipal Corporation and has a minimum of 100sqm area (9m x 9m).

A minimum of 2 no. Static / Portable Compactors are proposed at each site such that if one Compactor is being transported to the Treatment and Disposal site, the other Compactor is operational. The leachate generated by the compaction of the waste is proposed to be collected in an underground tank.

A minimum of 4 Hookloaders are envisaged to transport the filled Portable Compactors to the Treatment and Disposal site.

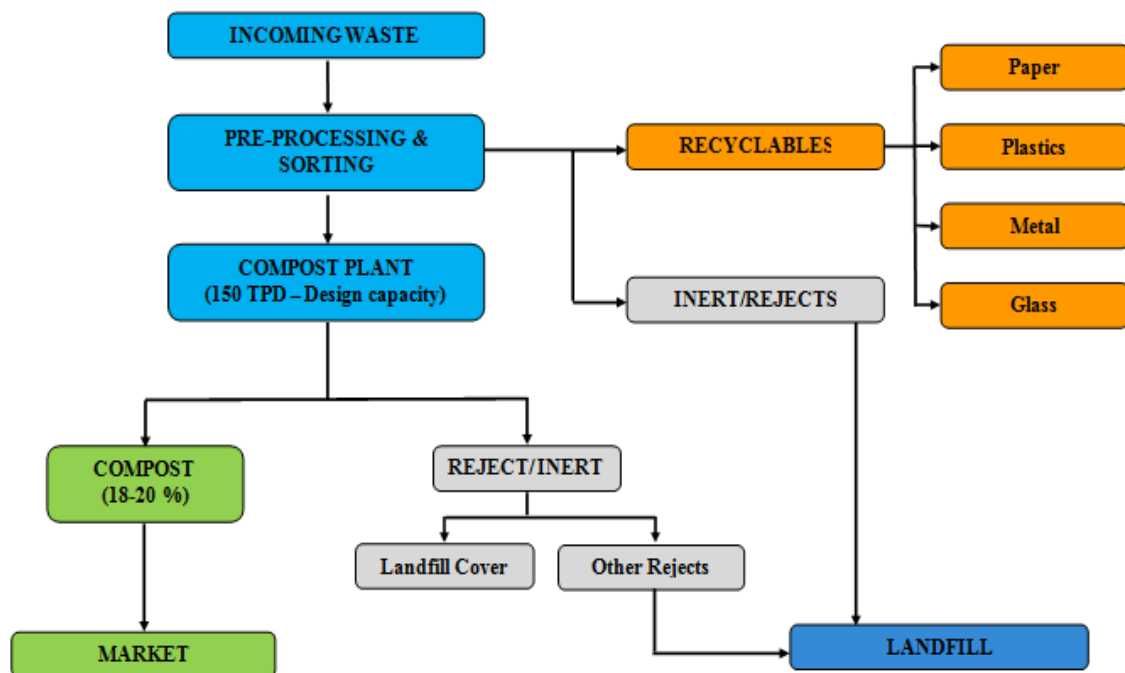
A vacuum truck is also envisaged to transport the leachate collected in the underground tank.

##### 2. Treatment and Disposal Facility:

The major components proposed are:

- Pre-sorting facility for segregation of waste and recovery of recyclables;
- Windrow composting system for processing of organic waste; and
- Sanitary landfill for disposal of rejects and inert material.

Figure 9: Proposed Municipal Solid Waste Treatment and Disposal



SWM Rules 2016 prescribe that land filling should be restricted to non-biodegradable, inert waste and other waste that are not suitable for recycling or for biological processing including residues and pre-processing rejects of waste processing facilities. SWM Rules 2016 also prescribe that land filling of mixed waste should be avoided unless the same is found unsuitable for waste processing. The physical composition of the MSW at Berhampur indicates that approximately 70% of the total MSW generated is bio-degradable. This necessitates the development of treatment facility along with the disposal facility.

Total land available for development of facility is 33.62 acres (approximately 13.6 ha). The land currently available for disposal of waste is sufficient to accommodate the processing and landfill facility for 25 years. However, for the current design, the life of the facility has been considered as 20 years. The total area requirement for development of composting and pre-sorting facility is 1.95 ha. The total area for development of landfill for 20 years is 7.59 Ha.

The land area requirement for facility component including treatment and disposal facility is summarized in Table below.

**Figure 10 Area required for Treatment and Disposal Facility**

SN	Parameter	Units	Area
<b>I</b>	<b>Total available area</b>	m <sup>2</sup>	<b>136,000</b>
<b>A</b>	<b>Compost &amp; Pre-Sorting Area Requirement</b>		
1	Tipping area / receiving of MSW	m <sup>2</sup>	600
2	Pre-sorting facility	m <sup>2</sup>	300
3	Compost pad	m <sup>2</sup>	7500
4	Monsoon Shed	m <sup>2</sup>	3010
5	Curing shed	m <sup>2</sup>	400
6	Refinement section	m <sup>2</sup>	300
7	Finishing section	m <sup>2</sup>	300
8	Storage/ Godown (90 days )	m <sup>2</sup>	400
9	Recyclable storage	m <sup>2</sup>	300
	<b>Total Compost &amp; pre-sorting area (including circulation area )</b>		<b>19,500</b>
<b>B</b>	<b>Landfill</b>		
1	Cell 1	m <sup>2</sup>	21080
2	Cell 2	m <sup>2</sup>	21318
3	Cell 3	m <sup>2</sup>	22334
	<b>Total landfill (20 years)</b>	<b>m<sup>2</sup></b>	<b>64732</b>
<b>C</b>	<b>Common infrastructure for Facility</b>		
1	Roads (3.5 meter width and 7 meter width)	m <sup>2</sup>	6900
2	Green belt (5 meters width)	m <sup>2</sup>	11040
3	Leachate collection pond	m <sup>2</sup>	600



4	Admin Building	m <sup>2</sup>	200
5	Guard Room	m <sup>2</sup>	15
6	Landfill Vehicle parking	m <sup>2</sup>	1000
7	Staff vehicle parking	m <sup>2</sup>	100
8	Panel Room	m <sup>2</sup>	20
	<b>Total common Infrastructure</b>	m <sup>2</sup>	19875
9	Weighbridge with cabin	m <sup>2</sup>	85

Figure 11 Process Flow Diagram of Compost Plant

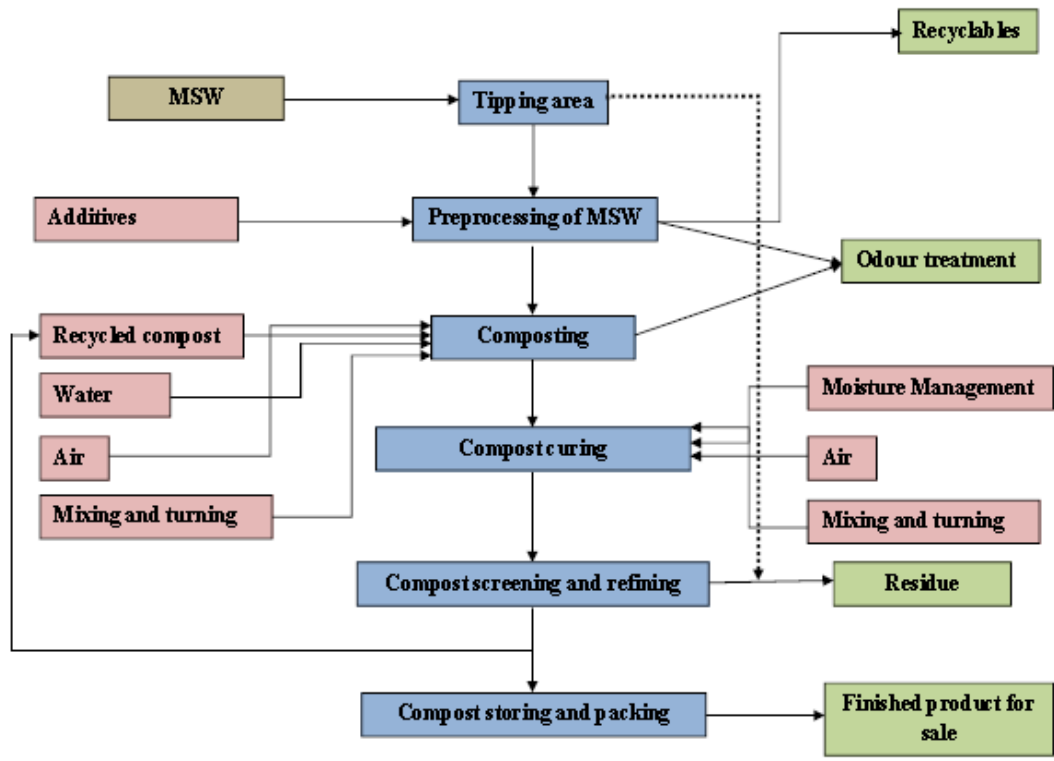


Figure 12 Tentative Mass Balance for the Compost Plant

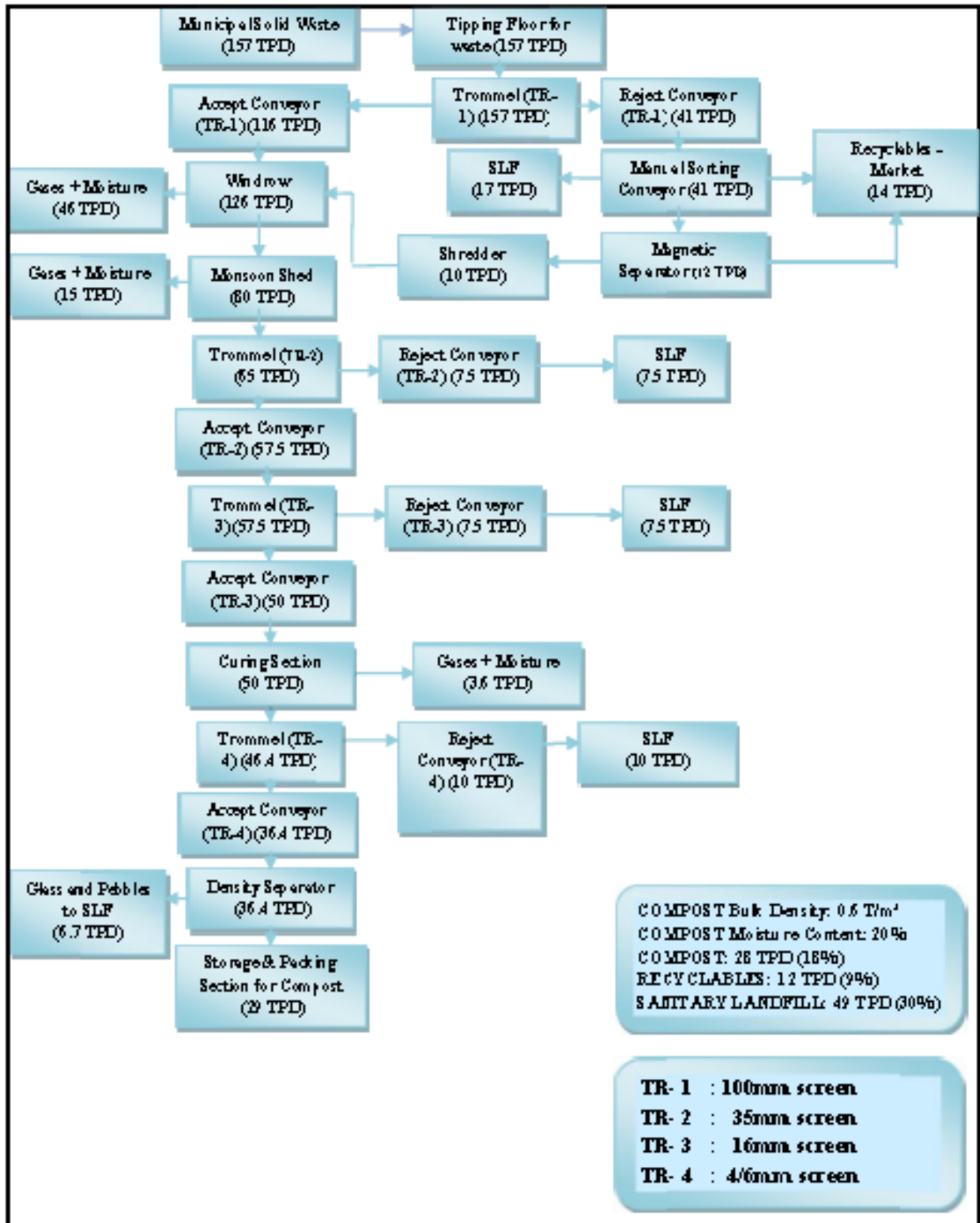
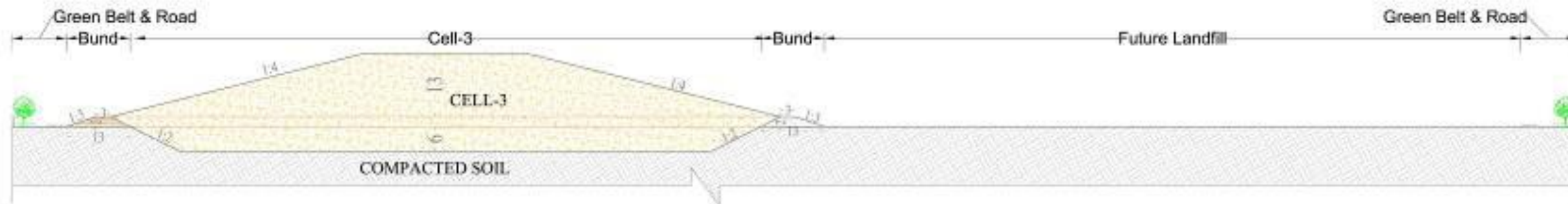


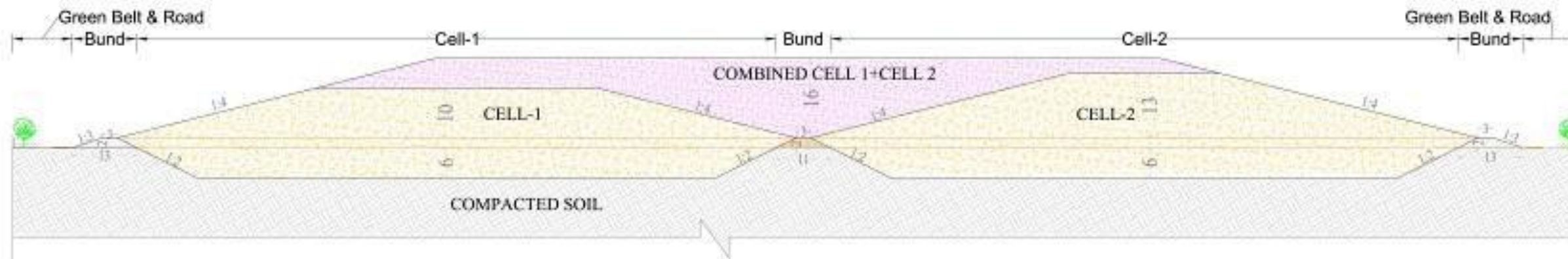
Figure 13 Tentative Layout Plan for Treatment and Disposal Facility



Figure 14 Tentative Sections for Scientific Landfill



SECTION A-A'



SECTION B-B'