Sindh Solid Waste Management Board

WASTE AMOUNT CHARACTERIZATION SURVEY IN MALIR, SOUTH, EAST & WEST DISTRICTS OF KARACHI

Final Report

July 2021

Project Procurement International (PPI)
Office # 26, Second Floor, Silver City Plaza, G-11 Markaz, Islamabad
Telephone: 051 236 3624 Cell: 0300 8540195; Fax: 051 236 3624
E-mail: projectpi@gmail.com; Web: www.projectpi.pk

Preface

Project Procurement International, the consultant, has prepared this document on the instructions of the Sindh Solid Waste Management Board for its sole and specific use. Any other person, company or institution cannot use this document or any information without prior permission of the Sindh Solid Waste Management Board. If anyone uses any information contained herein (report), do so at their own risk.

The report is developed in compliance with the Terms of Reference set for the Waste Amount Characterization Survey for District Malir, South, East & West, Karachi. The findings, conclusions and recommendations set out in the report are solely those of the consultant and or not binding on SSWMB or on any other organization.

The consultant would like to thank all those who assisted in the survey, particularly Mr. Zubair Ahmad Channa, Managing Director, SSWMB, Dr Shahzada Irshad Mohammed, CLICK, Deputy Directors of Malir, South, West & East Karachi, and the staff of SSWMB.

Executive Summary

Efficient and sustainable management of solid waste is getting more attention at national and local levels. Sindh Solid Waste Management Board (SSWMB) collects and disposes of municipal solid waste in its jurisdiction. The amount of solid waste collection and disposal is based on the quantity of waste carried by each vehicle to the dumping site. However, the exact waste generation, according to the population estimate, has not been carried out. Similarly, the physical and chemical Characterization of solid waste has not been determined.

The main objective of the study is to carry a study to estimate the waste composition, its physical and chemical composition in the District Malir, South, West & East of Karachi Division.

The study will analyze the Waste to Energy (WtE), RDF and MRF potential of waste generating in District Malir, South, West & East of Karachi Division.

An open-ended exploratory methodology was adopted for conducting the Waste Amount Characterization Survey in District Malir, South, West & East in Karachi Division. To get a representative sample from each zone and get the overall picture. The method adopted was ASTM D 5231 – 92 (2003).

The present population of Malir district is 2,108,514. The land use analysis of Malir district shows that Malir is predominantly 96% residential area, Landhi is 57% residential and 40% industrial area, whereas Bin Qasim is 36% residential and 60% industrial area.

An allowance of 10% for commercial areas and 30% for Bulk and industrial areas have been made for Malir District. The overall solid waste generation has been worked as 0.629 kg/capita/day, and 1,325 tons/day of solid waste is generated daily.

Overall, in Malir District, the major fraction of MSW was organic waste and shared 38.23% of the total waste, mostly consisting of kitchen waste, food, and fruits that are spoiled and fermented food waste. A second major part of MSW was plastic waste (including wrappers, bags, Styrofoam, etc.) and shared about 16.26% of the total generated solid waste. Dust and silt comprised 15.59% of the MSW, followed by textile at 10.35%, Pamper / Diapers / Sanitary Pads at 7.20%, residue material remaining on the sheet at 5.21%, grass and wood at 2.78% and Leather and Rubber at 1.36%. All the remaining items were less than 1%.

District East Karachi is in the South-eastern part of Karachi with a population of 3,015,256. There are two zones, namely Gulshan and Jamshed. The land use analysis of East district shows that Gulshan Zone is predominantly 97% residential area and only 3% is commercial area whereas, Jamshed Zone too is 98% residential area and only 2% commercial area.

An allowance for 10% for commercial areas and 5% for bulk and industrial waste has been made for district East Karachi. The overall solid waste generation has been worked as 0.516kg/capita/day, and 1,557 tons/day of solid waste is generated daily.

Overall, in District East, the major fraction of MSW was organic waste and shared 48.09% of the total waste, mostly consisting of kitchen waste, food, and fruits that are spoiled and fermented food waste. A second major part of MSW was plastic waste (including wrappers, bags, Styrofoam, etc.) and shared about 18.97% of the total generated solid waste. Pamper / Diapers / Sanitary Pads comprised 9.14%, textile at 8.29 %, paper at 3.71%, Grass and Wood

at 3.48% and residue material remaining on the sheet at 2.89%. All the remaining items were less than 1%.

District South Karachi is in the South-eastern part of Karachi with a population of 1,475,638. The district is comprised of two zones, i.e., Lyari and Saddar. The land use analysis of Lyari Zone is predominantly 83% residential area, 8% commercial, and 9% industrial area, whereas Saddar Zone is 69% residential, 21% commercial and 10% industrial area.

An allowance for 15% for commercial areas and 15% bulk and industrial waste has been made for District South Karachi. The solid waste generation has been worked as 0.584 kg/capita/day, and 861 tons/day of solid waste is generated daily.

Overall, in District South, the major fraction of MSW was organic waste and shared 52.74% of the total waste, mostly consisting of kitchen waste, food waste, including fruits that are spoiled and fermented. A second major part of MSW was plastic waste (including wrappers, bags, Styrofoam, etc.) and shared about 19.54 % of the total generated solid waste. Textile comprises 8.12% Pamper / Diapers / Sanitary Pads at 6.08%, soil/dust at 3.73 % and residue material remaining on the sheet at 2.84%. Wastepaper comprised only 1.81%, followed by Grass and Wood at 1.57%, Ceramics, stone at 1.17%. All the remaining items were less than 1%.

District West Karachi is in the South-eastern part of Karachi with a population of 4,459,587. The district West Karachi is comprised of four zones, i.e., Baldia, Kemari, Korangi and SITE. The land use analysis of Baldia is prenominal 93 % is a residential area, 3% commercial and 4% industrial area; Kemari 60% residential, 12% commercial and 28% industrial area; Korangi is 97% residential, 1% commercial, and 2% industrial area; and SITE is 38% residential, 1% commercial and 61% industrial.

An allowance for 10% for commercial areas and 30% for bulk and industrial waste has been made for District West Karachi. The overall solid waste generation has been worked as 0.629 kg/capita/day, and 2,803 tons/day of solid waste is generated daily.

Overall, in District West, the major fraction of MSW was organic waste and shared 49.48% of the total waste, mostly consisting of kitchen waste, food waste, including fruits that are spoiled and fermented. A second major part of MSW was plastic waste (including wrappers, bags, Styrofoam, etc.) and shared about 20.34% of the total generated solid waste. Textile comprises 6.52%, Pamper / Diapers / Sanitary Pads at 5.65%, residue material remaining on the sheet at 4.61%, the soil at 4.16% and ceramics at 3.27%. Wastepaper comprised only 1.83%, followed by Grass and Wood at 1.52%. All the remaining items were less than 1%.

The density of solid waste in District Malir, South, East and West were 333.711 kg/m^3, 289.487 kg/m^3, 303.51 kg/m^3, 366.788 kg/m^3, respectively.

During this survey, the moisture content of District Malir, South, East and West was 44.74%, 57.51%, 43.82% and 50.74%, respectively. The average value of moisture content is 49.20%.

The volatility of solid waste was studied in this survey. The volatile matter for District Malir was at 32.71%, 26.96% in District South, 33.20% at District East and District West the volatile matter was 28.15%. On average, the volatile matter is 30.26%.

Considering the waste characteristics, the waste amount for treatment and the technologies that are practical for developing countries[1], the following five technical options, including

[1] http://gwmc.com.pk/media/downloads/iswm-master-plan-in-gujranwala-volume-02.pdf

composting, MRF and waste to energy (incineration and RDF), and biogas, were selected to further study as possible intermediate treatment facilities for the four districts of Karachi division.

Based on the Waste Amount Characterization Survey findings, the potential uses of the waste stream as a resource have also been considered. The total number of recyclable materials is 23.34%. There is a potential for the establishment of Material Recovery Facilities at Garbage Transfer Stations.

The percentage of biodegradable wastes, i.e. kitchen waste, grass, wood, hairs and bones, accounts for 50.69% of the solid waste generated in all four districts combined. Kitchen waste also has a high percentage of moisture, i.e., 49.20%; therefore, composting has a high potential. Further, the average carbon to nitrogen ratio was found out to be 30.5, which is in the range for composting (25 - 40).

The energy content (average LCVwb) of District Malir and District East was 1,531 kcal/kg (6.41MJ/kg) and 1,520 kcal/kg (6.36 MJ/kg), respectively. The energy content (average LCVwb) of District South and West was 1,204 kcal/kg (5.04MJ/kg) and 1,310 kcal/kg (5.48 MJ/kg). In general, the average lower calorific value of waste should be at least 7 MJ/kg (1,671 kcal/kg) and must never fall below 6 MJ/kg (1,432.8 kcal/kg). Without this value, there would be a need to constantly supply auxiliary fuel, which would increase the viability of an MSW incineration facility at risk.

Based upon the waste characterization data, it can be concluded that in order to evaluate mass incineration (Waste to Energy), the Waste Amount Characterization Survey needs to be carried out at least twice a year or preferably quarterly to obtain year-round results as seasonal factors do play an important role in the determination of constant high calorific value evaluation throughout the year. However, combustible waste takes 32% of the Municipal Solid Waste, which shows a clear potential for RDF in all the Districts of Karachi.

Based on the Qualitative Evaluation Matrix of Intermediate Waste Treatment Options for District Central and Korangi, Karachi, the most suitable technological option for handling the municipal waste generated in District Malir, South, East and West Districts is a combination of mechanical and biological treatment options enabling around 95% of the organics, recyclables and combustibles from the landfill and saving landfill airspace for a longer time, recovering the economic potential of the waste and improving the environment through reducing the methane emission from the landfill. Also, a centralized waste management facility should follow proposed steps to handle MSW in the Districts of Karachi.

Table of Contents

List of Figures

List of Tables

Abbreviations & List of Units

%	Percentage
ASTM	American Standards for Material Testing
BTU/lb.	British Thermal Unit per pound
EPA	Environmental Protection Agency
GHG	Greenhouse Gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoS	Government of Sindh
GPS	Geographical Positioning System
GTS	Garbage Transfer Station
ISWA	International Solid Waste Association
IUCN	International Union for Conservation of Nature
kg	Kilogram
kg/c/day	Kilogram per capita per day
KP	Khyber Pakhtunkhwa
m^3	Cubic Metre
MJ/kg	Mega Joule per kilogram
mm	Millimetre
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
PET	Polyethylene Terephthalate
PKR	Pakistani Rupees
PPI	Project Procurement International
RDF	Refuse Derived Fuel
Rs.	Pakistani Rupees
sec	Seconds
Sq. km	Square kilometre
Sr. No	Serial Number
SGS	Société Générale de Surveillance (SGS)
SWM	Solid Waste Management
SSWMB	Sindh Solid Waste Management Board
UC	Union Council
WB	World Bank
WGR	Waste Generation Rate
WHO	World Health Organization

1 Introduction

1.1 Background

Karachi is one of the largest metropolitan cities in the world. Having a 16.05 million (2017 Census) population, the city has expanded exponentially over the last 30 years. Having a total area of 3,780 square kilometers, with a significant area still barren with mixed terrain rolling in the southern half and hilly on the north side of the city. The built-up area of Karachi amounted to about 379.09 square kilometers, which has been increased to about 328.56 square kilometers. Thus, the authorities responsible for maintaining and managing the municipal services face challenges in delivering public service to the citizens.

A very high demand scenario always existed specifically for improving rates of integrated waste reduction, reuse, recycling, and conversions systems for the entire metropolis while addressing health, environmental, climate change and safety concerns against the substantial probability of environmental disasters.

Sindh Solid Waste Management Board is mandated to perform municipal service within the municipal jurisdiction of any local council (after approval from the competent forum) through outsourcing, SSWMB since its inception, has outsourced Front End Collection of solid waste in four out of six Districts of Karachi Division. Presently, contractual arrangements of the solid waste management have not been successful in providing desired performance in providing core services of door-to-door collection of garbage, manual and mechanical sweeping, timely and efficiently lifting and cleaning of garbage, sorting and segregation of the collected and finally transportation to the designated landfill sites.

Current contract agreements also lack proper incentives for the improvement of service delivery and operational performance. Contacts also fail to include value recovery activities such as monetization of recyclables which may help offset public spending on the sector.

SSWMB is collecting and disposing of the municipal solid waste in its jurisdiction. The amount of solid waste collection and disposal is based on the quantity of waste carried by each vehicle to the dumping site.

This Waste Amount Characterization Survey (WACS) provides information about the types and amounts of the materials that are in the waste stream. The analysis enables local authorities to gather information on the range of materials in their waste stream and the amount of each of these materials, and their relative proportions in their waste.

This study has focused only on municipal solid waste characterization and the physical and chemical composition of solid waste produced in SSWMB jurisdiction in the year 2021.

1.2 Scope of Work

The scope of work designed to address the objectives as mentioned earlier for the study is to.

- Quantify the solid waste composition from GTS and Landfills.
- Parameters used for testing and analysis will be physical and chemical composition, moisture content, and ash.
- Find out the density of municipal solid waste at GTS.

- Compare the findings of this study with previous studies conducted by any other institute/organization.
- Analyze the potential revenue streams generated from the MSW
- Formulate recommendations based on findings of the study for the potential use of waste stream as a resource.

1.3 The objective of the Study

The main objective of the study is to carry a study to estimate the waste composition, its physical and chemical composition in the District Malir, South, West & East of Karachi Division.

The study will analyze the Waste to Energy (WtE), RDF and MRF potential of waste generating in District Malir, South, West & East of Karachi Division.

1.4 Organization Preparing the Report

M/s Project Procurement International, an Environmental and Management Consultancy Firm, Islamabad, has carried out the Waste Amount Characterization Survey of District Malir, South, East & West.

The list of names, qualifications and roles of team members carrying out the WACS and the brief profile of PPI has been provided as **Annexure-1**.

1.5 Significance of the Study

The study provides a research-based Waste Amount Characterization Survey in the SSWMB jurisdiction area. The results will help SSWMB to improve its solid waste management operation and determine the revenue potential of its various waste stream.

SSWMB understands that improper solid waste disposal and management can cause all types of pollution: air, soil, and water, leading to a variety of adverse impacts. The U.S. Public Health Service identified 22 human diseases that are linked to improper SWM. Exhaust fumes from waste collection vehicles, dust gushing from disposal practices and the open burning of waste also contribute to overall health problems.[2]

The main impacts due to waste mismanagement of solid waste lead to the major environmental and health risk issues as follows:

- Accumulation of wastes in the street increases contact possibilities. It offers perfect conditions for propagating germs, insects, rats, and other disease vectors such as cholera and dengue fever.
- Burning of waste causes the emission of toxic substances to the air, such as dioxins and furans.
- Uncollected wastes often clog drains and cause the stagnation of water, the breeding of mosquitoes, or water bodies' contamination.
- Respiratory disorders may result from inhaling particulate matter, bio-aerosols, and volatile organic compounds (VOCs) during collection and disposal.
- Sanitary workers and waste pickers are prone to Punctures or injuries caused by pieces of glass, needles, or other objects, which is very common. This can lead to

[2] The Sustainable World 381 www.witpress.com, ISSN 1743-3541 (on-line) WIT Transactions on Ecology and the Environment, Vol 142, © 2010

infections, tetanus, hepatitis, or HIV, especially if the wastes contain hazardous and medical materials.

- Health and safety issues to the population also arise from improper solid waste management, such as greenhouse gases are generated from the decomposition of organic wastes in landfills, and untreated leachate can pollute surrounding soil and water bodies.[3]

Possible environmental and health risks due to waste open burning and open dumping for municipal solid waste includes

- The leachate generated is released to the soil, polluting groundwaters mainly used for drinking and household purposes. The risks concern the health of the population through direct and indirect (agriculture) intake.
- The generation of methane and other GHGs increases global warming, the risk of local fires and the pollution of the atmosphere surrounding the final disposal sites
- The breeding of animals around the disposal sites and rodents and insects increases the risks of diseases transferring to the population through bites and direct contact with the animals.
- The uncontrolled disposal causes the release of waste fractions, mainly plastics, into water bodies, contaminating the rivers, lakes and then the oceans and the seas, causing marine littering.

The emissions due to uncontrolled waste fires produce significant amounts of contaminants that affect the population's health. Respiratory illnesses, especially in children, are common in areas with open burning practices. The generation of Carbon Monoxide, Carbon dioxide and other Greenhouse Gases affects the Global Warming Potential (GWP) more than the anaerobic degradation of organic waste.[4]

1.6 General Overview of Solid Waste Management Practices

Solid Waste Management is the generation, separation, collection, transfer, transportation, and disposal of waste in a way that considers public health, economics, conservation, aesthetics, and the environment and is responsive to public demands.[5]

Aside from a technical issue, solid waste management is strongly influenced by political, legal, social, cultural, environmental, economic, and available resources. All these issues need to be addressed to reach a sustainable solid waste management action. It must be stressed that the lack of environmental legislation itself is not the heart of the problem. Instead, it is the lack of enforcement and/or the availability of viable alternatives.

The contradiction between increasing waste-generation rates and decreasing waste-disposal capacities is very important with the rapid socio-economic development. In response to this concern, the development of effective MSW management strategies with satisfactory economic and environmental efficiencies are highly desired.[6]

---

[3] The Sustainable World 381 www.witpress.com, ISSN 1743-3541 (on-line) WIT *Transactions on Ecology and the Environment, Vol 142, © 2010*

[4] Un-Habitat. (2010). *Solid waste management in the world's cities*. UN-HABITAT

[5] Iliyas, M. (2008). Disposal of Waste. Eds.: Iliyas M, Shah KS. Public Health and Community Medicine. 7th edition. Karachi: Time Publisher, 261-273.

[6] Al-Maaded, M., Madi, N. K., Kahraman, R., Hodzic, A., & Ozerkan, N. G. (2012). An overview of solid waste management and plastic recycling in Qatar. *Journal of Polymers and the Environment*, *20*(1), 186-194.

The financial cost of the MSW should be considered, as Asian countries alone spent about US$25 billion on solid waste management per year in the early 1990s; the figure is expected to rise to around US$50 billion by 2025.[7] Land disposal is the most common method adopted. In developed countries, well-managed landfills are governed by local councils that provide regular construction and maintenance.[8]

On the other hand, the waste in less legislated regions is disposed of in open dumps, which leads to severe environmental degradation and results in the loss of natural resources.

The comparison of practices in solid waste management between high, middle & low-income countries is shown in **Table 1.1**. Similarly, waste management practices in different studies of Pakistan are mentioned in **Table 1.2**.

[7] Hoornweg D, Thomas L (1999) What a waste: solid waste management in Asia. World Bank Urban waste management working paper series no. 1, Washington
[8] Department of Energy (DOE/EIA) (1999) Report of greenhouse gas: methane emission from energy end use. EPA, USA

Table 1.1:Comparison of Solid Waste Management Practices in high, middle, and low-income countries

Activity	Low Income	Middle Income	High Income
Source Reduction	No organized programs, but reuse and low per capita waste generation rates are common.	Some discussion of source reduction, but rarely incorporated into an organized program.	Organized education programs emphasize the three 'R's' — reduce, reuse, and recycle.
Collection	Sporadic and inefficient. Service is limited to high visibility areas, the wealthy, and businesses willing to pay. A high fraction of inert and compostables impact collection—overall collection below 50%.	Improved service and increased collection from residential areas. Larger vehicle fleet and more mechanization. The collection rate varies between 50 to 80%. Transfer stations are incorporated into the solid waste management system.	Collection rate greater than 90%. Compactor trucks and highly mechanized vehicles and transfer stations are common. Waste volume is a key consideration. Ageing collection workers are often a consideration in system design.
Recycling	Although most recycling is through the informal sector and waste picking, recycling rates tend to be high for local markets and international markets and imports of materials for recycling, including hazardous goods such as e-waste and ship-breaking. Recycling markets are unregulated and include a number of 'middlemen'—large price fluctuations.	The informal sector is still involved; some high technology sorting and processing facilities. Recycling rates are still relatively high. Materials are often imported for recycling. Recycling markets are somewhat more regulated. Material prices fluctuate considerably.	Recyclable material collection services and high technology sorting and processing facilities are common and regulated. Overall, recycling rates are higher than low and middle income. Informal recycling still exists (e.g. an aluminium can collection.) Extended product responsibility is common.
Incineration	Not common, and generally not successful because of high capital, technical, and operation costs, the high moisture content in the waste, and a high percentage of inert material.	Some incinerators are used but experiencing financial and operational difficulties. Air pollution control equipment is not advanced and often bypassed—little or no stack emissions monitoring. Governments include incineration as a possible waste disposal option but costs prohibitive.	Prevalent in areas with high land costs and low availability of land (e.g., islands). Most incinerators have some form of environmental control and some type of energy recovery system. Governments regulate and monitor emissions.

Activity	Low Income	Middle Income	High Income
Landfilling/ Dumping	Low-technology sites usually open the dumping of wastes. High polluting to nearby aquifers, water bodies, settlements. Often receive medical waste. Waste is regularly burned—significant health impacts on local residents and workers.	Some controlled and sanitary landfills with some environmental controls. Open dumping is still common. CDM projects for landfill gas are more common.	Sanitary landfills with a combination of liners, leak detection, leachate collection systems, and gas collection and treatment systems. Often problematic to open new landfills due to concerns of neighbouring residents. Post-closure use of sites is increasingly important, e.g. golf courses and parks.
Costs	Collection costs represent 80 to 90% of the municipal solid waste management budget. Some local governments regulate waste fees, but the fee collection system is inefficient. Only a small proportion of the budget is allocated for disposal.	Collection costs represent 50% to 80% of the municipal solid waste management budget. Waste fees are regulated by some local and national governments, more innovation in fee collection e.g. included in electricity or water bills	Collection costs can represent less than 10% of the budget—large budget allocations to intermediate waste treatment facilities. Upfront community participation reduces costs and increases options available to waste planners (e.g., recycling and compost).

Source: Urban Development Series – Knowledge Papers, World Bank (*http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/Chap2.pdf*)

Table 1.2:Comparison of Solid Waste Management Practices in major cities of Pakistan

Activity	Lahore	Peshawar	Karachi
Source Reduction	No large scale and consistent programs are promoting source reduction, reuse and recycling. Lahore Waste Management Company carries out a cleanliness awareness drive occasionally. The activity aimed at briefing the public about the importance of cleanliness and plantation for a healthy life. [9]	No large scale and consistent programs are promoting source reduction, reuse and recycling. WSSP holds cleanliness drives, awareness drives and events such as Green Clean Peshawar. Community-based Mobilization sessions are planned in all 43 UC's of Peshawar for the awareness of the general public on the subject of WASH (Water and Sanitation, Hygiene)[10]	No large scale and consistent programs are promoting source reduction, reuse and recycling. Sindh Solid Waste Management Board holds cleanliness drives, awareness drives and events such as PSL cleaning activities.
Collection	Lahore Waste Management Company has outsourced collecting and lifting its solid waste to International Companies, namely Albaryak and Ozpak. [11]LWMC has an IT-based monitoring system of vehicles. The collection system of Lahore is considered the best in Pakistan.	WSSP is in charge of waste collection and transportation.	Sindh Solid, Waste Management Board, has outsourced four districts of Karachi Division for collection and lifting of its solid waste to International Companies.
Recycling/Treatment	There is no formal sorting of waste, and this activity is mainly in the hands of informal sector scavengers. Most of the recyclable materials consist of a variety of paper, cardboard, metal scrap, plastics, pet bottles, dry bread, heals of shoes, bones etc. The price of an item depends on its quality or agreement among scavengers and contractors.[12] Lahore is one of the few cities where there are a compost plant and an RDF facility. However, both these facilities were not very successful.	There is no formal sorting of waste, and this activity is mainly in the hands of informal sector scavengers. The government has planned to build a Refuse Derived Fuel (RDF), Composting Plant and possibly a Waste to Energy Power Plant.[13]	Recyclable material collection services and high technology sorting and processing facilities are common and regulated. Overall, recycling rates are higher than low and middle income. Informal recycling still exists (e.g. an aluminium can collection.)
Landfilling/ Dumping	Lahore is the only place in Pakistan with an engineered sanitary landfill named Lakhodair Landfill.	The Water and Sanitation Services Peshawar (WSSP) is planning to build a sanitary landfill.	There are two landfill/ dumping sites in Karachi. However, Karachi still lacks an engineered sanitary landfill.

[9] http://albayrak.com.pk/clean-green-lahore-albayrak-team-distributes-saplings-among-citizens-to-promote-plantation/
[10] http://wssp.gkp.pk/en_US/#1461328919259-f69cd27c-5029
[11] https://www.lwmc.com.pk/index.php
[12] M Asim, S A Batool, M N Chaudhry, Scavengers and their role in the recycling of waste in Southwestern Lahore, Resources, Conservation and Recycling 2011
[13] https://www.bioenergyconsult.com/peshawar-swm/

2 WACS Survey Methodology

2.1 Introduction

An open-ended exploratory methodology was adopted for conducting the Waste Amount Characterization Survey in District Malir, South, West & East in Karachi Division.

2.1.1 Literature Review and Sampling Methodology

The existing information and documents on Solid Waste Management in Pakistan have been reviewed and analysed, such as Solid Waste Management Rules and Guidelines, Municipal Solid Waste Management Treatment and Disposal studies prepared by the Federal/Provincial Governments of Pakistan, International Donors, Public and Private Sector Organizations.

The literature review has provided a better understanding of solid waste management practices being adopted in Karachi and facilitated preparing data collection tools for the Waste Amount Characterization Survey.

Several previously conducted Waste Amount Characterization Surveys in Pakistan were reviewed, particularly their methodology and sample size. The methodologies and sample size review enabled finalizing a sample size and methodology applicable in Pakistan's context.

2.1.2 Determination of Survey Method and Sample Size

There is currently no agreed international standard for waste stream analysis or waste generation and composition surveys. However, many European countries have their national procedures. According to Dahlen and Lagervist, 2008[14], there are almost 20 methods available internationally, which are used in the waste generation and composition surveys. Similarly, Pakistan also does not have any standardized method for conducting the Waste Amount Characterization Survey. Therefore, to get a representative sample from each zone and get the overall picture, ASTM D 5231 – 92 (2003) method was applied.

The ASTM D 5231 – 92 (2003) states the number of samples to be sorted is calculated based on statistical criteria selected by the investigators.

According to the ASTM standard, the formula for calculating sorting samples is determined by the following formula:

$$n = (t^* \, s/e \cdot \bar{x})^2 \qquad (1)$$

where:

t^* = student t statistic corresponding to the desired level of confidence,

s = estimated standard deviation,

e = desired level of precision, and

$\bar{x}$ = estimated mean.

Food Waste is selected as the governing component. A 90% confidence level is selected.

[14] Lisa &Anders, 2008, Methods for household waste composition studies, Waste Management 28 (2008) 1100–1112

A precision of 10% is desired. Therefore:

n	Required level of vehicle loads	
t*	Student t statistic corresponding to the desired level of confidence	1.645
s	estimated standard deviation	0.03
e	estimated level of precision	0.1
x	estimated mean	0.1

$$n = ((t^*.s)/(e.x)^2$$

N_0= 24.35

Referring to Table 4 of ASTM D 5231 (2003)

t^*_{90} (n = 24) = 1.714

n = 26

Table 2.1 shows the sampling scheme for the District Malir, South, East & West of Karachi Division. The sampling scheme has been developed considering the logistics and convenience to carry out the survey.

Table 2.1: Sampling Program for WACS in District Malir, South, East & West

Phase II - ASTM Characterisation at GTS - Vehicle Load Basis														
District	**Karachi Malir**		**Karachi East**		**Karachi South**		**Karachi West**				**Landfills**		**Total**	
	Date: 29/3/21	**Date: 30/3/21**	**Date: 31/3/21**	**Date: 1/4/21**	**Date: 2/4/21**	**Date: 3/4/21**	**Date: 5/4/21**	**Date: 5/4/21**	**Date: 6/4/21**	**Date: 6/4/21**	**Date: 7/4/21**	**Date: 7/4/21**		
	KM	KM	KE	KE	KS	KS	KW	KW	KW	KW	Jam Chakro	Gond Pass		Remark
Zones	Malir	Landhi	Jamshed	Gulshan	Lyari	Saddar	SITE	Korangi	Baldia	Kemari				
GTS	Sharafi		Imtiaz		Dhobi Ghat		Guttar Baghicha	German Playground	Qabristan	Truck Stand				At every GTS, samples from 5 vehicles coming from every zone were sampled.
No of Samples	5	5	5	6	5	5	5	5	5	5	2	2	55	
Total	5	5	5	6	5	5	5	5	5	5	2	2	55	
													26	Sample Size as per ASTM. The sample size is 54% higher than the required by ASTM.

2.1.3 Relevance of selected methodology in the national/international context

U.S. standard ASTM D5231 "Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste" has been considered for characterization study.

In the national context, this methodology/sample size has been adopted in Lahore. In the study, a total of 48 vehicles loads (sample size) were segregated for one week.[15]

The sample size for Waste Amount Characterization Survey in District Malir, South, West and East, Karachi has been kept high.

2.2 Survey Method

The Waste Amount Characterization Survey started with an orientation meeting with SSWMB regarding the selection of GTS located in Malir, East, West and South Karachi districts.

WACS Team: A total of 6 sanitary workers, laborers and supervisors were hired for the conduct of WACS in Malir, East, West and South Karachi districts. The consultant's team comprised of a Team Leader, two Environmental Engineers and two data collector supervisors. SSWMB nominated one focal person for coordination with the PPI team during the conduct of the survey.

HSE Plan for the Sanitary Workers: Personal Protective Equipment (PPEs) like gloves, masks, long boots, the Hi-Viz jacket were provided to the sanitary workers and laborers. Training on the use and importance of PPEs was imparted to the whole team with specific reference to Covid-19. A first-aid box was kept at the waste segregation site in case of injuries. Sanitary workers were made aware of the first aid facility availability and an emergency number to contact the nearest health facility.[16]

The team was briefed on the conduct of WACS, particularly on taking the waste sample from solid waste unloaded from vehicles coming from the respective zone.

Figure 2.1: PPEs and Tools used during conduct of WACS.

[15] http://lwmc.com.pk/uploads/Waste%20Characterization%20Study/July%202012%20Waste%20Charecterization%20Study%20Report.pdf

[16] *https://www.who.int/water_sanitation_health/medicalwaste/140to144.pdf?ua=1*

Survey Day Plan: The solid waste generated by the residential and commercial areas of each zone was first brought to the nearest Kachra Kundi and thereafter transported to the nearest Garbage Transfer Stations located in Malir, East, West, and South Karachi districts.

The solid waste from each incoming truck was first mixed with the help of a loader. A tag number was placed on the waste pile, which assisted in identifying the source of waste generation, i.e., zone and district name.

The solid waste samples were collected from the selected garbage trucks and brought to an open area within the Garbage Transfer Station for a characterization survey.

Waste characterization survey: A solid waste box having a total volume of 0.125 cubic meters was specifically prepared for the waste characterization survey. The solid waste box was filled from the targeted five truckloads of different garbage trucks was then emptied into different piles based on area, i.e., one pile for the sample1, 2nd pile for sample 2 and so on up to the five piles. The sorting area was solid ground at Garbage Transfer Station.

The density of waste was calculated by putting the waste into a 0.125 Cubic Meter bucket. After that, the bucket was dropped from a height of 24 -36 inches to allow the waste to settle naturally. As the solid waste settled, more waste was added to the bucket to fill it up. After this, the weight of the bucket was taken.

The formula of the calculation of waste density is

Density (D) = $Mass/Volume$

The density was calculated by dividing the weight of waste by the volume of the bucket. Then the physical Characterisation of waste was carried out as per the following 12 categories of waste:

- Kitchen waste
- Paper and cardboard
- Textile
- Grass and wood
- Plastic – all types
- Leather and rubber
- Metal and tin beverages
- Bottle and glass
- Ceramic, stone, and soil etc.
- Domestic hazardous wastes
- Residue Remaining (remaining material sheet)
- Miscellaneous: Hairs, Bone, Tetra pack, Diapers, Dust/Sieve and E-Waste

All solid waste was segregated into 12 categories for every pile of waste. The detailed description and pictorial presentation have been provided in **Annexure 2**.

2.3 Physical and Chemical Analysis of Solid Waste

2.3.1 Physical Parameters Analysis

Physical parameters of the collected waste samples were carried out at a centralized collection point, which is as follows:

Density/ Specific Weight

Specific weight is the weight per unit volume (also called density). The formula of the calculation of waste density is D = Mass/Volume.

Moisture Content

The moisture content was determined according to the ASTM D3173-03 standard. One gram of municipal solid waste was placed into an oven at 105℃ for two hours. The sample is then cooled in a desiccator and reweighed. The difference in weight represented the moisture content of the sample expressed in percentage.

The ratio of the weight of water present in waste to solid was expressed as a % of wet weight. The sample was taken to Société Générale de Surveillance (SGS) Karachi for moisture content testing.

$M = (w – d) * 100 / w$

Where m = moisture content, w = initial weight of sample (kg), d = dry wt. at 105˚ C

2.4 Summary of Conduct of Survey

The Waste Amount Characterization Survey for District Malir, South, West and East was conducted for nine days from 29th March - 7th April 2021.

A total of 5,050.761 kg of solid waste was collected from District Malir, South, East & West, Karachi. The waste amount characterization filled forms are attached as **Annexure-3**.

Table 2.2: Summary of Conduct of WACS in District Malir, South, East & West, Karachi

Districts	Survey Duration No of Days	Weight Collected from District Malir, South, East & West, Karachi				Total
		District Malir	District East	District South	District West	
Malir, South, West and East	9	675.817 kg	942.316 kg	1062.454 kg	2370.174 kg	5050.761 kg

2.4.1 Chemical Parameters Analysis of Waste

The chemical analysis of household solid waste was carried out by Société Générale de Surveillance (SGS) Karachi. A total of six samples were analyzed for proximate analysis, ultimate analysis, and calorific value.

PPI took six composite samples from 6 different waste sources samples for chemical analysis, i.e., from Malir, South, West, East and one sample each from Jam Chakro and Gond Pass Landfill site.

i. Proximate analysis

The proximate analysis was carried out to estimate the heating value of municipal solid waste fuel. It was used to determine the Characterisation of solid waste in terms of gross components of moisture, volatile matter, fixed carbon, and ash.

Volatile matter (additional loss of ignition at 950^0C):

The applicable ASTM standard D7582 for the determination of volatile matter was used. The sample used for moisture determination was again heated in a covered crucible to avoid contact with air during devolatilization. The covered crucible was placed into a furnace at 950℃ for two hours. Then the crucible was taken out, cooled in a desiccator. The weight difference due to devolatilization was referred to as a volatile matter.

Ash (residue after burning):

Ash is the inorganic solid residue left after the fuel is completely burned. The procedure used to determine ash is ASTM D3174. The remaining sample from the volatile matter calculation was placed in the furnace at 575℃ for an hour for combustion. All carbon was burnt, and the sample was cooled and reweighted.

Fixed carbon (remainder):

Fixed carbon in fuel was determined by the difference in the moisture, volatile matter, and ash contents.

FC= 100 - M - VM - ASH

Where: FC - Fixed carbon, M - Moisture, VM - Volatile matter and ASH – remaining ash

Fixed carbon represents the solid carbon in the MSW that remains in the char after the devolatilization process.

ii. Ultimate analysis

The ultimate analysis is the determination of the per cent of C (carbon), H (hydrogen), S (Sulphur) and ash.

The results are used to:

- Characterize the chemical composition of organic matter in municipal solid waste.
- Find the proper mix of waste material to obtain C/N ratios for biological conversion processes.

iii. Calorific value analysis

The calorific value of the sample was determined by using a standard bomb calorimeter. The municipal solid waste samples were dried and grounded to small particles. The particles were sieved and compressed to form pellets. The bomb was assembled and filled with pressurized oxygen of about 30 bars. The firing circuit was tested, and the calorimeter was adjusted by weighing sufficient water into the calorimeter vessel to submerge the bomb completely. The

bomb was fired, and after the temperature stabilization, the differences were noted and recorded. The calorific values of solid waste were calculated according to ASTM D5865.

2.5 Results and Findings

All the results obtained from Waste Amount Characterization Survey were recorded and analysed.

2.6 Conclusion and Recommendations

The conclusion and recommendations are made to view the socio-economic, financial, and planning aspects of solid waste management, treatment, and disposal.

A final Waste Amount Characterization Survey report is prepared as per terms of reference and submitted to SSWMB.

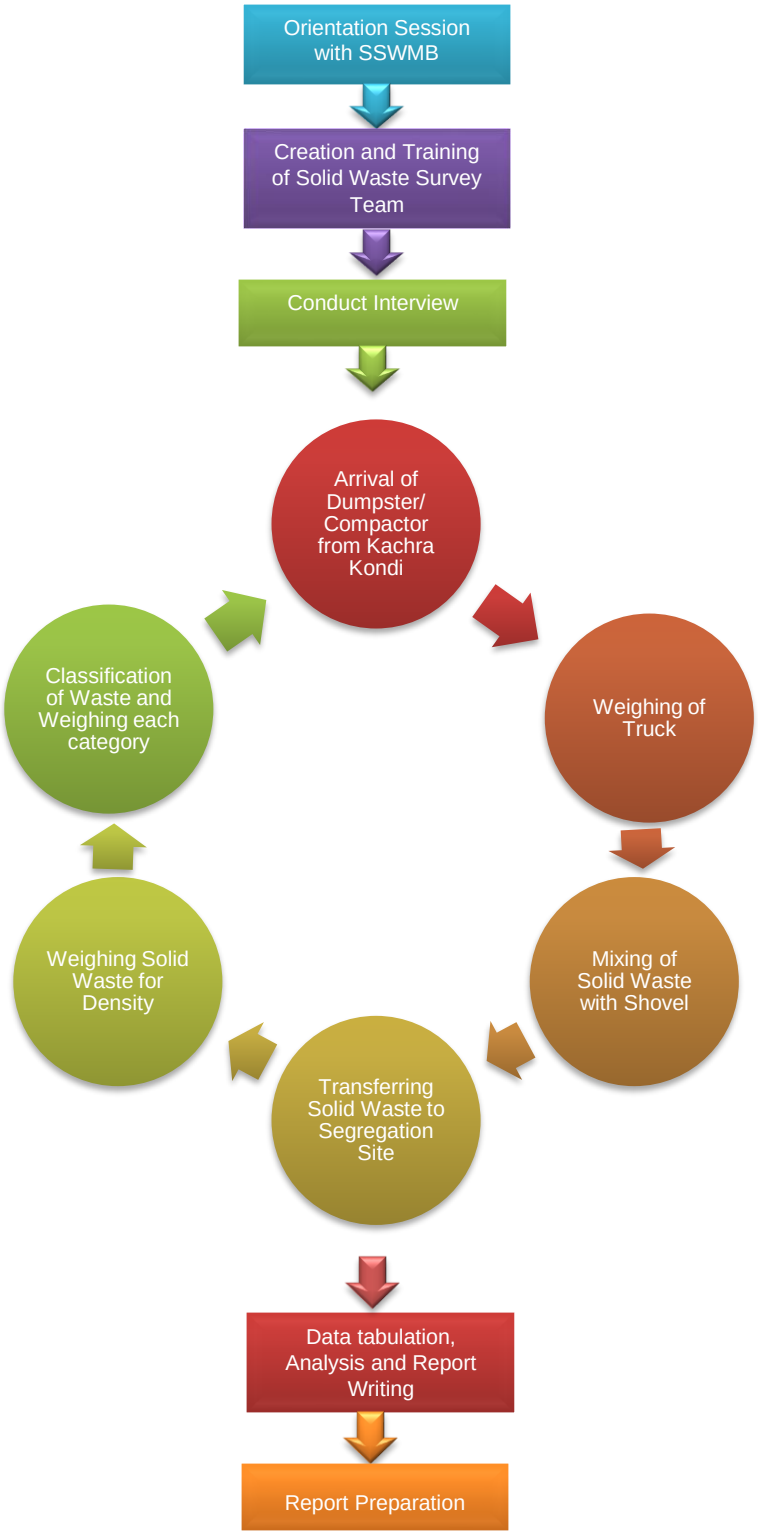
The flowsheet diagram of the survey methodology is shown in **Figure 2.2**.

2.6.1 Challenges faced during the survey

The challenges faced during the conduct of the Waste Amount Characterization Survey in District Malir, South, West and East Karachi are as follows:

- There was reluctance from the scavengers in this survey as they collected the recyclable materials from the GTS. Some of them even tried to take the waste from our garbage truck despite explaining the objectives and duration of the survey.
- Apart from the Sharafi, all the GTS were open and are under construction.

Figure 2.2: Flow Sheet Diagram of Methodology of Waste Amount Characterization Survey



Pictorial Presentation of Methodology

Exhibit 2.1: Arrival of Garbage Truck from Kachra Kondi

Exhibit 2.2: Arrival of Garbage Truck from Kachra Kondi

Exhibit 2.3: Mixing of Waste with the help of Loader

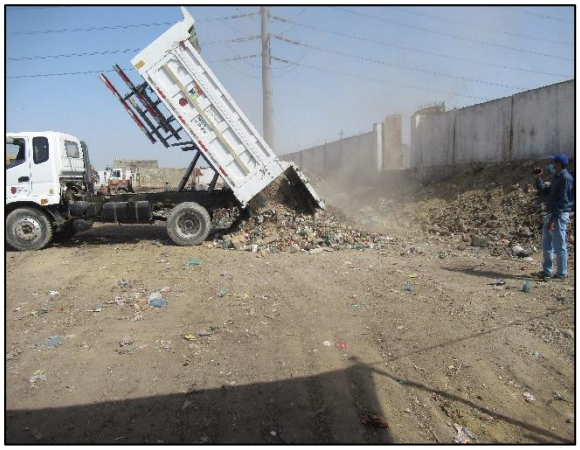
Exhibit 2.4: Mixing of Waste with the help of Loader

Exhibit 2.5: Collection of Waste for Segregation

Exhibit 2.6: Waste arrived in the Camp Site

Creation and Training of Solid Waste Survey Teams

Arrival and Mixing of Solid Waste from Kachra Kundi



Solid Waste being Collected and Transferred to Segregation Site

Weighing Waste for Density

Classification of Waste and Weighing each Component

3 Findings of Waste Amount Characterization Survey

This chapter describes the findings of the Waste Amount Characterization Survey conducted in District Malir, South, West and East Karachi.

3.1 Solid Waste Characterization Survey in District Malir, South, East and West, Division Karachi

The solid waste collected was segregated into 12 categories, as described in the methodology. The findings of the solid waste classification survey are provided in the tables given below.

3.2 Malir District, Karachi

Malir district is in the South-eastern part of Karachi with a present population of 2,108,514. The district is comprised of three zones, i.e., Bin Qasim, Landhi and Malir.

The land use analysis of Malir district shows that Malir is predominantly 96% residential area, Landhi is 57% residential and 40% industrial area, whereas Bin Qasim is 36% residential and 60% industrial area.

Table 3.1: Land use analysis of Malir District

Zone	Residential Area in %	Commercial area in %	Industrial area in %
Bin Qasim	36	4	60
Landhi	57	3	40
Malir	96	4	0

Figure 3.1: Map of Bin Qasim Zone, Malir District

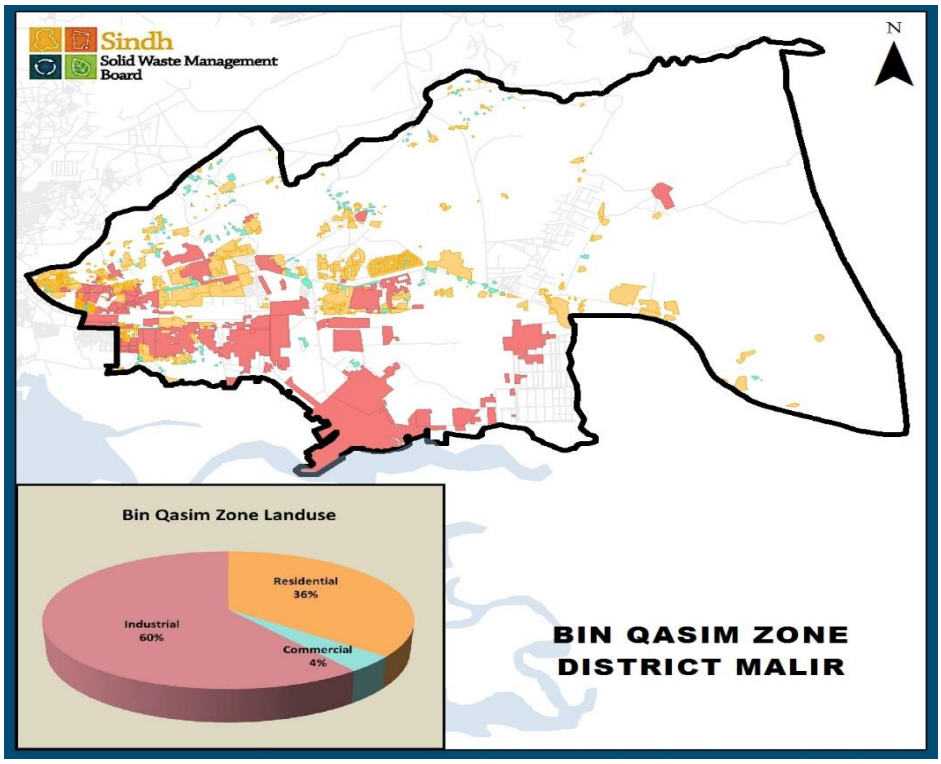


Figure 3.2: Map of Landhi Zone, Malir District

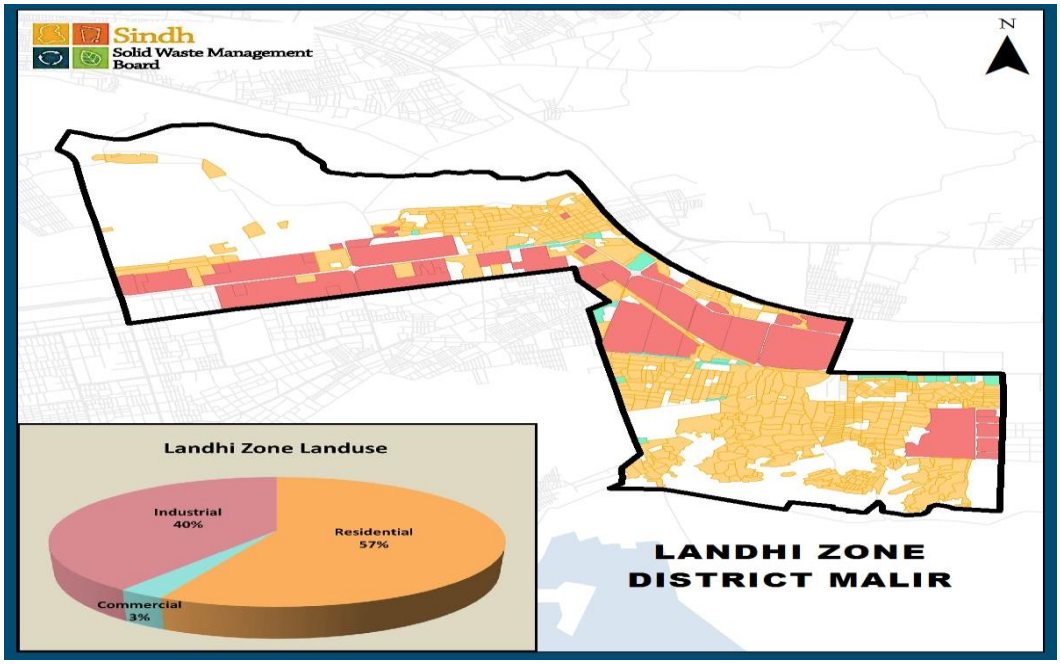
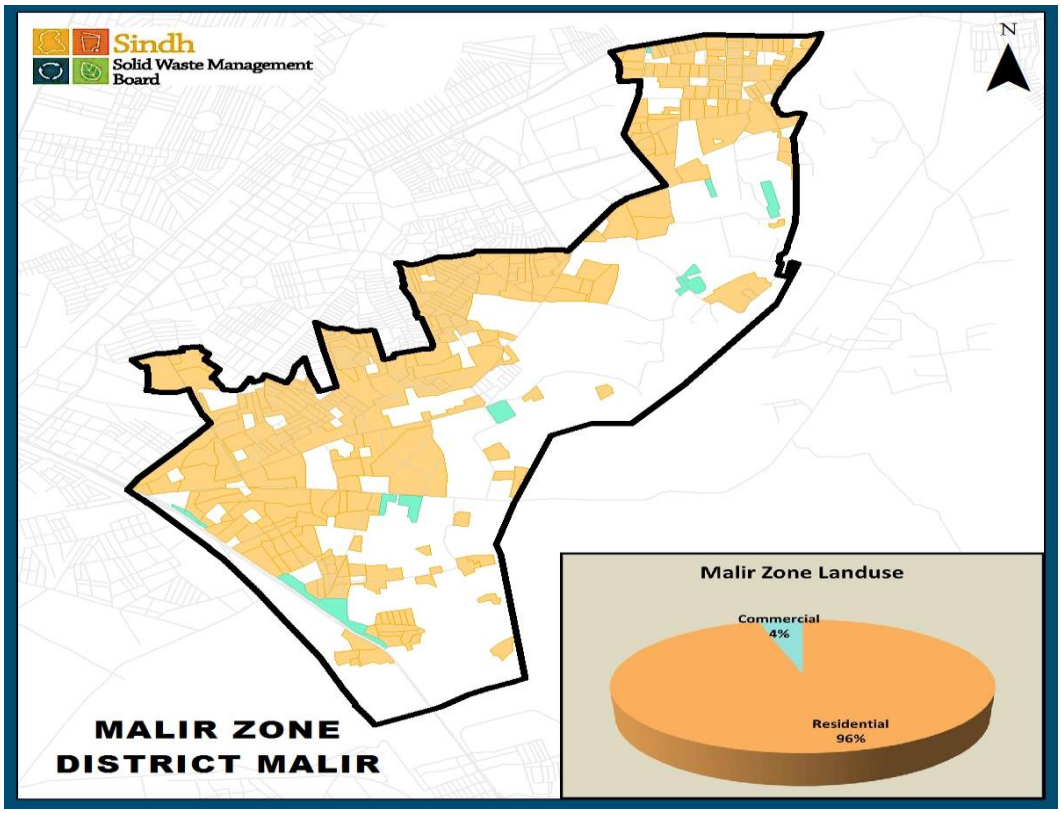


Figure 3.3: Map of Malir Zone, Malir District



3.3 Solid Waste Generation in District Malir

The present population of Malir district is 2,108,514. The residential solid waste generation rate of Karachi is 0.449 Kg/cap as per the Waste Amount Characterisation Survey of Central and Korangi District of Karachi. An allowance of 10% for commercial areas and 30% for Bulk and industrial areas have been made for Malir District.

The overall solid waste generation has been worked as 0.629 kg/capita/day, and 1,325 tons/day of solid waste is generated daily.

Table 3.2: Solid Waste Generation in Malir District

District	Population 2021	Residential Area in %	Commercial Area 10 %	Industrial area 30%	Total	Waste Generation in Tons/Day
Malir	2,108,514	0.449	0.045	0.135	0.629	1,325

3.4 Solid Waste Characterization in District Malir

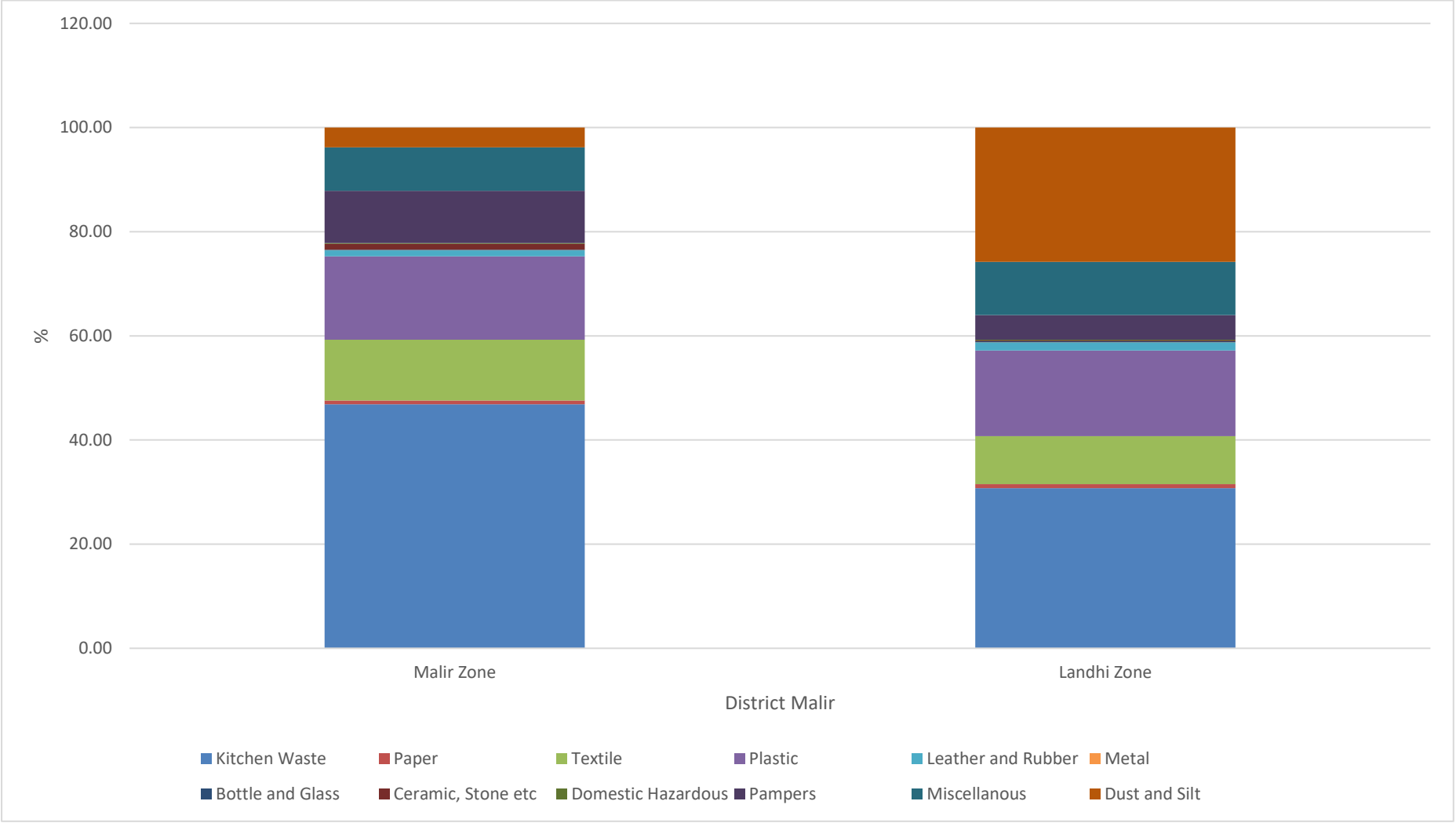
The major fraction of MSW was organic waste and shared 38.23% of the total waste, mostly consisting of kitchen waste, food waste, including fruits that are spoiled and fermented. A second major part of MSW was plastic waste (including wrappers, bags, Styrofoam, etc.) and shared about 16.26% of the total generated solid waste. Dust and silt comprised 15.59 % of the MSW, followed by textile at 10.35%, Pamper / Diapers / Sanitary Pads at 7.20%, residue material remaining on the sheet at 5.21%, grass and wood at 2.78% and Leather and Rubber at 1.36%. All the remaining items were less than 1%.

There is a notable difference in silt production in Malir and Landhi Zone. The main reason for this increased percentage is that there must be drainage cleaning activity being performed in the Landhi zone at the survey time.

Table 3.3: Characterization of MSW in District Malir

Sr No.	Item	Percentage		
		Malir Zone	Landhi Zone	Overall
1	Kitchen Waste	46.86	30.76	38.23
2	Paper	0.75	0.74	0.75
3	Textile	11.65	9.23	10.35
4	Grass and Wood	0.56	4.71	2.78
5	Plastic	16.03	16.45	16.26
6	Leather and Rubber	1.11	1.58	1.36
7	Metal	0.05	0.04	0.04
8	Bottle and Glass	0.11	0.15	0.13
9	Ceramic, stone	1.13	0.17	0.61
10	Domestic Hazardous Material	0.14	0.13	0.13
11	Residue Remaining (remaining material sheet)	5.45	5.00	5.21
12	Miscellaneous			
A	Tetrapack	1.34	0.12	0.69
B	Hairs	0.02	0.15	0.09
C	Pampers	10.02	4.76	7.20
D	Bones	0.99	0.01	0.46
E	Dust / Silt	3.78	25.81	15.59
F	E-Waste	0.00	0.20	0.11
	Total	**100.00**	**100.00**	**100.00**

Figure 3.4: Waste Characterization Variations in District Malir



3.4.1 District East, Karachi

District East Karachi is in the South-eastern part of Karachi with a population of 3,015,256. There are two zones, namely Gulshan and Jamshed.

The land use analysis of East district shows that Gulshan Zone is predominantly 97% residential area and only 3% is commercial area whereas, Jamshed Zone too is 98% residential area and only 2% commercial area.

Table 3.4: Land use analysis of District East, Karachi

Zone	Residential Area in %	Commercial area in %	Industrial area in %
Gulshan	97	3	0
Jamshed	98	2	0

Figure 3.5: Map of Gulshan Zone in District East

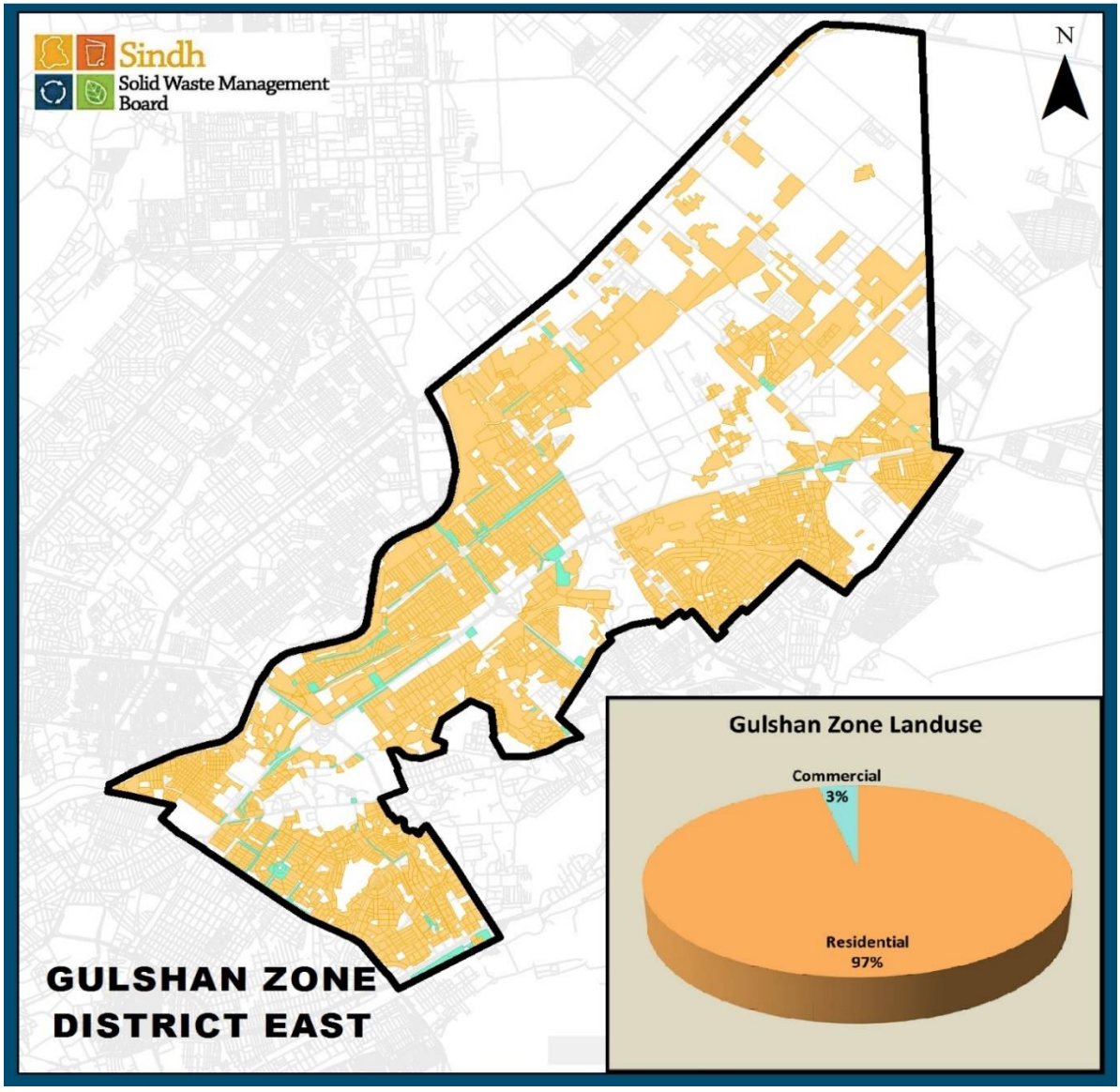
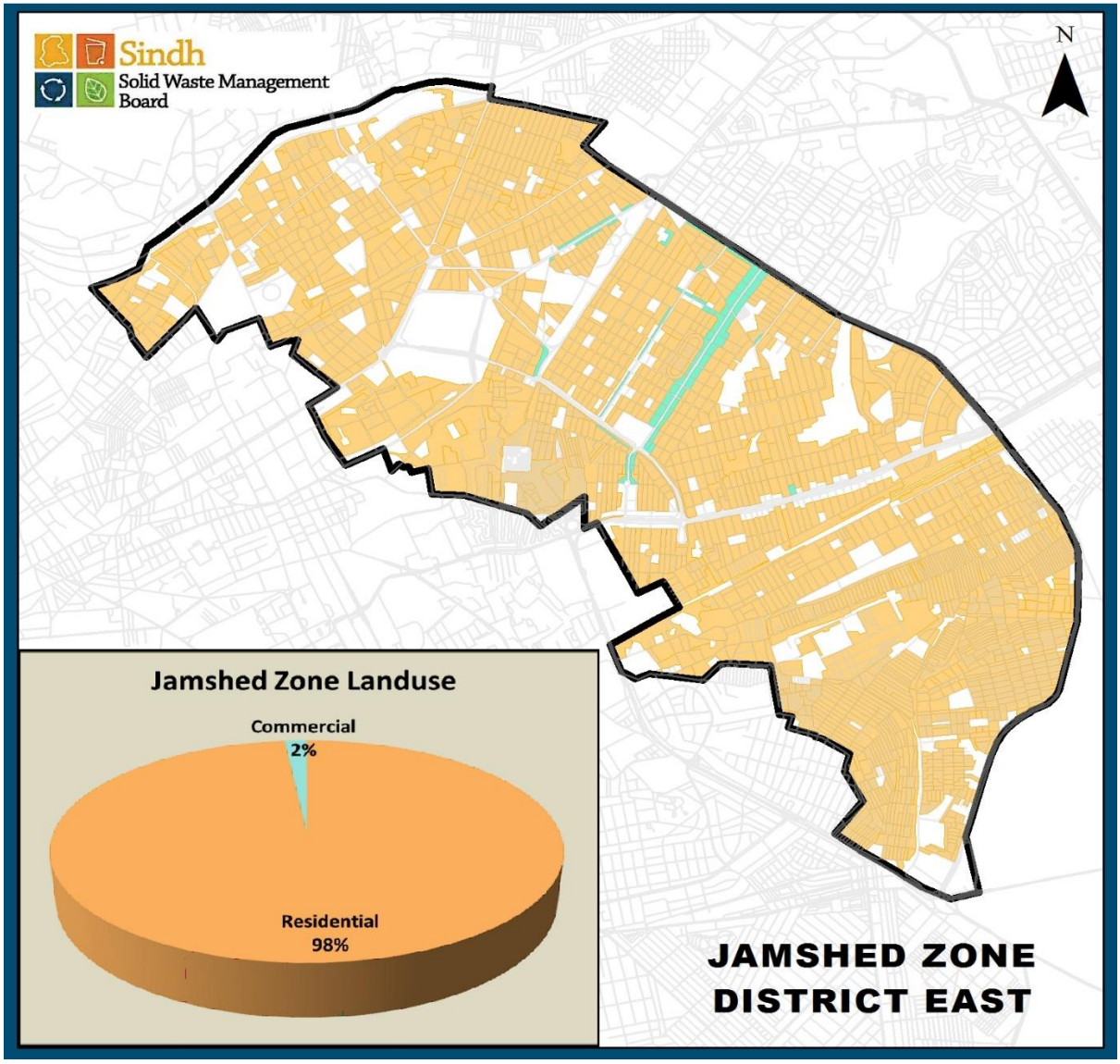


Figure 3.6: Map of Jamshed Zone – District East Karachi



3.4.2 Solid Waste Generation in District East

The present population of District East Karachi is 3,015,256. The residential solid waste generation rate of Karachi is 0.449 Kg/cap as per the Waste Amount Characterisation Survey of Central and Korangi District of Karachi. An allowance for 10% for commercial areas and 5% for bulk and industrial waste has been made for district East Karachi.

The overall solid waste generation has been worked as 0.516kg/capita/day, and 1,557tons/day of solid waste is generated daily.

Table 3.5: **Solid Waste Generation in District East, Karachi**

Population 2021	Residential waste in %	Commercial Area 10 %	5 % for Bulk and Industrial Waste in kg/c/d	Total Waste Generation Rate	Waste Generation in Tons/Day
3,015,256	0.449	0.045	0.022	0.516	1,557

3.4.3 Solid Waste Characterization in District East

The major fraction of MSW was organic waste and shared 48.09 % of the total waste, mostly consisting of kitchen waste, food waste, including fruits that are spoiled and fermented. A second major part of MSW was plastic waste (including wrappers, bags, Styrofoam, etc.) and shared about 18.97% of the total generated solid waste. Pamper / Diapers / Sanitary Pads comprised 9.14%, textile at 8.29 %, paper at 3.71%, Grass and Wood at 3.48% and residue material remaining on the sheet at 2.89%. All the remaining items were less than 1%.

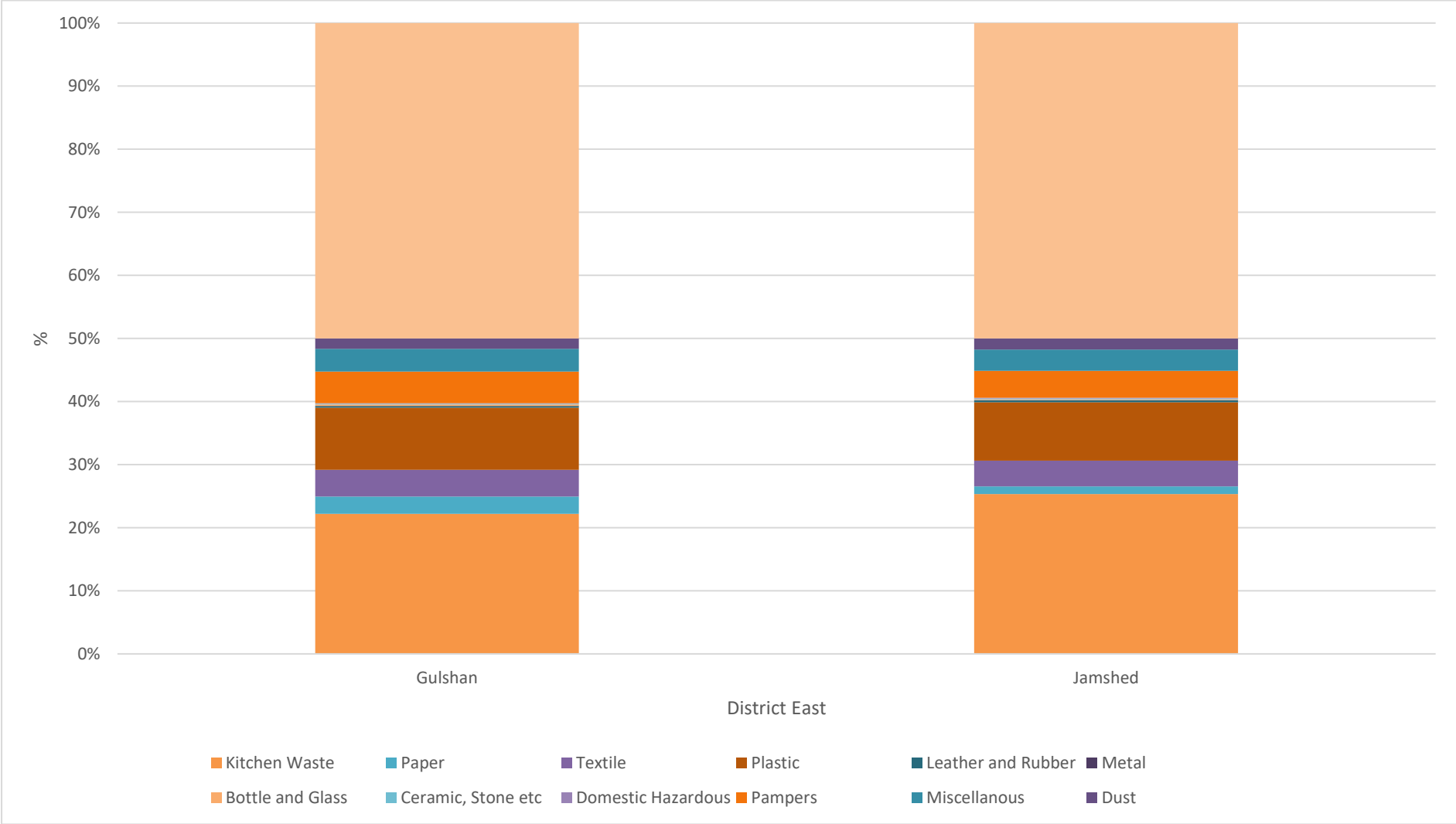
The characteristics of the area are visible in the MSW being generated in both zones. Gulshan Zone has a lot of universities and, overall, is more affluent than Jamshed Zone. In Gulshan Zone, a higher percentage of Paper, Plastic, Diapers/ Pampers and Glass and Bottles were seen than Jamshed Zone.

The characterization of the waste variation with the zones of District East, as shown in **Table 3.7**. The graphical presentation of this variation is shown in **Figure 3.7.**

Table 3.6: Characterization of MSW in District East

Sr No.	Item	Percentage		
		Gulshan Zone	Jamshed Zone	Overall
1	Kitchen Waste	44.39	50.68	48.09
2	Paper	5.50	2.45	3.71
3	Textile	8.50	8.15	8.29
4	Grass and Wood	4.24	2.95	3.48
5	Plastic	19.67	18.47	18.97
6	Leather and Rubber	0.51	0.68	0.61
7	Metal	0.05	0.03	0.04
8	Bottle and Glass	0.46	0.26	0.34
9	Ceramic, stone	0.22	0.24	0.23
10	Domestic Hazardous Material	0.14	0.26	0.21
11	Residue Remaining (material remaining sheet)	2.22	3.36	2.89
12	Miscellaneous			
A	Tetrapack	0.66	0.37	0.49
B	Hairs	0.01	0.01	0.01
C	Pampers	10.04	8.50	9.14
D	Bones	0.10	0.09	0.09
E	Dust	3.28	3.48	3.40
F	E-Waste	0.00	0.01	0.00
	Total	**100.00**	**100.00**	**100.00**

Figure 3.7: Waste Characterization Variation in District East



3.5 South District, Karachi

District South Karachi is in the South-eastern part of Karachi with a population of 1,475,638. The district is comprised of two zones, i.e., Lyari and Saddar.

The land use analysis of Lyari Zone is predominantly 83% residential area, 8% commercial, and 9% industrial area, whereas Saddar Zone is 69% residential, 21% commercial and 10% industrial area.

Table 3.7: Land use analysis of District South, Karachi

Zone	Residential Area in %	Commercial area in %	Industrial area in %
Lyari Zone	83	8	9
Saddar Zone	69	21	10

Figure 3.8: Map of Lyari, District South Karachi

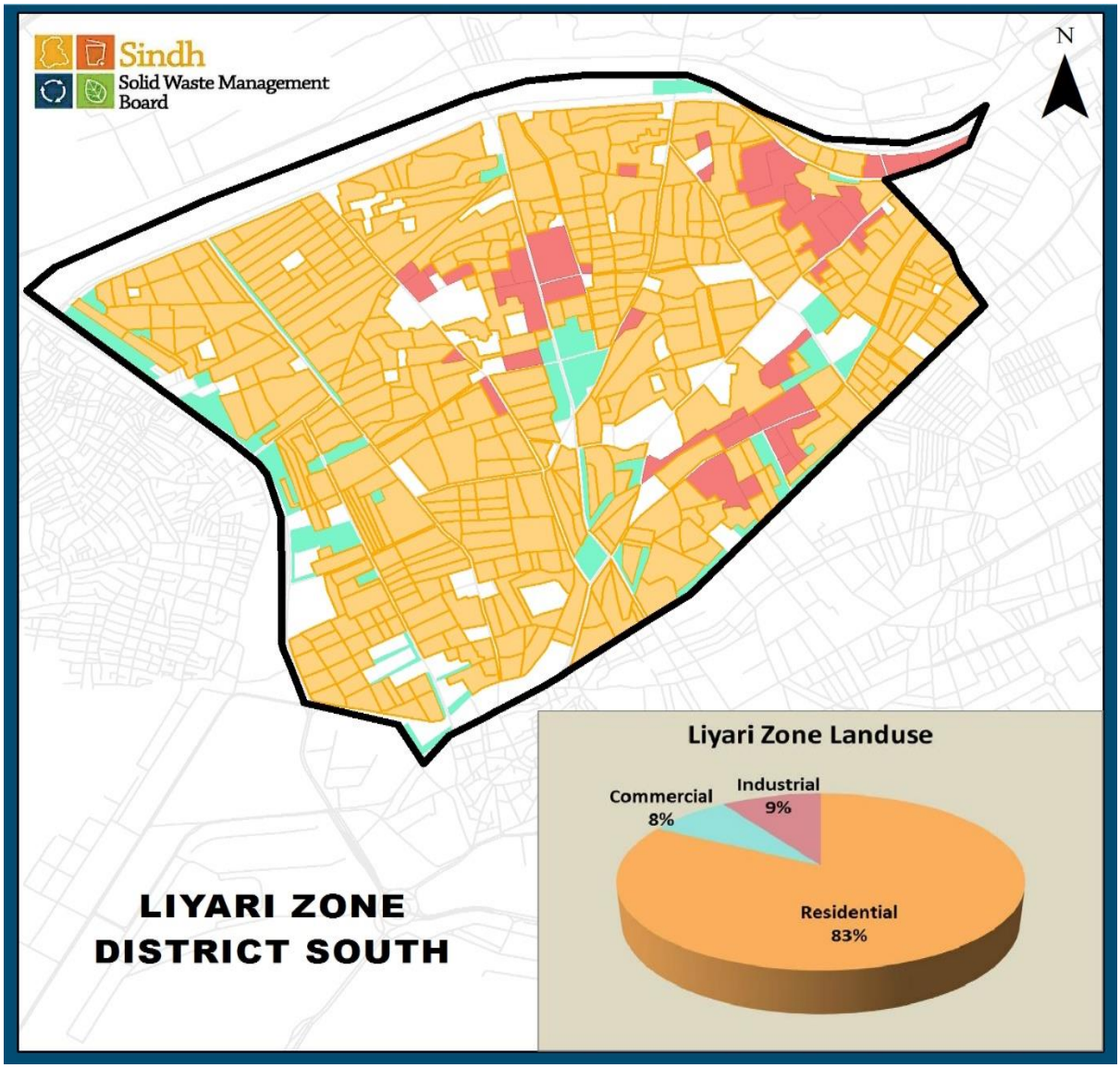
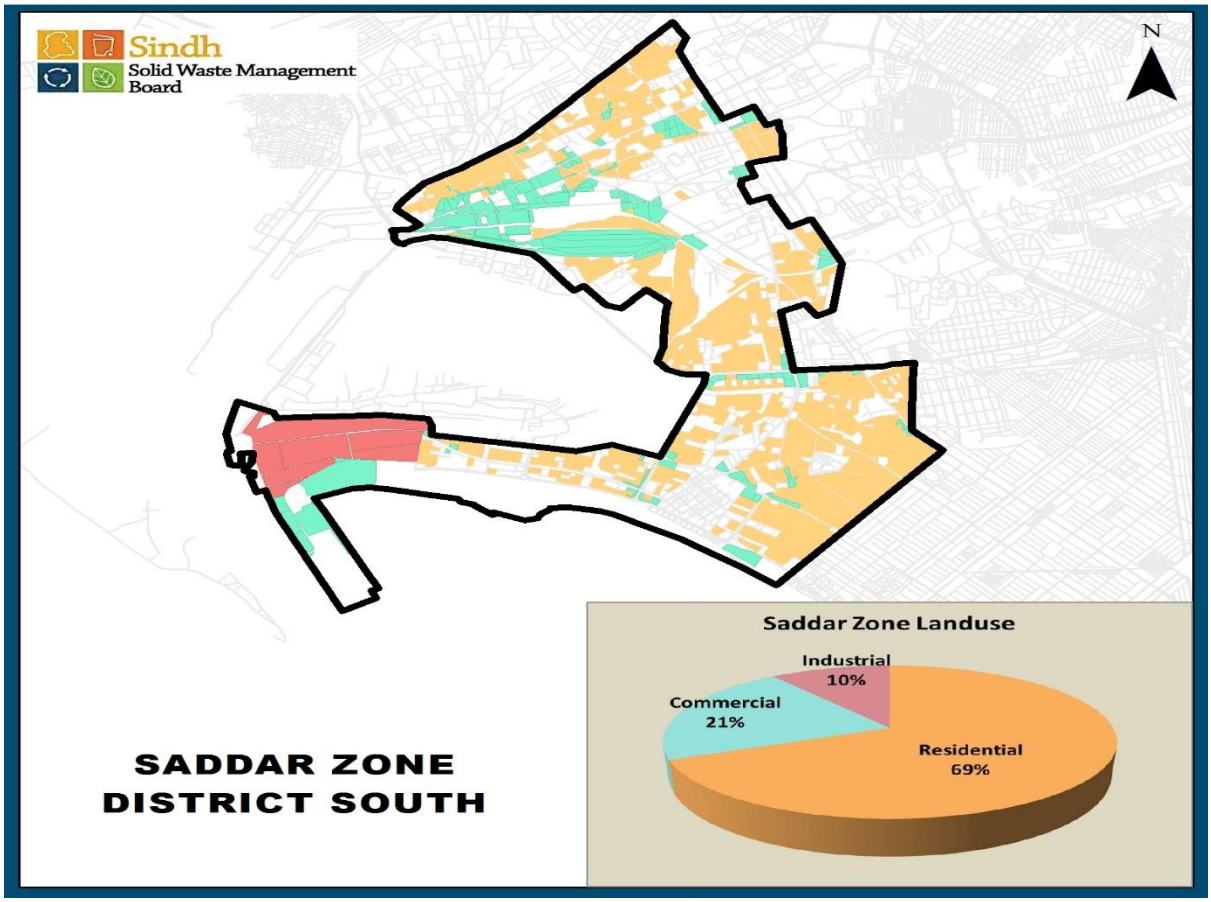


Figure 3.9: Materials required for Waste Amount Characterization Survey



3.5.1 Solid Waste Generation in District South, Karachi

The present population of District South Karachi is1,475,638. The residential solid waste generation rate of Karachi is 0.449 Kg/cap as per the Waste Amount Characterisation Survey of Central and Korangi District of Karachi. An allowance for 15% for commercial areas and 15% bulk and industrial waste has been made for District South Karachi.

The solid waste generation has been worked as 0.584 kg/capita/day and 861 tons/day of solid waste is generated daily.

Table 3.8: **Solid Waste Generation in District South, Karachi**

Population 2021	Residential Area in %	Commercial Area 15 %	Industrial 15%	Total	Waste Generation in Tons/Day
1,475,638	0.449	0.067	0.067	0.584	861

3.5.2 Solid Waste Characterization in District South

The major fraction of MSW was organic waste and shared 52.74 % of the total waste, mostly consisting of kitchen waste, food waste, including fruits that are spoiled and fermented. A second major part of MSW was plastic waste (including wrappers, bags, Styrofoam, etc.) and shared about 19.54 % of the total generated solid waste. Textile comprises 8.12% Pamper / Diapers / Sanitary Pads at 6.08%, soil/dust at 3.73 % and residue material remaining on the

sheet at 2.84%. Wastepaper comprised only 1.81%, followed by Grass and Wood at 1.57, Ceramics, stone at 1.17%. All the remaining items were less than 1%.

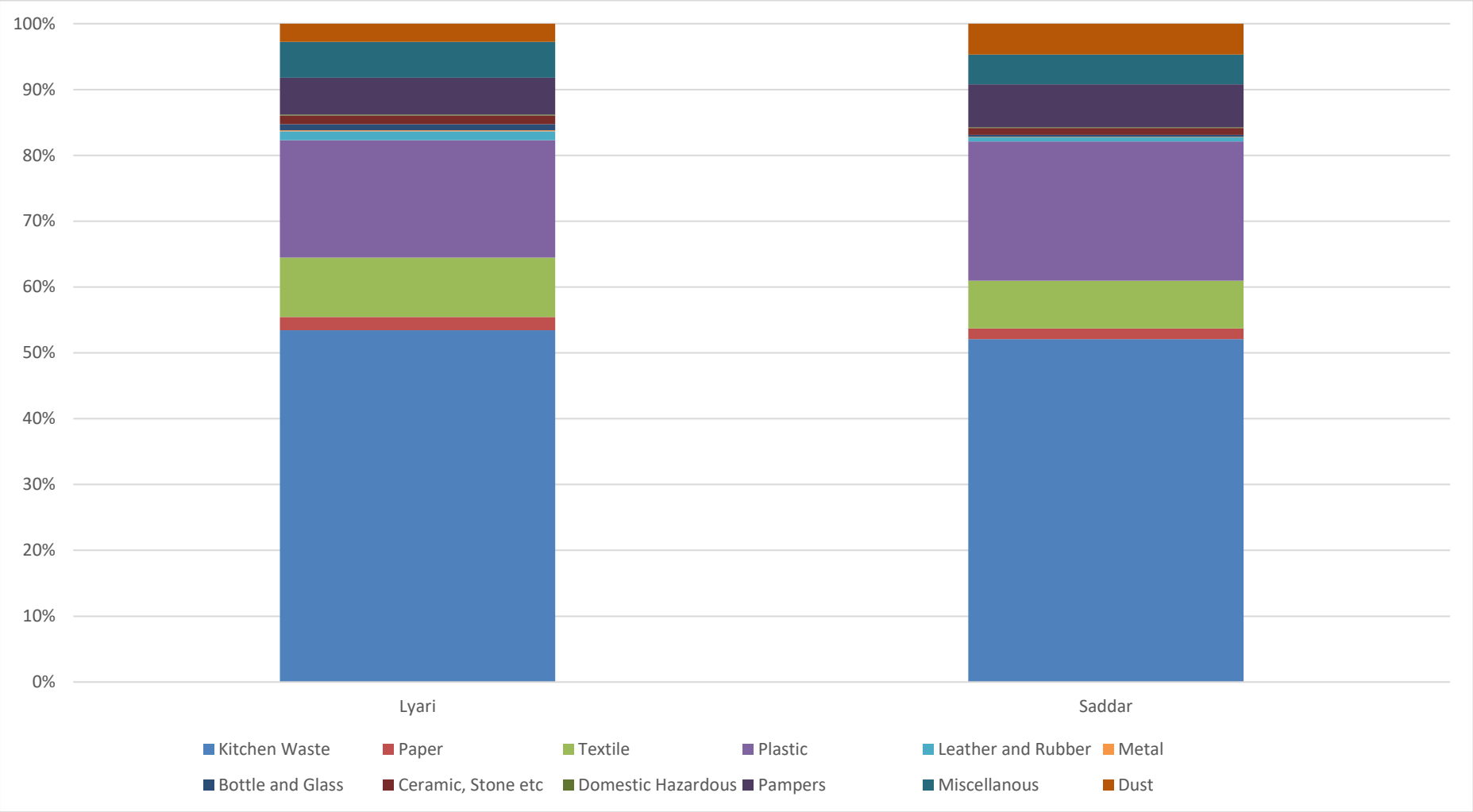
The characteristics of the area are visible in the MSW being generated in both zones. Lyari has a dense residential land use predominantly compared to Saddar, which has more commercial land use. This is being reflected in the MSW composition. Saddar zone has a comparatively higher percentage of paper, textile, metal, bottle, and glass items in waste than Lyari.

The characterization of the waste variation with the zones of District South, as shown in **Table 3.10**. The graphical presentation of this variation is shown in **Figure 3.10.**

Table 3.9: Characterization of MSW in District South

Sr No.	Item	Percentage		
		Lyari Zone	Saddar Zone	Average
1	Kitchen Waste	52.07	53.44	52.74
2	Paper	1.63	2.00	1.81
3	Textile	7.25	9.03	8.12
4	Grass and Wood	0.93	2.23	1.57
5	Plastic	21.17	17.85	19.54
6	Leather and Rubber	0.62	1.33	0.97
7	Metal	0.05	0.14	0.10
8	Bottle and Glass	0.30	0.92	0.61
9	Ceramic, stone	1.04	1.31	1.17
10	Domestic Hazardous Material	0.12	0.17	0.15
11	Residue Remaining (material remaining sheet)	3.07	2.60	2.84
12	Miscellaneous			
A	Tetrapack	0.42	0.45	0.43
B	Hairs	0.00	0.00	0.00
C	Pampers	6.54	5.60	6.08
D	Bones	0.09	0.13	0.11
E	Dust	4.68	2.75	3.73
F	E-Waste	0.01	0.04	0.02
	Total	**100.00**	**100.00**	**100.00**

Figure 3.10: Waste Characterization Variation – District South



3.6 West District, Karachi

District West Karachi is in the South-eastern part of Karachi with a population of 4,459,587. The district West Karachi is comprised of four zones, i.e., Baldia, Kemari, Korangi and SITE.

The land use analysis of Baldia is prenominal 93 % is a residential area, 3% commercial and 4% industrial area; Kemari 60% residential, 12% commercial and 28% industrial area; Korangi is 97% residential, 1% commercial, and 2% industrial area; and SITE is 38% residential, 1% commercial and 61% industrial.

The land use analysis of the West Karachi district shows that it is predominately a residential area with considerable industrial and commercial areas.

Table 3.10: Land use analysis of District West, Karachi

Zone	Residential Area in %	Commercial area in %	Industrial area in %
Baldia	93	3	4
Keamari	60	12	28
Orangi	97	1	2
SITE	38	1	61

Figure 3.11: Map of Baldia, District South, Karachi

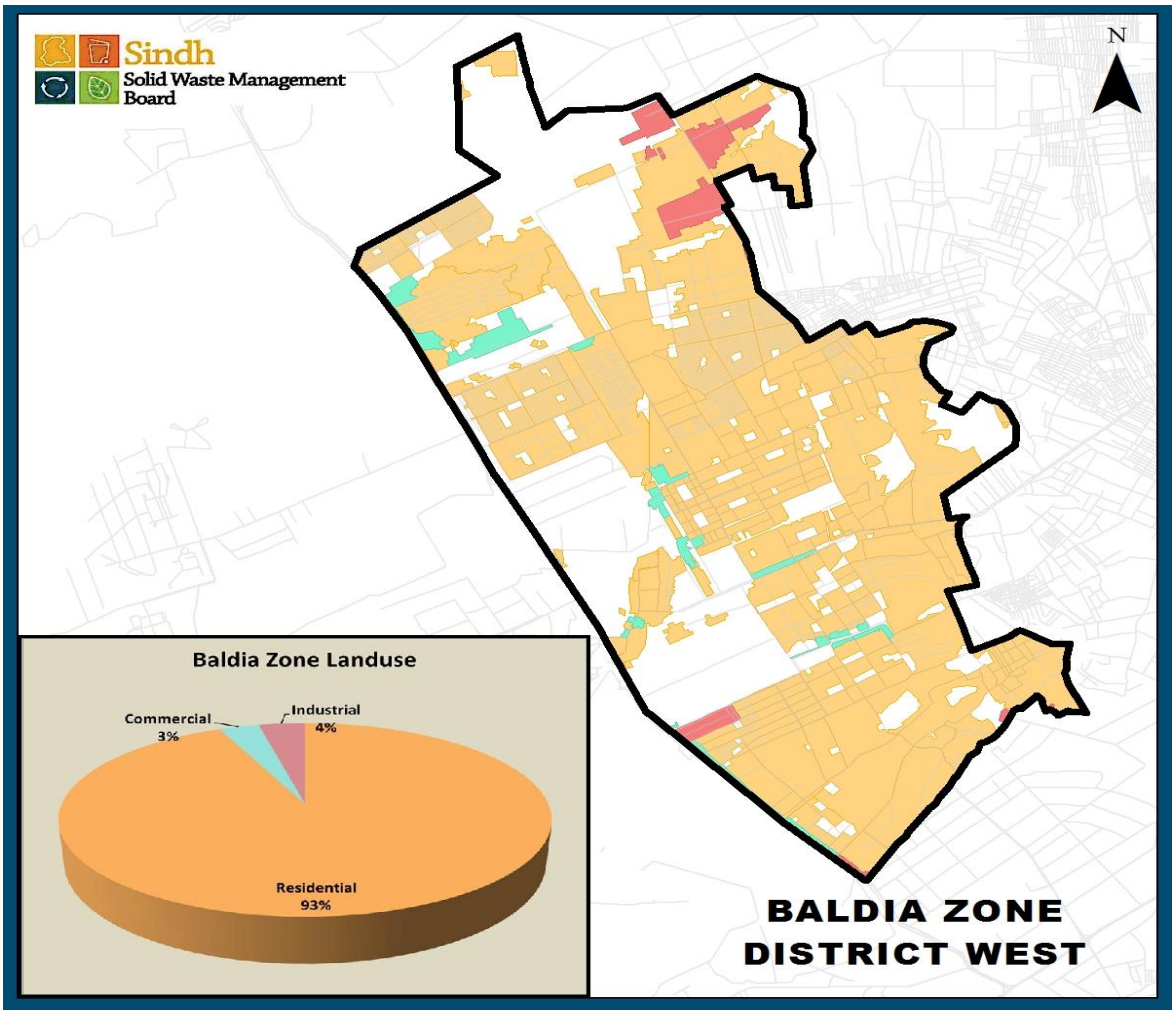


Figure 3.12: Map of Kemari Zone, District West

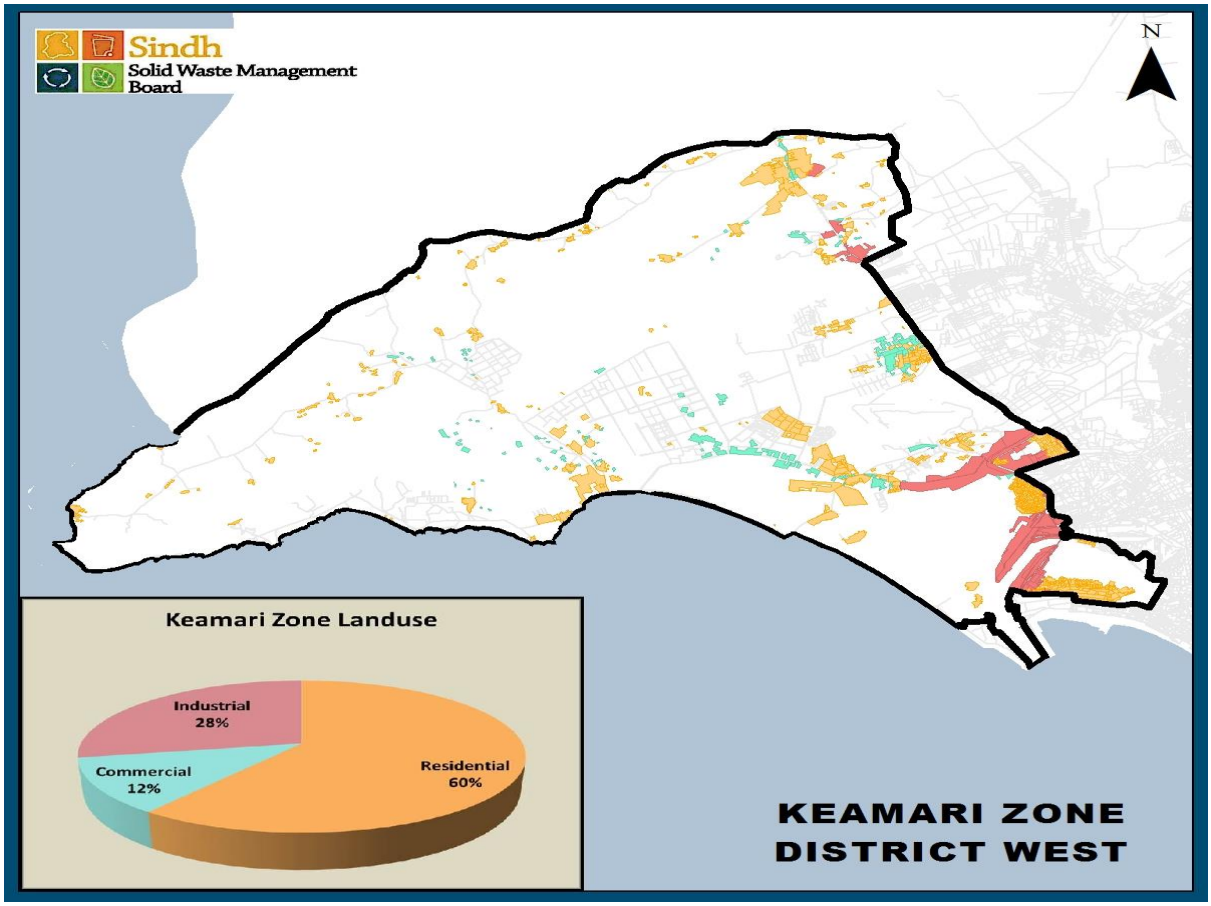


Figure 3.13: Materials required for Waste Amount Characterization Survey

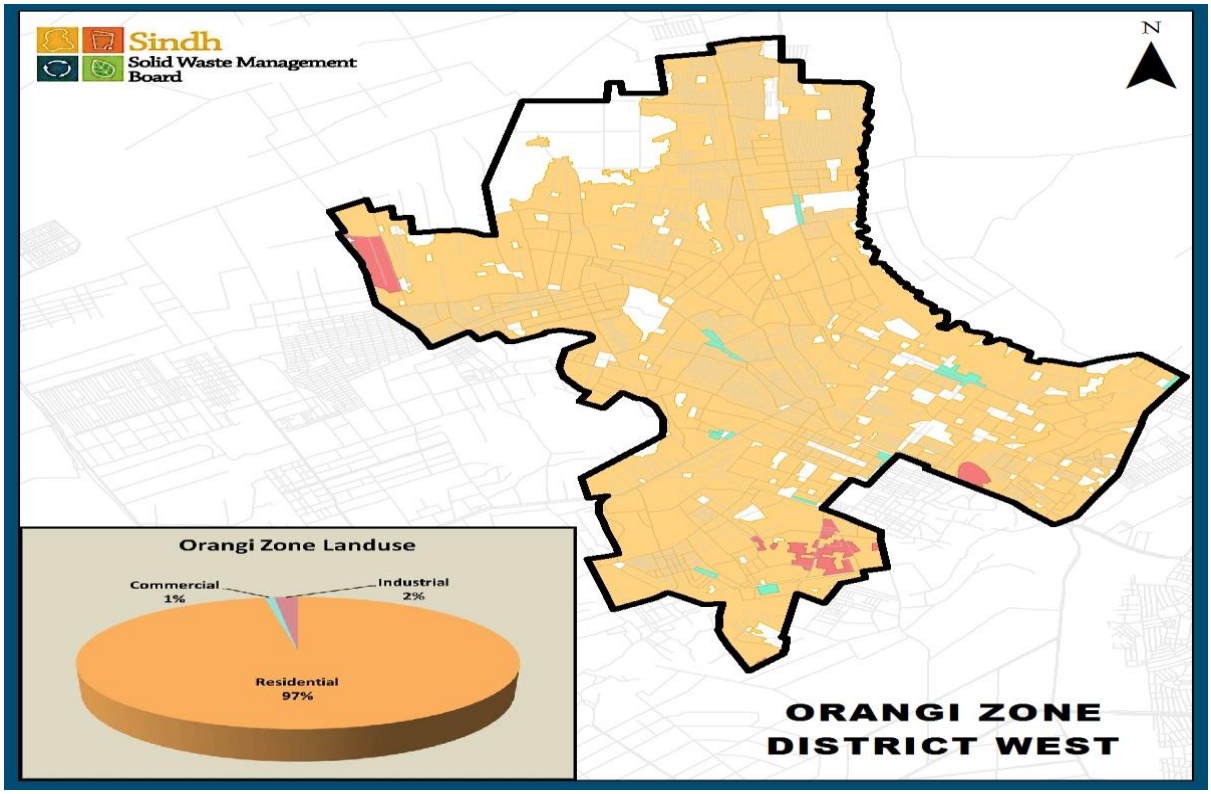
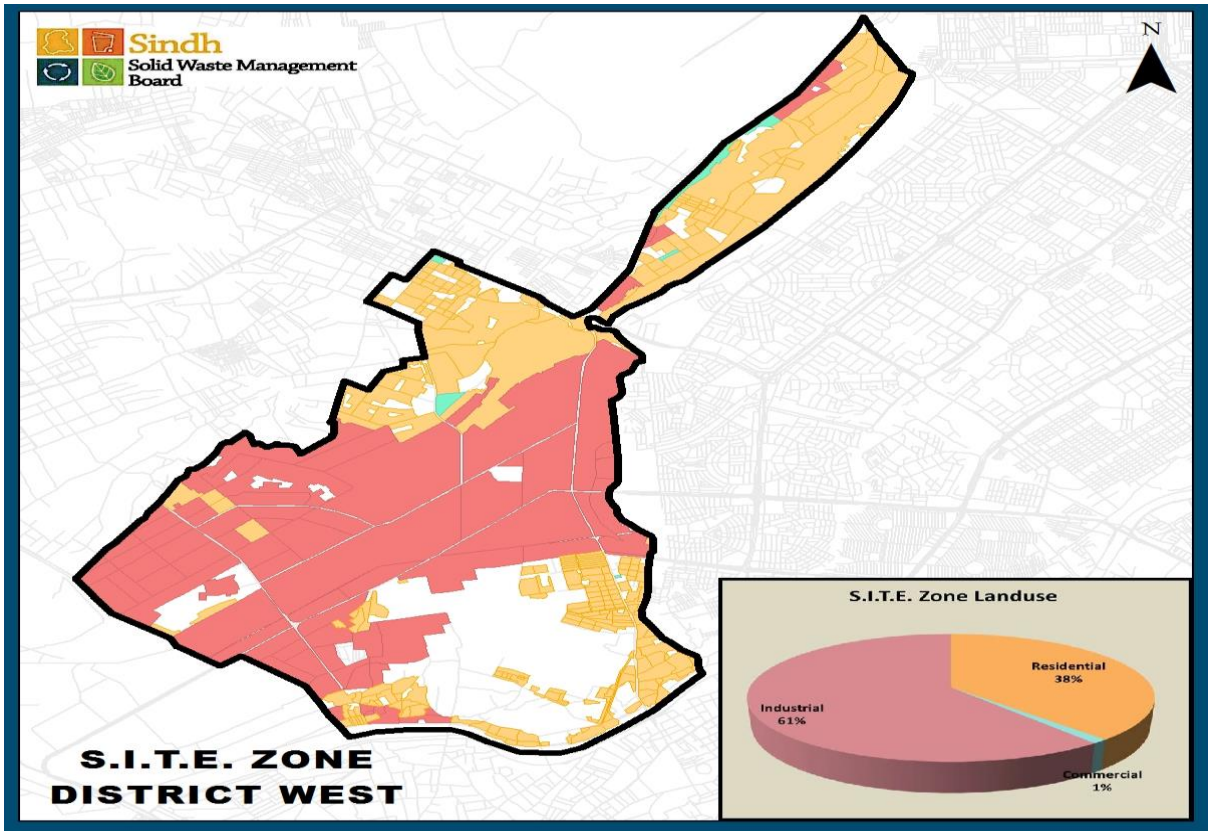


Figure 3.14: Materials required for Waste Amount Characterization Survey



3.6.1 Solid Waste Generation in District West

The present population of West Karachi is 4,459,587. The residential solid waste generation rate of Karachi is 0.449 Kg/cap as per the Waste Amount Characterisation Survey of Central and Korangi District of Karachi. An allowance for 10% for commercial areas and 30% for bulk and industrial waste has been made for District West Karachi.

The overall solid waste generation has been worked as 0.629 kg/capita/day, and 2,803 tons/day of solid waste is generated daily.

Table 3.11: Solid Waste Generation in District West, Karachi

Population 2021	Residential Area in %	Commercial Area 10%	Bulk and Industrial 30%	Total	Waste Generation in Tons/Day
4,459,587	0.449	0.045	0.135	0.629	2,803

3.6.2 Solid Waste Characterization in District West

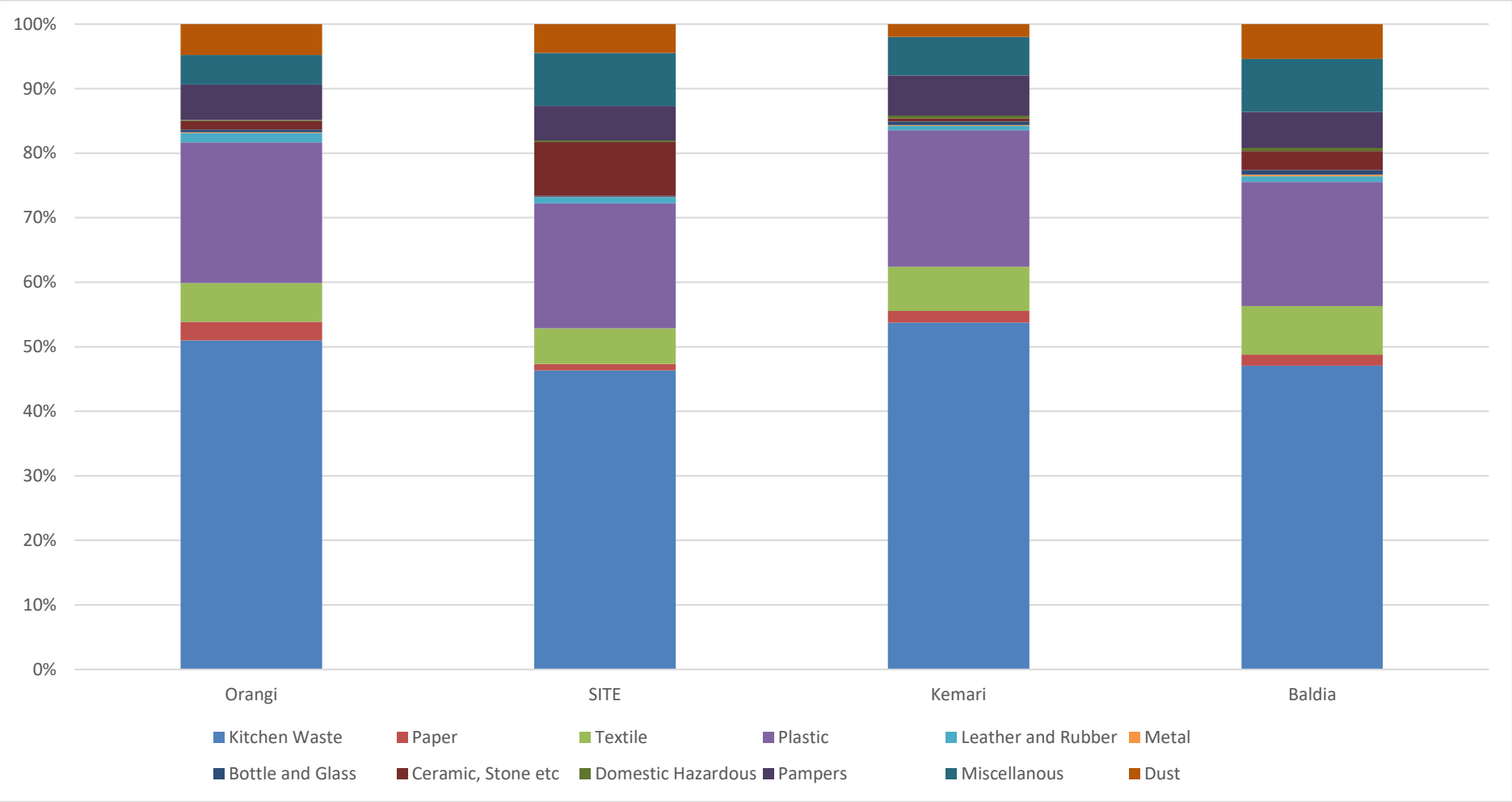
The major fraction of MSW was organic waste and shared 49.48% of the total waste, mostly consisting of kitchen waste, food waste, including fruits that are spoiled and fermented. A second major part of MSW was plastic waste (including wrappers, bags, Styrofoam, etc.) and shared about 20.34% of the total generated solid waste. Textile comprises 6.51%, Pamper / Diapers / Sanitary Pads at 5.65%, residue material remaining on the sheet at 4.61%, the soil at 4.16% and ceramics at 3.27%. Wastepaper comprised only 1.83%, followed by Grass and Wood at 1.52%. All the remaining items were less than 1%.

District West of Karachi Division comprises four zones, and each zone has a distinct character. SITE is predominantly an industrial area, and this is reflected in the MSW composition. The percentage of ceramics and stones in SITE is 8.33% compared to 1.31% in Korangi, 0.48 % in Kemari and 2.89 % in Baldia Town. The characterization of the waste variation with the zones of District South, as shown in **Table 3.13**. The graphical presentation of this variation is shown in **Figure 3.15.**

Table 3.12: Characterization of MSW in District West

Sr No.	Item	Percentage				
		Orangi	SITE	Kemari	Baldia	Overall
1	Kitchen Waste	50.98	46.33	53.74	47.06	49.48
2	Paper	2.88	0.99	1.79	1.74	1.83
3	Textile	6.02	5.54	6.85	7.54	6.51
4	Grass and Wood	0.59	2.23	1.55	1.63	1.52
5	Plastic	21.77	19.34	21.17	19.21	20.34
6	Leather and Rubber	1.46	0.96	0.68	0.86	0.98
7	Metal	0.11	0.07	0.12	0.27	0.15
8	Bottle and Glass	0.46	0.15	0.57	0.72	0.48
9	Ceramic, stone	1.31	8.33	0.48	2.89	3.27
10	Domestic Hazardous Material	0.16	0.24	0.42	0.55	0.35
11	Residue Remaining (material remaining sheet)	3.50	5.65	3.37	5.80	4.61
12	Miscellaneous					
A	Tetrapack	0.12	0.22	0.72	0.46	0.38
B	Hairs	0.01	0.01	0.00	0.00	0.01
C	Pampers	5.45	5.39	6.21	5.53	5.65
D	Bones	0.31	0.08	0.21	0.35	0.24
E	Dust	4.79	4.47	1.99	5.38	4.16
F	E-Waste	0.08	0.00	0.12	0.00	0.05
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Figure 3.15: Waste Characterization Variations– District West



3.7 Solid Waste Characterization Survey in Landfill of Karachi

The Solid Waste Characterization Survey was carried out in the two main landfills of Karachi. Solid Waste Characterization Survey was conducted on MSW from GTS and the existing solid waste present in Jam Chakro and Gondpass Landfill. Four samples were collected and analysed in which a fresh MSW sample coming from GTS was analysed from each GTS. Another sample was collected, which was approximately a year old (according to the Landfill Manager).

Solid Waste at Landfills has exhibited a different composition than the solid waste being brought at GTS. Overall, Dirt comprises the largest fraction at 38.73%, followed by Plastic at 26.97%, food waste at 10.41%, textile at 8.97% and residue remaining on the sheet at 4.32%. Pampers at 4.27%, Ceramics and stones at 2.71 and Wood at 1.59%. All the remaining items were less than 1%.

There is a sharp decline in Kitchen or Food Waste in the landfill compared to the solid waste available at GTS. One of the reasons is that over time food waste starts to decompose due to the inherent nature of being biodegradable. This is also seen in the approximately one-year-old, where there is negligible food waste. Other organic materials in the solid waste such as paper, grass, wood, hairs, bones, and cow dung become negligible in the year-old sample.

The percentage of plastics, stones, and dirt increases in the one-year-old sample compared to the fresh sample from GTS.

Figure 3.16: Waste Characterization Variation – Landfill

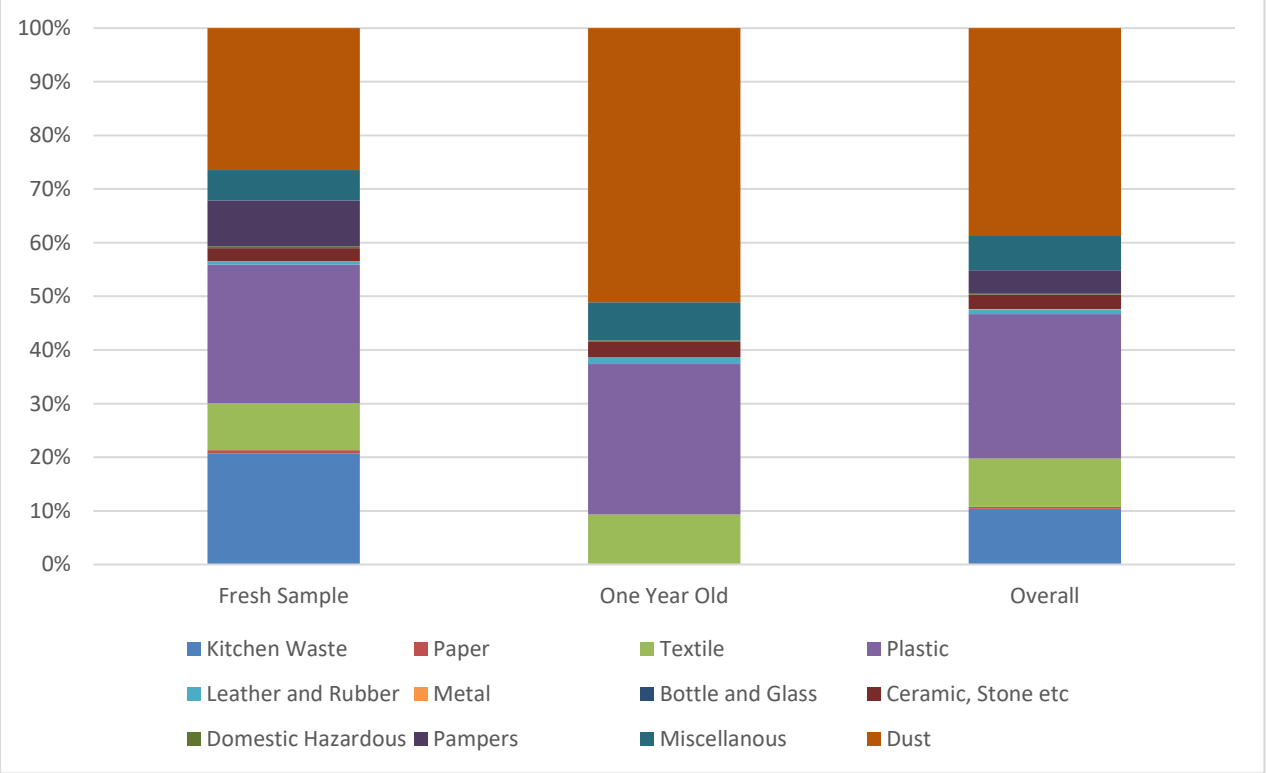


Table 3.13: Characterization of MSW in Landfills (Jam Chakro and Gondpass)

Sr No.	Item	Fresh	One Year Old	Overall
1	Kitchen Waste	20.71	0.00	10.41
2	Paper	0.58	0.14	0.36
3	Textile	8.78	9.16	8.97
4	Grass and Wood	1.95	1.23	1.59
5	Plastic	25.89	28.06	26.97
6	Leather and Rubber	0.46	1.27	0.87
7	Metal	0.09	0.00	0.05
8	Bottle and Glass	0.00	0.00	0.00
9	Ceramic, stone	2.46	2.96	2.71
10	Domestic Hazardous Material	0.39	0.19	0.29
11	Residue Remaining (remaining material sheet)	2.87	5.80	4.32
12	Miscellaneous			
A	Tetrapack	0.24	0.06	0.15
B	Hairs	0.01	0.00	0.01
C	Pampers	8.50	0.00	4.27
D	Bones	0.06	0.01	0.04
E	Dirt	26.47	51.12	38.73
F	Cow Dung	0.55	0.00	0.28
	Total	**100.00**	**100.00**	**100.00**

3.8 Physical and Chemical Analysis of Solid Waste

3.8.1 Density / Specific Gravity of Solid Waste

The density of waste is usually required to determine how much space it will take for collection, transportation, and disposal. Solid waste density is also an essential factor for planning and designing a solid waste management system, including waste storage, transportation, and disposal at landfill sites.

The density helps in determining the area required for the sanitary landfill or disposal site. It also helps determine the number of dustbins required for an area and the number of loading and transporting trucks. The density of solid waste at GTS points in the districts and landfill sites is shown in **Table 3.15**.

Table 3.14: Solid Waste Density (Kg/m^3)

Area		Density (Kg/m^3)
Malir	Malir	305.546
	Landhi	361.876
East	Gulshan	272.028
	Jamshed	306.946
South	Lyari	281.016
	Saddar	326.004
West	Korangi	327.453
	SITE	400.112
	Baldia	374.626
	Kemari	364.962
	Average	**332.057**
Landfill	Jam Chakro	482.747
	Gond Pass	384.707
	Average	**433.727**

The trend seen in **Figures 3.17** and **3.18** is that waste characterisation affects the density of waste. In Landhi Zone of District Malir and SITE Zone of District West had a higher percentage of Dirt, ceramic, and stone than the zone, which led to an increased specific gravity of Solid Waste.

Figure 3.17: Density of Solid Waste at GTS

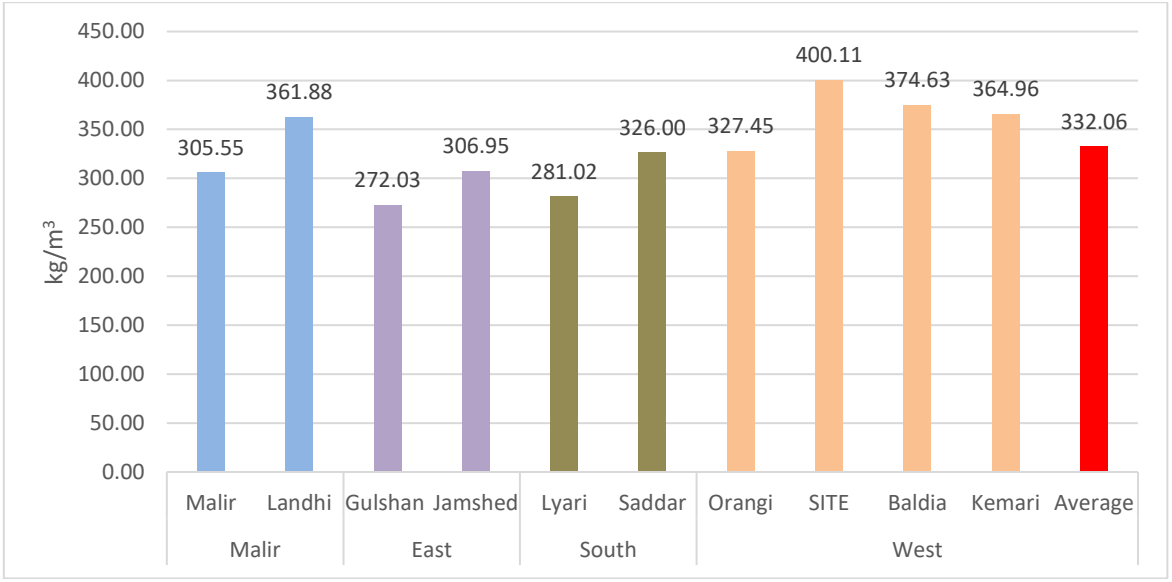
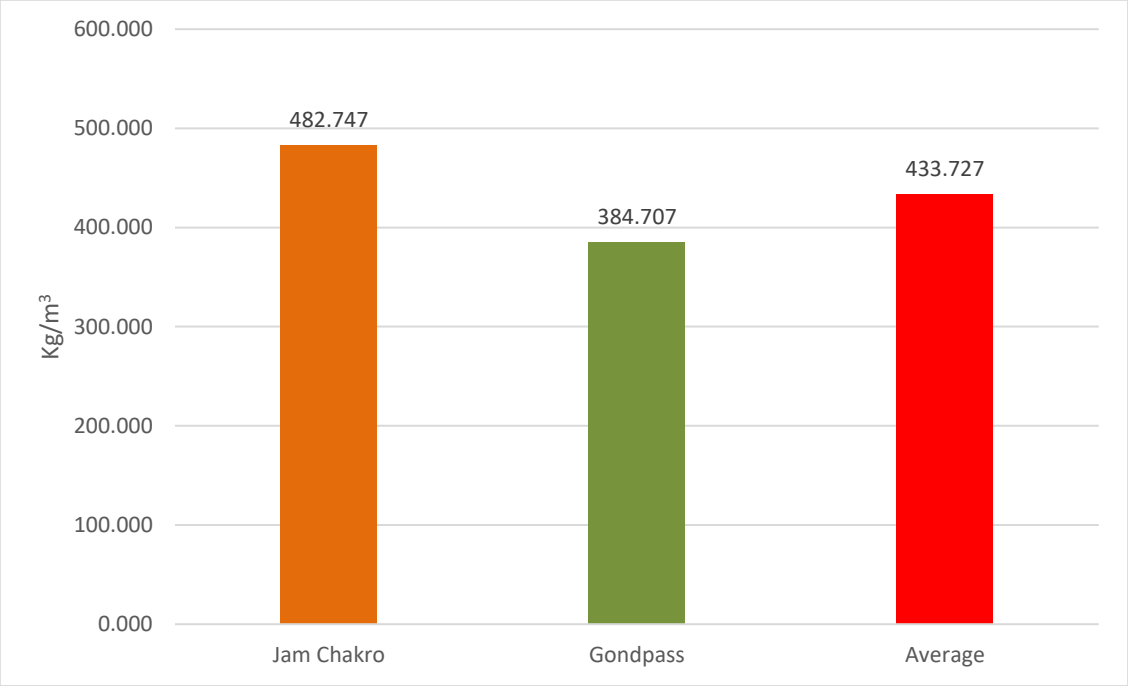


Figure 3.18: Density of Solid Waste at Landfill



3.8.2 Chemical Analysis of Solid Waste

The chemical analysis was performed on six composite samples from 6 different waste sources. The scan copy of the detailed chemical analysis report, including the values of As Received (AR) basis, Air Dried (AD) basis and Dry basis, are provided as **Annexure-4**. The chemical sample for Jam Chakro was taken from a fresh sample from a vehicle incoming from GTS. The result of the chemical testing is shown in **Table 3.16**.

Table 3.15: Chemical Results of District South, Malir, West and East of Karachi Division

Test	District South			District Malir			District West			District East			Average		
	AR	DRY	AD	AR	DRY	AD	AR	DRY	AD	AR	DRY	AD	AR	Dry	AD
Moisture, Total %	57.51			44.74			50.74			43.82			49.2025		
Moisture, Laboratory Sample %			2.99			3.95			3.56			4.98	3.87		
Ash %	13.18	31.03	30.10	16.64	30.12	28.93	17.92	36.39	35.09	19.65	34.98	33.24	16.85	33.13	31.84
Volatile Matter %	26.96	63.46	61.56	32.71	59.2	56.86	28.15	57.14	55.10	33.20	59.11	56.16	30.26	59.73	57.42
Fixed Carbon by Calculation %	2.35	5.51	5.35	5.91	10.68	10.26	3.19	6.47	6.25	3.33	5.91	5.62	3.70	7.14	6.87
Sulfur %	0.14	0.32	0.31	0.23	0.42	0.40	0.18	0.36	0.35	0.14	0.25	0.24	0.17	0.34	0.33
Gross Calorific Value kcal/kg	1649	3881	3765	1925	3483	3345	1699	3448	3325	1904	3389	3220	1794	3550	3414
Net CV @ Constant Pressure kcal/kg	1204	3622	3497	1531	3243	3091	1310	3259	3123	1520	3161	2975	1391	3321	3172
Oxygen (by difference) %	11.09	26.11	27.99	15.84	28.64	31.03	16.51	33.51	35.48	16.00	28.46	31.46	14.86	29.18	31.49
Carbon %	15.46	36.39	35.30	19.45	35.2	33.8	12.51	25.40	24.50	17.2	30.63	29.10	16.16	31.91	30.68
Hydrogen %	2.13	5.01	5.19	2.55	4.62	4.88	1.77	3.59	3.86	2.46	4.38	4.72	2.23	4.40	4.66
Nitrogen %	0.486	1.144	1.11	0.552	1.0	0.96	0.368	0.747	0.72	0.733	1.305	1.24	0.53	1.05	1.01

Table 3.16: Chemical Results of Landfill Sites (Gondpass and Jam Chakro)

Test	Jam Chakro			Gondpass			Average		
	AR	DRY	AD	AR	DRY	AD	AR	DRY	AD
Moisture, Total %	32.46			5.66			19.06		
Moisture, Laboratory Sample %			1.79			2.25			2.02
Ash %	34.96	51.76	50.83	21.21	22.49	21.98	28.09	37.13	36.41
Volatile Matter %	29.86	44.21	43.41	65.31	69.23	67.67	47.59	56.72	55.54
Fixed Carbon by Calculation %	2.72	4.03	3.97	7.82	8.28	8.10	5.27	6.16	6.04
Sulfur %	0.17	0.25	0.24	0.30	0.32	0.31	0.24	0.29	0.28
Gross Calorific Value kcal/kg	1652	2446	2402	4649	4928	4817	3,151	3,687	3,610
Net CV @ Constant Pressure kcal/kg	1333	2253	2202	4346	4642	4524	2,840	3,448	3,363
Oxygen (by difference) %	12.54	18.58	19.85	24.17	25.61	27.04	18.36	22.10	23.45
Carbon %	16.85	24.95	24.50	43.04	45.63	44.60	29.95	35.29	34.55
Hydrogen %	2.52	3.73	3.86	5.24	5.55	5.68	3.88	4.64	4.77
Nitrogen %	0.495	0.733	0.72	0.376	0.399	0.390	0.44	0.57	0.56

Proximate Analysis

The proximate analysis was carried out to estimate the heating value of municipal solid waste fuel. It is used to determine solid waste characterisation in terms of gross components of moisture, volatile matter, fixed carbon, and ash.

In proximate analysis, moisture content, volatile matter and ash are analysed. The results of the chemical analysis are shown in **Table 3.17**.

Table 3.17: Proximate Analysis of Solid Waste Characterization at District Malir, South, East, and West, Karachi

Parameters	Malir	South	East	West	Average
Total Moisture	44.74	57.51	43.82	50.74	49.20
Volatile Matter (As Received (AR))	32.71	26.96	33.20	28.15	30.26
Fixed Carbon	5.91	2.35	3.33	3.19	3.70
Ash (AR)	16.64	13.18	19.65	17.92	16.85

Table 3.18: Proximate Analysis of Solid Waste Characterization at Jam Chakro and Gondpass

Parameters	Gondpass	Jam Chakro	Average
Total Moisture	5.66	32.46	19.06
Volatile Matter (As Received (AR))	65.31	29.86	47.59
Fixed Carbon	7.82	2.72	5.27
Ash (AR)	21.21	34.96	28.09

Moisture Content: Moisture content is an important quality to test the maturity of compost produced by different kinds of organic waste. In compost, moisture is also essential for microbe activity as it increases its metabolism.[17]

The typical range of moisture varies from country to country, as in a survey conducted in the cities of Greece; this value ranges from 30-40%.[18]

In another survey in Ghana, this value ranged between 36-58% in different months of the year.[19] Chattopadhyay[20] reported that the percentage by mass of moisture of MSW should be approximately 25%. According to a survey in Pakistan, the average value of the moisture range is 36%. At the same time, for compost, this could increase within the range of 40-50%.[21]

[17] Ameen, A, Ahmad. J and Raza, S., Effect of pH and moisture content on composting of Municipal solid waste. International Journal of Scientific and Research Publications, Volume 6, Issue 5, May 2016. ISSN 2250-3153
[18] E. Gidarakos *, . Havas, P. Ntzamilis Municipal solid waste composition determination supporting the integrated solid waste management system in the island of Crete. Waste Management xxx (2005)
[19] R. Kuleape, S.J Cobbina., S.B, Dampare., A.B, Duwiejuah, E.E, Amoako, W, Asare. Assessment of the energy recovery potential of solid waste generated in Akosombo, Ghana, Vol. 8(5), pp.297-305, May 2014. DOI: 10.5897/AJEST2014.1663, ISSN 1996-0794.
[20] Chattopadhyay,P. (2006).Boiler Operation Engineering .Tata McGraw-Hill New Delhi.
[21] J, Seema, Municipal solid Waste Composting and its Assessment for reuse in plant production. Pak. J. Bot., 39(1): 271-277, 2007.

During this survey, the moisture content of District Malir, South, East and West was 44.74%, 57.51%, 43.82% and 50.74%, respectively. The average value of moisture content is 49.20%.

If these samples are considered for compost, this could prove a feasible option because the waste characterization reveals a high amount of organic waste (38 – 55%). Typically, Moisture Content is in the range of 50~70% for successful production of compost.

The sample taken from Gondpass was a one-year-old sample, whereas the sample taken from Jam Chakro was fresh. The chemical results show that as time is passing solid waste is losing moisture content. At GTS, the average moisture content was 49.20%. The fresh sample of solid waste reaching landfill has a moisture content of 32.46%. After an approximate year, the solid waste has a moisture content of 5.66%.

Volatile Matter: Volatile content and fixed carbon contents are good indicators of the combustion properties of waste. Volatile matter (VM) is the fuel fraction (except moisture) released when the organic or inorganic yield of MSW experience thermal cracking at high temperatures.

The volatility of solid waste was studied in this survey. The volatile matter for District Malir was at 32.71%, 26.96% in District South, 33.20% at District East and District West the volatile matter was 28.15%. On average, the volatile matter is 30.26%.

Similarly, fixed carbon percentage was 5.91% at District Malir, 2.35% in District South, 3.33% in District East and 3.19% in District West. Overall, the average fixed carbon percentage is 3.70%.

The fixed carbon percentages for solid waste at Jam Chakro was at 2.72%, whereas in Gondpass, the FC is fixed at 7.82%.

The high amount of loss on ignition represents that a significant fraction of wastes can be removed via incineration. The presence of a high percentage of fixed carbon in a waste shows its suitability for incineration, as it requires a longer retention time in the incinerator to attain complete burning. The present results agree with the reported data for volatile content ranging from 20.2% to 54.7%, and fixed carbon ranged from 0.9% to 5.8% by Sadef et al. in Lahore (2017).[22]

Ash: Ash (A) is the inorganic residue that is left over after fixed carbon burning. Ash content is influential in transport, handling, and overall process costs. The high ash content of the solid fuel tends to create slag deposits, causing higher thermal resistance to heat transfer and necessitating more expensive equipment maintenance.

During the survey, ash content is 13.18% to 19.65% in the four districts of Karachi. Whereas at the landfill, the average value of ash content is 28.09%. The high ash content at landfill indicates the presence of material that does not support complete combustion.

A study conducted in Malang city indicated average ash content of 5.51% (Dry Basis) specified that it is preferable for solid fuel with low operating cost.[23]

[22] Sadef, Y., Nizami, A. S., Batool, S. A., Chaudary, M. N., Ouda, O. K. M., Asam, Z. Z., ... & Demirbas, A. (2016). Waste-to-energy and recycling value for developing integrated solid waste management plan in Lahore. *Energy Sources, Part B: Economics, Planning, and Policy*, *11*(7), 569-579.

[23] Sukarni. (2016) Exploring the potential of municipal solid waste (MSW) as solid fuel for energy generation: Case study in the Malang City, Indonesia, AIP Publishing. https://doi.org/10.1063/1.4965733

Ultimate Analysis

This refers to an analysis of waste to determine the proportion of carbon and sulphur. The analysis is carried out to make mass balance calculations for a chemical or thermal process. The results of the ultimate analysis for District Malir, South, East and West are shown in **Table 3.20**. The result of the ultimate analysis carried out at the Landfill sample is shown in **Table 3.21**.

Table 3.19: Ultimate Analysis of Solid Waste in District Malir, South, East & West

Parameters	South	East	Malir	West	Average (%)
Carbon	15.46	17.20	19.45	12.51	16.16
Sulphur	0.14	0.14	0.23	0.18	0.17
Oxygen	11.09	16.00	15.84	16.51	14.86
Hydrogen	2.13	2.46	2.55	1.77	2.23
Nitrogen	0.48	0.73	0.55	0.36	0.53
Carbon / Nitrogen Ratio	32.20	23.56	38.9	34.75	30.49

Table 3.20: Ultimate Analysis of Solid Waste at Landfill

Parameters	Jam Chakro	Gondpass	Average (%)
Carbon	16.85	43.04	29.95
Sulphur	0.17	0.30	0.24
Oxygen	12.54	24.17	18.36
Hydrogen	2.52	5.24	3.88
Nitrogen	0.49	0.37	0.44
Carbon / Nitrogen Ratio	34.39	116.32	68.06

Carbon: The ultimate analysis determines the total carbon content, including the carbon present in volatile matter. There is no particular value for carbon, but it is accepted that the carbon content of a compost sample should be at least 40%.

Carbon and Nitrogen are of utmost importance for compost values. Their correct ratio favours waste to be used as a fertilizer.

Ideally, the C/N ratio for composting should be in the range of 25 to 40.[24] In the areas where the C/N ratio is less than the recommended range, additional food waste or yard trimmings can be added to bolster the C/N ratio. The carbon-nitrogen ratio in all the districts (Malir, South, East & West) is within the recommended range.

At the landfill site, the C/N Ratio at Jam Chakro is 34 and 116 at Gondpass. The high-value C/N ratio indicates the presence of wood-based products.

[24] Tom L. Richard. Municipal Solid Waste Composting: Biological Processing. 1996. http://compost.css.cornell.edu/MSWFactSheets/msw.fs2.html . Accessed on 16th April 2021.

Sulphur: The sulphur content in solid waste is calculated to see if the waste can be used as fuel. In the literature review, sulphur is reported to be near 0.1% of the solid waste.

The sulphur content in District Malir is 0.23%, District South at 0.14%, District East at 0.14% and District West at 0.18%. While on average, the sulphur content is 0.17%. The sulphur value range for the four districts is 0.14% – 0.23%. Whereas at Landfill, the sulphur value jumps to 0.24% on average. A higher amount of sulphur content means an increased percentage of SO_2 during combustion. To treat flue gases, a more robust air pollution control device will be needed. Thus, increasing the initial and operational cost of the project.

Oxygen: Oxygen is a parameter that affects the performance of the microbial activity. Inadequate oxygen levels lead to the growth of anaerobic micro-organisms, which can produce odorous compounds. While adequate oxygen can minimize these odours, it is important to note that anaerobic pockets will exist in a heterogeneous material like MSW. Some odours, including ammonia and some organic compounds, can be generated even under generally aerobic conditions.

Oxygen concentrations in the large pores must normally be at least 12-14 per cent (ideally 16-17 per cent) to allow adequate diffusion into large particles and water-filled pores[25]. The oxygen content in the solid waste characterization in District South is 11.09%, 16.00% in District South, 15.84% in District East, 16.51% in District West. In contrast, on average, the oxygen content is 14.86%.

The oxygen content in the four districts is very near the ideal range. Only a limited amount of manual aeration will increase the oxygen concentration in MSW.

Calorific Value

Calorific value is the basic tool to describe the energy content of the waste and propose the suitability of the waste and an energy source. For incineration or mass burning, the average lower calorific value of solid waste must be at least 1673.04 kcal/kg during all seasons. The annual average lower calorific value must not be less than 1434.03 kcal/kg. The gross calorific value analysis results are shown in **Table 3.22**.

Table 3.21: Calorific Value of Solid Waste

	District Malir	District South	District East	District West	Average (kcal/kg)
Gross Calorific Value (kcal/kg)	1925	1649	1904	1699	**1794**
Lower Calorific Value(kcal/kg)	1531	1204	1520	1310	**1391**

[25] Tom L. Richard. Municipal Solid Waste Composting: Biological Processing. 1996. http://compost.css.cornell.edu/MSWFactSheets/msw.fs2.html . Accessed on 18th April 2021.

3.9 Comparison of Solid Waste Composition Rates

The comparison of the Waste Amount Characterization Survey in District Malir, South, East & West results with National/International studies was carried out, which is a great way to survey the differences caused by the topography, climatic conditions, urbanisation, and socio-economic conditions.

3.9.1 Solid Waste Composition – Residential

The characterization of solid waste is almost the same all over the world. However, fractions of each component vary due to change in income level, climatic conditions, and cultural norms.[26] **Table 3.23** shows the comparison of the characterisation of solid waste in different cities of Pakistan.

[26] *Khajuria A (2010) Estimation of municipal solid waste generation and landfill area in Asian developing countries. Journal of Environmental Biology31: 649-654*

Table 3.22: Composition of Solid Waste in various cities of Pakistan

Items	Mardan[27]	District Central	District Korangi	District Malir	District South	District East	District West	Karachi[28]	Lahore[29]	Gujranwala[30]	Azad Jammu & Kashmir (Overall)[31]	Peshawar	Islamabad[32]
Kitchen waste	62.96	56.00	52.56	38.23	52.74	48.09	49.48	53	57.00	62.50	60.71	53.74	59.95
Paper	3.91	4.62	3.72	0.75	1.81	3.71	1.83	12	3.37	15.3	5.47	7.32	7.26
Textile	3.71	3.65	4.01	10.35	8.12	8.29	6.51	4	9.93	3.87	3.28	2.35	1.81
Grass and wood	1.05	0.30	0.95	2.78	1.57	3.48	1.52	0	-	1.63	1.33	10.29	-
Plastic	7.36	16.30	13.86	16.26	19.54	18.97	20.34	14	14.23	7.70	13.69	9.34	7.49
Leather and rubber	0.61	0.77	1.25	1.36	0.97	0.61	0.98	0	3.41	0.77	1.35	0.63	-
Metal	0.20	0.34	0.39	0.04	0.10	0.04	0.15	9	0.04	0.23	0.39	0.72	0.68
Bottle and glass	0.87	0.51	0.94	0.13	0.61	0.34	0.48	2	0.97	1.16	1.5	2.32	2.79

[27] Project Procurement International, 2018, Study of Waste Generation and Composition Survey in Mardan.
[28] UNESCAP, 2013, Baseline Study for Solid Waste Management – Karachi. https://www.unescap.org/sites/default/d8files/SWM-COMPLETE%20REPORT%20KARACHI%20%20%2012-Mar-13.pdf
[29] Y. Sadef, A. S. Nizami, S. A. Batool, M. N. Chaudary, O. K. M. Ouda, Z. Z. Asam, K. Habib, M. Rehan & A. Demirbas (2016) Waste-to-energy and recycling value for developing integrated solid waste management plan in Lahore, Energy Sources, Part B: Economics, Planning, and Policy, 11:7, 569-579, DOI: 10.1080/15567249.2015.1052595
[30] Nadeem et al. 2016, Waste Amount Survey and Physio-Chemical Analysis of Municipal Solid Waste Generated in Gujranwala-Pakistan
[31] Project Procurement International, 2019, Solid Waste (Generation and Classification) Survey in AJK.
[32] *Zia, A., Batool,S.A., Chaudhry M, N.,Munir., S Influence of Income Level and Seasons on Quantity and Composition of Municipal Solid Waste: A Case Study of the Capital City of Pakistan, Sustainability 2017, 9(9), 1568; doi:10.3390/su9091568.*

Items	Mardan[27]	District Central	District Korangi	District Malir	District South	District East	District West	Karachi[28]	Lahore[29]	Gujranwala[30]	Azad Jammu & Kashmir (Overall)[31]	Peshawar	Islamabad[32]
Ceramic, stone and soil etc.	3.09	0.87	0.95	0.61	1.17	0.23	3.27	0	1.54	1.10	0.73	12.32	-
Domestic hazardous wastes	0.45	0.63	1.32	0.13	0.15	0.21	0.35	0	0.65	0.60	0.51	-	-
Sieve remaining / Residue Material Remaining on Sheet	-	1.59	1.84	5.21	2.84	2.89	4.61	0	-	3.23	0.86	-	19.2
Miscellaneous													
Hairs	0.09	0.01	0.00	0.69	0.43	0.49	0.38	-	-	1.90	0.19	0.65	
Bones	0.21	0.39	0.17	0.09	0.00	0.01	0.01	3	-		0.07		
Tetra-pack	0.33	0..48	0.68	7.20	6.08	9.14	5.65	3	3.13		2.08		
Diapers	10.22	12.42	14.30	0.46	0.11	0.09	0.24		5.73		7.25	0.22	
Sieve Remaining/Dust	1.61	0.98	2.89	15.59	3.73	3.40	4.16		-		0.51	-	
E- Waste	0.15	0.04	0.15	0.11	0.02	0.00	0.05		-		0.06	0.10	
Hay / Animal Dung	3.19	-	-	-	-	-	-		-		-	-	
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

The percentage of kitchen waste in 10 different Cities / Districts ranges from 52.56 – 62.96%, and the fraction of kitchen waste in the four districts is comparatively in the lower range, particularly in District Malir. However, in the remaining districts, food waste hovers around 50%.

The percentage of plastics in Islamabad, Mardan and Gujranwala, is under 8%. The percentage of plastic in Azad Kashmir (Overall), Mirpur and Peshawar, is above 9%. In megacities, i.e., Lahore and the Districts of Karachi percentage of plastics is greater than 13.5% and less than 21%.

Seasonal variation does play a role in waste characterization. In Mardan and Gujranwala, the WACS studies were carried out in early spring. This season, there is very little consumption of soft drinks, juices, and other canned food items. All these food items are mostly packaged in plastics/metals. This can be further attested by the fact that in Mirpur, Muzaffarabad, and the overall AJK study, the percentage of plastics was above 10 %. The studies conducted in Kashmir were conducted in the summer season. Therefore, seasonal variations do affect the characterization of solid waste.

4 Potential Use of Waste Stream as a Resource

Based on the Waste Amount Characterization Survey findings, the potential uses of the waste stream as a resource have been explored in this chapter.

4.1 Waste Composition of District Malir, South, East & West, Karachi

To recommend the potential use of waste stream as a resource, it is first necessary to determine the waste characterization. To ease the discussion on the potential use of waste for District Malir, South, East and West, the overall waste characterization of the four districts have been combined and is shown in **Table 4.1**.

Table 4.1: Percentages of residential waste characterization - Combined

Sr No.	Item	Percentage				
		Malir	South	East	West	Overall
1	Kitchen Waste	38.23	52.74	48.09	49.48	48.40
2	Paper	0.75	1.81	3.71	1.83	2.03
3	Textile	10.35	8.12	8.29	6.51	7.70
4	Grass and Wood	2.78	1.57	3.48	1.52	2.06
5	Plastic	16.26	19.54	18.97	20.34	19.37
6	Leather and Rubber	1.36	0.97	0.61	0.98	0.96
7	Metal	0.04	0.10	0.04	0.15	0.10
8	Bottle and Glass	0.13	0.61	0.34	0.48	0.43
9	Ceramic, stone	0.61	1.17	0.23	3.27	1.91
10	Domestic Hazardous Material	0.13	0.15	0.21	0.35	0.25
11	Residue Remaining (material remaining sheet)	5.21	2.84	2.89	4.61	4.00
12	Miscellaneous					
A	Tetrapack	0.69	0.43	0.49	0.38	0.45
B	Hairs	0.09	0.00	0.01	0.01	0.02
C	Pampers	7.20	6.08	9.14	5.65	6.60
D	Bones	0.46	0.11	0.09	0.24	0.21
E	Dust	15.59	3.73	3.40	4.16	5.46
F	E-Waste	0.11	0.02	0.00	0.05	0.04
Total		**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Each component of the solid waste characterization was categorized to consider material recovery, composting and RDF treatment, as shown in **Table 4.2**. The total recyclable materials ratio is 23.34%.

The percentage of biodegradable wastes, i.e. kitchen waste, grass, wood, hairs and bones, accounts for 50.69% of the solid waste generated in District Malir, South, East and West. Kitchen waste also has a high percentage of moisture, i.e., 50~70%; therefore, it has a high potential for composting. This shows high composting potential. Combustible waste comprises 31.61% of MSW generated in the four districts. This shows potential for RDF and incineration treatment.

Table 4.2: 3R (Reduce, Reuse, Recycle) and Intermediate Potential by Solid Waste Composition

Material Recycling Potential		Composting Potential		RDF Potential	
Component	(%)	Component	(%)	Component	(%)
Paper	2.03	Kitchen waste	48.40	Paper	2.03
Plastic	19.37	Grass and wood	2.06	Plastic	19.37
Leather and rubber	0.96	Bones	0.21	Textile	7.70
Metal	0.10	Hairs	0.02	Grass and wood	2.06
Bottle and glass	0.43	**Total**	**50.69**	Tetra Pack	0.45
Tetrapack	0.45			**Total**	**31.61**
Total Recyclable Wastes	**23.34**				
Proposed Value for Planning	**24%**		**51%**		**32%**

Figure 4.1: Assessment of waste as fuel for District Malir, South, East and West indicated the need for further seasonal studies on waste characterization

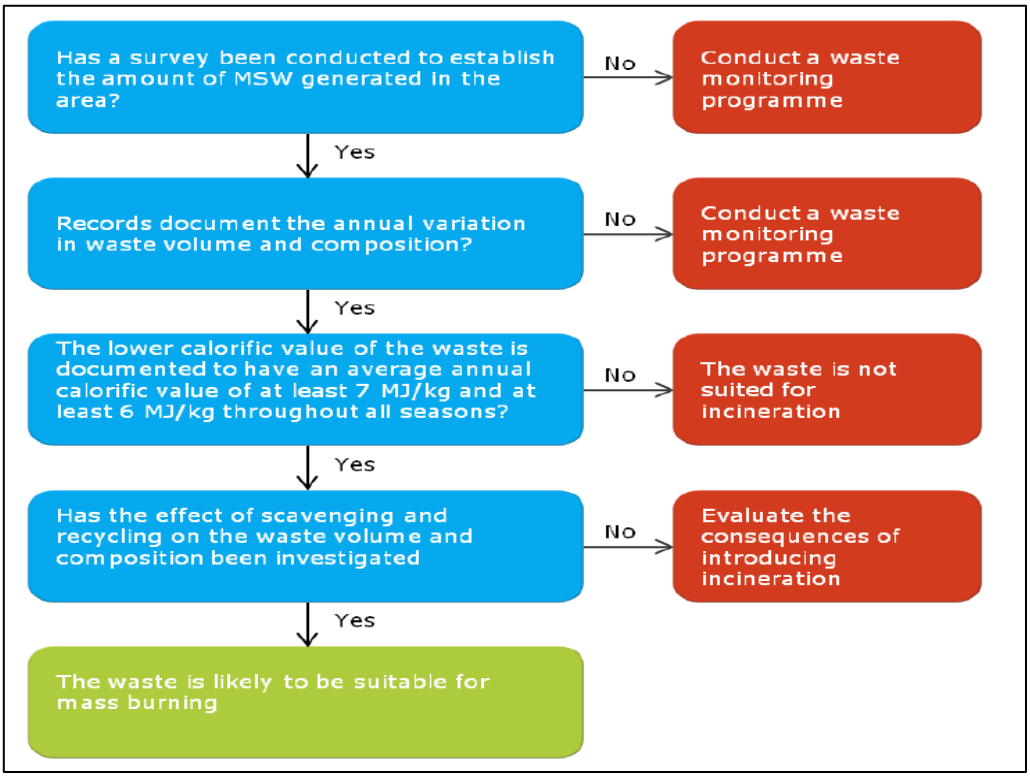
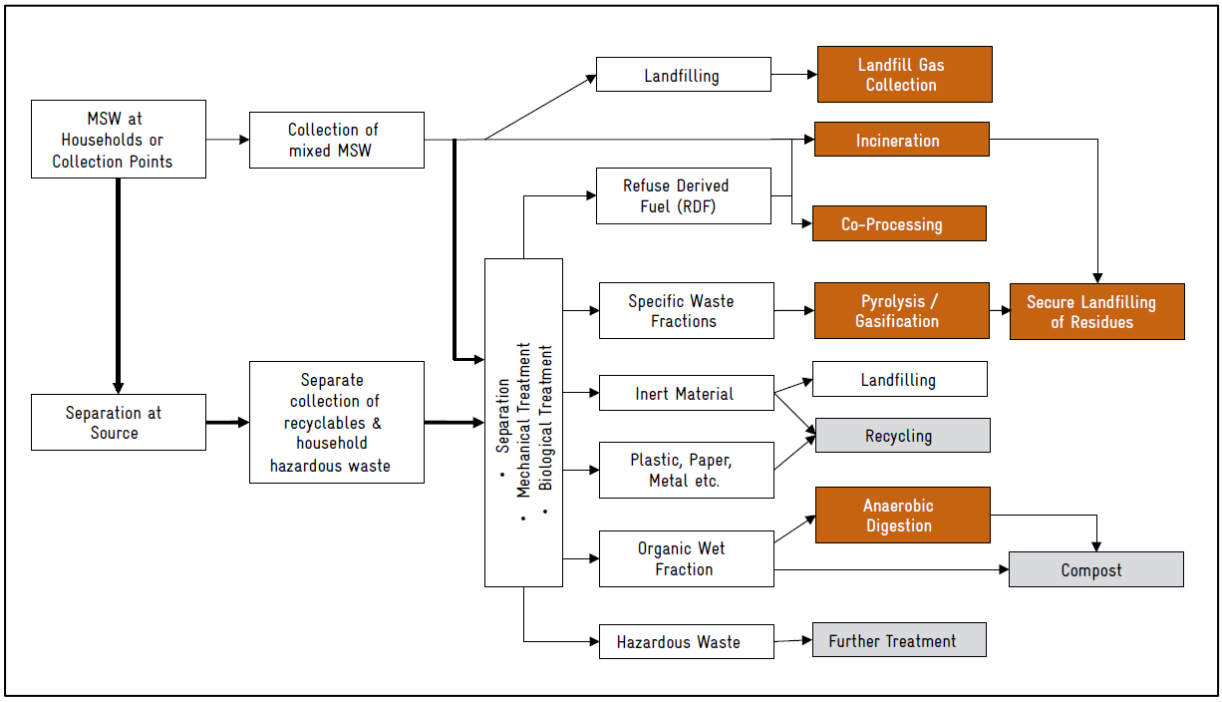


Figure 4.2: Overview of Municipal Solid Waste (MSW) material flow and its different utilization and treatment options (Source: GIZ, 2017).



4.2 Waste Utilization and Intermediate Treatment Options for District Malir, South, East & West

Waste collection usually constitutes the major solid waste management cost in cities and Municipalities. Therefore, Waste to Energy (WtE) options are of great interest within the municipal leadership to possibly (and partially) cover the waste collection cost. Utilities tend to consider their solid waste as a resource that, within appropriate institutional and financial arrangements, can be used to bring in private sector investment for waste to energy projects. However, care should be taken in applying off-the-shelf solutions to particular projects—each project should be evaluated on a stand-alone basis. These solutions should be sized to cater for the non-recyclable, non-recoverable, and non-up cyclable materials and any landfill mining over the life cycle of the project. One should not presume that all the municipal waste can be used for waste to energy projects[33].

There are many technical methods for the intermediate treatment of municipal waste. However, some of them are effective only for small-scale systems, and some other options are technically sophisticated. Considering the waste characteristics, the waste amount for treatment and the technologies that are practical for developing countries[34], the following five technical options, including composting, MRF and waste to energy (incineration and RDF), and biogas, were selected to further study as possible intermediate treatment facilities for the four districts of Karachi division.

MSW of District Malir, South, East, and West are distinct when compared with the MSW around the world as its paper quantity is significantly less. Other than that, the characterization of the MSW is quite similar for other items.

[33] Waste to Energy in the age of circular economy, Asian Development Bank, November 2020
[34] http://gwmc.com.pk/media/downloads/iswm-master-plan-in-gujranwala-volume-02.pdf

The large incinerator burning solid MSW is the process that comes to mind when WtE is mentioned. However, a similar public utility need can be met by making biogas from the organic fraction of municipal solid waste, which is mostly food; refuse-derived fuels (RDF) from combustible materials; and repurposing inert materials as fuel. The further utility can be provided by converting biogas to compressed biomethane fuel (Bio-CNG). Bio-CNG can be bottled to provide a solution to cooking, light industry, or even transport. ADB itself is considering the usage of biogas for transportation for a mass transit project in Karachi[35]. The point is that due consideration needs to be made before taking any pathway regarding the WtE project. Experiences around the globe say that there is no size fit all solution; countries must adapt different options available to develop a solution that may comprise of one or more than one technology for WtE project that suits well to their peculiar requirements

Table 4.3: WtE conversion techniques applicable to the waste available in Karachi:

Item	Technology	Output
Thermal	Combustion	Heat, Electricity, Bottom Ash and Fly Ash
Mechanical-thermal	Mechanical Biological Treatment	Biogas, Electricity, RDF, compost like material
	Landfill gas capture	Biogas, heat, electricity,
Thermo-chemical	Gasification	Syn Gas, Bottom Ash
	Pyrolysis	Syngas, char, oil

4.2.1 Waste as a fuel option

The viability of any MSW incineration facility depends highly, and most importantly, on the quantity and calorific value of the waste. The economic state of the country/area is highly correlated to the calorific value of the waste. Countries with a high degree of consumerism tend to have higher calorific waste characterization due to plastics and cardboard for packaging consumer goods etc.[36]

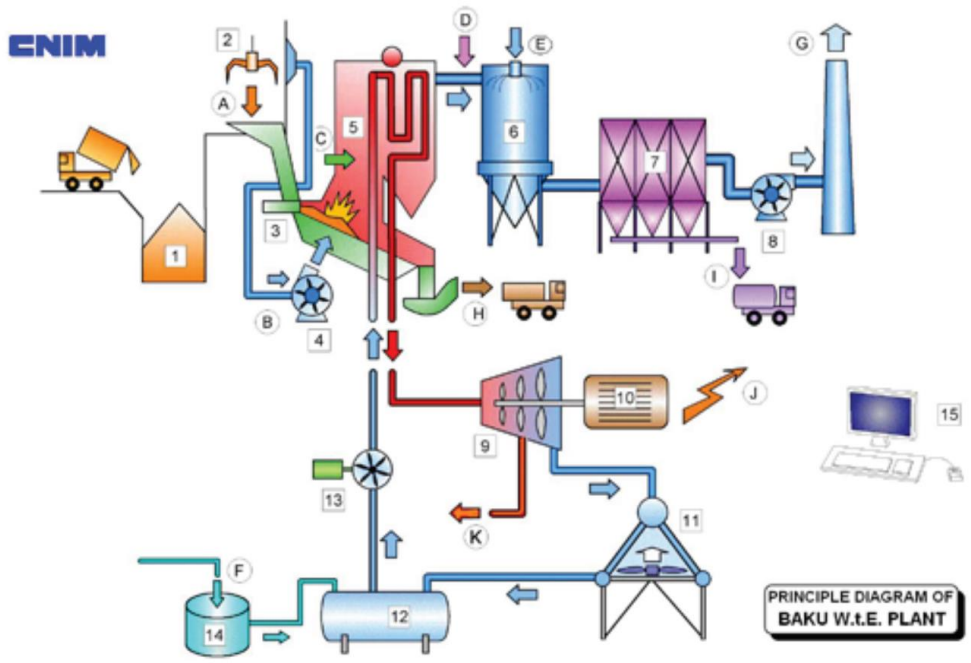
There are two wastes to energy options available are.

Municipal Solid Waste Incineration/ Mass Burning Option: Direct combustion is the oldest technology for biomass conversion, especially for generating heat and steam. The combustion technologies to convert MSW to heat and electricity use similar processes if using fossil fuels. The MSW is burned in a boiler to produce high-pressure steam that flows through a series of turbine blades, causing the turbine to rotate. The turbine is connected to an electric generator that produces electricity. Dumping grate type boilers are the preferred choice for MSW.

[35] https://www.thenews.com.pk/print/575719-red-line-brt-to-be-based-on-ecofriendly-biogas-says-adb-official-at-moot

[36] https://www.iswa.org/index.php?eID=tx_iswaknowledgebase_download

Figure 4.3: Mass Burning Process



Legend: EQUIPMENT: 1- Waste bunker, 2- Traveling crane and grab, 3- CNIM/MARTIN GmbH combustion grate, 4- Combustion air supply, 5- CNIM recovery boiler, 6- LAB Semi-dry type reactor, 7- Fabric filter, 8- Induced draft fan, 9- Steam turbine, 10-Alternator, 11-Air cooled condenser, 12-Deaerator and feed water tank, 13- Feed water pumps, 14- Feed water treatment and demineralized water tank, 15-Operation and control unit in control room.

INPUT: A- Waste; B- Air, C- Urea solution, D- Activated carbon, E- Lime slurry, F- Raw water.

OUTPUT: G-Clean flue gas, H- Coarse ash (clinker) to storage and maturation area, I- Fly ash and flue gas treatment by-products, J-Electricity, K- Steam to district heating network (future possibility).

Source: Constructions Industrielles de la Méditerranée (CNIM) Group.

Mass burning aims to reduce MSW volume and mass and make it chemically inert in a combustion process without the need for additional fuel (autothermic combustion). There are always about 25% residues from incineration in slag (bottom ash) and fly ash. Bottom ash is made up of fine particulates that fall to the bottom of the incinerator during combustion, whilst fly ash refers to fine particulates in exhaust gases that must be removed in flue gas treatment. These residues need further attention and, in the case of hazardous fly ash, a secure place for final disposal. Incinerate the waste and convert the heat derived from the process to generate electricity. The energy recovered from incineration produces power and/or steam, depending on local infrastructure and needs. For combined heat and power plants, one ton of waste can be converted to approximately 2 MWh heat and 2/3 MWh electricity.

In general, the average lower calorific value of waste should be at least 7 MJ/kg (1671 kcal/kg) and must never fall below 6 MJ/kg (1432.8 kcal/kg). Without this value, there would be a need to constantly supply auxiliary fuel, which would increase the viability of an MSW incineration facility at risk. The energy content of the District Malir, South, East, and West is shown in **Table 4.4**.

Table 4.4: Calorific Value of Solid Waste in District Malir, South, East & West

	District Malir	District South	District East	District West	Average (kcal/kg)
Gross Calorific Value (kcal/kg)	1925	1649	1904	1699	1794
Lower Calorific Value(kcal/kg)	1531	1204	1520	1310	1391

Table 4.4 shows that the energy content of District Malir and District East is higher than 1432.8 kcal/kg, which is the minimum required energy content needed for incineration. However, in District South and District West, the lower calorific value is 1204 kcal/kg and 1310 kcal/kg. One of the reasons that can be associated with a lower energy content in District South and West is the higher percentage of moisture content of solid waste. In District Malir and East, the moisture content is 44.74% and 43.82%. However, in District West and District South, the moisture content is comparatively higher at 50.74% and 57.51%, as shown in **Table 3.16**.

Seasonal factors play an important role in the determination of constant high calorific value evaluation throughout the year. Therefore, for all the districts, the waste to energy option will be completely evaluated after a seasonal survey on waste amount characterization. The Waste Amount Characterization Survey needs to be carried out at least twice a year or preferably quarterly to obtain year-round results.[37]

Another aspect is the economic viability of proposing such a facility. The specific investment and operation costs per ton of waste decrease as the capacity of the plant and the utilization rate increase.

Therefore, the plant capacity should be preferably higher than 100,000 tons per year to achieve optimal economies of scale together with average collection distances (GIZ, 2017). All the districts have enough waste generated to make incineration economically viable. Furthermore, GIZ calculates the net cost of using incineration to treat waste in developing countries as 40-80 Euro per ton.

Based on the proximate and ultimate analysis of the MSW of District Malir, South, East & West.

Table 4.5: Electricity generation potential of W2E plant

MSW tons per day	LHV kCal/kg	Energy in MSW MWh	Electrical Power Potential MW	Power to grid MW
6,885	1,391	7,797	97.5	66

In 2018, NEPRA announced a competitive upfront tariff of US Cents 10.007/kWh for waste to energy projects based on 25 years operational period, with an overall capacity of 250 MW wherein the share of each province and Federal Territory have been kept at 50 MW each[38]. In 2018, In line with the new tariff structure, NEPRA granted a generation license to a Chinese company registered in Pakistan as "Lahore Xing Zhong Renewable Energy Company (Private) Limited to construct and operate the waste to the energy power plant of 40MW at Lakhodhair in Lahore and accepting 20,000 tons/day of the municipal waste. NEPRA has announced the

[37] Hla, S.S., Roberts, D. Characterisation of chemical composition and energy content of green waste and municipal solid waste from Greater Brisbane, Australia. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.03.039
[38] https://nepra.org.pk/tariff/Tariff/Upfront/2018/UGTMSWPP-18%20Determination%2015-01-2018%20539-41.PDF

tariff of MSW based power plants to be 9.87 cent/kWH[39] for one project under this regime. It ought to be noted that this tariff is the highest among all the renewable tariffs announced by NEPRA on the date of compiling this report.

It ought to be noted that electrical energy accounts for 25% of the total revenues in waste-to-energy plants in the European Union. The remainder is for the environmental treatment fee (gate fee) and the sale of ancillary products, including heat, bottom ash, and slag. Therefore, the careful examination needs to be undertaken before going for waste to energy options generating electrical energy.

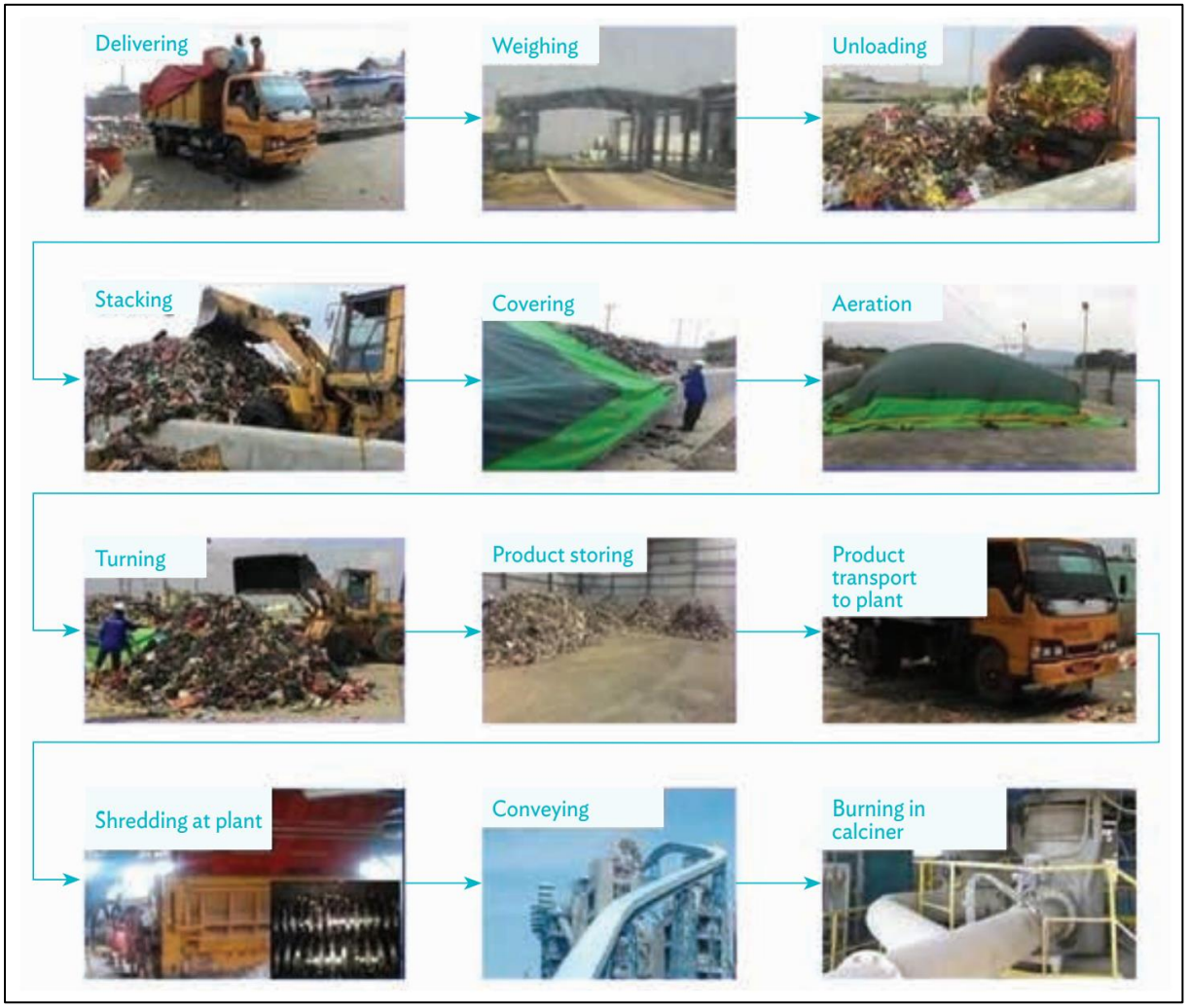
Refuse Derived Fuel Via Mechanical Biological treatment (MBT) Option: RDF consists largely of combustible components of municipal waste such as plastics and biodegradable waste. Refuse-derived fuel (RDF) or solid recovered fuel/specified recovered fuel (SRF) is a fuel produced by shredding and dehydrating solid waste with waste technology. Co-processing of RDF in cement plants has also become a widespread waste management system in several developing and emerging countries.

Mechanical biological treatment (MBT)[40] involves the combination of various processes such as mechanical (e.g., sorting, shredding, milling, separating, or screening) and biological components (drying, composting, or anaerobic digestion) to create solid recovered fuel or RDF and divert organic materials for fertilizer and energy. This fuel can be further processed as pellets or briquettes and can be used as feedstock in energy facilities as a replacement for fossil fuels. MBT consists of different treatment processes and has four types of outputs:

- RDF – has a high calorific value due to high paper and plastic content.
- Stabilized organic waste – produced from the biological treatment of the organic portion of the waste.
- Ferrous and non-ferrous metals – for potential recycling; and
- Inert wastes – scraps/residues that are disposed of in landfills.

[39] https://nepra.org.pk/tariff/Generation%20IPPs%20Waste%20to%20Energy.php
[40] F. Fe, Z. Wen, and S. Huang. 2018. Mechanical Biological Treatment of Municipal Solid Waste: Energy Efficiency, Environmental Impact and Economic Feasibility Analysis. https://doi.org/10.1016/j.jclepro.2018.01.060

Figure 4.4: Pictorial presentation of RDF Process



For RDF to be successful, a high percentage of the waste streams needs to have a high calorific value. The RDF potential in the four districts is 32%. Another aspect is the economic viability of proposing such a facility. According to GIZ Waste-to-Energy Options in Municipal Solid Waste Management, the minimum pre-sorted waste required is 50,000 tons per year. Furthermore, GIZ calculates the net operating cost of using RDF to treat waste in developing countries as 19-40 Euro per ton.

Refuse Derived Fuel is suitable for all the districts, i.e., Malir, South, East & West, due to high specific combustible waste quantity. MSW of District Malir, South, East & West has 33% material that can be used for RDF production. It is estimated that with the daily solid waste production of 6,885 tons, the potential of RDF stands at 2267 TPD. RDF price in the market stands at PKR 3,000 per ton. However, it fluctuates as per demand. Long term agreements can be sought with the cement plants near Karachi for the sale of RDF. There have been instances in Pakistan where cement plants have opted to establish RDF plants with their own investment while buying MSW at a price of PKR 52/ton from Lahore Waste Management Company[41]

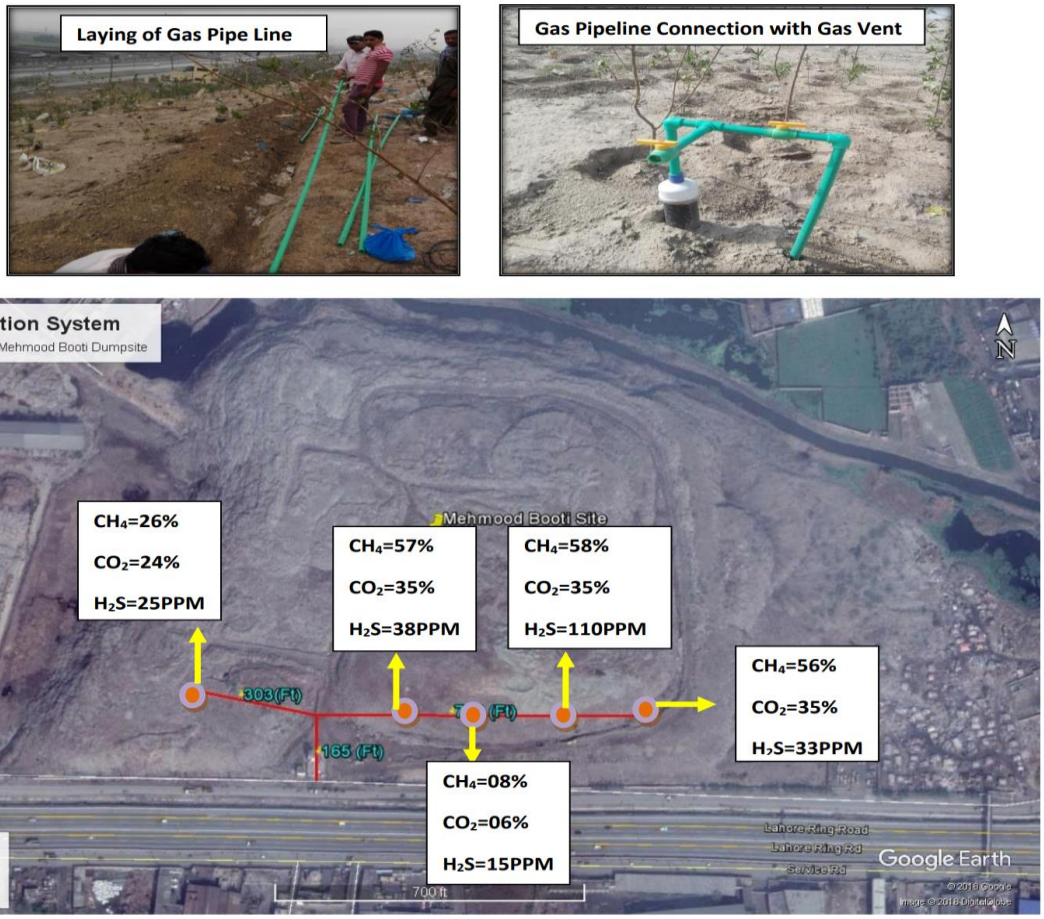
[41] https://tribune.com.pk/story/1966466/lahore-stands-tall-generating-green-fuel-waste

A similar quantity of compost can be expected out of the plant, i.e., 1814 TPD. The price of compost is Rs 6000 per ton. However, its market demand is uncertain.

Landfill Gas Capture: While operating an engineered or a sanitary landfill, landfill gas, which consists of 35%–55% methane, is generated by the anaerobic digestion of organic matter in the landfill body. To capture the methane generated, a landfill gas recovery plant is installed consisting of an extraction system and flaring system[42]

An example of one such pilot system was installed by LWMC at Mehmood Booti Dumpsite. Gas has been monitored initially from installed gas vents. During the trial project, Gas from four (04) identified Gas Vents already installed at the dumpsite was collected and transported through 900 feet long gas pipeline to one point for testing and flaring. After completion of work and gas has been tested during different intervals and as proposed. Methane gas has been identified, which is a combustible gas that can be utilized to generate heat and power. More than 50% concentration of methane was noted at most of the vents.

Figure 4.5: Pictorial Presentation of Landfill Gas Capturing Process



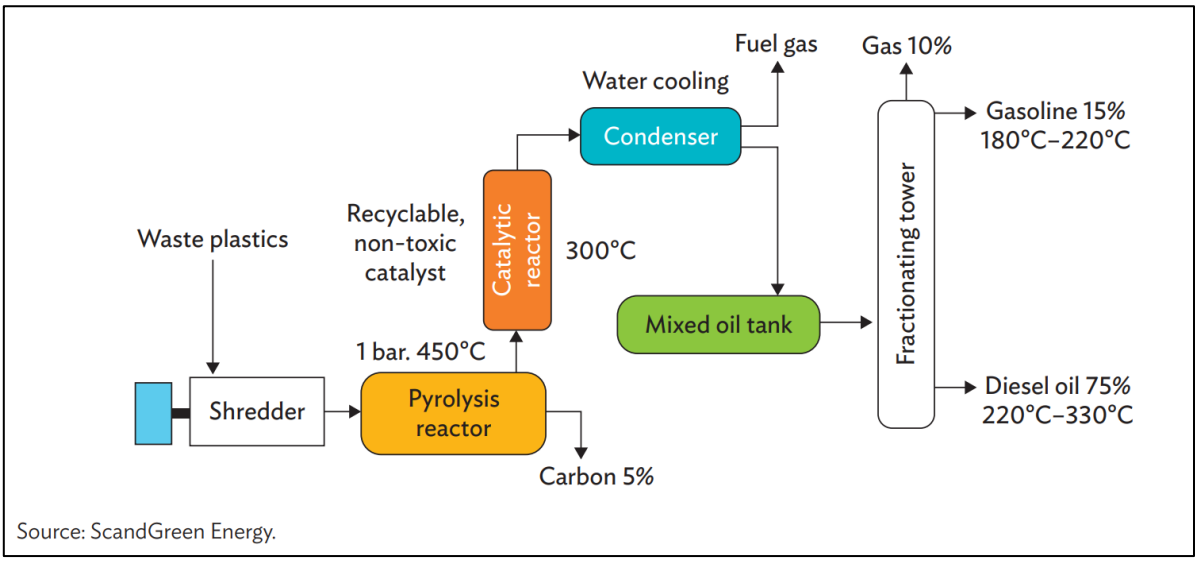
Given the fact that more than 80% of the MSW at District Malir, South, East & West is biodegradable, it has the potential of generating biogas under the right conditions. It is

[42] H. Terraza and H. Willumsen. 2009. Guidance Note on Landfill Gas Capture and Utilization. Technical Notes 108. InterAmerican Development Bank. http://www.resol.com.br/textos/guidance_note_on_landfill_gas_capture-idb.pd.

estimated that the MSW has the potential of generating 128,632 m^3 of biogas with an accumulative heat content of 2830 MMBTU. At the current SSGC industrial gas tariff, this energy monetized into PKR 2,982,729 per day.

Pyrolysis: Pyrolysis is a thermochemical process conducted at a temperature between 400˚C – 600˚C in the absence of air. As there is no oxygen present, the organic material does not combust, but chemical compounds such as cellulose, hemicellulose, and lignin decompose into combustible gases and charcoal. Depending on factors such as temperature, pressure, and heating rate, pyrolysis produces three products—solid, liquid, and gas in the form of char, fuel oil, and syngas.

Figure 4.6: Pyrolysis Process



Given the fact that more than 18% of the MSW at District Malir, South, East & West is plastic. It has the potential of generating diesel, petrol, and carbon black under the right pyrolysis conditions. It is estimated that the MSW has the potential of generating 388.6 tons of diesel, 261.4 tons of petrol and 91.8 tons of carbon black per day.

Table 4.6: Potentials of waste to energy options for MSW at Malir, East, West, South

Technology	Output per day
Combustion	1,263,160 kWh
Mechanical Biological Treatment	2,268 TPD RDF 1,814 TPD Compost
Landfill gas capture	2,830 MMBTU
Pyrolysis	388.6 tons of diesel, 261.4 tons of petrol and 91.8 tons of carbon black

However, it ought to be noted that the presented indicative waste to energy potential is based on industrial practices and consultant estimates based on similar projects. The selection of a single or mix of technologies will require detailed feasibility studies. Therefore, it is recommended that separate detailed technical, environmental, and financial feasibility studies for using waste to energy should be carried out by SSWMB.

4.2.2 Composting Option for District Malir, South, East, and West

High moisture content suggests the applicability of wet treatment options, including composting, anaerobic digestion, which are more feasible options for the segregated organic stream of the municipal waste. This could prove to be a feasible option because, during waste generation, a high amount of organic waste (more than 50%) with high moisture content (50~70%) was obtained that could be incorporated into compost successfully. Around 50% of MSW generated is biodegradable waste which can easily be converted to composting as intermediate treatment.

Carbon and Nitrogen are of utmost importance for compost values. Their correct ratio favours waste to be used as a fertilizer.

In the present study, the average calculated C/N values of household waste for districts combined is 21.5, within the recommended range. The optimal C/N value of the composting material is 25-40.[43]

Table 4.7: Chemical characterization based composting potential of waste components in District Malir, South, East, and West

	Moisture (%)	Carbon (%)	Carbon/ Nitrogen
District Malir	44.74	19.45	39
District South	57.51	15.46	32
District East	43.82	17.20	24
District West	50.74	33.8	35

In our study, if these samples from all the four districts are considered for compost, this could prove to be a feasible option because, waste composition reveals, a high amount of organic waste (up to 50%) was obtained that could be incorporated into compost successfully. Added moisture content could be obtained by inoculating agents like cow dung, poultry manure, yard waste etc., in the solid waste.

Some examples of composting in low-income countries include composting plants in Lahore, Pakistan, Indonesia, and Bangladesh. In Punjab, Pakistan, a composting plant is being operated in Lahore Compost (Pvt.) Ltd. (LCL). The LCL has been operating since 2006, and they produce compost and RDF. The plant could not sell the compost. More than half of the compost product remained unsold. One reason is no trust of the users (farmers and inhabitants) on organic fertilizers, i.e., compost.

In one of the largest parks in Gujranwala City, named Gulshan Iqbal Park, composting has been practised for more than 23 years. After establishing the Parks and Horticulture Authority (PHA) on 11 April 2014, the administration of all parks was handed over by the Tehsil Municipal Administrations (TMA) to PHA.

The pit and open heap/pile method of composting is being practised. In the open heap/pile method, cow dung, dry crushed leaves and earth are mixed at the ratio of 3:2:14. A periodic sprinkling of 5% DAP (Di-Ammonium Phosphate) solution is done on the pile. In the pit method

[43] Tom L. Richard. Municipal Solid Waste Composting: Biological Processing. 1996. http://compost.css.cornell.edu/MSWFactSheets/msw.fs2.html . Accessed on 16th April 2021

of composting, 2 feet high layers of leaves of a eucalyptus tree in the park are placed in the pit, and a periodic sprinkling of 5% DAP is also done.

The process is completed in 3 pits. After every three months, the material is transferred to the next pit. This type of compost gets prepared in 9 months. Compost prepared in this park is used only for horticulture and floriculture within the park. As many as 100,000 plants of 23 different varieties grew using this compost in 2014. PHA has a plan to expand composting into the other parks in Gujranwala City.[44]

In Surabaya, Indonesia, the breathing or ventilation type container compost plant such as the plastic basket lined with geotextile is used for the home method composting to put in raw wastes discharged from kitchens, etc., together with seeding material for composting.

In Dhaka, the capital of Bangladesh, Waste Concerns, the registered NGO, constructed a middle-scale compost plant with the capacity of 130 tons per day and started operations at the beginning of 2009 to produce compost from biodegradable wastes collected from markets upon approval by the Government of Bangladesh and by the project Executive Board of UN for the Project. This example is a good case to develop the central compost project through linkage with the activities of the private sector regardless of the financial weakness of the local government.

4.2.3 MRF (Material Recovery Facility) Option

Suitable waste input for MRF includes sorted waste for recycling metal, glass, paper, plastics, and other valuables. The recyclables are stored in the open space or small-scaled houses. Recyclables are sold to junkshops, recyclable shops, etc.

The survey results on characterization indicate a high potential of recyclable items in the waste stream, as shown in **Table 4.8**.

Table 4.8: Material Recovery Potential in District Malir, South, East, and West

Material Recycling Potential	
District	**(%)**
Malir	19.23
South	23.46
East	24.16
West	24.16
Overall	**23.34**

Table 4.8 clearly shows that there is potential for the establishment of a Material Recovery Facility. Therefore, it is recommended that the Material Recovery Facility should be installed at the Garbage Transfer Stations.

An example of the Philippines includes establishing a materials recovery facility (MRF), which is mandated to the local barangays (villages) under the Ecological Solid Waste Management Act of 2000 as the centre for recovery of recyclable waste. Accordingly, the MRF shall have the role as a core facility of 3R activities operated by the villages with the participation of

[44] Project For Integrated Solid Waste Management Master Plan In Gujranwala Final Report Volume 3 (http://open_jicareport.jica.go.jp/pdf/12246336_02.pdf page 18)

community residents. However, in most cases, the MRF facilities in the Philippines are operated mainly for the community level composting of organic wastes since the recovery of valuable wastes by private junkshops is very active. The valuable wastes brought to the MRFs are very few.

Another example of MRF in Thailand includes waste banks establishing segregated recyclable wastes such as paper, glass, plastics, and metal recovered directly from the waste generation sources by the residents and/or community activities. The recovered recyclables are sold at the bank. The junk shops or the recyclers purchase the recovered waste from the bank. According to the report "Waste Minimization in Thailand: Experience and Trend" by Mr Rangsan Pinthong, Pollution Control Department, MONRE, Thailand, nowadays, more than 500 waste recyclable bank systems have been established in 30 provinces.

4.2.4 Biogas

Biogas means gas produced by the anaerobic digestion or fermentation of organic matter. The organic matter can be manure, sewage sludge, municipal solid waste, biodegradable waste, or any other biodegradable feedstock. Biogas is mainly methane and carbon dioxide. Depending on where it is produced, biogas is also called: swamp gas, marsh gas, landfill gas, digester gas. Biogas can be used as vehicle fuel or for generating electricity. It can also be burned directly for cooking, heating, lighting, process heat and absorption refrigeration[45].

In Pakistan, biomass is readily available in most areas of the country, particularly in rural areas. Biomass energy uses natural materials such as trees, plants, and wastes to make electricity and biofuel. It is also environmentally friendly. Since 1974, more than 1,700 biogas plants have been installed under a nationwide programme funded by the Government of Pakistan.

NRSP provides the research to access the design, maintenance, usage, and sustainability of biogas plants as an energy source at the household level. "Evaluation of Biogas Initiative in Punjab", National Rural Support Programme (NRSP), August 2011.

The full cost of biogas plants in Punjab, Pakistan, is in ranges from Rs. 40,000 to Rs. 80,000 and above, depending on the size.[46] Based on the economic analysis conducted in the US, the total cost for a biogas plant, including all essential installations but not including land, is between 50-75 US Dollars per m^3 capacity. 35 - 40% of the total costs are for the digester.[47]

Table 4.9: Daily requirements of biogas plant by size[48]

Plant Size(m^3)	Daily dung requirements (kgs)	Livestock requirements (cow/bullocks)	Daily water requirements (litres)	Gas Production (M^3/day)
4	30	2-3	30	4
6	45	4-5	45	5-6
8	60	5-6	60	6-8
10	75	7+	75	8-10

[45] (https://simple.wikipedia.org/wiki/Biogas)
[46] http://www.nrsp.org.pk/publications/Evaluation-Assessment-Studies/Renewable-Energy-Evaluation-of-Biogas-Initiative-in-Punjab.pdf
[47] https://energypedia.info/wiki/Costs_of_a_Biogas_Plant#Production_Costs
[48] (Source: RSPN information brochure on biogas http://www.rspn.org/our_projects/projects_pdfs/Brochure.pdf)

4.3 Proposed Solution

Based on the Qualitative Evaluation Matrix of Intermediate Waste Treatment Options for District Central and Korangi, Karachi given under table 4.6-4.9, the most suitable technological option for handling the municipal waste generated in District Malir, South, East and West Districts is the combination of mechanical and biological treatment options enabling around 95% of the organics, recyclables and combustibles from the landfill and saving landfill airspace for a longer time, recovering the economic potential of the waste and improving the environment through reducing the methane emission from the landfill. A centralized waste management facility will be handling MSW in the following steps:

1. A sorting line consists of a bags opener, trommel screens/vibratory, magnets, ballistic separator, and baling units. The possibility of establishing a pyrolysis plant may be considered after ascertaining the plastic quantity that can be salvaged from scavengers.
2. After sorting and segregation, organic waste will be subjected to Anaerobic Digestion and subsequent composting using aerated piles.
3. Biogas produced will either be used to generate energy for the MSW plant and gas filling after necessary treatment or will be used as transportation fuel after necessary compression
4. RDF will be produced, which may be sold to the cement industries or brick kilns.
5. Recyclables will be sorted, which may be sold to the recycling industry.
6. The remaining inert waste will be landfilled

Table 4.10: Qualitative Evaluation Matrix of Intermediate Waste Treatment Options for District Malir, Karachi

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
Waste Type	Mixed waste	Biodegradable waste	Sorted waste for recycling	Combustible	Combustible (plastic, paper)	Biodegradable
Cost of Facility	No cost due to no facility	Cheaper	Cheaper	Very expensive	Expensive	Moderate
	-	**A**	**A**	**B**	**A**	**A**
Environmental Aspect	Need to acquire 100% collection efficiency	Odour if mishandled	Odour if mishandled	Need removal of pollutants from combustion gas emission. However, Incineration has additional environmental benefits as well.	Need removal of pollutants from combustion gas emission	Odour if mishandled
	B	**A**	**A**	**A**	**A**	**A**
Applicability	-	Small towns to large cities	Small communities to middle cities	Best for Large Cities	Small towns to large cities	Villages /small towns in rural areas
	A	**A**	**A**	**A**	**A**	**A**
Actual Practical Experiences in Pakistan	Present	There is the Lahore Compost Company.	Not present (Few projects are underprocessed)[49]	Not present	RDF as fuel in D.G. Khan Cement Company, and Lafarge/Fauji Cement companies.	Present (Installed by NRSP)
	B	**A**	**A**	**B**	**A**	**A**

[49] https://www.dawn.com/news/1613131/segregation-treatment-and-disposal-plant-to-be-functional-in-april

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
Recommendations for application to District Malir solid waste intermediate treatment facilities	-	Highly Applicable	High potential/ proportion (20%), but if the compost plant is established, MRF is viable as both activities are interdependent.	Energy Value above the minimum required range. Hower needs additional data to evaluate fully	Applicable as sufficient amount of combustibles are present	Organic matter was comparatively less. However, C/N ratio is in the recommended ranger
	-	**A**	**A**	**A**	**A**	**A**
Recommendation as per solid waste policies applicable to District Malir	Recommended options for waste utilization and recovery are Option 2: Composting, Option 3: Material Recovery Facility, Option 4: Incineration / Mass Burning, Option 5: RDF and Option 6: Biogas as the most practical/reliable intermediate treatment facilities in District Malir.					
	-	**A**	**A**	**A**	**A**	**A**
Evaluation Results		**A**	**A**	**A**	**A**	**A**

Legend: A- Suitable; B- Not suitable

Source: JICA Project Team, GWMC

Note:* NRSP stands for National Rural Support Programme (NGO).

** NRSP, Monitoring, Evaluation & Research Section, “Renewable Energy: Evaluation of Biogas Initiative in Punjab” August 2011

Table 4.11: Qualitative Evaluation Matrix of Intermediate Waste Treatment Options for District South, Karachi

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
Waste Type	Mixed waste	Biodegradable waste	Sorted waste for recycling	Combustible	Combustible (plastic, paper)	Biodegradable
Cost of Facility	No cost due to no facility	Cheaper	Cheaper	Very expensive	Expensive	Moderate
	-	A	A	B	A	A
Environmental Aspect	Need to acquire 100% collection efficiency	Odour if mishandled	Odour if mishandled	Need removal of pollutants from combustion gas emission. However, Incineration has additional environmental benefits as well.	Need removal of pollutants from combustion gas emission	Odour if mishandled
	B	A	A	A	A	A
Applicability	-	Small towns to large cities	Small communities to middle cities	Best for Large Cities such as District South	Small towns to large cities	Villages /small towns in rural areas
	A	A	A	A	B	A
Actual Practical Experiences in Pakistan	Present	There is the Lahore Compost Company.	Not present (Few projects are underprocessed)[50]	Not present	RDF as fuel in D.G. Khan Cement Company, and Lafarge/Fauji Cement companies.	Present (Installed by NRSP)
	B	A	A	B	A	A

[50] https://www.dawn.com/news/1613131/segregation-treatment-and-disposal-plant-to-be-functional-in-april

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
Recommendations for application to District South solid waste intermediate treatment facilities	-	Highly Applicable	High potential/ proportion (24%), but if the compost plant is established, MRF is viable as both activities are interdependent.	Low potential (Low energy value) needs additional data to fully evaluate	Applicable as sufficient amount of combustibles are present	Organic matter was comparatively less as compared to other Cities
	-	**A**	**A**	**B**	**A**	**B**
Recommendation as per solid waste policies applicable to District South	Recommended options for waste utilization and recovery are Option 2: Composting, Option 3: Material Recovery Facility and Option 5: RDF as the most practical/reliable intermediate treatment facilities in District South.					
	-	**A**	**A**	**B**	**A**	**A**
Evaluation Results		**A**	**A**	**B**	**A**	**A**

Legend: A- Suitable; B- Not suitable

Source: JICA Project Team, GWMC

Note:* NRSP stands for National Rural Support Programme (NGO).

** NRSP, Monitoring, Evaluation & Research Section, “Renewable Energy: Evaluation of Biogas Initiative in Punjab” August 2011

Table 4.12: Qualitative Evaluation Matrix of Intermediate Waste Treatment Options for District East, Karachi

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
Waste Type	Mixed waste	Biodegradable waste	Sorted waste for recycling	Combustible	Combustible (plastic, paper)	Biodegradable
Cost of Facility	No cost due to no facility	Cheaper	Cheaper	Very expensive	Expensive	Moderate
	-	**A**	**A**	**B**	**A**	**A**
Environmental Aspect	Need to acquire 100% collection efficiency	Odour if mishandled	Odour if mishandled	Need removal of pollutants from combustion gas emission. However, Incineration has additional environmental benefits as well.	Need removal of pollutants from combustion gas emission	Odour if mishandled
	B	**A**	**A**	**A**	**A**	**A**
Applicability	-	Small towns to large cities	Small communities to middle cities	Best for Large Cities such as District East	Small towns to large cities	Villages /small towns in rural areas
	A	**A**	**A**	**A**	**A**	**A**
Actual Practical Experiences in Pakistan	Present	There is the Lahore Compost Company.	Not present (Few projects are underprocessed)[51]	Not present	RDF as fuel in D.G. Khan Cement Company, and Lafarge/Fauji Cement companies.	Present (Installed by NRSP)
	B	**A**	**A**	**B**	**A**	**A**
Recommendations for application to District East solid	-	Highly Applicable	High potential/ proportion (25%), but if the compost plant is	Energy Value above the minimum required range. Hower needs	Applicable as sufficient amount of combustibles are present	Organic matter was comparatively less as compared to other Cities

[51] https://www.dawn.com/news/1613131/segregation-treatment-and-disposal-plant-to-be-functional-in-april

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
waste intermediate treatment facilities			established, MRF is viable as both activities are interdependent.	additional data to evaluate fully		
	-	**A**	**A**	**A**	**A**	**A**
Recommendation as per solid waste policies applicable to District East	Recommended options for waste utilization and recovery are Option 2: Composting, Option 3: Material Recovery Facility, Option 4: Incineration and Option 5: RDF as the most practical/reliable intermediate treatment facilities in District East.					
	-	**A**	**A**	**A**	**A**	**A**
Evaluation Results		**A**	**A**	**A**	**A**	**A**

Legend: A- Suitable; B- Not suitable

Source: JICA Project Team, GWMC

Note:* NRSP stands for National Rural Support Programme (NGO).

** NRSP, Monitoring, Evaluation & Research Section, “Renewable Energy: Evaluation of Biogas Initiative in Punjab” August 2011

Table 4.13: Qualitative Evaluation Matrix of Intermediate Waste Treatment Options for District West, Karachi

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
Waste Type	Mixed waste	Biodegradable waste	Sorted waste for recycling	Combustible	Combustible (plastic, paper)	Biodegradable
Cost of Facility	No cost due to no facility	Cheaper	Cheaper	Very expensive	Expensive	Moderate
	-	**A**	**A**	**B**	**A**	**A**
Environmental Aspect	Need to acquire 100% collection efficiency	Odour if mishandled	Odour if mishandled	Need removal of pollutants from combustion gas emission. However, Incineration has additional environmental benefits as well.	Need removal of pollutants from combustion gas emission	Odour if mishandled
	B	**A**	**A**	**A**	**A**	**A**
Applicability	-	Small towns to large cities	Small communities to middle cities	Best for Large Cities such as District West	Small towns to large cities	Villages /small towns in rural areas
	A	**A**	**A**	**A**	**A**	**A**
Actual Practical Experiences in Pakistan	Present	There is the Lahore Compost Company.	Not present (Few projects are underprocessed) [52]	Not present	RDF as fuel in D.G. Khan Cement Company, and Lafarge/Fauji Cement companies.	Present (Installed by NRSP)

[52] https://www.dawn.com/news/1613131/segregation-treatment-and-disposal-plant-to-be-functional-in-april

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
	B	**A**	**A**	**B**	**A**	**A**
Recommendations for application to District West solid waste intermediate treatment facilities	-	Highly Applicable	High potential/ proportion (25%), but if the compost plant is established, MRF is viable as both activities are interdependent.	Low potential (Low energy value) needs additional data to evaluate	Applicable as sufficient amount of combustibles are present	Organic matter was comparatively less as compared to other Cities
	-	**A**	**A**	**B**	**A**	**A**
Recommendation as per solid waste policies applicable to District West	Recommended options for waste utilization and recovery are Option 2: Composting, Option 3: Material Recovery Facility and Option 5: RDF as the most practical/reliable intermediate treatment facilities in District West.					
	-	**A**	**A**	**B**	**A**	**A**
Evaluation Results		**A**	**A**	**B**	**A**	**A**

Legend: A- Suitable; B- Not suitable

Source: JICA Project Team, GWMC

Note:* NRSP stands for National Rural Support Programme (NGO).

** NRSP, Monitoring, Evaluation & Research Section, “Renewable Energy: Evaluation of Biogas Initiative in Punjab” August 2011

5 Conclusion & Recommendations

This chapter describes the conclusion and recommendation of the Waste Amount Characterization Survey in District Malir, South, East & West, Karachi.

5.1 Conclusion

Following conclusions can be drawn from the Waste Amount Characterization Survey:

- Overall, in Malir District, the major fraction of MSW was organic waste and shared 38.23% of the total waste, mostly consisting of kitchen waste, food waste, including fruits that are spoiled and fermented. A second major part of MSW was plastic waste (including wrappers, baggies, Styrofoam, etc.) and shared about 16.26% of the total generated solid waste. Dust and silt comprised 15.59 % of the MSW, followed by textile at 10.35%, Pamper / Diapers / Sanitary Pads at 7.20%, residue material remaining on the sheet at 5.21%, grass and wood at 2.78% and Leather and Rubber at 1.36%. All the remaining items were less than 1%.
- The present population of Malir district is 2,108,514. A total of 5050.761 kg of solid waste was collected from 55 vehicles during the survey. The land use analysis of Malir district shows that Malir is predominantly 96% residential area, Landhi is 57% residential and 40% industrial area, whereas Bin Qasim is 36% residential and 60% industrial area.
- An allowance of 10% for commercial areas and 30% for Bulk and industrial areas have been made for Malir District. The overall solid waste generation has been worked as 0.651 kg/capita/day, and 1,373 tons/day of solid waste is generated daily.
- Overall, in District East, the major fraction of MSW was organic waste and shared 48.09 % of the total waste, mostly consisting of kitchen waste, food, and fruits that remain spoiled and fermented food waste. A second major part of MSW was plastic waste (including wrappers, baggies, Styrofoam, etc.) and shared about 18.97% of the total generated solid waste. Pamper / Diapers / Sanitary Pads comprised 9.14%, textile at 8.29 %, paper at 3.71%, Grass and Wood at 3.48% and residue material remaining on the sheet at 2.89%. All the remaining items were less than 1%.
- District East Karachi is in the South-eastern part of Karachi with a population of 3,015,256. The land use analysis of East district shows that Gulshan Zone is predominantly 97% residential area and only 3% is commercial area whereas, Jamshed Zone too is 98% residential area and only 2% commercial area.
- An allowance for 10% for commercial areas and 5% for bulk and industrial waste has been made for district East Karachi. The overall solid waste generation has been worked as 0.516 kg/capita/day, and 1,557 tons/day of solid waste is generated daily.
- Overall, in District South, the major fraction of MSW was organic waste and shared 52.74 % of the total waste, mostly consisting of kitchen waste, food, and fruits that remain spoiled and fermented food waste. A second major part of MSW was plastic waste (including wrappers, baggies, Styrofoam, etc.) and shared about 19.54 % of the total generated solid waste. Textile comprises 8.12% Pamper / Diapers / Sanitary Pads at 6.08%, soil/dust at 3.73 % and residue material remaining on the sheet at 2.84%. Waste paper comprised only 1.81%, followed by Grass and Wood at 1.57, Ceramics, stone at 1.17%. All the remaining items were less than 1%.
- District South Karachi is in the South-eastern part of Karachi with a population of 1,475,638. The land use analysis of Lyari Zone is predominantly 83% residential area,

8% commercial, and 9% industrial area, whereas Saddar Zone is 69% residential, 21% commercial and 10% industrial area.

- An allowance for 15% for commercial areas and 15% bulk and industrial waste has been made for District South Karachi. The solid waste generation has been worked as 0.584 kg/capita/day, and 861tons/day of solid waste is generated daily.
- Overall, in District West, the major fraction of MSW was organic waste and shared 49.48 % of the total waste, mostly consisting of kitchen waste, food, and fruits that remain spoiled and fermented food waste. A second major part of MSW was plastic waste (including wrappers, baggies, Styrofoam, etc.) and shared about 20.34% of the total generated solid waste. Textile comprises 6.52%, Pamper / Diapers / Sanitary Pads at 5.65%, residue material remaining on the sheet at 4.61%, the soil at 4.16% and ceramics at 3.27%. Wastepaper comprised only 1.83%, followed by Grass and Wood at 1.52%. All the remaining items were less than 1%.
- District West Karachi is in the South-eastern part of Karachi with a population of 4,459,587. The land use analysis of Baldia is prenominal 93 % is a residential area, 3% commercial and 4% industrial area; Kemari 60% residential, 12% commercial and 28% industrial area; Korangi is 97% residential, 1% commercial, and 2% industrial area; and SITE is 38% residential, 1% commercial and 61% industrial.
- An allowance for 10% for commercial areas and 30% for bulk and industrial waste has been made for District West Karachi. The overall solid waste generation has been worked as 0.629 kg/capita/day, and 2,803 tons/day of solid waste is generated daily.
- The density of solid waste in District Malir, South, East and West were 333.711 kg/m3, 289.487 kg/m3, 303.51 kg/m^3, 366.788 kg/m^3, respectively.
- Considering the waste characteristics, the waste amount for treatment and the technologies that are practical for developing countries53, the following five technical options, including composting, MRF and waste to energy (incineration and RDF), and biogas, were selected to further study as possible intermediate treatment facilities for the four districts of Karachi division.
- Overall, there is 29.56% recyclable components in the total waste collected. The organic components constituted 50.01 % of the waste, and 31.61% of the waste had RDF potential. Therefore, the proposed values for planning waste utilization and recovery options are 24%, 51% and 32% for recycling, composting, and RDF, respectively.
- Presently, the best method to treat the waste is establishing a Material Recovery Facility and Compost Plant at Garbage Transfer Stations. Composting is also favourable due to optimum moisture content and C/N ratio.
- The energy content (average LCVwb) of District Malir and District East is higher than 1432.8 kcal/kg, which is the minimum required energy content needed for incineration. However, in District South and District West, the lower calorific value is 1204 kcal/kg, and 1310 kcal/kg was seen.
- In general, the average lower calorific value of waste should be at least 7 MJ/kg (1671 kcal/kg) and must never fall below 6 MJ/kg (1432.8 kcal/kg). Without this value, there would be a need to constantly supply auxiliary fuel, which would increase the viability of an MSW incineration facility at risk.
- Based on the Qualitative Evaluation Matrix of Intermediate Waste Treatment Options for Karachi City, the most suitable technological option for handling municipal waste is to implement the combination of mechanical and biological treatment options.

[53] http://gwmc.com.pk/media/downloads/iswm-master-plan-in-gujranwala-volume-02.pdf

5.2 Recommendations

After reviewing the concluded results and data acquired, the following are the recommendations which are proposed for the betterment of the waste management system of District Malir, South, East, and West:

- The strategies of SSWMB should be an equal or higher emphasis on "upstream" waste reduction efforts compared to "downstream" waste management options such as treatment and disposal.
- SSWMB jurisdiction in District Malir, South, East & West produces 19.54% of plastic. With the growing concern on plastic waste pollution globally, SSWMB should ban non-biodegradable plastic and promote biodegradable plastic bags.
- Based upon the waste characterization data, a Compost Plant and a Material Recovery Facility is feasible. This will help divert a major portion of the solid waste generated close to the source of generation, thereby significantly reducing transportation costs and prolonging the lifespan of landfills. Furthermore, an awareness campaign to start segregation at the source can have a dramatic positive impact on the success of MRF.
- The energy content of District Malir and East have shown energy content of 1531 kcal/kg and 1520 kcal/kg, which is above the minimum required energy content for a waste to energy plant to be feasible. However, seasonal factors do play an important role in the determination of constant high calorific value evaluation throughout the year. Therefore, for all districts, the waste to energy option will be completely evaluated after a seasonal survey on waste generation.
- The characterisation is conducted in District Malir, South, East, and West. The Waste Amount Characterization Survey needs to be carried out at least twice a year or preferably quarterly to obtain year-round results.
- 3R (Reduce, Reuse, Recycle) should be incorporated in SSWMB Plans for waste minimization. The community's participation in implementing 3R (Reduce-Reuse-Recycle) should be incorporated for efficient MSW management.
- Mass awareness campaigns by the SSWMB needs to be planned, designed, and implemented to make the community aware of the consequences of improper solid waste handling and disposal.
- Based on the Qualitative Evaluation Matrix of Intermediate Waste Treatment Options for Karachi City, the most suitable technological option for handling the municipal waste is the combination of mechanical and biological treatment options enabling around 95% of the organics, recyclables and combustibles from the landfill and saving landfill airspace for a longer time, recovering the economic potential of the waste, and improving the environment through reducing the methane emission from the landfill.
- A centralized waste management facility will be handling MSW in the following steps:
  - A sorting line consists of a bags opener, trommel screens/vibratory, magnets, ballistic separator, and baling units. The possibility of establishing a pyrolysis plant may be considered after ascertaining the plastic quantity that can be salvaged from scavengers.
  - After sorting and segregation, organic waste will be subjected to Anaerobic Digestion and subsequent composting using aerated piles.
  - Biogas produced will either be used to generate energy for the MSW plant and gas filling after necessary treatment or will be used as transportation fuel after necessary compression
  - RDF will be produced, which may be sold to the cement industries or brick kilns.
  - Recyclables will be sorted, which may be sold to the recycling industry.
  - The remaining inert waste will be landfilled

Annexure-1: The Consultant – Project Procurement International

Project Procurement International has offered consultancy services in the field of environmental engineering and socio-economic development since 2004.

Over the years, PPI has experience of hundreds of consultancy assignments in Pakistan, ranging in scale and scope for International Non-Governmental Organizations (INGOs), multinational donor Organizations, public and private enterprises.

PPI will conduct the following types of consultancy studies for its clients:

- Environmental and Social Impact Assessment Studies,
- Hospital/Solid Waste Management, Treatment and Disposal,
- Environmental, Occupational Health & Safety Management System (EHSMS) Assessments and Audits,
- Socio-economic Development Studies, and
- Third-Party Validation /Mid Term/End of Project Evaluations

Solid Waste Management Treatment and Disposal

- Solid Waste Characterization and Quantification Studies
- Time and Motion Studies for Solid Waste Transportation System
- Need Assessment for Solid Waste Management System
- Integrated Solid Waste Management System
- Investigation and selection of a site for construction of Sanitary Landfill
- Preliminary Engineering Design of Sanitary Landfill
- Manual for the operation of Sanitary Landfill
- Guideline for Solid Waste Management Strategy
- Feasibility Study for Material Recovery Facility
- Feasibility Study for Recycling of Plastic Waste

PPI is proud to have a number of INGOs and multinational donor organizations on its client list. PPI website: www.projectpi.pk.

PPI Team for Waste Amount Characterization Survey in District Malir, South, East, and West. Karachi

Name of Staff and Designation	Educational Qualification	Professional Experience
Mr. Saadat Ali, Environmental Engineer/Team Leader	Postgraduate Diploma in Sanitary Engineering 1984, Institute of Hydraulic and Environmental Engineering, Delft, Netherland. B. Sc. Civil Engineering 1978, University of Peshawar, Peshawar	Mr Ali has 40 years of experience in project management, environmental impact assessment, solid waste management, treatment and disposal and third-party validation. More than 15 years of experience in the design and implementation of Solid Waste Management, Treatment and Disposal Facilities, Prepared on **Present Status of Solid Waste Management in Pakistan and strategy for its improvement, Guidelines on Solid Waste Management, establishment of sanitary landfills and Incineration for Environmental Protection Agency**. Conducted **Waste Amount Compositional Survey (WACS) for 22 Municipal Corporations/Private sector Housing Societies/Cities throughout Pakistan** to prepare Solid Waste Management strategy, Solid Waste Management Plans, and establishment of Material Recovery Facilities, including a feasibility study for plastic.
Mr Ali Abdullah, Environmental Engineer	M. Sc. Environmental Engineering, 2016 Newcastle Upon Tyne University, United Kingdom. B. Sc., Civil Engineering, 2014, University of Lahore, Lahore	More than five years of experience in baseline data collection, Hospital / Solid Waste Management, Treatment and Disposal and Environmental & Social Impact Assessment. He was the overall field research coordinator for the Hospital / Solid Waste (Generation and Classification) Survey in Azad Jammu & Kashmir (AJK). In the same assignment, he assisted in preparing a strategy and action plan for the improvement of Solid Waste Management in AJK. He has **conducted Waste Amount Characterization Survey (WACS) in 11 cities/towns and two private housing schemes** for Solid Waste Management strategy, Solid Waste Management Plans, and establishment of Material Recovery Facilities
Mr Ammar Yasser	MSc Engineering Management, University of	Mr Yasser has been a Licensed Professional Engineer working in the energy sector in various roles since 2007. Mr Yasser has worked on more than 23 projects (including five mega projects

Name of Staff and Designation	Educational Qualification	Professional Experience
	Engineering Technology, Taxila, 2009 BSc Mechanical Engineering, University of Engineering Technology, Lahore, 2005	having more than 25 beneficiaries) with accumulative power generation/saving, demand release impact of 435 MW.
Ms Fehmida Rafi, Environmental Scientist	MS in Water Resources and Management, MUET, Jamshoro BSc in Environmental Science, Fatima Jinnah Women University Rawalpindi,	Ms Fehmida has experience in baseline data collection on the physical, biological and socio-economic environment and solid waste management plans.
Mr Asadullah, Junior Engineer/ Research Assistant	BSc Environmental Scientist, Bahria University, Islamabad	Experience in Data Collection and Analysis

Annexure-2: Waste Composition Key

Categories	Components
Kitchen Waste	Food, bread, vegetable, fruit etc. **except bones**
Paper (Recyclable)	All office paper, cardboard, white paper, coloured paper, newspaper (bags and strings removed), magazines (all types), catalogues (all types), phonebooks (all types), junk mail, paperboard, tissue boxes, heavyweight folders, paper towel and toilet paper rolls, food packaging, shredded paper (in a plastic bag to minimize blow-away potential), books: all softcover, hardcovers should be ripped off, empty paper coffee cups (plastic lids removed)
Paper (Non-Recyclable) (all paper which has got wet)	Napkins, tissue paper, paper towels, wax paper, wrapping paper, any paper product which has the potential to be contaminated with bodily fluids
Textile	Thread, Yarn, Fabric, Rugs, Cotton etc
Grass and Wood	Plant parts, Grass, Wooden pieces etc
Plastic (Recyclable)	All plastic types: PET, food and beverage containers, screw-top jars, deli-style containers, clam-shell take-out containers, plastic cups (lids and straws removed), milk jugs, soap bottles, clean grocery and retail plastic bags (no other type accepted), plastic jugs/bottles: soda bottles, laundry detergent jugs
Plastic (Non-Recyclables)	Plastic tableware, Styrofoam containers, Polythene Bags, Crisps bag
Leather and Rubber	Leather, Rubber, nylon items, tyre, shoes etc.
Metal (Recyclable)	Metal and tin beverages containers, metal and tin food containers, Aluminium Foil, Aluminium take out containers, aluminium pie plates and containers, cutlery, kitchen cookware: metal pots, pans, tins and utensils, metal wires, metallic spare parts etc.
Metal (Non-Recyclable)	Motor Oil Cans, paint cans, metal and cardboard mixed containers
Bottles and Glass (Recyclable)	Colour/ transparent glass bottle and Jars, Juice bottles (unbroken)
Bottle and Glass (Non-Recyclable)	Light Bulbs, Mirror glass, Window glass (vehicles and home window), Crystal etc.
Ceramic and Stones	Stone and ceramic
Domestic Hazardous Waste	Battery cells, paint boxes, medicine bottles, chlorine bottles, Auto batteries, Antifreeze, Oils/Filters, Tires, Fertilizers, Lighter Fluid, Pesticides, Pool chemicals, Aerosol cans, Batteries (non-alkaline), Cleaners, Fluorescent bulbs, Furniture polish, Needles/syringes/lancets, propane/compressed gas cylinders
Residue Remaining	Particles larger than 6 mm (Basically the remaining material on the sheet)
Miscellaneous	
a. Hairs	Human / Animal hairs
b. Bones	Bones
c. Tetra pack	Milk box, fruit juice box, tetra pack
d. Diapers	Nappies /pampers / Sanitary pads
e. Dust/Sieve	Only Dust particles
f. E-Waste	TV appliances, computers, laptops, tablets, mobile phones, white goods

Figure 1: Paper Recyclable.

Figure 2: Paper Recyclable.

Figure 3: Ceramics.

Figure 4: Ceramics.

Figure 5: Plastic Non-Recyclable include Plastic tableware, Styrofoam containers.

Figure 6: Plastic Non-Recyclable include Plastic tableware, Styrofoam containers.

Figure 7: Kitchen Waste include all Food, bread, vegetable, fruit etc., **except bones.**

Figure 8: Kitchen Waste include all Food, bread, vegetable, fruit etc., **except bones.**

Figure 9: Plastic Recyclable include all plastic types: Pet bottles, food and beverage containers etc.

Figure 10: Plastic Recyclable include all plastic types: Pet bottles, food and beverage containers etc.

Figure 11: Tetra Pack.

Figure 12: Tetra Pack.

Figure 13: Polythene Bags

Figure 14: Polythene Bags.

Figure 15: Leather & Rubber.

Figure 16: Leather & Rubber.

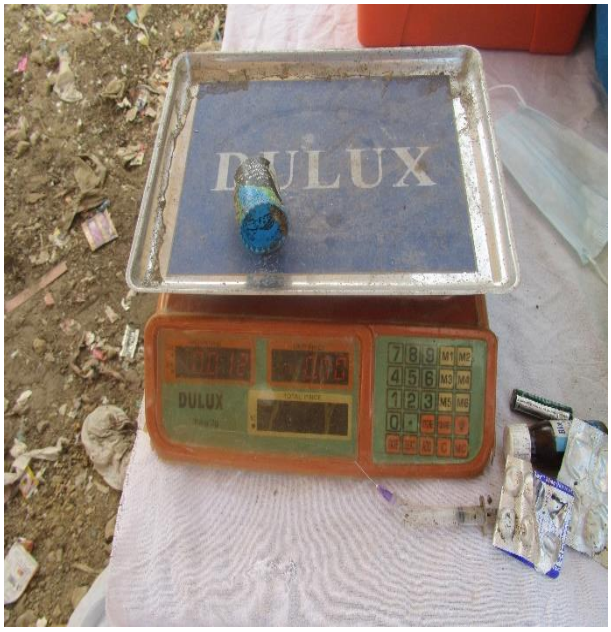


Figure 17: Metal Non-Recyclable includes Paint Cans.

Figure 18: Metal Non-Recyclable includes Motor Oil Cans, paint cans, metal, and cardboard mixed containers

Figure 19: Pampers.

Figure 20: Pampers.

Figure 21: Grass & Wood.

Figure 22: Grass & Wood.

Figure 23: E-Waste includes Charger.

Figure 24: E-Waste include wires.

Figure 25: Textile Waste

Figure 26: Textile Waste

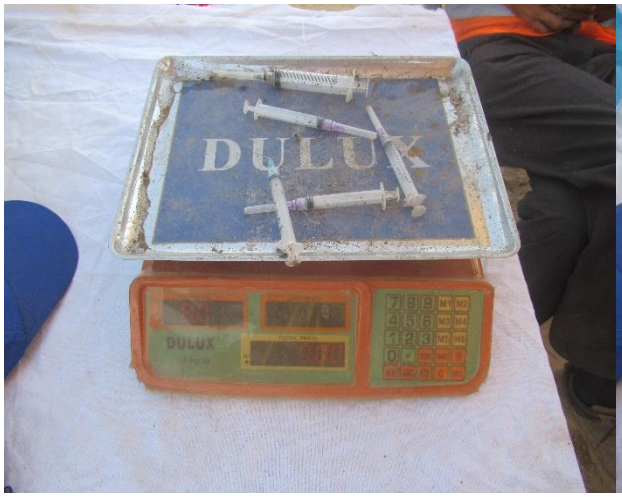


Figure 27: Domestic Hazardous Waste

Figure 28: Domestic Hazardous Waste

Figure 29: Residue Remaining

Figure 30: Residue Remaining

Figure 31: Dust

Figure 32: Dust

Figure 33: Bones

Figure 34: Bones

Figure 35: Paper Non- Recyclable includes any paper product that can be contamination with bodily fluids.

Figure 36: Paper Non- Recyclable includes any paper product that can be contaminated with bodily fluids.

Figure 37: Bottle & Glass Recyclable.

Figure 38: Bottle & Glass Recyclable.

Figure 39: Metal Recyclable.

Figure 40: Metal Recyclable.

Figure 41: Bottle & Glass Non-Recyclable.

Figure 42: Bottle & Glass Non-Recyclable.

Figure 43: Hairs.

Figure 44: Hairs.

Annexure 3: Waste Amount Characterization Survey Forms

Date:29/3/2021	Physical Composition Analysis of District Malir				
Item	**Sample # 1**				
	Amount(kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	26.97	1.26	25.71	40.48%	293.32
2. Paper (recyclable)	0	0	0	0.00%	
3. Paper (Non-Recyclable)	0.84	0.415	0.425	0.67%	
4. Textile	10.9	1.27	9.63	15.16%	
5. Grass and wood	1.01	0.415	0.595	0.94%	
6. Plastic (recyclable)	0.12	0	0.12	0.19%	
7. Plastic (non-recyclable)	2.125	1.355	0.77	1.21%	
8. Polythene Bags	21.125	10.99	10.135	15.96%	
9. Leather and rubber	0.535	0.415	0.12	0.19%	
10. Metal (recyclable)	0.1	0	0.1	0.16%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	1.56	0.415	1.145	1.80%	
15. Domestic hazardous wastes	0.62	0.415	0.205	0.32%	
16. Remaining Residue (the material remaining on the sheet)	3.2	0.415	2.785	4.38%	
Miscellaneous					
Tetra pack	2.66	0.925	1.735	2.73%	
Hairs	0.06	0	0.06	0.09%	
Pampers	4.755	0.415	4.34	6.83%	
Bones	0.48	0.415	0.065	0.10%	
Only Dust	6.54	0.96	5.58	8.78%	
E-Waste	0	0	0	0.00%	
Total	83.6	20.08	63.52	**100%**	

Item	Sample # 2				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	25.515	1.27	24.245	43.67%	351.08
2. Paper (recyclable)	0	0	0	0.00%	
3. Paper (Non-Recyclable)	0.87	0.6	0.27	0.49%	
4. Textile	9.36	1.27	8.09	14.57%	
5. Grass and wood	0	0	0	0.00%	
6. Plastic (recyclable)	0.675	0.61	0.065	0.12%	
7. Plastic (non-recyclable)	1.93	1.22	0.71	1.28%	
8. Polythene Bags	19.42	10.99	8.43	15.19%	
9. Leather and rubber	0.82	0.415	0.405	0.73%	
10. Metal (recyclable)	0.62	0.615	0.005	0.01%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0.86	0.615	0.245	0.44%	
15. Domestic hazardous wastes	1.39	1.23	0.16	0.29%	
16. Remaining Residue (the material remaining on the sheet)	3.57	0.415	3.155	5.68%	
Miscellaneous					
Tetra pack	1.7	0	1.7	3.06%	
Hairs	0	0	0	0.00%	
Pampers	5.91	0.415	5.495	9.90%	
Bones	0	0	0	0.00%	
Only Dust	2.955	0.415	2.54	4.58%	
E-Waste	0	0	0	0.00%	
Total	**75.595**	**20.08**	**55.515**	**100%**	

Item	Sample # 3				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	41.775	10.99	30.785	56.22%	337.52
2. Paper (recyclable)	0.48	0.415	0.065	0.12%	
3. Paper (Non-Recyclable)	0.66	0.415	0.245	0.45%	
4. Textile	6.96	1.22	5.74	10.48%	
5. Grass and wood	1.06	0.83	0.23	0.42%	
6. Plastic (recyclable)	0	0	0	0.00%	
7. Plastic (non-recyclable)	0.8	0.615	0.185	0.34%	
8. Polythene Bags	16.975	10.99	5.985	10.93%	
9. Leather and rubber	0.57	0.415	0.155	0.28%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0.715	0.415	0.3	0.55%	
15. Domestic hazardous wastes	0	0	0	0.00%	
16. Remaining Residue (the material remaining on the sheet)	3.925	0.95	2.975	5.43%	
Miscellaneous			0		
Tetra pack	0.625	0.415	0.21	0.38%	
Hairs	0	0	0	0.00%	
Pampers	6.44	0.415	6.025	11.00%	
Bones	0.53	0.415	0.115	0.21%	
Only Dust	2.16	0.415	1.745	3.19%	
E-Waste	0	0	0	0.00%	
Total	**83.675**	**28.915**	**54.76**	**100%**	

Item	Sample # 4				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	36.08	1.89	34.19	48.99%	246.01
2. Paper (recyclable)	1.44	1.035	0.405	0.58%	
3. Paper (Non-Recyclable)	0.78	0.605	0.175	0.25%	
4. Textile	7.645	0.95	6.695	9.59%	
5. Grass and wood	1.295	0.83	0.465	0.67%	
6. Plastic (recyclable)	0	0	0	0.00%	
7. Plastic (non-recyclable)	1.1	0.815	0.285	0.41%	
8. Polythene Bags	21.665	10.99	10.675	15.29%	
9. Leather and rubber	0.89	0.415	0.475	0.68%	
10. Metal (recyclable)	0.01	0	0.01	0.01%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.77	0.415	0.355	0.51%	
14. Ceramic, stone etc.	1.555	0.835	0.72	1.03%	
15. Domestic hazardous wastes	0.44	0.415	0.025	0.04%	
16. Remaining Residue (the material remaining on the sheet)	3.545	0.615	2.93	4.20%	
Miscellaneous					
Tetra pack	1.17	0.85	0.32	0.46%	
Hairs	0	0	0	0.00%	
Pampers	9.755	0.615	9.14	13.10%	
Bones	3.345	0.415	2.93	4.20%	
Sieve/Dust	0	0	0	0.00%	
E-Waste	0	0	0	0.00%	
Total	**91.485**	**21.69**	**69.795**	**100%**	

Item	Sample # 5				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	34.15	2.19	31.96	45.73%	299.20
2. Paper (recyclable)	0.82	0.615	0.205	0.29%	
3. Paper (Non-Recyclable)	1.175	0.615	0.56	0.80%	
4. Textile	6.98	0.615	6.365	9.11%	
5. Grass and wood	1.695	1.23	0.465	0.67%	
6. Plastic (recyclable)	0.735	0.615	0.12	0.17%	
7. Plastic (non-recyclable)	0.875	0.615	0.26	0.37%	
8. Polythene Bags	23.51	10.99	12.52	17.91%	
9. Leather and rubber	3.275	0.94	2.335	3.34%	
10. Metal (recyclable)	0.47	0.415	0.055	0.08%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	1.54	0.415	1.125	1.61%	
15. Domestic hazardous wastes	0.455	0.415	0.04	0.06%	
16. Remaining Residue (the material remaining on the sheet)	6.5	1.26	5.24	7.50%	
Miscellaneous					
Tetra pack	0.65	0.415	0.235	0.34%	
Hairs	0	0	0	0.00%	
Pampers	6.84	0.415	6.425	9.19%	
Bones	0	0	0	0.00%	
Only Dust	2.4	0.415	1.985	2.84%	
E-Waste	0	0	0	0.00%	
Total	**92.07**	**22.175**	**69.895**	**100%**	

Date:30/3/2021	Physical Composition Analysis of District Malir (Landhi)				
Item	**Sample # 1**				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	54.635	3.42	51.215	54.92%	392.96
2. Paper (recyclable)	0	0	0	0.00%	
3. Paper (Non-Recyclable)	1.135	0.615	0.52	0.56%	
4. Textile	11.035	1.26	9.775	10.48%	
5. Grass and wood	6.11	1.37	4.74	5.08%	
6. Plastic (recyclable)	0.53	0.515	0.015	0.02%	
7. Plastic (non-recyclable)	1.915	0.93	0.985	1.06%	
8. Polythene Bags	26.88	11.03	15.85	17.00%	
9. Leather and rubber	2.12	0.415	1.705	1.83%	
10. Metal (recyclable)	0.004	0	0.004	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.675	0.515	0.16	0.17%	
14. Ceramic, stone etc.	0.62	0.515	0.105	0.11%	
15. Domestic hazardous wastes	1.476	1.03	0.446	0.48%	
16. Remaining Residue (the material remaining on the sheet)	4.86	0.415	4.445	4.77%	
Miscellaneous					
Tetra pack	0.8	0.615	0.185	0.20%	
Hairs	0.54	0	0.54	0.58%	
Pampers	3.075	0.51	2.565	2.75%	
Bones	0	0	0	0.00%	
Only Dust	0	0	0	0.00%	
E-Waste	0	0	0	0.00%	
Total	**116.41**	**23.155**	**93.255**	**100%**	

Item	Sample # 2				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	24.675	1.26	23.415	36.76%	342.96
2. Paper (recyclable)	0.74	0.415	0.325	0.51%	
3. Paper (Non-Recyclable)	0	0	0	0.00%	
4. Textile	4.23	0.615	3.615	5.68%	
5. Grass and wood	1.245	0.615	0.63	0.99%	
6. Plastic (recyclable)	0.86	0.415	0.445	0.70%	
7. Plastic (non-recyclable)	0	0	0	0.00%	
8. Polythene Bags	21.97	11.03	10.94	17.18%	
9. Leather and rubber	1.74	0.615	1.125	1.77%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	**0**	**0**	0	0.00%	
16. Remaining Residue (the material remaining on the sheet)	1.7	0.615	1.085	1.70%	
Miscellaneous					
Tetra pack	0.57	0.415	0.155	0.24%	
Hairs	0	0	0	0.00%	
Pampers	7.465	0.855	6.61	10.38%	
Bones	0.64	0.615	0.025	0.04%	
Only Dust	2.37	0.415	1.955	3.07%	
Silt	25.43	12.06	13.37	20.99%	
Total	**93.635**	**29.94**	**63.695**	**100%**	

Item	Sample # 3				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	24.96	1.26	23.7	35.51%	337.52
2. Paper (recyclable)	0.74	0.615	0.125	0.19%	
3. Paper (Non-Recyclable)	0.55	0.415	0.135	0.20%	
4. Textile	6.14	0.615	5.525	8.28%	
5. Grass and wood	19.13	11.03	8.1	12.14%	
6. Plastic (recyclable)	0.45	0.415	0.035	0.05%	
7. Plastic (non-recyclable)	0.83	0.615	0.215	0.32%	
8. Polythene Bags	21.685	11.03	10.655	15.97%	
9. Leather and rubber	1.09	0.415	0.675	1.01%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0.92	0.415	0.505	0.76%	
15. Domestic hazardous wastes	0	0	0	0.00%	
16. Remaining Residue (the material remaining on the sheet)	7.757	0.95	6.807	10.20%	
Miscellaneous					
Tetra pack	0.705	0.615	0.09	0.13%	
Hairs	0.01	0	0.01	0.01%	
Pampers	6.54	0.415	6.125	9.18%	
Bones	0	0	0	0.00%	
Only Dust	4.45	0.415	4.035	6.05%	
E-Waste	0	0	0	0.00%	
Total	**95.957**	**29.22**	**66.737**	**100%**	

Item	Sample # 4				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	0	0	0	0.00%	436.73
2. Paper (recyclable)	0.74	0.615	0.125	0.14%	
3. Paper (Non-Recyclable)	0	0	0	0.00%	
4. Textile	5.69	1.03	4.66	5.16%	
5. Grass and wood	2.015	1.23	0.785	0.87%	
6. Plastic (recyclable)	1.28	0.96	0.32	0.35%	
7. Plastic (non-recyclable)	0.625	0.415	0.21	0.23%	
8. Polythene Bags	19.445	11.03	8.415	9.31%	
9. Leather and rubber	3.605	2.22	1.385	1.53%	
10. Metal (recyclable)	0.01	0	0.01	0.01%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	0	0	0	0.00%	
Electrical Waste, Batteries, Cells etc	0	0	0	0.00%	
Medicine Wrappers / Bottles	0	0	0	0.00%	
Syringes, Drip Bottles, etc.	0	0	0	0.00%	
16. Remaining Residue (the material remaining on the sheet)	0	0	0	0.00%	
Miscellaneous					
Tetra pack	0	0	0	0.00%	
Hairs	0	0	0	0.00%	
Pampers	0.725	0.415	0.31	0.34%	
Bones	0	0	0	0.00%	
Sieve/Dust	86.99	12.835	74.155	82.05%	
E-Waste	0	0	0	0.00%	
Total	121.125	30.75	90.375	**100%**	

Item	Sample # 5				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	14.39	1.26	13.13	27.20%	299.20
2. Paper (recyclable)	2.04	0.96	1.08	2.24%	
3. Paper (Non-Recyclable)	0.99	0.615	0.375	0.78%	
4. Textile	11.09	1.23	9.86	20.43%	
5. Grass and wood	3.21	0.415	2.795	5.79%	
6. Plastic (recyclable)	0.465	0.415	0.05	0.10%	
7. Plastic (non-recyclable)	1.84	1.23	0.61	1.26%	
8. Polythene Bags	21.89	11.03	10.86	22.50%	
9. Leather and rubber	1.24	0.415	0.825	1.71%	
10. Metal (recyclable)	0.535	0.415	0.12	0.25%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.685	0.415	0.27	0.56%	
13. Bottle and glass (non-recyclable)	0.74	0.615	0.125	0.26%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	0.645	0.615	0.03	0.06%	
16. Remaining Residue (the material remaining on the sheet)	6.385	0.615	5.77	11.95%	
Miscellaneous					
Tetra pack	0	0	0	0.00%	
Hairs	0.01	0	0.01	0.02%	
Pampers	2.24	0.615	1.625	3.37%	
Bones	0	0	0	0.00%	
Only Dust	0	0	0	0.00%	
E-Waste	1.35	0.615	0.735	1.52%	
Total	**69.745**	**21.475**	**48.27**	**100%**	

Karachi East

Date:31/3/2021	Physical Composition Analysis of District Karachi East				
Item	**Sample # 1**				
	Amount(kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	72.98	3.765	69.215	57.12%	334.80
2. Paper (recyclable)	1.71	0.83	0.88	0.73%	
3. Paper (Non-Recyclable)	0	0	0	0.00%	
4. Textile	9.925	1.675	8.25	6.81%	
5. Grass and wood	2.75	1.23	1.52	1.25%	
6. Plastic (recyclable)	2.12	1.36	0.76	0.63%	
7. Plastic (non-recyclable)	1.76	1.245	0.515	0.42%	
8. Polythene Bags	25.63	11.03	14.6	12.05%	
9. Leather and rubber	1.37	0.415	0.955	0.79%	
10. Metal (recyclable)	0.52	0.415	0.105	0.09%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	1.05	0.415	0.635	0.52%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	0	0	0	0.00%	
16. Remaining Residue (the material remaining on the sheet)	10.29	0.945	9.345	7.71%	
Miscellaneous					
Tetra pack	0.89	0.615	0.275	0.23%	
Hairs	0.425	0.415	0.01	0.01%	
Pampers	5.475	0.615	4.86	4.01%	
Bones	0.7	0.415	0.285	0.24%	
Only Dust	9.585	0.615	8.97	7.40%	
E-Waste	0	0	0	0.00%	
Total	**147.18**	**26**	**121.18**	**100%**	

Item	Sample # 2				
	Amount(kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	21.46	1.26	20.2	29.55%	242.80
2. Paper (recyclable)	0.46	0.415	0.045	0.07%	
3. Paper (Non-Recyclable)	1.83	0.415	1.415	2.07%	
4. Textile	10.305	0.945	9.36	13.69%	
5. Grass and wood	5.805	1.875	3.93	5.75%	
6. Plastic (recyclable)	1.61	1.245	0.365	0.53%	
7. Plastic (non-recyclable)	2.165	1.03	1.135	1.66%	
8. Polythene Bags	26.28	11.03	15.25	22.31%	
9. Leather and rubber	1.45	0.415	1.035	1.51%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.505	0.415	0.09	0.13%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	0.72	0.415	0.305	0.45%	
16. Remaining Residue (the material remaining on the sheet)	2.505	0.415	2.09	3.06%	
Miscellaneous					
Tetra pack	0.64	0.415	0.225	0.33%	
Hairs	0	0	0	0.00%	
Pampers	12.47	1.26	11.21	16.40%	
Bones	0.53	0.415	0.115	0.17%	
Only Dust	2.2	0.615	1.585	2.32%	
E-Waste	0	0	0	0.00%	
Total	**90.935**	**22.58**	**68.355**	**100%**	

Item	Sample # 3				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	42.04	3.47	38.57	49.85%	249.44
2. Paper (recyclable)	1.81	0.95	0.86	1.11%	
3. Paper (Non-Recyclable)	7.79	1.03	6.76	8.74%	
4. Textile	5.395	0.615	4.78	6.18%	
5. Grass and wood	6.66	1.675	4.985	6.44%	
6. Plastic (recyclable)	1.11	1.03	0.08	0.10%	
7. Plastic (non-recyclable)	4.625	2.675	1.95	2.52%	
8. Polythene Bags	22.8	11.03	11.77	15.21%	
9. Leather and rubber	0	0	0	0.00%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0.44	0.415	0.025	0.03%	
12. Bottle and glass (recyclable)	1.275	0.83	0.445	0.58%	
13. Bottle and glass (non-recyclable)	0.66	0.415	0.245	0.32%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	1.09	1.03	0.06	0.08%	
16. Remaining Residue (the material remaining on the sheet)	1.06	0.415	0.645	0.83%	
Miscellaneous					
Tetra pack	1.44	1.03	0.41	0.53%	
Hairs	0	0	0	0.00%	
Pampers	1.95	0.415	1.535	1.98%	
Bones	0	0	0	0.00%	
Only Dust	4.87	0.615	4.255	5.50%	
E-Waste	0	0	0	0.00%	
Total	**105.015**	**27.64**	**77.375**	**100%**	

Item	Sample # 4				
	Amount(kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	62.56	3.47	59.09	44.44%	330.72
2. Paper (recyclable)	1.335	0.95	0.385	0.29%	
3. Paper (Non-Recyclable)	2.815	0.615	2.2	1.65%	
4. Textile	15.54	1.23	14.31	10.76%	
5. Grass and wood	5.845	1.03	4.815	3.62%	
6. Plastic (recyclable)	6.93	1.675	5.255	3.95%	
7. Plastic (non-recyclable)	3.92	2.06	1.86	1.40%	
8. Polythene Bags	29.42	11.03	18.39	13.83%	
9. Leather and rubber	1.94	0.615	1.325	1.00%	
10. Metal (recyclable)	0.026	0	0.026	0.02%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0.695	0.415	0.28	0.21%	
15. Domestic hazardous wastes	2.26	1.445	0.815	0.61%	
16. Remaining Residue (the material remaining on the sheet)	4.97	0.95	4.02	3.02%	
Miscellaneous					
Tetra pack	1.195	0.615	0.58	0.44%	
Hairs	0.056	0	0.056	0.04%	
Pampers	18.29	1.26	17.03	12.81%	
Bones	0	0	0	0.00%	
Only Dust	3.15	0.615	2.535	1.91%	
E-Waste	0	0	0	0.00%	
Total	**160.947**	**27.975**	**132.972**	**100%**	

Item	Sample # 5				
	Amount(kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	98.415	4.81	93.605	60.82%	376.97
2. Paper (recyclable)	0.655	0.415	0.24	0.16%	
3. Paper (Non-Recyclable)	1.63	0.83	0.8	0.52%	
4. Textile	9.385	0.95	8.435	5.48%	
5. Grass and wood	1.91	0.83	1.08	0.70%	
6. Plastic (recyclable)	0.435	0.415	0.02	0.01%	
7. Plastic (non-recyclable)	10.185	1.78	8.405	5.46%	
8. Polythene Bags	32.97	11.03	21.94	14.26%	
9. Leather and rubber	0.885	0.415	0.47	0.31%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	2.285	1.23	1.055	0.69%	
15. Domestic hazardous wastes	1.065	0.83	0.235	0.15%	
16. Remaining Residue (the material remaining on the sheet)	3.14	0.615	2.525	1.64%	
Miscellaneous					
Tetra pack	1.165	0.615	0.55	0.36%	
Hairs	0	0	0	0.00%	
Pampers	13.405	0.94	12.465	8.10%	
Bones	0.11	0	0.11	0.07%	
Sieve/Dust	2.56	0.615	1.945	1.26%	
E-Waste	0.97	0.94	0.03	0.02%	
Total	**181.17**	**27.26**	**153.91**	**100%**	

Date:02/4/2021	Physical Composition Analysis of District Karachi South				
Item	**Sample # 1**				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen Waste	40.785	2.52	38.265	42.28%	231.44
2. Paper (recyclable)	1.04	0.615	0.425	0.47%	
3. Paper (Non-Recyclable)	2.005	0.615	1.39	1.54%	
4. Textile	6.02	0.95	5.07	5.60%	
5. Grass and wood	1.265	0.415	0.85	0.94%	
6. Plastic (recyclable)	0.635	0.615	0.02	0.02%	
7. Plastic (non-recyclable)	2.41	1.445	0.965	1.07%	
8. Polythene Bags	30.82	12.31	18.51	20.45%	
9. Leather and rubber	0.665	0.415	0.25	0.28%	
10. Metal (recyclable)	0.63	0.615	0.015	0.02%	
11. Metal (non-recyclable)	0.012	0	0.012	0.01%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.256	0	0.256	0.28%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous Southesk	0.148	0	0.148	0.16%	
16. Remaining Residue (the material remaining on the sheet)	5.17	0.415	4.755	5.25%	
Miscellaneous					
Tetra pack	0.595	0.415	0.18	0.20%	
Hairs	0	0	0	0.00%	
Pampers	14.89	0.95	13.94	15.40%	
Bones	0.14	0	0.14	0.15%	
Only Dust	5.72	0.415	5.305	5.86%	
E-Waste	0	0	0	0.00%	
Total	113.206	22.71	90.496	**100%**	

Item	Sample # 2				
	Amount(kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen Waste	50.165	2.625	47.54	48.58%	263.41
2. Paper (recyclable)	1.02	0.615	0.405	0.41%	
3. Paper (Non-Recyclable)	1.69	0.415	1.275	1.30%	
4. Textile	7.985	1.565	6.42	6.56%	
5. Grass and wood	1.89	1.03	0.86	0.88%	
6. Plastic (recyclable)	0.765	0.615	0.15	0.15%	
7. Plastic (non-recyclable)	2.05	1.03	1.02	1.04%	
8. Polythene Bags	44.37	22.1	22.27	22.76%	
9. Leather and rubber	0	0	0	0.00%	
10. Metal (recyclable)	0.445	0.415	0.03	0.03%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.84	0.415	0.425	0.43%	
14. Ceramic, stone etc.	4.55	1.245	3.305	3.38%	
15. Domestic hazardous souths	1.449	1.245	0.204	0.21%	
16. Remaining Residue (the material remaining on the sheet)	4.67	0.615	4.055	4.14%	
Miscellaneous					
Tetra pack	0.94	0.415	0.525	0.54%	
Hairs	0.001	0	0.001	0.00%	
Pampers	5.46	0.415	5.045	5.16%	
Bones	0.72	0.415	0.305	0.31%	
Sieve/Dust	4.415	0.415	4	4.09%	
E-Waste	0.97	0.94	0.03	0.03%	
Total	**134.395**	**36.53**	**97.865**	**100%**	

Item	Sample # 3				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	38.23	2.2	36.03	37.61%	234.96
2. Paper (recyclable)	1.625	0.95	0.675	0.70%	
3. Paper (Non-Recyclable)	2.13	0.95	1.18	1.23%	
4. Textile	7.39	1.26	6.13	6.40%	
5. Grass and wood	2.343	1.03	1.313	1.37%	
6. Plastic (recyclable)	0.665	0.615	0.05	0.05%	
7. Plastic (non-recyclable)	1.516	0.83	0.686	0.72%	
8. Polythene Bags	43.427	12.29	31.137	32.50%	
9. Leather and rubber	2.032	0.415	1.617	1.69%	
10. Metal (recyclable)	0.018	0	0.018	0.02%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.172	0	0.172	0.18%	
13. Bottle and glass (non-recyclable)	0.79	0.415	0.375	0.39%	
14. Ceramic, stone etc.	1.655	0.615	1.04	1.09%	
15. Domestic hazardous wastes	0.15	0	0.15	0.16%	
16. Remaining Residue (the material remaining on the sheet)	1.39	0.415	0.975	1.02%	
Miscellaneous					
Tetra pack	0.995	0.615	0.38	0.40%	
Hairs	0	0	0	0.00%	
Pampers	5.875	0.615	5.26	5.49%	
Bones	0.034	0	0.034	0.04%	
Only Dust	8.965	0.415	8.55	8.92%	
E-Waste	0.028	0	0.028	0.03%	
Total	**119.43**	**23.63**	**95.8**	**100%**	

Item	Sample # 4				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	97.202	14.165	83.037	63.21%	352.04
2. Paper (recyclable)	0.76	0.415	0.345	0.26%	
3. Paper (Non-Recyclable)	2.31	0.615	1.695	1.29%	
4. Textile	8.415	0.95	7.465	5.68%	
5. Grass and wood	3.695	1.86	1.835	1.40%	
6. Plastic (recyclable)	0.715	0.615	0.1	0.08%	
7. Plastic (non-recyclable)	1.745	0.83	0.915	0.70%	
8. Polythene Bags	31.09	12.29	18.8	14.31%	
9. Leather and rubber	0	0	0	0.00%	
10. Metal (recyclable)	0.186	0	0.186	0.14%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	1.54	0.415	1.125	0.86%	
15. Domestic hazardous wastes	0.046	0	0.046	0.04%	
16. Remaining Residue (the material remaining on the sheet)	4.97	0.95	4.02	3.06%	
Miscellaneous					
Tetra pack	1.25	0.615	0.635	0.48%	
Hairs	0.012	0	0.012	0.01%	
Pampers	7.775	0.415	7.36	5.60%	
Bones	0	0	0	0.00%	
Only Dust	5.355	1.565	3.79	2.89%	
E-Waste	0	0	0	0.00%	
Total	167.066	35.7	131.366	**100%**	

Item	Sample # 5				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	81.455	4.835	76.62	61.26%	346.08
2. Paper (recyclable)	0.95	0.615	0.335	0.27%	
3. Paper (Non-Recyclable)	1.715	0.615	1.1	0.88%	
4. Textile	15.99	1.9	14.09	11.26%	
5. Grass and wood	0.605	0.415	0.19	0.15%	
6. Plastic (recyclable)	0.53	0.415	0.115	0.09%	
7. Plastic (non-recyclable)	3.1	1.86	1.24	0.99%	
8. Polythene Bags	29.515	11.03	18.485	14.78%	
9. Leather and rubber	2.42	0.95	1.47	1.18%	
10. Metal (recyclable)	0.028	0	0.028	0.02%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.72	0.415	0.305	0.24%	
13. Bottle and glass (non-recyclable)	0.515	0.415	0.1	0.08%	
14. Ceramic, stone etc.	0.785	0.615	0.17	0.14%	
15. Domestic hazardous wastes	0.114	0	0.114	0.09%	
16. Remaining Residue (the material remaining on the sheet)	3.415	0.615	2.8	2.24%	
Miscellaneous					
Tetra pack	0.955	0.415	0.54	0.43%	
Hairs	0	0	0	0.00%	
Pampers	4.675	0.95	3.725	2.98%	
Bones	0	0	0	0.00%	
Only Dust	4.07	0.415	3.655	2.92%	
E-Waste	0	0	0	0.00%	
Total	**151.557**	**26.475**	**125.082**	**100%**	

Item	Sample # 1				
	Amount (kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	14.14	1.26	12.88	26.63%	230.96
2. Paper (recyclable)	0.5	0.415	0.085	0.18%	
3. Paper (Non-Recyclable)	1.085	0.615	0.47	0.97%	
4. Textile	3.375	0.615	2.76	5.71%	
5. Grass and wood	2.16	1.345	0.815	1.69%	
6. Plastic (recyclable)	0	0	0	0.00%	
7. Plastic (non-recyclable)	3.14	1.76	1.38	2.85%	
8. Polythene Bags	25.39	11.03	14.36	29.69%	
9. Leather and rubber	0.96	0.415	0.545	1.13%	
10. Metal (recyclable)	0.715	0.415	0.3	0.62%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	0	0	0	0.00%	
16. Remaining Residue (the material remaining on the sheet)	0	0	0	0.00%	
Miscellaneous			0		
Tetra pack	0.83	0.615	0.215	0.44%	
Hairs	0	0	0	0.00%	
Pampers	12.025	0.615	11.41	23.59%	
Bones	0	0	0	0.00%	
Only Dust	3.755	0.615	3.14	6.49%	
E-Waste	0	0	0	0.00%	
Total	**68.075**	**19.715**	**48.36**	**100%**	

Item	Sample # 2				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	28.655	1.875	26.78	36.71%	224.65
2. Paper (recyclable)	0.785	0.415	0.37	0.51%	
3. Paper (Non-Recyclable)	1.835	0.615	1.22	1.67%	
4. Textile	4.73	0.95	3.78	5.18%	
5. Grass and wood	6.35	0.83	5.52	7.57%	
6. Plastic (recyclable)	0.545	0.415	0.13	0.18%	
7. Plastic (non-recyclable)	3.115	2.06	1.055	1.45%	
8. Polythene Bags	23.095	11.03	12.065	16.54%	
9. Leather and rubber	0.715	0.415	0.3	0.41%	
10. Metal (recyclable)	0.425	0.415	0.01	0.01%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.77	0.415	0.355	0.49%	
13. Bottle and glass (non-recyclable)	0.6	0.415	0.185	0.25%	
14. Ceramic, stone etc.	0.56	0.415	0.145	0.20%	
15. Domestic hazardous wastes	0.675	0.415	0.26	0.36%	
16. Remaining Residue (the material remaining on the sheet)	7.24	1.26	5.98	8.20%	
Miscellaneous					
Tetra pack	0.74	0.615	0.125	0.17%	
Hairs	0	0	0	0.00%	
Pampers	10.4	0.615	9.785	13.41%	
Bones	0	0	0	0.00%	
Sieve/Dust	5.51	0.615	4.895	6.71%	
E-Waste	0	0	0	0.00%	
Total	**96.745**	**23.785**	**72.96**	**100%**	

Item	Sample # 3				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	57.555	3.465	54.09	55.51%	286.48
2. Paper (recyclable)	0.83	0.415	0.415	0.43%	
3. Paper (Non-Recyclable)	2.915	0.415	2.5	2.57%	
4. Textile	11.96	1.565	10.395	10.67%	
5. Grass and wood	0	0	0	0.00%	
6. Plastic (recyclable)	0.89	0.83	0.06	0.06%	
7. Plastic (non-recyclable)	1.99	1.445	0.545	0.56%	
8. Polythene Bags	36.775	22.06	14.715	15.10%	
9. Leather and rubber	1.27	0.615	0.655	0.67%	
10. Metal (recyclable)	0.48	0.615	-0.135	-0.14%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	1.37	0.415	0.955	0.98%	
14. Ceramic, stone etc.	0.61	0.415	0.195	0.20%	
15. Domestic hazardous wastes	1.2	1.03	0.17	0.17%	
16. Remaining Residue (the material remaining on the sheet)	1.76	0.415	1.345	1.38%	
Miscellaneous					
Tetra pack	1.655	0.615	1.04	1.07%	
Hairs	0.465	0.415	0.05	0.05%	
Pampers	11.025	1.56	9.465	9.71%	
Bones	0.54	0.415	0.125	0.13%	
Only Dust	1.265	0.415	0.85	0.87%	
E-Waste	0	0	0	0.00%	
Total	**134.555**	**37.12**	**97.435**	**100%**	

Item	Sample # 4				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	75.64	3.78	71.86	57.42%	315.84
2. Paper (recyclable)	0.555	0.415	0.14	0.11%	
3. Paper (Non-Recyclable)	1.875	0.615	1.26	1.01%	
4. Textile	10.515	0.615	9.9	7.91%	
5. Grass and wood	2.425	1.23	1.195	0.95%	
6. Plastic (recyclable)	0.475	0.415	0.06	0.05%	
7. Plastic (non-recyclable)	1.26	0.83	0.43	0.34%	
8. Polythene Bags	31.3	11.03	20.27	16.20%	
9. Leather and rubber	0.775	0.415	0.36	0.29%	
10. Metal (recyclable)	0.012	0	0.012	0.01%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.082	0	0.082	0.07%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	1.296	0.83	0.466	0.37%	
16. Remaining Residue (the material remaining on the sheet)	3.58	0.415	3.165	2.53%	
Miscellaneous					
Tetra pack	1.07	0.615	0.455	0.36%	
Hairs	0.008	0	0.008	0.01%	
Pampers	12.415	0.95	11.465	9.16%	
Bones	0.006	0	0.006	0.00%	
Only Dust	4.42	0.415	4.005	3.20%	
E-Waste	0	0	0	0.00%	
Total	**147.709**	**22.57**	**125.139**	**100%**	

Item	Sample # 5				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	52.54	3.8	48.74	51.23%	278.96
2. Paper (recyclable)	9.96	2.21	7.75	8.15%	
3. Paper (Non-Recyclable)	8.44	0.615	7.825	8.22%	
4. Textile	9.495	0.95	8.545	8.98%	
5. Grass and wood	2.92	1.03	1.89	1.99%	
6. Plastic (recyclable)	5.905	2.29	3.615	3.80%	
7. Plastic (non-recyclable)	2.815	1.98	0.835	0.88%	
8. Polythene Bags	23.195	11.03	12.165	12.79%	
9. Leather and rubber	0	0	0	0.00%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	0	0	0	0.00%	
16. Remaining Residue (the material remaining on the sheet)	1.01	0.415	0.595	0.63%	
Miscellaneous			0		
Tetra pack	1.415	0.415	1	1.05%	
Hairs	0	0	0	0.00%	
Pampers	2.555	0.615	1.94	2.04%	
Bones	0.66	0.415	0.245	0.26%	
Only Dust	0	0	0	0.00%	
E-Waste	0	0	0	0.00%	
Total	**120.91**	**25.765**	**95.145**	**100%**	

Item	Sample # 6				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	32.919	2.935	29.984	40.18%	295.28
2. Paper (recyclable)	0.47	0.415	0.055	0.07%	
3. Paper (Non-Recyclable)	1.71	1.03	0.68	0.91%	
4. Textile	8.805	1.26	7.545	10.11%	
5. Grass and wood	19.69	11.445	8.245	11.05%	
6. Plastic (recyclable)	0.67	0.615	0.055	0.07%	
7. Plastic (non-recyclable)	0.89	0.615	0.275	0.37%	
8. Polythene Bags	26.2	11.03	15.17	20.33%	
9. Leather and rubber	0.91	0.415	0.495	0.66%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.7	0.615	0.085	0.11%	
13. Bottle and glass (non-recyclable)	0.835	0.615	0.22	0.29%	
14. Ceramic, stone etc.	0.93	0.415	0.515	0.69%	
15. Domestic hazardous wastes	1.96	1.845	0.115	0.15%	
16. Remaining Residue (the material remaining on the sheet)	1.135	0.415	0.72	0.96%	
Miscellaneous					
Tetra pack	0.6	0.415	0.185	0.25%	
Hairs	0	0	0	0.00%	
Pampers	7.04	0.615	6.425	8.61%	
Bones	0	0	0	0.00%	
Only Dust	4.47	0.615	3.855	5.17%	
E-Waste	0	0	0	0.00%	
Total	**109.934**	**35.31**	**74.624**	**100%**	

Item	Sample # 1				
	Amount (kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen Waste	54.37	3.16	51.21	48.79%	302.40
2. Paper (recyclable)	1.15	0.615	0.535	0.51%	
3. Paper (Non-Recyclable)	1.77	0.615	1.155	1.10%	
4. Textile	12.55	1.565	10.985	10.47%	
5. Grass and wood	3.81	1.565	2.245	2.14%	
6. Plastic (recyclable)	0.795	0.615	0.18	0.17%	
7. Plastic (non-recyclable)	3.105	2.09	1.015	0.97%	
8. Polythene Bags	30.335	11.05	19.285	18.37%	
9. Leather and rubber	4.265	1.03	3.235	3.08%	
10. Metal (recyclable)	0.56	0.415	0.145	0.14%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous waste	0.44	0.415	0.025	0.02%	
16. Remaining Residue (the material remaining on the sheet)	3.88	0.615	3.265	3.11%	
Miscellaneous					
Tetra pack	0.78	0.415	0.365	0.35%	
Hairs	0	0	0	0.00%	
Pampers	6.87	0.615	6.255	5.96%	
Bones	0	0	0	0.00%	
Only Dust	5.675	0.615	5.06	4.82%	
E-Waste	0	0	0	0.00%	
Total	130.355	25.395	104.96	**100%**	

Item	Sample # 2				
	Amount (kg)	Wt. of bucket	amount - wt. of bucket	(%)	Density
1. Kitchen Waste	50.966	3.105	47.861	53.50%	240.56
2. Paper (recyclable)	1.705	1.03	0.675	0.75%	
3. Paper (Non-Recyclable)	1.665	0.615	1.05	1.17%	
4. Textile	7.5	0.615	6.885	7.70%	
5. Grass and wood	6.6	2.46	4.14	4.63%	
6. Plastic (recyclable)	0.45	0.415	0.035	0.04%	
7. Plastic (non-recyclable)	3.805	2.46	1.345	1.50%	
8. Polythene Bags	41.64	22.1	19.54	21.84%	
9. Leather and rubber	0.75	0.615	0.135	0.15%	
10. Metal (recyclable)	0.44	0.415	0.025	0.03%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	2.095	1.03	1.065	1.19%	
14. Ceramic, stone etc.	1.53	1.03	0.5	0.56%	
15. Domestic hazardous Southes	0.9	0.83	0.07	0.08%	
16. Remaining Residue (the material remaining on the sheet)	1.045	0.415	0.63	0.70%	
Miscellaneous			0		
Tetra pack	1.135	0.615	0.52	0.58%	
Hairs	0	0	0	0.00%	
Pampers	4.58	0.615	3.965	4.43%	
Bones	0.48	0.415	0.065	0.07%	
Only Dust	1.565	0.615	0.95	1.06%	
E-Waste	0	0	0	0.00%	
Total	**128.851**	**39.395**	**89.456**	**100%**	

Item	Sample # 3				
	Amount (kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen Waste	56.01	3.135	52.875	45.18%	352.40
2. Paper (recyclable)	1.08	0.615	0.465	0.40%	
3. Paper (Non-Recyclable)	1.86	0.615	1.245	1.06%	
4. Textile	14.82	0.95	13.87	11.85%	
5. Grass and wood	5.49	1.565	3.925	3.35%	
6. Plastic (recyclable)	0.865	0.615	0.25	0.21%	
7. Plastic (non-recyclable)	1.799	1.245	0.554	0.47%	
8. Polythene Bags	26.1	11.03	15.07	12.88%	
9. Leather and rubber	1.57	0.615	0.955	0.82%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	1.37	0.415	0.955	0.82%	
13. Bottle and glass (non-recyclable)	0.6	0.415	0.185	0.16%	
14. Ceramic, stone etc.	6.1	0.615	5.485	4.69%	
15. Domestic hazardous Southes	0.086	0	0.086	0.07%	
16. Remaining Residue (the material remaining on the sheet)	8.715	1.26	7.455	6.37%	
Miscellaneous					
Tetra pack	0.77	0.415	0.355	0.30%	
Hairs	0.002	0	0.002	0.00%	
Pampers	7.745	0.95	6.795	5.81%	
Bones	0.12	0	0.12	0.10%	
Only Dust	6.965	0.615	6.35	5.43%	
E-Waste	0.036	0	0.036	0.03%	
Total	**142.103**	**25.07**	**117.033**	**100%**	

Item	Sample # 4				
	Amount (kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	80.3112	22.475	57.8362	58.24%	322.36
2. Paper (recyclable)	2.477	0.615	1.862	1.88%	
3. Paper (Non-Recyclable)	2.49	0.615	1.875	1.89%	
4. Textile	15.595	11.03	4.565	4.60%	
5. Grass and wood	0.96	0.415	0.545	0.55%	
6. Plastic (recyclable)	0.9	0.615	0.285	0.29%	
7. Plastic (non-recyclable)	4.47	2.475	1.995	2.01%	
8. Polythene Bags	29.83	11.03	18.8	18.93%	
9. Leather and rubber	2.422	1.03	1.392	1.40%	
10. Metal (recyclable)	0.008	0	0.008	0.01%	
11. Metal (non-recyclable)	0.68	0.415	0.265	0.27%	
12. Bottle and glass (recyclable)	1.78	1.245	0.535	0.54%	
13. Bottle and glass (non-recyclable)	1.505	0.415	1.09	1.10%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	1.014	0.415	0.599	0.60%	
16. Remaining Residue (the material remaining on the sheet)	1.26	0.615	0.645	0.65%	
Miscellaneous			0		
Tetra pack	1.042	0.415	0.627	0.63%	
Hairs	0	0	0	0.00%	
Pampers	6.224	0.415	5.809	5.85%	
Bones	0.865	0.415	0.45	0.45%	
Only Dust	0	0	0	0.00%	
E-Waste	0.53	0.415	0.115	0.12%	
Total	154.3632	55.065	99.2982	**100%**	

Item	Sample # 5				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	74.735	5.65	69.085	62.18%	389.45
2. Paper (recyclable)	1.05	0.615	0.435	0.39%	
3. Paper (Non-Recyclable)	1.55	0.415	1.135	1.02%	
4. Textile	11.765	0.95	10.815	9.73%	
5. Grass and wood	1.41	0.615	0.795	0.72%	
6. Plastic (recyclable)	0.73	0.615	0.115	0.10%	
7. Plastic (non-recyclable)	1.46	1.03	0.43	0.39%	
8. Polythene Bags	25.275	11.03	14.245	12.82%	
9. Leather and rubber	2.195	0.95	1.245	1.12%	
10. Metal (recyclable)	0.308	0	0.308	0.28%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.925	0.415	0.51	0.46%	
13. Bottle and glass (non-recyclable)	0.89	0.415	0.475	0.43%	
14. Ceramic, stone etc.	1.465	0.615	0.85	0.77%	
15. Domestic hazardous wastes	0.132	0	0.132	0.12%	
16. Remaining Residue (the material remaining on the sheet)	2.185	0.615	1.57	1.41%	
Miscellaneous					
Tetra pack	0.88	0.415	0.465	0.42%	
Hairs	0.012	0	0.012	0.01%	
Pampers	7.03	0.615	6.415	5.77%	
Bones	0.042	0	0.042	0.04%	
Sieve/Dust	2.4	0.415	1.985	1.79%	
E-Waste	0.034	0	0.034	0.03%	
Total	**136.473**	**25.375**	**111.098**	**100%**	

Korangi Zone

Date:05/4/2021	Physical Composition Analysis of District Karachi West				
Item	**Sample # 1**				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	90.5	12.395	78.105	57.29%	410.72
2. Paper (recyclable)	2.82	0.95	1.87	1.37%	
3. Paper (Non-Recyclable)	3.15	0.615	2.535	1.86%	
4. Textile	7.22	0.95	6.27	4.60%	
5. Grass and wood	1.86	1.245	0.615	0.45%	
6. Plastic (recyclable)	0.66	0.415	0.245	0.18%	
7. Plastic (non-recyclable)	2.631	1.245	1.386	1.02%	
8. Polythene Bags	30.63	11.03	19.6	14.38%	
9. Leather and rubber	3.2	0.95	2.25	1.65%	
10. Metal (recyclable)	0.6	0.415	0.185	0.14%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.92	0.415	0.505	0.37%	
13. Bottle and glass (non-recyclable)	1.53	0.83	0.7	0.51%	
14. Ceramic, stone etc.	0.77	0.415	0.355	0.26%	
15. Domestic hazardous wastes	1.147	0.83	0.317	0.23%	
16. Remaining Residue (the material remaining on the sheet)	8.825	0.615	8.21	6.02%	
Miscellaneous					
Tetra pack	0.77	0.415	0.355	0.26%	
Hairs	0	0	0	0.00%	
Pampers	6.3	0.95	5.35	3.92%	
Bones	0	0	0	0.00%	
Only Dust	8.1	0.615	7.485	5.49%	
E-Waste	0	0	0	0.00%	
Total	**171.633**	**35.295**	**136.338**	**100%**	

Item	Sample # 2				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	45.27	2.52	42.75	46.34%	267.48
2. Paper (recyclable)	2.845	0.95	1.895	2.05%	
3. Paper (Non-Recyclable)	3	0.95	2.05	2.22%	
4. Textile	12.415	0.615	11.8	12.79%	
5. Grass and wood	1.555	0.415	1.14	1.24%	
6. Plastic (recyclable)	1.08	0.415	0.665	0.72%	
7. Plastic (non-recyclable)	6.52	2.595	3.925	4.26%	
8. Polythene Bags	27.97	11.03	16.94	18.36%	
9. Leather and rubber	2.884	0.615	2.269	2.46%	
10. Metal (recyclable)	0.5	0.415	0.085	0.09%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.655	0.415	0.24	0.26%	
13. Bottle and glass (non-recyclable)	0.825	0.415	0.41	0.44%	
14. Ceramic, stone etc.	2.49	0.83	1.66	1.80%	
15. Domestic hazardous wastes	1.29	1.03	0.26	0.28%	
16. Remaining Residue (the material remaining on the sheet)	1.43	0.615	0.815	0.88%	
Miscellaneous					
Tetra pack	0.635	0.415	0.22	0.24%	
Hairs	0	0	0	0.00%	
Pampers	3.25	0.415	2.835	3.07%	
Bones	1.56	0.415	1.145	1.24%	
Only Dust	1.335	0.615	0.72	0.78%	
E-Waste	0.835	0.415	0.42	0.46%	
Total	**118.344**	**26.1**	**92.244**	**100%**	

Item	Sample # 3				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	68.585	3.47	65.115	60.30%	285.28
2. Paper (recyclable)	8.29	1.98	6.31	5.84%	
3. Paper (Non-Recyclable)	1.08	0.415	0.665	0.62%	
4. Textile	10.205	1.365	8.84	8.19%	
5. Grass and wood	1.21	0.615	0.595	0.55%	
6. Plastic (recyclable)	2.225	1.03	1.195	1.11%	
7. Plastic (non-recyclable)	3.395	2.06	1.335	1.24%	
8. Polythene Bags	22.61	11.03	11.58	10.72%	
9. Leather and rubber	3.45	0.415	3.035	2.81%	
10. Metal (recyclable)	1.026	0.83	0.196	0.18%	
11. Metal (non-recyclable)	0.475	0.415	0.06	0.06%	
12. Bottle and glass (recyclable)	0.825	0.415	0.41	0.38%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0.9	0.415	0.485	0.45%	
15. Domestic hazardous wastes	0.895	0.83	0.065	0.06%	
16. Remaining Residue (the material remaining on the sheet)	0.52	0.415	0.105	0.10%	
Miscellaneous			0		
Tetra pack	0	0	0	0.00%	
Hairs	0.008	0	0.008	0.01%	
Pampers	7.6	0.95	6.65	6.16%	
Bones	0.71	0.415	0.295	0.27%	
Only Dust	1.4	0.415	0.985	0.91%	
E-Waste	0.465	0.415	0.05	0.05%	
Total	**135.874**	**27.895**	**107.979**	**100%**	

Item	Sample # 4				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	36.63	3.47	33.16	36.18%	346.33
2. Paper (recyclable)	0.84	0.615	0.225	0.25%	
3. Paper (Non-Recyclable)	0	0	0	0.00%	
4. Textile	4.45	0.615	3.835	4.18%	
5. Grass and wood	0	0	0	0.00%	
6. Plastic (recyclable)	0	0	0	0.00%	
7. Plastic (non-recyclable)	0.81	0.415	0.395	0.43%	
8. Polythene Bags	40.895	11.98	28.915	31.54%	
9. Leather and rubber	0.6	0.415	0.185	0.20%	
10. Metal (recyclable)	0.48	0.415	0.065	0.07%	
11. Metal (non-recyclable)	0.44	0.415	0.025	0.03%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.605	0.415	0.19	0.21%	
14. Ceramic, stone etc.	1.03	0.415	0.615	0.67%	
15. Domestic hazardous wastes	1.34	1.245	0.095	0.10%	
16. Remaining Residue (the material remaining on the sheet)	6.25	0.415	5.835	6.37%	
Miscellaneous					
Tetra pack	0	0	0	0.00%	
Hairs	0	0	0	0.00%	
Pampers	9.65	0.615	9.035	9.86%	
Bones	0	0	0	0.00%	
Sieve/Dust	10.04	0.95	9.09	9.92%	
E-Waste	0	0	0	0.00%	
Total	**114.06**	**22.395**	**91.665**	**100%**	

Item	Sample # 5				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	69.905	3.575	66.33	50.35%	395.12
2. Paper (recyclable)	1.18	0.615	0.565	0.43%	
3. Paper (Non-Recyclable)	0	0	0	0.00%	
4. Textile	4.24	1.26	2.98	2.26%	
5. Grass and wood	1.56	0.615	0.945	0.72%	
6. Plastic (recyclable)	0	0	0	0.00%	
7. Plastic (non-recyclable)	2.025	1.445	0.58	0.44%	
8. Polythene Bags	57.23	22.06	35.17	26.70%	
9. Leather and rubber	0.865	0.415	0.45	0.34%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.525	0.415	0.11	0.08%	
14. Ceramic, stone etc.	5.245	1.03	4.215	3.20%	
15. Domestic hazardous wastes	0.965	0.83	0.135	0.10%	
16. Remaining Residue (the material remaining on the sheet)	5.23	0.615	4.615	3.50%	
Miscellaneous					
Tetra pack	0.52	0.415	0.105	0.08%	
Hairs	0.46	0.415	0.045	0.03%	
Pampers	7.6	0.95	6.65	5.05%	
Bones	0.725	0.415	0.31	0.24%	
Only Dust	8.95	0.415	8.535	6.48%	
E-Waste	0	0	0	0.00%	
Total	**167.225**	**35.485**	**131.74**	**100%**	

SITE Zone

Date:05/4/2021	Physical Composition Analysis of District Karachi West				
Item	**Sample # 1**				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	64.07	3.575	60.495	45.10%	486.08
2. Paper (recyclable)	0.935	0.615	0.32	0.24%	
3. Paper (Non-Recyclable)	1.61	0.615	0.995	0.74%	
4. Textile	9.1	0.95	8.15	6.08%	
5. Grass and wood	2.155	1.23	0.925	0.69%	
6. Plastic (recyclable)	0.035	0	0.035	0.03%	
7. Plastic (non-recyclable)	0.965	0.415	0.55	0.41%	
8. Polythene Bags	17.955	2.52	15.435	11.51%	
9. Leather and rubber	1.585	0.415	1.17	0.87%	
10. Metal (recyclable)	0.034	0	0.034	0.03%	
11. Metal (non-recyclable)	0.03	0	0.03	0.02%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	27.9	1.03	26.87	20.03%	
15. Domestic hazardous wastes	0.931	0.415	0.516	0.38%	
16. Remaining Residue (the material remaining on the sheet)	5	0.415	4.585	3.42%	
Miscellaneous					
Tetra pack	1.065	0.615	0.45	0.34%	
Hairs	0	0	0	0.00%	
Pampers	6.28	0.615	5.665	4.22%	
Bones	0.535	0.415	0.12	0.09%	
Only Dust	8.4	0.615	7.785	5.80%	
E-Waste	0	0	0	0.00%	
Total	**148.585**	**14.455**	**134.13**	**100%**	

Item	Sample # 2				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	53.2	3.16	50.04	46.41%	345.20
2. Paper (recyclable)	1.05	0.615	0.435	0.40%	
3. Paper (Non-Recyclable)	1.235	0.415	0.82	0.76%	
4. Textile	6.38	0.615	5.765	5.35%	
5. Grass and wood	3.325	1.03	2.295	2.13%	
6. Plastic (recyclable)	0	0	0	0.00%	
7. Plastic (non-recyclable)	1.88	1.245	0.635	0.59%	
8. Polythene Bags	32.31	11.03	21.28	19.74%	
9. Leather and rubber	0.78	0.615	0.165	0.15%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	11.585	0.83	10.755	9.98%	
15. Domestic hazardous wastes	0.77	0.415	0.355	0.33%	
16. Remaining Residue (the material remaining on the sheet)	4.885	0.615	4.27	3.96%	
Miscellaneous					
Tetra pack	0.95	0.615	0.335	0.31%	
Hairs	0	0	0	0.00%	
Pampers	6.455	1.23	5.225	4.85%	
Bones	0.655	0.615	0.04	0.04%	
Only Dust	5.81	0.415	5.395	5.00%	
E-Waste	0	0	0	0.00%	
Total	**131.27**	**23.46**	**107.81**	**100%**	

Item	Sample # 3				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	63.1	3.16	59.94	55.64%	415.64
2. Paper (recyclable)	0.93	0.415	0.515	0.48%	
3. Paper (Non-Recyclable)	1.88	0.615	1.265	1.17%	
4. Textile	4.78	0.95	3.83	3.56%	
5. Grass and wood	7.54	0.95	6.59	6.12%	
6. Plastic (recyclable)	0.52	0.415	0.105	0.10%	
7. Plastic (non-recyclable)	1.62	0.83	0.79	0.73%	
8. Polythene Bags	31.12	11.03	20.09	18.65%	
9. Leather and rubber	2.845	0.415	2.43	2.26%	
10. Metal (recyclable)	0.575	0.415	0.16	0.15%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	0.004	0	0.004	0.00%	
16. Remaining Residue (the material remaining on the sheet)	5.04	0.615	4.425	4.11%	
Miscellaneous			0		
Tetra pack	0.85	0.615	0.235	0.22%	
Hairs	0	0	0	0.00%	
Pampers	5.63	0.615	5.015	4.66%	
Bones	0	0	0	0.00%	
Only Dust	2.745	0.415	2.33	2.16%	
E-Waste	0	0	0	0.00%	
Total	**129.179**	**21.455**	**107.724**	**100%**	

Item	Sample # 4				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	56.54	3.16	53.38	51.39%	353.53
2. Paper (recyclable)	0.695	0.415	0.28	0.27%	
3. Paper (Non-Recyclable)	1.405	0.615	0.79	0.76%	
4. Textile	8.94	0.95	7.99	7.69%	
5. Grass and wood	3.64	1.03	2.61	2.51%	
6. Plastic (recyclable)	0	0	0	0.00%	
7. Plastic (non-recyclable)	2.105	1.03	1.075	1.03%	
8. Polythene Bags	29.34	11.03	18.31	17.63%	
9. Leather and rubber	1.7	0.615	1.085	1.04%	
10. Metal (recyclable)	0.12	0	0.12	0.12%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.795	0.415	0.38	0.37%	
13. Bottle and glass (non-recyclable)	0.92	0.415	0.505	0.49%	
14. Ceramic, stone etc.	0.55	0.415	0.135	0.13%	
15. Domestic hazardous wastes	0.794	0.415	0.379	0.36%	
16. Remaining Residue (the material remaining on the sheet)	4.93	0.615	4.315	4.15%	
Miscellaneous					
Tetra pack	0.5	0.415	0.085	0.08%	
Hairs	0.046	0	0.046	0.04%	
Pampers	7.11	0.95	6.16	5.93%	
Bones	0	0	0	0.00%	
Sieve/Dust	6.84	0.615	6.225	5.99%	
E-Waste	0	0	0	0.00%	
Total	**126.97**	**23.1**	**103.87**	**100%**	

Item	Sample # 5				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	53.335	2.52	50.815	36.49%	376.96
2. Paper (recyclable)	1.06	0.615	0.445	0.32%	
3. Paper (Non-Recyclable)	0	0	0	0.00%	
4. Textile	8.88	1.78	7.1	5.10%	
5. Grass and wood	1.4	0.615	0.785	0.56%	
6. Plastic (recyclable)	0	0	0	0.00%	
7. Plastic (non-recyclable)	1.43	0.83	0.6	0.43%	
8. Polythene Bags	46.785	11.03	35.755	25.67%	
9. Leather and rubber	1.45	0.615	0.835	0.60%	
10. Metal (recyclable)	0.062	0	0.062	0.04%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	12.02	0.415	11.605	8.33%	
15. Domestic hazardous wastes	0.592	0.415	0.177	0.13%	
16. Remaining Residue (the material remaining on the sheet)	17.18	1.26	15.92	11.43%	
Miscellaneous					
Tetra pack	0.82	0.615	0.205	0.15%	
Hairs	0	0	0	0.00%	
Pampers	11.77	1.9	9.87	7.09%	
Bones	0.75	0.415	0.335	0.24%	
Only Dust	5.375	0.615	4.76	3.42%	
E-Waste	0	0	0	0.00%	
Total	**162.909**	**23.64**	**139.269**	**100%**	

Baldia Zone

Date:06/4/2021	Physical Composition Analysis of District Karachi West				
Item	**Sample # 1**				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	69.961	2.52	67.441	48.05%	478.16
2. Paper (recyclable)	1	0.615	0.385	0.27%	
3. Paper (Non-Recyclable)	1.47	0.615	0.855	0.61%	
4. Textile	7.58	0.95	6.63	4.72%	
5. Grass and wood	2.046	0.615	1.431	1.02%	
6. Plastic (recyclable)	0.815	0.415	0.4	0.29%	
7. Plastic (non-recyclable)	2.315	1.445	0.87	0.62%	
8. Polythene Bags	23.65	3.16	20.49	14.60%	
9. Leather and rubber	1.035	0.415	0.62	0.44%	
10. Metal (recyclable)	0.472	0.415	0.057	0.04%	
11. Metal (non-recyclable)	0.192	0	0.192	0.14%	
12. Bottle and glass (recyclable)	1.05	0.615	0.435	0.31%	
13. Bottle and glass (non-recyclable)	0.74	0.615	0.125	0.09%	
14. Ceramic, stone etc.	2.86	0.615	2.245	1.60%	
15. Domestic hazardous wastes	2.171	1.645	0.526	0.37%	
16. Remaining Residue (the material remaining on the sheet)	14.18	0.95	13.23	9.43%	
Miscellaneous					
Tetra pack	1.57	0.615	0.955	0.68%	
Hairs	0	0	0	0.00%	
Pampers	10.35	0.95	9.4	6.70%	
Bones	0	0	0	0.00%	
Only Dust	14.985	0.95	14.035	10.00%	
E-Waste	0.028	0	0.028	0.02%	
Total	**158.47**	**18.12**	**140.35**	**100%**	

Item	Sample # 2				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	74.57	11.98	62.59	58.71%	238.48
2. Paper (recyclable)	6.105	2.85	3.255	3.05%	
3. Paper (Non-Recyclable)	1.77	0.415	1.355	1.27%	
4. Textile	5.56	0.615	4.945	4.64%	
5. Grass and wood	1.245	0.615	0.63	0.59%	
6. Plastic (recyclable)	3.25	1.9	1.35	1.27%	
7. Plastic (non-recyclable)	4.8	2.26	2.54	2.38%	
8. Polythene Bags	29.925	11.445	18.48	17.34%	
9. Leather and rubber	3.8	1.23	2.57	2.41%	
10. Metal (recyclable)	1.47	0.615	0.855	0.80%	
11. Metal (non-recyclable)	0.51	0.415	0.095	0.09%	
12. Bottle and glass (recyclable)	0.835	0.615	0.22	0.21%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	2.075	1.23	0.845	0.79%	
15. Domestic hazardous wastes	2.935	2.06	0.875	0.82%	
16. Remaining Residue (the material remaining on the sheet)	2.17	0.415	1.755	1.65%	
Miscellaneous					
Tetra pack	1.385	0.95	0.435	0.41%	
Hairs	0	0	0	0.00%	
Pampers	2.49	0.415	2.075	1.95%	
Bones	2.35	0.615	1.735	1.63%	
Only Dust	0	0	0	0.00%	
E-Waste	0	0	0	0.00%	
Total	**147.245**	**40.64**	**106.605**	**100%**	

Item	Sample # 3				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	74.635	12.905	61.73	49.46%	422.88
2. Paper (recyclable)	0.985	0.615	0.37	0.30%	
3. Paper (Non-Recyclable)	1.82	0.615	1.205	0.97%	
4. Textile	13.19	0.615	12.575	10.08%	
5. Grass and wood	6.25	1.03	5.22	4.18%	
6. Plastic (recyclable)	0.75	0.415	0.335	0.27%	
7. Plastic (non-recyclable)	2.345	1.445	0.9	0.72%	
8. Polythene Bags	27.605	11.03	16.575	13.28%	
9. Leather and rubber	1.685	0.615	1.07	0.86%	
10. Metal (recyclable)	1.32	1.245	0.075	0.06%	
11. Metal (non-recyclable)	0.485	0.415	0.07	0.06%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.68	0.415	0.265	0.21%	
14. Ceramic, stone etc.	4.295	0.83	3.465	2.78%	
15. Domestic hazardous wastes	1.455	1.245	0.21	0.17%	
16. Remaining Residue (the material remaining on the sheet)	9.79	1.26	8.53	6.83%	
Miscellaneous			0		
Tetra pack	1.01	0.415	0.595	0.48%	
Hairs	0	0	0	0.00%	
Pampers	6.62	0.95	5.67	4.54%	
Bones	0.45	0.415	0.035	0.03%	
Only Dust	6.935	1.03	5.905	4.73%	
E-Waste	0	0	0	0.00%	
Total	**162.305**	**37.505**	**124.8**	**100%**	

Item	Sample # 4				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	56.07	11.03	45.04	36.01%	373.45
2. Paper (recyclable)	1.17	0.615	0.555	0.44%	
3. Paper (Non-Recyclable)	0.79	0.415	0.375	0.30%	
4. Textile	14.02	1.675	12.345	9.87%	
5. Grass and wood	1.97	0.95	1.02	0.82%	
6. Plastic (recyclable)	0.52	0.415	0.105	0.08%	
7. Plastic (non-recyclable)	1.28	0.83	0.45	0.36%	
8. Polythene Bags	39.165	11.03	28.135	22.50%	
9. Leather and rubber	0	0	0	0.00%	
10. Metal (recyclable)	0.63	0.415	0.215	0.17%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.72	0.415	0.305	0.24%	
13. Bottle and glass (non-recyclable)	0.96	0	0.96	0.77%	
14. Ceramic, stone etc.	12.046	0.83	11.216	8.97%	
15. Domestic hazardous wastes	1.35	0.83	0.52	0.42%	
16. Remaining Residue (the material remaining on the sheet)	10.4	0.615	9.785	7.82%	
Miscellaneous					
Tetra pack	1.045	0.615	0.43	0.34%	
Hairs	0.01	0	0.01	0.01%	
Pampers	7.09	0.615	6.475	5.18%	
Bones	0	0	0	0.00%	
Sieve/Dust	7.54	0.415	7.125	5.70%	
E-Waste	0	0	0	0.00%	
Total	**156.776**	**31.71**	**125.066**	**100%**	

Item	Sample # 5				
	Amount (kg)	**Wt. of bucket**	**amount - wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	59.42	2.52	56.9	44.68%	360.16
2. Paper (recyclable)	1.758	0.615	1.143	0.90%	
3. Paper (Non-Recyclable)	1.965	0.615	1.35	1.06%	
4. Textile	11.5	0.95	10.55	8.29%	
5. Grass and wood	2.93	1.03	1.9	1.49%	
6. Plastic (recyclable)	0.97	0.83	0.14	0.11%	
7. Plastic (non-recyclable)	3.454	1.98	1.474	1.16%	
8. Polythene Bags	38.69	11.03	27.66	21.72%	
9. Leather and rubber	1.74	0.615	1.125	0.88%	
10. Metal (recyclable)	0.57	0.415	0.155	0.12%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.705	0.415	0.29	0.23%	
13. Bottle and glass (non-recyclable)	2.31	0.415	1.895	1.49%	
14. Ceramic, stone etc.	0.71	0.415	0.295	0.23%	
15. Domestic hazardous wastes	2.54	1.245	1.295	1.02%	
16. Remaining Residue (the material remaining on the sheet)	3.32	0.415	2.905	2.28%	
Miscellaneous					
Tetra pack	0.84	0.415	0.425	0.33%	
Hairs	0.01	0	0.01	0.01%	
Pampers	11.535	0.615	10.92	8.58%	
Bones	0.82	0.415	0.405	0.32%	
Only Dust	7.115	0.615	6.5	5.10%	
E-Waste	0	0	0	0.00%	
Total	**152.902**	**25.565**	**127.337**	**100%**	

Kemari Zone

Date:06/4/2021	Physical Composition Analysis of District Karachi West				
Item	**Sample # 1**				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	66.225	12.73	53.495	50.77%	301.12
2. Paper (recyclable)	0.93	0.41	0.52	0.49%	
3. Paper (Non-Recyclable)	2.305	0.6	1.705	1.62%	
4. Textile	10.7	0.91	9.79	9.29%	
5. Grass and wood	8.06	1.56	6.5	6.17%	
6. Plastic (recyclable)	1.302	1.005	0.297	0.28%	
7. Plastic (non-recyclable)	2.86	1.935	0.925	0.88%	
8. Polythene Bags	33.41	11.02	22.39	21.25%	
9. Leather and rubber	1.94	0.43	1.51	1.43%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	1.095	0.635	0.46	0.44%	
13. Bottle and glass (non-recyclable)	0.82	0.635	0.185	0.18%	
14. Ceramic, stone etc.	0.995	0.635	0.36	0.34%	
15. Domestic hazardous wastes	0.729	0.625	0.104	0.10%	
16. Remaining Residue (the material remaining on the sheet)	3.84	0.43	3.41	3.24%	
Miscellaneous					
Tetra pack	1.635	0.615	1.02	0.97%	
Hairs	0.635	0.63	0.005	0.00%	
Pampers	2.81	0.615	2.195	2.08%	
Bones	0	0	0	0.00%	
Only Dust	0	0	0	0.00%	
E-Waste	0.905	0.41	0.495	0.47%	
Total	**141.196**	**35.83**	**105.366**	**100%**	

Item	Sample # 2				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	79.655	11.98	67.675	57.40%	369.08
2. Paper (recyclable)	1.87	0.615	1.255	1.06%	
3. Paper (Non-Recyclable)	1.755	0.95	0.805	0.68%	
4. Textile	5.19	1.26	3.93	3.33%	
5. Grass and wood	0.465	0.415	0.05	0.04%	
6. Plastic (recyclable)	0.46	0.415	0.045	0.04%	
7. Plastic (non-recyclable)	4.44	1.86	2.58	2.19%	
8. Polythene Bags	30.43	11.03	19.4	16.45%	
9. Leather and rubber	0	0	0	0.00%	
10. Metal (recyclable)	0.455	0.415	0.04	0.03%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0.51	0.415	0.095	0.08%	
13. Bottle and glass (non-recyclable)	0.56	0.415	0.145	0.12%	
14. Ceramic, stone etc.	0.775	0.415	0.36	0.31%	
15. Domestic hazardous wastes	1.47	1.245	0.225	0.19%	
16. Remaining Residue (the material remaining on the sheet)	2.24	0.415	1.825	1.55%	
Miscellaneous					
Tetra pack	1.55	0.615	0.935	0.79%	
Hairs	0	0	0	0.00%	
Pampers	12.64	0.95	11.69	9.91%	
Bones	1.505	0.83	0.675	0.57%	
Only Dust	7.13	0.95	6.18	5.24%	
E-Waste	0	0	0	0.00%	
Total	**153.1**	**35.19**	**117.91**	**100%**	

Item	Sample # 3				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	75.375	3.78	71.595	55.63%	445.64
2. Paper (recyclable)	0.775	0.415	0.36	0.28%	
3. Paper (Non-Recyclable)	2.31	0.615	1.695	1.32%	
4. Textile	9.49	0.95	8.54	6.64%	
5. Grass and wood	1.75	0.615	1.135	0.88%	
6. Plastic (recyclable)	0.54	0.415	0.125	0.10%	
7. Plastic (non-recyclable)	1.13	0.415	0.715	0.56%	
8. Polythene Bags	29.055	4.42	24.635	19.14%	
9. Leather and rubber	2.03	1.03	1	0.78%	
10. Metal (recyclable)	0.455	0.415	0.04	0.03%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	1.535	0.615	0.92	0.71%	
14. Ceramic, stone etc.	0.615	0.415	0.2	0.16%	
15. Domestic hazardous wastes	1.83	1.245	0.585	0.45%	
16. Remaining Residue (the material remaining on the sheet)	8.29	0.95	7.34	5.70%	
Miscellaneous			0		
Tetra pack	1.78	0.615	1.165	0.91%	
Hairs	0	0	0	0.00%	
Pampers	5.94	0.415	5.525	4.29%	
Bones	0	0	0	0.00%	
Only Dust	3.75	0.615	3.135	2.44%	
E-Waste	0	0	0	0.00%	
Total	**146.65**	**17.94**	**128.71**	**100%**	

Item	Sample # 4				
	Amount (kg)	Wt. of bucket	amount-wt. of bucket	(%)	Density
1. Kitchen waste	54.275	2.52	51.755	45.13%	349.85
2. Paper (recyclable)	1.89	0.415	1.475	1.29%	
3. Paper (Non-Recyclable)	1.355	0.415	0.94	0.82%	
4. Textile	13.875	2.21	11.665	10.17%	
5. Grass and wood	2.83	1.565	1.265	1.10%	
6. Plastic (recyclable)	0.67	0.415	0.255	0.22%	
7. Plastic (non-recyclable)	3.45	1.445	2.005	1.75%	
8. Polythene Bags	39.3	11.98	27.32	23.82%	
9. Leather and rubber	2.035	1.03	1.005	0.88%	
10. Metal (recyclable)	0.765	0.415	0.35	0.31%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.98	0.615	0.365	0.32%	
14. Ceramic, stone etc.	0.92	0.615	0.305	0.27%	
15. Domestic hazardous wastes	2.65	1.86	0.79	0.69%	
16. Remaining Residue (the material remaining on the sheet)	4.135	0.415	3.72	3.24%	
Miscellaneous					
Tetra pack	1.016	0.415	0.601	0.52%	
Hairs	0	0	0	0.00%	
Pampers	9.165	0.95	8.215	7.16%	
Bones	0.79	0.615	0.175	0.15%	
Sieve/Dust	2.9	0.415	2.485	2.17%	
E-Waste	0	0	0	0.00%	
Total	**143.001**	**28.31**	**114.691**	**100%**	

Item	Sample # 5				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	78.42	4.11	74.31	58.71%	359.12
2. Paper (recyclable)	1.175	0.415	0.76	0.60%	
3. Paper (Non-Recyclable)	1.5	0.415	1.085	0.86%	
4. Textile	8.09	1.365	6.725	5.31%	
5. Grass and wood	0.675	0.415	0.26	0.21%	
6. Plastic (recyclable)	0.635	0.415	0.22	0.17%	
7. Plastic (non-recyclable)	2.17	1.03	1.14	0.90%	
8. Polythene Bags	45.58	22.06	23.52	18.58%	
9. Leather and rubber	1.14	0.615	0.525	0.41%	
10. Metal (recyclable)	1.555	1.245	0.31	0.24%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	1	0.415	0.585	0.46%	
13. Bottle and glass (non-recyclable)	1.055	0.415	0.64	0.51%	
14. Ceramic, stone etc.	2.025	0.415	1.61	1.27%	
15. Domestic hazardous wastes	2.455	1.66	0.795	0.63%	
16. Remaining Residue (the material remaining on the sheet)	4.125	0.415	3.71	2.93%	
Miscellaneous					
Tetra pack	1.15	0.615	0.535	0.42%	
Hairs	0	0	0	0.00%	
Pampers	10.185	0.95	9.235	7.30%	
Bones	0.815	0.415	0.4	0.32%	
Only Dust	0	0	0	0.00%	
E-Waste	1.035	0.83	0.205	0.16%	
Total	**164.785**	**38.215**	**126.57**	**100%**	

Date:07/4/2021	Physical Composition Analysis of GondPass				
Item	**Sample # 1**				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	11.175	0.615	10.56	9.35%	516.88
2. Paper (recyclable)	0	0	0	0.00%	
3. Paper (Non-Recyclable)	0	0	0	0.00%	
4. Textile	9.25	1.26	7.99	7.07%	
5. Grass and wood	3.9	1.23	2.67	2.36%	
6. Plastic (recyclable)	0.485	0.415	0.07	0.06%	
7. Plastic (non-recyclable)	0.67	0.415	0.255	0.23%	
8. Polythene Bags	33.97	11.03	22.94	20.30%	
9. Leather and rubber	0.615	0.415	0.2	0.18%	
10. Metal (recyclable)	0.685	0.615	0.07	0.06%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	2.405	0.415	1.99	1.76%	
15. Domestic hazardous wastes	1.87	1.645	0.225	0.20%	
16. Remaining Residue (the material remaining on the sheet)	4.595	0.615	3.98	3.52%	
Miscellaneous					
Tetra pack	0	0	0	0.00%	
Hairs	0.44	0.415	0.025	0.02%	
Pampers	10.73	2.52	8.21	7.27%	
Bones	0.96	0.83	0.13	0.12%	
Only Dust	63.53	11.03	52.5	46.46%	
Cow Dung	1.595	0.415	1.18	1.04%	
Total	**146.875**	**33.88**	**112.995**	**100%**	

Item	Sample # 2				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	37.9	3.47	34.43	29.14%	331.16
2. Paper (recyclable)	0.96	0.615	0.345	0.29%	
3. Paper (Non-Recyclable)	1.38	0.415	0.965	0.82%	
4. Textile	14.215	1.565	12.65	10.71%	
5. Grass and wood	6.705	1.03	5.675	4.80%	
6. Plastic (recyclable)	0.5	0.415	0.085	0.07%	
7. Plastic (non-recyclable)	1.775	1.245	0.53	0.45%	
8. Polythene Bags	48.82	11.445	37.375	31.64%	
9. Leather and rubber	1.41	0.415	0.995	0.84%	
10. Metal (recyclable)	0.905	0.83	0.075	0.06%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.62	0.415	0.205	0.17%	
14. Ceramic, stone etc.	2.26	0.415	1.845	1.56%	
15. Domestic hazardous wastes	1.34	1.245	0.095	0.08%	
16. Remaining Residue (the material remaining on the sheet)	9.68	0.95	8.73	7.39%	
Miscellaneous					
Tetra pack	0.815	0.615	0.2	0.17%	
Hairs	0.46	0.415	0.045	0.04%	
Pampers	2.9	0.415	2.485	2.10%	
Bones	0	0	0	0.00%	
Only Dust	12.67	1.26	11.41	9.66%	
E-Waste	0	0	0	0.00%	
Total	**145.315**	**27.175**	**118.14**	**100%**	

Item	Sample # 3				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	0	0	0	0.00%	306.08
2. Paper (recyclable)	0.72	0.415	0.305	0.29%	
3. Paper (Non-Recyclable)	0	0	0	0.00%	
4. Textile	17.67	2.21	15.46	14.45%	
5. Grass and wood	3.25	1.245	2.005	1.87%	
6. Plastic (recyclable)	0.46	0.415	0.045	0.04%	
7. Plastic (non-recyclable)	1.37	0.83	0.54	0.50%	
8. Polythene Bags	49.265	22.06	27.205	25.44%	
9. Leather and rubber	1.9	0.83	1.07	1.00%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.625	0.415	0.21	0.20%	
14. Ceramic, stone etc.	7.135	0.83	6.305	5.90%	
15. Domestic hazardous wastes	0.97	0.83	0.14	0.13%	
16. Remaining Residue (the material remaining on the sheet)	0	0	0	0.00%	
Miscellaneous			0		
Tetra pack	0.74	0.615	0.125	0.12%	
Hairs	0	0	0	0.00%	
Pampers	0	0	0	0.00%	
Bones	0.44	0.415	0.025	0.02%	
Only Dust	64.55	11.03	53.52	50.04%	
E-Waste	0	0	0	0.00%	
Total	**149.095**	**42.14**	**106.955**	**100%**	

Date:07/4/2021	Physical Composition Analysis of Jam Chakaro				
Item	**Sample # 1**				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	44.95	11.03	33.92	33.33%	377.76
2. Paper (recyclable)	0	0	0	0.00%	
3. Paper (Non-Recyclable)	1.85	0.615	1.235	1.21%	
4. Textile	11.81	0.95	10.86	10.67%	
5. Grass and wood	2.14	0.615	1.525	1.50%	
6. Plastic (recyclable)	0.63	0.415	0.215	0.21%	
7. Plastic (non-recyclable)	8.895	1.245	7.65	7.52%	
8. Polythene Bags	35.505	11.03	24.475	24.05%	
9. Leather and rubber	1.21	0.415	0.795	0.78%	
10. Metal (recyclable)	0.54	0.415	0.125	0.12%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	4.315	1.03	3.285	3.23%	
15. Domestic hazardous wastes	2.265	1.66	0.605	0.59%	
16. Remaining Residue (the material remaining on the sheet)	2.79	0.615	2.175	2.14%	
Miscellaneous					
Tetra pack	0.92	0.415	0.505	0.50%	
Hairs	0	0	0	0.00%	
Pampers	10.65	0.615	10.035	9.86%	
Bones	0	0	0	0.00%	
Only Dust	4.97	0.615	4.355	4.28%	
E-Waste	0	0	0	0.00%	
Total	133.44	31.68	101.76	**100%**	

Item	Sample # 2				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	55.72	11.98	43.74	38.50%	502.56
2. Paper (recyclable)	0	0	0	0.00%	
3. Paper (Non-Recyclable)	0.725	0.615	0.11	0.10%	
4. Textile	6.62	1.26	5.36	4.72%	
5. Grass and wood	0	0	0	0.00%	
6. Plastic (recyclable)	0	0	0	0.00%	
7. Plastic (non-recyclable)	1.085	0.83	0.255	0.22%	
8. Polythene Bags	36.915	11.03	25.885	22.79%	
9. Leather and rubber	2.015	0.83	1.185	1.04%	
10. Metal (recyclable)	0.44	0.415	0.025	0.02%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0.545	0.415	0.13	0.11%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	1.34	1.245	0.095	0.08%	
16. Remaining Residue (the material remaining on the sheet)	29.51	1.9	27.61	24.30%	
Miscellaneous					
Tetra pack	0.65	0.415	0.235	0.21%	
Hairs	0	0	0	0.00%	
Pampers	1.33	0.615	0.715	0.63%	
Bones	0.56	0.415	0.145	0.13%	
Only Dust	8.73	0.615	8.115	7.14%	
E-Waste	0	0	0	0.00%	
Total	**146.185**	**32.58**	**113.605**	**100%**	

Item	Sample # 3				
	Amount (kg)	**Wt. of bucket**	**amount-wt. of bucket**	**(%)**	**Density**
1. Kitchen waste	0	0	0	0.00%	567.92
2. Paper (recyclable)	0	0	0	0.00%	
3. Paper (Non-Recyclable)	0	0	0	0.00%	
4. Textile	4.64	0.615	4.025	3.80%	
5. Grass and wood	1.22	0.615	0.605	0.57%	
6. Plastic (recyclable)	0.5	0.415	0.085	0.08%	
7. Plastic (non-recyclable)	1.385	0.83	0.555	0.52%	
8. Polythene Bags	42.265	11.03	31.235	29.49%	
9. Leather and rubber	2.055	0.415	1.64	1.55%	
10. Metal (recyclable)	0	0	0	0.00%	
11. Metal (non-recyclable)	0	0	0	0.00%	
12. Bottle and glass (recyclable)	0	0	0	0.00%	
13. Bottle and glass (non-recyclable)	0	0	0	0.00%	
14. Ceramic, stone etc.	0	0	0	0.00%	
15. Domestic hazardous wastes	1.09	0.83	0.26	0.25%	
16. Remaining Residue (the material remaining on the sheet)	13.28	0.95	12.33	11.64%	
Miscellaneous			0		
Tetra pack	0	0	0	0.00%	
Hairs	0	0	0	0.00%	
Pampers	0	0	0	0.00%	
Bones	0	0	0	0.00%	
Only Dust	57.705	2.52	55.185	52.10%	
E-Waste	0	0	0	0.00%	
Total	**124.14**	**18.22**	**105.92**	**100%**	

Annexure 4: Chemical Analysis Report

Report of Analysis
Work Order : PKS2109266
[Report File No.: 0000013301]

To: PROJECT PROCUREMENT INTERNATIONAL
Office 26, Second Floor,
Silver City Plaza Sector G - 11 Markaz

P.O. No.: 2016111
Project No.: -
Samples: 1
Received: Mar 30, 2021
Pages: Page 1 of 2

April 27, 2021

Client Reference: 2016111
Sample ID: District Malir
Product: Municipal Solid Waste

SGS Minerals Sample ID: PKS2109266.001

Tests	Method	AR	Dry	AD
Moisture, Total %	Based on ASTM D3302	44.74		
Moisture, Laboratory Sample %	Based on ASTM D3173			3.95
Ash %	Based on ASTM D3174	16.64	30.12	28.93
Volatile Matter %	Based on ASTM D 7582	32.71	59.20	56.86
Fixed Carbon by Calculation %	Based on ASTM D3172	5.91	10.68	10.26
Sulfur %	Based on ASTM D4239 Method A	0.23	0.42	0.40
Gross Calorific Value kcal/kg	Based on ASTM D5865	1925	3483	3345
Net CV @ Constant Pressure kcal/kg	Based on ASTM D5865	1531	3243	3091
Oxygen (by difference) %	Based on ASTM D3176	15.84	28.64	31.03
		AR	Dry	AD
Carbon %	Based on ASTM D5373	19.45	35.20	33.80
Hydrogen %	Based on ASTM D5373	2.55	4.62	4.88
Nitrogen %	Based on ASTM D5373	0.552	1.000	0.960

Analytical Services Laboratory
Ahsan Anis
Assistant Manager

Certified By :
Iqbal Ashraf
Manager Laboratory

SGS Pakistan Private Limited
Chemical & Environmental Lab KHI
H-3/3, Sector-5, Korangi Industrial Area Karachi -74900, UAN: +92 (21) 111-222-SGS (747), Fax: +92 (21) 35121329
Member of the SGS Group (Societe Generale de Surveillance)

ref: MINE/F029

Report of Analysis
Work Order : PKS2109430
[Report File No.: 0000013304]

To: PROJECT PROCUREMENT INTERNATIONAL
Office 26, Second Floor,
Silver City Plaza Sector G - 11 Markaz

P.O. No.: 2016196
Project No.: -
Samples: 1
Received: Apr 6, 2021
Pages: Page 1 of 2

April 27, 2021

Client Reference: 2016196
Sample ID: District South Sample # 03
Product: Municipal Solid Waste

SGS Minerals Sample ID: PKS2109430.001

Tests	Method	AR	Dry	AD
Moisture, Total %	Based on ASTM D3302	57.51		
Moisture, Laboratory Sample %	Based on ASTM D3173			2.99
Ash %	Based on ASTM D3174	13.18	31.03	30.10
Volatile Matter %	Based on ASTM D 7582	26.96	63.46	61.56
Fixed Carbon by Calculation %	Based on ASTM D3172	2.35	5.51	5.35
Sulfur %	Based on ASTM D4239 Method A	0.14	0.32	0.31
Gross Calorific Value kcal/kg	Based on ASTM D5865	1649	3881	3765
Net CV @ Constant Pressure kcal/kg	Based on ASTM D5865	1204	3622	3497
Oxygen (by difference) %	Based on ASTM D3176	11.09	26.11	27.99
		AR	Dry	AD
Carbon %	Based on ASTM D5373	15.46	36.39	35.30
Hydrogen %	Based on ASTM D5373	2.13	5.01	5.19
Nitrogen %	Based on ASTM D5373	0.486	1.144	1.110

Analytical Services Laboratory
Ahsan Anis
Assistant Manager

Certified By :
Iqbal Ashraf
Manager Laboratory

SGS Pakistan Private Limited
Chemical & Environmental Lab KHI
H-3/3, Sector-5, Korangi Industrial Area Karachi -74900, UAN: +92 (21) 111-222-GGS (747), Fax: +92 (21) 35121329
Member of the SGS Group (Societe Generale de Surveillance)

ref: MINE/F029

Report of Analysis
Work Order : PKS2109339
[Report File No.: 0000013305]

To: PROJECT PROCUREMENT INTERNATIONAL
Office 26, Second Floor,
Silver City Plaza Sector G - 11 Markaz

P.O. No.: 2016195
Project No.: -
Samples: 1
Received: Apr 2, 2021
Pages: Page 1 of 2

April 27, 2021

Client Reference: 2016195
Sample ID: District East
Product: Municipal Solid Waste

SGS Minerals Sample ID: PKS2109339.001

Tests	Method	AR	Dry	AD
Moisture, Total %	Based on ASTM D3302	43.82		
Moisture, Laboratory Sample %	Based on ASTM D3173			4.98
Ash %	Based on ASTM D3174	19.65	34.98	33.24
Volatile Matter %	Based on ASTM D 7582	33.20	59.11	56.16
Fixed Carbon by Calculation %	Based on ASTM D3172	3.33	5.91	5.62
Sulfur %	Based on ASTM D4239 Method A	0.14	0.25	0.24
Gross Calorific Value kcal/kg	Based on ASTM D5865	1904	3389	3220
Net CV @ Constant Pressure kcal/kg	Based on ASTM D5865	1520	3161	2975
Oxygen (by difference) %	Based on ASTM D3176	16.00	28.46	31.46
		AR	Dry	AD
Carbon %	Based on ASTM D5373	17.20	30.63	29.10
Hydrogen %	Based on ASTM D5373	2.46	4.38	4.72
Nitrogen %	Based on ASTM D5373	0.733	1.305	1.240

Analytical Services Laboratory
Ahsan Anis
Assistant Manager

Certified By :
Iqbal Ashraf
Manager Laboratory

SGS Pakistan Private Limited
Chemical & Environmental Lab KHI
H-3/3, Sector-5, Korangi Industrial Area Karachi -74900, UAN: +92 (21) 111-222-SGS (747), Fax: +92 (21) 35121329
Member of the SGS Group (Societe Generale de Surveillance)

ref: MINE/F029

Report of Analysis
Work Order : PKS2109464
[Report File No.: 0000013303]

To: PROJECT PROCUREMENT INTERNATIONAL
Office 26, Second Floor,
Silver City Plaza Sector G - 11 Markaz

P.O. No.: 2016262
Project No.: -
Samples: 1
Received: Apr 7, 2021
Pages: Page 1 of 2

April 27, 2021

Client Reference: 2016262
Sample ID: District West Sample # 04
Product: Municipal Solid Waste

SGS Minerals Sample ID: PKS2109464.001

Tests	Method	AR	Dry	AD
Moisture, Total %	Based on ASTM D3302	50.74		
Moisture, Laboratory Sample %	Based on ASTM D3173			3.56
Ash %	Based on ASTM D3174	17.92	36.39	35.09
Volatile Matter %	Based on ASTM D 7582	28.15	57.14	55.10
Fixed Carbon by Calculation %	Based on ASTM D3172	3.19	6.47	6.25
Sulfur %	Based on ASTM D4239 Method A	0.18	0.36	0.35
Gross Calorific Value kcal/kg	Based on ASTM D5865	1699	3448	3325
Net CV @ Constant Pressure kcal/kg	Based on ASTM D5865	1310	3259	3123
Oxygen (by difference) %	Based on ASTM D3176	16.51	33.51	35.48
		AR	Dry	AD
Carbon %	Based on ASTM D5373	12.51	25.40	24.50
Hydrogen %	Based on ASTM D5373	1.77	3.59	3.86
Nitrogen %	Based on ASTM D5373	0.368	0.747	0.720

Analytical Services Laboratory
Ahsan Anis
Assistant Manager

Certified By :
Iqbal Ashraf
Manager Laboratory

SGS Pakistan Private Limited
Chemical & Environmental Lab KHI
H-3/3, Sector-5, Korangi Industrial Area Karachi -74900, UAN: +92 (21) 111-222-SGS (747), Fax: +92 (21) 35121329
Member of the SGS Group (Société Générale de Surveillance)

ref: MINE/F029

Report of Analysis
Work Order : PKS2109497
[Report File No.: 0000013302]

To: PROJECT PROCUREMENT INTERNATIONAL
Office 26, Second Floor,
Silver City Plaza Sector G - 11 Markaz

P.O. No.: 2016263
Project No.: -
Samples: 2
Received: Apr 8, 2021
Pages: Page 1 of 3

April 27, 2021

Client Reference: 2016263
Sample ID: Land Fill Janchakro
Product: Municipal Solid Waste

SGS Minerals Sample ID: PKS2109497.001

Tests	Method	AR	Dry	AD
Moisture, Total %	Based on ASTM D3302	32.46		
Moisture, Laboratory Sample %	Based on ASTM D3173			1.79
Ash %	Based on ASTM D3174	34.96	51.76	50.83
Volatile Matter %	Based on ASTM D 7582	29.86	44.21	43.41
Fixed Carbon by Calculation %	Based on ASTM D3172	2.72	4.03	3.97
Sulfur %	Based on ASTM D4239 Method A	0.17	0.25	0.24
Gross Calorific Value kcal/kg	Based on ASTM D5865	1652	2446	2402
Net CV @ Constant Pressure kcal/kg	Based on ASTM D5865	1333	2253	2202
Oxygen (by difference) %	Based on ASTM D3176	12.54	18.58	19.85
		AR	Dry	AD
Carbon %	Based on ASTM D5373	16.85	24.95	24.50
Hydrogen %	Based on ASTM D5373	2.52	3.73	3.86
Nitrogen %	Based on ASTM D5373	0.495	0.733	0.720

Analytical Services Laboratory
Ahsan Anis
Assistant Manager

Certified By :
Iqbal Ashraf
Manager Laboratory

SGS Pakistan Private Limited
Chemical & Environmental Lab KHI
H-3/3, Sector-5, Korangi Industrial Area Karachi -74900, UAN: +92 (21) 111-222-SGS (747), Fax: +92 (21) 35121329
Member of the SGS Group (Société Générale de Surveillance)

ref: MINE/F029

Report of Analysis
Work Order : PKS2109497
[Report File No.: 0000013302]

To: PROJECT PROCUREMENT INTERNATIONAL
Office 26, Second Floor,
Silver City Plaza Sector G - 11 Markaz

P.O. No.: 2016263
Project No.: -
Samples: 2
Received: Apr 8, 2021
Pages: Page 2 of 3

April 27, 2021

Client Reference: 2016263
Sample ID: Land Fill Gondpass
Product: Municipal Solid Waste

SGS Minerals Sample ID: PKS2109497.002

Tests	Method	AR	Dry	AD
Moisture, Total %	Based on ASTM D3302	5.66		
Moisture, Laboratory Sample %	Based on ASTM D3173			2.25
Ash %	Based on ASTM D3174	21.21	22.49	21.98
Volatile Matter %	Based on ASTM D 7582	65.31	69.23	67.67
Fixed Carbon by Calculation %	Based on ASTM D3172	7.82	8.28	8.10
Sulfur %	Based on ASTM D4239 Method A	0.30	0.32	0.31
Gross Calorific Value kcal/kg	Based on ASTM D5865	4649	4928	4817
Net CV @ Constant Pressure kcal/kg	Based on ASTM D5865	4346	4642	4524
Oxygen (by difference) %	Based on ASTM D3176	24.17	25.61	27.04
		AR	Dry	AD
Carbon %	Based on ASTM D5373	43.04	45.63	44.60
Hydrogen %	Based on ASTM D5373	5.24	5.55	5.68
Nitrogen %	Based on ASTM D5373	0.376	0.399	0.390

Analytical Services Laboratory
Ahsan Anis
Assistant Manager

Certified By :
Iqbal Ashraf
Manager Laboratory

SGS Pakistan Private Limited
Chemical & Environmental Lab KHI
H-3/3, Sector-5, Korangi Industrial Area Karachi -74900, UAN: +92 (21) 111-222-SGS (747), Fax: +92 (21) 35121329
Member of the SGS Group (Société Générale de Surveillanc

ref: MINE/F029

Project Procurement International (PPI)
Office # 26, Second Floor, Silver City Plaza, G-11 Markaz, Islamabad
Telephone: 051 236 3624 Cell: 0300 8540195; Fax: 051 236 3624
E-mail: projectpi@gmail.com; Web: www.projectpi.pk