2018

Site Assessment Study Covering Soil Investigation, Topographic Study Covering Geographical and Environmental Features of Njalianparambu in Calicut District Kerala"

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EXECUTIVE SUMMARY

Introduction

The rapid urbanization, constant change in consumption pattern and social behaviour have increased the generation of municipal solid waste (MSW) in Kerala beyond the management capacity of the existing waste management systems. Therefore, there is an urgent necessity of improved planning and implementation of comprehensive MSW management systems for upgrading the environmental scenario of the State. KSIDC intends to develop MSW processing plants across the state under public private partnership (PPP) format with the assistance of Transaction Advisor. In this regard KSIDC has appointed IRGSSA to Worked on "Site assessment study covering soil Investigation, topographic study covering geographical and environmental features of Njalianparambu in Calicut district Kerala"on its behalf. The broad objectives of the Study are to determine a technically and economically viable solid waste management project for a phased implementation to meet the requirements of the year 2043. The specific objectives include : To analyze the existing solid waste management system in the study area; To carry out Environment Due diligence for the processing site and To Examine the Physical chemical and Environmental parameters of the processing site.

The major scope of work include : To Examine the (Physical and chemical) properties of Feedstock/MSW in the catchment area; To examine the Climate data of the catchment area; Existing and projected waste generation for 25 years; Examine the capacity of 12.67 Acres of land for WtE project including landfill requirement; To Examine Existing site conditions (Owership of land, exact total area requirement, nearest substation for power evacuation, sources of water available nearby i.e. surface water & ground water, topographic and soil conditions); and Compliance with SWM Rules 2016 for site conditions and its subsequent amendments. A very comprehensive approach & methodology has been adopted to carry out the six items mentioned in scope of work. Major approach includes: Step 1: Desk review; Step 2: Field visit; Step 3: Sample audit & testing and Step 4: Interaction with plant officials.

Site Conditions

The Proposed site is located on the coastal plain in the Chaliyas river basin of the Khozikode district. The site falls under the jurisdiction of Kozhikode Municipal Corporation (KMC) and is currently being used for composting with IL&FS as an operator. Average Elevation of site is 11 m (Lowest 7.0 m, Highest 16.) Contour map (topographic) of the site based on Aster DEM (Digital Elevation model)is shown in Figure 2.5. Contour map shows undulating formations which on ground truthing indicated municipal waste dumps.

Geologically, pebble beds occur on the coast and along banks of the Beypore river. The pebble bed is associated with grit and clay and it is lateritised. It comprises well rounded pebbles of quartz, granite, quartzite and granulite. It is considered to be of Pleistocene origin. Sporadic laterite is recorded from the charnockite country to the southwest. Quaternary deposits are of marine and fluvial origin. The Proposed site has Alluvial soil.

Groundwater fluctuations have been reported in pre and post monsoon season. The Seasonal fluctuation (8 m to 10 m) of the water table is due to variation in the rainfall, evapotranspiration, withdrawals for irrigation and other purposes, base flow, seepage from surface water bodies etc. CGWB data indicates that Net Annual Ground Water (GW) Availability in the Corporation area is almost 37.70 MCM with 5.03 MCM as existing gross GW Draft for irrigation 26.09 as existing GW draft for domestic & Industrial water supply. Overall the block is safe for gound water usages.

Climate

Kozhikode district experienced annual rainfall of 3698 mm in the year 2006 to 3973 in 2011. The minimum temperature ranges between 22 and 25.8° C and the maximum between 28.2 and 32.9° C. The temperature reaches its peak in the month of April and attains minimum in January. The wind speed ranges from 8.1 to 12.6 km/h. The annual Potential Evapo-transpiration (PET) is 1505.7 mm.

Current SWM Management

The Urban local body (ULB) in Kozhikode is responsible for collection, transportation and disposal of Solid Waste except untreated bio-medical waste and hazardous industrial waste. Storage and segregation of waste at source is not very prominent KMC. About 281.99 MT of Municipal solid waste is generated in Kozhikode Corporation every day. The per capita waste generation is estimated to be 450 gm/cap/day considering a population of 626651. Out of this about 150 tons is collected by the Corporation every day. Therefore, the collection efficiency is 53%. Households generate 53% of the total MSW generated in the city. It is followed by commercial establishments, hotels, street sweeping & markets. Considering 60% of solid waste generation from households & hotels, it is expected that the solid waste to be rich in organic content. The calorific value of the waste is more than 1500 Kcal/kg.

The Corporation has provided 2 types of 15 Litre buckets to each household – green bucket for bio degradable waste and white bucket for non biodegradable waste. The waste is segregated and collected at source in these buckets. The primary waste collection is carried by Push cart, Auto Tipper and Tipper Trucks in these wards. The sweepers employed by the municipality could clean only the main roads and central areas daily. They keep the waste in small heaps which are removed by a hand cart crew and coverage is limited. KMC operates 36 numbers of secondary collection points out of which 29 are open collection points. In almost all the wards there are temporary collection points. At some points open containers are placed by the municipality. People leave the waste at the nearest containers. Most of the time these containers will be overflowing and the waste will be deposited around the containers. KMC is operating covered tractor trailers and covered LCV to transfer the waste collected from primary collection vehicles directly to the secondary transportation vehicle. A mixed fleet of vehicles which are under operation include Dumper placer, covered tractor trailers, two compartment covered LCV, tipper trucks and ordinary tractors. There are 32 vehicles out of which on an average 24 vehicles are in operation. Waste segregation at source is not a general practice. Households which are given the bins segregate the organic and inorganic waste at source itself. An informal sector consisting of rag pickers, sub depots

buying recyclables from rag pickers, and major depots sorting and selling waste to recyclers separate plastic, paper, glass and metal to an extent. Some of the households and commercial establishments also separate recyclables and sell directly to vendors . With door to door collection, Kudumbsree units also separate recyclables and sell to sub depots. The Municipal Corporation owns a compost plant at Njalianparambu, 8km away from city centre, in Cheruvannur Panchayat. The wastes are being processed in the plant and converted into Bio- manure. The wastes are being heaped into windrows and treated with adequate inoculum and then subjected to aerobic composting. The reject from the compost plant are dumped around the compost plant. The area which is around compost plant is totally filled with large heaps of waste, which are partly remediated. **It is proposed to develop the entire ISWM project consisting of waste to energy (WTE) option with provision of only 10% rejects going into the landfill site. The entire project is being proposed on 12.67 Acres based on PPP format. Future waste projections from the year 2017 till 2041 have been carried out considering a catchment of 30 KM around Njalianparambu site. Municipalities, which are covered in this catchment include Feroke, Kondotty, Kozhikode, Parappanangadi, Tanur, Tirurangadi, Quilandy, Ramanattukara, Olavanna, Kadalundi and Kunnamangalam . Assumptions, which have been made, are: (1) Per capita waste generation is 400 gm; (2) Total population for all municipalities (2017) is 962006, (3) Estimated waste per day is 384.8 tons' (4) Collection Efficiency is 70% - 75%.The total waste generated per annum ranges from 1,03,897 tons in 2017 to 2,03,940 tons in 2041. Overall site assessment is shown below.**

Sl. No	SWM 2016 Criteria for Sanitary Landfill/Plant	Status	Remarks
1	100 meter away from river		
2	200 meter away from a pond		
3	200 meter away from Highways, Habitations, Public Parks and water supply wells	EIA required if sanitary landfill site is proposed with the plant (Operator's Responsibility)	Habitation just few meters from the site & the site is just besides NH 17
4	20 km away from Airports or Airbase		
5	Within the flood plains as recorded for the last 100 years, zone of coastal regulation, wetland, Critical habitat areas, sensitive eco-fragile areas		
	Complied with EIA requirement		
	Complied		

The entire project is proposed to be completed in two stages in 24 months. Site is suitable for Integrated Solid Waste Management Facility provided safeguards are in place as per SWM Rules 2016.

CHAPTER – 1: INTRODUCTION & METHODOLOGY

1.1 Introduction

The rapid urbanization, constant change in consumption pattern and social behaviour have increased the generation of municipal solid waste (MSW) in Kerala beyond the management capacity of the existing waste management systems. Therefore, there is an urgent necessity of improved planning and implementation of comprehensive MSW management systems for upgrading the environmental scenario of the State. It requires detailed information on the quantity and character of MSW generated and their physical and chemical properties. This is to evolve appropriate waste management strategy based on the principles of reduce, reuse and recycle and design appropriate collection, transportation, and processing and disposal system by using reliable data on quantity and quality of MSW generated in the State. KSIDC intends to develop MSW processing plants across the state under public private partnership (PPP) format with the assistance of Transaction Advisor.

1.2 Need for Study

The overall goal of solid waste management is to collect, treat and dispose of solid wastes generated by all population groups in an environmentally and socially satisfactory manner using the most economical means available. Seven sites in the state have been identified to be developed as waste processing plants.

In this regard KSIDC has appointed IRGSSA to Worked on "Site assessment study covering soil Investigation, topographic study covering geographical and environmental features of Njalianparambu in Calicut district Kerala"on its behalf as per the following scope of work.

1.3 Objectives of Study

The broad objectives of the Study are to determine a technically and economically viable solid waste management project for a phased implementation to meet the requirements of the year 2043. Following are the specific objectives:

- To analyze the existing solid waste management system in the study area.
- To carry out Environment Due diligence for the processing site.
- To Examine the Physical chemical and Environmental parameters of the processing site

1.4 Scope of Work

The major scope of work identified is summarized below:

- To Examine the (Physical and chemical) properties of Feedstock/MSW in the catchment area.
- To examine the Climate data of the catchment area.
- Existing and projected waste generation for 25 years.
- Examine the capacity of 12.67 Acres of land for WtE project including landfill requirement
- To Examine Existing site conditions (Owership of land, exact total area requirement, nearest substation for power evacuation, sources of water available nearby i.e. surface water & ground water, topographic and soil conditions).
- Compliance with SWM Rules 2016 for site conditions and its subsequent amendments.

1.5 Approach & Methodology

A very comprehensive approach & methodology has been adopted to carry out the six items mentioned in scope of work. Major approach includes the following steps:

Step 1: Desk review,
Step 2: Field visit,
Step 3: Sample audit
Step 4: Interaction with plant officials

These steps are based on the broad principles of Environmental Site Assessment and cover the following methodology:

- Review the present conditions and evaluate any likely Processing site history.
- Evaluation of risks of neighboring properties upon the subject property
- Review of Metrological data and hydro geological data
- Interview of persons knowledgeable regarding the plant history
- Verification of the records through sample audit & field visit.
- Conclusions & Recommendations

These steps are based on the broad principles of Phase 1 Environmental Site Assessment and cover the following tasks.

Task 1: Site visit & due diligence as per MSW Rules 2016 & amendments
Task 2: MSW sample testing (2 samples)
Task 3: Secondary data collection
Task 4: Data compilation & data analysis
Task 5: Report Preparation

Steps 1 to 4 were carried out during 9th October to 17th October 2018 followed by the analysis of data, findings and compilation of the report.

1.6 Format of Report

The report consists of the following chapters:

Chapter 1: Introduction & Methodology
Chapter 2: Existing Condition at Site
Chapter 3: Existing systems of SWM in Study Area
Chapter 4: Proposed Management Plan for Site
Chapter 5: Conclusions

CHAPTER – 2: EXISTING CONDITION AT SITE

2.0 Introduction

The proposed project is the development of Municpal Solid Waste Management Facility Facility at Njalianparambu Site. This chapter describes the existing site conditions particularly its location, physiography, topography, geology, soil & climatic conditions.

2.1 Njalianparambu Site

The proposed site is located at Njalianparambu **between 11.204907° N, 75.817240° E** at an altitude of 10 to 15 meters above mean sea level (ASL). The site falls in Cheruvannur Panchayat at the Kozhikode District summarized in **Table 2.1**. The site is located on an undulating terrain just beside National Highway 17. The proposed site is approximately 3 km away aerial from the sea shore. The area of the site is around 12.67 acres, the site location along with 100 meters to 200 meters buffer zone is shown in **Figure 2.3**. The site is connected to NH 17 through 180 meter long, 6 m wide cement concrete **(Figures 2.4)**

Table 2.1: Location Details of the Site

Site	Njalianparambu, Cheruvannur Panchayat (8 Km from city centre)
District	Kozhikode
Location	11.204907N, 75.817240 E (Adjoining NH 17)
Altitude in meters (ASL)	11 m (Lowest 7.0 m, Highest 16 m)
Land Area	12.67 Acres
Land Ownership	Kozhikode Municipal Corporation
Approach Road	180 m long, 6 m wide Cement Concrete road from NH 17

Figure 2.1: Njalianparambu Site Location

Figure 2.2: Njalianparambu Site & Site Buffer

Figure 2.3: 100 m & 200 m Buffer Around Njalianparambu Site

Figure 2.4: Access road to Site

2.2 Physiography & Topography

The physiographic divisions of Kozhikode district from west to east viz., (i) coastal plain - low land (<7.6 m amsl), mid land (7.6 to 76 m amsl) and high land – hilly terrain (above 76 m amsl).

The coastal plain is very narrow, 5 – 10km wide, gently sloping with a maximum height of about 10m in the east. It comprises depositional landforms of marine, fluvial and fluvio-marine origin. There is a well-developed beach all along the coast with sea cliffs and rocky beaches near Quilandy, Elattur and Kappad. The low land extends as a narrow stretch of land lying along the coast from South Kadalundi to North Mahe. The plain is interrupted by steep laterite cliffs and rock outcrops. The low land forms 6.7% of the total area of the district.

The midland area lies at a height between 7.6 and 76 m amsl. It may be further classified into low rolling terrain and moderately undulating terrain. The low rolling terrain has a slope of less than 15%. It consists of rolling laterite hills surrounded by valleys. The valleys are flood plain alluvium and red loamy soil. The moderately undulating terrain covering large area of the district has a slope between 15 and 25%. In addition to the agricultural crops of paddy and coconut, cash crops like rubber and arecanut are cultivated.

Area with elevation above 76 m amsl is called the highland. It is in the eastern part of the

district. The area is prone to landslides and land slips and comprises of steep slopes and barren rocks. The highest elevation of the district is 1935 m amsl at Nilamala in north-eastern corner of the district.

The landform units identified in Kozhikode are alluvial plain, flood plain, valley fill, linear ridge, hillcrest, sloping terrain, rocky slope (scarp face) and hilly terrain. The flood plain and valley fill are the major fluvial landforms whereas moderately sloping terrain, highly sloping terrain, rocky slope (scarp face), linear ridge and hillcrest are major denudational landform units. The fluvial and gently sloping terrains are promising zones of groundwater. Denudational landforms are unproductive zones.

The Proposed site is located on the coastal plain of the district. Average Elevation of site is 11 m (Lowest 7.0 m, Highest 16.) Contour map (topographic) of the site based on Aster DEM (Digital Elevation model)is shown in Figure 2.5. Contour map shows undulating formations which on ground truthing indicated municipal waste dumps. The site falls under the jurisdiction of Kozhikode Municipal Corporation (KMC) and is currently being used for composting with IL&FS as an operator.

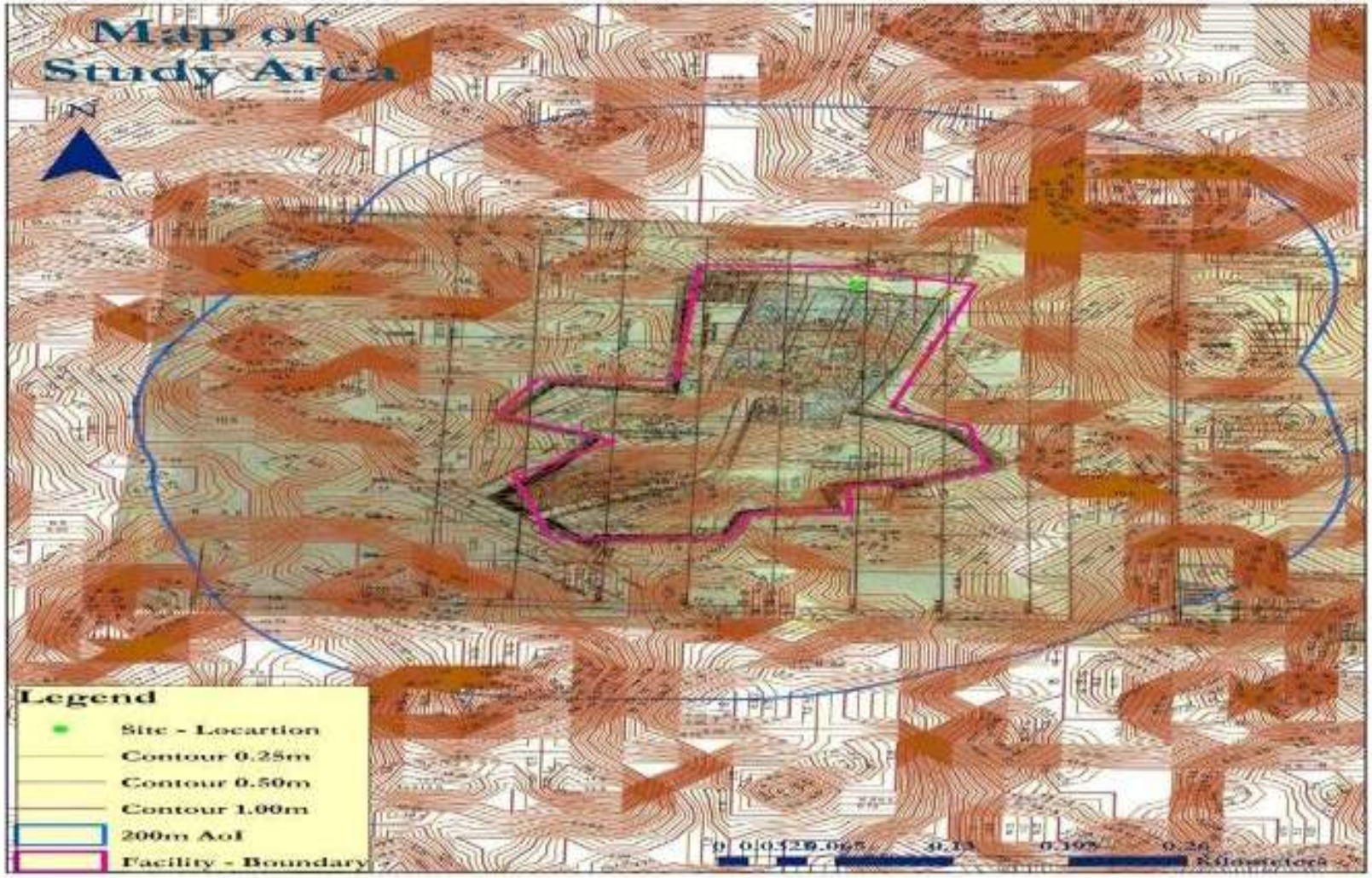


Figure 2.5: Topography of Existing Site

Drainage

Proposed site falls in the plain drained by Chaliya River. The district is drained by six rivers of which one is of medium nature and all others are minor ones namely *Chaliyar, Kuttiyadi, Mahe, Kadalundi, Kallayi and Korapuzha* **(Figure 2.6)**. The Chaliyar River is a medium river and originates at a height of 2066 m amsl in Ilambalari hills of Western Ghats of Gudallur district, Tamil Nadu. The Chaliyar drains in to Beypore estuary. It is a sixth order stream with a length of 169 km. At its upper reaches it is formed by *Punnurpuzha, Pandiyur, Karimpuzha, Cherupuzha, Kanhirampuzha, Kurumbanpuzha, Vathatpurampuzha & Iruvantipuzha*. At its lower reaches near Cheruvannur, it is flowing as a broad river developing inlets **(Figure 2.7)**.

Figure 2.6: Drainage Pattern of District & the Proposed Site

Figure 2.7: Chaliya River Near Proposed Site

The major irrigation schemes, the district is irrigated by number of minor irrigation schemes, lift irrigation schemes, community irrigation schemes, wells and tanks.

2.3 Geology & Soil

Kozhikode district can be divided into three geological belts viz., (i) a linear NW-SE trending gneissic belt, along the middle extending from north to south, (ii) a charnockite belt occupying areas in the northeast and south, extending to the adjacent districts and also occurring as pockets within the gneissic terrain and (iii) a narrow coastal belt.

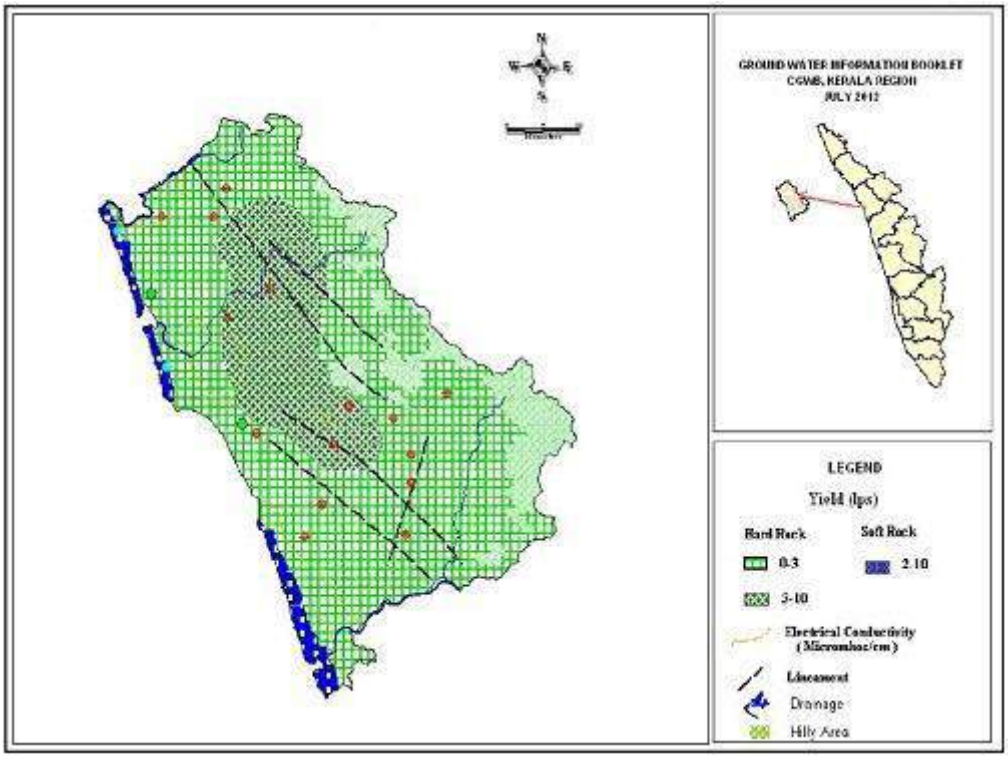


Figure 2.8: Hydrogeology Kozhikode District Kerala

Granite gneiss belonging to the Peninsular Gneissic Complex is the oldest unit of the area and occurs north of Alampore. Charnockite belonging to the Charnockite Group has a very wide distribution, especially in the northeast and south with variations like biotite-hypersthene gneiss, biotite-hornblende-hypersthene gneiss and hornblende-hypersthene gneiss. Magnetite quartzite, another unit of this group, occurs as narrow linear bodies within charnockite. Hornblende-biotite gneiss of the Migmatite Complex extends from north to south and is well foliated. Garnetiferous quartzo-feldspathic gneiss, another member of Migmatite Complex, occurs as lenses within charnockite, in the east. NW-SE trending dolerite dykes. These dykes are 10-20m wide.

The Proposed site is located on the coastal plain in the Chaliyas river basin of the district. Pebble beds occur on the coast and along banks of the Beypore river. The pebble bed is associated with grit and clay and it is lateritised. It comprises well rounded pebbles of quartz, granite, quartzite and granulite. It is considered to be of Pleistocene origin. Sporadic laterite is recorded from the charnockite country to the southwest. Quaternary deposits are of marine and fluvial origin.

Soil types

The soils of the district are alluvial soil, lateritic soil and forest loam. Alluvial soil is seen mostly along the coastal plain and valley. **The Proposed site has Alluvial soil**. They are coastal alluvial soil and river alluvial soils. They are excessively drained to moderately drained and are of sandy to clayey textures. Majority of the area under riverine alluvium was once occupied by paddy cultivation. But those areas are now utilised for the cultivation of various crops especially plantain. The riverine alluvium contains moderate organic matter, nitrogen, phosphorous and potash.

A soil sample of the proposed site was taken for the lab analysis. The results of the different parameters are summarized in **Table 2.2**. The soil has been found to little acidic with major hazardous elements like Cd, Hg, Cv, Ni & Lead much below 0.1 mg/kg. The Soil has reasonable C:N ratio.

Table 2.2: Soil Properties at Dumpsite

Parameter	Results
pH	5.51
Moisture	14.47%
Cadmium as Cd	<0.01mg/kg
Iron as Fe	5200 mg/kg
Manganese as Mn	105 mg/kg
Copper as Cu	<0.1 mg/kg
Zinc as Zn	92 mg/kg
Mercury as Hg	<0.1 mg/kg
Chromium as Cr	<0.1 mg/kg
Nickel	<0.1 mg/kg
Lead	<0.01 mg/kg
C:N Ratio	6.5

2.4 Ground Water Scenario

Ground water occurs in the weathered, fractured, crystalline and alluvial formations in the Kozhikode district **(Figure 2.9)**. Phreatic conditions exist in weathered formation and are mostly developed by dug wells for domestic and irrigation purposes. Semi-confined conditions exist in deep fractures and storage and movement of groundwater is mainly controlled by the fracture system. Deep high yielding bore wells are located along fractures / lineaments.

The district is divisible into two hydrological provinces viz., (i) the eastern Wayanad Plateau where dug wells give moderate yield and bore wells are feasible along fracture planes and (ii) the western mountains, which are generally unsuitable for groundwater development but the valleys with thick alluvium sustain dug wells. All the four blocks in the district are having similar hydro geological conditions. The major water bearing formations in the district are weathered/fractured crystalline, alluvium and valley fills.

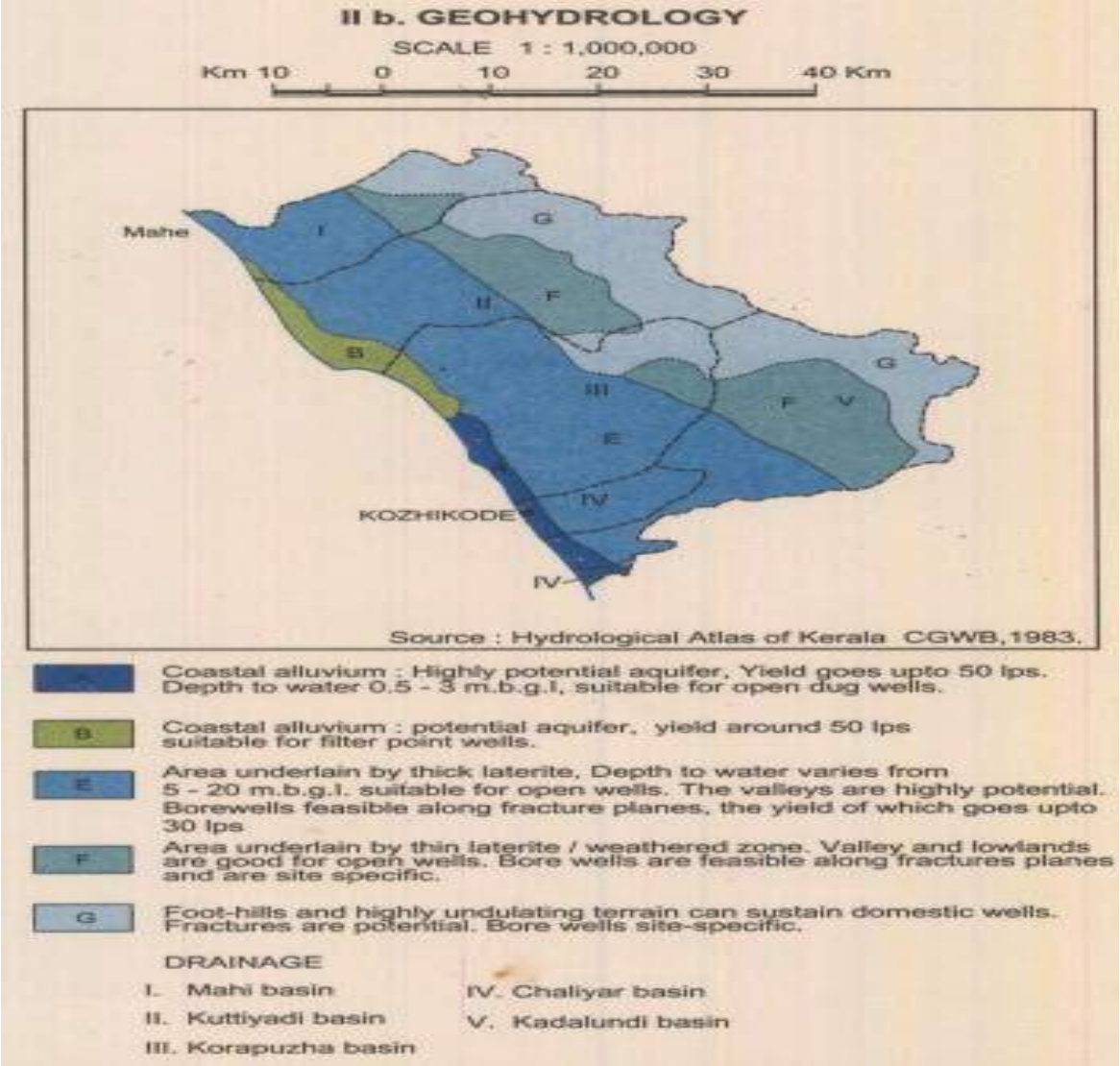


Figure 2.9: Geohydrology of Kozhikode

(Source: District Resource map, Kozhikode district, Geological Survey of India)

The depth of bore wells drilled by CGWB in the district varies from 114 to 200 m bgl with yield in the range of 10 to 1020 LPM. The yield of bore wells in hornblende biotite gneiss varies between 10 and 402 LPM and that in biotite gneiss varies between 150 and 410 LPM. The highly fractured potential aquifer among the crystalline rocks is hornblende-biotite gneiss. The yield of bore wells in Charnockite varies between 82 and 286 LPM. Exploration drilling by CGWB has revealed occurrence of deep potential fractures between 70 and 151 m bgl along lineaments. The abstraction structures in alluvium are dug wells and filter point wells wherever the saturated sand thickness is 4 m or more. The depth of wells ranges between 3.14 and 9.12 m bgl. The depth to water level ranges from around 2.00 to 6.63 m bgl in pre-monsoon period and from 0.99 to 4.03 m bgl in post-monsoon period. The yield of wells ranges between 30 and 80 m 3 /day.

The Proposed site falls in the corporation area of the Kozhikode district (Figure 2.10). The Seasonal fluctuation (8 m to 10 m) of the water table is due to variation in the rainfall, evapotranspiration, withdrawals for irrigation and other purposes, base flow, seepage from surface water bodies etc. The Decadal depth to water level in the Ground Water Monitoring Wells of CGWB during pre and post monsoon periods are shown in Figure 2.11 & Figure 2.12 respectively. CGWB data indicates that Net Annual Ground Water (GW) Availability in the Corporation area is almost 37.70 MCM with 5.03 MCM as existing gross GW Draft for irrigation 26.09 as existing GW draft for domestic & Industrial water supply. Overall the block is safe for gound water usages.

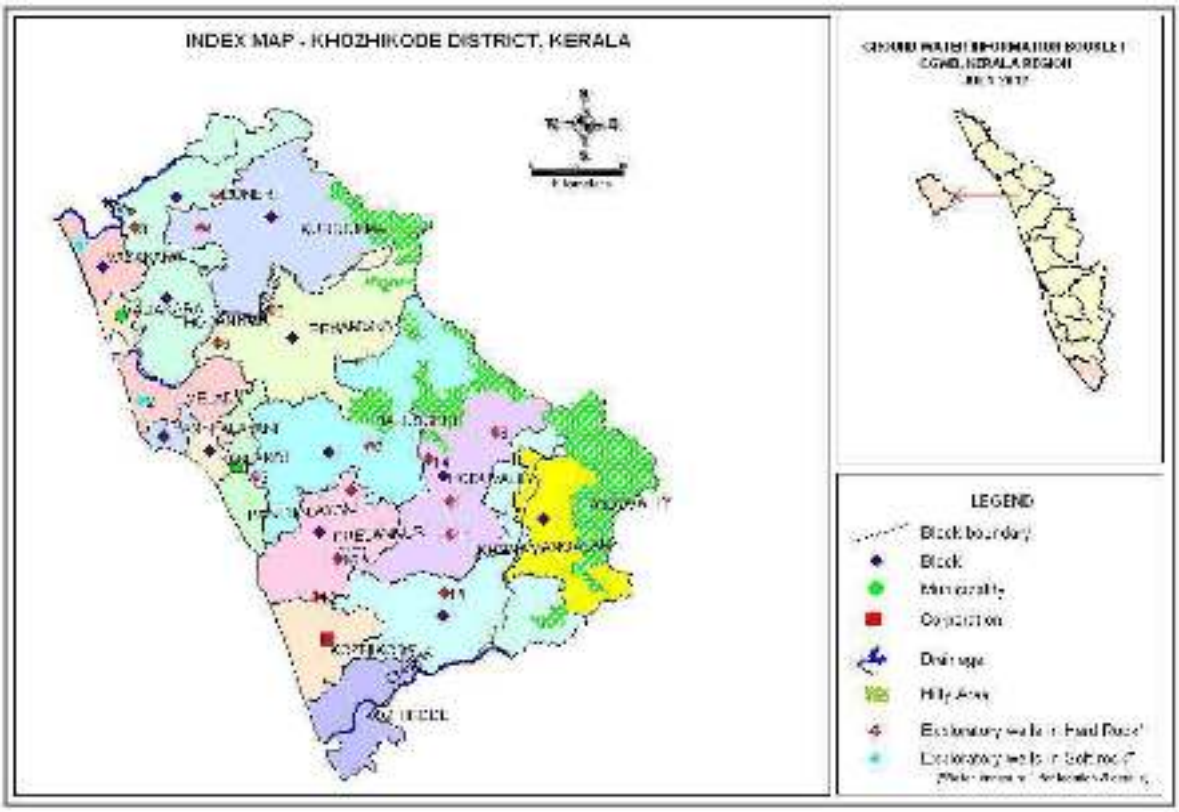


Figure 2.10: Index map of Kozhikode District

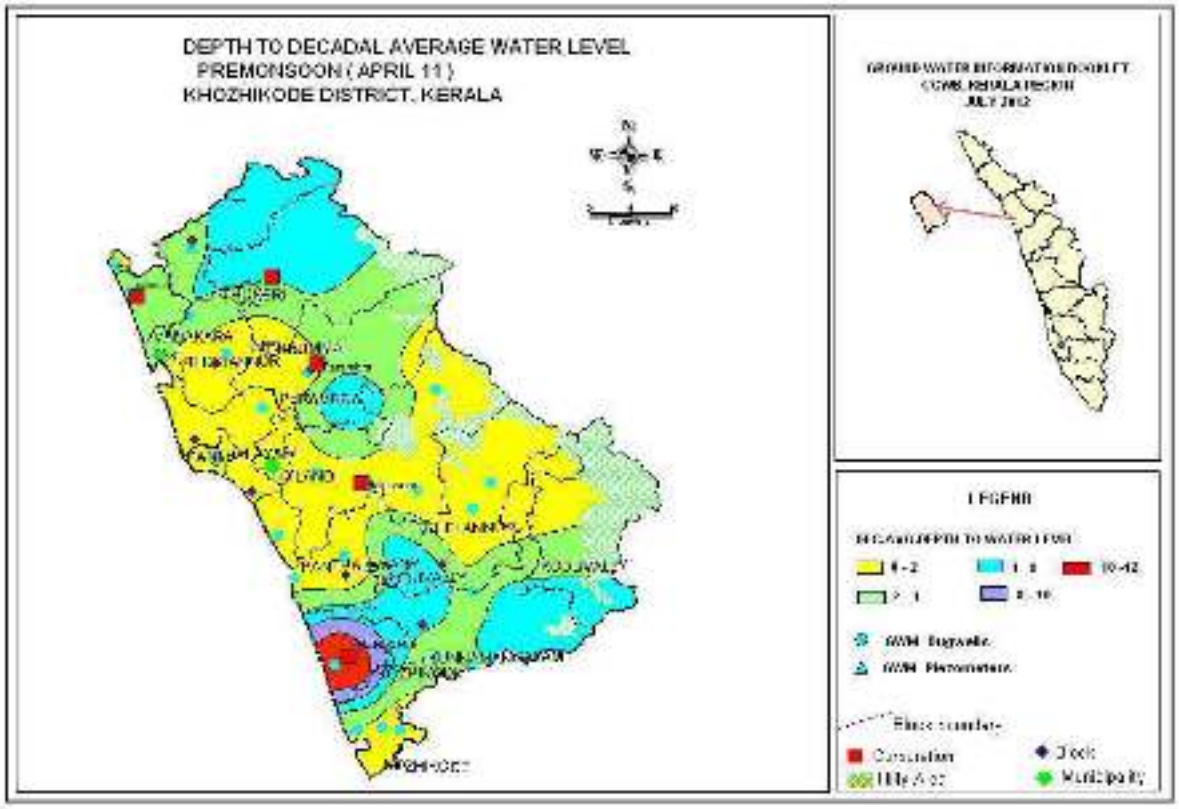


Figure 2.11: Depth to Decadal Average Water Level - Premonsoon (April 2002-11)

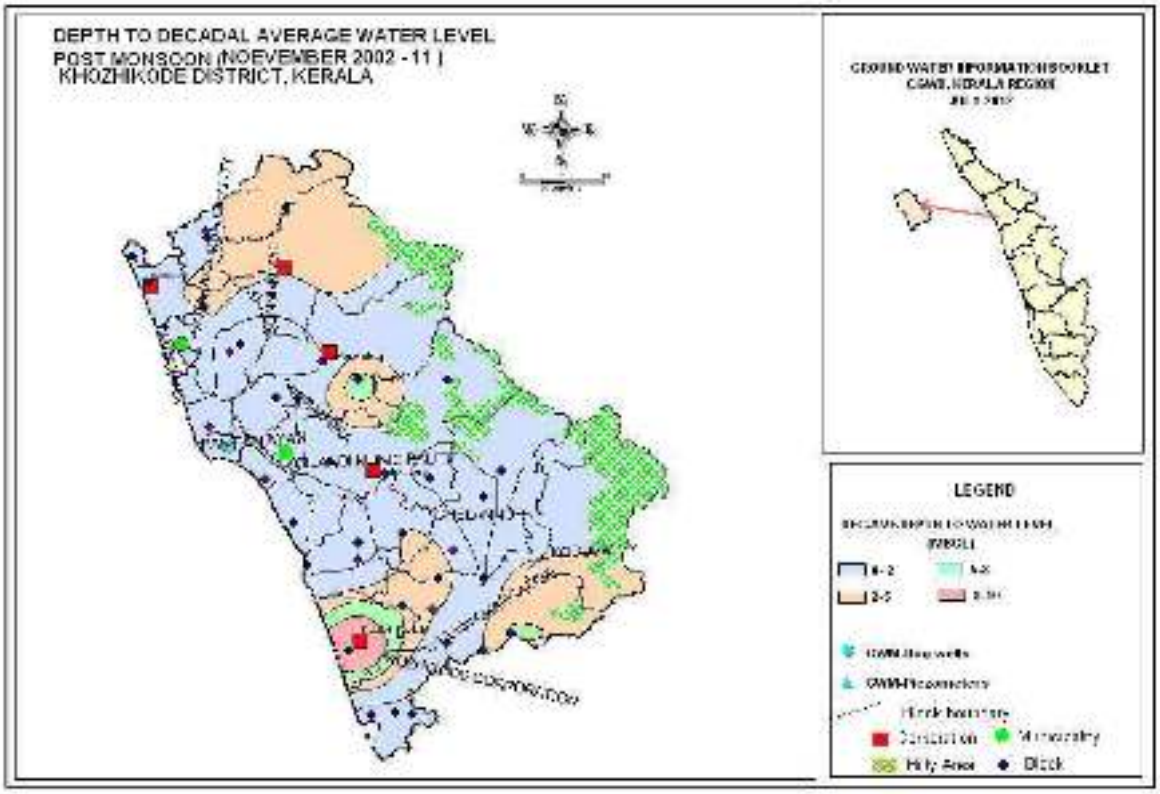


Figure 2.12: Depth to Decadal Average Water Level – Post-monsoon (Nov-2002-2011)

2.5 Climatic Conditions

Climatic condition of the Kozhikode district have been described in terms of Rainfall, Temperature, Relative Humidity, Wind speed & Evapotranspiration. The climate of the area is divided in to four seasons – summer, South West Tropical Monsoon period, North East Tropical Monsoon period and winter. **Kozhikode district experienced annual rainfall of 3698 mm in the year 2006 to 3973 in 2011.** It has been noticed that rainfall displays an increasing trend towards north-eastern areas of the district.

The SW and NE monsoons mainly contribute rainfall in the area with 82.77 % of the rainfall. In 2006 during winter (January to March), summer (April and May), SW tropical monsoonal (June to October) and NE tropical monsoonal seasons, Kozhikode district received 0.49%, 16.74%, 72.15% and 10.63% rainfall respectively. The month of June experiences maximum rainfall. The months of July, August and October also receive heavy rainfall. The agricultural activity of the district depends on the onset of SW Tropical monsoon. The Annual Rainfall in Kozhikode district, Kerala (2006-2011) has been described in **Table 2.3**

Table 2.3: Annual Rainfall in Kozhikode district, Kerala (2006-2011)

Rainfall (mm) during						
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
January	6	11	0	10.10	7.1	0
February	0	10	0	00.30	0.3	0
March	12	16	272	102.70	0	1
April	13	109	68	42.90	143.3	131
May	606	606	854	226.70	249.9	91
June	811	382	419	443.20	1094.5	1176
July	694	1153	409	983.40	897.8	870
August	547	753	450	335.80	368.9	669
September	616	720	614	533.00	321.1	610
October	279	439	13	296.10	495.1	205
November	105	106	6	236.10	280	215
December	9	1	0	107.20	13.9	5
Total	**3698**	**4306**	**3105**	**3348**	**3873**	**3973**

Other meteorological parameters

Temperature

The minimum temperature ranges between 22 and 25.8° C and the maximum between 28.2 and 32.9° C. The temperature reaches its peak in the month of April and attains minimum in January.

Relative Humidity

The relative humidity ranges from 74 to 92 % during morning hours and from 64 to 89% in evening hours. The monsoon months record high humidity.

Wind speed

The wind speed ranges from 8.1 to 12.6 km/h. The maximum wind speed is during April and minimum in November.

Potential Evapo-transpiration

The annual Potential Evapo-transpiration (PET) is 1505.7 mm. The monthly PET ranges from 92.9 to 170.2 mm. The PET is less than the rainfall during May to November and hence the possibility of recharge to ground water regime is more during these months.

CHAPTER – 3: EXISTING SYSTEM OF SOLID WASTE MANAGEMENT

3.0 Introduction

Existing Solid Waste Management (SWM) System has been described considering current situation of Solid waste, its generation, its physical & chemical characteristics & its current system of collection, treatment & disposal.

3.1 Present Situation- Kozhikode Corporation

The Urban local body (ULB) in Kozhikode is responsible for collection, transportation and disposal of Solid Waste except untreated bio-medical waste and hazardous industrial waste. Storage and segregation of waste at source is not very prominent KMC. Health department of the ULB is responsible for solid waste management. ULB has a net work of community collection points and this waste is collected manually into a fleet of vehicles. Waste is also collected through door to door waste collection system. But this system covers only a part of the town. Most of the waste is thrown into open spaces/drains/water bodies. The waste collected from the collection points, is being deposited in a waste dumping yard at Njalianparambu in Cheruvannur - Nallalam panchayat.

3.2 Sources and Quantity of Solid Waste Generated

About 281.99 MT of Municipal solid waste is generated in Kozhikode Corporation every day. The per capita waste generation is estimated to be 450 gm/cap/day considering a population of 626651. Out of this about 150 tons is collected by the Corporation every day. Therefore, the collection efficiency is 53%. Source-wise generation of solid waste generated in the city is described in **Table 3.1**

Table 3.1: Source wise quantity of Solid Waste generated in Corporation Area

Sr. No.	Source	Total Waste (Tonnes/day)	% of Total
1	Households	150.4	53.34
2	Commercial Establishment	34.37	12.19
3	Marriage Hall	3.58	1.27
4	Hotels	34.02	12.06
5	Markets	12.08	4.28
6	Institutions	10.62	3.77
7	Street Sweeping	19.28	6.84
8	Hospitals	6.64	2.35
9	C & D Waste	11	3.90
		281.99	100.00

Table 3.1 indicates that households generates 53% of the total MSW generated in the city. It is followed by commercial establishments, hotels, street sweeping & markets. Considering 60% of solid waste generation from households & hotels, it is expected that the solid waste to be rich in organic content.

Table 3.2: Physical Characteristics of MSW

Parameters	% to total Weight
Paper	3.10
Plastic	2.95
Metals	0.32
Glass	0.76
Rubber &Leather	0.84
Inerts	0.77
Ash & Fine earth	1.90
Compostable organic matter	88.34
Batteries/Pesticides/hazardous medicines	0.17
Others	0.85%
Total	100%

Table 3.3: Chemical Properties of the Solid Waste

Sr. No.	Parameter	Results
1	pH	4.08
2	Density	1.0195 g/m^3
3	Calorific Value	1762 Kcal/Kg
4	Total Phosphate	2833 mg/kg
5	Total Nitrogen	4280 mg/kg
6	Total Potassium	1800 mg/kg
7	Total Organic Carbon	30%
8	Copper	<0.1 mg/kg
9	Iron	800 mg/kg
10	Nickel	<0.1 mg/kg
11	Zinc	38 mg/kg
12	Chromium	<0.1 mg/kg
13	Lead	<0.1 mg/kg
14	Cadmium	<0.1 mg/kg
15	C :N Ratio	36:48

Two sample of MSW were collected from the site as well as from the catchment area. Their physical and chemical analysis, which were carried out are summarized (Average Value) in **Table 3.2 and Table 3.3. Table 3.2 indicates that the waste is rich in organic content, while Table 3.3 indicates that the calorific value of the waste is more than 1500 Kcal/kg.**

3.3 Primary Collection

As part of a project supported by Central and State pollution Control Board, KMC has organized 71 Kudumbsree units (each unit consists of 10 members) Which have been

formed in each of the selected ward of the city with the help of State Poverty Eradication Mission. **The primary waste collection is carried by Push cart, Auto Tipper and Tipper Trucks in these wards (Figure 3.1).**

Figure 3.1: Primary Collection System

3.4 Street Sweeping

The sweeping operation managed by Health Circles, covers only the main roads and certain parts of city centre area on a daily basis. The streets branching off from main roads are swept on alternate days or once in a week. It is estimated that about 56% of roads are covered daily out of about 655 km of roads comprises of black top, Gravel and concrete roads.

Figure 3.2: Street Sweeping in the City

The sweepers employed by the municipality could clean only the main roads and central areas daily. They keep the waste in small heaps which are removed by a hand cart crew and coverage is limited. A glimpse of Street cleaning is shown in **Figure 3.2**.

3.5 Secondary Collection and Storage

KMC operates 36 numbers of secondary collection points (Figure 3.3) out of which 29 are open collection points. KMC aims at reducing the collection points by vehicle to vehicle transfer. Major markets are provided with dumper containers.

Figure 3.3: Collection Point

3.6 Vehicles to Vehicles Transfer System

KMC is operating covered tractor trailers and covered LCV to transfer the waste collected from primary collection vehicles directly to the secondary transportation vehicle. However the transfer is cumbersome and manual as shown in **Figure 3.4.**

Figure 3.4: Vehicle to Vehicle Waste Transfer

3.7 Transportation of waste

A mixed fleet of vehicles which are under operation include Dumper placer, covered tractor trailers, two compartment covered LCV, tipper trucks and ordinary tractors.

There are 32 vehicles out of which on an average 24 vehicles are in operation. (Figure 3.5)

Figure 3.5: Waste Transportation

3.8 Door to Door Collection System

The Corporation has provided 2 types of 15 Litre buckets to each household – green bucket for bio degradable waste and white bucket for non biodegradable waste. The waste is segregated and collected at source in these buckets. A massive awareness programme has also been launched to make people aware of the management of solid waste at household level. Initial feedbacks indicate that the programme is well received by the people. The amount collected from houses vary with the economic status and quantity of waste. Therefore the charges for waste collection ranges from Rs. 15- to 50 per households. Plastic is collected once in a week. The waste collected from houses usually is emptied to 50 Litre boxes which is transferred to Autorikshaws. Up to 24 boxes can be placed in an auto. From the autos, the boxes are emptied to the containers in the trucks and then taken to the disposal yard at Njalianparambu in Cheruvannur Panchayat. This system is practiced in most of the Municipal wards.

With the introduction of door step collection, and awareness campaigns, the community participation is improving as seen from the increasing participation. About 55% households participate in door to door collection. The Residents' Associations play a key role in participating in this programmes. The ward level committee set up during the Model Project Implementation has been instrumental in promoting participation in the initial stages.

3.9 Segregation and Storage at Source

Waste segregation at source is not a general practice. Households which are given the bins segregate the organic and inorganic waste at source itself. An informal sector consisting of rag pickers, sub depots buying recyclables from rag pickers, and major depots sorting and selling waste to recyclers separate plastic, paper, glass and metal to an extent. Some of the households and commercial establishments also separate recyclables and sell directly to vendors (Figure 3.6). With door to door collection,

Kudumbsree units also separate recyclables and sell to sub depots. Though the opportunities of rag pickers reduce due to the direct collection by the door to door crew, the percentage of segregation of recyclables has increased.

Figure 3.6: Waste Segregation

3.10 Collection from Temporary Collection Points

In almost all the wards there are temporary collection points. At some points open containers are placed by the municipality. People leave the waste at the nearest containers. Most of the time these containers will be overflowing and the waste will be deposited around the containers. In some localities where there are no containers the local people deposit the waste directly to the ground. From these temporary storage points waste is collected by the municipal staff and transported to disposal yard. Market waste is directly collected in containers. Shops and stalls have no individual storage bins. The waste collection points are scattered with in the municipal area. All the open storage points as well as containers are being emptied by municipal staff manually. On enquiry and also from the discussions with the local population, it is seen that most of the storage points are not cleared every day.

3.11 Disposal and Treatment of Waste

The Municipal Corporation owns a compost plant at Njalianparambu, 8km away from city centre, in Cheruvannur Panchayat. The wastes are being processed in the plant and converted into Bio- manure. The wastes are being heaped into windrows and treated with adequate inoculum and then subjected to aerobic composting.

The plant erected in the year 2000 is in operation since then, but had problem of irregular operation due to various reasons which include the absence of reject landfill sites and consequent accumulation, inadequate roof coverage for monsoon processing ,issues with private entrepreneurs operating, foul smell from uncovered dumps etc. (**Figure 3.7**). Currently, the plant can process 160 tons/day of MSW.

Figure 3.7: Composting Process

The reject from the compost plant are dumped around the compost plant. The area around compost plant is totally filled with large heaps of waste, which are partly remediated. Largely exposed heaps generating lot of leachate especially during rains which run down to neighborhoods. It has no green belt around, and doesn't have proper drainage, leachate collection and treatment system. Due to Constraints of space KMC has contracted removal of rejects, but the frequency is irregular. The existing plant layout is shown in **Figure 3.8**.

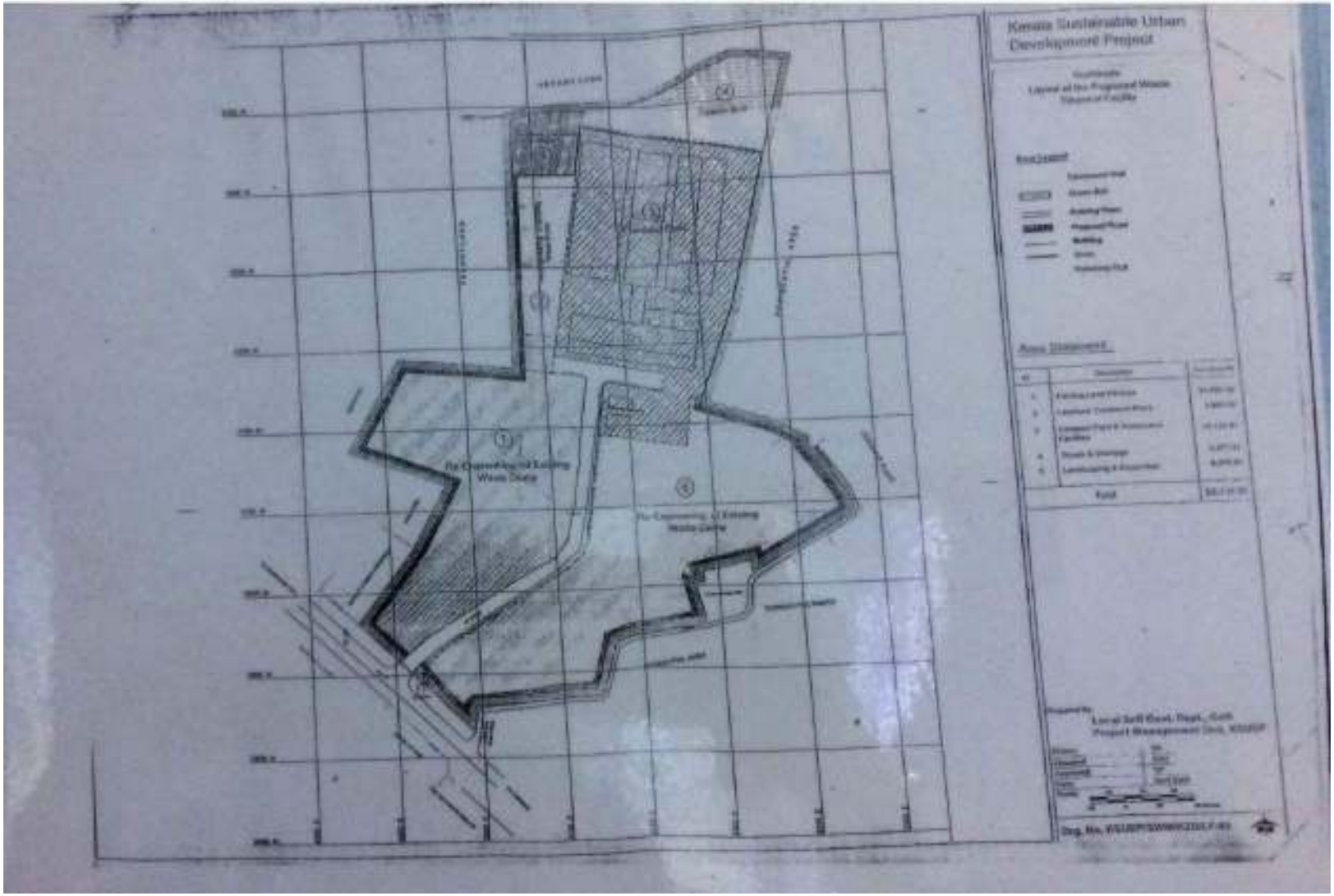


Figure 3.8: Existing Plant Layout

CHAPTER – 4: PROPOSED MANAGEMENT PLAN

4.1 Introduction

Management of municipal solid waste and adoption of processing technologies are dependent on the quantity and characteristics of the total waste generated in a local authority, the financial resources available and in-house capability of local authorities to oversee project implementation. The Integrated Solid Waste Management (ISWM) system proposes a waste management hierarchy with an aim to reduce the amount of waste being disposed, while maximizing resource conservation and resource efficiency. Based on the suggested waste management hierarchy and an assessment of KMC, it is proposed to develop the entire project as shown in **Figure 4.1**.

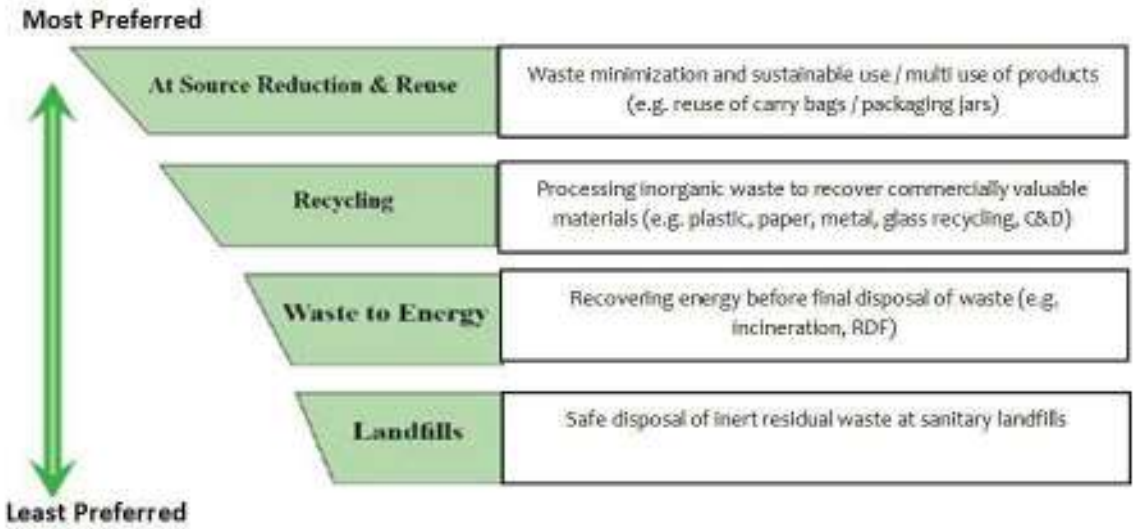


Figure 4.1: Integrated Solid Waste Management (ISWM) System

It is proposed to develop the entire ISWM project with provision of only 10% rejects going into the landfill site. The entire project is being proposed on 12.67 Acres based on PPP format.

4.2 Future Waste Projections

Future waste projections from the year 2017 till 2041 have been carried out considering a catchment of 30 KM around Njalianparambu site. Municipalities, which are covered in this catchment include Feroke, Kondotty, Kozhikode, Parappanangadi, Tanur, Tirurangadi, Quilandy, Ramanattukara, Olavanna, Kadalundi and Kunnamangalam (Figure 4.2). Assumptions, which have been made are given below.

1. **Per capita waste generation - 400 gm**
2. **Total population for all municipalities (2017) - 962006**
3. **Estimated waste per day - 384.8 tons**
4. **Collection Efficiency - 70% - 75%**

Table 4.1: Waste Projection for 25 Years

Year	Per Capita Waste	Waste (TPD) (70-75% collection efficiency)	Total Waste/ year	Landfill able waste/Year
				10%
2017	400	284.65	1,03,897	10,390
2018	405	292.76	1,06,858	10,686
2019	411	301.11	1,09,904	10,990
2020	416	309.69	1,13,036	11,304
2021	422	318.51	1,16,257	11,626
2022	427	327.59	1,19,571	11,957
2023	433	336.93	1,22,978	12,298
2024	439	346.53	1,26,483	12,648
2025	445	356.41	1,30,088	13,009
2026	451	366.56	1,33,795	13,380
2027	456	377.01	1,37,608	13,761
2028	463	387.75	1,41,530	14,153
2029	469	398.80	1,45,564	14,556
2030	475	410.17	1,49,712	14,971
2031	481	421.86	1,53,979	15,398
2032	488	433.88	1,58,367	15,837
2033	494	446.25	1,62,881	16,288
2034	501	458.97	1,67,523	16,752
2035	507	472.05	1,72,297	17,230
2036	514	485.50	1,77,207	17,721
2037	521	499.34	1,82,258	18,226
2038	528	513.57	1,87,452	18,745
2039	535	528.20	1,92,794	19,279
2040	542	543.26	1,98,289	19,829
2041	549	558.74	2,03,940	20,394

The total waste generated per annum ranges from 1,03,897 tons in 2017 to 2,03,940 tons in 2041.

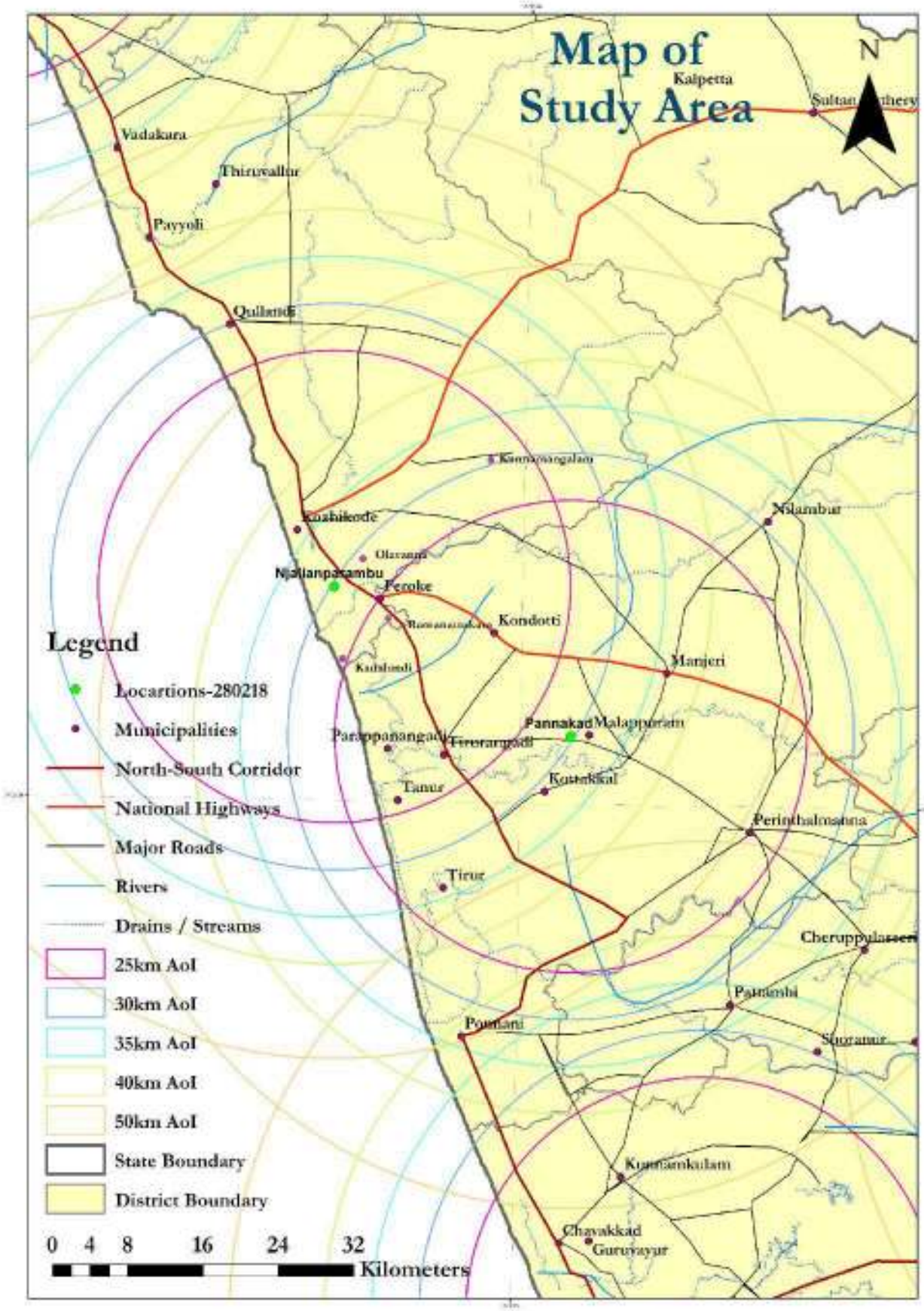


Figure 4.2: Catchment Area of Proposed ISWM Facility

4.3 Detailed Technology Description

Based on MSW composition of KMC and evaluation of the technological options indicate that waste can be reduced by 60% to 90% through a number of options. These include waste to energy (WTE) either through biomethanation or incineration. **A case study of incineration has been described below though the operator can choose any option.**

Case Study: WTE through Incineration

WTE power plant can be designed to produce 10 MW Power (Gross) at generator terminals. Under RDF Option, the waste will be converted into rich calorific value. Residue Derived Fuel (RDF) can also be used as fuel for the WTE power plant where as under Direct Option, the waste will be directly burned after segregation and mixing it with the fresh waste to maintain the required calorific value of the waste to the extent of ≥ 1200 kcal/kg. **Considering technology neutral nature of the project, the operator has the choice to choose its technology.**

Ash coming out of Hot Air Generator (HAG) and power plant boiler (both bottom ash and fly ash) will be used for C&D Plant. If there is a demand, it will be given to building contractors / fly ash brick manufacturers or recycled through contractors in C&D Plant. Depending on the viability, inert fraction can be disposed to landfill site. Recyclable matter coming out of RDF plant would be given to Recycling units. Storage space for such items would be provided in the plant.

The power plant will be operating throughout the year except for the period during which 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 333 days. The plant shall 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. **Figure 4.3** gives the process flow and scheme for waste to energy from MSW.

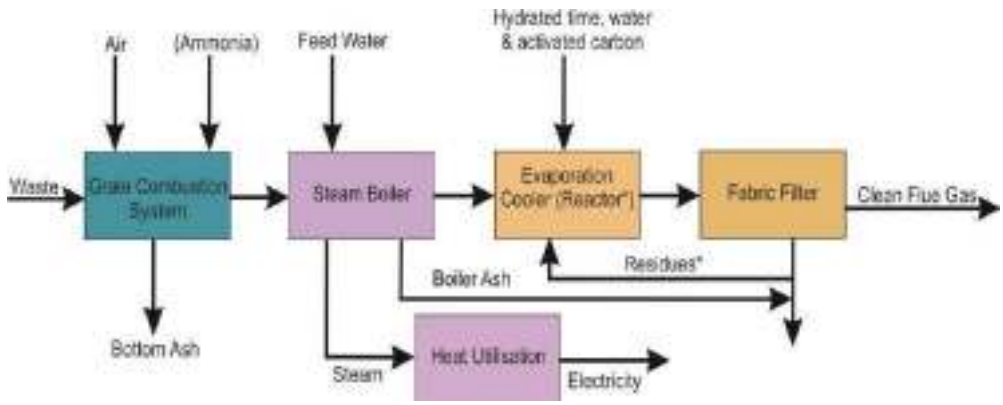


Figure 4.3: Waste to Energy Flow Chart

Based on the above flow chart for broad Waste to Energy Power Plant, an indicative layout plan has been prepared & shown in Figure 4.4.

Land filling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, land filling shall be done following proper norms & regulations. A green belt has been proposed around the landfill site.

Figure 4.4 indicates are a requirements of power plant, auxiliaries, power sub station and landfill site. Considering 10% inert reaching the site, it is expected that landfill site will have a life of minimum ten to twelve years. However, the operator is expected to minimize the inert through innovative its use.

Landfill Design Facilities (Refer Annexure – 1)

The conceptual landfill design is based on geological and hydro-geological conditions, projected waste generations volumes along with procedures to reduce potential impacts to the existing natural and social environment of the site. The basic steps include:

1. Landfill sizing
2. Site layout
3. Landfill layout
4. Leachate management
5. Landfill gas management

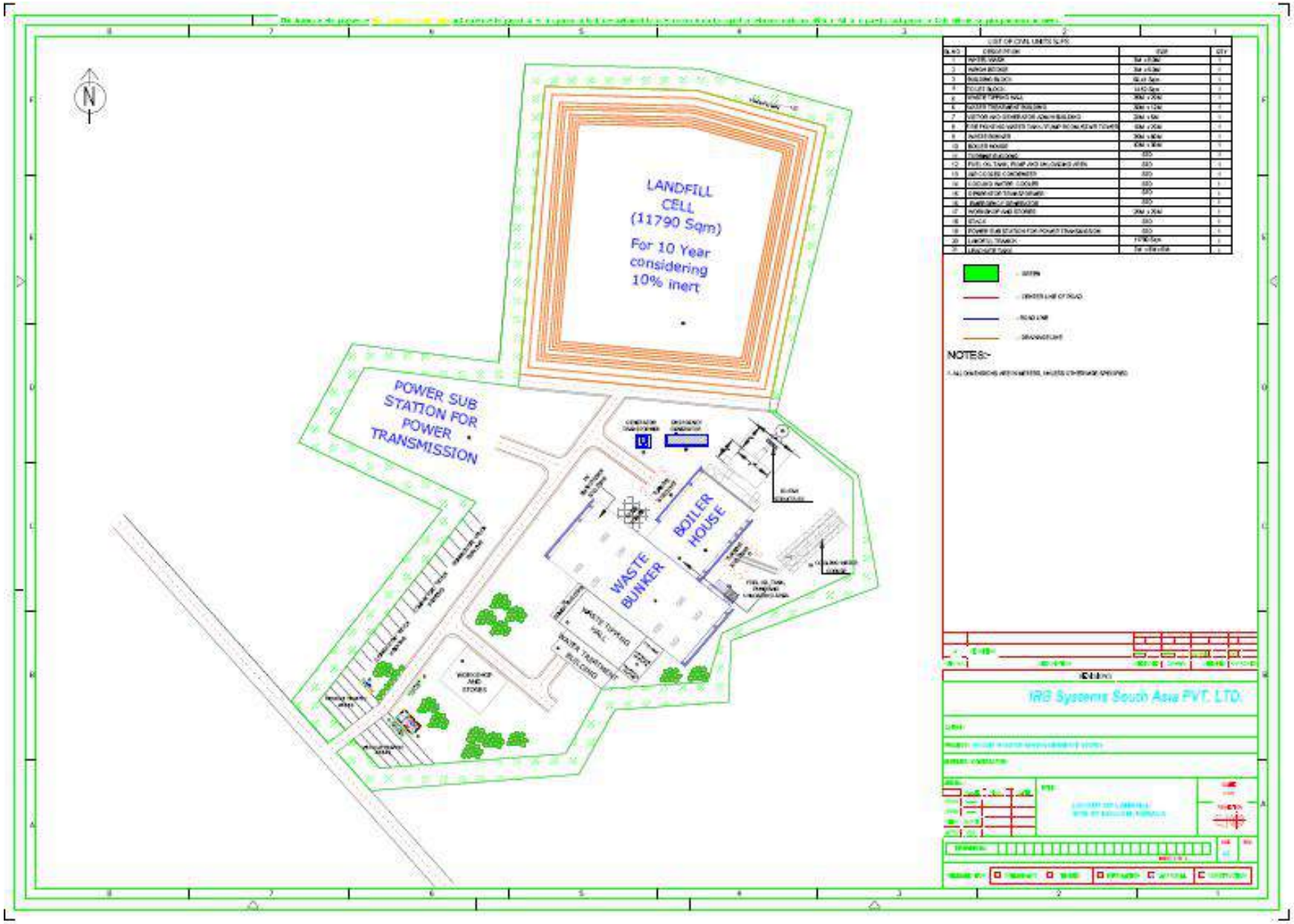


Figure 4.4: Layout Plans for Processing and Disposal of waste

The liner system for landfill site at Njalianparambu is based on MoEF&CC recommendations. As per MoEF&CC "Construction of a non-permeable lining system at the base and wall of waste disposal site area - For landfill receiving residues of waste processing facilities or mixed waste or waste having contamination of hazardous material (such as aerosol, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specification shall be a composite barrier having 2.5mm High Density Polyethylene (HDPE) geomembrane or equivalent overlying 90cm of soil (clay/amended soil) having permeability coefficient not greater than 1X10-7cm/sec."

Therefore for the landfill site liner system of following specifications has been recommended complying Municipal Solid Waste Management Rules 2016.

The liner system will comprise of following layers below waste

- A drainage layer of 300 mm thick granular material of permeability not greater than 10^{-2} cm/sec.
- A 200 mm thick protective clay layer
- A HDPE geomembrane liner of thickness 2.5mm
- A 6 mm thick Synthetic clay liner
- A 1000mm compacted soil at most of bottom

Main components of liner system are clay/amended soil layer and geomembrane liner and performance of landfill largely depends on this liner system.

Daily Cover at Landfill: The daily soil cover required would have to be stored at site in a demarcated area. If the soil is not available from the site itself it will have to be brought from outside and stacked or drain silt and waste from road sweeping. The soil of 100 to 150 mm should be applied on the waste coming in.

Intermediate Cover: Waste should be covered at the end of each working day with a daily cover. If a stretch of waste is not to be filled over in the immediate future (for example - for one week), it should be covered with a thicker interim cover. Prior to the commencement of monsoon season, an intermediate cover of 40-65 cm thickness of soil should be placed on the landfill with proper compaction and grading to prevent infiltration during monsoon. The intermediate cover will follow the slopes and grading of the underlying waste. Placement of tarpaulin covers may be required at locations where either stagnation is observed or at locations where there is a possibility of erosion of the interim cover.

Final Cover System: The landfill cover system will extend above the elevations denoted in drawing. The average height of the waste would be 25 m above the embankment. The Landfill will be capped as per the SWM 2016 Rules.

4.4 Leachate Collection and Removal System

An effective leachate collection and removal system is a pre-requisite for landfill sites. For existing sites, the installation of an improved collection and removal system should be considered in the light of data obtained by way of the environmental monitoring. **(Annexure – 1).**

The leachate collection system (LCS) consists of three main components; a drainage layer, a series of collector pipes, and a non-woven Geotextile separator layer. These components are discussed in more detail below.

The leachate collection system and its components will be laid over the HDPE geomembrane. The LCS layer consists of a 300 mm thick gravel drainage layer of 12-25 mm sized rounded gravel and perforated HDPE pipes embedded in this gravel layer. The HDPE pipes will collect the leachate and are connected to a leachate evaporation pond. The gravel layer will be laid according to the slopes mentioned in the base soil liner layer.

The Header pipes have a slope of 1% to one side. The header pipes are then connected to the Leachate collection chambers from where the leachate would be pumped onto the incoming waste. The Leachate collection pipes must be wrapped in Non-woven Geotextile so as to reduce the clogging of the pipes.

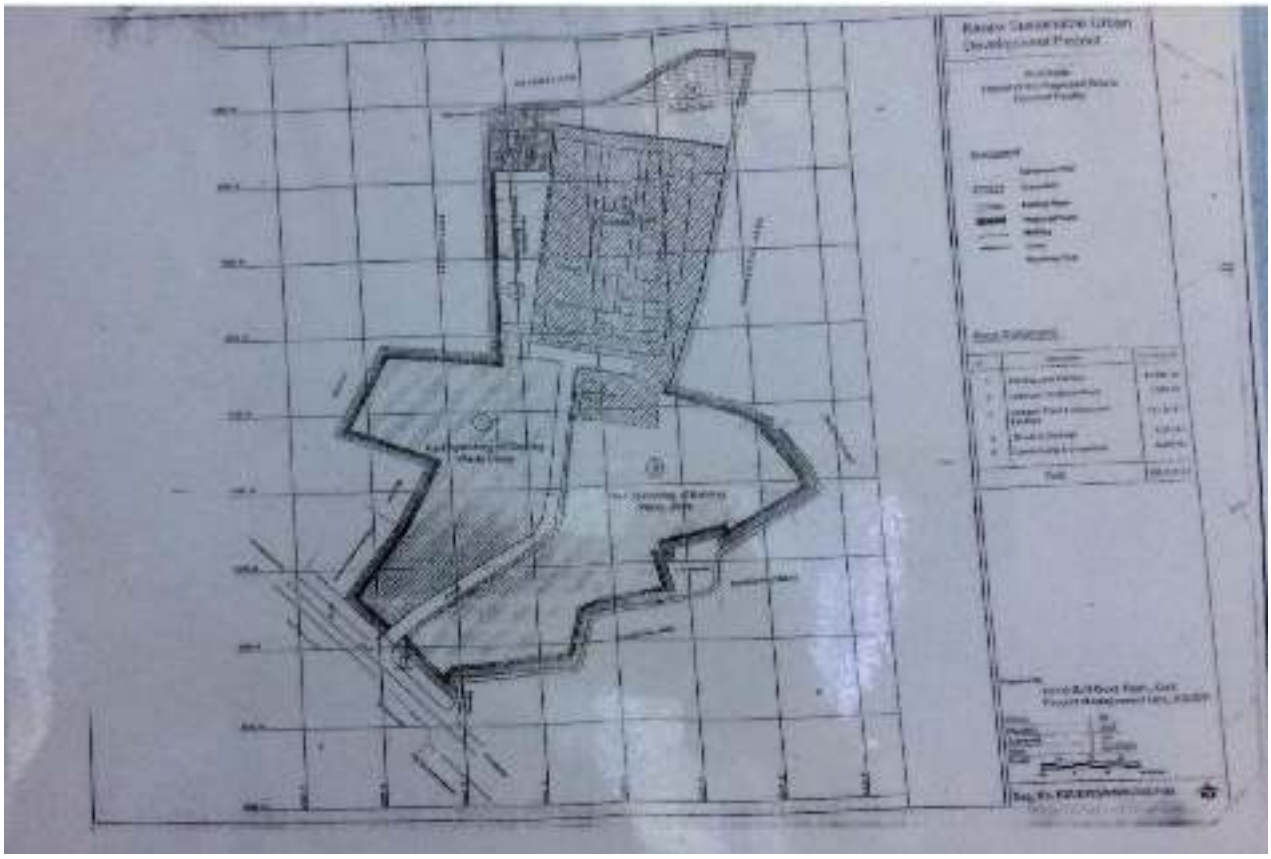
A weekly operating record of leachate management systems shall be kept in the post-closure period. Periodic inspection of the leachate collection systems (2 to 4 times a year) is to be undertaken to identify broken pipes, leakage of gas (if any) and damaged or clogged wells/sumps. Repair work will require skilled manpower and shall be carried out by the agencies operating the gas treatment and leachate treatment facilities. It may be necessary to install new gas extraction wells and leachate collection wells if the damaged / clogged facilities are inaccessible and irreparable.

4.5 Closure of Landfill Site and Post Closure Plan

Determination of the end-use of a landfill site is an essential part of the plan for landfill closure and post-closure maintenance. Closure and Post closure care involves the routine inspection of the completed landfill site, maintenance of infrastructure and environmental monitoring. The authority shall inspect all facilities during the closure and post closure period at least once a year. The authority/concessionaire that operates the sanitary landfill shall be responsible for post closure activities and monitoring.

4.6 Project Implementation Plan

A project implementation plan has been prepared consisting of two stages i.e. stage 1 & stage 2. **Figure 4.5** indicates the comparison of existing condition versus proposed project layout. **Figure 4.6** indicates the location of stage 1 and stage 2. **Figure 4.7** indicates the complete project implementation plan with the completion of stage 1 in 24 months.



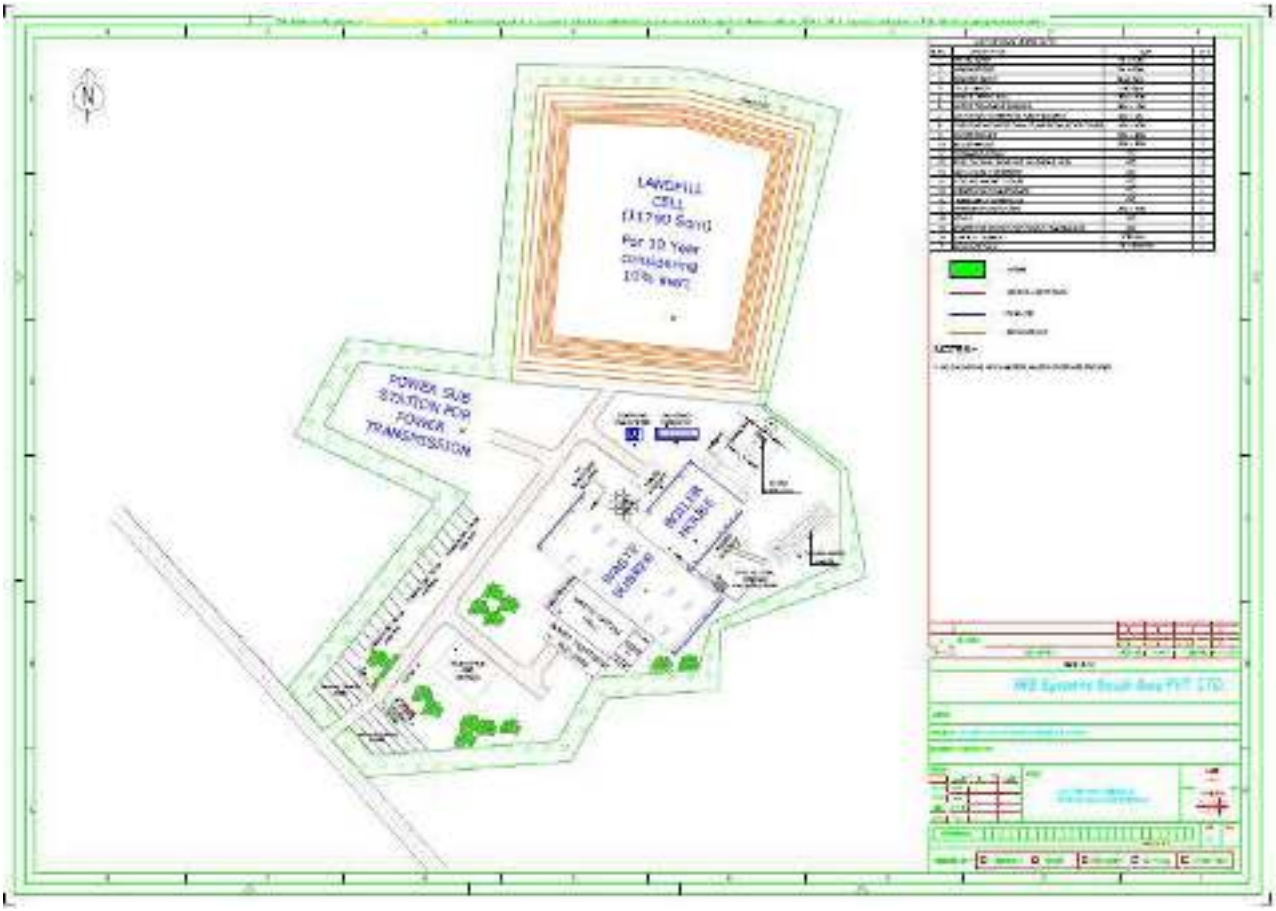


Figure 4.5: Layout Plans for Processing and Disposal of Waste Versus Existing Site

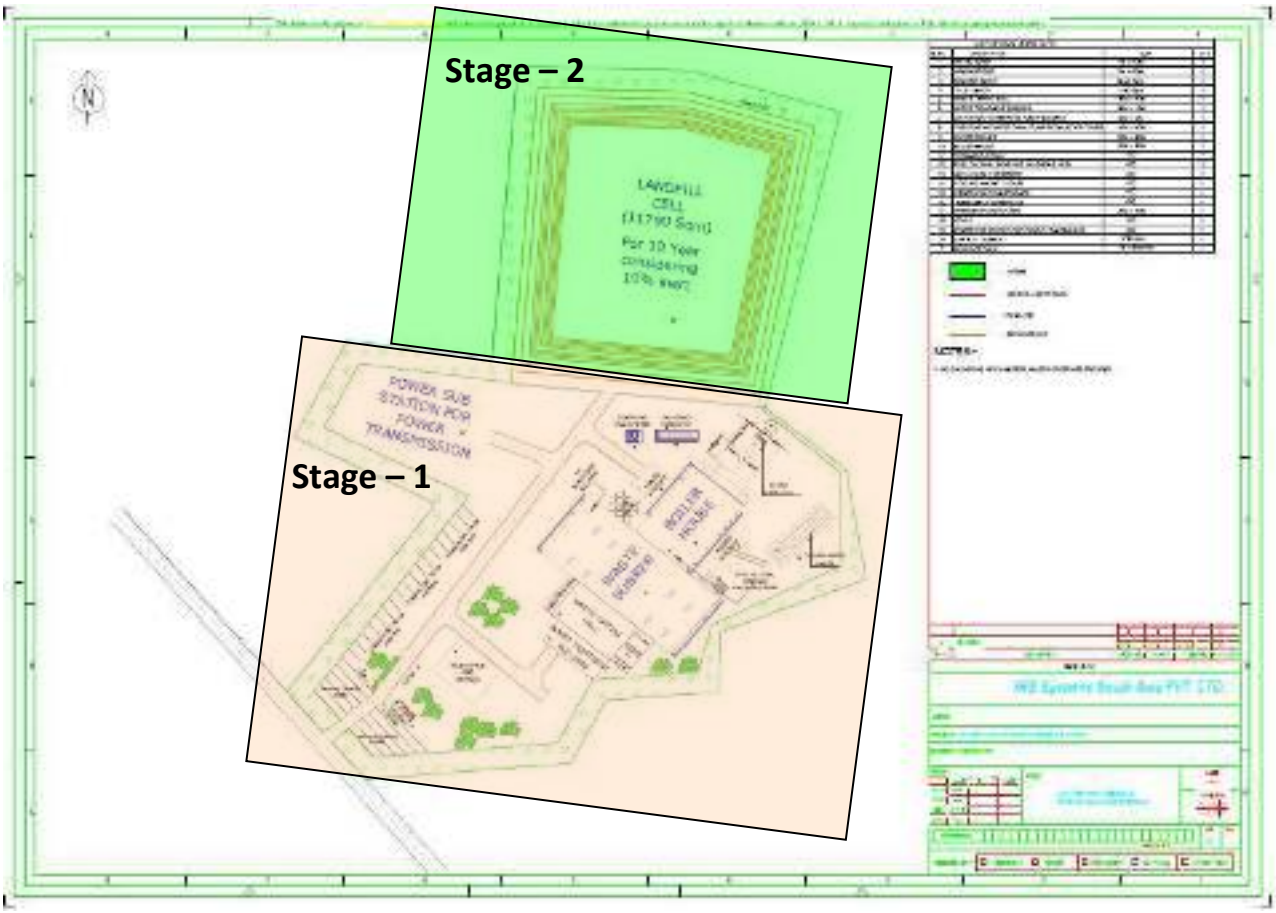


Figure 4.6: Stage Wise Development of Proposed Project

Project Development Schedule

S.NO	Project Milestone	2018		2019												2020												2021												2022	
		Nov.	Dec.	Jan	Feb	March	April	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Jan	Feb	March	April	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Jan	Feb	March	April	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Jan	Feb
Stage – 1																																									
1	Project Feasibility and DPR																																								
2	Tender preparation																																								
3	Publishing Tender																																								
4	Pre-bid meeting																																								
5	Suggestions & objections reply to be uploaded																																								
6	Tender submission																																								
7	Tender Evaluation																																								
8	Placing of Work Order																																								
9	Selection and Appointment of Contractor/ Operator																																								
10	Selection and Appointment of Independent Engineer																																								
11	Detail design																																								
12	Construction																																								
13	Site Preparartion																																								
14	Water pipeline and allied Infrastructure																																								
15	Foundation and Civil Work																																								
16	Plant Erection																																								
18	Commissioning of plant																																								
Stage – 2																																									
19	Dismantling of Compost Plant																																								
20	Landfill Development																																								

Figure 4.7: Stage Wise Project Milestone for Development of Waste to Energy (WtE) Project

Note: Above Schedule is dependent on clearances and approvals

CHAPTER – 5: CONCLUSION

5.0 Site Conditions

The Proposed site is located on the coastal plain in the Chaliyas river basin of the Khozikode district. The site falls under the jurisdiction of Kozhikode Municipal Corporation (KMC) and is currently being used for composting with IL&FS as an operator. Average Elevation of site is 11 m (Lowest 7.0 m, Highest 16.) Contour map (topographic) of the site based on Aster DEM (Digital Elevation model)is shown in Figure 2.5. Contour map shows undulating formations which on ground truthing indicated municipal waste dumps.

Geologically, pebble beds occur on the coast and along banks of the Beypore river. The pebble bed is associated with grit and clay and it is lateritised. It comprises well rounded pebbles of quartz, granite, quartzite and granulite. It is considered to be of Pleistocene origin. Sporadic laterite is recorded from the charnockite country to the southwest. Quaternary deposits are of marine and fluvial origin. The Proposed site has Alluvial soil.

Groundwater fluctuations have been reported in pre and post monsoon season. The Seasonal fluctuation (8 m to 10 m) of the water table is due to variation in the rainfall, evapotranspiration, withdrawals for irrigation and other purposes, base flow, seepage from surface water bodies etc. CGWB data indicates that Net Annual Ground Water (GW) Availability in the Corporation area is almost 37.70 MCM with 5.03 MCM as existing gross GW Draft for irrigation 26.09 as existing GW draft for domestic & Industrial water supply. Overall the block is safe for gound water usages.

5.1 Climate

Kozhikode district experienced annual rainfall of 3698 mm in the year 2006 to 3973 in 2011.
The minimum temperature ranges between 22 and 25.8° C and the maximum between 28.2 and 32.9° C. The temperature reaches its peak in the month of April and attains minimum in January. The wind speed ranges from 8.1 to 12.6 km/h. The annual Potential Evapo-transpiration (PET) is 1505.7 mm.

5.2 Current SWM Management

The Urban local body (ULB) in Kozhikode is responsible for collection, transportation and disposal of Solid Waste except untreated bio-medical waste and hazardous industrial waste. Storage and segregation of waste at source is not very prominent KMC. About 281.99 MT of Municipal solid waste is generated in Kozhikode Corporation every day. The per capita waste generation is estimated to be 450 gm/cap/day considering a population of 626651. Out of this about 150 tons is collected by the Corporation every day. Therefore, the collection efficiency is 53%.

Households generate 53% of the total MSW generated in the city. It is followed by commercial establishments, hotels, street sweeping & markets. Considering 60% of solid waste generation from households & hotels, it is expected that the solid waste to be rich in organic content.
The calorific value of the waste is more than 1500 Kcal/kg.

The Corporation has provided 2 types of 15 Litre buckets to each household – green bucket for bio degradable waste and white bucket for non biodegradable waste. The waste is segregated and collected at source in these buckets. The primary waste collection is carried by Push cart, Auto Tipper and Tipper Trucks in these wards. The sweepers employed by the municipality could clean only the main roads and central areas daily. They keep the waste in small heaps which are removed by a hand cart crew and coverage is limited. KMC operates 36 numbers of secondary collection points out of which 29 are open collection points. In almost all the wards there are temporary collection points. At some points open containers are placed by the municipality. People leave the waste at the nearest containers. Most of the time these containers will be overflowing and the waste will be deposited around the containers. KMC is operating covered tractor trailers and covered LCV to transfer the waste collected from primary collection vehicles directly to the secondary transportation vehicle. A mixed fleet of vehicles which are under operation include Dumper placer, covered tractor trailers, two compartment covered LCV, tipper trucks and ordinary tractors. There are 32 vehicles out of which on an average 24 vehicles are in operation.

Waste segregation at source is not a general practice. Households which are given the bins segregate the organic and inorganic waste at source itself. An informal sector consisting of rag pickers, sub depots buying recyclables from rag pickers, and major depots sorting and selling waste to recyclers separate plastic, paper, glass and metal to an extent. Some of the households and commercial establishments also separate recyclables and sell directly to vendors . With door to door collection, Kudumbsree units also separate recyclables and sell to sub depots.

The Municipal Corporation owns a compost plant at Njalianparambu, 8km away from city centre, in Cheruvannur Panchayat. The wastes are being processed in the plant and converted into Bio-manure. The wastes are being heaped into windrows and treated with adequate inoculum and then subjected to aerobic composting. The reject from the compost plant are dumped around the compost plant. The area which is around compost plant is totally filled with large heaps of waste, which are partly remediated.

It is proposed to develop the entire ISWM project with provision of only 10% rejects going into the landfill site. The entire project is being proposed on 12.67 Acres based on PPP format. Future waste projections from the year 2017 till 2041 have been carried out considering a catchment of 30 KM around Njalianparambu site. Municipalities, which are covered in this catchment include Feroke, Kondotty, Kozhikode, Parappanangadi, Tanur, Tirurangadi, Quilandy, Ramanattukara, Olavanna, Kadalundi and Kunnamangalam . Assumptions, which have been made are given below.

5. **Per capita waste generation - 400 gm**
6. **Total population for all municipalities (2017) - 962006**
7. **Estimated waste per day - 384.8 tons**
8. **Collection Efficiency - 70% - 75%**

The total waste generated per annum ranges from 1,03,897 tons in 2017 to 2,03,940 tons in 2041. Overall site assessment is shown below.

Sl. No	SWM 2016 Criteria for Sanitary Landfill/Plant	Status	Remarks
1	100 meter away from river		
2	200 meter away from a pond		
3	200 meter away from Highways, Habitations, Public Parks and water supply wells	EIA required if sanitary landfill site is proposed with the plant (Operator's Responsibility)	Habitation just few meters from the site & the site is just besides NH 17
4	20 km away from Airports or Airbase		
5	Within the flood plains as recorded for the last 100 years, zone of coastal regulation, wetland, Critical habitat areas, sensitive eco-fragile areas		
	Complied with EIA requirement		
	Complied		

The entire project is proposed to be completed in two stages in 24 months. Site is suitable for Integrated Solid Waste Management Facility provided safeguards are in place as per SWM Rules 2016.

Annexure – 1

Landfill Design Calculations

Design of Land Fill Site Trenches for Town			
TOTAL AREA FOR LANDFILL SITE:-		**Acres**	
Design Criteria	**Formula**	**Design for disposal of waste from the year 2017 to 2021**	
Waste to be disposed of in to land fill site up to design period of 30 years	W_{d25} or W_{d1}	66952.31	Tons
Density of compacted waste	d	0.70	Tons / cum
Volume of waste required to be disposed of	V_{25} or $V_1 = W_{d25}$ or W_{d1}/d	95646.16	Cum
Depth of land fill below ground	D_b	5.00	meter
Height of land fill above ground	D_u	15.00	meter
Thickness of liners & filter media	t_l	1401.50	mm
Top length of one trench	L	120.00	meter
Top width of trench	B	120.00	meter
Side slope above meter from ground (H:V)	S_s	3.00	
Side slope blew meter from ground (H:V)	S_s	3.00	
Bottom length of trench	$L_b = L - (2xS_sxD_b)$	90	meter
Bottom width of trench	$B_b = B - (2xS_sxD_b)$	90	meter
Top length of fill above from ground	$L_u = L - (2xS_sxD_u)$	30	meter
Top width of fill above from ground	$B_u = B - (2xS_sxD_u)$	30	meter
Volume of waste filled in one trench	$V_{t1} = [\{(LxB)+(L_bxB_b)\}xD_b/2\}] + [\{(LxB)+(L_uxB_u)\}xD_u/2\}]$	1,71,000	Cum
Number of trenches required (aasuming 100% collection efficiency)	$N_t = V_{25}$ or V_1 / V_{t1}	0.56	
Say	as per drawing one trench would be developed os same volume	1	No.

Calculation of leachate quantity

Landfill plan area of year 2018 (17800)	17800 m^2
Average annual rainfall (2018)	715 mm
Average rainfall for one month period	60 mm/month
Assuming 50% or rainfall turning as leachate.	
Hence, Average volume of leachate collected	297 m^3/month