PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

DRAFT FINAL REPORT

VOLUME 2

SUPPORTING REPORT

SECTION A

WASTE GENERATION AND COMPOSITION ANALYSIS

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SECTION A

WASTE AMOUNT AND COMPOSITION ANALYSIS

1. INTRODUCTION

1.1 Background of the Waste Amount and Composition Analysis

In response to the request of the Government of Pakistan (GOP), the Government of Japan (GOJ), through the Japan International Cooperation Agency (JICA), decided to conduct "Project for Integrated Solid Waste Management Master Plan in Gujranwala." The survey consists of the Waste Amount and Composition Survey (WACS) and the analysis of incoming waste records of the existing truck scale in order to quantify the volume and type of waste being generated in the city.

1.2 Objectives of the Waste Amount and Composition Analysis

The Solid Waste Amount and Composition Survey (hereinafter referred to as "WACS") was started as a part of the study for Integrated Solid Waste Management Master Plan in Gujranwala to identify the amount and composition of the different types of waste generated in Gujranwala City. The characteristics of representative municipal solid wastes were obtained through the WACS for domestic waste, commercial waste, institutional waste, market waste, street waste, etc., at the waste generation sources. The results/analysis of WACS are used for the basic data to formulate the waste collection, 3R, intermediate treatment and waste disposal plans for review, updating and formulation of the SWM Master Plan.

The WACS was contracted out with a local contractor and its field survey was started in October 2014 and continued up to June 2015 to cover three different seasons including the wet and dry seasons. The first field survey was conducted from 13 to 20 October 2014, the second field survey was from 9 to 16 February 2015 and the third field survey was conducted from 18 to 25 May 2015.

2. WASTE AMOUNT SURVEY

2.1 Type of Waste Generation Sources and Number of Samples

The types of waste generation sources and number of samples for the waste amount survey according to the generation sources are shown in **Table A.2.1**.

Table A.2.1 Types of Waste Generation Sources and Number of Samples for Waste Amount Survey

Type		Waste Amount Survey				
		Area	Samples per Area	Number of Samples	Survey Days	Total Samples
				A × B		C × D
		A	B	C	D	E
Household	High Income	2	5	10	8	80
	Middle Income	6	5	30	8	240
	Low Income	4	5	20	8	160
	Rural Area	2	5	10	8	80
Commercial	Restaurants	1	5	5	8	40
	Others	1	5	5	8	40
Markets (Food, Vegetable, etc.)		5	2	10	8	80
Institution		5	1	5	8	40
Street Sweeping		1	1	1	8	8
Park		1	1	1	8	8
Total			---	97	---	776

Note: The number of samples is for one season only.

2.2 Union Council Classification

The division of Gujranwala urban union councils (UCs) into high, middle and low income areas on the basis of income level was a pre-requisite to the conduct of various surveys including this WACS for the subject master plan. However, the data regarding these three income levels per UC is not available. Therefore, the criterion used for this classification was set by infrastructure including road condition and width, and house size and landscape. The views of the field staff of GWMC deployed in jurisdiction areas and the observations made after visiting the representative areas were taken into account for this task, as described below.

- Level of Infrastructure

The UCs having small houses and mostly unpaved and narrow streets are categorised as low income areas where the sanitation service is poor and most of the drains are open. The UCs tagged as high income areas have bigger houses and wider streets and receive relatively good sanitation services. The UCs in middle income areas are situated in between the two. The houses in middle income areas mostly range from 5 to 10 *marlas* (from 126.47 m^2 to 252.93 m^2).

- Level of Income

Actually, it is quite difficult to obtain the data of income level for each household in Pakistan. The classification as shown below is, therefore, not based on any scientific research but only for reference.*

High Income : more than Rs. 100,000 per month
Middle Income : from around Rs. 20,000 up to Rs. 100,000 per month
Low Income : less than around Rs. 20,000 per month

Note:* http://www.dawn.com/news/219652/defining-income-groups: Afshan Subohi, Defining income groups, Dawn published *Nov 20, 2006 12:00 am.* The range of income level is modified based on this article.

2.3 Survey Method

This survey has selected a total of 97 sampling points from each type of waste generation source to obtain the waste amount discharge ratio by generation source. The selection of sampling areas for each type was made through discussion between the Pakistani side and the JICA Project Team in the initial stage of the Project. The number of sampling points is summarised in the table above. The Contractor has carried out the survey and obtained 8-day results of at least the total number of samples for each type as shown in the table.

It is necessary that sampling is conducted for the duration of eight days consecutively. The result of the first day sample is disregarded assuming that the first day may have some waste accumulated together with the previous day. The first day sampling is carried out to familiarise the participating sectors and the JICA Project Team personnel on the collection of samples.

Before the execution of sampling, the required number of plastic bags was distributed to all selected sampling points except the points for market waste. Samples discharged from markets were collected by a collection vehicle specially assigned to the Project.

Each plastic bag of collected waste from the sampling points is bound with code numbers according to the generation source, so that no intermingling of samples will occur. Then, the amount of waste is measured by weight and recorded on the recording sheet at the collection points.

For market wastes transported by collection trucks, the collection truck loaded with waste is measured by a weighbridge before going to the disposal site for the waste composition survey.

The Contractor obtained the necessary data/information for estimation of unit waste generation rate on each type of waste generation resource in consultation of the Client.

The waste amount survey included the sampling of amounts of recycling material of self-treated waste at each generation source. The unit generation amount at each generation source was verified through comparative examination with existing data.

2.4 Survey Result

The waste generation amount per capita per day of each generation source is as shown in **Table A.2.2**. The average waste generation amount per capita per day of the four groups in residential areas ranges from 0.33 kilogrammes per capita per day (kg/c/d) to 0.46 kg/c/d, as shown in **Figure A.2.1.**

Table A.2.2 Waste Generation Rate of Each Generation Source

Type		Unit	Waste Generation (kg/day)			
			1st Survey 13-20 October 2014	2nd Survey 9-16 February 2015	3rd Survey 18-25 May 2015	Average
Household	High Income	person	0.46	0.46	0.48	0.47
	Middle Income	person	0.41	0.36	0.29	0.35
	Low Income	person	0.40	0.40	0.33	0.38
	Rural Area	person	0.33	0.36	0.26	0.32
Commercial	Restaurants	establishment	11.00	20.00	16.4	15.80
	Others	establishment	2.10	2.10	1.50	1.90
Markets (Food, Vegetable, etc.)		market	200.00	360.00	923.00	494.00
Institution		establishment	4.70	9.00	3.70	5.80
Street Sweeping		m	0.61	0.19	0.20	0.33
Park		park	9.40	10.00	14.5	11.30

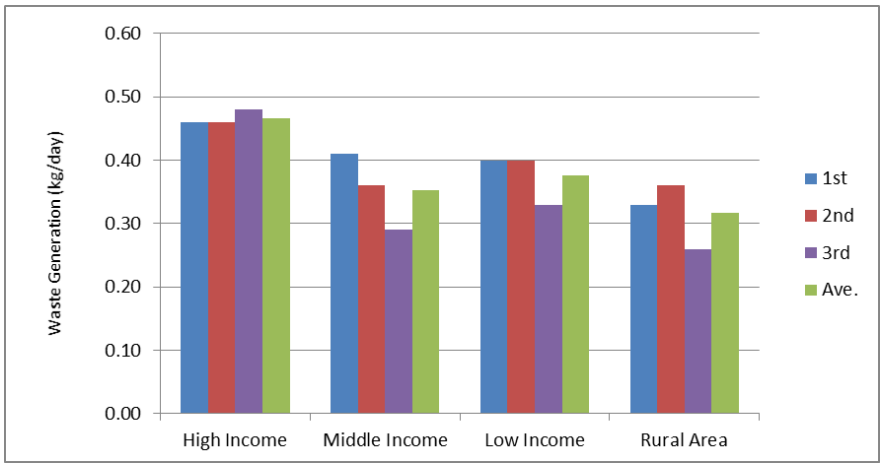

Figure A.2.1 Waste Generation per Capita in Household in Gujranwala

3. WASTE COMPOSITION SURVEY (PHYSICAL COMPOSITION: WET BASE)

3.1 Type of Waste Generation Sources and Number of Samples

The type of waste generation sources and number of samples for waste composition survey according to the generation sources are shown in **Table A.3.1** below. This sample came from the reduction method described in Item (2) below; that is, the sample of Waste Amount Survey in the previous section is different from that of Waste Composition Survey in this section.

Table A.3.1 Types of Waste Generation Sources and Number of Samples for the Waste Composition Survey

Type of Waste Generation Source		Waste Composition Survey		
		Samples	Survey Days	Number of Physical Composition
				F × G
		F	G	H
Household	High Income	1	8	8
	Middle Income	1	8	8
	Low Income	1	8	8
	Rural Area	1	8	8
Commercial	Restaurants	1	8	8
	Others	1	8	8
Markets (Food, Vegetable, etc.)		1	8	8
Institution		1	8	8
Street Sweeping		1	8	8
Park		1	8	8
Total		10	-	80

Note: The number of samples is for one season only.

3.2 Survey Method

The samples analysed are among those extracted during the waste amount survey. Samples from ten discharge sources, i.e., residential sources (high, middle and low income groups, and rural areas as the peri-urban area) and non-residential sources (restaurants, other commercial entities, markets, institutions, streets, park), are brought to the workshop of the Gujranwala Waste Management Company (GWMC) separately. The samples of large waste generation sources are then subjected to the reduction method that entails repetition of the process below until the intended sampling weight of approximately 200 kg is obtained.

- Mixing of wastes; bulky items in waste are cut into pieces.
- Division of waste into four piles of approximately the same volume once the mixture is homogeneous.
- Removal of two portions at diagonally opposite ends and the mixture of the remaining amount.

The above procedures are illustrated in **Figure A.3.1**.

Then, the waste is loaded into a plastic bucket. The plastic bucket containing the waste is dropped three times from a height of 30 cm to the ground, and then the volume is measured by a measuring tape and the total weight by a scale.

The Apparent Specific Gravity (ASG) is calculated through the following formula:

ASG = Weight of Waste (kg)/Volume of Waste (m^3)

Then the physical composition of waste is sorted into the following 15 items:

1. Kitchen waste
2. Paper (recyclable/clean paper)
3. Paper (other paper)
4. Textile
5. Grass and wood
6. Plastic (recyclable plastic)
7. Plastic (non-recyclable plastic)
8. Leather and rubber
9. Metal (recyclable metal)
10. Metal (non-recyclable metal)
11. Bottle and glass (recyclable bottles and glasses)
12. Bottle and glass (non-recyclable bottles and glasses)
13. Ceramic, stone and soil etc.
14. Domestic hazardous wastes
15. Miscellaneous

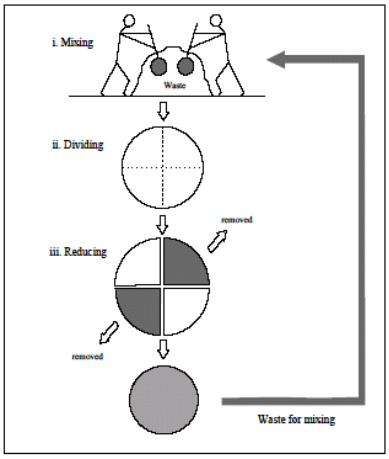

Figure A.3.1 Method of Physical Composition Analysis

3.3 Survey Result

The average waste composition in the first and second survey season was adopted to calculate the physical composition of waste. The results are summarised in **Table A.3.2, Table A.3.3**, **Table A.3.4** and **Table A.3.5,** and presented also in **Figure A.3.2**, **Figure A.3.3**, **Figure A.3.4** and **Figure A.3.5**. From these tables and figures, the characteristics of the two survey results are summarised as follows:

- The highest percentage of waste composition is kitchen waste from households (58-69%), restaurants (85%) and markets (61%) followed by paper (4-11%) or plastics (5-11%).
- The opposite trend is shown on commercial (others). The highest percentage of waste composition is paper (47%) and plastic (27%) is the second highest percentage in the category.
- High percentage of grass and wood from institutions (45%), street sweeping (8%) and parks (56%) can be observed because they might include garden waste.
- Except the waste from street sweeping, the ratio of organic waste is quite high at 70 to 98%.
- The percentage of Domestic Hazardous waste is low in all categories and it ranges from 0.1% to 1.1 %.
- The ratio of recyclable material such as paper, plastic, metal and glass from households varies from 4% to 6%, and its average is around 3.7% considering the rate of population for each income group (Detailed discussions are presented in **Section 5**).

Table A.3.2 Waste Composition of Each Generation Source (First Survey)

(Unit: %)

Waste Composition		Household				Commercial		Market	Institu-tion	Street sweep-ing	Park
		High Income	Middle Income	Low Income	Rural Area	Restaurants	Others				
Kitchen Waste		66.3	55.2	67.6	42.9	77.0	1.2	49.0	5.3	3.6	3.1
Paper	Paper (recyclable/clean)	7.4	5.3	3.2	2.9	13.8	52.1	6.7	10.8	1.7	0.9
	Paper (others)	0.5	1.9	0.5	0.2	0.5	3.8	0.5	0.8	0.3	0.2
	Subtotal-Paper	*7.9*	*7.2*	*3.7*	*3.1*	*14.3*	*55.9*	*7.2*	*11.6*	*2.0*	*1.1*
Textile		5.4	5.7	4.9	3.8	0.1	5.5	2.4	0.5	1.8	0.1
Grass and wood		0.3	0.7	0.5	9.3	0.0	0.0	26.8	42.6	16.7	76.3
Plastics	Plastic (recyclable)	1.8	1.4	0.8	0.8	0.0	3.9	0.1	0.8	0.1	7.4
	Plastic (non-recyclable)	9.8	8.4	10.9	6.6	7.3	25.3	4.7	7.4	3.5	2.1
	Subtotal-Plastic	*11.6*	*9.8*	*11.7*	*7.4*	*7.3*	*29.2*	*4.8*	*8.2*	*3.6*	*9.5*
Leather and rubber		0.6	1.5	1.8	0.5	0	0.0	0.6	0.0	0.2	0.2
Organic Waste - Subtotal		**92.1**	**80.1**	**90.2**	**67.0**	**98.7**	**91.8**	**90.8**	**68.2**	**27.9**	**90.3**
Metal	Metal (recyclable)	0.2	0.6	0.1	0.4	0.0	0.0	0.1	0.4	0.0	0.0
	Metal (non-recyclable)	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	7.2
	Subtotal-Metal	*0.2*	*0.6*	*0.1*	*0.4*	*0.0*	*0.4*	*0.1*	*0.4*	*0.0*	*7.2*
Bottle and glass	Bottle and glass (recyclable)	0.3	1.0	1.5	0.0	1.3	5.5	0.0	0.2	0.1	0.0
	Bottle and glass (non-recyclable)	1.0	0.5	0.8	0.0	0.0	1.7	0.2	0.3	0.0	0.0
	Subtotal-Bottle and glass	*1.3*	*1.5*	*2.3*	*0.0*	*1.3*	*7.2*	*0.2*	*0.5*	*0.1*	*0.0*
Ceramic, stone and soil etc.		0.5	8.3	2.5	27.2	0.0	0.1	8.4	30.7	72.0	1.2
Inorganic Waste - Subtotal		**2.0**	**10.4**	**4.9**	**27.7**	**1.3**	**7.7**	**8.7**	**31.6**	**72.1**	**8.4**
Domestic Hazardous Waste		0.5	1.0	0.8	0.5	0.0	0.5	0.5	0.0	0.0	0.3
Miscellaneous		5.4	8.5	4.1	4.9	0.0	0.0	0.0	0.2	0.0	1.0
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 1). (This work was subcontracted to the company by the JICA Project Team under the Project.

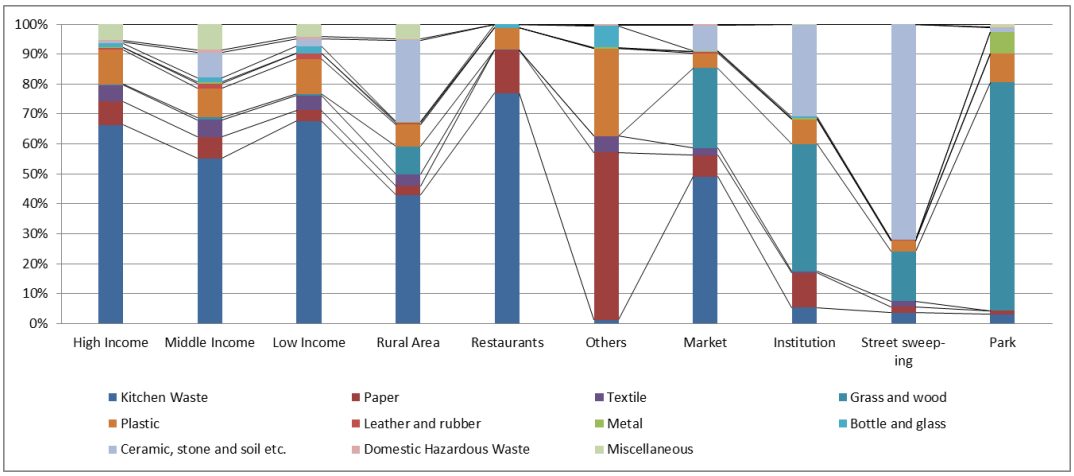

Figure A.3.2 Physical Composition of Each Generation Source (First Survey)

Table A.3.3 Waste Composition of Each Generation Source (Second Survey)

(Unit: %)

Waste Composition		Household				Commercial		Market	Institu-tion	Street sweep-ing	Park
		High Income	Middle Income	Low Income	Rural Area	Restau-rants	Others				
Kitchen Waste		68.0	55.6	64.0	60.9	89.8	4.0	78.1	2.8	16.0	20.3
Paper	Paper (recyclable/clean)	2.6	2.6	2.7	2.8	0.2	14.3	0.7	3.0	0.9	1.1
	Paper (others)	12.4	15.2	10.4	3.7	2.6	33.3	4.1	5.1	4.8	1.6
	Subtotal-Paper	*15.0*	*17.8*	*13.1*	*6.5*	*2.8*	*47.6*	*4.8*	*8.1*	*5.7*	*2.7*
Textile		2.3	5.9	3.4	3.1	2.2	7.2	1.3	0.8	1.6	0.4
Grass and wood		1.5	1.6	1.8	5.0	0.2	0.2	4.1	47.8	3.3	66.1
Plastics	Plastic (recyclable)	1.2	1.0	0.6	1.8	0.0	5.4	0.1	0.8	0.3	0.5
	Plastic (non-recyclable)	5.8	7.8	6.7	5.3	4.1	23.8	3.2	6.7	3.2	5.2
	Subtotal-Plastic	*7.0*	*8.8*	*7.3*	*7.1*	*4.1*	*29.2*	*3.3*	*7.5*	*3.5*	*5.7*
Leather and rubber		1.0	1.0	0.4	1.3	0.2	1.8	0.4	0.1	0.1	0.7
Organic Waste - Subtotal		**94.8**	**90.7**	**90.0**	**83.8**	**99.3**	**90.0**	**92.0**	**67.1**	**30.2**	**95.9**
Metal	Metal (recyclable)	0.4	0.2	0.1	0.7	0.0	0.7	0.0	0.2	0.0	0.0
	Metal (non-recyclable)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Subtotal-Metal	*0.4*	*0.2*	*0.1*	*0.7*	*0.0*	*0.7*	*0.0*	*0.2*	*0.0*	*0.0*
Bottle and glass	Bottle and glass (recyclable)	0.9	1.3	0.9	0.6	0.3	3.4	0.0	0.0	0.1	0.3
	Bottle and glass (non-recyclable)	0.2	0.2	0.0	0.7	0.3	0.0	0.0	0.7	0.0	0.0
	Subtotal-Bottle and glass	*1.1*	*1.5*	*0.9*	*1.3*	*0.6*	*3.4*	*0.0*	*0.7*	*0.1*	*0.3*
Ceramic, stone and soil etc.		0.5	1.8	1.0	2.9	0.0	0.4	0.9	5.3	2.4	0.2
Inorganic Waste - Subtotal		**2.0**	**3.5**	**2.0**	**4.9**	**0.6**	**4.5**	**0.9**	**6.2**	**2.5**	**0.5**
Domestic Hazardous Waste		0.6	0.9	0.3	0.3	0.1	0.3	0.0	0.1	0.3	0.0
Sieve Remaining		1.7	4.0	4.0	4.6	0.0	3.7	3.5	6.0	18.5	1.3
Miscellaneous		0.9	0.9	3.7	6.3	0.0	1.5	3.6	20.6	48.5	2.3
Total		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 2). (This work was subcontracted to the company by the JICA Project Team under the Project.

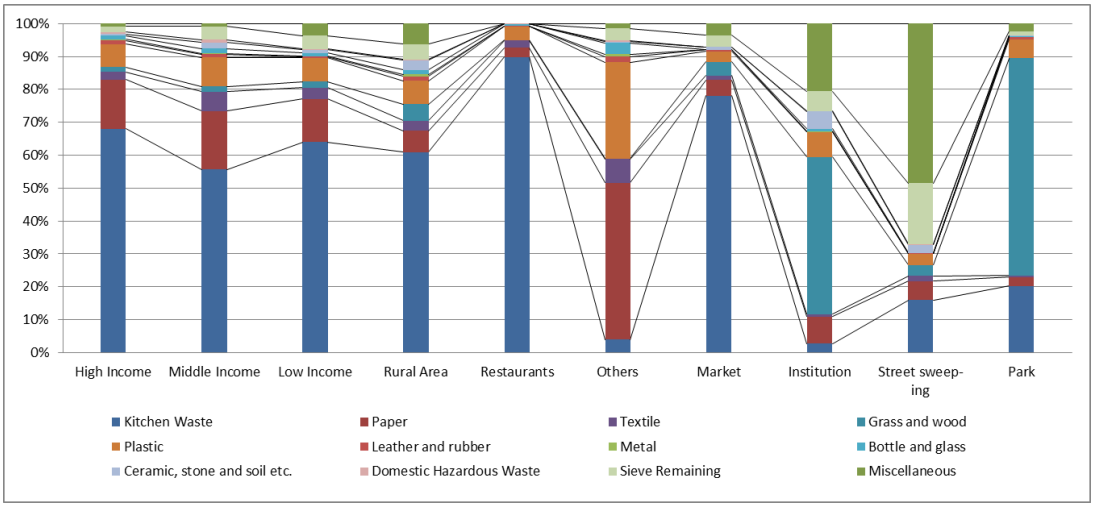

Figure A.3.3 Physical Composition of Each Generation Source (Second Survey)

Table A.3.4 Waste Composition of Each Generation Source (Third Survey)

(Unit: %)

Waste Composition		Household				Commercial		Market	Institu-tion	Street sweep-ing	Park
		High Income	Middle Income	Low Income	Rural Area	Restau-rants	Others				
Kitchen Waste		71.6	62.6	69.0	49.5	89.3	21.8	56.3	4.9	9.8	9.0
Paper	Paper (recyclable/clean)	3.1	2.4	1.9	3.0	0.5	13.7	1.6	12.4	2.0	1.5
	Paper (others)	6.2	4.0	1.1	0.7	1.9	24.2	3.8	5.4	2.7	3.7
	Subtotal-Paper	*9.3*	*6.4*	*3.0*	*3.7*	*2.4*	*37.9*	*5.4*	*17.8*	*4.7*	*5.2*
Textile		2.6	6.5	5.4	5.0	1.0	8.1	1.5	1.0	0.6	3.8
Grass and wood		0.5	0.8	1.0	5.3	0.0	3.6	19.7	44.3	4.9	26.8
Plastics	Plastic (recyclable)	1.0	1.1	1.6	2.5	0.2	2.8	1.0	1.5	0.0	6.6
	Plastic (non-recyclable)	11.1	12.0	10.6	5.6	3.8	20. 7	4.3	7.9	2.1	5.4
	Subtotal-Plastic	*12.1*	*13.1*	*12.2*	*8.1*	*4.0*	*23.5*	*5.3*	*9.4*	*2.1*	*12.0*
Leather and rubber		0.8	1.0	0.4	0.7	0.0	0.0	0.3	0.0	0.1	0.4
Organic Waste - Subtotal		**96.9**	**90.4**	**91.0**	**72.3**	**96.7**	**94.9**	**88.5**	**77.4**	**22.2**	**57.2**
Metal	Metal (recyclable)	0.4	0.4	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.5
	Metal (non-recyclable)	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	3.0
	Subtotal-Metal	*0.4*	*0.4*	*0.0*	*0.1*	*0.0*	*0.8*	*0.0*	*0.0*	*0.0*	*3.5*
Bottle and glass	Bottle and glass (recyclable)	0.6	0.1	0.0	0.1	0.0	1.4	0.2	1.4	0.0	0.5
	Bottle and glass (non-recyclable)	0.9	0.9	1.2	0.4	1.0	1.4	0.1	1.8	0.0	0.5
	Subtotal-Bottle and glass	*1.5*	*1.0*	*1.2*	*0.5*	*1.0*	*2.8*	*0.3*	*3.2*	*0.0*	*1.0*
Ceramic, stone and soil etc.		0.5	3.3	0.6	8.8	2.3	0.0	0.9	1.7	72.0	1.2
Inorganic Waste - Subtotal		**2.4**	**4.7**	**1.8**	**9.4**	**3.3**	**3.6**	**1.2**	**4.9**	**72.0**	**14.2**
Domestic Hazardous Waste		0.7	1.3	0.9	0.9	0.0	1.0	0.2	0.4	0.0	0.7
Sieve Remaining		0.0	1.1	1.7	6.1	0.0	0.5	2.6	4.6	5.8	5.6
Miscellaneous		0.0	2.5	4.6	11.3	0.0	0.0	7.5	12.7	0.0	30.8
Total		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 3). (This work was subcontracted to the company by the JICA Project Team under the Project.

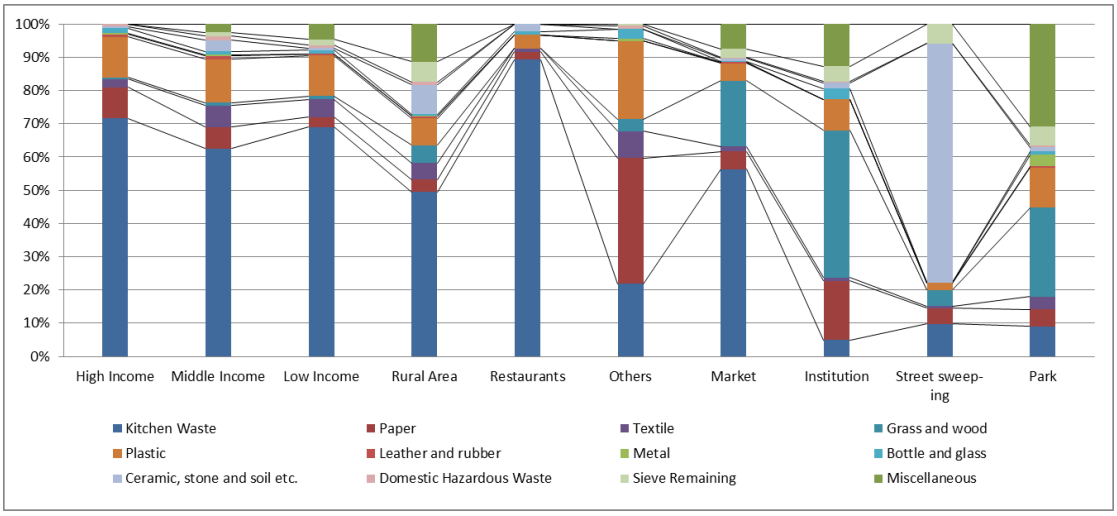

Figure A.3.4 Physical Composition of Each Generation Source (Third Survey)

Table A.3.5 Waste Composition of Each Generation Source (Average)

Waste Composition		Household				Commercial		Market	Institu-tion	Street sweep-ing	Park
		High Income	Middle Income	Low Income	Rural Area	Restau-rants	Others				
Kitchen Waste		68.70	57.80	66.90	51.10	85.30	9.00	61.10	4.30	9.80	10.80
Paper	Paper (recyclable/clean)	4.30	3.50	2.60	2.90	4.80	26.70	3.00	8.70	1.50	1.20
	Paper (others)	6.40	7.00	4.00	1.50	1.70	20.40	2.80	3.80	2.60	1.80
	Subtotal-Paper	*10.70*	*10.50*	*6.60*	*4.40*	*6.50*	*47.10*	*5.80*	*12.50*	*4.10*	*3.00*
Textile		3.40	6.00	4.60	4.00	1.10	6.90	1.70	0.80	1.30	1.40
Grass and wood		0.80	1.00	1.10	6.50	0.10	1.30	16.90	44.90	8.30	56.40
Plastics	Plastic (recyclable)	1.30	1.20	1.00	1.70	0.10	4.00	0.40	1.00	0.10	4.80
	Plastic (non-recyclable)	8.90	9.40	9.40	5.80	5.10	23.30	4.10	7.40	3.00	4.20
	Subtotal-Plastic	*10.20*	*10.60*	*10.40*	*7.50*	*5.20*	*27.30*	*4.50*	*8.40*	*3.10*	*9.00*
Leather and rubber		0.80	1.20	0.90	0.80	0.10	0.60	0.40	0.00	0.10	0.40
Organic Waste - Subtotal		**94.60**	**87.10**	**90.50**	**74.30**	**98.30**	**92.20**	**90.40**	**70.90**	**26.70**	**81.00**
Metal	Metal (recyclable)	0.30	0.40	0.10	0.40	0.00	0.30	0.00	0.20	0.00	0.20
	Metal (non-recyclable)	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	3.40
	Subtotal-Metal	*0.30*	*0.40*	*0.10*	*0.40*	*0.00*	*0.60*	*0.00*	*0.20*	*0.00*	*3.60*
Bottle and glass	Bottle and glass (recyclable)	0.60	0.80	0.80	0.20	0.50	3.40	0.10	0.50	0.10	0.30
	Bottle and glass (non-recyclable)	0.70	0.50	0.70	0.40	0.40	1.00	0.10	0.90	0.00	0.20
	Subtotal-Bottle and glass	1.30	1.30	1.50	0.60	0.90	4.40	0.20	1.40	0.10	0.50
Ceramic, stone and soil etc.		0.50	4.50	1.40	13.00	0.80	0.20	3.40	12.60	48.80	0.90
Inorganic Waste - Subtotal		**2.10**	**6.20**	**3.00**	**14.00**	**1.70**	**5.20**	**3.60**	**14.20**	**48.90**	**5.00**
Domestic Hazardous Waste		0.60	1.10	0.70	0.60	0.00	0.60	0.20	0.20	0.10	0.30
Sieve Remaining		0.60	1.70	1.90	3.60	0.00	1.40	2.00	3.50	8.10	2.30
Miscellaneous		2.10	3.90	3.90	7.50	0.00	0.60	3.80	11.20	16.20	11.40
Total		**100.0**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 1-3). (This work was subcontracted to the company by the JICA Project Team under the Project.

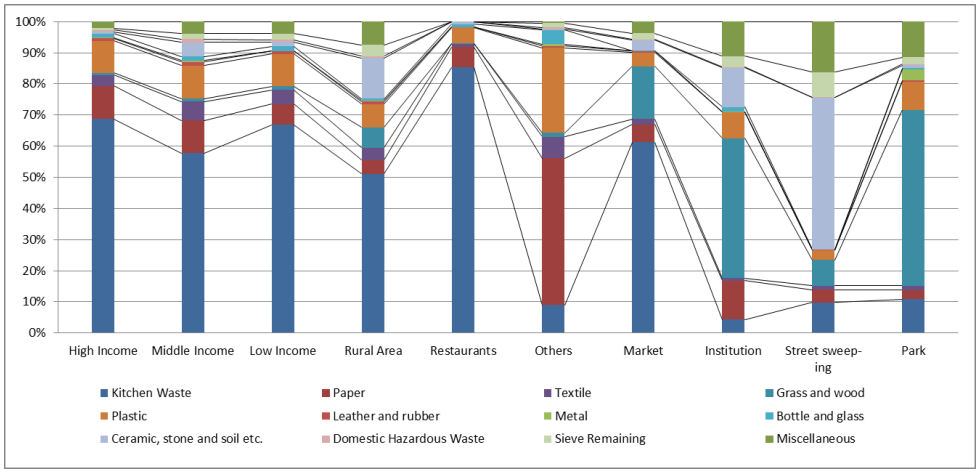

Figure A.3.5 Physical Composition of Each Generation Source (Average)

The Apparent Specific Gravity (hereinafter referred to as "ASG") of solid waste in ton/m3 is an important tool required to assess the total mass and volume of waste. The average ASG calculation

results for each generation source survey in the first and second time are shown in **Figure A.3.6.** As shown in the following figure, commercial waste especially those from restaurants have the highest apparent specific gravity of about 0.56 ton/m^3 while the other commercial waste from shops have the lowest. The apparent specific gravity of household is at around 0.28 ton/m^3.

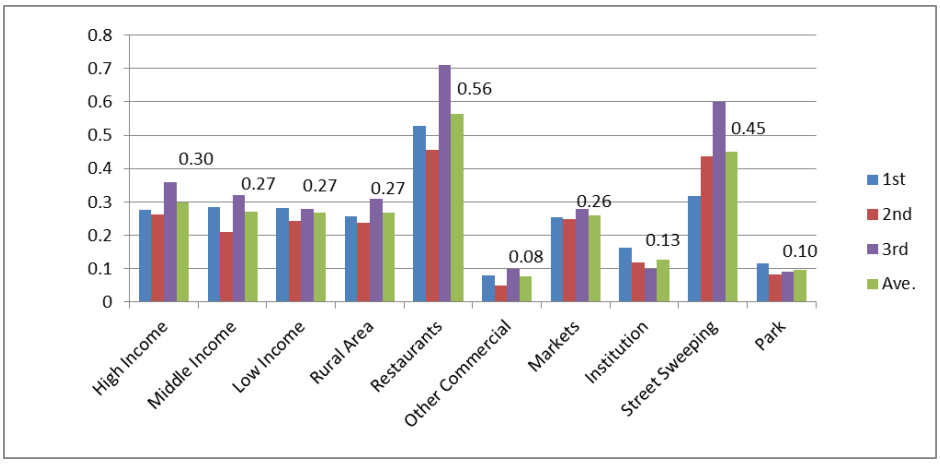

Figure A.3.6 Apparent Specific Gravity

4. THREE (3) COMPONENT ANALYSIS, CARBON AND NITROGEN ANALYSIS, AND MOISTURE CONTENTS ANALYSIS

4.1 Type of Waste Generation Sources and Number of Samples

In consideration of the possibility of intermediate treatment, the large waste discharge amount from domestic waste and market waste is subject to the Three Component Analysis, Carbon and Nitrogen Analysis, and Moisture Contents Analysis. Three Component Analysis, Carbon and Nitrogen Analysis, and Moisture Contents Analysis are carried out for the waste discharge sources/types specified in **Table A.4.1**. The total number of samples for the analysis is as follows:

Three Components Analysis : 3 samples × 3 days × 4 discharge sources = 36 samples

Carbon and Nitrogen Analysis : 3 samples × 3 days × 4 discharge sources = 36 samples

Moisture Contents : 3 samples × 3 days × 4 discharge sources = 36 samples

Table A.4.1 Number of Samples for Chemical Composition Survey

Type		Chemical Composition Survey			
		Discharge Source	Three Component Analysis	Carbon and Nitrogen Analysis	Moisture Contents
		F	Samples	Samples	Samples
Households	High Income	1	3 × 3 days = 9	3 × 3 days = 9	3 × 3 days = 9
	Middle Income	1	3 × 3 = 9	3 × 3 = 9	3 × 3 = 9
	Low Income	1	3 × 3 = 9	3 × 3 = 9	3 × 3 = 9
Markets (Food, Vegetable, etc.)		1	3 × 3 = 9	1 × 3 = 9	3 × 3 = 9
Total		4	36	36	36

Note: Number of samples is for one season only.

4.2 Survey Method

Data and information from the Three (3) Component Analysis, Carbon and Nitrogen Analysis, and Moisture Contents Analysis of wastes are used as the basic data for considering the introduction of intermediate treatment facilities. The following analysis is carried out:

- Analysis of the three components (waste types 1 to 15)
- Analysis of Carbon and Nitrogen concentration in wastes (waste type 1, 2, 3 and 5)
- Measurement of moisture content of combustible waste (waste type 1, 2, 3, 4, 5 and 8)

The above analysis is carried out for seven consecutive days in eight days as shown in **Table A.4.2** below.

Table A.4.2 Daily Schedule of Chemical Composition Survey

Physical Composition	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day
1. Kitchen Waste		3 components; C and N; Moisture content		3 components; C and N; Moisture content		3 components; C and N; Moisture content	
2. Paper (recyclable /clean paper)		3 components; C and N; Moisture content		3 components; C and N; Moisture content		3 components; C and N; Moisture content	
3. Paper (non-recyclable/clean paper)		3 components; C and N; Moisture content		3 components; C and N; Moisture content		3 components; C and N; Moisture content	
4. Textile		3 components; Moisture content		3 components; Moisture content		3 components; Moisture content	
5. Grass and Wood		3 components; C and N; Moisture content		3 components C and N; Moisture content		3 components; C and N; Moisture content	
6. Plastic (recyclable plastic)		3 components		3 components		3 components	
7. Plastic (non-recyclable plastic)		3 components		3 components		3 components	
8. Leather and Rubber		3 components; Moisture content		3 components; Moisture content		3 components; Moisture content	
9. Metal (recyclable metal)		3 components		3 components		3 components	
10. Metal (non-recyclable metal)		3 components		3 components		3 components	
11. Bottle and Glass (recyclable bottles and glasses)		3 components		3 components		3 components	
12. Bottle and Glass (non-recyclable bottles and glasses)		3 components		3 components		3 components	
13. Ceramics, Stone and Soil, etc.		3 components		3 components		3 components	
14. Domestic Hazardous Waste		3 components		3 components		3 components	
15. Sieve Remaining		3 components		3 components		3 components	
16. Miscellaneous		3 components		3 components		3 components	

Note: "Three (3) components" is obtained from the result of waste composition survey and water content for estimating the percentage of combustible waste, incombustible waste including ash and water content.

4.3 Survey Result

Data and information from the Three (3) Component Analysis, Carbon and Nitrogen Analysis, and Moisture Contents Analysis of wastes are used as the basic data for considering the introduction of intermediate treatment facilities.

For this study, the chemical analysis considered was the chemical property analysis of the three contents, namely; moisture, ash and combustible. The average results of the three-content analysis for each generation source in the first, second and third seasons are shown in **Table A.4.3** and **Figure A.4.1**. The three components exhibit almost the same tendency, i.e., the average ratio of moisture, ash and combustible ranges from around 67% to 74%, 4% to 13% and 20% to 23%, respectively. Wastes from

the high income groups in residential areas showed the highest value of moisture content while the market wastes have the highest percentages of ash content.

Table A.4.3 Results of Three-Component Analysis of Each Generation Source

Type of Waste Generation Source		Moisture (%)		Ash (%)		Combustible (%)	
		1st	Average	1st	Average	1st	Average
		2nd		2nd		2nd	
		3rd		3rd		3rd	
Household	High Income	70.28	73.2	1.82	4.7	27.90	22.1
		78.03		5.44		16.53	
		71.35		6.78		21.87	
	Middle Income	63.25	70.2	10.02	8.9	26.73	20.9
		76.28		7.39		16.33	
		71.19		9.31		19.85	
	Low Income	65.46	69.3	2.95	8.5	31.59	22.1
		77.89		8.49		13.63	
		64.64		14.14		21.21	
Markets (Food, Vegetable, etc.)		65.62	67.7	8.95	12.8	25.43	19.5
		68.33		16.49		15.18	
		69.21		13.05		17.74	

Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 1-3). (This work was subcontracted to the company by the JICA Project Team under the Project.

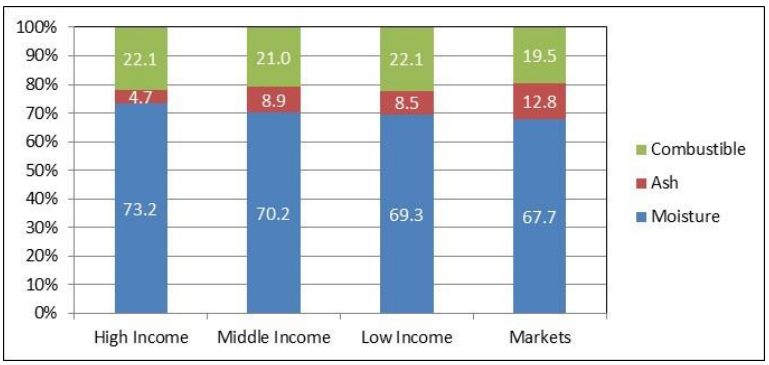

Figure A.4.1 Results of Three Component Analysis (Average)

The average results of the Carbon and Nitrogen (C/N) analysis for each generation source in the first, second and third seasons are shown in **Table A.4.4** and **Figure A.4.2**. The three components exhibit almost the same tendency, i.e., the average ratio of Carbon, Nitrogen and C/N Ratio ranges from around 49% to 53%, 0.34% to 0.44% and 119 to 177, respectively. Wastes from the middle income groups in residential areas showed the highest C/N ratio while the market wastes have the lowest income groups in residential area showed the lowest percentages of the ratio.

Table A.4.4 Results of Carbon and Nitrogen Analysis of Each Generation Source

Type of Waste Generation Source		Carbon (%)		Nitrogen (%)		C/N	
		1st*	Average	1st*	Average	1st	Average
		2nd*		2nd*		2nd	
		3rd		3rd		3rd	
Household	High Income	54.2	52.20	0.48	0.42	113.31	147.85
		51.09		0.21		241.77	
		51.32		0.58		105.20	
	Middle Income	54.1	51.47	0.41	0.34	131.13	176.51
		48.03		0.18		273.91	
		52.29		0.42		124.50	
	Low Income	54.13	49.56	0.48	0.44	113.13	119.13
		49.23		0.31		157.08	
		45.33		0.52		87.17	
Markets (Food, Vegetable, etc.)		54.15	49.78	0.67	0.43	80.65	151.69
		45.14		0.17		265.61	
		50.05		0.46		108.80	

* Carbon (%) = content (%) = (100-ash %) /1.83, Nitrogen (%) = (C/N) / Carbon (%)
Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 1-3). (This work was subcontracted to the company by the JICA Project Team under the Project.)

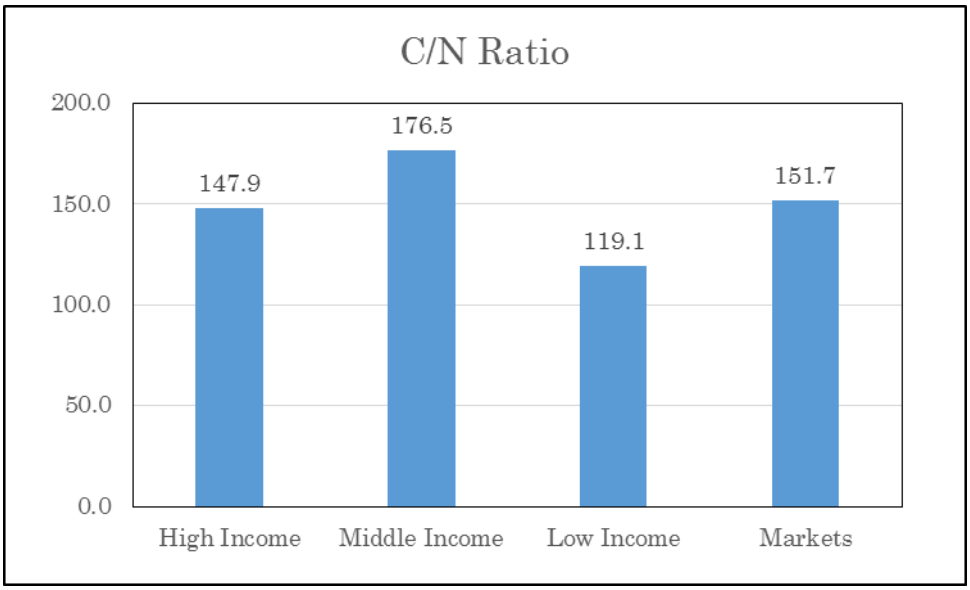

Figure A.4.2 Results of C/N Ratio (Average)

5. PRESENT AND FUTURE WASTE AMOUNT AND COMPOSITION

5.1 Introduction

Future waste generation amount will be predicted based on the various factors and waste management stream including service population, collection service ratio, per capita waste generation amount, recovery amount of recyclable materials, etc. This chapter presents the study about those factors for prediction of future waste generation amount to provide basic data and solid waste management flow to formulate the ISWM Master Plan comprised of collection and transportation plan, intermediate and 3R promotion plan, final disposal plan and other soft components.

5.2 Relation between Waste Collection Amount and Waste Generation Amount

The relation between current waste collection amount and waste generation amount is examined based on the results of waste amount and composition survey and incoming waste amount and composition survey which were carried out in the course of the Project. The step-wise study is carried out in accordance with the flow chart shown in **Figure A.5.1** and described in the following subsections.

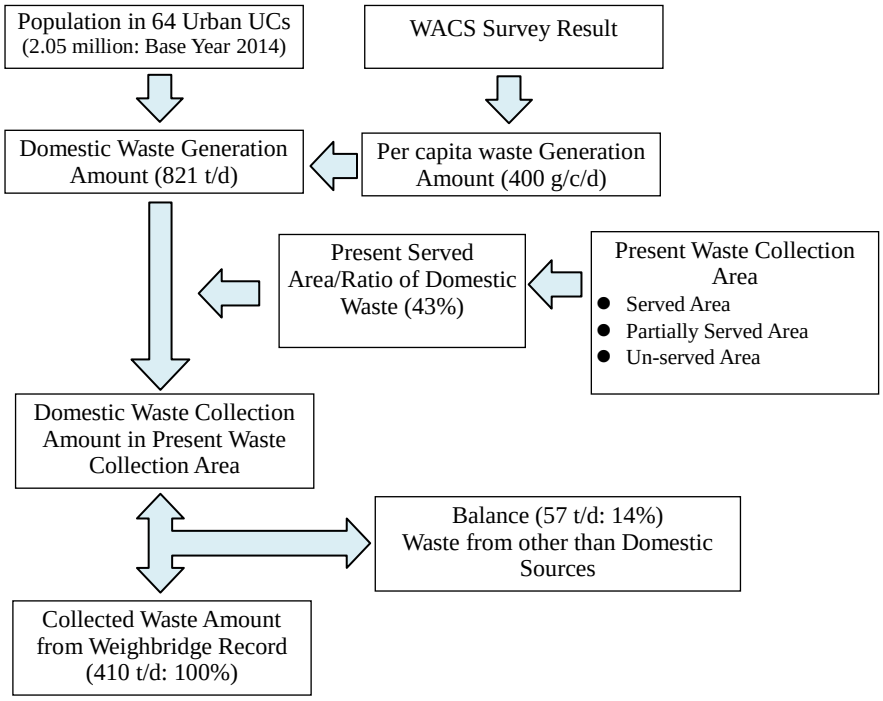

Figure A.5.1 Flowchart for Confirmation of Present Waste Amount (2014)

5.2.1 Per Capita Waste Generation Rate in 2014

WACS survey was carried out at the areas categorised as high income group area, middle income group area and low income group area in 64 urban UCs and rural area in peri-urban UCs. Weight of the samples discharged from 20 households of each income group for 7 days were processed and converted by the family size of each household to obtain the per capita waste generation amount. The information on the population of each income groups was not available. Therefore the survey was conducted together with the sanitary supervisor of each UC to categorise the 64 urban UCs into each income group areas. **Table A.5.1** summarises the survey result for the numbers of UCs categorised into three income groups. From this result, the ratio of 10%, 60% and 30% were set for the high income group, middle income group and low income group, respectively.

Table A.5.1 Income Group Ration in 64 Urban UCs

Income Level	No. of UCs	Ratio (%)	Adopted Ratio (%)
High Income Group UCs	6	9.4	10
Middle Income Group UCs	36	56.2	60
Low Income UCs	22	34.4	30
Total	64	100.0	100

The domestic waste generation ratio of each income group was processed by the weight of the number of UCs to obtain the average per capita waste generation rate of 64 urban UCs. **Table A.5.2** summarises the domestic waste per capita waste generation rate of the first and second waste amount survey for each income group and the weighted average. As a result, the per capita waste generation rate for 64 urban UCs is adopted at 0.40 kilogram per capita per day (kg/c/d) and 0.35 kg/c/d for the peri-urban UCs for estimating waste generation amount for the base year 2014.

Table A.5.2 Adopted Per Capita Domestic Waste Generation Rate in 2014

Area Category	Per Capita Waste Generation Amount from WACS Survey (kg/capita/day)					
	Result of 1st WACS Survey	Result of 2nd WACS Survey	Average	Income Group Ratio	Weighted Average	Result of 3rd WACS Survey
High income area	0.46	0.45	0.46	10%	0.40	0.48
Middle income area	0.41	0.36	0.39	60%		0.29
Low income area	0.40	0.40	0.40	30%		0.33
Rural area	0.33	0.36	0.35	100%	0.35	0.26

5.2.2 Daily Average Waste Collection Amount at Gondlanwala Temporary Disposal Site

GWMC carries out waste collection services within the area of 64 urban UCs and collection service in 34 peri-urban UCs is basically not carried out at present. GWMC started weighing incoming waste amount at Gondlanwala temporary disposal site since September 2014 by the weighbridge equipment installed by the Project. According to the analysis of daily incoming waste amount tabulated in **Table A.5.3**, the average daily incoming waste amount during the last 6 months are obtained at 410 tons per day, which are collected from domestic (households), commercial, business, institutional and other waste generation sources.

Table A.5.3 Daily Average Regular Time Waste Collection Amount (Sep.2014 - Feb.2015)

Month-Year	Breakdown of Incoming Waste Amount at Gondlanwala Disposal Temporary Site (t/d)		
	Total Waste Amount	Regular Collection Service	One Time Collection Service
September - 2014	439	428	11
October - 2014	540	373	167
November - 2014	423	371	52
December - 2014	419	368	51
January - 2015	493	451	42
February - 2015	517	469	48
Average	472	410	62

5.2.3 Waste Collection Area and Service Population

As discussed in **Section B, Waste Collection and Transportation**, GWMC demarcated the entire area of 64 urban UCs into served area, partially served area and unserved area through the field survey and the interview to the sanitary supervisors of each UC. The result of demarcation work in town-wise area and ratio is as shown is **Table A.5.4.** In order to determine the regular waste collection service area, assumption was made based on the current operation condition that the collection service has been carried out once in a week (1 time per 7 days) more or less in the partial collection service area and

adjusted the regular collection service area. As a result, the served area adjusted by conversion of the partially served area to served area for every 4 towns, i.e., Qila Didar Singh, Khaiali Shahpur, Aroop and Nandipur is calculated at 35%, 27%, 40% and 69%, respectively. Consequently, the present waste collection area or served population is estimated at 43% for domestic waste for the average of these percentages.

Table A.5.4 Demarcation of Waste Collection Service Area (March 2014)

Name of Town	Served Area (km^2) (1)	Partially Served Area (km^2) (2)	Unserved Area (km^2) (3)	Total Area (km^2) (4)	Converted Served Area (km^2) (5) = (2) / 7	Adjusted Served Area (km^2) (6) = (1) + (5)
Qila Didar Singh	2.5	6.1	1.0	9.6	0.9	3.4
(%)	(25.9)	(63.6)	(10.5)	(100.0)	(9)	(35)
Khiali Shahpur	3.5	13.4	3.0	19.8	1.9	5.4
(%)	(17.5)	(67.4)	(15.0)	(100.0)	(10)	(27)
Aroop	8.6	4.6	10.1	23.4	0.7	9.3
(%)	(37.0)	(20.0)	(43.0)	(100.0)	(3)	(40)
Nandipur	8.0	2.5	1.7	12.2	0.4	8.4
(%)	(65.6)	(20.8)	(13.6)	(100.0)	(3)	(69)

Note: Totals may neither become 100% nor always be equal to the sum of the subjected column or row due to rounding off to the first decimal point.

5.2.4 Estimation of Present Waste Generation Amount, Domestic and Commercial Wastes

The population in 64 urban UCs in 2014 is estimated at 2.05 million, approximately. Assuming that the collection service ratio is 43% as mentioned above, the served population is calculated at 882 thousand. The domestic waste amount deemed collected is estimated at 353 t/d with the relation between the said service population and the per capita waste generation rate at 400 g/c/d. On the other hand, as mentioned before, the collected and transported waste amount carried into the final disposal site is determined at 410 t/d. Accordingly, the balance between the collected domestic waste amount of 353 t/d and the total waste disposal amount of 410 t/d is considered as the waste from other than domestic source such as commercial, business and institutional waste generators. Based on this result, the present domestic waste ratio and commercial and institutional waste ratio is determined at 86% and 14%, respectively, to the total waste collection and transportation amount for further analysis to predict the future waste amount.

5.3 Estimation of Future Waste Generation Amount

Waste generation amount in the Project Area is carried out separately for domestic waste, and commercial and institutional waste in 64 urban UCs and peri-urban UCs based on the step-wise works as shown in **Figure A.5.2**.

Estimation of domestic waste generation amount is carried out based on the estimated future population in the Project Area, population projection and the per capita waste generation rate. The per capita waste generation rate tends to increase depending on the economic development and increase of disposal income of each individual. On the other hand, the per capita waste generation rate decrease depending on the implementing status of 3R programmes proposed in the ISWM Master Plan. In fact, the present waste generation rate per capita per day at 400 g/c/d in 64 Urban UCs and 350 g/c/d in the peri-urban UCs are still low level as compared with that of the neighbouring developing countries. Considering the said situations, the minimum increase ratio of 1 % per annum is assumed for the per capita waste generation rate. As a result, the per capita waste generation rate in 64 urban UCs and 34 peri-urban UCs are as summarised in **Table A.5.5**.

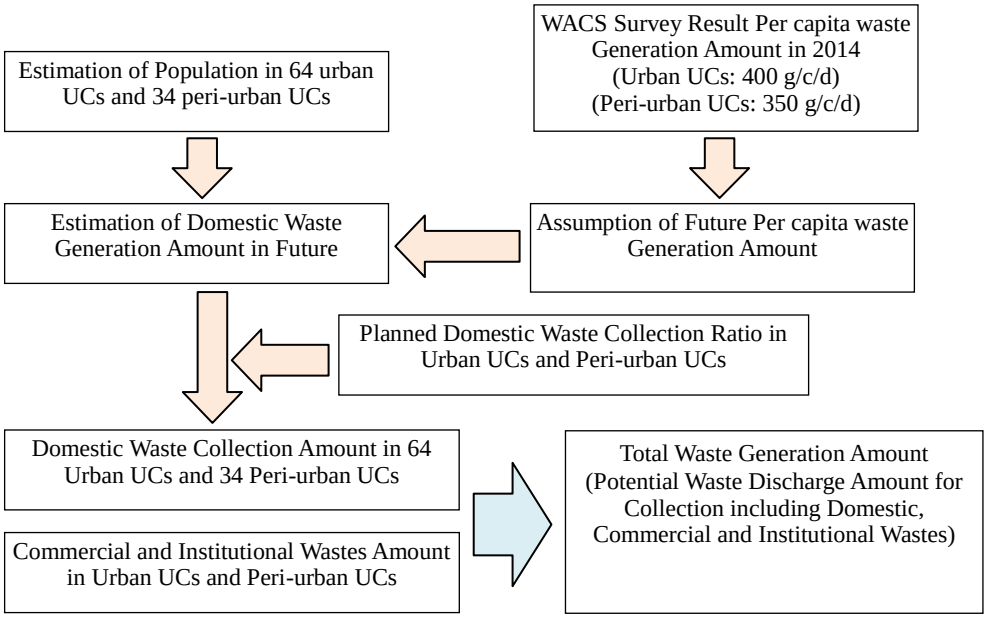

Figure A.5.2 Flowchart for Estimating Future Waste Generation Amount

Table A.5.5 Per Capita Domestic Waste Generation Rate

(Unit: g/c/d)

UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Urban UCs	400	404	408	412	416	420	424	428	432	436	440	444	448	452	457	462	467
Peri-urban UCs	350	354	358	362	366	370	374	400	404	386	390	394	398	402	406	410	414

Under this Project, the waste amount of commercial, business, institutional and other sources are estimated in the relation of collection amount and the ratio to the domestic waste. **Table A.5.6** shows the planned domestic waste collection ratio which was determined after several discussions among the parties concerned. The waste collection ratio of 64 urban UCs was set at 100% in 2018 and the collection ratio of 34 peri-urban UCs was determined to start with 10% in 2019 and set the target to reach 100% in 2030. Meanwhile, the mixed ratio of commercial and institutional wastes to domestic waste collection amount is determined at 14% in 2014 for the area of 64 urban UCs. With regard to the mixed ratio of 34 peri-urban UCs at 12%, it was determined by the relation of per capita waste generation ratio in each area and the said mixed ratio in the area of 64 urban UCs. In addition, the economic growth in the area brings about more discharge amount of commercial and business wastes. It is assumed that the growth of mixed ratio of commercial waste will become double in the final target year of the Project in 2030 as summarised the mixed ratio of commercial and institutional waste in **Table A.5.7.**

Table A.5.6 Planned Domestic Waste Collection Ratio

(Unit: %)

UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Urban UCs	43	57	71	85	100	100	100	100	100	100	100	100	100	100	100	100	100
Peri-urban UCs	0	0	0	0	0	10	20	30	40	50	60	67	73	80	87	93	100

Table A.5.7 Commercial and Institutional Waste Ratio to Domestic Waste Amount for Collection

(Unit: %)

UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Urban UCs	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Peri-urban UCs	12	13	14	15	16	17	17	18	19	20	21	22	23	24	24	25	26

The future waste generation amount is estimated by the factors mentioned above, and summarised in **Table A.5.8** and in **Figure A.5.3**. As a result of the estimation of future waste generation amount in the Project Area, the present waste amount of 1,196 t/d in 2014 will increase up to 3,346 t/d in 2030 which is approximately 2.8 times of the present waste amount.

Table A.5.8 Estimated Waste Generation Amount in the Project Area

(Unit: t/d)

UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Domestic 64 UCs	821	861	903	946	991	1,039	1,089	1,140	1,195	1,251	1,311	1,373	1,438	1,506	1,580	1,658	1,739
Domestic 34 UCs	318	334	351	368	386	406	425	446	468	491	515	540	566	593	622	652	683
Commercial	61	90	126	169	223	250	286	327	372	422	478	536	598	668	746	831	924
Total Project Area	1,200	1,285	1,380	1,483	1,600	1,694	1,800	1,913	2,035	2,165	2,304	2,449	2,602	2,766	2,948	3,140	3,346

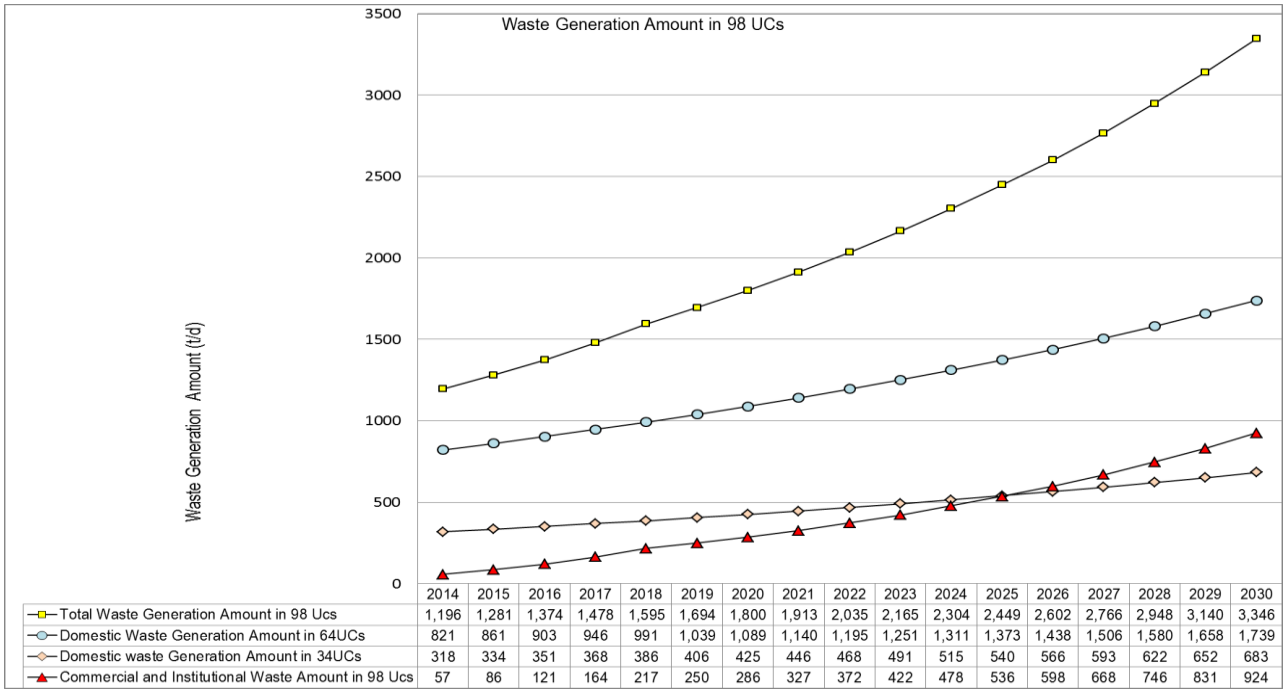

Figure A.5.3 Trend of Estimated Waste Generation Amount in the Project Area (unit: t/d)

5.4 Domestic Waste Composition

The following **Table A.5.9** shows the domestic waste composition of the second WACS. The values are obtained by processing the waste composition result of high income group, middle income group and low income group by the weight of each population size as well as the method adapted to the calculation of the average waste generation rate per capita per day. These values are studied to consider 3R and intermediate treatment as described in the following paragraph.

Each component of domestic waste composition was categorised for consideration material recovery, composting and RDF treatment as shown in **Table A.5.10.** The total recyclable materials ratio is 26.5% and the clean recyclable takes 5.6% which accounts for only 20% of the total recyclable materials. The ratio of biodegradable wastes, total of kitchen waste and grass and wood, accounts for 61 % which shows higher composting potential from the results of the WACS survey. The total of combustible waste takes 31 % of the domestic waste for consideration of RDF and incineration treatment as well. From the WACS survey results, the mixed ratio of resource materials for planning is proposed at 30% for material recycling, 60% for composting and 30% for RDF.

Table A.5.9 Weighted Average of Domestic Waste Composition

Waste Composition	Ratio (%)
Kitchen waste	59.37
Paper (recyclable)	2.63
Paper (non-recyclable)	13.46
Textile	4.80
Grass and wood	1.64
Plastic (recyclable)	0.89
Plastic (non-recyclable)	7.26
Leather and rubber	0.79
Metal (recyclable)	0.21
Metal (non-recyclable)	0.01
Bottle and glass (recyclable)	1.12
Bottle and glass (non-recyclable)	0.15
Ceramic, stone and soil etc.	1.46
Domestic hazardous wastes	0.65
Sieve Remaining	3.76
Miscellaneous	1.80
Total	100.00

Table A.5.10 3R and Intermediate Potential by Domestic Waste Composition

Material Recycling Potential		Composting Potential		RDF/Incineration Potential	
Component	Ratio (%)	Component	Ratio (%)	Component	Ratio (%)
Paper (recyclable)	2.63	Kitchen waste	59.37	Paper (recyclable)	2.63
Plastic (recyclable)	0.89	Grass and wood	1.64	Paper (non-recyclable)	13.46
Leather and rubber	0.79	**Total**	**61.01**	Textile	4.80
Metal (recyclable)	0.21			Grass and wood	1.64
Bottle and glass (recyclable)	1.12			Plastic (recyclable)	0.89
Subtotal (clean recyclables)	*5.64*			Plastic (non-recyclable)	7.26
Paper (Non-Recyclable)	13.46			Leather and rubber	0.79
Plastic (non-recyclable)	7.26			**Total**	**31.46**
Metal (non-recyclable)	0.01				
Bottle and glass (non-recyclable)	0.15				
Subtotal (dirty recyclables)	*20.88*				
Total Recyclable Wastes	**26.52**				
Proposed Value for Planning	**30%**		**60%**		**30%**

5.5 Waste Stream and Amount in Formulation of ISWM Master Plan for Gujranwala

Waste amount is estimated for each stage of waste management operation based on the waste generation, planned waste collection ratio, intermediate treatment and 3R promotion planning including recovery of recyclable materials, composting of organic waste, and final disposal. **Table A.5.11** shows the summary of the present estimated waste amount in each stage of operation. As of 2014, the waste amount is estimated at 1,200 t/d for waste generation, 724 t/d for uncollected waste amount, 66 t/d for recovery amount of recyclable materials in town and at the disposal site, 410 t/d for waste collection amount and 406 t/d for final disposal after reduction of recovery of recyclable materials of 4 t/d at the disposal site. The flow and waste amount in 2014 are shown in **Figure A.5.4**.

Table A.5.11 Waste Amount for Major Elements in Waste Management Stream in 2014

Item	2014
Total Waste Generation Amount (t/d)	1,200
Uncollected Waste Amount (t/d)	724
Waste Collection Ratio in 64 Urban UCs (%)	54
Waste Collection Ratio in 34 Peri-urban UCs (%)	0
Waste Discharge Amount for Collection (t/d)	476
Waste Generation Prevention Amount (t/d)	0
Recovery Amount of Resource Materials (t/d)	66
Intermediate Treatment Amount (Composting/RDF) (t/d)	0
Waste Collection Amount (t/d)	410
Recovery of Resource Materials at Disposal Site (t/d)	4
Waste Disposal Amount (t/d)	406

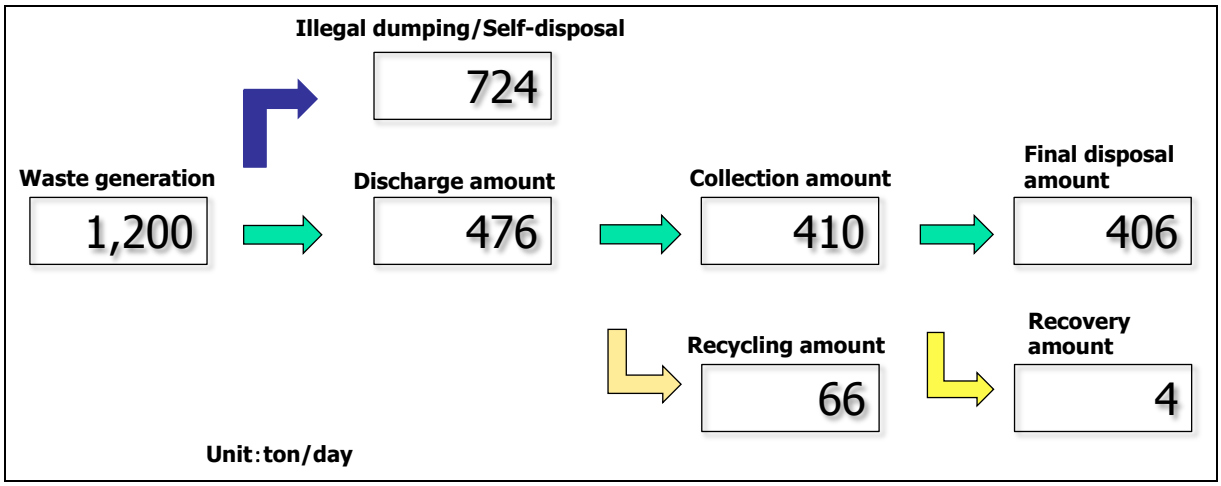

Figure A.5.4 Waste Management Flow and Estimated Waste Amount in 2014

PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

DRAFT FINAL REPORT

VOLUME 2

SUPPORTING REPORT

SECTION B

WASTE COLLECTION AND TRANSPORTATION

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SECTION B

WASTE COLLECTION AND TRANSPORTATION

1. INTRODUCTION

Gujranwala is the second largest city in Panjab Province. Sanitary condition in the city has deteriorated due to lack of waste collection equipment and inadequate solid waste management. The Master Plan for Solid Waste Management has been established to integrate the conditions in the city and it includes the collection and transportation plans for solid waste management.

Based on the interview survey with Gujranwala Waste Management Company (GWMC) officers, the solid waste collection rate in Gujranwala is 60%. Uncollected garbage from households is abandoned along the streets and this condition deteriorates the sanitary and healthy condition in the city. It not only worsens the urban landscape but also affects infrastructures such as the drainage system and others. It also causes the spread of communicable diseases due to the deteriorated sanitary condition.

Gujranwala City is considering an integrated solution to the situation. However, human resources and budgetary allocation for solid waste management are limited. Therefore, the current solid waste management plan needs to be reviewed and an optimal plan be established for the city.

This supporting report consists of the 1) Introduction; 2) Description and Evaluation of Current Condition; 3) Relevant Studies; 4) Formulation of the Master Plan; and 5) Explanation of the Action Plan.

2. DESCRIPTION AND EVALUATION OF CURRENT CONDITION

2.1 Time and Motion Study for Collection Work

2.1.1 General

There is no organised data/record or information on waste management activities available, especially the efficiency of waste collection and transportation vehicles in Gujranwala. The Time and Motion Study (the Study) was, therefore, conducted to evaluate the efficiency of waste collection and transportation by the vehicles currently operated by the Gujranwala Waste Management Company (GWMC), which serves as the "Special Purpose Vehicle" (SPV) for the activities.

The results of the first field survey that was carried out by the JICA Project Team with the collaboration of GWMC and the Urban Unit (UU), Government of the Punjab from the 9th of December to the 24th of December 2014 were evaluated as the basic data for the waste collection and transportation plan. The second survey on the other hand was implemented from the 31st of March to the 8th of April 2015.

2.1.2 Objective of the Study

The objectives of the Time and Motion Study were as follows:

- To grasp the operation condition of the different types of waste collection and transportation vehicles in service;
- To evaluate the loading, unloading, travelling and total operational time from the viewpoint of loading, unloading and total operation time in relation to waste collection and transportation amount, travelling distance and fuel consumption; and
- To develop the basic data for the formulation of a waste collection and transportation plan.

2.1.3 Study Method

Four (4) teams each consisting of a Waste Manager, Research Assistant (hereinafter referred to as "counterparts") and survey assistants carried out the Study under the guidance of the JICA Project Team. The Study included the recording of time for travelling, loading and unloading of waste, tracking of the collection route and travelling distance, waste collection amount, fuel consumption and waste collection operation efficiency, etc.

All of the activities from the starting point of collection vehicles (i.e., GWMC Workshop, hereinafter referred to as "garage" located at Sheikhupura Road) to the collection points and return to the garage were recorded as to time and route by GPS devices. The main activities carried out during the field survey are as summarised below:

- Chasing of the objective collection vehicle and the recording of time consumed for each stop/departure by GPS device;
- Recording of the mileage of odometer, respectively, of the start of collection work, end of collection work, arrival at disposal site for unloading, start of 2nd/3rd collection work, etc., in data sheets;
- Recording by GPS device of the collection route of each objective vehicle;
- Recording of the fuel consumption of each vehicle, and
- Recording of observed road conditions, traffic conditions, condition of collection points, workers behaviour, etc.

2.1.4 Study Result

The primary purpose of using a mini-dumper is to collect waste from narrow streets or roads that are not accessible to tractor trolleys and arm-roll trucks. Tractor trolleys are used for both waste collection and transportation whereas the arm-roll trucks transport the wastes collected by handcarts and donkey carts from the primary collection points to the dumpsite. The number of vehicles subjected to the field survey of 5 days is 8 and the total number of samples collected is 40.

The results of the field survey were evaluated based on the average values computed and tabulated in **Table B**.2.1 for the key factors of waste collection and transportation activities. As mentioned above, due to the different types of services allotted to each vehicle, the values cannot be compared simply but comparison or evaluation of the performance or the efficiency of the three types of vehicles are described in the following subsections.

Table B.2.1 Summary of Waste Collection and Transportation Analysis by Vehicle Type

No.	Evaluation Items	Vehicle Type									
		Arm-Roll Truck			Tractor Trolley			Mini-Dumper			
		Season 1	Season 2	Average	Season 1	Season 2	Average	Season 1 (T/S)	Season 2 (T/S)	Average	Season 2 (D/S)
1	Average Waste Handling Amount (kg)	12,050	16,640	14,345	3,502	3,870	3,686	2,430	3,170	2,800	2,050
2	Average Mileage (km)	144	137	141	51	45	48	49	57	53	88
3	Average Fuel Consumption (litre)	35	34	35	15	16	16	9	9	9	13
4	Average Number of Trips (times/day)	5.4	4.5	5.0	1.7	1.8	1.8	4.6	5.6	5.1	4.2
5	Average Number of Crew (Persons)	1	1.0	1	2.7	2.3	2.5	2.5	2.6	2.6	2
6	Average Loading Time (minutes)	40	31	36	193	233	213	282	237	260	251
7	Average Travel Time (minutes)	364	405	385	265	284	275	234	224	229	333
8	Average Unloading Time (minutes)	40	37	39	12	15	14	31	16	24	30
9	Average Total Operating Time (minutes)	445	474	460	471	533	502	547	477	512	615
10	Average Mileage per Unit Fuel Consumption (km/litre)	4.1	4.0	4.1	3.6	2.8	3.2	5.4	6.3	5.9	6.8
11	Average Waste Handling Amount per Unit Distance (kg/km)	84	121	103	69	86	78	50	56	53	23
12	Average Waste Handling Amount per Loading Time (kg/hr)	18,075	32,206	25,141	1,089	997	1,043	517	803	646	490
13	Average Waste Handling Amount per Travel Time (kg/hr)	1,986	2,465	2,226	793	818	806	623	849	734	369
14	Average Waste Handling Amount per Total Time (kg/hr)	1,625	2,106	1,866	446	436	441	267	399	328	200
15	Average Waste Handling Amount per Unit Fuel Consumption (kg/litre)	344	489	417	250	242	246	270	352	311	158

(1) Average Waste Handling Amount (kg)

The value indicates the average amount of waste handled per day or shift of each type of vehicle used for the waste collection and transportation or only for waste collection or transportation.

An arm-roll truck was used only for transferring the waste containers to the disposal site. The amount of waste carried by an arm-roll truck per day (14 tons) is 3.8 times more than that of a tractor trolley (3.7 tons) although it cannot be compared simply with the performance of a tractor trolley which was used both for waste collection and waste transportation.

Mini-dumpers that go to the transfer station [hereafter, mini-dumpers (T/S)] collect less waste (2.8 tons) and mini-dumpers that go to the landfill site [hereafter, mini-dumper (D/S)] collect less waste (2.0 tons) compared with the tractor trolleys which collect and transport waste, since mini-dumpers that go to the transfer station have many collection points and waste loaded is only 646 kg/hr and the mini-dumpers that go to the landfill site have a limited capacity and waste loaded is only 490 kg/hr [see **Item (12)** below].

(2) Average Mileage (km)

Figure B.2.1 shows the average mileage of each vehicle (km). Arm-roll trucks were used only for hauling waste containers to the disposal site, so that the number of trips and travelling distance is more. The daily average mileage of an arm-roll truck is 141km, which is approximately three times more than that of the tractor trolley (48km). Tractor trolleys were used for waste collection and transportation, but most of them are old so that performance was low, and the average travelling distance per shift was shorter.

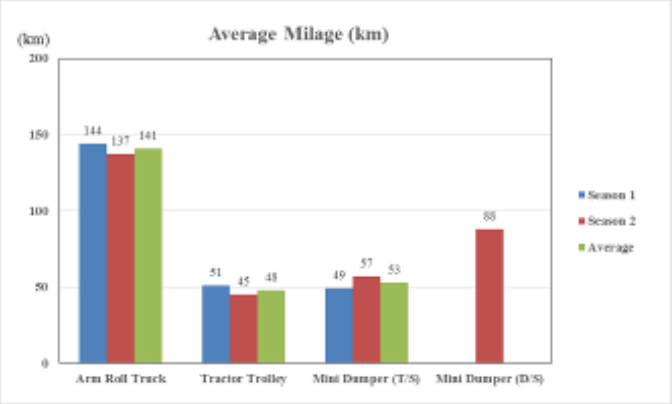

Figure B.2.1 Average Mileage (km)

Mini-dumpers (T/S) were deployed for areas surrounding the waste container sites which are used currently as the temporary transfer stations. On the other hand, mini-dumpers (D/S) were deployed in areas close to the landfill site.

A mini-dumper (T/S) collects waste from many collection points and the loading time is long, so that the average travelling distance per shift is short. The daily average mileage of a mini-dumper (T/S) is 53km while the daily average mileage of a mini-dumper (D/S) is 88km, which is the second longest among the four types of vehicles.

(3) Average Fuel Consumption (litre)

The average fuel consumption of an arm-roll truck is 35 litres per day while that of the tractor trolley is 16 litres on average. The mini-dumper (T/S) and the mini-dumper (D/S) consume only 9 litres and 13 litres per day, respectively, the lowest among the three types of vehicles. The capacity of the engine is 800 cc, which is relatively small. On the other hand, the engine capacity of an arm-roll truck is bigger than those of the mini-dumper and tractor trolley.

The fuel consumption of a tractor trolley is relatively low because this vehicle could not be driven faster and the mileage is limited during the operation. Therefore, it does not consume much fuel compared to the arm-roll truck.

(4) Average Number of Trips (times/day)

Figure B.2.2 shows the average number of trips for each type of vehicle. The number of trips in a day for the arm-roll truck is 5.0 on average while that of the tractor trolley is 1.8 on average. Mini-dumpers (T/S) operate more frequently at 4 to 5 trips a day and 5.1 on average although the mini-dumper has many collection points. Mini-dumpers (D/S) operate at 4.2 trips per day on average, which is lower than the mini-dumpers (T/S). The reason for this is that a vehicle has to go to the landfill site directly once it finishes collecting waste from the households. Since all tractor trolleys are old and consume more fuel, there is a tendency that the arm-roll trucks and mini-dumpers are preferable to be used in the site.

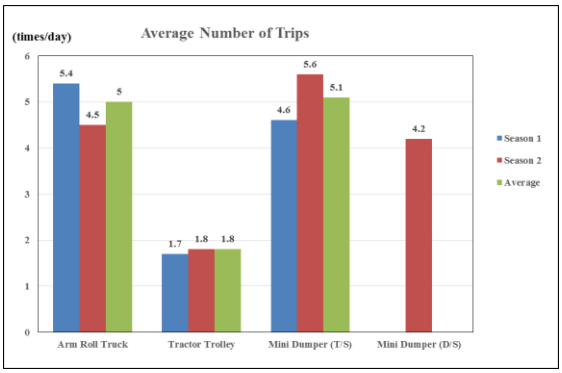

Figure B.2.2 Average Number of Trips

(5) Average Number of Crew (person)

The average number of crew per arm-roll truck, tractor trolley or mini-dumper is 1.0, 2.5 and 2.3, respectively. The arm-roll truck requires one driver only; however, the tractor trolley or the mini-dumper always requires one or two loaders and one driver. In terms of manpower, the arm-roll truck is the most efficient among the three types of vehicles.

(6) Average Loading Time (minutes: min.)

The arm-roll trucks load, transport and unload the waste containers. Therefore, they do not take much time to load wastes (36 min.) and takes only about one-fifth of the operation time compared with that of the tractor trolley (213 min.). On the other hand, the mini-dumpers take 4 hours and 23 minutes (263 min.) to load waste, which is almost equal to 50 percent of the total working time per day.

When the efficiency of average loading time of each vehicle is compared with the average waste loading time per waste amount per trip, the arm-roll truck has 0.5 min./ton/trip (=26/14.35/5.0), the tractor trolley has 32 min./ton/trip (=213/3.69/1.8), the mini-dumper (T/S) has 18.2 min./ton/trip (=260/2.8/5.1) and the mini-dumper (D/S) has 29.2 min./ton/trip (=251/2.05/4.2). Based on these results, the loading time by the tractor trolley is the longest of the three while the arm-roll truck shows very high efficiency.

(7) Average Traveling Time (min.)

The travel time of an arm-roll truck is longer than the others. The time is spent for frequent round-trips between the waste container sites and the disposal site. Around 6.5 hours per day or 80% of the total operating time is spent for travel time.

Average travel time of the tractor trolley is 4 hours and 35 minutes (275 min.) per day. The average transportation time of the mini-dumpers (T/S) is about 3 hours and 49 minutes per day (229 min.), which is 45% of the total operating time per day. The average transportation time of the mini-dumpers (D/S) is about 5 hours and 33 minutes per day (333 min.), which is 54% of the total operating time per day. The average travel time will be used for comparing the average travel time per waste amount.

(8) Average Unloading Time (min.)

The unloading time of each type of vehicle varies depending on the number of transportation times. The arm-roll trucks transport waste containers and unload the waste at the disposal site about 5 times per day for spending the total unloading time of 39 minutes.

On the other hand, tractor trolleys transport waste 2 times and spend 14 minutes for the daily operation. The total unloading time of a mini-dumper (T/S) is 24 minutes, and it was found that the unloading time at the disposal site is more than 5 times at the temporary transfer station site. The total unloading time of a mini-dumper (D/S) is 30 minutes.

(9) Average Total Operating Time (min.)

The longest total operating time per day is approximately 9 hours by the mini-dumper (T/S) (512 min.), and approximately 10 hours by the mini-dumper (T/S) (615 min.). The average total operating time per day of the arm-roll truck is almost 7 hours (533 min.) and tractor trolley is 7 hours and 40 minutes (460 min.).

(10) Average Mileage per Unit Fuel Consumption (km/litre)

The average mileage per unit fuel consumption of a mini-dumper is the highest among the three objective vehicles calculated at 5.9 to 6.8 km per litre. The engine capacity of a mini-dumper is 800cc, which is relatively small compared with that of the other two types of vehicle and it reflects the fuel consumption efficiency of the vehicle.

The average mileage per unit fuel consumption of an arm-roll truck is calculated at 4.1 km per litre which is the middle value among the three vehicles.

The average mileage per unit fuel consumption of a tractor trolley is calculated at 3.2 km per litre which is the worst value among the three vehicles.

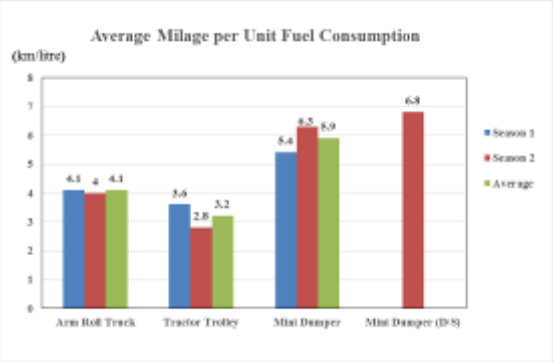

Figure B.2.3 Mileage per Unit Fuel Consumption by Type of Vehicle

The tractor trolley is not good at travelling long distances. In addition, these vehicles have been used for more than 10 years. Therefore, it is considered that the vehicle is decrepit. Reference also shall be made to **Figure B.2.3**.

(11) Average Waste Handling Amount per Unit Distance (kg/km)

The total waste hauling amount per mileage covered by the arm-roll truck is 103 kg/km which is the highest among the three types of vehicle. The total waste hauling amount per mileage covered by the tractor trolley is 78 kg/km while the mini-dumper truck performed only 23 to 56 kg/km. Due to the difference of utilisation purpose of each type of vehicle (transfer, transfer and collection, and collection), however, the average waste handling amount per unit distance cannot be simply compared.

(12) Average Waste Handling Amount per Loading Time (kg/hr)

The average waste handling amount per loading time of arm-roll truck is 25 tons per hour which is 25 times more than that of the tractor trolley (1.0 ton). The waste handling amount per loading time of the mini-dumper is approximately 0.5 to 0.6 tons per hour which is more than one-half of the performance of the tractor trolley. This is because of the operation mode of the mini-dumper for collection of waste from many collection points including door-to-door collection although this

value also cannot be compared simply due to the difference of utilisation purpose of each type of vehicle.

(13) Average Waste Handling Amount per Travel Time (kg/hr)

The average waste handling amount per travel time of the arm-roll truck is approximately 2 tons per hour which is the most efficient value among the three types of vehicle. The handling amount per travel time of arm-roll truck is approximately 2.5 times higher than that of the waste handling amount of the tractor trolley (0.8 tons).

The result of mini-dumper is the lowest at 0.4 to 0.7 tons per hour due to the collection from many collection points including door-to-door collection. This value also cannot be compared simply due to the difference of utilisation purpose of each type of vehicle for transportation, collection and transportation or only for waste collection.

(14) Average Waste Handling Amount per Total Time (kg/hr)

The average waste handling amount per total operating time of arm-roll truck is approximately 1.9 tons/hr, which is the highest value among the three types of vehicle. The mini-dumper performed approximately 0.2 to 0.3 tons/hr, which is 60% of the value performed by the tractor-trolley (0.4 tons/hr).

From the result of average waste handling amount per total operating time of arm-roll truck and mini-dumper, it is found that the capacity of 7 units of mini-dumper is equivalent to the capacity of one unit of arm-roll truck. These values also cannot be compared simply due to the difference of the utilisation purpose or service of each type of vehicle. Reference shall be made also to **Figure B**.2.4.

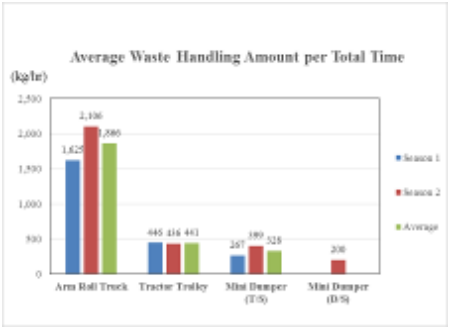

Figure B.2.4 Waste Handling Amount per Unit Distance by Type of Vehicle

During the field survey, the key factors regarding loading, unloading and travel time which consist of the total time were observed as explained in detail in **Table B.2.2**.

Table B.2.2 Key Factors affecting Operation Time during the Time and Motion Survey

Objective	Arm-roll truck	Tractor trolley	Mini-dumper (T/S)	Mini-dumper (D/S)
Loading Time	36 minutes (min.) (8% of total time)	3:33 (hr : min.) (42% of total time)	4:20 (hr : min.) (51% of total time)	4:11 (hr : min.) (41% of total time)
	a) Driver has to wait for a container to be fully filled due to late transportation of primary collected waste. b) Partial filling and littering of waste outside the container. c) Improper location of container and traffic problem. d) Loaded the container from the temporary transfer station and skipped the allotted containers. e) Residents are reluctant to place the container near	a) Lack of designated crew for loading. b) Delay due to late sweeping of roads/streets by sanitation staff. c) Timing of traffic congestion at school and office site. d) Routes to access the containers are also used by mini-dumpers. e) Traffic congestion at School and Office timing f) In UC-19 & UC-46, handcarts are also unloaded from mini-dumpers and tractor trolleys.		

Objective	Arm-roll truck	Tractor trolley	Mini-dumper (T/S)	Mini-dumper (D/S)
	their houses. It sometimes takes time to change the location of a container.			
Traveling Time	6:25 (hr : min) (84% of total time)	4:35 (hr : min) (55% of total time)	3:49 (hr : min) (45% of total time)	5:33 (hr : min) (54% of total time)
	a) Container is not, or partially, filled at the arrival of arm-roll truck and the driver has to move the vehicle to find some other allotted points for loading filled/partially filled containers. b) Allotted containers are not from adjacent UCs and far from each other. c) Fan belt of Hino-11 is broken. d) Engine problem in Hino-14	a) Travel at a speed of 5-6km/hr. b) 20 years old machinery, engine struck out of TT-9774, Gear Plate and Hauling Jack of TT-Holland-1 was out of order, Belt of cylinder broke out and tyre of Holland-2 was also punctured. c) Steering lever of TT-451 was broken and it took 90 minutes to repair it. d) Waste collection route by TT-451 was not appropriate: streets are narrow so that it is difficult for the vehicle to turn around the corner and it also causes traffic congestion problem.	a) Most drivers make the first trip with partially filled dumper. b) Travel at slow speed to avoid littering of waste.	
Unloading Time	39 minutes (8% of total time)	14 minutes (3% of total time)	24 minutes (4% of total time)	30 minutes (5% of total time)
	a) Absence of records-keeper at 7:30 a.m. b) Delay in alignment of remaining waste of previous day at Gondlanwala. c) Delay due to dumping of other vehicles at designated points.	a) Bucket unloaded the waste from tractor trolley (Holland-1) due to the problem in hauling jack. b) Steering wheel of TT-6946 was broken and it took 6 days to repair it. c) Fuel tank of TT-6946 leaked.	a) Delay due to dumping of other mini-dumpers at the transfer station. b) GAJ-49 spends 40 minutes for hauling the waste to Gondlanwala.	

(15) Average Waste Handling Amount per Fuel Consumption (kg/litre)

The average waste handling amount per fuel consumption or per unit fuel amount of the arm-roll truck, tractor trolley, mini-dumper (T/S) and mini-dumper (D/S) are calculated at 417 kg, 246 kg, 311 kg and 158 kg per litre, respectively. This means that the arm-roll truck collects and transports 1.7 times the amount of waste per litre compared with that of the tractor trolley in the area where a mini-dumper does not collect waste.

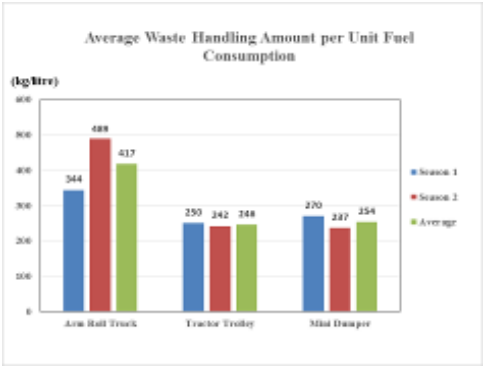

Figure B.2.5 Comparison of Waste Collection and Transportation Vehicles against Fuel Consumption

In case of waste collection and transportation by the combination of mini-dumper and arm-roll truck, the mini-dumper needs to have 1.3 litres of fuel for collecting 417 kg of waste which is the waste amount transported by one arm roll truck. In this case, 417 kg of waste is collected and transported by mini-dumper and arm-roll truck using 2.3 litres of fuel.

Thus, this combination of two types of vehicle, i.e., mini-dumper and arm-roll truck has the capability of waste collecting and transporting 181 kg of waste per litre (=417kg/2.3 litre). Comparing the value with that of the result of tractor trolley that was 246 kg/litre, the number of average waste handling amount per fuel consumption of these two vehicles is approximately 74% of the value performed by the tractor trolley. However, the average waste handling amount per fuel consumption on the combination of arm-roll truck and mini-dumper is slightly greater than that of mini-dumper (D/S). Reference also shall be made to **Figure B.2.5**.

2.1.5 Major Findings and Recommendations

Based on the results of the Time and Motion Study, major findings and matters to be recommended with respect to improvement of the operation of waste collection and transportation vehicles are as summarised below.

- The arm-roll truck with a container is the most efficient vehicle among the three types in terms of handling waste amount, operating time and manpower. However, since container placement is limited to relatively wide roads or vacant spaces, the utilisation of mini-dumpers for narrow streets/roads is recommendable.
- Average mileage per unit fuel consumption of the tractor trolley is as low as 3.2 km/litre and the travel performance as well as waste handling amounts is low. In addition, most of the tractor trolleys are aging, so that maintenance costs would increase. Tractor trolleys shall therefore be replaced with other appropriate types of vehicle such as compactors as soon as possible from the viewpoint of cost-effectiveness.
- Loading efficiency of mini-dumpers (T/S) is quite low at 311 kg/litre due to the large number of collection points and door-to-door operation. The loading efficiency must be improved by increasing to two sanitary workers and asking cooperation from the residents on the method of discharging waste from their households.
- Loading efficiency of mini-dumpers (D/S) is quite low at 158 kg/litre due to the large number of collection points and the door-to-door operation. In addition, the vehicle has limited collection capacity and goes to the landfill site directly so that loading efficiency of a mini-dumper (D/S) is lower than that of a mini-dumper (T/S). Thus, using a mini-dumper for door-to-door collection is not recommended. A 4 m^3 compactor is recommended for door-to-door collection because the vehicle has almost the same body length, almost the same fuel consumption and has 4 times the capacity of a mini-dumper.

- The performance of the combined use of mini-dumper and arm-roll truck for collection and transportation work is lower than that of the tractor trolley alone in terms of fuel consumption. Since the distance to the disposal site is less than 10 km from the centre of the city and not much time and fuel is needed, this kind of waste transfer operation shall be limited to the minimum to save on cost.

In addition to the recommendations above, the following points observed and learned during the Time and Motion Study are also recommended to improve the operation:

- The parking lot for each vehicle at the GWMC garage should be fixed to avoid delay in the start of waste collection service caused by the waiting of early comer drivers for the late comers.
- Not only repair and maintenance equipment for tire puncture, etc., should also be made available at the GWMC garage but also the drivers are obliged to conduct checking the vehicles at the start of operation to prevent causing the problems during the work.
- Waste collection points and route for routine work should be specified for each vehicle to avoid calls from drivers asking for the next collection point which causes waste of time.
- Route of mini-dumpers should be different from that of the donkey carts and handcarts to avoid the duplication of service area and thus maximise their service area.
- Adjacent container points should be allocated to each arm-roll truck to avoid extra travel distance for loading and transporting waste.
- Adopting the radio-frequency identification device (RFID) would be useful for monitoring the operation status. The system will help in checking the waste transportation efficiency.
- The UC supervisor should supervise the container points since arm-roll trucks sometimes skip their designated container points and load the container from the temporary transfer station to meet their allotted 4-5 trips per shift.

2.2 Present Status of Waste Collection and Transportation Work

2.2.1 Responsibilities of the GWMC

GWMC currently collects solid waste generated in only 64 UCs and has the following responsibilities:

(i) Waste collection and transportation
(ii) Street cleansing
(iii) Drainage and gutter cleansing along streets partially, since the streets having the width of more than two feet is managed by WASA and GWMC is responsible for the other drainages and gutters.
(iv) Dead animal collection
(v) Others

GWMC collects some construction and demolition wastes while cleaning the city roads/streets although it is not obligated to collect them. The issues on construction and demolition waste are as presented in ***Volume 2 Supporting Report, Section I, Hospital, Industrial, and Construction and Demolition Waste Management***.

(1) Primary Collection

Basically, residents throw waste into containers allotted by GWMC if there is a container near their houses, but containers are not located all over the city (see **Subsection 2.2.3**). Therefore, sanitary workers collect the garbage put in front of the door of each household. In some places, sanitary

workers collect garbage directly from the residents. The hearing survey was to clarify whether or not the sanitary workers receive some amount of money from the households for the service.

The hearing survey was also to clarify that there are few cases where some retired sanitary workers conduct primary collection and receive collection fee from households. Some waste pickers take valuables out from the garbage put outside the door of households and pass the remaining waste to the sanitary workers. Valuable wastes in the garbage from households are collected by the waste pickers or sanitary workers.

There is no waste collection service in some union councils (UCs). In these areas, residents throw their garbage into nearby open plots and on the streets. The waste left on the open plots and streets are then scattered by animals scavenging for food, and these plots become illegal dumpsites.

(2) Secondary Collection

The situation of secondary garbage collection conducted by GWMC is summarised as follows:

- Collection System: One to three $5m^3$ containers and/or $10m^3$ containers, and normally 6 to 7 handcarts are deployed in each UC. However, the number of containers is limited, so that no container is deployed in some parts of a UC.
- Frequency of Collection: Garbage collection from the containers is made every day. If the container is not full, the garbage is not collected.
- Collection Method: Collection is by arm-roll truck, tractor trolley or mini-dumper based on the infrastructure conditions such as road width, accessibility and space for placement. The current collection service is carried out by a combination of 37 tractor trolleys working together with 7-8 units of handcart deployed at each UC and 35 mini-dumpers and 26 units of arm-roll trucks for the 231 units of waste containers placed in the town area.
- Collection Equipment: Arm-roll truck, tractor trolley, mini-dumper, handcart, donkey cart and motorbike rickshaw.

The collection method varies depending mainly on the size of road. An arm-roll truck and a tractor trolley are utilised on large and medium-sized streets. In a small street, the donkey cart and handcart are utilised. Since the end of 2014, GWMC started using mini-dumpers together with donkey carts and handcarts for the collection of waste.

2.2.2 Service Area

GWMC collects garbage from the whole city of Gujranwala which consists of 64 union councils (UCs) and the service area for waste collection is demarcated by the same UCs' boundary as shown in **Figure B**.2.7. As shown in this figure, there are three categories in terms of waste collection service level covered by GWMC; namely, the served area, partially served area and unserved area which includes private housing societies, open lands, green lands, etc. **Table B.2.3** shows the area and population of each category and the ratio to total area. GWMC provides the waste collection services for 76% of the total area of 64 UCs including the partially served area while 34 UCs in the peri-urban area are not covered by GWMC collection services. Detailed analysis regarding the service area is given in ***Volume 2 Supporting Report, Section A, Section 5***.

Table B.2.3 Waste Collection Service Coverage Area and Population, and their Percentage

Service Coverage	Area (km^2)	Population*	Percentage of 64 UCs (%)		Percentage of 98 UCs (%)	
			Area	Population	Area	Population
64 UCs						
Served	22.6	747,192	34.8	36.4	6.9	25.2
Partially served	26.7	878,752	41.1	42.8	8.1	29.7
Unserved	15.7	427,721	24.1	20.8	4.8	14.4
Sub-Total	*65.0*	*2,053,665*	*100.0*	*100.0*		
34 UCs in peri-urban area Unserved	262.6	909,749	-	-	80.2	30.7
Total	327.6	2,963,414	-	-	100.0	100.0

Note: *Population is estimated as the figures as of 2014.

After GWMC's commencement of operation, the UCs were divided into 8 zones for management purposes, as shown in **Figure B.2.6**.

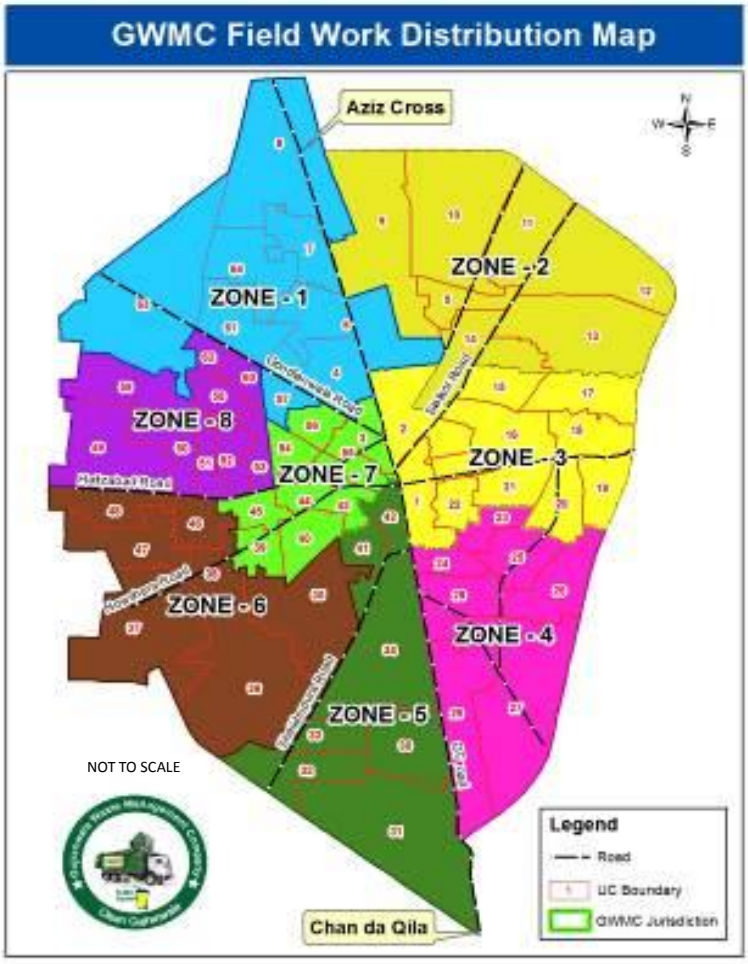

Figure B.2.6 Zoning Map of GWMC Service Area

Source: GWMC

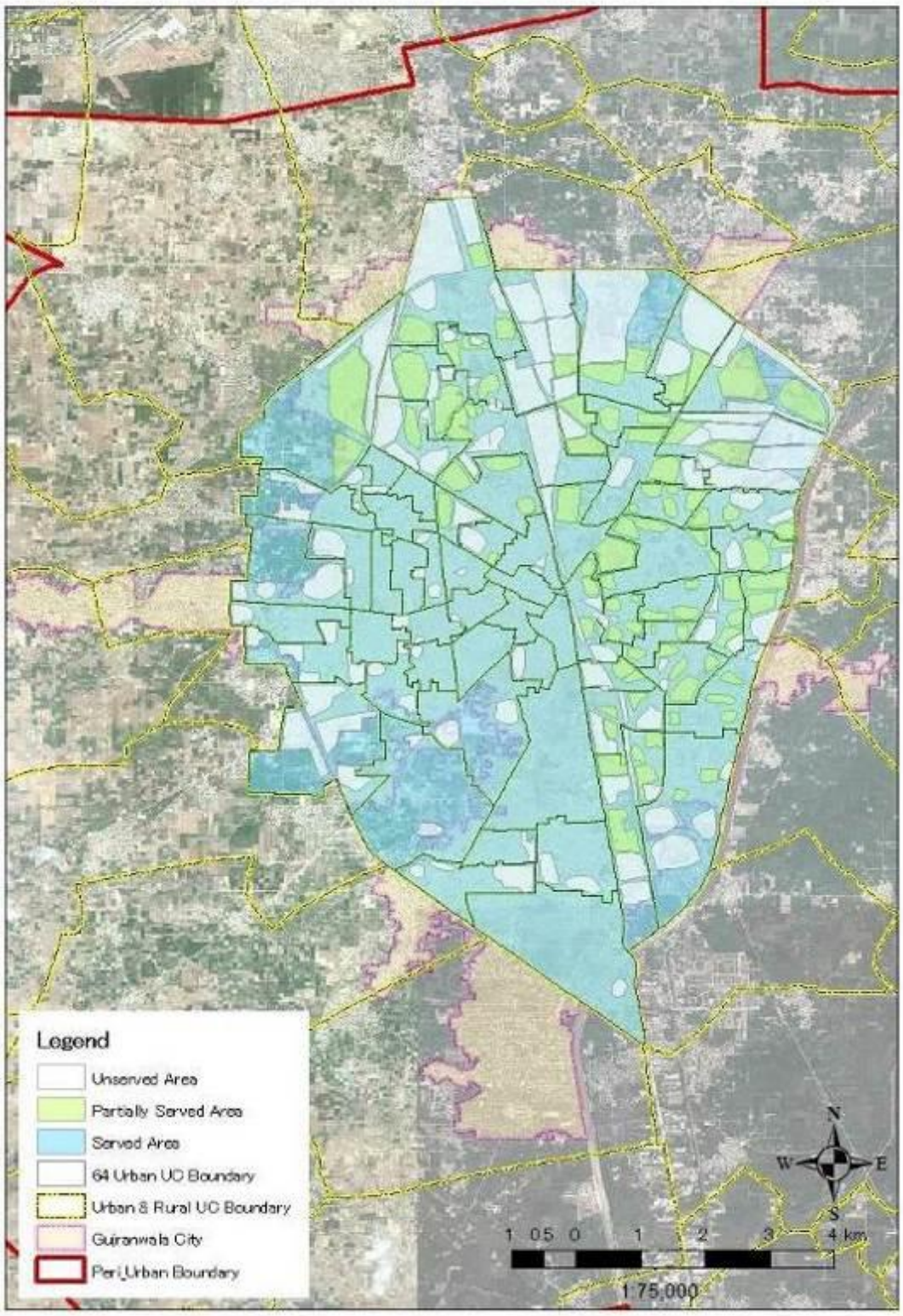

Figure B.2.7 Service Area Map of Waste Collection in Union Councils

Source: GWMC, April 2014.

2.2.3 Locations of Garbage Container

Some 216 sets of $5m^3$ containers and 15 sets of $10m^3$ garbage containers (see **Photo B.2.1**) have been allocated in Gujranwala City as of January 2015 as shown in **Table B**.2.4 and **Figure B**.2.8. Considering the size of the city, the number of containers seems inadequate. To offset the situation, handcarts and/or donkey carts are utilised for garbage collection from households to the garbage containers. In addition, 24 dust bins are located in the city.

$5m^3$ container

$10m^3$ container

Photo B.2.1 Shapes of $5m^3$ and $10m^3$ Garbage Containers

Table B.2.4 Locations of Garbage Container in Gujranwala City

Location	UC Number/Road	Number of Containers		
		$5m^3$ Containers	$10m^3$ Containers	Total
Zone 1	4, 6, 7, 8, 57, 61, 63, 64	19	2	21
Zone 2	5, 9, 10, 11, 12, 13, 14	19	0	19
Zone 3	1, 2, 15, 16, 17, 18, 19, 20, 21, 22	36	0	36
Zone 4	23, 24, 25, 26, 27, 28, 29	25	2	27
Zone 5	30, 31, 32, 33, 34, 41, 42	33	0	33
Zone 6	35, 36, 37, 38, 46, 47, 48	19	0	19
Zone 7	3, 39, 40, 43, 44, 45, 54, 55, 56	14	1	15
Zone 8	49, 50, 51, 52, 53, 58, 59, 60, 62	13	0	13
Miscellaneous	G.T. Road, Sialkot Road, Sheikhupura Road	16	5	21
Workshop		0	2	2
On Arm-rolls		22	3	25
Total		216	15	231

Source: GWMC, January 2015.

Containers are supposed to be allocated in each UC. However, the number of containers allocated is not planned by GWMC, but based on the request of individual UCs. In other words, the location of containers is determined by the infrastructure conditions and residents' consent of each UC; that is, all the streets/roads are not wide enough to lift and place the containers. Moreover, most residents are reluctant to place a container near their houses, shops or stores due to the smell, flies, etc. In some of the UCs, containers are located far from the residences which have resulted in the illegal dumping in the city.

One empty $5m^3$ container and one empty $10m^3$ container are attached to each of the 22 arm-roll trucks before the daily collection starts. The reason for this is that one of the empty containers is placed at the edge of the road to replace the container full of garbage which will be taken by the trucks to the final

landfill site. Life duration of containers is approximately 5 to 7 years. Repair work for the containers is conducted in the workshop.

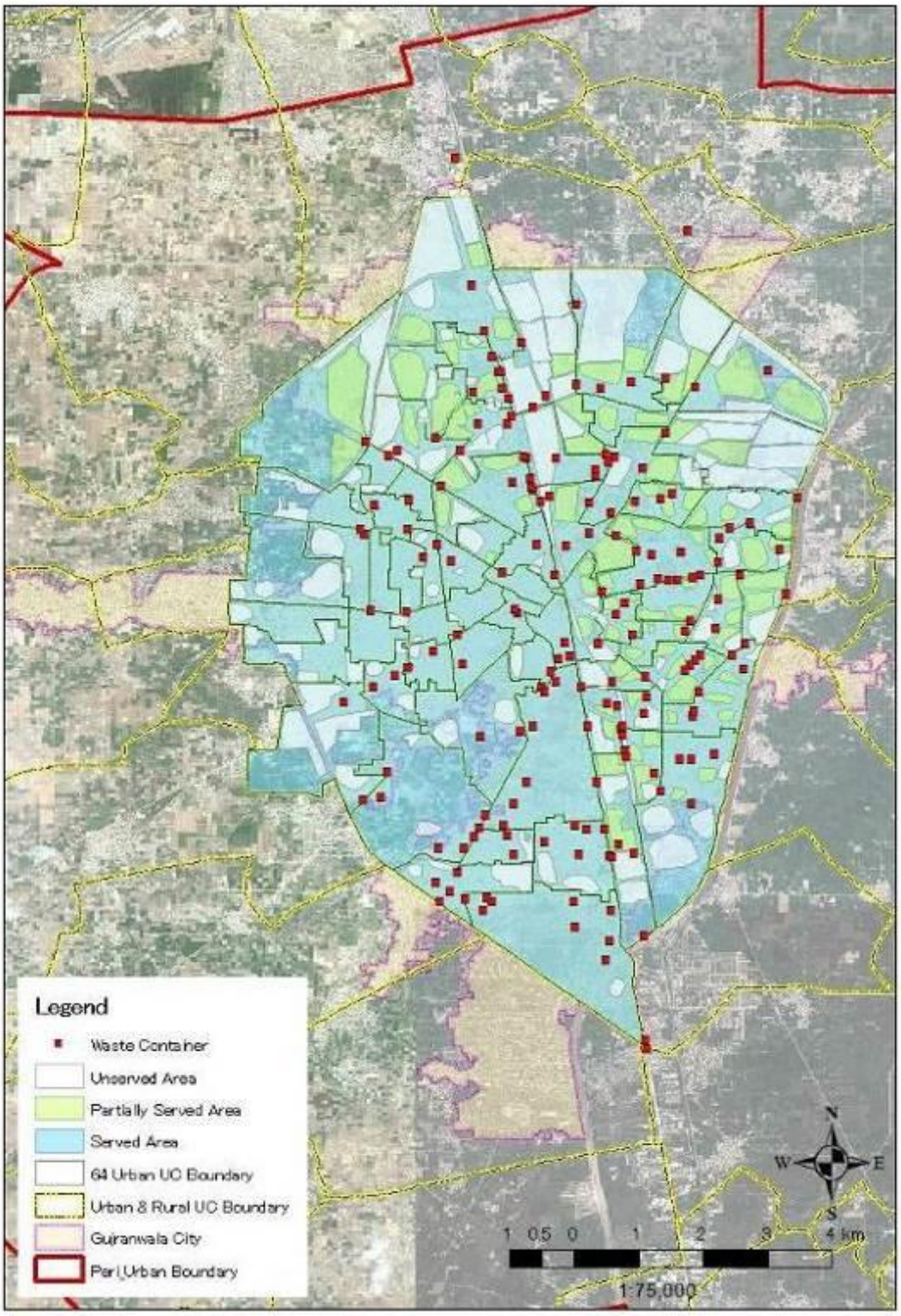

Figure B.2.8 Location Map of Garbage Containers in Gujranwala City

Source: GWMC, April 2014.

2.2.4 Transfer Station

(1) Function of Transfer Station

There are five (5) transfer stations/masonry enclosures in the city; namely, the Khiali, Garjakh, and General bus stations, DHQ Hospital and Khan Mahal. They are called transfer stations, but the containers are put on the concrete floor surrounded by masonry walls, practically, and only receive garbage from the surrounding UCs. Once a container is filled with garbage, an arm-roll truck replaces it with an empty container and hauls the container with garbage. There is no function such as transfer of garbage from another container.

(2) Location and Operation Status of each Transfer Station

Figure B.2.9 indicates the location of transfer stations in Gujranwala City.

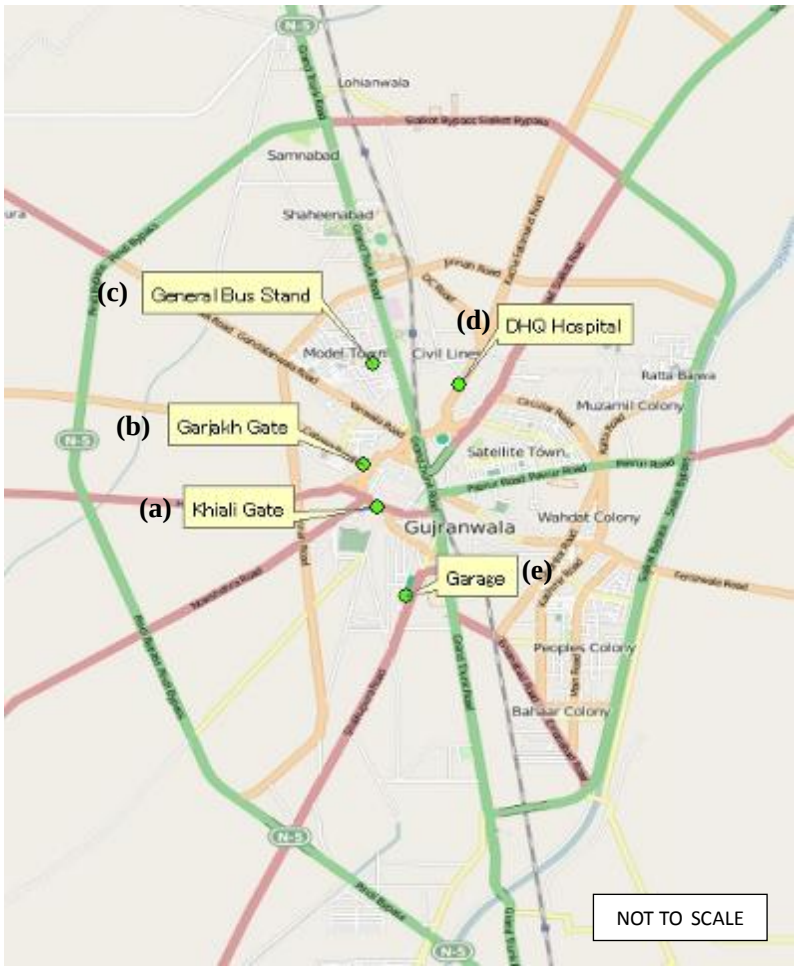

Figure B.2.9 Location of Transfer Stations in Gujranwala City

Source: GWMC, April 2014.

(a) Khiali Transfer Station

This transfer station is located in the centre of the commercial area. The operation started in 2008. Floor area is approximately 50m^2. The entrance to the transfer station is 5 metres wide which seems to be narrow for incoming vehicles. There is a working space of approximately 8 metres by 8 metres inside the station. The roof was covered with vinyl sheets when the

station started operation, but some parts are now exposed due to aging and deterioration and the transfer station is almost located outside of the original location.

Two (2) containers are set inside the transfer station. Garbage from 3 or 4 targeted UCs are carried by donkey cart or handcart and dumped into the containers. These containers are taken to the final landfill site almost everyday.

The working hour is from 6 a.m. to 3 p.m. One supervisor administers the operation of this station and no worker for sorting is assigned. Some waste pickers take out valuables from the garbage sorted outside of the station, and finally put the garbage into the containers. In view of this situation, GWMC does not deploy workers at this transfer station.

No record of collection amount is kept but the waste manager in charge assumes that approximately 12m^3 of garbage is taken into the station according to the interview survey.

As-built drawings, other types of drawings and operation record/document, etc., are not kept in the office. **Photo B.2.2** shows the current situation in Khiali Transfer Station.


Photo B.2.2 Current Situation of Waste Collection in Khiali Transfer Station

(b) Garjakh Transfer Station

This transfer station is located in the centre of the commercial area. The operation started in 2008. Floor area is approximately 50m^2. The station has no roof and the four sidewalls have collapsed so that it is completely exposed to the outside.

Two (2) containers are set in the station. Garbage from 3 targeted UCs is dumped into the containers by donkey cart or handcart. These containers are collected by arm-roll truck twice a day and are taken to the final landfill site.

The working hour is from 6 a.m. to 3 p.m. One supervisor administers the operation of this station and two workers are deployed. Waste pickers also collect valuables from the garbage in this transfer station. However, the working space is narrowing compared with the Khiali Transfer Station and workers are deployed in the station. The number of waste pickers is fewer than those in the Khiali Transfer Station.

Photo B.2.3 Situation of Waste Collection in Garjakh Transfer Station

No record of collection amount is kept, but the waste manager in charge assumes that approximately 16m^3 of garbage is taken into the station according to the interview survey.

As-built drawings, other types of drawings and operation record/document, etc., are not kept in the office. **Photo B.2.3** shows the situation of waste collection in Garjakh Transfer Station.

(c) General Bus Station (Masonry Enclosure)

This transfer station is located in the General Bus Station. The operation started in 2008. Floor area is approximately 110m^2. The entrance to the enclosure is 5 metres wide and 12 metres in the longitudinal side. The roof is covered with vinyl sheet and it seems that weather condition does not affect the work inside of the station. Compared with the other two transfer stations, i.e., Khiali and Garjakh, the working space is secured.

One (1) container is set in the station. Garbage from General Bus Station and one UC (No. 4) is dumped into the containers by donkey cart or handcart. These containers are collected by arm-roll truck once a day and are taken to the final landfill site.

The working hour is from 6 a.m. to 3 p.m. No supervisor administers the operation of this station and no worker for sorting is deployed. Some waste pickers take out valuables from the garbage sorted outside of the station, and finally put the garbage into the containers. Since GWMC does not deploy workers inside the enclosure, garbage has piled up on the floor and the sanitary condition seems to have deteriorated.

No record of collection amount is kept but according to the interview survey the waste manager in charge assumes that approximately 4m^3 of garbage is taken into the station.

As-built drawings, other types of drawings, operation records/documents, etc., are not kept in the office. **Photo B.2.4** shows the situation in General Bus Station.

Photo B.2.4 Situation of Waste Collection in General Bus Station

(d) DHQ Hospital (Masonry Enclosure)

This masonry enclosure is located along the main road to the DHQ Hospital. Operation started in 2008. Floor area is approximately 38m^2. There are two entrances to the transfer station and each is 2.5 metres in height and 6 metres in longitudinal side. The roof is covered with vinyl sheet and it seems that the weather condition does not affect the work inside of the station.

Despite the large floor area, only one container is set in the enclosure and hence the working space is secured. Municipal waste from the DHQ Hospital and road is dumped into the container by handcart. This container is collected by an arm-roll truck daily and taken to the final landfill site.

The working hour is from 6 a.m. to 3 p.m. There is no supervisor assigned to manage the operation and there is also no worker to do the sorting of garbage in the station. Some waste pickers take out valuables from the garbage sorted outside of the enclosure, and finally put the garbage into the containers. In view of this situation, GWMC does not deploy workers at this station. However, garbage has piled up on the floor and it seems that the sanitary condition is inadequate.

No record of collection amount is kept but according to the interview survey the waste manager in charge assumes that approximately 5m^3 of garbage is taken into the station. As-built drawings, other types of drawings, operation records/documents, etc., are not kept in the office.

(e) Khan Mahal (Masonry Enclosure): Closed

This facility with masonry enclosure is located southwest of the GWMC workshop. The operation was started in 2008, but closed within a couple of weeks because the residents near the station strongly rejected CDGG's utilisation of the station.

2.2.5 Current State of Collected Waste

(1) Collected Waste Amount

Collected waste is conveyed to the dumpsite by collection vehicles. No record of disposed amount was available before the establishment of GWMC. However, GWMC studied the waste collection amount data utilising the data of a private weighbridge during May to August, 2014. In addition, a new truck scale was installed in Gondlanwala and it started measuring the weight of each collection vehicle since 04 September 2014. **Figure B.2.10** shows the said waste collection amount although this amount includes the waste collected by One-Time Cleaning Activity as mentioned in **Section 2.3**.

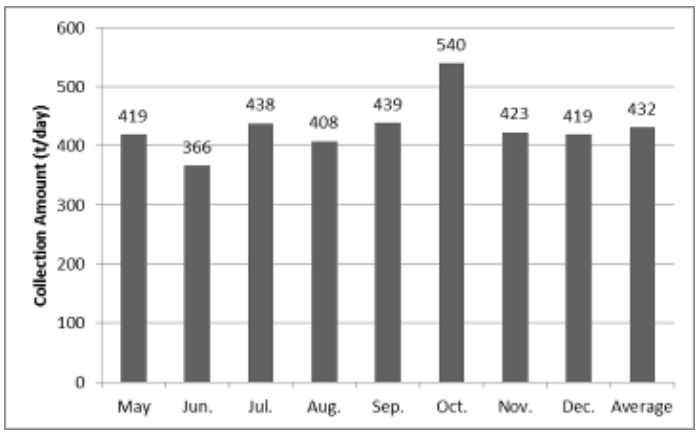

Figure B.2.10 Total Waste Collection Amount (May - December 2014)

Approximately 370 to 540 tons of waste per day is collected and transported to the landfill site. Since GWMC started two-shift collection from July 2014, the waste collection amount has increased. The waste amount in October was larger than that of the other months because people celebrated the "Eid Holiday" (*Eid ai-Fitr*, the festival of Sacrifice for Muslims), butchered and ate many goats or sheep resulting in a quite large amount of leftovers in the city. **Figure B**.2.11 and **Table B**.2.5 show the average daily tonnage per arm-roll truck or tractor trolley.

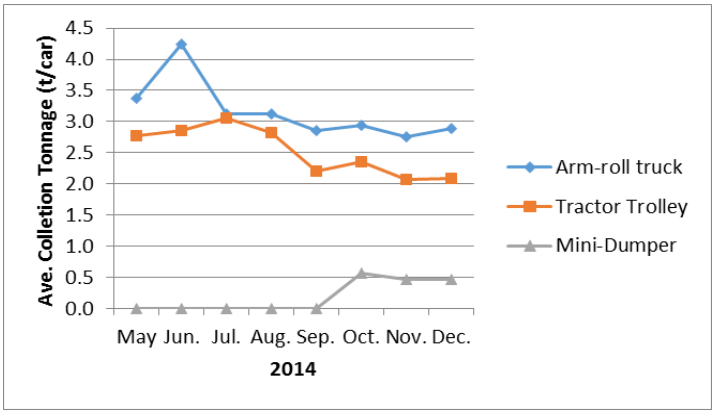

Figure B.2.11 Average Daily Collection Tonnage per Arm-roll Truck or Tractor Trolley

Table B.2.5 Average Daily Collection Tonnage per Arm-roll Truck or Tractor Trolley

(Unit: ton/car)

Item	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Arm-roll truck	3.37	4.25	3.12	3.12	2.85	2.94	2.76	2.89	3.16
Tractor Trolley	2.78	2.85	3.06	2.82	2.21	2.35	2.07	2.09	2.53
Mini-Dumper	-	-	-	-	-	0.56	0.47	0.46	0.50

According to the survey, an arm-roll truck conveys approximately 3.2 tons and a tractor trolley conveys 2.5 tons daily. A total of 35 mini-dumpers have been newly commissioned for primary collection since October 2014 and are operating mainly for narrow streets and unload their waste at a transfer station. A mini-dumper carries about 0.5 tons in a day.

The capacity of a tractor trolley is approximately 3.0m3, and it is three-fifths of the $5m^3$ container capacity, i.e., around 1.5 tons of waste. The arm-roll truck transports a $5m^3$ container with approximately 2.5 tons. In each case, it is found that both types of vehicle carry an excess amount of waste.

Table B.2.6 shows the average number of trips per arm-roll truck/tractor trolley. These values are slightly different from the results of the Time and Motion Study described in Section 2.1 due to the different survey periods and subject vehicles.

Table B.2.6 Average Number of Trips per Arm-Roll Truck/Tractor Trolley

(Unit: trip/day)

Item	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Arm-roll truck	2.9	2.8	4.3	4.1	4.2	4.9	4.7	4.5	4.1
Tractor Trolley	2.0	1.2	1.8	2.2	1.7	2.0	2.0	2.0	1.9
Mini-Dumper	-	-	-	-	-	1.8	1.7	2.4	2.0

(2) Collection Rate

There is no data regarding collection rate. According to the interview survey with waste managers, the collection seems to be sixty (60) percent in Gujranwala City in the end of December, 2014.

According to the collection record, waste amount in a container is assumed to be around 3 tons. The total waste amount that all of the containers could keep is, therefore, 603 tons since the number of containers before December 2014 was about 201; that is, 201 units × 3 tons = 603 tons. According to the interview survey with waste managers, approximately 1,000 tons of waste is generated in the city as 0.55kg/capita/day was considered. Based on the results of the interview, it is assumed that 60% (603/1,000) of waste is collected. This is relatively close to the waste managers' estimate. A more detailed discussion in terms of current collection rate is given in **Supporting Report Section A, Section 5**.

2.2.6 Collection Workers

One zone is managed by one Assistant Manager (Operations) of GWMC who has one or two chief sanitary inspectors under him. The Chief Sanitary Inspector manages some of the UCs and every UC has at least one supervisor who manages around 10 to 30 sanitary workers. The total number of sanitary workers is 1, 655. They are assigned as sanitary workers and/or street sweepers. According to GWMC, the number of sanitary workers is 675 and the number of street sweepers is 980 at present.

The average number of sanitary workers deployed per UC is 18 which is not enough to cover the whole area. In actual work, 250-300 houses and 10-15 streets are allotted to one worker per day. Accordingly,

workers skip their assigned job in some parts of the allotted area every day because the area is too wide to cover by only one worker in a day.

Workers are not provided with safety gadgets like masks, safety shoes and gloves. Workers sweep streets and collect waste from 6:00 a.m. to 2:00 p.m. in dusty areas where there is a high potential of getting asthma. Waste is not segregated at waste generation sources, so that there is also the risk of handling sharp materials like needles or any dangerous material which may cause injury to the workers.

2.2.7 Collection Vehicles

(1) Summary of Collection Vehicles

Table B.2.7 shows the list of vehicles owned by GWMC as of January 2015. Currently, 119 vehicles are utilised for waste collection and transportation, and street cleansing operation. The oldest vehicle was procured in the year 1968 and the latest one was procured in the year 2014. Mini-dumpers were introduced by GWMC in the end of 2014. Most of the-arm roll trucks were procured in 2009 and the tractor trolleys were procured in 1996 by the City District Government Gujranwala (CDGG) and then all of the vehicles were transferred to GWMC in 2014 based on the Services and Assets Management Agreement (SAAMA).

Based on the Time and Motion Study (see **Section 2.1**), the efficiency of tractor trolley is lower than that of the other main collection and transportation vehicles, i.e., arm-roll trucks and mini-dumpers. Only two (2) tractor trolleys were procured after the year 2007 and the rest were before 2000. The rate of operation of those superannuated tractor trolleys is thus low due to frequent maintenance and repair. Additionally, the truck bed of a tractor trolley is high for the workers to load waste from the ground so that the loading time is longer. High fuel consumption and low travelling performance are the disadvantages of a tractor trolley so that it is inappropriate to use them for the waste collection service. Moreover, if age deterioration of the vehicle is considered, GWMC also requires preparation of additional maintenance cost for the vehicles as well.

Table B.2.7 List of Vehicles in GWMC

Type of Vehicle	Number of Vehicle	Procurement Year
Arm-roll truck ($5m^3$)	22 (22)	2007 - 2011
Arm-roll truck ($10m^3$)	4 (4)	2001 - 2002
Tractor trolley	37 (36)	1977 - 2007
Mini-dumper	35	2014
Mechanical sweeper	4 (4)	2011
Tractor with bucket, 4×4	3(3)	2008
Tractor with bucket, 2×2	4 (4)	1998, 2000
Tractor with blade	4 (4)	1988
Rikshaw	2 (2)	-
Water sprinkler	2 (2)	2009
Spray machine	1 (1)	2014
Water bowser	1 (1)	1968
Total	119 (83)	-

Source: GWMC, January 2015.

(2) Workshop/Garage

The workshop and the garage are located in Sheikhubura Road, which is 5 km away from the city centre. The workshop has an area of 6,000 m^2 and is unpaved. The workshop/garage is also annexed to the administration building. Two engineers, two truck technicians, three tractor technicians, one

electrician, four welders, seven helpers, one washman, one assistant washman, three security guards, one painter and one office boy have been assigned as of June 2015.

Operation condition of waste collection vehicles are monitored at the administration building. These conditions are recorded on a logbook and driving operation is thus administered according to the logbook. However, the driving route for each vehicle is not at all recorded on the book. Thus, waste collection and transportation are also administered according to the logbook.

There are docks for car repair/check-up in the garage/workshop. General check-up such as changing tires could be conducted in the workshop/garage, but vehicle malfunctions which could not be dealt with in the workshop are repaired by outsourcing.

There is no carwash facility in the workshop and waste collection vehicles are washed at private carwash facilities. The expense for carwash is paid by the driver and reimbursed once in every two weeks.

Used tires, broken containers and broken vehicles are stored in the workshop/garage. These items are planned to be sold by auction after repair. **Photo B.2.5** shows the current situation of the workshop.


Photo B.2.5 Current Situation of Vehicle Workshop

(3) Vehicle Condition

More than 110 vehicles are operated for waste collection and transportation in a day. Since GWMC requests the car dealers to undertake regular check-up and maintenance of the vehicles, the condition of vehicles is relatively maintained.

According to the interview survey, the major cause of vehicle malfunction is flat tire by broken ceramics abundantly scattered on the streets. The number of malfunction by flat tire is more than the number of mechanical malfunction of vehicles.

(4) Spare Parts for Vehicles

Spare parts for car maintenance are procured through car dealers/private workshops in Gujranwala. Spare parts not available in Gujranwala are procured in Lahore. Therefore, no issue is found with the procurement of spare parts in particular.

Most of the collection vehicles were manufactured around the year 2000. Although it is impossible to procure genuine spare parts for these vehicles, generic spare parts or other alternatives such as other manufacturer's spare parts are utilised for the maintenance or repair of these vehicles.

(5) O&M Expense for Vehicles

Table B.2.8 shows the operation and maintenance (O&M) expenses paid by CDGG from 2006 to 2013.

Table B.2.8 O&M Expense from 2006 to 2013

Item	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
O&M Expense (Rs.)	6,651,535	3,069,816	2,829,089	-	4,476,970	5,815,355	10,751,845

Source: CDGG

Note: There is no data available on 2009-2010.

There is no data before year 2006, but the expenditure for O&M has been increasing in the past three (3) years. Most of vehciles were repaired in 2006 and the repaired vehicles did not cause big problem during operation. Therefore, it might help to reduce the repair cost and the O&M expenditure was almost half figure of 2006 in three years starting from 2007 to 2009. Since most of the vehicles were made in the year 2000 and utilised for almost 10 years, these vehicles should have been renewed in the term of 2012-2013. In addition, vehicles procured in 2009 are also broke down in this duration. This is the reason the O&M expense of 2012-2013 was therefore getting higher than that of 2011-2012 and the O&M expense is doubled in a year.

2.2.8 NGO

There was one NGO, OPE (Organisation Pan Environment), that worked in UC No. 8 (Shaheenabad) during 2008 to 2010. The organisation used to conduct primary collection; however, some issues such as shortage of funds and not having cooperation by the residents occurred and the activity was terminated after two years.

2.2.9 Waste Collection and Transportation Scheme Conducted by GWMC

Based on the results of the site reconnaissance and field surveys mentioned above, the waste collection and transportation scheme conducted by GWMC from generation sources to the final disposal site is illustrated in **Figure B.2.12**. The amount of waste for each flow was identified in consideration of the results of incoming waste survey, waste pickers survey and other related surveys and data collection as presented in ***Volume 2 Supporting Report, Section A, Section 5***.

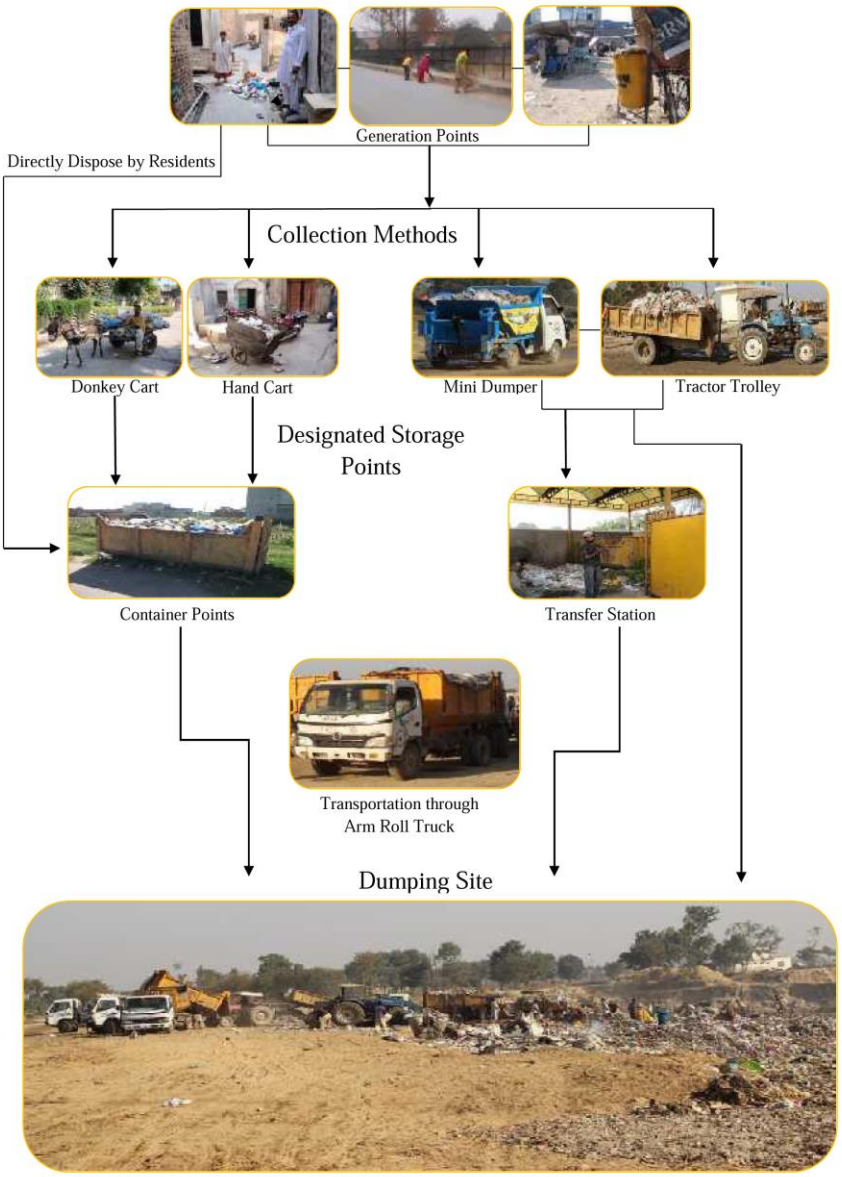

Figure B.2.12 Waste Collection and Transportation Scheme Conducted by GWMC

2.3 One Time Cleaning Activity

2.3.1 General

GWMC has been conducting collection of accumulated waste throughout the city temporarily since June 2014. The wastes piled up in vacant lots and along the roads have been dumped illegally. During the early stage, the activity was implemented once a month, but it is currently conducted almost daily.

2.3.2 Waste Amount Collected by the Activity

The waste amount collected by this one-time cleaning activity after the installation of truck scale at Gondlanwala is recorded and summarised in **Table B.2.9**. Around 60 tons of waste were collected by the activity in a day in the latest five months. Roughly 7% of waste generation is being collected under the activity.

Table B.2.9 Waste Amount Collected by the One Time Cleaning Activity

Month	Sep. 2014	Oct. 2014	Nov. 2014	Dec. 2014	Jan. 2015	Average
Waste Amount per Day (ton/day)	77	77	52	52	43	60

2.3.3 Vehicle Fleet Allocation

The One-Time Cleaning Activity is conducted daily by two sets of one tractor trolley, one tractor with bucket and one tractor with blade. After the activity, the fleet goes to join the ordinary waste collection and transportation operation.

2.4 Illegal Dumping

2.4.1 Causes of Illegal Dumping

There are almost 800 illegal dumpsites in Gujranwala City and these sites are mainly vacant plots. According to the interview with UU and GWMC, the causes of illegal dumping are: (1) the insufficient number of containers; and (2) the long distance from a resident's household to the container location, which temps a resident to dispose his garbage on an empty plot, road or gutter near his house although a container is located in the UC. Illegally dumped garbage on vacant lots or streets in the UC has thus piled up because they are not collected by the GWMC. Garbage is brought to these sites regularly and the number of illegal dumpsites had increased.

The residents do not feel that throwing garbage on a vacant lot is a bad practice, in particular. This shows the lack of sanitation consciousness which is one of the causes of illegal dumping of waste. Some parts of the illegal dumpsites used to be swamps, and some landlords filled them with garbage and made flat.

At some locations, garbage is scattered around the containers and the situation is similar to the illegal dumpsites. This means that the residents near a container do not dispose their garbage into the container or they do not mind even if the tossed garbage drops outside of the container.

The organisation and budget for solid waste collection are also limited. Therefore, the current situation of data management, facility operation and the organisation has not improved.

Figure B.2.13 shows the relationship between the containers and the illegal dumpsites. The red squares on the map show the location of containers in the 200 metre or 500 metre circles set on the map. These circles mean that residents in these circles are considered to be able to access the container within five minutes to ten minutes. Basically, illegal dumpsites are seen outside of the circles, which mean that these illegal dumpsites are located in areas where collection service is poor. Moreover, there are some illegal dumpsites even inside the 500-metre circles. This reveals that public awareness on solid waste is relatively low among the residents.

GWMC conducts the clean-up campaign once in a month as countermeasure for illegal dumpsites as presented in the previous **Section 2.3**. In the campaign, waste on an illegal dumpsite is removed by a wheel-loader, dumped into a container and taken to the final landfill site. A large number of illegal dumpsites exist and the scale of each site varies. No sweeping measure against illegal dumping has been planned by GWMC and hence illegal dumping is still done by the residents.

2.4.2 Location of Illegal Dumping Sites

Table B.2.10 shows the list of illegal dumpsites in the towns as of April 2014 while **Figure B**.2.14 (page B-29) shows their location. **Photo B.2.6** shows the current situation of illegal dumpsites.

As mentioned in the preceding **Section 2.3**, GWMC conducts a clean-up drive against illegal dumpsites regularly. However, several dumpsites still exist in the city. It is difficult to clean up all dumpsites in a short period of time. In addition, a cleaned-up site becomes a dumpsite again even after GWMC has conducted the clean-up activity.

Table B.2.10 Number of Illegal Dumpsites in the Towns

Town	Number of Illegal Dumping Site
Aroop	292
Qila Didar Singh	67
Nandi Pur	111
Khiali	329
Total	799

Source: GWMC, April 2014.

Photo B.2.6 View of Illegal Dump Sites in Gujranwala City

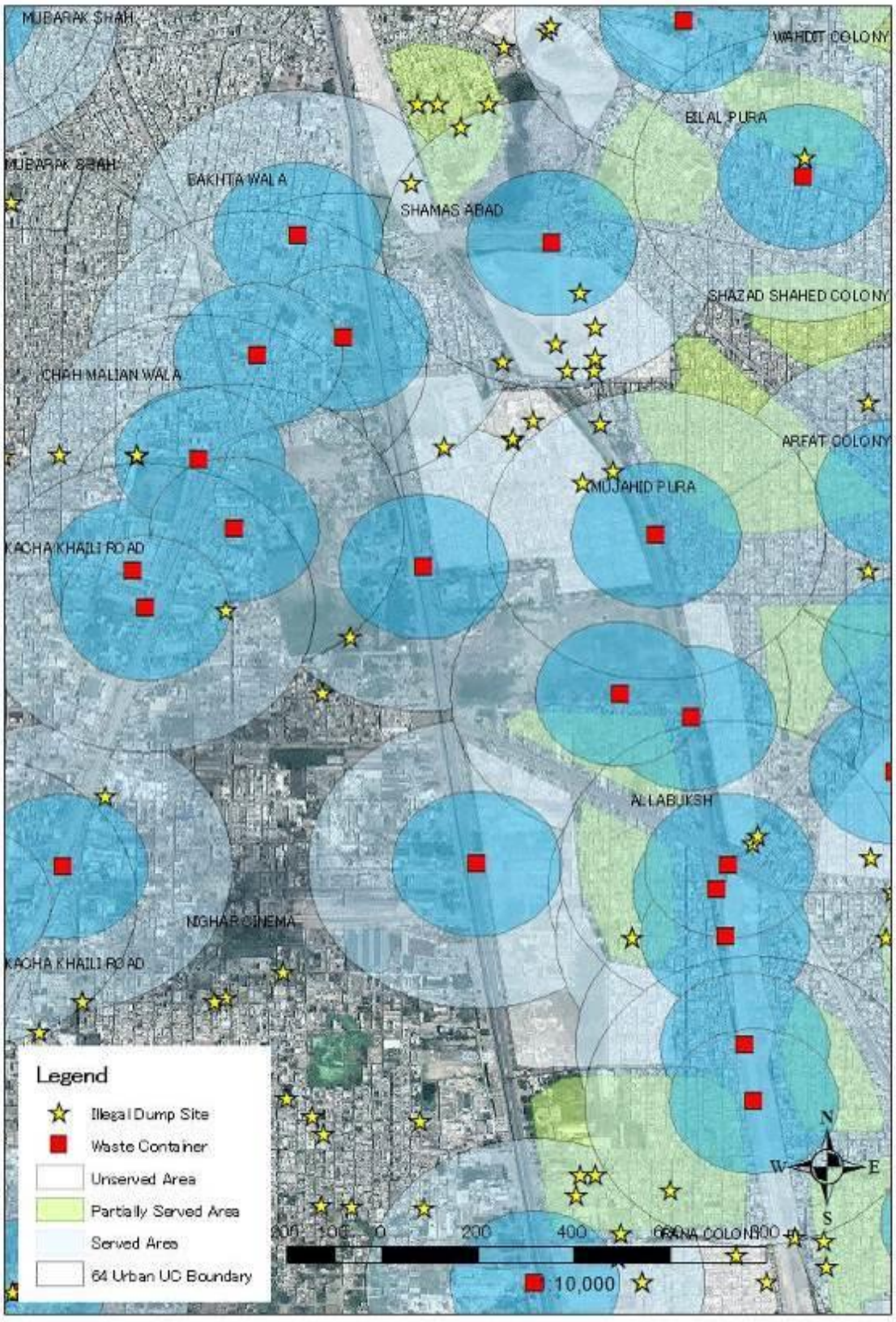

Figure B.2.13 Relationship between Containers and Illegal Dump Sites

Source: GWMC, April 2014.

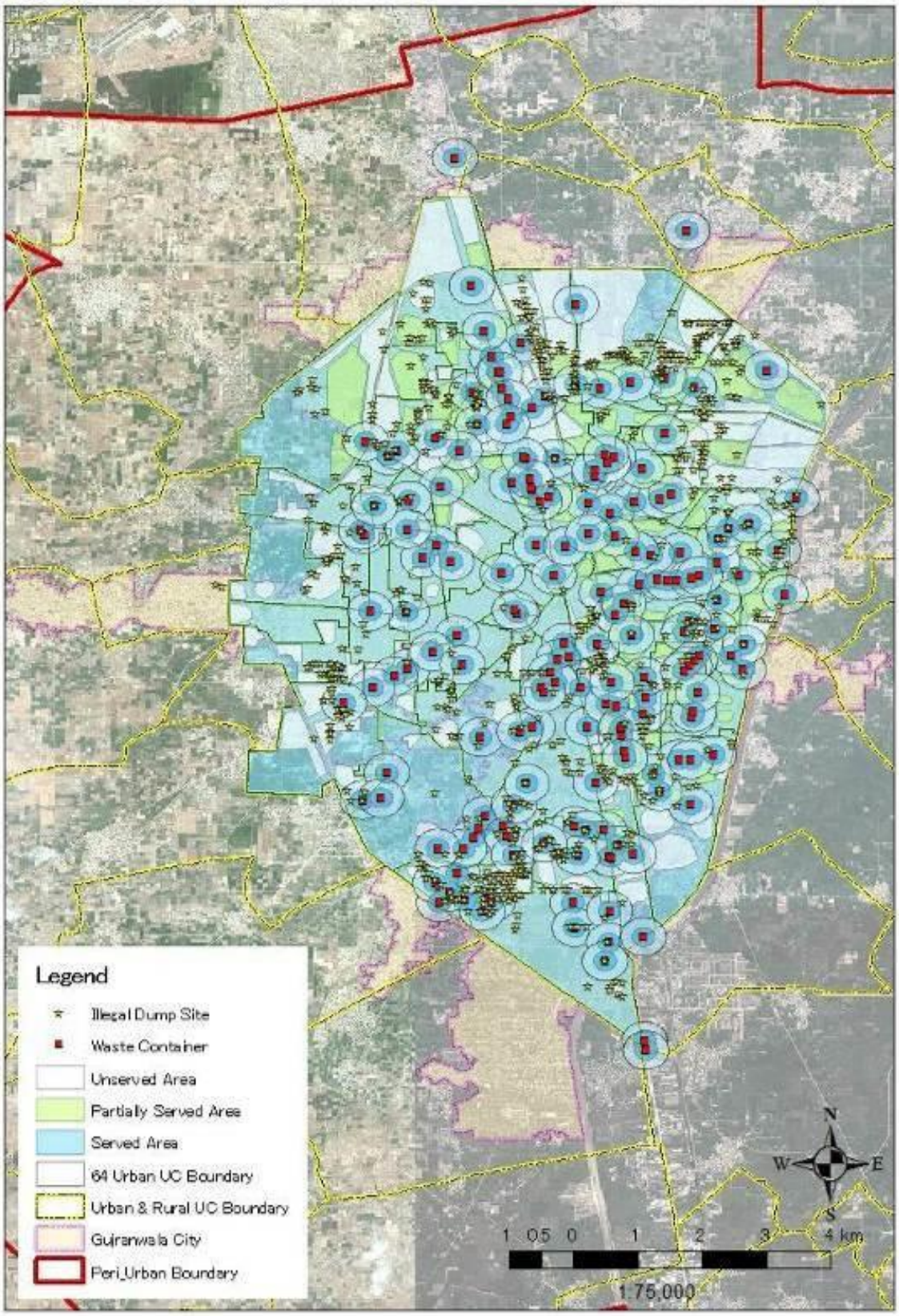

Figure B.2.14 Location Map of Illegal Dump Sites

Source: GWMC, April 2014.

2.5 Installation of Truck Scale

2.5.1 Purpose of Weighbridge Installation

A record of collected waste amount is important information for conducting solid waste management. However, no record of collected waste amount is kept by GWMC. A weighbridge procured in this project has started operation since 4 September 2014. A new truck scale is also utilised for conducting the survey on incoming waste amounts.

2.5.2 Specification of the Weighbridge

Table B.2.11 shows the specification of the procured weighbridge while **Figure B.2.15** shows its general plan.

A weighbridge with forty (40) tons of measurement capacity has been procured in this project. The measurement capacity of 20 tons or 30 tons satisfies the requirements for the existing arm-trucks or truck trolleys with collected waste on their assigned quota. Although GWMC plans to adopt $12m^3$ or $19m^3$ sized compactors in future, the gross vehicle weight for each car is more or less 18 tons or 26 tons and it can be measured within the loading limit of this weighbridge.

The gross weight of each vehicle is measured by the weighbridge. The tare weight of each vehicle is measured beforehand and registered in the weighbridge computer program. Incoming waste amount of each vehicle is measured automatically by subtracting the tare weight of the encoded vehicle from the gross weight of the incoming vehicle. This type of computerised weighbridge measuring method has become common in Pakistan. It is easy for GWMC to maintain the weighbridge in case of malfunction. Thus, the weighbridge is suited for the project.

GWMC does not accept the waste carrying into the landfill site by private companies. If the private companies come to dispose the waste in the landfill site, GWMC refuses to accept/dispose the waste in the site.

Table B.2.11 Specifications of the Procured Weighbridge

1. PLATFORM STRUCTURE		
Construction	:	Steel construction, Specially designed V Beam
Platform Side Rail System	:	Cylindrical form steel
Platform Size	:	12 m × 3 m
Capacity	:	40 tons maximum
2. TRUCK SCALE INDICATOR:		
Display	:	6 Digit 20 mm LED display
Warning Symbols	:	Zero, tare, standstill, net, pcs, kg, weighing area
Keyboard	:	Membrane type, 8 function touch-key for zeroing and calibration
Storage Capacity	:	100000 vehicle ID's in Computer Software
Dimensions & Material LL 2	:	21×15×16 cm aluminium cast boxing
3. LOAD CELLS		
Load Cells	:	Model CT 036 Analogue Load Cells, Stainless Steel
Nominal Capacity	:	30 tons each
Number of Load Cells	:	6
Material	:	Stainless Steel

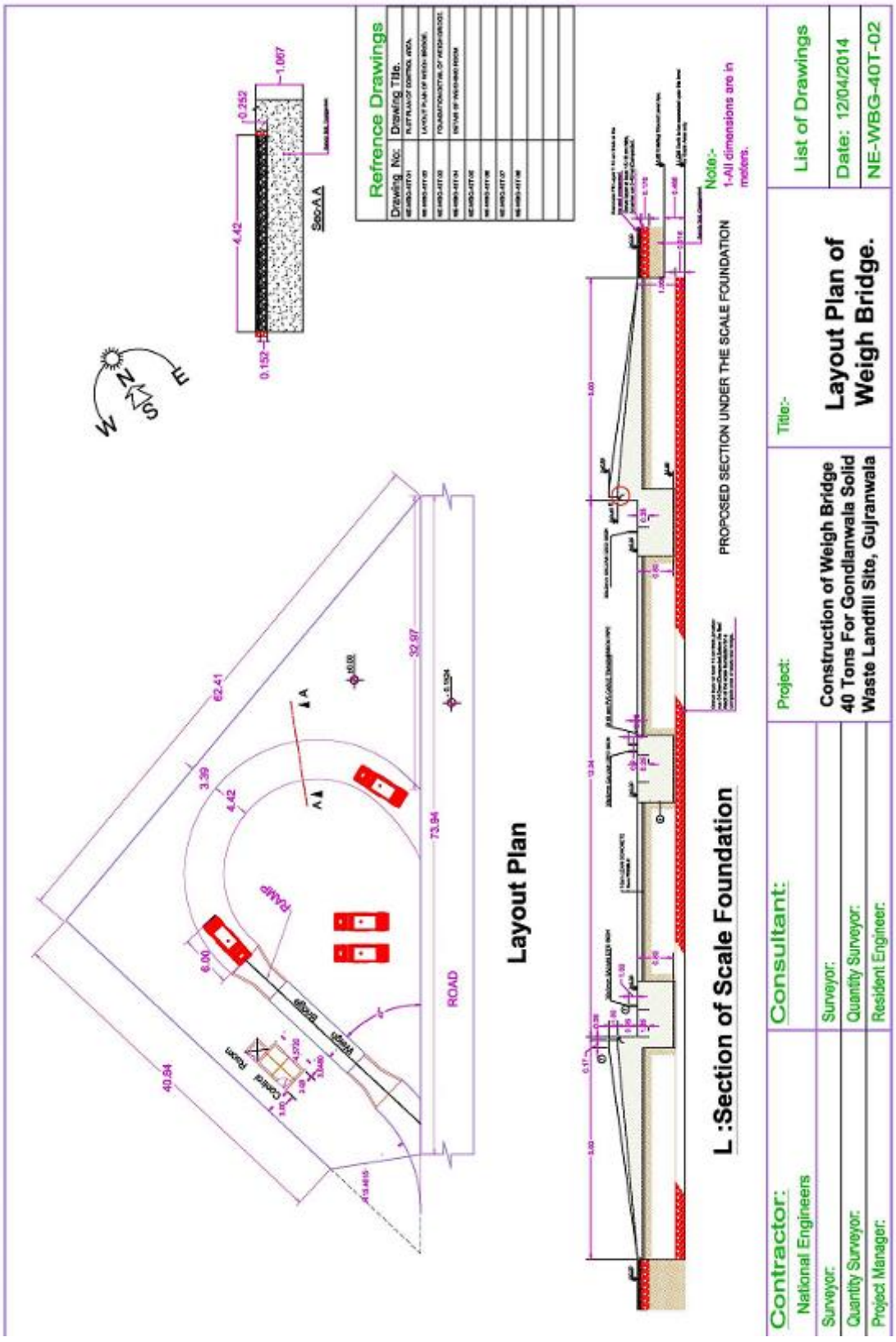

Figure B.2.15 General Plan of Procured Weighbridge at Gondlanwala Solid Waste Landfill Site, Gujranwala

2.5.3 Location of Weighbridge

The weighbridge is installed at the northern side of the temporary Gondlanwala final landfill site. After installation of the weighbridge, all GWMC collection vehicles were registered on the data collection system in a computer that connects to the weighbridge. Waste amounts brought to the final landfill site by each vehicle are recorded in the computer.

However, this weighbridge is planned to be relocated at minimal cost, say less than a million rupees or so when the new landfill site is opened. **Photo B.2.7** shows the installed weighbridge.

Photo B.2.7 Installed Weighbridge at Gondlanwala

2.6 Evaluation of Waste Collection and Transportation Condition

The problems and issues in relation to waste collection and transportation activities under the current situation are summarised in **Table B.2.12**. These items will be the basic elements to develop the plans, programmes and projects to comprise the waste collection and transportation plan in the Integrated Solid Waste Master Plan for Gujranwala.

Table B.2.12 Identification of Problems and Issues on Waste Collection and Transportation

Problem	Description of Problem	Issues for Solving the Problems
1. Not fully covered waste collection service for 64 urban UCs	Uncollected area and partially collected area exist in the current collection area, and 100% of the area or the entire area of 64 urban UCs has not always been collected. Therefore, as a result, waste is scattered in the streets and open spaces in the uncollected and partially collected areas in the town area.	The method of waste discharge and temporary storage, type of collection vehicles, collection frequency, etc., shall be reviewed for improvement of the primary and secondary collection services that should cover the entire city area.
2. No waste collection service in rural 34 UCs	Waste collection work is being carried out only within the area of 64 urban UCs resulting in the scattering of waste in the 34 rural UCs. GWMC will be responsible for the waste collection and transportation services in these extended areas in the future.	Waste collection service areas in the developed and urbanised areas of 34 peripheral UCs should be expanded to prevent the scattering of waste, and clean-up operation in the affected areas should be carried out continuously.
3. Insufficient number of waste containers and arm-roll trucks	The number of collection vehicles and waste containers is insufficient for the collection of all wastes generated in the city causing obstacles to traffic, overflowing of waste from the waste containers and increase of illegal dumpsites in the town area. Such a situation has become a nuisance to daily life of the neighbouring residents.	Formulation and implementation of overall waste collection and transportation plan is required for future upgrading of the service. In particular, appropriate types of waste collection vehicle should be carefully considered to fit the site conditions, such as road width, accessibility, space for container placement and so on.
4. Inadequate management of waste containers	Discharged waste by the residents overflows around the containers. In addition, some residents do not dispose their waste directly into the containers. As a result, waste is scattered around the containers causing odour and deteriorating the environment.	Implementation of the education program is required to raise awareness of the waste generators on the proper discharge of waste into the waste containers. In addition, the collection work should be regulated to require collection workers and/or street sweepers to clean the area immediately around the containers.

Problem	Description of Problem	Issues for Solving the Problems
5. Low efficiency by using a tractor trolley	Most of the tractor trolleys are old; consequently, fuel consumption is high and travel performance is low. Besides, the number of workers is insufficient for the waste loading work onto the tractor trolleys. Therefore, the low waste collection efficiency of tractor trolley has resulted in the difficulty to execute regular waste collection services in the designated service areas.	In accordance with the procurement plan for new vehicles, tractor trolleys should not be used and should be replaced by arm-roll trucks and mini-dumpers. The retired trucks should be used for the other collection areas that will be expanded or created outside of the 64 UCs.
6. Small haulage amount and cause of nuisance by mini-dumper	The work efficiency is low because the mini-dumpers could transport only small amounts of waste to the distant landfill site and return again for the next collection service. In addition, wastes collected by mini-dumpers are unloaded at an open space beside the waste containers to be transported by arm-roll trucks, causing nuisance to the neighbouring residents.	GWMC is planning to deploy the mini-dumpers only for waste collection in surrounding areas with about 5-7 trips per shift and transfer the collected waste to large loading capacity trucks for transportation to the landfill site. For this purpose, two waste transfer stations for mini-dumpers that are located in the north-east side and the south-west side of the city respectively have been planned, and one of them has already started operations.
7. High risk of disease infection for sanitary workers	Sanitary workers are not provided with any protective gear such as masks, safety shoes and gloves in their operation. The sanitary workers pick up wastes and put them into their handcarts by hand. There is high risk of handling hazardous materials and infectious wastes directly.	It is essentially required to provide protective gears for all sanitary workers. It is also important to train them to handle the waste properly and to take a medical check on a regular basis.
8. A large number of illegal dumpsites	Many dumpsites exist illegally in the town area causing environmental degradation in the surrounding areas. These illegal sites are located in areas adjacent to residential houses and have become a nuisance to the residents. In view of the situation, GWMC has started the programme of One-Time Cleaning Activity since June 2014.	The One-Time Cleaning Activity by GWMC and/or outsourcing should be accelerated to remove the cause of nuisance to residents, including execution of measures that shall not allow the sites to be used again as waste dumping site. Preparation of urgent project programmes for the clean-up operation and execution of well-planned work is indispensable.

3. PLANNING DIRECTIONS OF WASTE COLLECTION AND TRANSPORTATION PLAN

3.1 Objective

The overall objective of the Waste Collection and Transportation Plan is to improve the existing collection service activities and expand the coverage area in Gujranwala City in order to maintain public sanitation and cleanliness of the city.

3.2 Planning Policy

The planning policy is as follows:

- The development plan of the waste collection and transportation shall cover 64 UCs to achieve 100% collection by the year 2018, and the planning area shall start expanding to 34 UCs in the year 2019 and reach the 100% collection coverage by the year 2030.
- Targeted waste in the master plan shall be municipal waste.
- Construction and demolition (C&D) waste shall be handled in a different operation from the ordinary waste collection and transportation work.
- Separate collection system shall be adopted in the master plan.

3.3 Planning Strategy

The planning strategy is as follows:

- Type of municipal solid waste shall be defined for the objective waste for waste collection and transportation plan.
- Technical alternatives of waste collection and transportation system shall be studied by evaluating the most efficient result in terms of waste collection and transportation from generation source to final disposal site, as well as evaluation from the viewpoint of less impact to society and the environment.
- Separate collection system shall be established under the conditions with involvement of all the waste generators in the future.
- Implementation of waste collection and transportation is carried out based on the phased procurement of a sufficient number of waste containers and waste collection vehicles. The procurement plan for waste collection vehicles and containers on waste collection and transportation plan shall be determined as the most optimum system of collection and transportation.
- Urgent clean-up work shall be promoted for illegal dumping sites in the city.
- Street cleaning work shall be conducted.
- Collection of bulky waste shall be conducted.
- Construction of necessary parking areas shall be conducted.

4. FORMULATION OF WASTE COLLECTION AND TRANSPORTATION PLAN

4.1 Development of Alternatives for Waste Collection and Transportation Plan

4.1.1 Planning Concept for Development of Alternatives

For selecting the optimum waste collection and transportation plan, possible options shall be developed depending upon what kind of waste is dealt with, what kind of vehicle and equipment are used, what method of waste transfer can be applied and so forth. The following concept is adopted to define the possible alternatives:

(1) Introduction of Source Separation

Waste generated from households or commercial entities can be separated when it is discharged for collection, and this is one of important options in the master plan to determine which collection and transportation method is adopted appropriately at the site. Additionally, since waste recovery such as composting or RDF facility is applied in the city, wastes separated from other disposed wastes such as organic waste is necessary for operation of the plant. The waste collected after source separation may have the potential for conversion into environmentally friendly resources.

Source separation is also beneficial for the residents who segregate valuables and sell them to waste pickers or junk shops in the city at present. If source separation techniques are disseminated to the residents, they will have the opportunity to earn money from wastes they usually dispose as garbage.

Currently, GWMC collects mixed waste and transfers them to the landfill site. The condition of waste has deteriorated causing undesirable odour, because the collection vehicles collect and transfer the containers only when they become full of waste. It is difficult to separate organic waste from the other wastes. In addition, there is no custom such as source separation in households at present, so that potential recyclable materials are also disposed.

There is concern that it will take time to disseminate such a new system of waste separation at source to the residents. However, it is assumed that the issue can be solved by conducting public awareness and educational campaigns, monitoring of the disposal method around the containers or introducing a different type of the container on site. In this sense, public awareness and educational campaigns to support this effort should be started in the early stage of project to build understanding about the importance of proper solid waste management among the residents.

Since one of the ultimate purposes in integrated solid waste management (ISWM) is the recycling of waste, source separation matches with the goal of the ISWM plan. Therefore, source separation activities shall start from the Mid-Term, i.e., 2019 in the master plan.

(2) Waste Collection Method by Street Condition

The road configuration in Gujranwala City is complicated and it is difficult to classify them into categories. Generally, however, the street condition in the city tends to be different according to the income level of residents; namely, high income group, middle income group and low income group. Street width in the middle income group and low income group is narrow, and there is no room for two-way traffic. On the other hand, street width in the high income group is wider than those of the middle income and low income group areas.

Since the width of the street affects the waste collection and transportation method during the operation, the waste collection and transportation options in this study takes into account the following two street conditions: narrow and wide streets. For planning purposes, however, it is

difficult to distinguish the type of the street with accuracy. Therefore, the optimum street classification is considered in the latter part of this report.

(a) Narrow Street

The street with a width of less than four (4) metres is defined as a narrow street from the viewpoint of workability of collection vehicles. In general, an arm-roll truck and a large compactor cannot approach the road in this case.

For instance, the width of an arm-roll truck is 2.5 metres and a street gutter on one side is 0.5 metre. Based on the situation of a narrow street, a sanitary worker has to conduct waste collection in the space of only 0.25 metre width of street, which will reduce the working efficiency significantly. Large vehicles are, therefore, not usable in a narrow street.

(b) Wide Street

The street with a width of more than four (4) metres is considered as a wide street. Any type of waste collection vehicle is able to access this street.

(3) Consideration of Waste Discharge Method

The waste discharge method is also considered since the method of discharging the waste is closely related to the method of collection and haulage. In consideration of the site condition, three (3) methods are discussed in this study: door-to-door, curb-side (stationary) and waste container. The conditions in each case are described as follows:

(a) Door-to-Door

The residents pass the waste to a sanitary worker during the collection. This waste discharge method is applicable for a narrow street and it is currently applied in the middle and low income group areas of the city.

(b) Curbside (Stationary)

The residents are obliged to put the waste in a designated discharge point and the sanitary worker collects the disposed waste on site. This waste discharge method is applicable for a wide street and it is currently applied in the high income group areas in the city.

(c) Waste Container

The residents need to dump the waste into the container in a designated location. This waste discharge method is applicable for a wide street and GWMC mainly uses this method.

4.1.2 Possible Options for Waste Collection and Transportation

Based on the above preconditions, the possible options for waste collection and transportation can be evolved in accordance with the actual operation procedures. Specifically, there are two (2) options of a primary collection method on a narrow street and other two (2) options exist for a secondary collection on a wide street.

Since only the primary collection options can be adopted for waste collection in a narrow street while the waste collection in a wide street does not require the primary collection, the following two (2) are exclusively considered:

- Primary collection method in a narrow street; and
- Secondary collection method in a wide street.

(1) Primary Collection Method in a Narrow Street

Two options; namely, (i) mini-dumper and (ii) mini-compactor are set as the primary collection methods in a narrow street in this case. GWMC utilises mini-dumpers for waste collection in low income group areas in the city although it does not apply mini-compactors for waste collection.

The carrying capacity of the mini-dumper and the mini-compactor is quite small at 500kg of waste per one trip for one mini-dumper and 2.0 tons of waste per one trip for one mini-compactor. Therefore, both cases necessitate a transfer station to make up for the small haulage amount per one trip by increasing the number of trips. Waste collected by a mini-dumper is, therefore, transported to the landfill site via the transfer station and this is one of the waste transportation system contemplated in the study.

The waste collection using mini-dumpers has some alternatives depending on the combination with auxiliary equipment; namely, (i) mini-dumper + arm-roll truck; (ii) mini-dumper + compaction unit + arm-roll truck; (iii) mini-dumper + compactor; and (iv) mini-dumper + compaction container + arm-roll truck. Handcarts are checked off in this study. Since the handcart is a subsidiary tool for waste collection, the function of handcarts will be decreased if a mini-dumper or a mini-compactor starts operating for waste collection. In summary, the following five (5) alternatives are to be considered for the comparison:

(a) Mini-Dumper + Arm-Roll Truck

Mini-dumpers dump collected waste into a 10 cubic metres container in the transfer station. Once the container is filled with waste, a $10m^3$ arm-roll truck hauls the waste to the landfill site.

(b) Mini-Dumper + Compaction Unit + Arm-Roll Truck

Mini-dumpers dump collected waste into a $10m^3$ container in the transfer station. After the compaction unit in the transfer station compresses the waste, a $10m^3$ arm-roll truck hauls the waste to the landfill site.

(c) Mini-Dumper + Compaction Container + Arm-Roll Truck

Mini-dumpers dump collected waste into a container in the transfer station with the compaction unit. After the compaction unit in the transfer station has compressed the waste, a $10m^3$ arm-roll truck hauls the waste to the landfill site.

(d) Mini-dumper + Compactor

Mini-dumpers dump collected waste into a compactor of $13m^3$ capacity in the transfer station. After the compaction unit in the transfer station has compressed the waste, the compactor hauls the waste to the landfill site.

(e) Mini-compactor

Mini-compactors haul the collected waste from each generation source to the landfill site directly. No transfer station is required in this option.

(2) Secondary Collection Method on a Wide Street

On wide streets in the city, (i) arm-roll trucks and (ii) compactors are to be applied as the secondary collection method in the study, as described below.

(a) Arm-Roll Truck

One or two containers ($10m^3$ or $5m^3$) are deployed on the street based on the present road and traffic conditions. This method is being utilised broadly in the city.

(b) Compactor

One or two small containers ($0.8m^3$) are deployed on the street. This method is being applied in Lahore at present.

4.1.3 Development of Combinations of Waste Collection and Transportation Option

Based on the possible options described the above, the waste collection and transportation method is developed by a combination of the options. **Figure B.4.1** gives a sample flowchart of the combination of collection methods in each operation stage, and all cases for the comparison of waste collection and transportation alternatives are shown in **Figure B.4.2**.

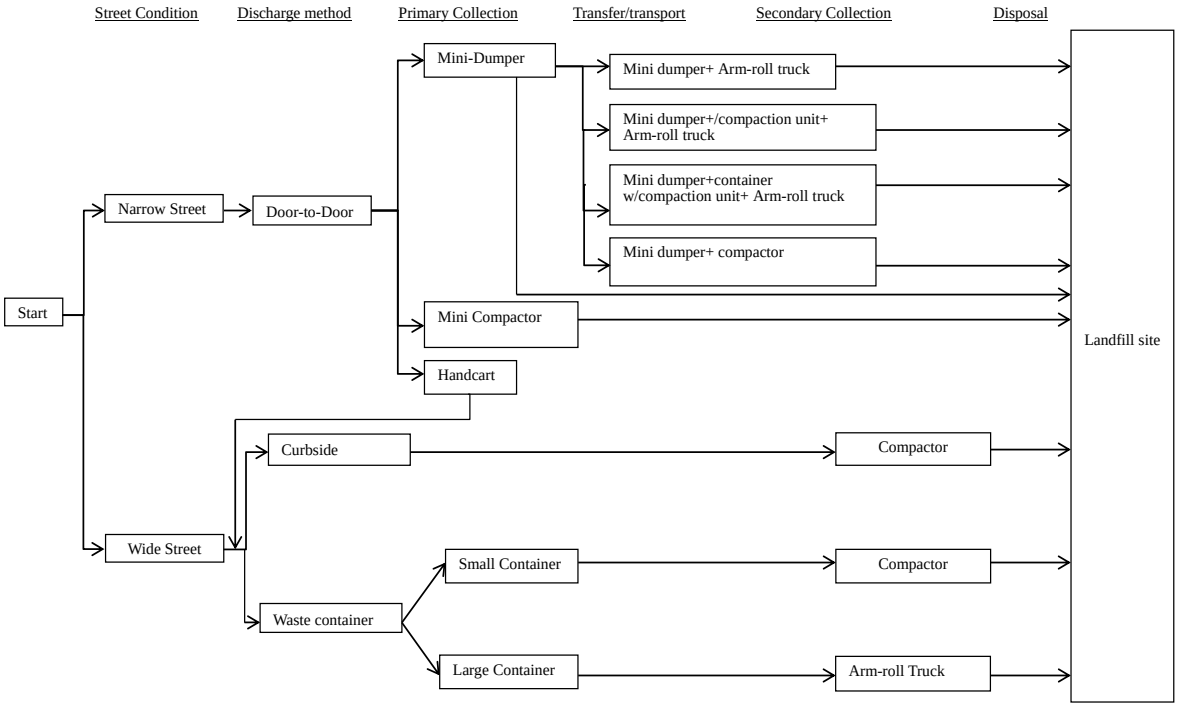

Figure B.4.1 Sample Flowchart of a Combination of Collection Methods in Each Operation Stage of Waste Collection and Transportation

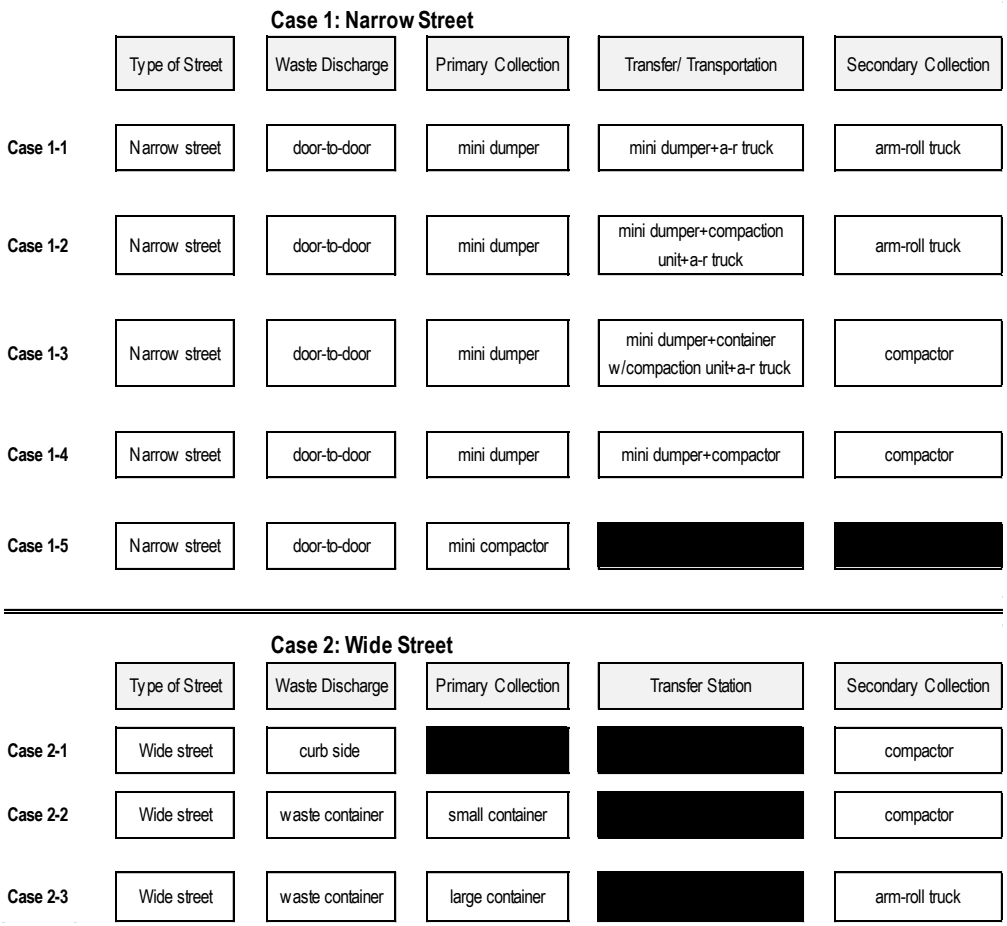

Figure B.4.2 Cases for the Comparison of Waste Collection and Transportation Alternatives

4.1.4 Comparison of Alternatives of Waste Collection Method in Narrow Streets

(1) Cases for Comparison

There is not enough space for the setting of a stationary point or a container point in narrow streets. Therefore, for the selection of waste collection system for narrow streets which are usually located in the middle and low income group areas, five cases of door-to-door collection are set as shown in **Table B**.4.1. The waste collection and transportation method on a narrow street applies the optimal case in the table as described below.

Table B.4.1 Summary of Each Case on a Narrow Street

Item	Waste Collection and Transportation Method	Primary Collection	Transfer / Transportation
Case 1-1	Door-to-Door	Mini-Dumper	Mini-dumper + Arm-roll truck
Case 1-2			Mini-dumper + compaction unit + Arm-roll truck
Case 1-3			Mini-dumper + container w/ compaction unit + Arm-roll truck
Case 1-4			Mini-dumper + Compactor
Case 1-5		Mini-Compactor	-

Case 1-1: A mini-dumper collects waste and dumps it into a container at the transfer station. Once the container is filled with waste, an arm-roll truck hauls it to the landfill site.

Case 1-2: A mini-dumper collects waste and dumps it into a container at the transfer station. Once the container is filled with waste, an arm-roll truck hauls it to the landfill site. Necessary area of the transfer station is smaller than in Case 1-1.

Case 1-3: A mini-dumper collects waste and dumps it into a container attached to a compaction unit at the transfer station. The compaction unit with a container compresses the waste dumped into the container. Then, after compaction, an arm-roll truck hauls the waste to the landfill site. The area necessary for the transfer station is smaller than in Case 1-1. The difference between Case 1-2 and Case 1-3 is the compaction method and type of compaction machinery.

Case 1-4: A mini-dumper collects waste and takes it to the transfer station. A large compactor receives the waste from the mini-dumper and compresses it. Then the large compactor hauls the waste to the landfill site after compaction of the waste by compaction unit. The area necessary for the transfer station is the smallest among Case 1-1 to Case 1-4.

Case 1-5: A mini-compactor collects waste and hauls it directly to the landfill site. There is no transfer station in this case.

(2) Transfer Station

Mini-dumpers used to haul the waste and dump it at the Sabrri Chowk transfer station, UC No. 17, and Qadri Darbar, UC No. 52. However, the land got full of garbage and seems to be like a temporary landfill site. Waste unloaded on the ground is scooped by a wheel loader and dumped into a $5m^3$ container. Then, an arm-roll truck picks up the container when it gets full of garbage.

The unloaded waste chronically exists at the transfer stations because the waste collection vehicles kept coming to dump the wastes there. For this reason, GWMC got complaints from the residents near the Qadri Darbar transfer station and had to close its operation. The Sabrri Chowk transfer station was also closed because GWMC found another place for a transfer station in Mugal Chowk, UC No. 12, which is located in the north-eastern part of the city, and near the Sialkot, where a bypass road is located.

Currently, some wastes are collected by mini-dumpers and transported to the open plot. Transported waste is loaded into a container on the site by a wheel loader and hauled to the landfill site. GWMC rents the land and uses it as a temporary transfer station. However, the condition of the land is the same as the previous transfer stations. It might be a matter of time before closure due to complaints from the residents near the Mughal Chowk transfer station.

For comparison of the five Door-to-Door cases, the location of the transfer station is set at the Mughal Chowk site. The site is close to a large road, Sialkot Bypass Road.

Figure B.4.3 shows the tentative location of the transfer station. **Figure B.4.4** on the other hand shows a tentative layout plan of the transfer station.

Figure B.4.3 Tentative Location of the Transfer Station at the Mughal Chowk Site

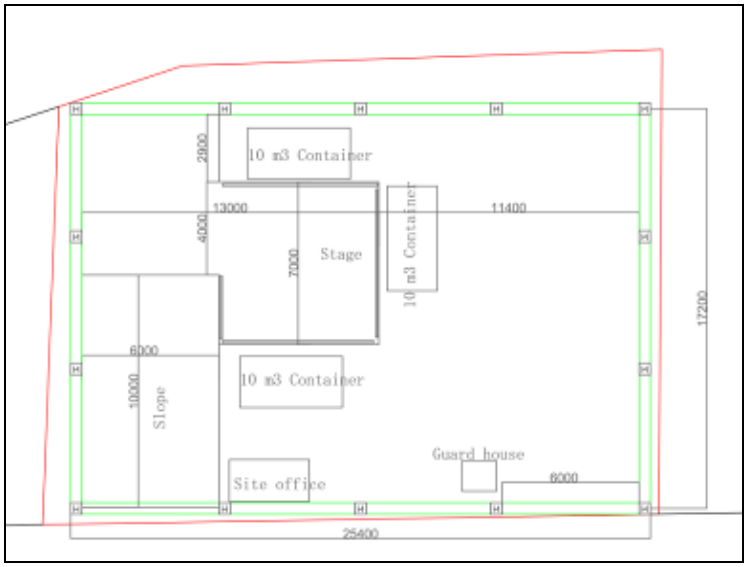

Figure B.4.4 Tentative Layout Plan of Mughal Chowk Transfer Station (Not to Scale)

The specifications of the Mughal Chowk transfer station is as follows:

- Area: 18m × 25m (450m^2)
- Number of containers: 3 units (10m^3)
- Structure: steel skeleton structure
- Office: 1 unit
- Guardhouse: 1 unit
- Gate: 1 unit

(3) Comparison of the Five Cases for a Narrow Street

The selection criteria in this study consider the following conditions: (a) Environmental impact, (b) Workload, and (c) Cost comparison.

(a) Environmental Impact

If a transfer station is located in a residential area, the residents near the station might complain about the odour from the transfer station.

There is no environmental impact on direct hauling.

(b) Workload

Collected waste has to be unloaded at the transfer station. Performance is low if the collected waste is first unloaded at the transfer station and then hauled again to the landfill site.

(c) Cost Comparison

For estimating the cost on each case, vehicle, compaction unit and container cost information is provided from the local supplier. The annual cost of each vehicle is set by considering the depreciation periods (8 years). The annual maintenance cost for a vehicle is set as 5%. As one of operating cost, two workers (driver + sanitary worker) are deployed on a compactor and one driver is deployed on an arm-roll truck. Another operating cost such as fuel cost is estimated based on the result of the time and motion study and the information from LWMC. The annual container cost is calculated in the same manner, i.e., the depreciation year is set as 5 years and annual maintenance cost is 5%.

Table B.4.2 shows the annual cost of each vehicle. As discerned from the vehicle prices on the table, the mini-dumper is the most economical vehicle and the mini-compactor is the second most economical vehicle.

Table B.4.2 Comparison of Annual Costs of Vehicles considered for Narrow Streets

Vehicles	Vehicle Cost (Rs.)	Depreciation Period (Year)	Annual Vehicle & Container Cost (Rs.)	Maintenance Cost (Rs.)	Operation Cost (Rs.)	Labour Cost (Rs.)	Annual Cost (Rs.)
Mini-dumper	1,000,000	8	125,000	50,000	196,128	396,000	767,128
Compaction Unit	2,400,000	8	300,000	120,000	30,000	180,000	630,000
Container w/ Compaction unit	2,400,000	8	300,000	120,000	30,000	180,000	630,000
Mini-Compactor (4 m^3)	3,500,000	8	437,500	175,000	196,128	396,000	1,204,628
Arm-roll truck (10 m^3)	5,000,000	8	625,000	250,000	819,360	216,000	1,910,360
Compactor (13 m^3)	9,200,000	8	1,150,000	460,000	282,240	396,000	2,288,240
Transfer Station	15,936,183	30	531,206	24,146	24,146	198,000	777,498

Note: Vehicle, compaction unit and container costs are based on the quotation from the supplier.

The necessary number of mini-dumpers per case is considered as follows:

Case 1-1: Container 10m^3/ (Mini-dumper 1m^3 × 5Trips) = 2 Mini-dumpers

Case 1-2: Container 10m^3/ (Mini-dumper 1m^3 × 5Trips) / Compaction unit (0.5m^3) = 4 Mini-dumpers

Case 1-3: Container 10m^3/ (Mini-dumper 1m^3 × 5Trips) / Compaction unit (0.5m^3) = 4 Mini-dumpers

Case 1-4: Compactor $13m^3$/ (Mini-dumper $1m^3 \times 5$Trips) = 3 Mini-dumpers

Case 1-5: There is no mini-dumper in this case.

Waste hauling cost of each case has been estimated. **Table B.4.3** shows the cost comparison among the five cases. As discerned from this table, Case 1-5 is the most economical plan among the five cases. Since all wastes are transferred to the transfer station in the other four cases, the operating operation and maintenance cost is higher.

Even if there is no transfer station in Case 1-4, Case 1-5 is still the most economical among the five cases. The reason for this is that Case 1-4 needs to have 3 mini-dumpers for filling up the compactor.

Table B.4.3 Cost Comparison Table on Five Cases of Waste Collection

Case No.	Mini-dumper/ Mini-compactor (Rs.)	Transfer Station (Rs.)	Compaction Unit (Rs.)	Arm-roll truck/Large Compactor (Rs.)	Total Cost (Rs.)
Case 1-1	1,534,256	777,498	-	1,910,360	4,222,114
Case 1-2	3,068,512	777,498	630,000	1,910,360	6,386,370
Case 1-3	3,068,512	777,498	630,000	1,910,360	6,386,370
Case 1-4	2,301,384	777,498	-	2,288,240	5,367,122
Case 1-5	1,204,628	-	-	-	1,204,628

Table B.4.4 shows the results of comparison in each case. As discerned, Case 1-5 is the optimal plan among the five cases. Collected wastes are hauled directly in Case 1-5, so that the case is evaluated "better" in all conditions.

Table B.4.4 Results of Comparison among the Five Cases

Item	Case 1-1	Case 1-2	Case 1-3	Case 1-4	Case 1-5
Environmental Impact	Fair	Fair	Fair	Good	Better
Workload	Good	Fair	Fair	Fair	Better
Cost Comparison	Fair	Fair	Fair	Good	Better
Evaluation Result	Good	Fair	Fair	Good	Better

(4) Optimal Plan for Waste Collection on a Narrow Street

As the result of comparison, Case 1-5 is applied for the waste collection and transportation on a narrow street. Construction of a transfer station is not applied in this case.

4.1.5 Comparison of Alternatives of Waste Collection Method for Wide Streets

There is no restriction on a wide street due to the street condition. Therefore, curb-side collection or container collection is applicable for the waste collection method. For selecting the waste collection system for a wide street, the three cases shown in **Figure B.4.5** have been evaluated and the optimal case is set as the waste collection and transportation method. **Table B.4.5** gives the summary of each case. Based on the waste discharge method on a street, the utilised vehicle varies in each case.

Table B.4.5 Summary of Three Cases of Waste Collection for a Wide Street

Item	Waste Discharge Point	Secondary Collection
Case 2-1	Curb-side	Compactor
Case 2-2	Small Container	Compactor
Case 2-3	Large Container	Arm-roll truck

Case 2-1: Waste is disposed at a designated curb-side by the residents and a compactor collects the waste and hauls it to the landfill site.

Case 2-2: A smaller container compared to the currently used container is deployed on the street. A compactor collects waste from the container and transfers it to the landfill site.

Case 2-3: A large-sized container is deployed on the street. An arm-roll truck collects the container and hauls it to the landfill site. GWMC is currently applying this method.

(1) Comparison of the Three Cases for a Wide Street

Set as selection criteria in this study are (a) Environmental impact, and (b) Workload and Cost comparison.

(a) Environmental Impact

- If curb-side collection is applied, uncollected waste is scattered at the station. In addition, livestock with free-range on the street mess up uncollected waste at the station.
- Currently, illegal dumping on the open plots is one of the serious issues in the city. It is assumed that there are some people who throw their wastes at other times than the designated day. The open plots look like illegal dumping sites.
- Small container: The lid is attached to the top of the container so that few residents attempt to throw their waste into the container. The environment around the container is cleaner than the other two cases.
- Larger container: Some residents throw their waste into the container. Therefore, wastes that do not go into the container is scattered around the container making the location dirty and unsanitary. The weather condition affects the condition of scattered waste.

(b) Workload

- Curb-side collection: A sanitary worker collects all wastes from the ground which sometimes takes much time. If waste is not disposed in an appropriate way (e.g., the bag is torn and waste is scattered on the ground), the worker has to clean it up. The condition of the collection point is affected by the weather condition. The disposed waste flows out during the monsoon season.
- Small container: A sanitary worker disposes the collected waste from the container into a compactor and it might take time for loading the waste. However, it is assumed that the amount of scattered waste around the container is less so that the worker does not require much time for cleaning around the container.
- Large container: An arm-roll truck with driver collects the container. A sanitary worker has to clean the waste scattered around the container. It is, therefore, assumed that the time takes much longer compared with the work using a small container.

(c) Cost Comparison

For estimating the cost on each of the three cases, vehicle, compaction unit and container cost information is provided from the local supplier. The annual cost of each vehicle is set with consideration on depreciation periods (8 years). The annual maintenance cost for the vehicle is set as 5%. As one of the operating costs, two workers (driver + sanitary worker) are deployed

on a compactor and one driver is deployed on an arm-roll truck. Another operating cost such as fuel cost is estimated based on the result of the time and motion study and the information from LWMC. The annual container cost is calculated in the same manner, i.e., the depreciation year is set as 5 years and annual maintenance cost is 5%. **Table B.4.6** shows the annual cost of each item. Based on the table, the middle compactor is the most economical vehicle among the three.

Table B.4.6 Comparison of Annual Costs of Vehicles for a Wide Street

Vehicle Type	Vehicle/ Container Cost (Rs.)	Depreciation Period (Year)	Annual Vehicle and Container Cost (Rs.)	Maintenance Cost (Rs.)	Vehicle Operation Cost (Rs.)	Labour Cost (Rs.)	Annual Cost (Rs.)
Compactor (7 m^3)	4,500,000	8	562,500	225,000	282,240	396,000	1,465,740
Arm-roll truck (5 m^3)	3,500,000	8	437,500	175,000	819,360	216,000	1,647,860
Small Container (0.8 m^3)	28,000	5	5,600	1,400	-	-	7,000
Large Container (5 m^3)	200,000	5	40,000	10,000	-	-	50,000

The necessary number of containers per vehicle is considered in three cases as follows:

Case 2-1: No container

Case 2-2: Compactor 7m^3/ container 0.8m^3 × 2 trips/day × 6 days × 4 weeks × 12 months = 5,040 units

Case 2-3: Large container 5m^3 × 5 trips/day × 6 days × 4 weeks × 12 months = 7,200 units

Table B.4.7 shows the annual cost for each case. Case 2-1 has the lowest cost among the three cases because there is no container cost. On the other hand, Case 2-3 is the most expensive. The number of containers collected by an arm-roll truck reflects the cost.

Table B.4.7 Annual Cost of Three Cases of Waste Collection Method

Item	Vehicle Cost (Rs.)	Container Cost (Rs.)	Total Cost (Rs.)
Case 2-1	1,465,740	-	1,465,740
Case 2-2	1,465,740	35,280,000 (7,000 × 5,040)	36,745,740
Case 2-3	1,647,860	360,000,000 (50,000 × 7,200)	361,647,860

Table B.4.8 gives a comparison among the three cases. As discerned, Case 2-2 is the optimal plan in the Master Plan. The cost comparison shows that Case 2-1 is the lowest; however, it is too early to apply the curb-side collection in the city based on the current waste disposal practice of the residents. The disposal method needs to be controlled by GWMC.

Table B.4.8 Comparison of the Three Cases of Waste Collection Method

Item	Case 2-1	Case 2-2	Case 2-3
Environmental Impact	Bad	Better	Fair
Workload	Fair	Better	Good
Cost Comparison	Better	Good	Fair
Evaluation Result	Fair	Better	Good

(2) Optimal Plan for Waste Collection and Transportation on a Wide Street

Case 2-2 is the most economical and environmentally friendly among the three cases of collection method. Thus, the combination of a small container and a middle compactor is applied in this master plan. Construction of the transfer station is not applied in this case.

4.1.6 Planned Waste Collection Amount

Based on the planned waste collection population, area and amount, the number of planned waste collection and transportation vehicles has been decided. The number of vehicles and containers has to meet the necessary waste collection amount in each year.

(1) Waste Collection Area and Its Areal Population

Currently, waste collection is conducted in 64 UCs. **Figure B.4.5** shows the planned waste collection area. GWMC had divided the 64UCs into 8 zones and collects waste from each zone.

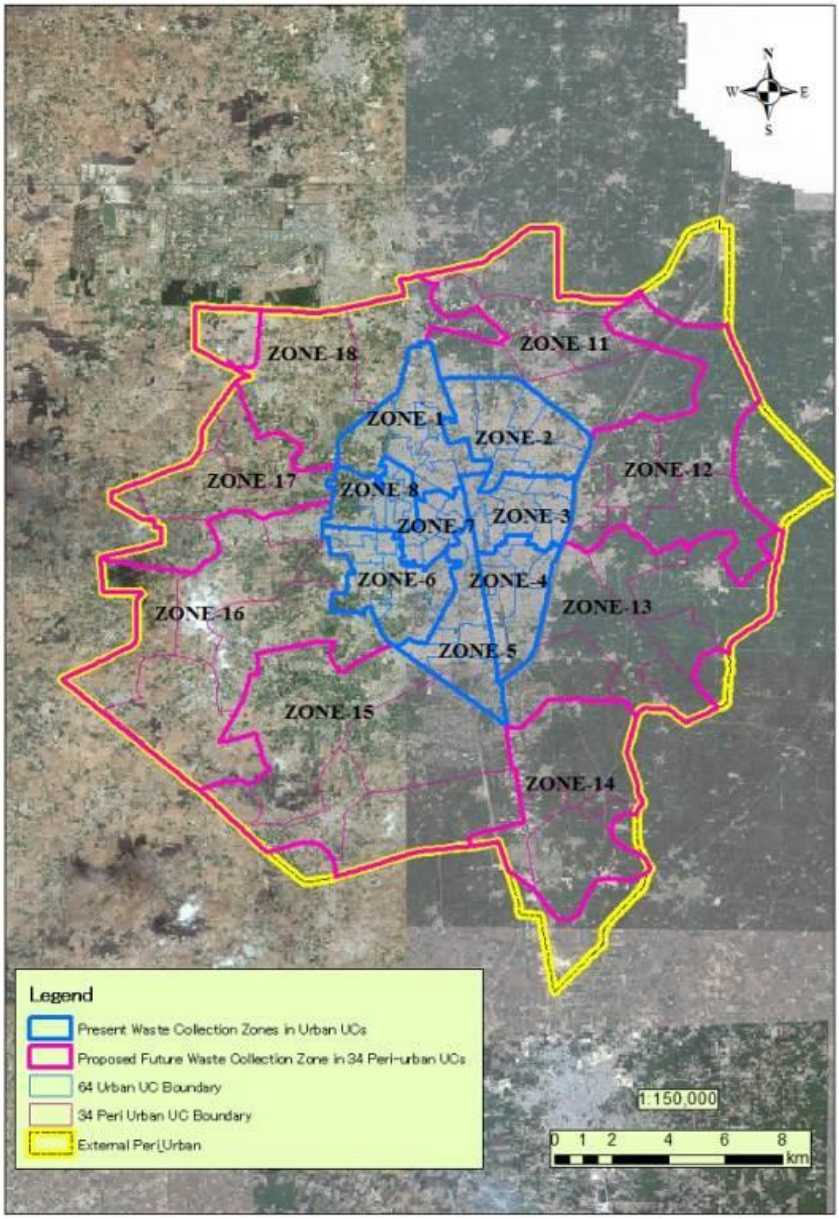

Figure B.4.5 Planned Waste Collection Zones in the 64 UCs

In the Master Plan, the waste collection area is expanded to cover 100% collection in the 64 UCs in 2018. On the other hand, waste collection operation is to start in the 34 UCs in 2019 to cover 100% in 2030. The 34 UCs are also divided into 8 zones while Zone 9 and Zone 10 are set as the street sweeping areas. Collection zones in the 34 UCs are also expanded from 8 zones to 16 zones. **Table B**.4.9, **Table B.4.10** and **Table B.4.11** show the collection area in each zone. Population in the 98 UCs is estimated to be 5,373,752 in 2030.

Table B.4.9 Collection Areas and Population in Waste Collection Zones (Year 2014-2019)

Item	Area (km^2)	2014	2015	2016	2017	2018	2019
Zone-1	11.30	260,390	270,259	280,501	291,132	302,165	313,617
Zone-2	11.45	219,759	228,087	236,731	245,702	255,014	264,678
Zone-3	7.23	317,412	329,442	341,928	354,888	368,338	382,299
Zone-4	7.57	235,384	244,306	253,564	263,174	273,147	283,499
Zone-5	8.69	219,182	227,489	236,109	245,058	254,347	263,987
Zone-6	9.81	223,582	232,054	240,848	249,976	259,450	269,282
Zone-7	3.67	298,929	310,257	322,015	334,218	346,885	360,031
Zone-8	5.27	279,027	289,601	300,576	311,969	323,794	336,066
Sub-Total	64.99	2,053,665	2,131,495	2,212,272	2,296,117	2,383,140	2,473,459
Zone-11	29.68	188,686	195,839	203,259	210,963	218,959	227,258
Zone-12	29.85	159,180	165,212	171,474	177,973	184,718	191,719
Zone-13	35.66	115,017	119,377	123,901	128,597	133,470	138,529
Zone-14	24.07	108,222	112,324	116,582	121,000	125,586	130,346
Zone-15	51.82	111,162	115,375	119,748	124,286	128,997	133,886
Zone-16	45.80	130,528	135,475	140,609	145,939	151,470	157,211
Zone-17	21.90	51,949	53,918	55,962	58,083	60,285	62,570
Zone-18	23.70	45,005	46,710	48,480	50,318	52,225	54,204
Sub-Total	262.48	909,749	944,230	980,015	1,017,159	1,055,710	1,095,723
Grand Total	327.47	2,963,414	3,075,725	3,192,287	3,313,276	3,438,850	3,569,182

Table B.4.10 Collection Areas and Population in Waste Collection Zones (Year 2020-2024)

Item	Area (km^2)	2020	2021	2022	2023	2024
Zone-1	11.30	325,503	337,840	350,645	363,935	377,727
Zone-2	11.45	274,709	285,121	295,926	307,143	318,785
Zone-3	7.23	396,788	411,827	427,436	443,636	460,450
Zone-4	7.57	294,244	305,396	316,969	328,982	341,451
Zone-5	8.69	273,992	284,377	295,155	306,341	317,951
Zone-6	9.81	279,487	290,079	301,073	312,485	324,328
Zone-7	3.67	373,676	387,838	402,537	417,794	433,629
Zone-8	5.27	348,804	362,024	375,745	389,985	404,765
Sub-Total	64.99	2,567,203	2,664,502	2,765,486	2,870,301	2,979,086
Zone-11	29.68	235,871	244,810	254,087	263,717	273,713
Zone-12	29.85	198,986	206,527	214,355	222,478	230,911
Zone-13	35.66	143,780	149,228	154,884	160,754	166,847
Zone-14	24.07	135,286	140,413	145,734	151,258	156,991
Zone-15	51.82	138,960	144,226	149,692	155,364	161,252
Zone-16	45.80	163,170	169,354	175,773	182,434	189,348
Zone-17	21.90	64,941	67,402	69,956	72,607	75,359
Zone-18	23.70	56,259	58,392	60,605	62,902	65,286
Sub-Total	262.48	1,137,253	1,180,352	1,225,086	1,271,514	1,319,707
Grand Total	327.47	3,704,456	3,844,854	3,990,572	4,141,815	4,298,793

Table B.4.11 Collection Areas and Population in Waste Collection Zones (Year 2025-2030)

Item	Area (km^2)	2025	2026	2027	2028	2029	2030
Zone-1	11.30	392,042	406,900	422,321	438,328	454,939	472,180
Zone-2	11.45	330,867	343,408	356,423	369,930	383,950	398,502
Zone-3	7.23	477,900	496,012	514,812	534,322	554,574	575,591
Zone-4	7.57	354,391	367,822	381,762	396,231	411,249	426,835
Zone-5	8.69	330,000	342,506	355,487	368,960	382,944	397,458
Zone-6	9.81	336,620	349,378	362,621	376,365	390,629	405,434
Zone-7	3.67	450,063	467,120	484,823	503,197	522,268	542,061
Zone-8	5.27	420,105	436,025	452,551	469,701	487,502	505,978
Sub-Total	64.99	3,091,988	3,209,171	3,330,800	3,457,034	3,588,055	3,724,039
Zone-11	29.68	284,087	294,854	306,029	317,627	329,665	342,159
Zone-12	29.85	239,661	248,745	258,172	267,957	278,112	288,652
Zone-13	35.66	173,171	179,733	186,545	193,615	200,953	208,569
Zone-14	24.07	162,941	169,115	175,525	182,177	189,081	196,247
Zone-15	51.82	167,363	173,706	180,290	187,122	194,214	201,574
Zone-16	45.80	196,524	203,973	211,704	219,728	228,055	236,699
Zone-17	21.90	78,214	81,178	84,255	87,448	90,763	94,202
Zone-18	23.70	67,760	70,328	72,993	75,759	78,631	81,611
Sub-Total	262.48	1,369,721	1,421,632	1,475,513	1,531,433	1,589,474	1,649,713
Grand Total	327.47	4,461,709	4,630,803	4,806,313	4,988,467	5,177,529	5,373,752

(2) Waste Collection Rate

GWMC has been conducting waste collection services for 64 UCs, but the service area does not cover the whole city. For instance, there are some places where waste is collected once or twice a

week or every two weeks and these are called as partial collection areas. Based on the survey done by waste managers of GWMC, percentages of collection area, partial collection area and no collection area are known.

Table B.4.12 and **Table B.4.13** show the waste collection rate from 2014 to 2030. The waste collection rate is 43% in 2014 as mentioned in ***Volume 2 Supporting Report, Section A, Section 5***. In the Master Plan, the waste collection rate in 2018 is 100% and the waste collection service in the 34 UCs (Peri-urban areas) starts in 2019 and covers 100% in 2030.

Table B.4.12 Waste Collection Rates from 2014 to 2021

(Unit: %)

Year	2014	2015	2016	2017	2018	2019	2020	2021
64 UCs	43	57	71	85	100	100	100	100
34 UCs	0	0	0	0	0	10	20	30
98 UCs	34	45	55	65	76	78	81	84

Table B.4.13 Waste Collection Rates from 2022 to 2030

(Unit: %)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
64UCs	100	100	100	100	100	100	100	100	100
34UCs	40	50	60	67	73	80	87	93	100
98UCs	86	89	91	93	94	96	97	99	100

(3) Waste Collection Population

Table B.4.14 shows the waste collection population in each year. Waste collection population in each year is multiplied by the waste collection rate in each service year.

Table B.4.14 Waste Collection Population in Each Service Year

Year	64 UCs	34 UCs	Total
2014	883,076	0	883,076
2015	1,214,952	0	1,214,952
2016	1,570,713	0	1,570,713
2017	1,951,699	0	1,951,699
2018	2,383,140	0	2,383,140
2019	2,473,459	109,572	2,583,031
2020	2,567,203	227,451	2,794,654
2021	2,664,502	354,106	3,018,608
2022	2,765,486	490,034	3,255,520
2023	2,870,301	635,757	3,506,058
2024	2,979,086	791,824	3,770,910
2025	3,091,988	917,713	4,009,701
2026	3,209,171	1,037,791	4,246,962
2027	3,330,800	1,180,411	4,511,210
2028	3,457,034	1,332,347	4,789,381
2029	3,588,055	1,478,211	5,066,266
2030	3,724,039	1,649,713	5,373,752

(4) Waste Amount per Capita

For estimating the total waste amount in the Master Plan, waste amount per capita is calculated from the results of the WACS survey.

Table B.4.15 and **Table B.4.16** show the waste amounts per capita in each service year. Waste generation per capita is related with the economic growth so that one percent (1%) of increment in each year is estimated and added to the waste amount per capita in the Master Plan. In 2030, waste amount per capita in the 64 UCs is 0.467 kg and that in the 34 UCs is 0.414kg.

Table B.4.15 Waste Amount per Capita in Each Service Year (Year 2014-2022)

(Unit: kilograms per capita)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
64 UCs	0.400	0.404	0.408	0.412	0.416	0.420	0.424	0.428	0.432
34 UCs	0.350	0.354	0.358	0.362	0.366	0.370	0.374	0.378	0.382

Table B.4.16 Waste Amount per Capita in Each Service Year (Year 2023-2030)

(Unit: kilograms per capita)

Year	2023	2024	2025	2026	2027	2028	2029	2030
64 UCs	0.436	0.440	0.444	0.448	0.452	0.457	0.462	0.467
34 UCs	0.386	0.390	0.394	0.398	0.402	0.406	0.410	0.414

(5) Waste Generation Amount (Domestic Waste)

Waste generation amount is calculated by the population in a waste collection area and the waste amount per capita. **Table B.4.17** and **Table B.4.18** show the waste generation amount in each year. In 2014, waste generation will amount to 821 tons per day in the 64 UCs and 318 tons per day in the 34 UCs. In 2030, the waste generation amount becomes 1,739 tons per day in the 64 UCs and 683 tons per day in the 34 UCs.

Table B.4.17 Waste Generation Amount in Each Service Year (Year 2014-2022)

(Unit: ton/day)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
64 UCs	821	861	903	946	991	1,039	1,089	1,140	1,195
34 UCs	318	334	351	368	386	406	425	446	468

Table B.4.18 Waste Generation Amount in Each Service Year (Year 2023-2030)

(Unit: ton/day)

Year	2023	2024	2025	2026	2027	2028	2029	2030
64 UCs	1,251	1,311	1,373	1,438	1,506	1,580	1,658	1,739
34 UCs	491	515	540	566	593	622	652	683

(6) Commercial and Other Wastes

GWMC is also responsible for the collection of commercial waste and other wastes such as wastes from the government offices, schools, commercial facilities, restaurants, street sweeping, etc. **Table B**.4.19 and **Table B**.4.20 show the rates of commercial, institutional, park, street cleaning and market wastes. It is assumed that commercial and other economic activities in the city will increase in the future. For this reason, the commercial and other wastes in the 64 UCs is set as 30% in 2030 and those in the rural area (34 UCs) is 26% in 2030.

Table B.4.19 Amounts of Commercial and Other Wastes (Year 2014-2021)

(Unit: %)

Year	2014	2015	2016	2017	2018		2019	2020	2021
64 UCs	0.14	0.15	0.16	0.17	0.18		0.19	0.2	0.21
34 UCs	0.12	0.13	0.14	0.15	0.16		0.17	0.17	0.18

Table B.4.20 Amounts of Commercial and Other Wastes (Year 2022-2030)

(Unit: %)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
64 UCs	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.3
34 UCs	0.19	0.2	0.21	0.22	0.23	0.24	0.24	0.25	0.26

(7) Planned Waste Collection Amount

The waste collection amount is calculated by the waste generation amount, waste collection rate and commercial and other waste rates. For estimating the number of vehicles and containers, the waste collection amount is calculated as 6/7, which means 6 waste collection days in a week and amount for waste collection and transportation needs to consider the amount on Sundays.

Table B.4.21 and **Table B.4.22** show the planned waste collection amount. Total waste collection amount in the 98 UCs is 3,904 ton/day in 2030.

Table B.4.21 Planned Waste Collection Amounts (Year 2014-2022)

(Unit: ton/day)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
64 UCs	478	673	889	1,129	1,410	1,496	1,586	1,683	1,786
34 UCs	0	0	0	0	0	55	117	185	260
Total	478	673	889	1,129	1,410	1,551	1,703	1,868	2,046

Table B.4.22 Planned Waste Collection Amounts (Year 2023-2030)

(Unit: ton/day)

Year	2023	2024	2025	2026	2027	2028	2029	2030
64 UCs	1,895	2,011	2,135	2,265	2,405	2,560	2,724	2,898
34 UCs	344	436	514	592	684	786	886	1,006
Total	2,239	2,447	2,649	2,857	3,089	3,346	3,610	3,904

The waste collection rate is 43% in 2014 based on the calculation. In the Master Plan, the waste collection rate in 2018 is 100% and the waste collection service in the 34 UCs (Peri-urban areas) is to start in 2019 and covers 100% of the 34 UCs in 2030.

(8) Summary of Planned Waste Collection Population and Amount

Table B.4.23, **Table B.4.24**, **Table B.4.25** and **Table B.4.26** show the summary of planned waste collection population and amount. Total waste collection amount in the 98 UCs is 3,904 tons/day in 2030.

Table B.4.23 Summary of Planned Waste Collection Population and Amounts (Year 2014-2018)

Item		2014	2015	2016	2017	2018
64 UCs	(1) Population	2,053,665	2,131,495	2,212,272	2,296,117	2,383,140
	(2) Waste amount per capita per day (kg/day)	0.4	0.404	0.408	0.412	0.416
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	821	861	903	946	991
	(4) Collection ratio (domestic) (%)	43	57	71	85	100
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	353	491	641	804	991
	(6) Commercial ratio (%)	14	15	16	17	18
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	57	86	121	164	217
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	410	577	762	968	1,208
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	478	673	889	1,129	1,410
34 UCs	(1) Population	909,749	944,230	980,015	1,017,159	1,055,710
	(2) Waste amount per capita per day (kg/day)	0.35	0.354	0.358	0.362	0.366
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	318	334	351	368	386
	(4) Collection ratio (domestic) (%)	0	0	0	0	0
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	0	0	0	0	0
	(6) Commercial ratio (%)	12	13	14	15	16
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	0	0	0	0	0
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	0	0	0	0	0
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	0	0	0	0	0
98 UCs	(10) Total waste collection amount (ton/day) (10) = 64UCs(8)+34UCs(8)	410	577	762	968	1,208
	(11) Required waste collection amount (ton/day) (11) = 64UCs(9)+34UCs(9)	478	673	889	1,129	1,410
	(12) Waste collection rate* (%) (12) = (10)/(11)	43	57	71	85	100

Note:* Target waste collection area from 2014 to 2018 is 64 UCs. Thus, the waste collection rate shown on this table is for 64 UCs.

Table B.4.24 Summary of Planned Waste Collection Population and Amounts (Year 2019-2022)

Item		2019	2020	2021	2022
64 UCs	(1) Population	2,473,459	2,567,203	2,664,502	2,765,486
	(2) Waste amount per capita per day (kg/day)	0.42	0.424	0.428	0.432
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	1,039	1,089	1,140	1,195
	(4) Collection ratio (domestic) (%)	100	100	100	100
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	1,039	1,089	1,140	1,195
	(6) Commercial ratio (%)	19	20	21	22
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	243	271	302	336
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	1,282	1,360	1,442	1,531
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	1,496	1,586	1,683	1,786
34 UCs	(1) Population	1,095,723	1,137,253	1,180,352	1,225,086
	(2) Waste amount per capita per day (kg/day)	0.37	0.374	0.378	0.382
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	406	425	446	468
	(4) Collection ratio (domestic) (%)	10	20	30	40
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	41	85	134	187
	(6) Commercial ratio (%)	17	17	18	19
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	7	15	25	36
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	47	100	158	223
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	55	117	185	260
98 UCs	(10) Total waste collection amount (ton/day) (10) = 64UCs(8)+34UCs(8)	1,329	1,459	1,601	1,754
	(11) Required waste collection amount (ton/day) (11) = 64UCs(9)+34UCs(9)	1,551	1,703	1,868	2,046
	(12) Waste collection rate (%) (12) = (10)/(11)	78	81	84	86

Table B.4.25 Summary of Planned Waste Collection Population and Amounts (Year 2023-2026)

Item		2023	2024	2025	2026
64 UCs	(1) Population	2,870,301	2,979,086	3,091,988	3,209,171
	(2) Waste amount per capita per day (kg/day)	0.436	0.44	0.444	0.448
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	1,251	1,311	1,373	1,438
	(4) Collection ratio (domestic) (%)	100	100	100	100
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	1,251	1,311	1,373	1,438
	(6) Commercial ratio (%)	23	24	25	26
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	373	413	457	504
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	1,624	1,724	1,830	1,942
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	1,895	2,011	2,135	2,265
34 UCs	(1) Population	1,271,514	1,319,707	1,369,721	1,421,632
	(2) Waste amount per capita per day (kg/day)	0.386	0.39	0.394	0.398
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	491	515	540	566
	(4) Collection ratio (domestic) (%)	50	60	67	73
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	245	309	362	413
	(6) Commercial ratio (%)	20	21	22	23
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	49	65	79	94
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	295	374	441	507
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	344	436	514	592
98 UCs	(10) Total waste collection amount (ton/day) (10) = 64UCs(8)+34UCs(8)	1,919	2,098	2,271	2,449
	(11) Required waste collection amount (ton/day) (11) = 64UCs(9)+34UCs(9)	2,239	2,447	2,649	2,857
	(12) Waste collection rate (%) (12) = (10)/(11)	89	91	93	94

Table B.4.26 Summary of Planned Waste Collection Population and Amounts (Year 2027-2030)

Item		2027	2028	2029	2030
64 UCs	(1) Population	3,330,800	3,457,034	3,588,055	3,724,039
	(2) Waste amount per capita per day (kg/day)	0.452	0.457	0.462	0.467
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	1,506	1,580	1,658	1,739
	(4) Collection ratio (domestic) (%)	100	100	100	100
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	1,506	1,580	1,658	1,739
	(6) Commercial ratio (%)	27	28	29	30
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	556	614	677	745
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	2,062	2,194	2,335	2,484
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	2,405	2,560	2,724	2,898
34 UCs	(1) Population	1,475,513	1,531,433	1,589,474	1,649,713
	(2) Waste amount per capita per day (kg/day)	0.402	0.406	0.41	0.414
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	593	622	652	683
	(4) Collection ratio (domestic) (%)	80	87	93	100
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	474	541	606	683
	(6) Commercial ratio (%)	24	24	25	26
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	112	132	154	179
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	586	673	760	862
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	684	786	886	1,006
98 UCs	(10) Total waste collection amount (ton/day) (10) = 64UCs(8)+34UCs(8)	2,648	2,867	3,094	3,346
	(11) Required waste collection amount (ton/day) (11) = 64UCs(9)+34UCs(9)	3,089	3,345	3,610	3,904
	(12) Waste collection rate (%) (12) = (10)/(11)	96	97	99	100

4.1.7 Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation

(1) Types of Waste Collection Vehicle and Waste Collection

GWMC operates 5 cubic metre ($5m^3$) arm-roll trucks, $10m^3$ arm-roll trucks, tractor trolleys and mini-dumpers for waste collection and transportation. **Table B.4.27** shows the type of vehicles in use. Most vehicles are used for waste transfer except mini-dumpers. Only 5 mini-dumpers directly haul the waste to the landfill site.

Table B.4.27 Type of Waste Collection Vehicles Currently Used by GWMC

Type of Vehicle	Number of Vehicles
Arm-roll Truck (10 m^3)	4
Arm-roll Truck (5 m^3)	22
Tractor Trolley	37
Mini-Dumper	5 (35)

Note: Total number of mini-dumpers is 35. However, five mini-dumpers go to the landfill site directly after waste collection from each UC.

Most of the vehicles were procured in approximately the year 2000. Service life of the vehicles has expired. However, GWMC make repairs when a vehicle breaks down and continues to utilise them up to the present.

There are various types of street in Gujranwala and the waste collection method such as vehicles needs to suit the road condition. In the Master Plan, five types of collection method are set; namely, (a) Narrow Street (Road width approximately 4 meters, Case 1-5): Compactor (4 m^3); (b) Wide Street (Road width more than 4 meters, Case 2-2): Compactor (7 m^3) + 0.8 m^3 container; (c) Major Road (GT Road, bypass road, etc.): Compactor (13 m^3) + 0.8 m^3 container; (d) Narrow Street in densely populated area (road width less than 3 metres): Mini-dumper + Door-to-Door collection; and (e) Large Waste Generators: Arm-Roll Truck (5 m^3) + 5 m^3 Container.

(a) Narrow Street (Road width approximately 4 metres, Case 1-5)

As the result of calculation in 4.1.4, the compactor (4 m^3) is applied for the waste collection in the Master Plan.

(b) Wide Street (Road width more than 4 metres, Case 2-2)

As the result of calculation in 4.5, the compactor (7 m^3) + 0.8 m^3 container is applied for the waste collection in the Master Plan.

(c) Major Road (GT Road, Bypass Road, etc.)

There are various types of shop along the major streets such as GT Road and the bypass road and the waste generation amount is large so that a large compactor such as the 13m^3 compactor + 0.8m^3 container is suitable for waste collection. The waste collection capacity is approximately doubled compared with the 7m^3 compactor. The vehicle can take waste loading time compared with the 7m^3 compactor. Thus, the 13m^3 compactor + 0.8m^3 container is utilised for the major streets.

(d) Narrow Street in Densely Populated Area (road width less than 3 metres)

The 4 m^3 compactor is able to access most of the narrow streets in the city. However, there are some areas where the 4m^3 compactor could not pass through. In this case, a mini-dumper is utilised for door-to door waste collection and the collected waste is dumped into a 13m^3 or 7m^3 compactor (Mini-Dumper for Door-to-Door Collection + 13m^3 or 7m^3 compactor).

(e) Large Waste Generators

There are some fruit markets, shopping centres and institutions in the city that discharge large amounts of waste in one day. To deal with the wastes disposed from these establishments, one unit of 5m^3 waste container is needed to be set at the site and once the container is full of waste, a 5m^3 arm-roll truck collects the container and replaces it with an empty container for incoming wastes (5m^3 Arm-Roll Truck + 5m^3 Container).

Table B.4.28 shows the vehicles applied for waste collection and transportation in the Master Plan. Three types of compactor are newly applied to conduct waste collection and transportation in the master plan.

Table B.4.28 Vehicles Applied to Waste Collection and Transportation in the Master Plan

Type of Vehicle	Carrying Capacity (ton)
Compactor (13m^3)	6.5
Compactor (7m^3)	3.5
Compactor (4m^3)	2.0

(2) Basic Conditions for the Estimation of Required Number of Vehicles

For estimating the necessary number of vehicles, the following conditions are set.

(a) Waste Loading Capacity of Each Vehicle

Table B.4.29 shows the waste loading capacity of each vehicle. For estimating the waste carrying amount of each vehicle, the waste loading capacity is set. The bulk specific gravity is set as $0.5m^3$ per ton. According to the interview survey with a GWMC Waste Manager, the bulk specific gravity of the waste coming to the landfill site is $0.5m^3$ per ton. This ratio is applied in the Master Plan.

Table B.4.29 Waste Loading Capacity of Types of Waste Collection Vehicle

Vehicle Type	Waste Loading Capacity (ton/vehicle)
Arm-Roll Truck ($5m^3$)	2.5
Arm-Roll Truck ($10m^3$)	5.0
Tractor Trolley	1.6
Compactor ($13m^3$)	6.5
Compactor ($7m^3$)	3.5
Compactor ($4m^3$)	2.0

(b) Number of Trips

The number of trips is estimated from the result of the Time and Motion Study. **Table B**.4.30 shows the number of trips of each vehicle. The number of trips per vehicle is one of the factors to estimate the waste collection amount per vehicle.

Table B.4.30 Number of Trips of Each Type of Collection Vehicle

Vehicle Type	Number of Trips
Arm-Toll Truck ($5m^3$)	5
Arm-Roll Truck ($10m^3$)	5
Tractor Trolley	3
Compactor ($13m^3$)	1
Compactor ($7m^3$)	2
Compactor ($4m^3$)	3
Mini-Dumper	4

The conditions for estimating the number of trips of each type of collection vehicle are as follows:

- The number of trips of a $5m^3$ arm-roll truck is set based on the results of the Time and Motion Study.
- The number of trips of a $10m^3$ arm-roll truck is referred to the $5m^3$ arm-roll truck. The size of both trucks is almost the same.
- The number of trips of a tractor trolley is set at 2 times based on the results of the Time and Motion Study. However, the waste collection amount exceeds the capacity because it is twice as much as the capacity so that the tractor trolley will always be overloaded which affects its efficiency. Once the optimum waste amount is collected and transferred by the tractor trolley, the number of trips would increase. The number of trips of a tractor trolley is thus set as 3 trips.
- The number of trips of the $13m^3$ compactor is set based on the results for tractor trolley in the Time and Motion Study. A tractor trolley collects 1 ton of waste per hour. Even if the sanitary worker changes the collection method, it is assumed that the time consumed for collection work is the same. Since the capacity of a 6.5 ton compactor is $13m^3$, it is estimated that 6 to 6.5 hours for waste collection is necessary per trip. A vehicle can thus make only one trip in a day.

- The number of trips of the $7m^3$ compactor is set based on the results for tractor trolley in the Time and Motion Study. A tractor trolley collects 1 ton of waste per hour. Even if the sanitary worker changes the collection method, it is assumed that the time consumed for collection work is the same. Since the capacity of a compactor is $7m^3$ (3.5 tons), it is estimated that 3 to 3.5 hours for waste collection is necessary per trip. A vehicle can thus make only 2 trips in a day.
- The number of trips of the $4m^3$ compactor is set based on the results for tractor trolley in the Time and Motion Study. A tractor trolley collects 1 ton of waste per hour. Even if the sanitary worker changes the collection method, it is assumed that the time consumed for the collection work is the same. Since the capacity of a compactor is $4m^3$ (2 tons), it is estimated that 2 to 2.5 hours for waste collection is necessary per trip. The vehicle can thus make only 3 trips in a day.
- The number of trips for mini-dumper is set based on the results of the Time and Motion Study.

(c) Other Conditions

Other conditions such as durable year of a vehicle are set as follows:

- Number of necessary vehicles is calculated from the necessary waste collection amount in each year.
- Durable year for a vehicle is set at 8 years. After 8 years, 10% of the vehicles are replaced or reassigned to other areas. (All procured vehicles are replaced or reassigned after 18 years from vehicle procurement.)
- Currently existing vehicles are planned to be utilised in the 64 UCs until 2018. These vehicles are planned to be utilised in the 34 UCs from 2019 to 2021. All existing vehicles are phased out in 2022.
- Two mini-dumpers are deployed for the primary collection in each zone. Basically, the primary collection is conducted by the compactor. However, there are few small streets where the compactor cannot access. Mini-dumpers are applied to this type of street. Collected waste is transferred to a large-sized compactor such as $13m^3$ or $7m^3$ compactor on such street.

(3) Necessary Number of Waste Collection Vehicles

Table B.4.31 and **Table B.4.32** show the total number of vehicles in the 64 UCs. The total number of vehicles in the 64 UCs becomes 449 in 2030. **Table B.4.33**, **Table B.4.34** and **Table B.4.35** show the total waste collection capacity per vehicle in the 64 UCs. **Figure B.4.6** shows the total number of vehicles in the 64 UCs. Total waste collected capacity in the 64 UCs becomes 2,165 tons/day in 2030.

Table B.4.36 and **Table B.4.37** show the total number of vehicles in the 34 UCs. The total number of vehicles in the 34 UCs becomes 151 in 2030.

Table B.4.38, Table B.4.39 and Table B.4.40 show the total waste collection amount per vehicle in the 34 UCs. Figure B.4.7 shows the total number of vehicles in the 34 UCs. The total waste collected capacity in the 64 UCs becomes 2,921 tons/day in 2030.

Table B.4.31 Total Number of Vehicles Required in 64 UCs (Year 2016-2022)

64 UCs			2016	2017	2018	2019	2020	2021	2022
Existing	Arm-Roll Truck	10.0 m^3	4	4	4	0	0	0	0
	Arm-Roll Truck	5.0 m^3	22	22	22	0	0	0	0
	Tractor Trolley	3.2 m^3	37	37	37	0	0	0	0
	Mini-Dumper	1.0 m^3	35	35	35	35	35	35	35
Master Plan	Arm-Roll Truck	10.0 m^3	0	0	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	0	0	0	5	5	5	5
	Compactor	13.0 m^3	13	28	68	78	93	93	108
	Compactor	7.0 m^3	38	58	98	98	98	112	112
	Compactor	4.0 m^3	0	0	40	40	40	40	40
	Mini-Dumper	1.0 m^3	0	0	0	0	0	0	0
Total			149	183	303	256	271	285	300

Table B.4.32 Total Number of Vehicles Required in 64 UCs (Year 2023-2030)

64 UCs			2023	2024	2025	2026	2027	2028	2029	2030
Existing	Arm-Roll Truck	10.0 m^3	0	0	0	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	0	0	0	0	0	0	0	0
	Tractor Trolley	3.2 m^3	0	0	0	0	0	0	0	0
	Mini-Dumper	1.0 m^3	28	24	21	17	14	10	6	3
Master Plan	Arm-Roll Truck	10.0 m^3	0	0	0	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	5	5	5	6	6	6	6	6
	Compactor	13.0 m^3	117	128	140	148	160	171	189	206
	Compactor	7.0 m^3	120	126	135	145	153	164	172	181
	Compactor	4.0 m^3	40	40	40	40	40	40	40	40
	Mini-Dumper	1.0 m^3	0	0	0	0	2	6	10	13
Total			310	323	341	356	375	397	423	449

Table B.4.33 Total Waste Collection Capacity per Vehicle in 64 UCs (Year 2016-2020)

64 UCs			Capacity (ton)	Number of trips	2016	2017	2018	2019	2020
Existing	Arm-Roll Truck	10.0 m^3	5	5	100	100	100	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	275	275	275	0	0
	Tractor Trolley	3.2 m^3	1.6	3	178	178	178	0	0
	Mini-Dumper	1.0 m^3	0.5	5	13	13	13	13	13
Master Plan	Arm-Roll Truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	0	0	0	63	63
	Compactor	13.0 m^3	6.5	1	85	182	442	507	605
	Compactor	7.0 m^3	3.5	2	266	406	686	686	686
	Compactor	4.0 m^3	2	3	0	0	240	240	240
	Mini-Dumper	1.0 m^3	0.5	0	0	0	0	0	0
Total (ton)					916	1,153	1,934	1,509	1,607
Planned Waste Collection Capacity (ton)					889	1,129	1,410	1,496	1,586

Table B.4.34 Total Waste Collection Capacity per Vehicle in 64 UCs (Year 2021-2025)

64 UCs			Capacity (ton)	Number of trips	2021	2022	2023	2024	2025
Existing	Arm-Roll Truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	0	0	0	0	0
	Tractor Trolley	3.2 m^3	1.6	3	0	0	0	0	0
	Mini-Dumper	1.0 m^3	0.5	5	13	10	10	8	8
Master Plan	Arm-Roll Truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	63	63	63	63	63
	Compactor	13.0 m^3	6.5	1	605	702	761	832	910
	Compactor	7.0 m^3	3.5	2	784	784	840	882	945
	Compactor	4.0 m^3	2	3	240	240	240	240	240
	Mini-Dumper	1.0 m^3	0.5	0	0	0	0	0	0
Total (ton)					1,705	1,799	1,913	2,025	2,166
Planned Waste Collection Capacity (ton)					1,683	1,786	1,895	2,011	2,135

Table B.4.35 Total Waste Collection Capacity per Vehicle in 64 UCs (Year 2026-2030)

64 UCs			Capacity (ton)	Number of trips	2026	2027	2028	2029	2030
Existing	Arm-Roll Truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	0	0	0	0	0
	Tractor Trolley	3.2 m^3	1.6	3	0	0	0	0	0
	Mini-Dumper	1.0 m^3	0.5	5	5	5	2.5	0	0
Master Plan	Arm-Roll Truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	75	75	75	75	75
	Compactor	13.0 m^3	6.5	1	962	1,040	1,112	1,229	1,339
	Compactor	7.0 m^3	3.5	2	1,015	1,071	1,148	1,204	1,267
	Compactor	4.0 m^3	2	3	240	240	240	240	240
	Mini-Dumper	1.0 m^3	0.5	0	0	0	0	0	0
Total (ton)					2,297	2,431	2,577	2,748	2,921
Planned Waste Collection Capacity (ton)					2,265	2,405	2,560	2,724	2,898

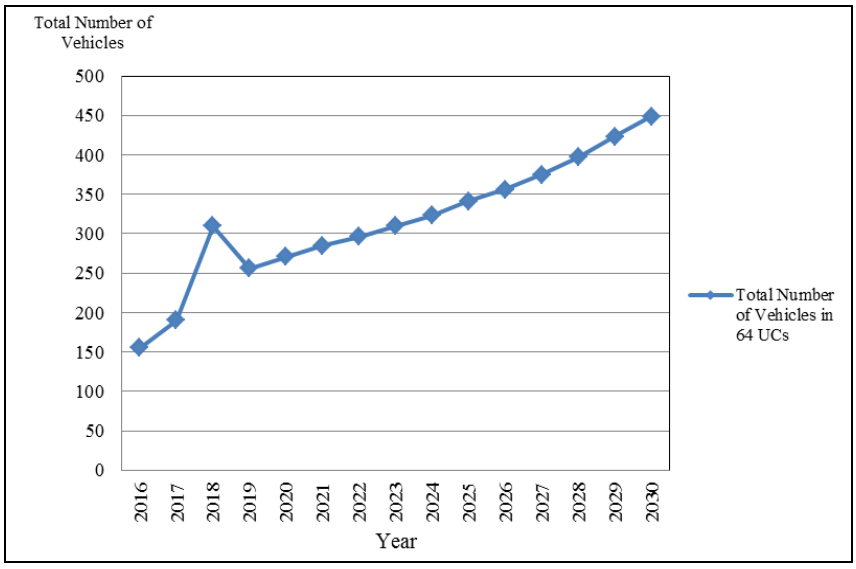

Figure B.4.6 Total Number of Vehicles in 64 UCs

Table B.4.36 Total Number of Vehicles Required in 34 UCs (Year 2016-2022)

34UCs			2016	2017	2018	2019	2020	2021	2022
Existing	Arm-Roll Truck	10.0 m^3	0	0	0	4	4	4	0
	Arm-Roll Truck	5.0 m^3	0	0	0	22	22	22	0
	Tractor Trolley	3.2 m^3	0	0	0	37	37	37	0
	Mini-Dumper	1.0 m^3	0	0	0	0	0	0	0
Master Plan	Arm-Roll Truck	10.0 m^3	0	0	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	0	0	0	0	0	0	0
	Compactor	13.0 m^3	0	0	0	0	0	12	24
	Compactor	7.0 m^3	0	0	0	0	0	15	15
	Compactor	4.0 m^3	0	0	0	0	0	0	0
	Mini-Dumper	1.0 m^3	0	0	0	0	0	0	0
Total			0	0	0	63	63	90	39

Table B.4.37 Total Number of Vehicles Required in 34 UCs (Year 2023-2030)

34 UCs			2023	2024	2025	2026	2027	2028	2029	2030
Existing	Arm-Roll Truck	10.0 m^3	0	0	0	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	0	0	0	0	0	0	0	0
	Tractor Trolley	3.2 m^3	0	0	0	0	0	0	0	0
	Mini-Dumper	1.0 m^3	0	0	0	0	0	0	0	0
Master Plan	Arm-Roll Truck	10.0 m^3	0	0	0	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	0	0	0	0	0	0	0	0
	Compactor	13.0 m^3	29	36	42	48	54	61	66	73
	Compactor	7.0 m^3	23	30	35	40	46	53	61	70
	Compactor	4.0 m^3	0	0	0	1	3	4	6	8
	Mini-Dumper	1.0 m^3	0	0	0	0	0	0	0	0
Total			52	66	77	89	106	118	133	151

Table B.4.38 Total Waste Collection Capacity per Vehicle in 34 UCs (Year 2016-2020)

34 UCs			Capacity (ton)	Number of Trips	2016	2017	2018	2019	2020
Existing	Arm-Roll Truck	10.0 m^3	5	5	0	0	0	100	100
	Arm-Roll Truck	5.0 m^3	2.5	5	0	0	0	275	275
	Tractor Trolley	3.2 m^3	1.6	3	0	0	0	178	178
	Mini-Dumper	1.0 m^3	0.5	5	0	0	0	0	0
Master Plan	Arm-Roll Truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	0	0	0	0	0
	Compactor	13.0 m^3	6.5	1	0	0	0	0	0
	Compactor	7.0 m^3	3.5	2	0	0	0	0	0
	Compactor	4.0 m^3	2	3	0	0	0	0	0
	Mini-Dumper	1.0 m^3	0.5	5	0	0	0	0	0
Total (ton)					0	0	0	533	533
Planned Waste Collection Amount (ton)					0	0	0	55	117

Table B.4.39 Total Waste Collection Capacity per Vehicle in 34UCs (Year 2021-2025)

34UCs			Capacity (ton)	Number of Trips	2021	2022	2023	2024	2025
Existing	Arm-Roll Truck	10.0 m^3	5	5	100	0	0	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	275	0	0	0	0
	Tractor Trolley	3.2 m^3	1.6	3	178	0	0	0	0
	Mini-Dumper	1.0 m^3	0.5	5	0	0	0	0	0
Master Plan	Arm-Roll Truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	0	0	0	0	0
	Compactor	13.0 m^3	6.5	1	78	156	189	234	273
	Compactor	7.0 m^3	3.5	2	105	105	161	210	245
	Compactor	4.0 m^3	2	3	0	0	0	0	0
	Mini-Dumper	1.0 m^3	0.5	5	0	0	0	0	0
Total (ton)					736	261	350	444	518
Planned Waste Collection Capacity (ton)					185	260	344	436	514

Table B.4.40 Total Waste Collection Capacity per Vehicle in 34UCs (Year 2026-2030)

34UCs			Capacity (ton)	Number of Trips	2026	2027	2028	2029	2030
Existing	Arm-Roll Truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	0	0	0	0	0
	Tractor Trolley	3.2 m^3	1.6	3	0	0	0	0	0
	Mini-Dumper	1.0 m^3	0.5	5	0	0	0	0	0
Master Plan	Arm-Roll Truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-Roll Truck	5.0 m^3	2.5	5	0	0	0	0	0
	Compactor	13.0 m^3	6.5	1	312	351	397	429	475
	Compactor	7.0 m^3	3.5	2	280	322	371	427	490
	Compactor	4.0 m^3	2	3	6	18	24	36	48
	Mini-Dumper	1.0 m^3	0.5	5	0	0	0	0	0
Total (ton)					598	691	792	892	1,013
Planned Waste Collection Capacity (ton)					592	684	786	886	1,006

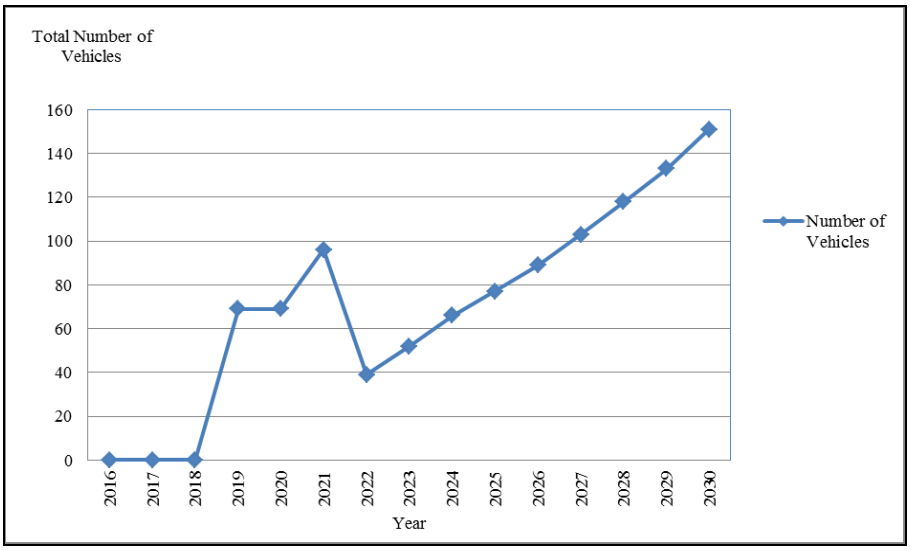

Figure B.4.7 Total Number of Vehicles in 34 UCs

(4) Necessary Number of Waste Containers

A container of 0.8 cubic metres with lid is applied in the Master Plan. Currently, 5m^3 and 10m^3 containers are deployed by GWMC in its waste collection areas. Large-sized containers can receive a large amount of waste, but the size is a disadvantage to waste collection because they require a large space at the site so that it is sometimes difficult to find a place for a container or there is no space in certain areas.

Another issue on containers is that they do not have a lid at the top. Therefore, foul odour is not prevented and may cause complaints from the nearby residents. For solving this issue, a container with lid is applied in the Master Plan to prevent the emission of odour.

The size of the container is much smaller than the large container so that there is no issue in considering the location on the street. Durable year of the container is set as five years. After 5 years, 10% of the containers are replaced.

Some of the 5m^3 containers are stationed at large discharge points such as commercial areas or shopping malls in the city.

Table B.4.41 shows the existing containers in the city and **Table B.4.42** shows the applied container in the Master Plan. The concept of bulk specific gravity is the same as the waste collection and transportation vehicles.

Table B.4.41 Existing Waste Containers in the City

Item	Container Capacity
Container (5 m^3)	2.5 ton/container
Container (10 m^3)	5.0 ton/container

Table B.4.42 Container Applied in the Master Plan

Item	Container Capacity
Container (0.8 m^3)	0.4 ton/container

The number of required containers is estimated from the waste collection capacity necessary in each year. However, the existing containers and waste collection vehicles are deployed in the 64 UCs from 2016 to 2018, and from 2019 to 2021 in the 34 UCs. Necessary waste collection

capacity of a small container needs to consider the collection amount from existing containers and vehicles. Following is the calculation method for estimating the required number of containers.

(Necessary waste collection capacity - Waste collection capacity of existing containers and vehicles) / small container capacity = Required number of containers)

Table B.4.43 and **Table B.4.44** show the total number of containers in the 64 UCs. **Table B**.4.45, **Table B**.4.46 and **Table B.4.47** show the total waste collection capacity of containers in the 64 UCs. **Figure B.4.8** shows the total number of containers in the 64 UCs.

Table B.4.48, **Table B.4.49** and **Table B.4.50** show the total waste collection capacity of containers in the 34 UCs. **Figure B.4.9** shows the total number of containers in the 34 UCs.

The total collection capacity of containers on-site has to exceed the necessary waste collection amount in each year. In 2030, the total number of containers in 98 UCs is 9,912.

Table B.4.43 Total Number of Containers Required in 64 UCs (Year 2016-2022)

64 UCs		2016	2017	2018	2019	2020	2021	2022
Existing	10.0 m^3	6	6	6	0	0	0	0
	5.0 m^3	195	195	195	30	30	30	30
Master Plan	10.0 m^3	4	4	4	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0
	0.8 m^3	950	1,650	2,250	3,600	3,815	4,070	4,325
Total		1,155	1,855	2,455	3,630	3,845	4,100	4,355

Table B.4.44 Total Number of Containers Required in 64 UCs (Year 2023-2030)

64UCs		2023	2024	2025	2026	2027	2028	2029	2030
Existing	10.0 m^3	0	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0	0
Master Plan	10.0 m^3	0	0	0	0	0	0	0	0
	5.0 m^3	30	30	30	30	30	30	30	30
	0.8 m^3	4,600	4,890	5,205	5,545	5,883	6,271	6,694	7,362
Total		4,630	4,920	5,235	5,575	5,913	6,301	6,724	7,392

Table B.4.45 Total Waste Collection Capacity of Containers in 64 UCs (Year 2014-2022)

64 UCs		Capacity (ton)	2016	2017	2018	2019	2020	2021	2022
Existing	10.0 m^3	5.0	30	30	30	0	0	0	0
	5.0 m^3	2.5	488	488	488	75	75	75	75
Master Plan	10.0 m^3	5.0	20	20	20	0	0	0	0
	5.0 m^3	2.5	0	0	0	0	0	0	0
	0.8 m^3	0.4	380	660	900	1,440	1,526	1,628	1,730
Total (ton)			918	1,198	1,438	1,515	1,601	1,703	1,805
Planned Waste Collection Capacity (ton)			889	1,129	1,410	1,496	1,586	1,683	1,786

Table B.4.46 Total Waste Collection Capacity of Containers in 64 UCs (Year 2023-2030)

64UCs		Capacity (ton)	2023	2024	2025	2026	2027	2028	2029	2030
Existing	10.0 m^3	5.0	0	0	0	0	0	0	0	0
	5.0 m^3	2.5	0	0	0	0	0	0	0	0
Master Plan	10.0 m^3	5.0	0	0	0	0	0	0	0	0
	5.0 m^3	2.5	75	75	75	75	75	75	75	75
	0.8 m^3	0.4	1,840	1,956	2,082	2,218	2,353	2,508	2,678	2,945
Total (ton)			1,915	2,031	2,157	2,293	2,428	2,583	2,753	3,020
Planned Waste Collection Capacity (ton)			1,895	2,011	2,135	2,265	2,405	2,560	2,724	2,898

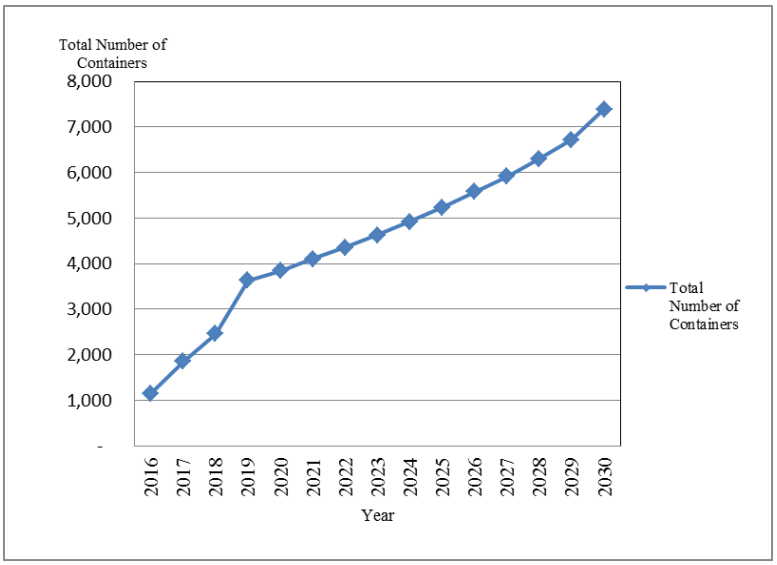

Figure B.4.8 Total Number of Containers in 64 UCs

Table B.4.47 Total Number of Containers Required in 34 UCs (Year 2016-2022)

34UCs		2016	2017	2018	2019	2020	2021	2022
Existing	10.0 m^3	0	0	0	10	10	10	0
	5.0 m^3	0	0	0	90	80	70	0
Master Plan	10.0 m^3	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0
	0.8 m^3	0	0	0	0	0	300	750
Total		0	0	0	100	90	380	750

Table B.4.48 Total Number of Containers Required in 34 UCs (Year 2023-2030)

34UCs		2023	2024	2025	2026	2027	2028	2029	2030
Existing	10.0 m^3	0	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0	0
Master Plan	10.0 m^3	0	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0	0
	0.8 m^3	900	1,150	1,350	1,505	1,730	1,990	2,225	2,520
Total		900	1,150	1,350	1,505	1,730	1,990	2,225	2,520

Table B.4.49 Total Waste Collection Amount of Containers in 34 UCs (Year 2014-2022)

34 UCs		Capacity (ton)	2016	2017	2018	2019	2020	2021	2022
Existing	10.0 m^3	5.0	0	0	0	50	50	50	0
	5.0 m^3	2.5	0	0	0	225	200	175	0
Master Plan	10.0 m^3	5.0	0	0	0	0	0	0	0
	5.0 m^3	2.5	0	0	0	0	0	0	0
	0.8 m^3	0.4	0	0	0	0	0	180	300
Total (ton)			0	0	0	275	250	405	300
Planned Waste Collection Capacity (ton)			0	0	0	55	117	185	260

Table B.4.50 Total Waste Collection Amount of Containers in 34 UCs (Year 2023-2030)

34 UCs		Capacity (ton)	2023	2024	2025	2026	2027	2028	2029	2030
Existing	10.0 m^3	5.0	0	0	0	0	0	0	0	0
	5.0 m^3	2.5	0	0	0	0	0	0	0	0
Master Plan	10.0 m^3	5.0	0	0	0	0	0	0	0	0
	5.0 m^3	2.5	0	0	0	0	0	0	0	0
	0.8 m^3	0.4	360	460	540	600	692	796	890	1,008
Total (ton)			360	460	540	600	692	796	890	1,008
Planned Waste Collection Capacity (ton)			344	436	514	592	684	786	886	1,006

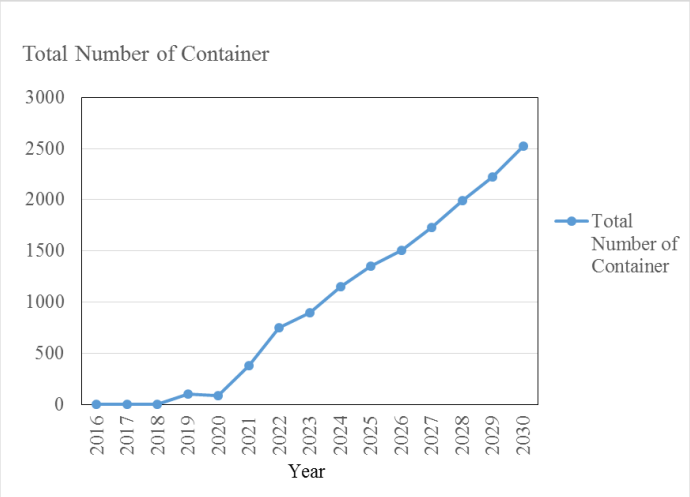

Figure B.4.9 Total Number of Containers in 34 UCs

(5) Necessary Number of Workers for Waste Collection

Based on the necessity of collection vehicles, the total number of workers is estimated for the Master Plan. For estimating the number of workers, four types of workers are set: (a) Sanitary Inspector, (b) Sanitary Supervisor, (c) Driver, and (d) Sanitary Worker.

(a) Sanitary Inspector

Currently, sanitary inspectors are deployed and responsible for checking in several UCs. They get the report regarding waste collection work from the sanitary supervisors. GWMC has 8 zones in 64 UCs. Therefore, one sanitary worker is sufficient for one zone. In the Master Plan, one sanitary inspector is assigned to each zone. Therefore, the total number of sanitary inspectors for waste collection and transportation is 16 persons.

(b) Sanitary Supervisor

Sanitary supervisors are responsible for checking the waste collection and illegal dumping sites in the assigned UC. If there is a problem with waste collection, they report it to their sanitary inspectors. In the master plan, one sanitary supervisor is deployed on each UC. The total number of sanitary supervisors is 98 persons.

(c) Vehicle Driver

One driver is deployed on each vehicle.

(d) Sanitary Worker

Sanitary workers are deployed in each UC. However, the waste collection method is changed in the Master Plan so that sanitary workers also work with the driver during waste collection.

Table B.4.51 and **Table B.4.52** show the necessary number of workers for waste collection. **Figure B.4.10** shows the total number of workers in each year. For achieving the waste collection and transportation, GWMC requires 390 workers in 2016 and 1,852 workers in 2030. The total number of workers in 2022 temporarily decreases compared with the total number of workers in 2021 because all existing vehicles are phased out in 2022 and total necessary number of vehicles is decreased.

Table B.4.51 Necessary Number of Workers for Waste Collection (Year 2016-2022)

Item		2016	2017	2018	2019	2020	2021	2022
64 UCs	Driver	155	190	270	216	231	245	256
	Sanitary Worker	163	233	473	472	502	530	556
	Sanitary Supervisor	64	64	64	64	64	64	64
	Sanitary Inspector	8	8	8	8	8	8	8
34 UCs	Driver	0	0	0	63	63	90	39
	Sanitary Worker	0	0	0	26	26	80	78
	Sanitary Supervisor	0	0	0	34	34	34	34
	Sanitary Inspector	0	0	0	8	8	8	8
Total	Driver	155	190	270	279	294	355	295
	Sanitary Worker	163	233	473	498	528	610	634
	Sanitary Supervisor	64	64	64	98	98	98	98
	Sanitary Inspector	8	8	8	16	16	16	16
	Grand Total	390	495	815	891	936	1,059	1,043

Table B.4.52 Necessary Number of Workers for Waste Collection (Year 2023-2030)

Item		2023	2024	2025	2026	2027	2028	2029	2030
64 UCs	Driver	270	283	301	316	335	357	383	409
	Sanitary Worker	587	617	656	689	728	772	824	876
	Sanitary Supervisor	64	64	64	64	64	64	64	64
	Sanitary Inspector	8	8	8	8	8	8	8	8
34 UCs	Driver	52	66	77	89	103	118	133	151
	Sanitary Worker	104	132	154	178	206	236	266	302
	Sanitary Supervisor	34	34	34	34	34	34	34	34
	Sanitary Inspector	8	8	8	8	8	8	8	8
Total	Driver	322	349	378	405	438	475	516	560
	Sanitary Worker	691	749	810	867	934	1,008	1,190	1,178
	Sanitary Supervisor	98	98	98	98	98	98	98	98
	Sanitary Inspector	16	16	16	16	16	16	16	16
	Grand Total	1,127	1,212	1,302	1,386	1,486	1,597	1,720	1,852

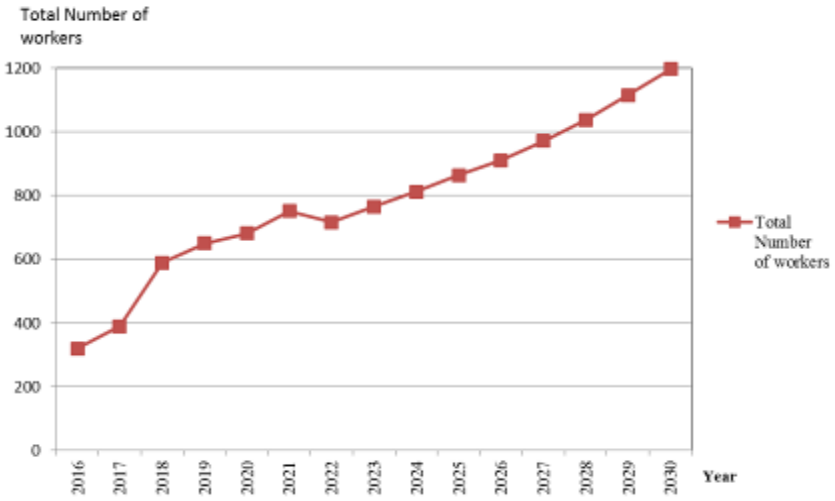

Figure B.4.10 Total Number of Workers in Each Year

(6) Procurement Cost

Table B.4.53 shows the procurement cost of waste collection and transportation. For estimating the implementation cost, procurement cost of each item is referred from the quotation of a local supplier and GWMC. Price of compactors is higher than arm-roll trucks and mini-dumpers. Compactors are equipped with a compaction unit and the system of the unit is complicated compared with the arm-roll truck and mini-dumper.

Table B.4.53 Procurement Cost for Waste Collection and Transportation Vehicles

Item	Procurement Cost (Rs.)
Arm-Roll Truck (5 m^3)	5,000,000
Arm-roll truck (10 m^3)	3,500,000
Compactor (13 m^3)	9,200,000
Compactor (7 m^3)	4,500,000
Compactor (4 m^3)	3,500,000
Mini-dumper	1,000,000
Container (10 m^3)	36,0000
Container (5 m^3)	20,0000
Container (0.8 m^3)	28,000

Based on the information, operation and maintenance cost is calculated. The total amount of operation and maintenance cost is shown below in **item (8), Implementation Cost of Waste and Transportation.**

(7) Operation and Maintenance Cost

Operation cost is necessary for daily waste collection. Necessary items for daily operation are labour cost, diesel oil and gasoline, etc. Similar to operation cost, maintenance cost is needed for waste collection and transportation in the master plan. Waste collection vehicles operate 6 days in a week. GWMC needs to conduct regular check-up of vehicles and prepare for unexpected vehicle breakdown during the operation.

There is an argument that it is possible to reduce the greenhouse gas emission by using CNG gas instead of diesel gas/gasoline on waste collection vehicles. However, CNG is not applied in the master plan.

In Pakistan, the demand of liquid gas including CNG cannot follow its supply in winter so that the Punjab Government implements the scheme of prioritizing the supply of gas to households. Gas for vehicles is not available in winter. It is not appropriate to consider CNG as alternative fuel for waste collection vehicles under the unsustainable supply situation. The master plan thus applies diesel and gasoline on waste collection vehicles.

(a) Fuel Consumption on Each Vehicle

Fuel consumption is also one of the important factors for waste collection and transportation operations. **Table B**.4.54 shows the fuel consumption and daily mileage per vehicle based on the fuel consumption and number of trips of each vehicle. The fuel consumption of each vehicle is referred from the result of the Time and Motion Study and information from the LWMC Operation Division acquired by a GWMC Waste Manager.

Table B.4.54 Fuel Consumption and Daily Mileage of Waste Collection and Transportation Vehicles

Item	Fuel Consumption (km/litre)	Daily Mileage (km)
Arm-Roll Truck (5 m^3)	4.10	144
Arm-Roll Truck (10 m^3)	4.10	144
Tractor Trolley	3.60	50
Compactor (13 m^3)	2.75	50
Compactor (7 m^3)	3.75	50
Compactor (4 m^3)	5.40	49
Mini-Dumper	5.40	49

The conditions for fuel consumption and daily mileage of each vehicle are the following:

- Fuel consumption and daily mileage of arm-roll truck ($5m^3$) is set based on the Time and Motion Study.
- Fuel consumption and daily mileage of arm-roll truck ($10m^3$) is referred to the arm-roll truck ($5m^3$). The size of both trucks is almost the same.
- Fuel consumption and daily mileage of tractor trolley is set based on the Time and Motion Study.
- Fuel consumption and daily mileage of compactor ($13m^3$) is set based on the result for tractor trolley in the Time and Motion Study and information from LWMC. A compactor in LWMC consumes 2.75 km per litre during operation. For the daily mileage, it is assumed that waste collection behaviour of a compactor is similar to a tractor trolley.
- Fuel consumption and daily mileage of a compactor ($7m^3$) is set based on the result for a tractor trolley in the Time and Motion Study and information from LWMC. A compactor in LWMC consumes 3.75 km per litre during operation. For the daily mileage, it is assumed that waste collection behaviour of a compactor is similar to a tractor trolley.
- Fuel consumption and daily mileage of compactor ($4m^3$) is set based on the result for a mini-dumper in the Time and Motion Study. The size of the compactor is similar to mini-dumper so that it is assumed that fuel consumption and daily mileage of the compactor is the same.

Fuel consumption and daily mileage are set based on the Time and Motion Study.

(b) Maintenance Cost

It is difficult to estimate the maintenance cost for each vehicle because there are various types of vehicle applied in the master plan. In this master plan, 5% of vehicle cost is set as maintenance cost. However, the maintenance cost for the tractor trolley is set as the same as the arm-roll truck ($5m^3$). The reasons for this are as follows:

- Most of the tractor trolleys are old. The oldest one was made in the 1970's. They need much maintenance cost.
- The frequency of breakdown of a tractor trolley is occasional during waste collection operation. In fact, a tractor trolley monitored at the Time and Motion Study broke down and the alternative trolley also broke down during the Study.

The above circumstances means that GWMC needs to take much care of trolleys and this may cost much.

As for the maintenance cost of containers, the same manner applied to vehicles is adopted. The maintenance cost of a container is estimated as 5% of its procurement cost.

(c) Fuel Cost

Table B.4.55 shows the fuel cost. The price of each type of fuel is based on the current price checked by the GWMC Waste Manager. The price of diesel shows a unique tendency. Normally, the price of diesel oil is cheaper than the price of gasoline. However, prices in Pakistan are the opposite.

Table B.4.55 Fuel Cost

Item	Price (Rs./litre)
Diesel	81
Gasoline	75

(d) Labour Cost

Table B.4.56 shows the monthly and annual wages of workers. The information was provided by CDGG through a GWMC officer.

Table B.4.56 Monthly and Annual Wages of Workers

Item	Monthly Wage (Rs.)	Annual Wage (Rs.)
Sanitary Inspector	31,000	372,000
Sanitary Supervisor	21,000	252,000
Driver	18,000	216,000
Sanitary Worker	15,000	180,000

Based on the information, operation and maintenance cost is calculated. The total amount of operation and maintenance cost is shown in the following **item (8), Implementation Cost for Waste and Transportation.**

(8) Implementation Cost for Waste Collection and Transportation

Table B.4.57 and **Table B.4.58** show the total cost of waste collection and transportation vehicles. Total cost of waste collection and transportation vehicles is Rs. 11,891,465,000 in the master plan. **Table B**.4.59 and **Table B.4.60** show the total cost of waste collection containers. Total cost of waste collection and transportation container is Rs. 574,308,000 in the master plan.

Table B.4.57 Total Cost of Waste Collection and Transportation Vehicles (Year 2016-2023)

(Unit: thousand Rs.)

Vehicle	2016	2017	2018	2019	2020	2021	2022	2023
Procurement Cost	173,000	228,000	688,000	92,000	138,000	240,900	248,400	237,200
Maintenance Cost	27,605	41,387	76,627	72,595	79,796	92,828	105,825	116,610
Operating Cost	121,564	146,175	235,964	261,578	276,109	302,350	277,837	297,687
Total	322,169	415,562	1,000,591	426,173	493,905	636,078	632,062	651,497

Table B.4.58 Total Cost of Waste Collection and Transportation Vehicles (Year 2024-2030)

(Unit: thousand Rs.)

Vehicle	2024	2025	2026	2027	2028	2029	2030	Total
Procurement Cost	278,500	337,800	451,600	512,800	537,200	624,600	651,200	5,439,200
Maintenance Cost	128,371	140,372	151,030	163,548	176,960	192,412	209,200	1,776,568
Operating Cost	319,308	342,025	362,767	388,212	415,493	447,381	481,247	4,675,697
Total	726,179	820,197	965,397	1,064,560	1,129,653	1,264,393	1,341,647	11,891,465

Table B.4.59 Total Cost of Waste Collection Containers (Year 2016-2023)

(Unit: thousand Rs.)

Container	2016	2017	2018	2019	2020	2021	2022	2023
Procurement Cost	16,800	19,600	16,800	37,800	7,000	22,400	20,160	24,200
Maintenance Cost	1,402	2,382	3,222	5,040	5,341	6,328	7,105	8,000
Total	18,202	21,982	20,022	42,840	12,341	28,728	27,265	32,200

Table B.4.60 Total Cost of Waste Collection Containers (Year 2024-2030)

(Unit: thousand Rs.)

Container	2024	2025	2026	2027	2028	2029	2030	Total
Procurement Cost	25,200	25,200	26,880	30,800	35,600	65,800	83,100	457,340
Maintenance Cost	8,756	9,477	10,170	10,958	11,865	12,787	14,135	116,968
Total	33,956	34,677	37,050	41,758	47,465	78,587	97,235	574,308

4.1.8 Street Cleaning

According the interview survey with a waste manager, GWMC conducts street sweeping manually. Sanitary workers conduct the street sweeping early in the morning for 6 days to avoid the heavy traffic in the city in the daytime. GWMC also conducts mechanical road sweeping on major streets such as

G.T. Road. Since there is no official record on working area except Zone 9 and Zone 10, the total length of mechanical and manual sweeping is not known by GWMC.

Street sweeping is also included in this master plan.

(1) Street Sweeping Length

GWMC has set Zone 9 and Zone 10 as street sweeping areas. Street sweeping on middle-sized roads is conducted by sanitary workers. However, GWMC does not have any accurate data such as total length and waste amount of the roads in the city. Targeted streets in Zone 9 and Zone 10 are as follows. **Table B.4.61** shows a summary of major road lengths.

Zone 9: G.T. Road, Gondlanwala Road, Nowshera Road, Hafizabad Road and Sheikhupura Road

Zone 10: G.T. Road, Pasrur Road, Sialkot Road, DC Road and Civil Hospital Road

Table B.4.61 Summary Major Road Lengths

Zone	Name of Road	Length (km)
9	Gondlanwala Road	4.4
	Nowshera Road	3.2
	Hafizabad Road	4.4
	Sheikhupura Road	4.2
	G.T. Road	6.9
Sub-Total		23.1
10	G.T. Road	5.5
	Pasrur Road	3.0
	Sialkot Road	4.7
	DC+Hospital Road	3.3
Sub-Total		16.5
Grand Total		39.6

GWMC conducts street cleaning for 23.1 km of major city streets in Zone 9 and 16.5 km in Zone 10. In this master plan, other roads such as Sialkot Bypass Road are also targeted for street cleaning.

The necessary length for street sweeping has been estimated by measurement from the map in Google Earth. Based on the result of the measurement, targeted length is set in the master plan.

Figure B.4.11 shows the targeted major roads for street cleaning. **Table B.4.62** shows the total length of streets in Zone 9 and **Table B.4.63** shows the total length of streets in Zone 10.

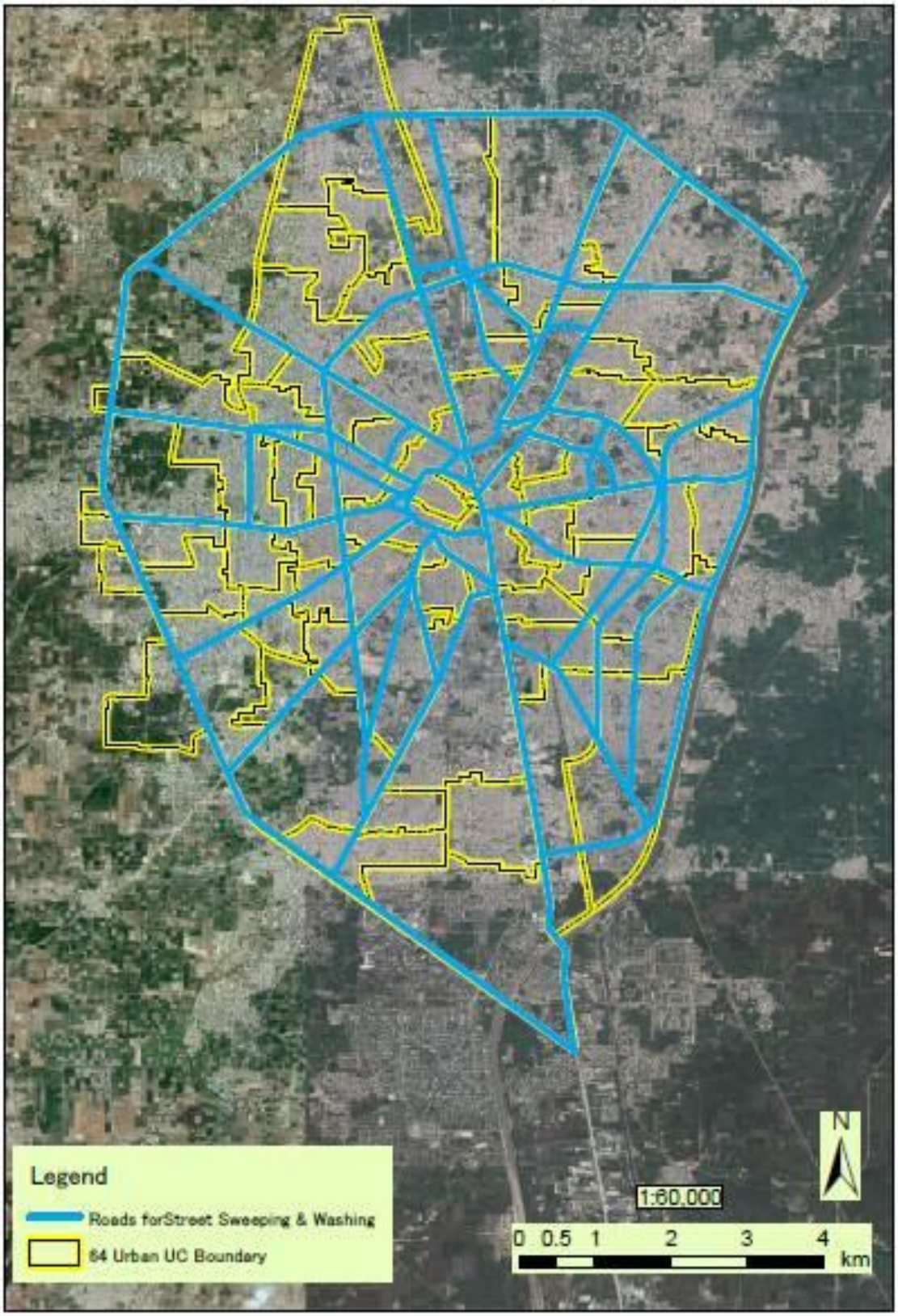

Figure B.4.11 Map of Major Roads Targeted for Street Cleaning

Table B.4.62 Total Length of Streets in the City (Zone 9)

Road Name	Length (km)	Number of Lanes	Necessary Cleaning Length (km)
Gondlanwala Road	4.4	3	26.4
Nowshera Road	3.2	3	19.2
Hafizabad Road	4.4	3	26.4
Sheikhupura Road	4.2	3	25.2
G.T. Road	6.9	3	41.4
Nomania Road	0.6	2	2.4
Kharadian+Daingawala Bazar	0.6	2	2.4
Urdu Bazar	0.4	2	1.6
Daal Bazar	0.3	2	1.2
Circular Road	1.8	2	7.2
Nomania+College+Garjakh Road	4.3	2	17.2
Clock Tower Road	0.4	2	1.6
Rail Bazar	3.0	2	12.0
Qazafi Road	1.2	2	4.8
Parao+Mubarikshah Road	1.6	2	6.4
Mian Sansi Road	1.4	2	5.6
Kach Khiali Road	2.2	2	8.8
Nowshera Sansi Road	3.3	2	13.2
Jinnah Road	7.3	2	29.2
Bypass Road - West Side	15.5	2	93.0
Total	51.5	-	345.2

Note: All roads are two-way traffic.

Table B.4.63 Total Length of Streets in the City (Zone 10)

Road name	Length (km)	Number of lanes	Necessary Cleaning Length (km)
G.T. Road	5.5	3	33.0
Pasrur Road	3.0	3	18.0
Sialkot Road	4.7	3	28.2
DC+Hospital Road	3.3	3	19.8
Kacha Fatomand	3.1	2	12.4
Main Road	2.9	2	11.6
Kashmir Road	3.5	2	14.0
Jalaludeen Road	1.7	2	6.8
Aminabad Road+Faisal Road	3.0	2	12.0
Circuar Road+Ghordor Road	4.3	2	17.2
Faerozwala Road	2.8	2	11.2
Sir Syad Ali Road Satellite Town	1.3	2	5.2
Fateh ali Road	0.9	2	3.6
Hamilton Road	0.5	2	2.0
Gill Road+Sui-Gas Road	3.8	2	15.2
Kachari Road	0.7	2	2.8
Jinnah Road	4.3	2	17.2
Approach Road	0.9	2	3.6
Bypass Road - East Side	14.3	2	85.8
Total	50.2	-	319.6

Note: All roads are two-way traffic.

The total length of other roads in the city has been estimated from satellite map. (**Figure B**.4.12) The congested area in the centre of the city was selected for calculating the street length.

Total area of 64 UCs: 65km^2

Sample area: 200m × 500m (= 0.1km^2)

Number of streets in the area: 200m × 10 units (two-way street, 1 lane on each way)

Total street length in sample area: 4,000m (200m×10×2)

Total street length in the inner city: 65km^2/0.1km^2×4,000m = 2,600km

Figure B.4.12 Sample Area for Estimation of Total Length of City Roads (Not to Scale)

If, for example, both sides of the streets are to be cleaned, the total street length for cleaning becomes double, i.e., 5,200km. If the streets are to be cleaned by street sweepers, the required total number of street sweepers is estimated at about 1,000 persons based on the condition that one person can sweep 1.5km to 2km per day as obtained from the present activities and sweeping twice in a week.

(2) Necessary Number of Vehicles for Street Cleaning

Traffic on major roads such as G.T. Road and the Bypass road is heavy but it is necessary to clean them portion by portion once a week. Traffic on roads in the city area is also heavy but not as heavy as the major roads and hence sufficient to conduct street cleaning portion by portion once in every two weeks. The street sweeper is applied for major roads and road washing machine is applied for other roads. **Table B.4.64** shows the number of street cleaning equipment. Two mechanical sweepers and four road washers are deployed in the master plan.

Table B.4.64 Number of Street Cleaning Equipment

Item	Number of Vehicles	Cleaning Length per Vehicle (km/month)	Cleaning Length per Vehicle (km/month)	Total Length of Road (km)	Frequency of Cleaning per Location
Street sweeper	2	1,248	2,496	665	Once a week
Road washer	4	1,248	4,992	2,600	Once in two weeks

Table B.4.65 and **Figure B.4.13** show the number of vehicles for street cleaning in each year. Waste collection amount in 2016 is 762 ton/day, that of 2021 is 1,601 ton/day and that of 2025 is 2,271 ton/day. The tendency shows that waste collection amount is doubled in 2021 and tripled in 2025. It is assumed that it reflects the commercial activity in the city and improvement or extension of the major roads is expected in the future. For meeting the future situation, 6 street sweepers and 6 road washers are to be deployed in 2030. Compared with the major roads, development of the residential area in the city centre is relatively low due to congestion. Since it is difficult to assume the number of road washers between 2021 and 2030, the total number of road washers is set as the same number as the street sweepers.

Table B.4.65 Number of Vehicles for Street Cleaning (Year 2016-2030)

Item	2016-2020	2021-2025	2026-2030
Street sweeper	2	4	6
Road washer	4	4	6

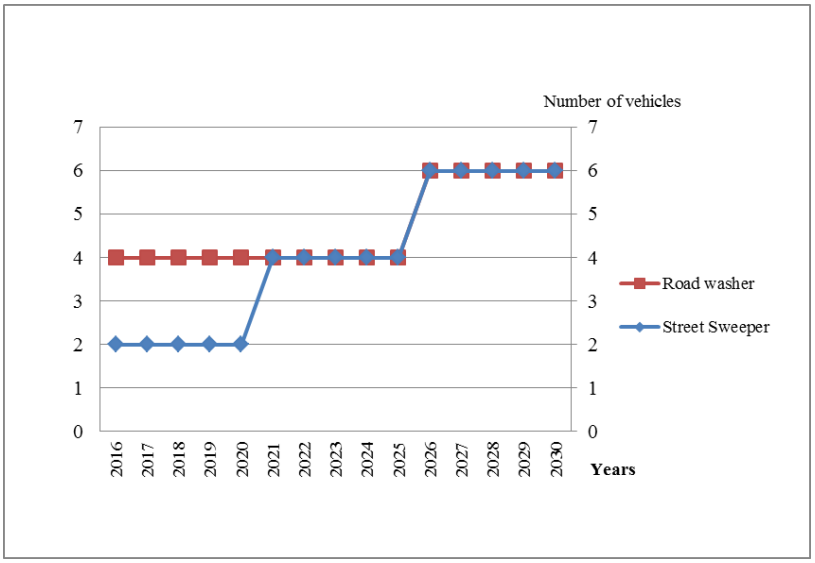

Figure B.4.13 Number of Vehicles for Street Cleaning (Year 2016-2030)

(3) Procurement and Operation and Maintenance Costs

(a) Procurement Cost

Based on the necessary vehicles, workers and street sweeping cost is estimated. For estimating the procurement cost and maintenance cost, procurement cost on each item is referred from the quotation of a local supplier and GWMC. **Table B.4.66** shows the procurement cost per unit of vehicle.

Table B.4.66 Procurement Cost per Unit of Vehicle

Vehicle	Procurement Cost (Rs.)
Street sweeper	12,000,000
Road washer	9,200,000

(b) Operating Cost

The conditions for labour cost and fuel cost are the same as the prices mentioned in **Subsection 4.1.7, Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation**. Since fuel consumption amount for street cleaning vehicles varies depending on the traffic condition, the amounts are not appropriate to set the fuel consumption per vehicle and hence the consumption of arm-roll truck is applied. The chassis of both cleaning vehicles are the same as the arm-roll truck and daily mileage of each type is around 48 km. The average speed of each type of vehicle for cleaning a street is 6 km/hr and working hour is 8 hours.

(c) Maintenance Cost

The condition for maintenance cost is the same as the price mentioned in **Subsection 4.1.7, Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Five per cent (5%) of vehicle cost is set as maintenance cost.

(4) Implementation Cost

Table B.4.67 and **Table B.4.68** show the total cost of street sweeping.

Table B.4.67 Total Cost of Street Cleaning (Year 2016-2023)

(Unit: thousand Rs.)

Item	2016	2017	2018	2019	2020	2021	2022	2023
Procurement Cost	60,800	0	0	0	0	24,000	0	0
Maintenance Cost	2,780	2,780	2,780	2,780	2,780	3,160	3,160	3,160
Operating Cost	3,748	3,748	3,748	3,748	3,748	5,237	5,237	5,237
Total	67,328	6,528	6,528	6,528	6,528	32,397	8,397	8,397

Table B.4.68 Total Cost of Street Cleaning (Year 2024-2030)

(Unit: thousand Rs.)

Item	2024	2025	2026	2027	2028	2029	2030	Total
Procurement Cost	21,200	0	42,400	9,200	0	12,000	9,200	178,800
Maintenance Cost	3,160	3,160	4,740	4,740	4,740	4,740	4,740	53,400
Operating Cost	5,237	5,237	7,855	7,855	7,855	7,855	7,855	84,198
Total	29,597	8,397	54,995	21,795	12,595	24,595	21,795	316,398

Currently, GWMC utilises 980 street sweepers who are currently involved in main roads on site and planned to be shifted to work for narrow streets. Since the labour cost for street sweepers amounting to approximately Rs. 200 million per year is regularly paid by CDGG, this expense is excluded from the financial analysis in the master plan.

4.1.9 Bulky Waste

There are 36 public parks in Gujranwala and the total area is approximately 580,000 square metres (m^2). The largest park in the city is Gulshan-e-Iqbal Park (106,000 m^2) abutted on G.T. Road. There are also trees along the street. Green waste is generated from the park and the street.

Bulky wastes generated from tree trimming, old furniture, etc., need to be considered for waste collection. Since they are not occasionally generated from the source, necessary vehicles and workers for these wastes are deployed separately from the regular collection in the master plan.

(1) Necessary Vehicles and Workers for Bulky Waste

Two 5-ton trucks and one wheel loader are deployed for the collection of bulky wastes. One driver and one sanitary worker are deployed per 5-ton truck and one driver is deployed on the wheel loader. **Table B.4.69** and **Figure B.4.14** give a summary of the vehicles and workers for bulky waste. The workers are deployed as one team and work in 6 days (Monday to Saturday). Basically, the team collects green waste such as tree trimmings. However, if a sanitary supervisor or sanitary inspector orders them to collect bulky waste from households, they collect them from the source.

Table B.4.69 Summary of Vehicles and Workers for Bulky Waste

Item	Number of Vehicles and Workers
5 ton truck	2
Wheel Loader	1
Sanitary worker	1

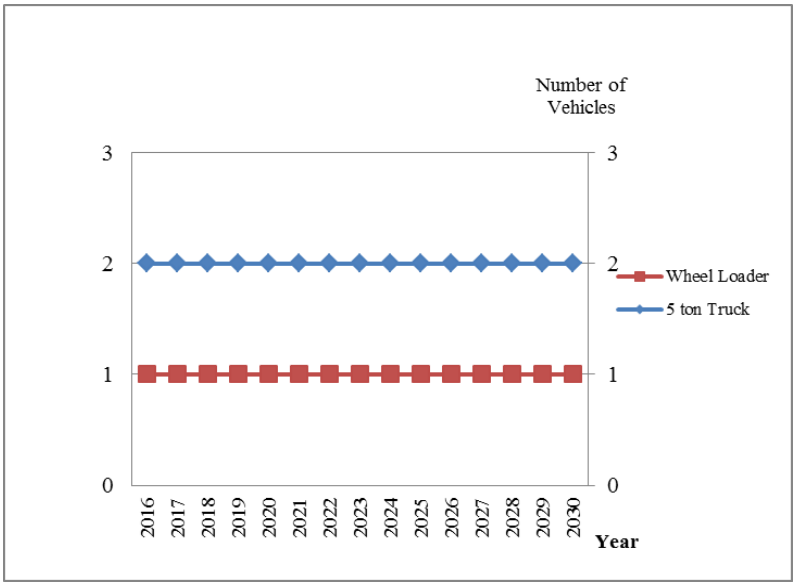

Figure B.4.14 Number of Bulky Waste Collection Vehicles (Year 2016-2030)

(2) Operation and Maintenance Cost

(a) Procurement Cost

Based on the necessary vehicles and workers for collecting bulky waste, waste collection cost is estimated. **Table B.4.70** shows the procurement cost of each item. For estimating the procurement cost and maintenance cost, procurement cost on each item is referred from the quotation of a local supplier and GWMC.

Table B.4.70 Procurement Cost of Vehicles for Bulky Waste

Item	Procurement Cost (Rs.)
5 Ton Truck	3,800,000
Wheel Loader	12,000,000

(b) Operating Cost

The condition for labour cost and fuel cost is the same as the price mentioned in **Subsection 4.1.7, Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation**. Fuel consumption, daily mileage and number of trips for a 5 ton truck are set based on the arm-roll truck. The fuel consumption for operating the wheel loader is set at 0.3 litres per ton.

(c) Maintenance Cost

The condition for maintenance cost is the same as the price mentioned in **Subsection 4.1.7, Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation**. Five per cent (5%) of vehicle cost is set as maintenance cost.

(3) Implementation Cost for Bulky Waste

Table B.4.71 and **Table B.4.72** show the project cost for bulky waste. The total cost for collecting bulky waste is Rs. 97,343 thousand in total.

Table B.4.71 Implementation Cost for Bulky Waste (Year 2016-2023)

(Unit: thousand Rs.)

Item	2016	2017	2018	2019	2020	2021	2022	2023
Procurement Cost	19,600	0	0	0	0	0	0	0
Maintenance Cost	980	980	980	980	980	980	980	980
Operation Cost	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150
Total	23,730	4,130	4,130	4,130	4,130	4,130	4,130	4,130

Table B.4.72 Implementation Cost for Bulky Waste (Year 2024-2030)

(Unit: thousand Rs.)

Item	2024	2025	2026	2027	2028	2029	2030	Total
Procurement Cost	15,800	0	0	0	0	0	0	35,400
Maintenance Cost	980	980	980	980	980	980	980	14,700
Operation Cost	3,150	3,150	3,150	3,150	3,150	3,150	3,150	47,250
Total	19,930	4,130	4,130	4,130	4,130	4,130	4,130	97,350

4.1.10 Illegal Dumping Site

There are nearly 800 illegal dumpsites in Gujranwala City. Some of these illegal dumpsites are large and some are small and consist of some heaps of garbage scattered over an open plot. These illegal dumpsites degrade not only the scenery and environment but also the health and sanitary conditions due to obnoxious odour and proliferation of disease causing organisms. Thus, urgent countermeasures are one of the important activities of solid waste management. Clearing of the illegal dumpsites should thus be one of the urgent issues to be tackled by GWMC.

GWMC tried to outsource and conduct bidding for the clean-up of illegal dumpsites in the city on May 2014, but the price offered by the Contractor was above the budget and hence ended in failure. To solve the situation, GWMC has been conducting one-time cleaning operations (hereafter referred to as "OTC") since September 2014 by deploying two tractor trolleys and one wheel loader on weekdays to do work separately from the regular waste collection, and eight to ten arm-roll trucks and one wheel loader every Sunday.

(1) Amount of Waste of Illegal Dumpsites in the City

Waste managers in GWMC conducted a survey on the location and amount of waste in the illegal dumpsites in the city in August 2014. According to the survey, there are 799 illegal dumpsites and the total amount of waste is 31,385 tons. It seems that the amount of waste in the sites has decreased. However, illegal dumping occurs at the same location after two or three weeks. One site has been totally cleaned by OTC.

Table B.4.73 gives information on the illegal dumpsites and OTC, showing that there are still 21,739 tons of waste at the sites. The target collection amount of illegal dumpsites is 21,739 tons. The waste collection amount from the illegal dumpsites is, however, not taken into account in the incoming waste amount for the final landfill site because the estimated total waste amount from the illegal dumpsites is negligible compared to the daily incoming waste amount.

Table B.4.73 Summary of Illegal Dumpsites and OTC

Zone	Number of Illegal Dumpsites	Waste Amount (ton)
1	86	6,949
2	203	2,030
3	81	9,346
4	68	2,754
5	191	4,660
6	112	4,749
7	15	349
8	43	998
(1) Sub-Total	799	31,835
(2) OTC		10,094
Waste Amount [(1)-(2)]		21,739

(2) Time Duration for Cleaning the Sites

In this master plan, the period of cleaning the illegal dumpsites is set as 3 years. The work is planned to start in 2016 and finished in 2018. At the end of 2018, the waste collection in 64 UCs should be 100% as proposed in the master plan in accordance with the waste collection plan.

(3) The Optimal Plan for Cleaning Illegal Dumping Sites

There are two possibilities to solve this issue: (i) GWMC conducts the cleaning of illegal dumpsites and (ii) GWMC hires a contractor for the cleaning of illegal dumpsites. Based on the cost comparison, the optimal plan for the cleaning of illegal dumpsites is as proposed in the master plan.

(a) Cleaning of Illegal Dumpsites by GWMC

In this case, GWMC procures adequate vehicles and workers for cleaning the sites in the city. Two units of 5-ton truck, one unit of wheel loader and two workers are needed for the work. **Table B**.4.74 shows the necessary vehicles and workers for the cleaning work. The assigned vehicles and workers conduct only the cleaning work and are separate from the regular waste collection work.

Table B.4.74 Necessary Vehicles and Workers for the Clean-up Work on Illegal Dumpsites

Item	Number of Vehicles and Workers
5 Ton Truck	2
Wheel Loader	1
Driver	3
Sanitary Worker	2

The conditions for cleaning the illegal dumping sites are the following:

- The number of trips for one unit of 5-ton truck is 5 based on the number of trips of arm roll truck in the time and motion study because both types of truck are similar in machinery.
- The loading capacity is set as 5 tons. Therefore, 5 tons × 5 trips/day × 2 vehicles = 50 tons/day = 1,200 tons/month (6 working days, 4 weeks).
- Minimum waste collection amount is 604 tons/month (21,739 tons for 36 months).
- If one 5-ton truck is deployed for the work, the waste collection amount is 600 tons/month (5-ton × 5 trips/day × 1 vehicle = 25 tons/day = 600 tons/month (6 working days, 4 weeks).
- For loading waste into two units of 5-ton trucks, one unit of wheel loader is deployed.

(b) Cleaning of Illegal Dumping Sites by a Hired Contractor

In this case, GWMC will procure the services of a contractor for cleaning the illegal dumpsites. The contractor is then obligated to procure and deploy the necessary number of vehicles for the clean-up of illegal dumpsites in the city.

(4) Operating Cost

(a) Cleaning of Illegal Dumpsites by GWMC

- Procurement Cost

  Based on the necessary vehicles and workers, cleaning cost for illegal dumping sites in the city is estimated. For estimating the procurement cost and maintenance cost, procurement cost of each item is referred from the quotation of a local supplier and GWMC. The price is the same as the price in **Subsection 4.1.9, Bulky Waste**.

- Operating Cost

  The condition for labour cost and fuel cost is the same as the price mentioned in **Subsection 4.1.7. Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Fuel consumption, daily mileage and number of trips of one 5-ton truck are set based on the values for an arm-roll truck. The fuel consumption for operating the wheel loader is set at 0.3 litres per ton.

- Maintenance Cost

  The condition for maintenance cost is the same as the price mentioned in **Subsection 4.1.7, Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Five percent (5%) of vehicle cost is set as the maintenance cost.

Table B.4.75 shows the total cost of the clean-up work conducted by GWMC. It is estimated that the clean-up work for all illegal dumpsites will take 18 months at the cost of Rs. 23,772,280. The average cost is Rs. 1,094 per ton.

Table B.4.75 Total Cost of Clean-up Work Conducted by GWMC for Illegal Dumpsites

Responsible Agency	Work Duration (months)	Implementation Cost (Rs.)
GWMC	18	23,772,280

(b) Clean-up of Illegal Dumpsites by a Hired Contractor

In this case, GWMC hires a contractor for cleaning the sites in the city. GWMC conducted the tender for cleaning the illegal dumpsites in May 2014. However, the tender price from the contractor exceeded the ceiling price so that there was no eligible tenderer for the work. **Table B**.4.76 shows the unit cost submitted by the contractor. The size and amount of waste on site vary in each site. Thus, the unit price for cleaning the site is adopted based on the average unit price offered by the contractor.

Table B.4.76 Unit Cost of Clean-up Work Submitted by a Contractor for Illegal Dumpsites

Item	Unit Cost per Ton (Rs.)
Lot 1	1,590
Lot 2	1,550
Lot 3	1,680
Lot 4	1,500
Average	1,565

The contractor submitted the unit price for the work as Rs. 1,565 per ton on average. In this master plan, the total cost for the work is estimated from the unit price.

Total amount 21,739 tons × Rs. 1,565/ton = Rs. 34,218,848

The total cost of cleaning all illegal dumpsites is Rs. 34,218,848.

(5) Cost Comparison and Conclusion

Table B.4.77 shows the comparison of cost for the clean-up work. The cost of outsourcing the work is more expensive than the work conducted by GWMC by itself. The master plan adopts the clean-up work for illegal dumpsites done by GWMC.

Table B.4.77 Comparison of Costs for the Clean-up of Illegal Dumpsites

(Unit: thousand Rs.)

Item	Total Cost in three 2 years
Clean-up work conducted by GWMC	23,773
Outsourcing of clean-up work	34,022

(6) Implementation Cost

Table B.4.78 shows the annual project cost of cleaning the illegal dumpsites in the city. The total cost for the clean-up work is Rs. 25,627,000.

Table B.4.78 Cost for the Clean-up of Illegal Dumpsites in the City (Year 2016-2018)

(Unit: thousand Rs.)

Item	2016	2017	Total
Cost for Clean-up of illegal dumpsites	22,382	1,391	23,773

4.1.11 Construction and Demolition Waste

The collection and disposal of construction and demolition waste (C&D waste) is not the responsibility of GWMC as clearly stipulated by law. However, construction companies or developers leave their C&D waste at the construction site or dump them in open plots in the city. Thus, the clean-up of C&D waste has become a part of GWMC's cleaning activity according to the survey conducted by the JICA Project Team. C&D waste collection is also a part of the Master plan.

According to the LWMC report, the daily generation amount of the waste is 141 tons. However, it is difficult to assume the actual generation amount of C&D waste since the waste is collected with other types of waste and abandoned C&D waste is scattered all over the city. Another reason for the difficulty of assumption is that C&D waste is not discharged in a particular place or particular amount. C&D waste generation is related to the process of land development by the public and private sectors so that it is also unpredictable for GWMC to foresee the future development plan.

In this master plan, C&D waste is supposed to be collected separately.

(1) Fee for Collection of C&D Waste and Outsourcing the Waste Collection

Currently, GWMC collects the waste for free. No fee is taken from building contractors or land developers, and most of the C&D wastes generated from construction sites are taken to borrow pits in the city. However, the others are dumped illegally on the roadsides or open plots and GWMC takes the waste to the landfill site for free.

GWMC needs to set a schedule of charges for C&D waste. Outsourcing of the collection of C&D wastes to a private company is thus being considered. C&D waste is generated from commercial activity. Most of them are rocks, sand, concrete and reinforced bar and the character of the waste is totally different from domestic waste or other commercial wastes. A special vehicle for the waste collection and transportation is also necessary for conducting the work. For acquiring the cost of operating and maintaining the vehicles, setting the schedule of charges is necessary. For instance, GWMC estimates the necessary cost such as fuel cost etc. for C&D waste carriage per ton. Once collected C&D waste is collected and measured on weighbridge at landfill site, a contractor will pay the bill at GWMC head office.

It is difficult for GWMC to handle C&D waste collection by itself since time is also needed for the collection of domestic and commercial waste. It has to focus on the current waste collection work for the following reasons: 1) the collection area in 64 UCs has to be 100% covered in 2018; 2) collection amount is increased up to 2030; 3) waste collection in 34 UCs in peri-urban area starts in 2019; and 4) collection area in 34 UCs is to be 100 % covered in 2030. Outsourcing the collection of C&D waste to a private company is necessary to lessen the work load of GWMC.

(2) Operation and Maintenance Cost

(a) Number of Vehicles and Workers

C&D waste is generated from construction sites and consists of rocks, sand and concrete, among others so that a compactor is not suitable for C&D waste collection. Most construction sites do not have enough space for C&D waste and large heaps are usually formed so that loading them into a collection vehicle is an arduous job for the sanitary workers.

It is necessary to deploy a wheel loader for loading C&D waste. **Table B.4.79** shows the necessary collection vehicles. To reduce the idle time on trucks, three 5-ton trucks and one wheel loader for the collection work are to be deployed.

Table B.4.79 Vehicles Necessary for the Collection of C&D Waste

Item	Number of Vehicles
5-ton Truck	3
Wheel Loader	1

(b) Procurement Cost

Based on the necessary number of vehicles and workers, cleaning cost for illegal dumpsites in the city is estimated. For estimating the procurement cost and maintenance cost, procurement cost of each item is referred from the quotation provided by a local supplier and GWMC. The price is the same as that of item (10), Bulky Waste.

GWMC is considering the outsourcing of C&D waste collection work to a private company so that depreciation is considered in estimating the procurement cost.

(c) Operating Cost

The condition for labour cost and fuel cost is the same as the price mentioned in **Subsection 4.1.7, Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Fuel consumption, daily mileage

and number of trips of a 5-ton truck are set based on the values for arm-roll truck. Fuel consumption for operating a wheel loader is set as 0.3 litres per ton.

(d) Maintenance Cost

The condition for maintenance cost is the same as the price mentioned in **Subsection 4.1.7, Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Five per cent (5%) of vehicle cost is set as maintenance cost.

(3) Implementation Cost

Table B.4.80 shows the annual cost of C&D waste collection. Based on the implementation cost, GWMC needs to set the schedule for charges of C&D waste.

Table B.4.80 Annual Cost of C&D Waste Collection

Item	Annual Cost (Rs.)
Collection cost for C&D waste	7,690,126

4.1.12 Parking Area

The number of collection vehicles has been increasing and the collection rate has improved. An additional parking area for procured vehicles is necessary in the future.

GWMC has its own parking area/garage in the centre of the city. The garage can accommodate approximately 100 vehicles. GWMC has no expansion plan or additional parking plan. The current garage has a limited area so that construction of an additional car parking area is necessary for the collection operation.

In this master plan, the number of parking areas is planned to be gradually increased based on the total number of collection vehicles from 2016 to 2030. Annual number of vehicles in the master plan is shown in **Table B.4.81, Table B.4.82** and **Table B.4.83**. The total number of vehicles includes waste collection and transportation vehicles, vehicles for bulky waste and vehicles for street sweeping.

Table B.4.81 Annual Number of Waste Collection Vehicles in the Master Plan (Year 2014-2019)

Year	2014	2015	2016	2017	2018	2019
Number of Waste Collection Vehicles	96	121	155	190	310	325

Table B.4.82 Annual Number of Waste Collection Vehicles in the Master Plan (Year 2020-2025)

Year	2020	2021	2022	2023	2024	2025
Number of Waste Collection Vehicles	340	383	343	370	397	426

Table B.4.83 Annual Number of Waste Collection Vehicles in the Master Plan (Year 2026-2030)

Year	2026	2027	2028	2029	2030
Number. of Waste Collection Vehicles	457	490	527	568	612

In 2030, the total number of vehicles could be 612. However, the existing garage can accommodate only approximately 100 vehicles. Hence, the designated number of vehicles in one parking area is set as 100 vehicles. This number is the same as the capacity of the existing parking area. The necessary number of parking areas is calculated as follows:

Total number of vehicles: 612 / 100 vehicles per parking area = 6 parking areas

Necessary number of parking areas in 2030 is set and capacity of parking area is calculated again as: 612/6 = 102 vehicles per parking area.

Based on the calculation, a parking area is designed for the parking capacity of 102 vehicles. The function of the parking area is only to park vehicles. The repair work is performed in the existing garage. The specifications of the new parking area are as follows:

- Size of the area: 6,000m^2
- Parking area: The area accommodates 102 vehicles
- Roofing: Steel skeleton structure
- Pavement: Asphalt-paved
- Security system: 1 unit of guardhouse; fencing around the parking area

For security reasons, one guardhouse is built and steel fence is installed around the facility. The place where vehicles are parked is covered with a steel skeleton building for protection against rain.

The existing garage has no pavement and no roofing in parking area. The cost for improvement of the garage is included in the master plan.

- Necessary pavement area on existing garage: 3,735m^2
- Necessary roofing area on existing garage: 1,344m^2

Based on the total number of vehicles in each year, total number of necessary parking area is estimated. **Table B.4.84** and **Table B.4.85** show the total number of parking area in each year. **Figure B.4.15** shows the total number of waste collection vehicles and parking areas. Four parking areas are needed in short term and middle term. In 2030, six parking areas are needed.

Table B.4.84 Annual Number of Parking Areas (Year 2016-2023)

Year	2016	2017	2018	2019	2020	2021	2022	2023
Number of Parking Area	2	2	4	4	4	4	4	4

Table B.4.85 Annual Number of the Parking Areas (Year 2024-2030)

Year	2024	2025	2026	2027	2028	2029	2030
Number of Parking Area	4	5	5	5	6	6	6

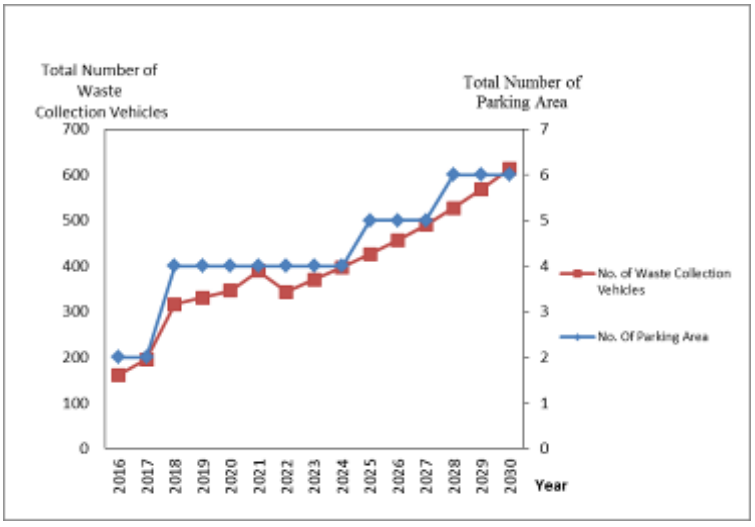

Figure B.4.15 Graphical Presentation of the Total Number of Waste Collection Vehicles and Parking Areas (Year 2016-2030)

(1) Procurement, Operation and Maintenance Cost

(a) Procurement Cost

Based on the necessary items, the procurement cost for the parking area is estimated. For estimating the procurement cost and maintenance cost, the unit price of each item is referred from the quotation provided by a local contractor and GWMC. **Table B.4.86** shows the unit price of each item. GWMC may need to rent the necessary land for the parking area.

Table B.4.86 Unit Price of Each Item

Item	Unit Cost (Rs.)
Land Rental	50/m^2
Fencing	7,000/m
Asphalt Pavement	1,150/m^2
Guardhouse	16,140/m^2
Skeleton Structure Building	15,900/m^2
Gate	200,000/set

(b) Operating Cost

The operating cost varies depending on the operation status in the parking area. Thus, it is illogical to estimate the operating cost for the parking area. In this master plan, 10% of land rental is set as the operating cost.

(c) Labour Cost

Table B.4.87 shows the monthly and annual wages of a security guard. The information was provided by CDGG through a GWMC officer.

Table B.4.87 Monthly and Annual Wages of a Security Guard

Item	Monthly Wage (Rs.)	Annual Wage (Rs.)
Security Guard	16,500	198,000

(d) Maintenance Cost

Due to weather condition or status of use in the parking area, the maintenance cost varies. Thus, it is illogical to estimate maintenance cost for the parking area. In this master plan, 5% of procurement cost is set as the maintenance cost.

(2) Implementation Cost for the Parking Area

Table B.4.88 and **Table B.4.89** show the annual implementation cost of a parking area.

Table B.4.88 Annual Implementation Cost of Parking Area (Year 2016-2023)

(Unit: thousand Rs.)

Item	2016	2017	2018	2019	2020	2021	2022	2023
Procurement Cost	118,582	0	388,848	0	0	0	0	0
Maintenance Cost	6,726	2,430	2,430	2,430	2,430	2,430	2,430	2,430
Operating Cost	1,116	1,116	2,232	2,232	2,232	2,232	2,232	2,232
Total	126,424	3,546	393,510	4,662	4,662	4,662	4,662	4,662

Table B.4.89 Annual Implementation Cost of Parking Area (Year 2024-2030)

(Unit: thousand Rs.)

Item	2024	2025	2026	2027	2028	2029	2030	Total
Procurement Cost	0	243,030	0	0	291,636	0	0	1,042,096
Maintenance Cost	2,430	2,430	2,430	2,430	2,430	2,430	2,430	40,746
Operating Cost	2,232	2,790	2,790	2,790	3,348	3,348	3,348	36,270
Total	4,662	248,250	5,220	5,220	297,414	5,778	5,778	1,119,112

4.1.13 Project Cost

Table B.4.90 and **Table B.4.91** show the project cost of waste collection and transportation. The total cost of waste collection and transportation is Rs. 14,020,790,000 in the master plan.

Table B.4.90 Project Cost of Waste Collection and Transportation (Year 2016-2023)

(Unit: thousand Rs.)

Year	2016	2017	2018	2019	2020	2021	2022	2023
Procurement Cost	408,382	247,600	1,093,648	129,800	145,000	287,300	268,560	261,400
Maintenance Cost	40,283	47,972	82,817	78,785	85,986	99,398	112,395	123,180
Operating Cost	139,260	162,875	252,784	278,398	292,929	320,659	296,146	315,996
Total	587,925	458,447	1,429,249	486,983	523,915	707,357	677,101	700,576

Table B.4.91 Project Cost of Waste Collection and Transportation (Year 2024-2030)

(Unit: thousand Rs.)

Year	2024	2025	2026	2027	2028	2029	2030	Total
Procurement cost	340,700	606,030	520,880	552,800	864,436	702,400	743,500	7,172,436
Maintenance Cost	134,941	146,942	159,180	171,698	185,110	200,562	217,350	1,886,599
Operating Cost	337,617	360,892	384,252	409,697	437,536	469,424	503,290	4,961,755
Total	813,258	1,113,864	1,064,312	1,134,195	1,487,082	1,372,386	1,464,140	14,020,790

4.2 Evaluation of Separate Collection and Alternate-Day Collection Alternatives

4.2.1 Development of Options

Door-to-door collection and container collection are proposed to the waste collection and transportation plan in the Master Plan as already discussed in the previous Section 4.2. In order to match the waste collection and transportation system with other ISWM activities, especially, the Intermediate Treatment and 3R Promotion Plan, the introduction of separate collection must be evaluated. Furthermore, alternate-day collection is evaluated to study the efficiency of waste collection and transportation operation and the cost effectiveness.

4.2.2 Options for Mixed Waste Collection and Separate Waste Collection

Source separation is adopted in the master plan. For evaluating source separation in the master plan, two alternatives are set: There are no Separation at Source and Zero options.

(1) Separation at Source

Separation at source is conducted by each household. The activity starts in 2019. Two types of waste containers are applied to the plan. One is for disposing organic waste such as kitchen waste and market waste; the other is for disposing other wastes except organic waste. These two containers are distinguished by painting them in two different colours for the residents to easily identify the appropriate container. Wastes from these containers are collected on alternate days. For example, organic waste is collected every Monday, Wednesday and Friday, and the other container is collected every Tuesday and Thursday. The containers of $5m^3$ in capacity are placed at the large

waste discharge points such as shopping malls or markets in the city. The containers are collected once they are full of waste. Although it is an arduous work for the residents to separate waste for the first time and it may take time for them to understand the separation of waste in the right way, the city would become cleaner and this option is compatible to the 3R plan in the master plan. **Table B**.4.92 shows the result of environmental and social survey on separation at source. The result of the survey shows that the separation at source gives positive impact. Separation at source is good from the environmental and social aspects.

Table B.4.92 Result of Environmental and Social Survey on Waste Separation at Source

Item	Environmental Impact
Soil	Minor Positive Impact
Waste	Moderate Positive Impact
Ecosystems	Minor Positive Impact
Employment & Livelihood	Moderate Positive Impact
Utilisation of Land & Local Resources	Moderate Positive Impact
Infectious Diseases	Moderate Positive Impact

(2) No Separation at Source

No separation at source means that separation is not conducted by each household. Mixed waste is directly disposed into the container. Since the waste disposal method is not changed although it is easy for the residents to understand the disposal method, this option is not compatible with the 3R plan in the master plan. **Table B.4.93** shows the result of environmental and social survey on the no source separation method. It is difficult to separate organic waste after the collection of waste. The result of the survey shows that no separation at source presents a negative impact. The city becomes cleaner but mixed waste is collected and transferred to the landfill site. This option is not suitable for the 3R plan.

Table B.4.93 Result of Environmental and Social Survey on No Separation at Source

Item	Environmental Impact
Soil	Minor Negative Impact
Waste	Moderate Negative Impact
Ecosystems	Minor Negative Impact
Involuntary Settlement	Moderate Negative Impact
Employment & Livelihood	Moderate Positive Impact
Utilisation of Land & Local Resources	Major Negative Impact
Infectious Diseases	Moderate Negative Impact

(3) Zero Option

This option is the case where GWMC does not conduct any of the plans suggested in this master plan. There is no separation at source conducted by the residents. Waste collection area in the city is limited and uncollected waste is scattered on the open plots. The sanitation condition in the city deteriorates by waste. Currently, there is no separation at source conducted by the residents so that the result of environmental and social impact is negative. The sanitation condition in the city therefore gets worse.

(4) Advantage and Disadvantage of Each Option

Table B.4.94 shows the advantages and disadvantages of each alternative measure. Both separation at source and no source separation systems make the city cleaner. Source separation is better if 3R

activity is considered in the master plan, but "no separation" is not compatible with the 3R plan. It takes time and cost for separation from mixed waste to organic waste.

The cost difference between Separation at Source and No Source Separation is Rs. 6 million Containers having the capacity of $5m^3$ and Arm-roll trucks with the capacity of $5m^3$ are utilised for large waste generators in the Separation at Source. This cost reflects the cost difference for Separation at Source and No Source Separation.

Separation at Source is the most advantageous method for 3R activity. Collected organic waste is directly utilised for composting. However, Separation at Source activity is the first time to be applied in the city. Since it may take time to adjust to the new system, it is necessary to monitor the containers during the waste collection and transportation activity in coordination with the conduct of public awareness campaign.

It is advantageous for the residents to adopt No Source Separation because they do not need to change their waste disposal custom. However, mixed waste collected from containers makes the conduct of 3R activity difficult and it is totally disadvantageous to the solid waste management by GWMC.

On the other hand, Zero Option considers no source separation and increase of waste collection vehicles and containers. The residents do not have to change their waste disposal custom. The project cost is the lowest between three cases; however, the environmental situation is not changed or even gets worse.

Table B.4.94 Advantages and Disadvantages of Each Alternative

Item	Advantages	Disadvantages	Project cost (million Rs)	Evaluation
Separation at Source	- The city becomes cleaner. - The system has positive impacts on environmental and social condition. - The system is compatible with the 3R system.	- It takes time for residents to accustom themselves with waste separation. - Some residents may dispose waste in a wrong container.	14,021	Better
No Source Separation	- Residents do not need to change their disposal method. - The city becomes cleaner. - All types of waste are disposed in one container. - No need to procure arm-roll trucks and large containers. Therefore, Project cost is cheaper than that of separation at source.	- The environmental condition does not change. - The system has a negative impact on environmental and social condition. - The system does not correspond with the 3R system.	14,017	Fair
Zero Option	- Residents do not need to change their disposal method. - The project cost is the lowest among the three cases.	- The environmental condition does not change or even gets worse. - The system has a negative impact on environmental and social condition	3,624	Bad

(5) Selection of Option between Mixed Waste Collection and Separate Waste Collection

Source separation is adopted in the master plan for the following reasons:

- The city becomes cleaner;
- Source separation can omit the waste separation process at the landfill site, if collected waste is utilised for waste recovery such as composting, RDF, etc.;
- Source separation is compatible with the 3R plan;

- Source separation gives positive impact on environment; and
- Other separation systems may be easily applied after the adoption of source separation by the residents.

4.2.3 Options for Daily Collection and Alternate-Day Collection

GWMC provides, basically, the waste collection and transportation service on a daily basis so that the alternate-day waste collection will be a new system in the city, if it is adopted. The advantages and disadvantages of daily and alternate-day collection are shown in **Table B.4.95**. The most advantageous feature of alternate-day collection is its economical aspect; that is, fuel consumption of the alternate-day collection is almost one-half that of the daily collection because the travelling distance within the collection area by the alternate-day collection is around one-half of that of the daily collection.

According to the result of the Time and Motion Study, the total travelling distance of a tractor trolley is 44km per day in two trips per collection. Out of 50km, the travelling distance for collection work is recorded at 3km. Also, based on the same survey results, the travelling distance ratio of waste collection operation to the total distance for the day is calculated at 3km/44km, say 7%. Therefore, in this case, about 3.5% of collection distance can be saved by introduction of alternate-day collection. Once the collection vehicles are replaced by the compactors, the benefit of alternate-day collection will increase more significantly and thus more savings on fuel cost.

Table B.4.95 Advantages and Disadvantages of Daily Collection and Alternate-Day Collection

Option	Advantages	Disadvantages
Daily Collection	- Container collection is carried out before garbage generates odour. - Residents of households practicing the door-to-door collection store only one day amount of garbage in their homes.	- Collection vehicle travels more distance for loading waste to the full capacity. - Daily collection operation could be a nuisance to the residents.
Alternate-Day Collection	- Collection vehicle travels less distance for loading waste to the full capacity. - Residents are free from the nuisance of daily collection operation.	- Odour may be generated from the containers in the 2nd day. - Residents of households practicing door-to-door collection must store garbage for two days at their homes.

4.2.4 Necessity of Implementation of a Pilot Project for the Introduction of Separate Collection and Alternate-Day Collection

A challenging attempt has to be carried out to improve the waste collection service in coordination with the implementation of relevant projects. Separate collection and alternate-day collection of wastes shall be the attempted by GWMC to upgrade its SWM services under the ISWM master plan for Gujranwala. In the Intermediate Treatment and 3R Promotion Plan, a composting plant is proposed to start operating from year 2020. To assure a certain level of quality for composting products, organic waste should be segregated from discharged waste of households and it is thus strongly advisable that separate collection should be introduced.

The separate collection is totally a new system to the residents of Gujranwala. Considering low public awareness towards SWM, it is recommended that a small scale of separate collection shall be carried out at first as a pilot project involving some selected areas before the new system is applied in the whole city. The separate collection is, therefore, scheduled to start in 2019 and the segregated organic waste shall be used for the compost plant that will be operated from 2020. As for the separate collection of combustible waste, the pilot operation will be started in 2028 and continue for one year to prepare for the actual operation in the following year since combustible waste separate collection is scheduled to start in 2029 for raw materials of the RDF plant.

Regarding alternate-day collection, GWMC should also prepare for the introduction of this new collection service in addition to the implementation of the pilot separate collection project. A

representative collection area in terms of the development status of the town shall be selected as a model area to conduct the pilot operation in 2016.

The pilot operation for separate collection and alternate-day collection need the cooperation of all waste generators such as households, workplaces, etc. in the pilot operation area. Environmental education programmes and orientation/guidance programmes related to specific methods of separate collection and alternated-day collection should be carried out in the communities prior to the pilot operation. The pilot operation must be evaluated at the end every month and feedbacks for improving the methods shall be record as required. After establishing a good practice model, the procedures shall be introduced to the adjacent areas and, gradually, to the entire area. Detailed plan for Implementation of a Pilot Project for the Introduction of Separate Collection and Alternate-Day Collection is described on ***5.2 Project for Introduction of Separate Collection and Alternate-Day Collection through Implementation of a Pilot Project.***

4.3 Identification of Project Components for Waste Collection and Transportation Plan

4.3.1 Short-Term Plan (2016-2018)

(1) Introduction of Separate Collection and Alternate-Day Collection through Implementation of Pilot Project

GWMC should designate the pilot project area for the introduction of separate collection and alternate-day collection targeting organic waste from the generation sources. Separate collection and alternate-day collection of targeted waste for waste collection and transportation shall start full scale operation in 2019 to prepare for the operation of the composting facility in 2020. Since these collection systems are new to the residents and the GWMC staff concerned, it may take time to spread the new system smoothly. Therefore, the new system shall be introduced, firstly, at the representative collection zone as a pilot operation and establish the optimum promotion method during the 3 years in the short-term period.

(2) Increase of Waste Collection Rate in 64 UCs up to 100% in 2018

GWMC shall be responsible for expanding the waste collection areas in all 64 UCs. GWMC shall thus prepare the necessary waste collection vehicle and waste container deployment plan for the 8 zones.

The waste collection and transportation is to be carried out to jibe with the practice of separate collection and alternate-day collection. Since these collection systems are new to the residents and the GWMC staff concerned, it may also be difficult to carry out the new system smoothly at the beginning. The new system will therefore be introduced firstly at the representative collection zone, Zone 6, as a pilot operation and expand to the adjacent zones gradually during the 3 years in the short-term period.

(3) Conducting Street Cleaning in 64 UCs

GWMC is obligated to conduct street cleaning in the 64 UCs. For this purpose, GWMC has to procure the necessary street cleaning vehicles.

(4) Collection of Bulky Waste

GWMC is obligated to collect bulky waste. For this purpose, GWMC has to procure the necessary waste collection vehicles for bulky waste.

(5) Clean-up of Illegal Dumpsites in 64 UCs

GWMC needs to employ a private contractor for cleaning up approximately 800 places of illegal dumpsites in the 64 UCs. GWMC should monitor the condition after finishing the clean-up of the sites. The duration of cleaning the illegal dumping sites is set at three (3) years.

(6) Collection of Construction and Demolition Waste

GWMC is obligated to collect construction and demolition waste generated from construction sites. The collection work shall be separate from the ordinary collection of waste. Necessary collection vehicles and equipment shall be deployed for the work. The wastes are generated from sources such as the construction industry. Thus, GWMC has to set the appropriate fee schedule for the collection of construction and demolition waste.

(7) Construction of Parking Area

GWMC is obligated to construct necessary parking areas. Collection vehicles will increase gradually for the waste collection activity. Necessary facilities shall therefore be allocated by GWMC.

4.3.2 Mid-Term Plan (2019-2024)

(1) Planning/Implementation of Separate Collection in 98 UCs

The new collection system of separate collection and alternate-day collection is to be introduced in all the collection zones in accordance with the good practices established in the Zone 6 collection zone. The implementation of the new system in 2019 is intended as the activities in the transitional period toward full- scale operation prior to the start of operation of the compost plant scheduled in 2020. Separate collection will be practiced basically for i) biodegradable waste; ii) recyclable materials (paper, plastics, glass and metals); and iii) other residual wastes. Two types of waste container are to be allocated for separate collection. One is for biodegradable waste and the other is for recyclable materials and other residual wastes. The planning/implementation shall be carried out by the following key factors for implementation in the 98 UCs:

- Determination of type of recyclable materials for segregation at source;
- Consideration of method of discharging/recovering the objective resource materials;
- Selection of the type, size and number of receptacles/containers for temporary storage depending on the recovery site and discharge amount (for example, biodegradable waste put in a $5m^3$ container for fresh market, 20-50 litre container for large waste generators of biodegradable waste, and a $0.8m^3$ container for general domestic waste generators);
- Determination of the method and frequency of recovery and transportation, and the delivery site of each resource material;
- Orientation/education of participating waste generators;
- Dissemination of the activity in 98 UCs;
- Procurement and/or dispatch of vehicles, receptacles/containers, and staffing for separate collection operation; and
- Evaluation of the project implementation and feedbacks for improvement.

(2) Increase of Waste Collection Rate in 34 UCs from 0% to 60% in 2024

GWMC has to expand the waste collection area from the 64 UCs to the 34 UCs in the peri-urban area. GWMC has to prepare necessary waste collection vehicles and the waste containers deployment plan for 9 zones of the peri-urban area.

(3) Sustaining the Waste Collection Rate in 64 UCs with 100% in 2024

GWMC needs to sustain 100% of waste collection rate in the 64 UCs. GWMC has to monitor the deployment of waste collection vehicles and containers in the service area. If the deployment of waste vehicles and/or waste containers is not adequate, GWMC has to employ measures to rectify the situation.

(4) Procurement of Waste Collection Vehicles and Containers in 98 UCs

GWMC has to procure the necessary waste collection vehicles and containers, with the approval of the Punjabi Government, from 2019 to 2023.

(5) Monitoring of Improvement of Waste Collection and Transportation in 98 UCs

GWMC continuously requires carrying out regular monitoring of waste collection amount and waste collection rate. GWMC also needs to monitor the waste collection vehicles and waste containers in 2023. GWMC needs to take measures to improve the collection of waste if the actual waste collection rate does not achieve the target waste collection rate and waste amount. In addition, GWMC needs to monitor the implementation status of source separation during the waste collection.

(6) Conducting Street Cleaning in 64 UCs

GWMC is obligated to conduct street cleaning in the 64 UCs. GWMC has to procure the necessary street cleaning vehicles.

(7) Collection of Bulky Waste

GWMC is continuously obligated to conduct the collection of bulky waste. GWMC has to prepare the necessary waste collection vehicles for bulky waste.

(8) Collection of Construction and Demolition Waste

GWMC is obligated to collect construction and demolition waste generated from construction sites. The collection work shall be separate from the ordinary collection of waste. Necessary collection vehicles and equipment shall be deployed for the work. GWMC has to revise the fee schedule for construction and demolition waste if the economic situation in the city is changed.

(9) Construction of Parking Area

GWMC is obligated to construct necessary parking areas. Collection vehicles will increase gradually for waste collection activity. Necessary facility shall be allocated by GWMC.

4.3.3 Long-Term Plan (2025-2030)

(1) Introduction of Separate Collection through Implementation of Designated Pilot Project Area in 2028 and Promotion of Separate Collection in Other Zones in 2029

GWMC has to conduct the introduction of separate collection of combustible waste on the designated area in short term. This additional separation method is to be introduced in 2028 since separate collection of targeted waste for waste collection and transportation will start full scale in 2029 when the RDF facility starts operation. Once the optimum promotion method is established during the probation period, it shall be disseminated to the other areas in 2029.

(2) Increase of Waste Collection Rate in 34 UCs to 100% in 2030

GWMC has to expand the waste collection area in 34 UCs, which are in peri-urban areas. GWMC has to prepare the necessary waste collection vehicles and the waste containers deployment plan for 9 zones in the peri-urban areas.

(3) Sustaining Waste Collection Rate in 64 UCs from the Present to 100% in 2030

GWMC needs to sustain 100% of waste collection rate in 64 UCs. GWMC has to monitor whether or not the waste vehicles and containers are deployed adequately in the service areas. If the deployment of waste vehicles and/or waste containers is inadequate, GWMC has to employ measures to rectify the situation.

(4) Procurement of Waste Collection Vehicles and Containers in 98 UCs

GWMC shall continuously procure the necessary waste collection vehicles and containers, with the approval of the Punjabi Government, from 2021 to 2030.

(5) Monitoring of Improvement of Waste Collection and Transportation in 98 UCs

GWMC is continuously required to carry out regular monitoring of waste collection amounts and waste collection rate. GWMC also needs to monitor the waste collection vehicles and waste containers in 2030. GWMC needs to take measures to improve the collection of waste if the actual waste collection rate does not achieve the target waste collection rate and waste amount. In addition, GWMC needs to monitor the implementation status of source separation during waste collection.

(6) Conducting Street Cleaning in 64 UCs

GWMC is obligated to conduct street cleaning in the 64 UCs. GWMC has to procure the necessary street cleaning vehicles.

(7) Collection of Bulky Waste

GWMC is obligated to collect bulky waste. GWMC has to procure the necessary waste collection vehicles for bulky wastes.

(8) Outsourcing of Waste Collection and Transportation Services to a Private Company in 2025

GWMC needs to consider the outsourcing of waste collection and transportation service to a private company. Due to the expansion of waste collection service area, service population will be equal to the number of population in half of Lahore City in the year of 2025. LWMC has been practicing the outsourcing of waste collection and transportation service to a Turkish private company and has achieved satisfactory outcome of the services. GWMC should also consider this option for its waste collection and transportation services. Preparation for the tender of outsourcing, conducting the tender and selection of the contractor shall be conducted by GWMC as the part of their daily work. Procurement cost for necessary numbers of waste collection equipment is allocated on **Item (4)** Procurement of Waste Collection Vehicles and Containers in 98 UCs.

(9) Collection of Construction and Demolition Waste

GWMC is obligated to collect construction and demolition waste generated from construction sites. The collection work has to be separate from the ordinary waste collection activities. Necessary collection vehicles and equipment are to be deployed for the work. GWMC has to revise the fee schedule for construction and demolition waste if the economic situation in the city is changed.

(10) Construction of Parking Areas

GWMC is obligated to construct necessary parking areas. Collection vehicles will increase gradually for the waste collection activity. Necessary facilities shall thus be allocated by GWMC.

4.4 Implementation Schedule of Waste Collection and Transportation Plan

Figure B.4.16 shows the implementation schedule of the master plan. GWMC needs to monitor the waste collection and transportation work from 2016 to 2030.

Time Framework of the Master Plan		Short-Term Plan Period								Mid-Term Plan Period					Long-Term Plan Period					
Year		2016				2017				2018				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4												
WBS for Short-Term Plan																									
S-1-1	Introduction of Separate Collection and Alternate-Day Collection through Implementation of Pilot Project																								
S-1-2	Increase of Waste Collection Rate in 64 UCs up to 100% in 2018																								
S-1-3	Conducting Street Cleaning in 64 UCs																								
S-1-4	Collection of Bulky Waste																								
S-1-5	Cleaning up of Illegal Dumping Sites in 64 UCs																								
S-1-6	Collection of Construction and Demolition Waste																								
S-1-7	Construction of Parking Area																								
WBS for Mid-Term Plan																									
M-1-1	Planning/Implementing for the Method of Separate Collection in 98 UCs																								
M-1-2	Increase of Waste Collection Rate in 34 UCs from 0% to 60% in 2024																								
M-1-3	Sustaining the Waste Collection Rate in 64 UCs with 100% in 2024																								
M-1-4	Procurement of Waste Collection Vehicles and Containers in 98 UCs																								
M-1-5	Monitoring on Improvement of Waste Collection and Transportation in 98 UCs																								
M-1-6	Conducting Street Cleaning in 64 UCs																								
M-1-7	Collection of Bulky Waste																								
M-1-8	Collection of Construction and Demolition Waste																								
M-1-9	Construction of Parking Area																								
WBA for Long-Term Plan																									
L-1-1	Introduction of Separate Collection through Implementation of Designated Pilot Project Area in 2028 and Promotion of Separate Collection to Other Zones in 2029																								
L-1-2	Increase of Waste Collection Rate in 34 UCs to 100% in 2030																								
L-1-3	Sustaining Waste Collection Rate in 64 UCs from the Current with 100% in 2030																								
L-1-4	Procurement of Waste Collection Vehicles and Containers in 98 UCs																								
L-1-5	Monitoring on Improvement of Waste Collection and Transportation in 98 UCs																								
L-1-6	Conducting Street Cleaning in 64 UCs																								
L-1-7	Collection of Bulky Waste																								
L-1-8	Outsourcing the Waste Collection and Transportation Service to a Private Company in 2025																								
L-1-9	Collection of Construction and Demolition Waste																								
L-1-10	Construction of Parking Areas																								

Figure B.4.16 Implementation Schedule of the Collection and Transportation Plan

4.5 Project Cost of Waste Collection and Transportation Plan

Table B.4.96 shows the project cost for the Master Plan and **Figure B.4.17** shows the Project Cost and Responsibility under the Collection and Transportation Plan. The total cost of waste collection and transportation is Rs. 14,020,790,000.

Table B.4.96 Project Cost under the Waste Collection and Transportation Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 1: Waste Collection and Transportation Plan																	
Short-Term Plan																	
S-1-1	Introduction of Separate Collection and Alternate day collection through Implementation of Pilot Project	143,625	82,343	40,823	80,659												
S-1-2	Increase of Waste Collection Rate in 64 UCs up to 100% in 2018	1,649,399	288,026	394,639	966,732												
S-1-3	Conducting Street Cleaning in 64 UCs	80,384	67,326	6,528	6,528												
S-1-4	Collection of Bulky Waste	31,990	23,730	4,130	4,130												
S-1-5	Cleaning Up of Illegal Dumping Sites in 64 UCs	23,773	22,382	1,391													
S-1-6	Collection of Construction and Demolition Waste	23,070	7,690	7,690	7,690												
S-1-7	Construction of Parking Area	523,480	126,424	3,546	393,510												
	Sub-Total	2,475,621	587,925	458,447	1,459,249												
Mid-Term Plan																	
M-1-1	Planning/Implementing for the Method of Separate Collection in 98 UCs	GWMC															
M-1-2	Increase of Waste Collection Rate in 34 UCs from 0% to 60% in 2024	GWMC															
M-1-3	Sustaining Waste Collection Rate in 64 UCs with 100% in 2024	GWMC															
M-1-4	Procurement of Waste Collection Vehicles and Containers in 98 UCs	3,702,654				463,973	500,805	653,478	652,222	675,607	751,379						
M-1-5	Monitoring on Improvement of Waste Collection and Transportation in 98 UCs	GWMC															
M-1-6	Conducting Street Cleaning in 64 UCs	91,644				6,528	6,528	32,397	8,397	8,397	29,997						
M-1-7	Collection of Bulky Waste	49,880				4,130	4,130	4,130	4,130	4,130	19,930						
M-1-8	Collection of Construction and Demolition Waste	46,140				7,690	7,690	7,690	7,690	7,690	7,690						
M-1-9	Construction of Parking Area	27,972				4,662	4,662	4,662	4,662	4,662	4,662						
	Sub-Total	3,909,190				486,963	523,815	707,357	677,101	700,576	813,258						
Long-Term Plan																	
L-1-1	Introduction of Separate Collection through Implementation of Designated Pilot Project Area in 2028 and Promotion of Separate Collection to Other Zones in 2029	GWMC										8,397	54,995	21,795	12,595	24,595	21,795
L-1-2	Increase of Waste Collection Rate in 34 UCs to 100% in 2030	GWMC										4,130	4,130	4,130	4,130	4,130	4,130
L-1-3	Sustaining Waste Collection Rate in 64 UCs from the Current with 100% in 2030	GWMC															
L-1-4	Procurement of Waste Collection Vehicles and Containers in 98 UCs	6,853,227										845,397	992,277	1,095,360	1,185,253	1,330,193	1,424,747
L-1-5	Monitoring on Improvement of Waste Collection and Transportation in 98 UCs	GWMC															
L-1-6	Conducting Street Cleaning in 64 UCs	144,172										8,397	54,995	21,795	12,595	24,595	21,795
L-1-7	Collection of Bulky Waste	24,780										4,130	4,130	4,130	4,130	4,130	4,130
L-1-8	Outsourcing the Waste Collection and Transportation Service to a Private Company in 2025	GWMC															
L-1-9	Collection of Construction and Demolition Waste	46,140										7,690	7,690	7,690	7,690	7,690	7,690
L-1-10	Construction of Parking Area	867,660										248,250	5,220	5,220	297,414	5,778	5,778
	Sub-Total	7,935,979										1,113,864	1,064,312	1,134,195	1,487,052	1,372,306	1,464,140
	Grand Total	14,320,790	587,925	458,447	1,459,249	486,963	523,815	707,357	677,101	700,576	813,258	1,113,864	1,064,312	1,134,195	1,487,052	1,372,306	1,464,140

Programme No.	WBS No.	WBS	Legal Action (Required=●)	Name of Act/Regulation/By-law	Budgetary Arrangment (Required=●)	Total Budget (Thousand Rs.)	Responsibility Assignment Matrix: M=Main Responsibility, S=Sub Responsibilities. B=Budgetary Arrangement, L=Legal Action, P=Participation in Discussions																
							GWMC/Operation Unit	GWMC/P&C Unit	GWMC/Financial Unit	GWMC/HR & Administration Unit	City District Government Gujranwala (CDGG)	The Urban Unit, Government of the Punjab	P&D Dept., Government of the Punjab	Local Gov't Dept., Government of the Punjab	Environment Protection Department (EPD)	Donor Organisations	Private Contractors/ Consultant	Recyclers	CBOs & NGOs	Waste Pickers	PAPs around Gondianwala Disposal Site	PAPs around Shaikhupwall Disposal Site	Gujranwala Citizens
Programme 1: Waste Collection and Transportation Plan																							
Short-Term Plan																							
	S-1-1	Introduction of Separate Collection and Alternate-Day Collection through Implementation of Pilot			●	143,525	M	B	B		S	P	L						P				
	S-1-2	Increase of Waste Collection Rate in 64 UCs up to 100% in 2018			●	1,649,399	M	B	B		S	P	L						P				
	S-1-3	Conducting Street Cleaning in 64 UCs			●	80,384	M	B	B	S	P				P				P				P
	S-1-4	Collection of Bulky Waste			●	31,990	M	B	B	S	P				P				P				P
	S-1-5	Cleaning Up of Illegal Dumping Sites in 64 UCs			●	23,773	M	B	B	S	S				P				P				P
	S-1-6	Collection of Construction and Demolition Waste			●	23,070	M	B	B	S	S				P								P
	S-1-7	Construction of Parking Area			●	523,480	M	B	B	S													
		Sub-Total				2,475,621																	
Mid-Term Plan																							
	M-1-1	Planning/Implementing for the Method of Separate Collection in 98 Ucs				GWMC	M	B	B		S	P	L						P				
	M-1-2	Increase of Waste Collection Rate in 34 UCs from 0% to 60% in 2024				GWMC	M	B	B	S	S	P	L						P				P
	M-1-3	Sustaining Waste Collection Rate in 64 UCs with 100% in 2024					M	B	B	S	S	P	L										
	M-1-4	Procurement of Waste Collection Vehicles and Containers in 98 Ucs			●	3,702,654	M	B	B	S	P		L										
	M-1-5	Monitoring on Improvement of Waste Collection and Transportation in 98 Ucs				GWMC	M	B	B	S	S	P		S					P				P
	M-1-6	Conducting the Street cleaning in 64UCs			●	91,844	M	B	B	S	S				P				P				P
	M-1-7	Collection of Bulky waste			●	40,580	M	B	B	S	P				P				P				P
	M-1-8	Collection of Construction and Demolition Waste			●	46,140	M	B	B	S	S				P								P
	M-1-9	Construction of parking area			●	27,972	M	B	B	S													
		Sub-Total				3,909,190																	
Long-Term Plan																							
	L-1-1	Introduction of Separate Collection through Implementation of Designated Pilot Project Area in 2028 and Promotion of Separate Collection to Other Zones in 2029				GWMC	M	B	B	S	S	P	L						P				P
	L-1-2	Increasing of Waste Collection ratio in 34 UCs to 100% in 2030				GWMC	M	B	B	S	S	P	L						P				P
	L-1-3	Sustaining Waste Collection ratio in 64UCs from the current with 100% in 2030				GWMC	M	B	B	S	S	P	L										
	L-1-4	Procurement of waste collection vehicles and containers in 98UCs			●	6,853,227	M	B	B	S	P		L										
	L-1-5	Monitoring on Improvement of waste collection and transportation in 98UCs				GWMC	M	B	B	S	S	P		S					P				P
	L-1-6	Conducting the Street cleaning in 64UCs			●	144,172	M	B	B	S	S				P				P				P
	L-1-7	Collection of Bulky waste			●	24,780	M	B	B	S	P				P				P				P
	L-1-8	Outsourcing the Waste Collection and Transportation Service to a private company in				GWMC	M	B	B	S	S	P	L		P								
	L-1-9	Project for Collection of Construction and Demolition Waste			●	46,140	M	B	B	S	S				P								P
	L-1-10	Project for Construction of Parking areas			●	567,660	M	B	B	S													
		Sub-Total				7,635,979																	
		Grand Total				14,020,790																	

Figure B.4.17 Project Cost and Responsibility under the Waste Collection and Transportation Plan

5. PROPOSAL FOR THE ACTION PLAN

5.1 Selection of Priority Projects

The priority projects are defined as projects for the short-term period of the Master Plan which will be developed into the action plans in this chapter. Based on the detail discussions described in **Chapter 4,** the following projects are selected as the priority projects:

1. Project for Introduction of Separate Collection and Alternate-Day Collection through Implementation of a Pilot Project
2. Project for Increasing of Waste Collection Ratio in 64 UCs up to 100% in 2018
3. Project for Conducting Street Cleaning in 64 UCs
4. Project for Collection of Bulky Waste
5. Project for Clean-up of Illegal Dumpsites in 64 UCs
6. Project for Collection of Construction and Demolition Waste
7. Project for Construction of Parking Area

5.2 Project for Introduction of Separate Collection and Alternate-Day Collection through Implementation of a Pilot Project

5.2.1 Formulation of Detailed Plan for the Pilot Project Area

As mentioned in **Section 4.2**, separate waste collection and alternate-day collection are to be applied as the pilot project. One of the eight zones in the 64 UCs has been selected as the pilot project area and a detailed plan is formulated for the implementation. Separation at source and alternate-day collection are to be introduced for the first time in the city and it takes some time for the residents to acknowledge the conduct of these new activities. GWMC needs to establish an optimum promotion method through operation in the pilot project area. The detailed plan should thus include a) the necessary number of collection vehicles and containers, b) the allocation of vehicles and containers, c) specifications of required vehicles and containers, d) organization for operation and management, and e) method of monitoring and feedback of the operations.

Commencement of separate collection and alternate-day collection all over the city, i.e., in 98 UCs, are planned to start in 2019 in order to prepare for operation of the composting facility that has to be started in 2020. Based on the lessons learned from the result of the pilot project, the method of promoting the new activities in the pilot project zone shall be disseminated to the other zones in order to spread the practice of separation at source and alternate-day collection throughout the whole city.

The candidate zone for the pilot project should contain various types of land use and the city of Gujranwala as a whole has various types of land use. Zone 6 is selected as a pilot project zone because this zone is congested with both residential and vacant areas such as farmland, i.e., several land use types can be seen in the zone.

5.2.2 Procurement of Waste Collection Vehicles and Containers for Pilot Project

Based on the detailed waste collection and transportation plan formulated in **Subsection 5.2.1**, the necessary number of waste collection vehicles and containers needs to be procured by GWMC. Some $13m^3$ compactors, $7m^3$ compactors, $4m^3$ compactors are utilised for waste collection and mini-dumpers are utilised to assist in the primary collection. Additionally, $5m^3$ containers and $8m^3$ containers are utilised for waste collection.

Table B.5.1, **Table B.5.2**, **Table B.5.3**, **Table B.5.4**, **Table B.5.5** and **Table B.5.6** show general specifications of each type of vehicle and container as reference. All specifications are from the local manufacturer. Based on the general specification of each waste collection vehicle and waste collection

container, GWMC shall procure the equipment required under the plan. The procurement of equipment is to start in 2016 and shall continue until 2018.

Table B.5.1 General Specification of a 13m^3 Compactor

Item	Specifications
1. General	The garbage compactor consists of a body mounted on the chassis, a tailgate with compression mechanism, an ejection plate inside the body, the hydraulic installation and control mechanism.
2. Dimension (reference)	(1) Inside Height (mm): 2,100-2,250 (minimum) (2) Body inside width: 1,800-2,050mm (minimum),
3. Body Structure	(1) Hopper capacity:1.0-1.3m^3 (2) Body material: Structural steel plates (3) Double acting hydraulic cylinders to lift and tilt refuse containers, lift 0.8 to 1.0 cubic meter bin lifting capacity 800 kg
4. Truck Chassis Specifications (reference)	(1) Horsepower: 4x2 200HP (2) GVW: 18,000 GVW, (3) Pay Load: 13,320Kg (4) Wheel base: 4,650mm

Table B.5.2 General Specification of a 7m^3 Compactor

Item	Specifications
1. General	The garbage compactor consists of a body mounted on the chassis, a tailgate with compression mechanism, an ejection plate inside the body, the hydraulic installation and control mechanism
2. Dimension (reference)	(1) Inside Height (mm): 1,500mm (minimum) (2) Body inside width: 19,000mm (minimum)
3. Body Structure	(1) Hopper capacity: 0.8-1.0m^3 (2) Body material: Structural steel plates (3) Double Acting Hydraulic Cylinders.
4. Truck Chassis Specifications (reference)	(1) Horsepower: 4x2 120HP (2) GVW: 8,800 GVW (3) Pay Load: 6,470 Kg (4) Wheelbase: 3,815 mm

Table B.5.3 General Specification of a 4m^3 Compactor

Item	Specifications
1. General	The garbage compactor consists of a body mounted on the chassis, a tailgate with compression mechanism, an ejection plate inside the body, the hydraulic installation and control mechanism.
2. Dimension (reference)	(1) Inside Height (mm): 1,300mm (minimum) (2) Body inside width: 1,750mm (minimum)
3. Body Structure	(1) Hopper Capacity: 0.6-0.8m^3 (2) Body material: Structural steel plates (3) Double acting hydraulic cylinders (4) Safety valves on back lid cylinders
4. Truck Chassis Specifications (reference)	(1) Horse Power: 4X2 80HP (2) GVW: 8,800 GVW (3) Pay Load: 5,200kg (4) Wheel base: 2,460mm

Table B.5.4 General Specification of a Mini-Dumper

Item	Specifications
1. General	The mini-dumper consists of a body mounted on the chassis, a tailgate with tank, the hydraulic installation and control mechanism.
2. Dimension (reference)	(1) Inside Height (mm): 1,300mm (minimum) (2) Body inside width: 1,750mm (minimum)
3. Body Structure	(1) Loading Platform Capacity: 1m^3 (2) Paint: 2 coats of Zinc based Epoxy Primer and one coat of final paint done with two components Poly-Urethane based paints. (3) Capacity to lift waste: 400 kg

Table B.5.5 General Specification of a 5m^3 Container

Item	Specifications
General Specification	(1) Body Type: Arm Roll type with full opening of back door, to allow easy dumping. (2) Lifting Hook: Made from 50mm dia, high carbon steel bar welded with brackets of 12 mm thick MS plate. (3) Hook Plate: Made from MS 10mm thick plate (4) Lifting Locks: The container is to be equipped with locks to match arm roll vehicle. (5) Wheels: Support cast steel wheels at rear end, dia 150mm (6) Colour: One coat of red oxide with 2 coats of enamel golden yellow

Table B.5.6 General Specification of a 0.8m^3 Container

Item	Specifications
General Specification	(1) Shape: Rectangular (With Conical Bottom) (2) Dimensions (HxWxL): (1,220mmx 1,220mm x 800mm) (3) Wheels: 4. Caster Wheel and a Wheel locking mechanism (4) Emptying Method: Lifting by rear end loading garbage Compactor
Coating (Inside and outside)	3 coatings (1st Coating: zinc, 2nd: Neo Gose and 3rd: NY Porin)

GWMC shall procure the equipment from 2016 up to 2018 based on the plan. For this purpose, GWMC has to prepare documents and submit them to the Provincial Government for the annual budgetary arrangement for procurement of waste collection vehicles and waste containers.

5.2.3 Dispatch of Waste Collection Containers

Two sizes of waste containers, i.e., $5m^3$ and $0.8m^3$ containers, are to be used in the pilot project. Each container is set to have the optimum waste collected from the source. Since the purpose of posting the $5m^3$ container is to collect a large amount of waste from the source, they are placed in a large waste discharge point such as a shopping mall, shopping centre, school, public office and market. The purpose of the $0.8m^3$ container, on the other hand, is to collect waste from households. Based on the detailed design formulated in **Subsection 5.2.1**, the necessary number of waste containers needs to be allocated in Zone 6 by GWMC.

Number of 0.8 m^3 containers in each location is calculated as follows:

Total waste amount collected from 64 UCs in 2018: 1,208 ton/day

Total area in 64 UCs: $65km^2$

Therefore, for 18.6 ton/km^2

2 sets of containers: 120 meters radius

0.4 ton/set * 2 sets = 0.8 ton. 18.6 ton/km^2 / 0.8 ton = 24 sets/km^2

($1km^2$/24sets/3.14)^0.5=120m

3 sets of containers: 140 meters

0.4 ton/set * 3 sets = 1.2 ton. 18.6 ton/km^2 / 1.2 ton = 16 sets/km^2

($1km^2$/16sets/3.14)^0.5=140m

4 units of containers: 160 meters

0.4 ton/unit * 4sets = 1.6 ton. 18.6 ton/km2 / 1.6 ton = 12 sets/km^2

($1km^2$/12sets/3.14)^0.5=160m

In the plan, 4 sets of containers are deployed in one location to enable access by a wide range of residents around them. However, the number of containers varies depending on the site condition. Since the city centre of Gujranwala is congested and it is difficult to find room for putting 4 sets of containers, the number of containers may be decreased. The inspectors shall decide on the number of containers required for the waste collection operation.

Based on the detailed design formulated in **Subsection 5.2.1**, the necessary number of waste containers needs to be allocated by GWMC in each zone in the 64 UCs. For the example, Zone 6 is selected as the modelling zone for the detail design on the allocation of waste containers in the waste collection and transportation plan. The zone has a congested residential area and vacant areas such as farmland. In other words, several land use is seen in the zone. For this reason, it is an ideal zone for modelling the waste collection area. Waste collection and transportation vehicles and containers in the other zones also need to be arranged with reference to the modelling zone.

Once waste containers are allocated on site, GWMC needs to acquire feedback and update the allocation of containers for each zone. The optimum allocation plan for waste containers needs to be established during the operation.

Zone 6 consists of farmland and residential areas and it is difficult to find an open space for the installation of containers. Therefore, it is recommended that a large number of containers shall be allocated at each site. In consideration of accessibility to the containers and the required area for their placement, four units are to be installed at each site in the plan. One $5m^3$ container is dispatched on commercial area such as fruit market and shopping centre. The number of necessary containers in Zone 6 is allocated depending on the waste collection amount in Zone 6. Based on the allocation of necessary

units of waste containers, 24 units of 5m^3 containers and 240 units of 0.8m^3 containers are necessary for Zone 6 in 2018. **Table B.5.7** shows the necessary number of waste collection vehicles and containers.

Table B.5.7 Necessary Number of Containers in Zone 6

Item	2016	2017	2018
5m^3 container	24	24	24
0.8 m^3 container	110	170	240

Figure B.5.1 shows the allocation plan of waste containers in Zone 6. Since 4 units of containers are to be dispatched in one location, the waste containers are located in 60 locations (240/4=60 locations). These container locations need to be relocated flexibly during the operation if there are requests from the residents or an optimal container location is found during the waste collection operation.

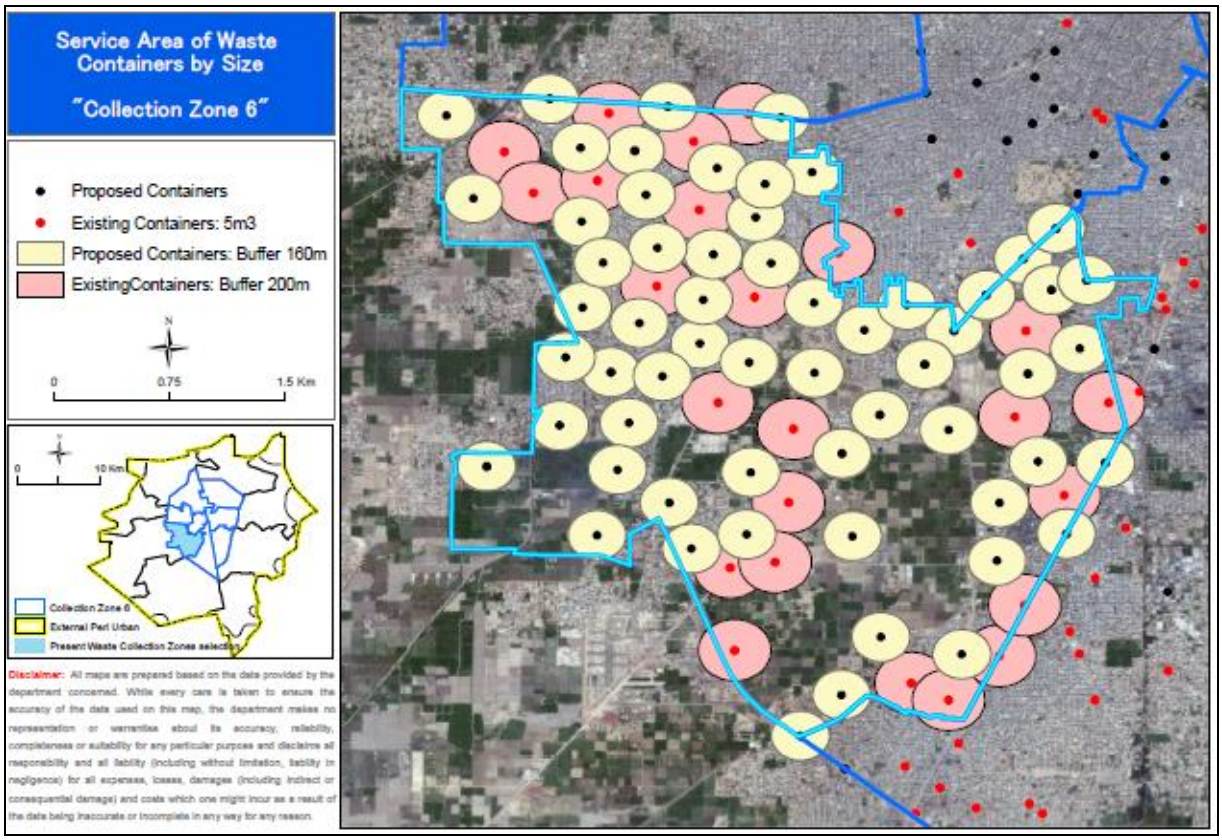

Figure B.5.1 Dispatch of Waste Containers in Zone 6

5.2.4 Dispatch of Waste Collection Vehicles

For secondary collection, a combination of 13m^3 compactor, 7m^3 compactor and 4m^3 compactor is to be utilised to support a 1m^3 mini-dumper. The area for each collection vehicle is defined as follows:

The area for each collection vehicle is defined as follows:

- 13 m^3 compactor: the vehicle is dispatched on a large street such as bypass road and other major streets;
- 7 m^3 compactor: the vehicle is dispatched on a wide street and major street;
- 4 m^3 compactor: the vehicle is dispatched on a narrow street;
- Mini-dumper: the vehicle is dispatched on a narrow street and assists in secondary collection;

- 5m^3 Arm-roll truck: the vehicle is dispatched for collecting waste from markets and shopping centres, and;
- Tractor trolley: the vehicle is dispatched on a narrow street.

Based on the detailed design formulated in **Subsection 5.2.1**, the necessary number of waste collection vehicles needs to be allocated on each zone in 64 UCs by GWMC.

For the example of the detailed design for allocation of waste collection vehicles on waste collection and transportation plan, Zone 6 is selected as the modelling zone in the plan. The zone has a congested residential area and vacant areas such as farmland. In other words, several land use is seen in the zone. For this reason, it is an ideal zone for modelling the waste collection area. Waste collection and transportation vehicles and containers in other zones also need to be arranged with reference to the modelling zone.

Once waste collection vehicles are allocated on each zone, GWMC needs to acquire feedback and update the allocation of vehicles on each zone. GWMC needs to establish the optimum allocation plan for waste vehicles during the operation.

Zone 6 has main streets such as bypass road, wide streets and narrow streets. Considering these street conditions, adequate type of vehicles has to be dispatched to the zone. The number of necessary waste collection vehicles in Zone 6 is allocated depending on the waste collection amount in Zone 6. Based on the allocation of necessary units of waste collection vehicles, the number of waste collection vehicles in Zone 6 will be 37 units in 2018. **Table B.5.8** shows the necessary number of waste collection vehicles in Zone 6.

Table B.5.8 Necessary Number of Vehicles in Zone 6

Item	2016	2017	2018
5 m^3 Arm-roll truck	3	3	3
Tractor trolley	4	4	4
13m^3 compactor	2	2	10
7m^3 compactor	5	8	10
4m^3 compactor	-	-	5
Mini-dumper	5	5	5
Total	19	22	37

Figure B.5.2 shows the dispatch of waste collection vehicles in Zone 6. The 13m^3 and 7m^3 compactors are dispatched on the main street (green zone). In addition, since most of the markets or shopping centres are situated along the main street, arm-roll trucks are also allocated.

On the other hand, most parts of the residential area are congested and the streets consist of wide and narrow streets. It is, therefore, difficult to dispatch a specific type of waste collection vehicle and hence 7m^3 compactors, 4m^3 compactors and mini-dumpers are applied in the area (blue zone).

Moreover, there are some vacant areas in Zone 6, and houses are sparsely-distributed. Besides, the width of road is relatively wide in these areas and hence 7m^3 compactors are dispatched (red zone). The allocation plan should be modified from time to time to obtain the optimum efficiency during operation.

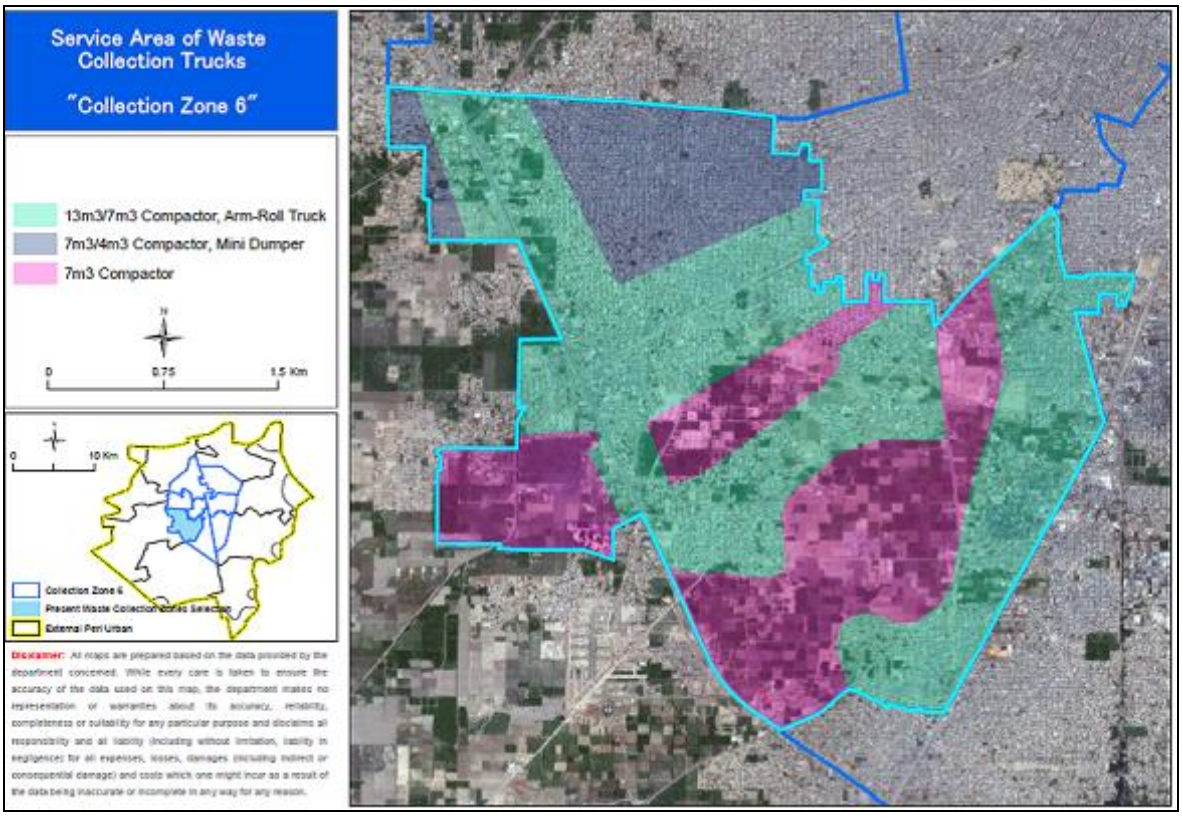

Figure B.5.2 Dispatch of Waste Collection Vehicles in Zone 6

5.2.5 Conduct of Separate Collection in Zone 6

Separate collection is conducted in the plan. Four containers are dispatched for each location so that two containers are utilised for organic waste and the other containers are utilised for other wastes such as paper waste. Separate collection starts in only Zone 6 in 2016. Separate collection in the other zones will start in 2019.

These two types of containers are painted with different colours to distinguish the contents. For instance, containers for organic waste are painted in red and the others are painted in yellow.

Waste collection vehicles in wide and major streets collect only the containers with organic waste on designated days, for instance Monday, Wednesday and Friday. Containers of other wastes are collected on Tuesday and Thursday.

The same manner is applied for waste collection in narrow streets. Organic waste and other wastes are collected on designated days. Sanitation workers collect organic wastes from the residents and dump them into the waste collection vehicle.

Public announcement of separate collection is needed for the residents, especially, those living along narrow streets where Door-to-Door collection is inevitable for achieving the optimum waste collection and transportation. It should be conducted as a part of the public awareness campaign.

Once the modelling of separate collection is established on Zone 6, it shall be promoted to the other zones.

5.2.6 Conduct of Alternate Day Waste Collection in Zone 6

As mentioned in **Subsection 4.2.3**, alternate day waste collection is conducted in the plan. It also starts in Zone 6 in 2016. For example, containers with organic waste are collected on Monday, Wednesday and Friday, and the other containers of waste are collected on Tuesday and Thursday. Alternate day collection in other zones shall start in 2019.

The disposed amount from the source varies so that it is necessary to check the waste amount during the waste collection. If the disposed amount is larger than the container capacity, GWMC needs to dispatch additional waste containers or increase the frequency of waste collection at the location. This type of adjustment is needed during the operation.

Public announcement for alternate day collection is needed for the understanding of residents in addition to the announcement of separate collection. It should be conducted as a part of the public awareness campaign. Once the modelling of alternate day waste collection is established in Zone 6, it shall be introduced in the other zones.

5.2.7 Operation of Waste Collection Vehicles and Containers

For implementing the waste collection and transportation work in the pilot project, the task of each staff must be defined clearly. The job description for each appointment is as follows:

General Manager Operation: The General Manager Operation is responsible for the overall operation of the waste collection and transportation services. The General Manager receives reports from the Senior Manager and submits them to the Managing Director. He is also responsible for giving instructions to the Senior Manager for solving problems on daily waste collection and transportation operation.

Senior Manager: The Senior Manager is responsible for receiving the reports from the Assistant Manager and forwards them to the General Manager Operation. The Senior Manager also gives instructions to the Assistant Manager for solving problems on the matter concerned.

Assistant Manager: The Assistant Manager is responsible for reporting the situation to the General Manager Operation once the Assistant Manager receives the report from the Inspector(s). In addition, the Assistant Manager conveys the instructions from the General Manager Operation to the Inspector(s).

Inspector: The Inspector is responsible for grasping the condition of waste collection and transportation on each waste collection zone reported by the Supervisor, and reports it to the Assistant Manager. The Inspector consults with the Assistant Manager and obtains direction from the Assistant Manager over field work problems encountered at site. The Inspector together with the Supervisor solves the problems through instruction and guidance to the Supervisor.

An operation manual of waste collection and transportation should be prepared by a task force organized by the representative staff of GWMC. The manual must be completed by the beginning of 2016. The manual may be revised as necessary to meet the actual condition in consideration of effectiveness and efficiency of the work. The contents of the manual shall include following items:

- Preparation work for cleaning around containers;
- Initial inspection of waste collection vehicles at the garage;
- Waste collection method;
- Points to be checked during waste collection;
- Reporting items; and
- Items for regular inspection, etc.

The manual has to be compiled in a booklet form and copies of the manual provided to all waste collection workers. All waste collection workers have to follow the work procedures stated in the manual to carry out the services more efficiently. In addition, regular training sessions for workers must be conducted for assuring/enhancing the knowledge on waste collection operation under the Comprehensive Capacity Development Programme (CCDP) proposed in ***Volume 2, Supporting Report, Section G: Institutional Strengthening and Organizational Study***..

5.2.8 Monitoring of Improvement of Waste Collection and Transportation

Regular monitoring of waste collection amount and waste collection rate must be carried out by GWMC for evaluating performance of the waste collection and transportation service in the pilot project. The

monitoring of waste collection vehicles and waste containers is not only to check the operation status of daily waste collection work, but also to improve the waste collection efficiency and effectiveness by feedback from the information on the daily work. Especially, the allocation of waste collection vehicles and waste collection containers should be monitored carefully since it is linked with the waste collection efficiency and effectiveness.

Monitoring items are stipulated in the operation manual prepared under the activities of the above **Subsection 5.2.7**, and the monitoring items and method must be established in the beginning of 2016. The required minimum monitoring items for waste collection and transportation are proposed as follows:

- Sanitary condition around the container;
- Condition of separate collection;
- Conduction of regular time collection;
- Recording the waste collection amount on the weighbridge; and
- Computerization of the waste collection record.

These monitoring items have to be check on site and the results recorded in a monitoring paper. Sanitary workers are obligated to report the situation and any issue, if any, to the sanitary supervisor. The record has to be submitted to the GWMC head office for computerisation and compilation.

The monitoring plan has to be designed in the first year and conducted for 6 months in the second year. After six months, the plan is to be reviewed for three months and the other three months is to be utilised for improvement. The monitoring activity has to be conducted on a full scale in the third year.

5.3 Project for Increase of Waste Collection Rate in 64 UCs up to 100% in 2018

5.3.1 Formulation of Detailed Design for Waste Collection Ratio in 64 UCs up to 100% in 2018

Increasing the waste collection rate in 64 UCs up to 100% in 2018 is the ultimate target for the short-term period of the Master Plan. To achieve the target, it is necessary to formulate a detailed waste collection and transportation plan in the early part of 2016. The contents of the detailed plan should include an allocation plan for the adequate number of waste collection vehicles, waste containers and sanitary workers on each zone in 64 UCs. Once the waste collection vehicles, waste containers and sanitary workers are in operation on site based on the plan, GWMC needs to acquire feedback and update the allocation of equipment and human resources on each zone if something has to be improved. The optimum waste collection and transportation plan, therefore, shall be established during the operation phase.

For allocating the waste collection vehicles and waste collection containers, necessary number of waste collection vehicles and waste collection containers are distributed based on the waste generation amount in each zone and the total number of waste collection vehicles and waste collection containers except Zone 6. **Table B**.5.9, **Table B**.5.10 and **Table B**.5.11 show Necessary number of waste collection vehicles and waste collection containers on other zones from 2016 to 2018. The actual number/type of waste collection vehicles and containers for the respective zones except Zone 6 shall be distributed and adjusted in consideration of the site conditions, such as road width and surrounding land use, etc., although the required number of waste collection vehicles and containers for each zone is presented in **Table B**.5.9, **Table B**.5.10 and **Table B**.5.11 .

Table B.5.9 Necessary Number of Waste Collection Vehicles and Waste Collection Containers in Other Zones (2016)

Zone	$10m^3$ Container	$5m^3$ Container	$0.8m^3$ Container	$10m^3$ Arm-roll Truck	$5m^3$ Arm-roll Truck	Tractor trolley	$13m^3$ Compactor	$7m^3$ Compactor	$4m^3$ Compactor	Mini-Dumper
1	0	26	130	0	3	5	0	7	0	5
2	2	24	70	1	2	5	2	2	0	5
3	0	24	200	0	3	4	4	8	0	4
4	0	25	100	0	3	4	2	5	0	4
5	2	24	70	1	3	5	0	1	0	4
7	3	24	160	1	3	6	1	5	0	4
8	3	24	120	1	2	4	3	5	0	4
Total	10	171	850	4	19	33	12	33	0	30

Note: *The table on distribution of waste collection vehicles and containers are not considered the current situation such as street width etc. Therefore, discrepancy may be seen on the table. The number/type of waste collection vehicles and containers needs to be adjusted on site.

Table B.5.10 Necessary Number of Waste Collection Vehicles and Waste Collection Containers in Other Zones (2017)

Zone	$10m^3$ Container	$5m^3$ Container	$0.8m^3$ Container	$10m^3$ Arm-roll Truck	$5m^3$ Arm-roll Truck	Tractor trolley	$13m^3$ Compactor	$7m^3$ Compactor	$4m^3$ Compactor	Mini-Dumper
1	0	26	200	0	3	5	3	10	0	5
2	2	24	130	1	2	5	5	3	0	5
3	0	24	300	0	3	4	8	10	0	4
4	0	25	180	0	3	4	3	8	0	4
5	2	24	170	1	3	5	0	5	0	4
7	3	24	270	1	3	6	4	6	0	4
8	3	24	240	1	2	4	4	7	0	4
Total	10	171	1,490	4	19	33	27	49	0	30

Note: *The table on distribution of waste collection vehicles and containers are not considered the current situation such as street width etc. Therefore, discrepancy may be seen on the table. The number/type of waste collection vehicles and containers needs to be adjusted on site.

Table B.5.11 Necessary Number of Waste Collection Vehicles and Waste Collection Containers in Other Zones (2018)

Zone	$10m^3$ Container	$5m^3$ Container	$0.8m^3$ Container	$10m^3$ Arm-roll Truck	$5m^3$ Arm-roll Truck	Tractor trolley	$13m^3$ Compactor	$7m^3$ Compactor	$4m^3$ Compactor	Mini-Dumper
1	0	26	300	0	3	5	6	10	5	5
2	2	24	210	1	2	5	8	11	5	5
3	0	24	400	0	3	4	12	16	5	4
4	0	25	250	0	3	4	10	10	5	4
5	2	24	210	1	3	5	8	12	5	4
7	3	24	340	1	3	6	13	15	5	4
8	3	24	300	1	2	4	10	15	5	4
Total	10	171	2,010	4	19	33	67	89	35	30

Note: *The table on distribution of waste collection vehicles and containers are not considered the current situation such as street width etc. Therefore, discrepancy may be seen on the table. The number/type of waste collection vehicles and containers needs to be adjusted on site.

Once waste collection vehicles, waste collection containers are in operation on site, GWMC needs to acquire feedback and update the allocation of the equipment on each zone. The optimum allocation plan for waste collection and transportation plan needs to be established during the operation.

5.3.2 Procurement of Waste Collection Vehicles and Containers in 64UCs

Based on the number of waste collection vehicles and waste collection containers distributed in **Subsection 5.3.1**, he necessary number of waste collection vehicles and containers needs to be procured by GWMC between 2016 and 2018.

The required general specification on each waste collection vehicle and waste collection container is same as **Subsection 5.2.2**.

5.3.3 Operation of Waste Collection and Container

GWMC also requires commencement of the waste collection and transportation operation not only in Zone 6 but also in other zones in 2016. The operation and management of waste collection and transportation services are the same as those of Zone 6 mentioned in **Subsection 5.2.3**.

However, separation at source starts in the other zones from 2019, so that items required for separation at source are not needed to be included during the operation in other zones until end of 2018.

5.3.4 Monitoring and Feedback of the Operation

Monitoring and feedback of the waste collection and transportation work are conducted in other zones. As mentioned **Section 5.2.4**, regular monitoring of waste collection amount and waste collection rate are also necessary to be carried out by GWMC for evaluating the performance of waste collection and transportation service. The contents of monitoring items are the same as Zone 6; however, items required for separation at source are not needed to be monitored on site as mentioned on **Subsection 5.3.3**.

5.4 Project for Conducting Street Cleaning in 64 UCs

5.4.1 Plan for Conducting Street Cleaning

According to the interview survey with a waste manager, GWMC conducts the street sweeping manually. Sanitary workers conduct the street sweeping early in the morning for 6 days to avoid the heavy traffic in the city in the daytime. GWMC also conducts mechanical road sweeping on major streets such as G.T. Road. Since there is no official record on the working area except Zone 9 and Zone 10, the total length of the mechanical and manual sweeping is not known by GWMC. Street sweeping is also included in the plan. It shall start from 2016.

The necessary length for street sweeping was estimated by measurement from the satellite map. Based on the result of the measurement, the targeted length is set on the plan. As shown in **Table B**.4.62 and **Table B**.4.63, the lengths of street cleaning in Zone 9 and Zone 10 are 345.2 km and 319.6 km, respectively, or 665 km in total.

The speed of the street sweeper is set at 6 km per hour on average and the vehicle travels 8 hours per day. Thus, total travel distance of the street sweeper in a day is 48km per vehicle per day. Since GWMC has set 2 zones for street cleaning and one vehicle is dispatched for each zone, two vehicles are, therefore, necessary for the street cleaning work.

Calculation of street cleaning frequency is as follows:

665 km / 48 (km/day) / 2 vehicles = 6.9 days; Say, 7 days (once a week)

Street cleaning on the same place is thus conducted once in a week.

As mentioned in **Subsection 4.1.8**, the total length of other roads in the city estimated from satellite map is 2,600 km. Water tank is dispatched for other roads. The speed of the road washer is set to 6 km per hour on average and the vehicle travels 8 hours per day. Thus, total travel distance of the road washer in a day is 48km per vehicle per day. Since GWMC has set 2 zones for street cleaning and two vehicles are dispatched for each zone, two vehicles are necessary for the street cleaning work.

Calculation of street cleaning frequency is as follows:

2,600 km / 48 (km/day) / 4 vehicles =13.5 days= 14 days (once in two weeks)

Street cleaning on the same place is thus conducted once in two weeks.

5.4.2 Necessary Number of Vehicles for Street Cleaning

Table B.5.12 shows the number of vehicles for street cleaning in each year.

Table B.5.12 Number of Vehicles for Street Cleaning (Year 2016-2018)

Item	2016	2017	2018
Street Sweeper	2	2	2
Road Washer	4	4	4

GWMC is obligated to conduct street cleaning in the 64 UCs. For this purpose, GWMC has to procure the necessary street cleaning vehicles.

5.4.3 Specification of Street Cleaning Vehicles

Table B.5.13 and **Table B.5.14** show the specifications of street cleaning vehicles. Based on the general specification of each waste collection vehicle, GWMC needs to procure the equipment for the plan.

Table B.5.13 General Specifications of Street Sweeper

Item	Specifications
Chassis	(1) Gross Weight: 8,800 kg (2) Wheel Base: 3,300 – 3,500 mm (3) Drivetrain: 4×2
Waste Tank	Garbage tank: 4 m^3
Water Tank	(1) Tank Capacity: 1,000 litres (2) Water Hose: 10 m
Brushes	(1) Two disc brushes, one located on each side, and a cylindrical middle brush. Sweeping width is 2,100 mm (2) Side brushes: diameter of 800 mm, Steel made (3) Middle brush: diameter of 400 mm, 1,300 mm long, and have a safety latch.
Suction Unit	(1) Suction nozzle: aluminium casting and lined with rubber, (2) Wandering hose: diameter of 150 mm and a length of 4.5 meters.
Water Spray System	(1) Pressure: 140 bar (2) Regulator water pump that makes pressure balance, membrane type, 40 bar pressure

Table B.5.14 General Specifications of Road Washer

Item	Specifications
Water Tank	(1) Tank Capacity: 5,000 litres; locally fabricated with 2 baffles (2) Shape: rectangular (3) Hose Reel: Rear mounted hydraulically powered hose reel suitable for carrying 50 feet of jetting hose 3/4" (4) Level Gauge: Suitable liquid level indicator for observing water level in tank
High Pressure Plunger Pump	(1) Flow: 100 – 150 LPM (2) Pressure:100- 120 bar (3) Power Required: 35- 45 HP, RPM: 1,400 - 1,700
Truck	(1) Horsepower : 110 to 140 PS / HP (2) GVW: 8,000 to 9,000 Kg (3) Payload: 6,000 to 6,500 Kg (4) Wheel Base : 3,800 to 3,900 mm (5) Overall length: 6,500 to 6,850 mm (6) Overall width : 1,900 to 2,050 mm (7) No. of Cylinder: 04 cylinder

5.5 Project for Collection of Bulky Waste

The purpose of the project for the collection of bulky waste is the collection of green waste from parks in the city and old furniture from households. There are 36 public parks in Gujranwala and the total area is approximately 580,000 square metres. The largest park in the city is Gulshan-e-Iqbal Park (106,000 m^2) abutted on G.T. Road. There are also trees along the street. Green waste is generated from the park and the street. The project shall start in 2016 and continue until 2030.

5.5.1 Collection of Bulky Waste

Bulky wastes generated from tree trimming, old furniture, etc., need to be considered for waste collection. Since bulky waste is not occasionally generated from the source, necessary vehicles and workers for these wastes are deployed separately from the regular collection of GWMC.

GWMC needs to travel and collect green waste from parks in the city on regular basis starting from 2016. However, old furniture is collected by GWMC whenever a resident calls up for waste collection. Therefore, GWMC needs to set the schedule of collection fees for bulky wastes such as old furniture.

Table B.5.15 shows the name of parks in Gujranwala. There are 36 parks in the city. The smallest park is Allah Hoo Park in Zone 1, which area is 253 m^2, and the largest park is Gulshan-e-Iqbal Park, which is 106,000 m^2.

Table B.5.15 Name of Parks in Gujranwala

No.	Name of Town	Name of Park	Zone	Area (m^2)
1	Nandi Pur	Liaquat Park	Zone – 3	22,259
2		Muhammadi Park	Zone – 3	9,713
3		Mumtaz Baigum Park	Zone – 3	3,035
4		Tanki Park	Zone – 3	2,024
5		Takoni Park	Zone – 3	607
6		Chakki Ground	Zone – 3	10,118
7		Khawaja Park Ground	Zone – 3	13,153
8		Takoni Park	Zone – 3	1,012

No.	Name of Town	Name of Park	Zone	Area (m^2)
9		Dhobi Ghat Park	Zone – 3	6,071
10		Manzoor Hassan Park	Zone – 3	13,760
11		Aysha Bibi Park	Zone – 3	125,457
12		Ghulam Hussain Park	Outside of 64 UCs	10,118
13		Younas Park / Ch. Rahmat Ali Park	Outside of 64 UCs	6,071
14		Babu Ismail Park	Zone – 4	31,162
15		Saddique Akbar Park	Zone - 4	8,094
16		Melad-e-Mustafa Park	Zone - 4	16,188
17		Taqwa Park	Zone - 4	10,725
18		Teenkona Park	Zone - 4	14,165
19		Madina Park	Zone - 4	6,071
20		Usman Ghani Park	Zone - 4	5,059
21		Madni Park	Zone - 4	9,106
22		Ghosia Park	Zone - 4	4,047
23		Raza-e-Mujtaba Park	Zone - 4	5,059
24		Muslim Park	Zone - 4	28,329
25		Aqsa Park	Zone - 4	5,059
26		Office Nandi Pur Town Park	Zone - 3	6,071
27	Aroop	Gulshan-e-Iqbal Park	Zone - 1	105,728
28		Rasikh Irfani Park	Zone - 1	22,259
29		Children Park	Zone - 1	3,035
30		Lady Park	Zone - 1	4,300
31		Mounji Ground Park	Zone - 1	4,553
32		Allah Hoo Park	Zone - 1	253
33	Khiali Shah Pur	Jinnah Park	Zone – 5	32,376
34	Qila Didar Singh	Sageer Park	Zone – 7	3,541
35		Jannat Bibi Park	Zone - 7	4,553
36		Sheranwala Bagh Park	Zone - 5	27,823

GWMC operates 6 days in a week so that 36 parks / 6 days = 6 parks per day. GWMC is thus able to collect green waste from 6 parks in a day. If a resident needs to dispose bulky waste, GWMC also collects the waste during the regular operation.

5.5.2 Necessary Number of Vehicles for Bulky Waste

Table B.5.16 gives a summary of the vehicles and workers for bulky waste. Two units of 5-ton trucks and one wheel loader are deployed for the collection of bulky wastes. One driver and one sanitary worker are deployed per 5-ton truck and one driver is deployed on a wheel loader. The workers are deployed as one team and work in 6 days (Monday to Saturday). Basically, the team collects green waste such as tree trimmings. However, if a sanitary supervisor or sanitary inspector orders them to collect bulky waste from households, they collect them from the source.

Table B.5.16 Summary of Vehicles and Workers for Bulky Waste

Item	Number of Vehicles and Workers
5-ton truck	2
Wheel Loader	1
Sanitary worker	1

5.5.3 Specification of Vehicle for Bulky Waste

Table B.5.17 shows the specification of a 5-ton truck and **Table B.5.18** shows the specification of a wheel loader. Based on the general specification of each waste collection vehicle, GWMC needs to procure the equipment for the plan.

Table B.5.17 General Specification of 5 ton Truck

Item	Specifications
1. Body Structure	(1) Maximum Lifting Capacity: 8-10 tons (2) Available Volume: 10-12 m^3 minimum
2. Truck Chassis	(1) Horsepower: 200-220 PS/HP (2) GVW: 18,000-22,000 kg (3) Payload: 130,000-14,000 kg (4) Wheelbase: 4,600-4,800 mm

Table B.5.18 General Specification of Wheel Loader

Item	Specification
Type	Industrial Type with Self Levelling Bucket
Compatibility	100hp, 4 Wheel Drive
Lifting Capacity	2,800-3,000kg

5.6 Project for Clean-up of Illegal Dumpsites in 64 UCs

5.6.1 Plan for Clean-up of Illegal Dumpsites

GWMC needs to eliminate all illegal dumpsites in the city between 2016 and 2018. Therefore, GWMC has to monitor all locations of illegal dumpsites in the city.

For the clean-up activity, GWMC needs to decide on the following items:

- Plan for the clean-up schedule;
- Formation of the clean-up team;
- Procurement of necessary vehicles;
- Monitoring of cleaned sites after the clean-up activity; and
- Conduct of public awareness campaign and installation of warning signboards.

5.6.2 Plan for the Clean-up Schedule and Formation of the Clean-up Team

Illegal dumpsites are located at 799 locations at present based on the survey conducted by GWMC waste managers. The number of illegal dumping sites to be cleaned is thus set as follows:799 locations / 6 days / 4 weeks /12 months / 3 years = 0.9 location/day; that is, GWMC has to clean one illegal dumpsite per day if GWMC intends to eliminate all of the illegal dumpsites in the city in three years.

However, GWMC has to provide ordinary waste collection services for households and commercial establishments on a daily basis. Therefore, a clean-up team has to be established exclusively for the clean-up of illegal dumpsites in this action plan. The composition and capacity of the clean-up team are determined in the following procedure:

Step 1: The number of trips for a 5-ton truck is set at 5 based on the number of trips of arm-roll truck in the result of Time and Motion Study because both types of truck have similar machinery.

Step 2: Two units of 5-ton truck are dispatched for the clean-up of illegal dumpsites because one truck is to load waste while the other truck hauls the waste to the landfill site. For loading waste into a 5-ton truck, one wheel loader is also deployed.

Step 3: The loading capacity is assumed to be 5 tons per vehicle. Therefore, 5 tons × 5 trips/day × 2 vehicles = 50 tons/day = 1,200 tons/month (6 working days, 4 weeks).

Step 4: Minimum waste collection amount is calculated as 604 tons/month (remaining waste: 21,739 tons / 36 months).

Step 5: If only one 5-ton truck is deployed for the work, the waste collection amount per month is 600 tons/month (5-ton × 5 trips/day × 1 vehicles = 25 ton/day = 600 ton/month (6 working days, 4 weeks). This amount is less than the required minimum amount.

Step 6: Therefore, the clean-up team should be composed of two 5-ton trucks and one wheel loader.

Step 7: In this case, the duration of clean-up is 21,739 (ton) /1,200 (ton/month) = 18 months, i.e., the clean-up work is finished in around one-and-a-half years.

5.6.3 Number of Necessary Vehicles

Two units of 5-ton trucks, one wheel loader and two workers are needed for the work. **Table B.5.19** shows the necessary vehicles and workers for the cleaning. The deployed vehicles and workers shall conduct only the cleaning work separately from the regular waste collection work.

Table B.5.19 Necessary Vehicles and Workers for the Clean-up Work

Item	Number of Vehicles and Workers
5-Ton Truck	2
Wheel Loader	1
Driver	3
Sanitary Worker	2

The specification of the 5 ton truck and wheel loader is the same as that stated in **Subsection 5.5.3, Specification of Vehicles for Bulky Waste**. Based on the general specification of each waste collection vehicle, GWMC needs to procure the equipment for the plan.

5.6.4 Monitoring of Sites after Clean-up

Once the clean-up activity is conducted for a site, GWMC needs to keep eye on that site. An inspector and/or a sanitation supervisor need to patrol around the site. If illegal dumping activity is seen on site, they need to stop the activity.

5.6.5 Conducting Public Awareness Campaign and Installation of Warning Signboard

Not only patrol but also public awareness campaign is needed for keeping the cleaned-up site clean. For instance, a warning sign is placed clearly stating that disposing any garbage at the site is strictly prohibited.

5.7 Project for Collection of Construction and Demolition Waste

5.7.1 Collection of Construction and Demolition Waste

As mentioned in **Subsection 4.1.9**, the collection and disposal of construction and demolition waste (C&D waste) is part of GWMC's obligation according to the survey conducted by the JICA Project Team. The necessary number of C&D waste collection vehicles has to be taken into account for the plan starting from 2016. The project is to continue until 2030.

According to the LWMC report, the daily amount of waste generated is 141 tons. However, it is difficult to assume the actually generated amount of C&D waste since this waste is collected together with the other types of waste, and abandoned C&D wastes are scattered all over the city. Another reason for the difficulty of assumption is that C&D waste is not discharged in a particular place or particular amount.

C&D waste generation is related to the process of land development by public and private sectors so that it is also unpredictable for GWMC to foresee the future development plan. In the plan, C&D waste is collected separately. GWMC is responsible for collecting C&D waste; however, it needs to give first priority to the collection of municipal waste and outsource the C&D waste collection work to a private company.

Currently, no C&D waste collection fee is charged from building contractors or land developers, and GWMC collects the waste for free. Most of the C&D wastes generated from construction sites are taken to borrow pits in the city. However, the others are dumped on roadsides or open plots illegally and GWMC manages to take the waste to the landfill site for free.

C&D waste is generated from commercial activities. Most of them are rocks, sand, concrete and reinforced bar, and the character of the waste is totally different from domestic waste or other commercial wastes. Special vehicles for the waste collection and transportation are, therefore, necessary for conducting the work and, in order to generate the cost for operation and maintenance of the vehicles, setting a schedule of collection fees is necessary.

5.7.2 Necessary Number of Vehicles for the Collection of C&D Waste

C&D wastes are generated from construction sites and consist of rocks, sand, concrete, etc., so that a compactor is not suitable for C&D waste collection. Since most of the construction sites do not have enough space for C&D waste, the wastes become a large heap and loading them into a vehicle is an arduous job for the sanitary workers. It is, therefore, necessary to deploy a wheel loader for loading the waste. **Table B.5.20** shows the necessary vehicles for C&D waste. For reducing the idle time of trucks, three units of 5-ton trucks and one unit of wheel loader are to be deployed for the collection work.

Table B.5.20 Necessary Vehicles for the Collection of C&D Waste

Item	Number of Vehicles
5-ton Truck	3
Wheel Loader	1

GWMC is obligated to collect construction wastes generated from the construction sites. The collection is separate from the ordinary collection of waste and hence the necessary collection vehicles and equipment shall be deployed for the work. Since this kind of waste is generated from sources such as the construction industry, GWMC has to set an appropriate fee schedule for the construction and demolition waste.

5.8 Project for the Construction of Parking Area

Parking areas are for the storage of waste collection vehicles at night after the waste collection and transportation work. Since the number of collection vehicles is increasing and the collection rate is improved, additional parking areas for the procured vehicles are necessary in the future. The project is to start in 2016 and continue until 2030. A parking area does not have the minimum function of repair work because the existing garage has the capability of repair work and repair is centralised for efficiency.

5.8.1 Number of Parking Areas

In 2030, the total number of vehicles becomes 612. However, the existing garage could accommodate only approximately 100 vehicles. Hence, the designated number of vehicles in one parking area is set as 100 vehicles. This value is the same as the capacity of the existing parking area. Necessary number of parking areas is calculated as follows:

Total number of vehicles: 612 / 100 vehicles per parking area = 6 parking areas

Therefore, 612/6 = 102 vehicles per parking area.

Based on the calculation, the capacity of parking area is designed for the parking capacity of 102 vehicles. The function of the parking area is only to park vehicles. The repair work is performed in the existing garage.

Table B.5.21 shows the number of vehicles annually (year 2016 to 2018). As mentioned in **Subsection 4.1.10, Construction of Parking Area**, a parking area needs to accommodate 100 vehicles and the average parking area is set as 600 square metres. However, the total area may vary depending on the acquisition and/or location of the area.

Table B.5.21 Annual Number of Vehicles (Year 2016-2018)

Year	2016	2017	2018
Number of Waste Collection Vehicles	161	196	316
Number of Parking Areas	2	2	4

The existing garage has a limited roofed area so that most of the vehicles are soaked with rain, especially, during the monsoon season. To avoid this situation, roofing is set for the parking area. In addition, roofing is also required for the existing garage.

Pavement is also required for the new parking area and the existing garage to improve work efficiency and condition.

5.8.2 Specification of the Parking Area

GWMC needs to build new parking areas for waste collection vehicles based on the following specifications:

- Size of area: 6,000m^2
- Parking area: The area shall be able to accommodate 102 vehicles
- Roofing: Steel skeleton structure
- Pavement: Asphalt-pavement, 30mm thick
- Security system: 1 unit of guardhouse, fencing around the parking area

For security reasons, one guardhouse is built and steel fence is installed at the perimeter of the facility. The place where the vehicles are parked shall consist of a roofed steel skeleton building for protection against rain.

The existing garage has no pavement and no roofing in parking area. The cost for improving the garage is included in the plan, as follows:

- Necessary pavement area on existing garage: 30mm thick, 3,735m^2
- Necessary roofing area on existing garage: steel skeleton structure, 1,344m^2

5.9 Plan of Operations and Cost of Action Plan

Figure B.5.3 shows the Operation of Waste Collection and Transportation Plan (Short-Term) and **Table B.5.22** shows the Estimated Cost of the Waste Collection and Transportation Plan (Short-Term).

Time Framework of the Master Plan		Short-Term Plan Period											
Year		2016				2017				2018			
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WBS for Short-Term Plan													
S-1-1	Introduction of Separate Collection and Alternate day collection through Implementation of Pilot Project												
S-1-1-1	Formulation of Detailed Plan for the Pilot Project Area												
S-1-1-2	Procurement of Waste Collection Vehicles and Containers for Pilot Project												
S-1-1-3	Operation of Waste Collection and Container												
S-1-1-4	Monitoring and Feedback of the Pilot Project Operation												
S-1-2	Increasing of Waste Collection Ratio in 64 UCs up to 100% in 2018												
S-1-2-1	Formulation of Detailed Design for Waste Collection Ratio in 64 UCs up to 100% in 2018												
S-1-2-2	Procurement of Waste Collection Vehicles and Containers in 64UCs												
S-1-2-3	Operation of Waste Collection and Container												
S-1-2-4	Monitoring and Feedback of the Operation												
S-1-3	Conducting Street Cleaning in 64UCs												
S-1-3-1	Plan for conducting Street Cleaning in 64UCs												
S-1-3-2	Procurement of Waste Collection for Street Cleaning												
S-1-3-3	Conducting Street Cleaning in 64UCs												
S-1-4	Collection of bulky waste												
S-1-4-1	Procurement of Waste Collection for Bulky Waste												
S-1-4-2	Collection of bulky waste												
S-1-5	Cleaning up of Illegal dumping sites in 64 UCs												
S-1-5-1	Procurement of Waste Collection Illegal dumping sites in 64UCs												
S-1-5-2	Cleaning up of Illegal dumping sites in 64 Ucs												
S-1-6	Collection of Construction and Demolition Waste												
S-1-6-1	Plan for Collection of Construction and Demolition Waste												
S-1-6-2	Collection of Construction and Demolition Waste												
S-1-7	Construction of Parking area												
S-1-7-1	Construction of Paking area												

Figure B.5.3 Plan of Operations of the Waste Collection and Transportation Plan (Short-Term)

Table B.5.22 Cost of Operations for Waste Collection and Transportation Action Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost		
			2016	2017	2018
Programme 1: Waste Collection and Transportation Plan					
Short-Term Plan					
S-1-1	Introduction of Separate Collection and Alternate day collection through implementation of Pilot Project	143,525	52,343	40,523	50,659
S-1-1-1	Formulation of Detailed Plan for the Pilot Project Area	GWMC			
S-1-1-2	Procurement of Waste Collection Vehicles and Containers for Pilot Project	78,420	34,500	19,680	24,240
S-1-1-3	Operation of Waste Collection and Container	65,105	17,843	20,843	26,419
S-1-1-4	Monitoring and Feedback of the Pilot Project Operation	GWMC			
S-1-2	Increasing of Waste Collection Ratio in 64 UCs up to 100% in 2018	1,649,399	288,028	394,639	966,732
S-1-2-1	Formulation of Detailed Design for Waste Collection Ratio in 64 UCs up to 100% in 2018	GWMC			
S-1-2-2	Procurement of Waste Collection Vehicles and Containers in 64UCs	998,675	137,457	207,077	654,141
S-1-2-3	Operation of Waste Collection and Container	650,724	150,571	187,562	312,591
S-1-2-4	Monitoring and Feedback of the Operation	GWMC			
S-1-3	Conducting Street Cleaning in 64UCs	80,384	67,328	6,528	6,528
S-1-3-1	Plan for conducting Street Cleaning in 64UCs	GWMC			
S-1-3-2	Procurement of Waste Collection for Street Cleaning	60,800	60,800		
S-1-3-3	Conducting Street Cleaning in 64UCs	19,584	6,528	6,528	6,528
S-1-4	Collection of bulky waste	31,990	23,730	4,130	4,130
S-1-4-1	Procurement of Waste Collection for Bulky Waste	19,600	19,600		
S-1-4-2	Collection of bulky waste	12,390	4,130	4,130	4,130
S-1-5	Cleaning up of Illegal dumping sites in 64 UCs	23,773	22,382	1,391	
S-1-5-1	Procurement of Waste Collection illegal dumping sites in 64UCs	19,600	19,600		
S-1-5-2	Cleaning up of illegal dumping sites in 64 Ucs	4,173	2,782	1,391	
S-1-6	Collection of Construction and Demolition Waste	23,070	7,690	7,690	7,690
S-1-6-1	Plan for Collection of Construction and Demolition Waste	GWMC			
S-1-6-2	Collection of Construction and Demolition Waste	23,070	7,690	7,690	7,690
S-1-7	Construction of Parking area	523,480	126,424	3,546	393,510
S-1-7-1	Construction of Paking area	523,480	126,424	3,546	393,510
	Total (Short-Term)	2,475,621	587,925	458,447	1,429,249

6. CONCLUSION

6.1 Improvement of Waste Collection and Transportation Service

Currently, waste collection and transportation do not cover the whole CDGG administrative area and the UCs in the peri-urban area are not targeted. Therefore, scattered wastes could be seen in many parts of the city. This condition defiles the environment and affects the sanitary condition of the residents. GWMC needs to start waste collection and transportation in all of the 64 UCs very urgently. At the same time, the checking of sanitary condition and implementation of waste collection in the 34 UCs should be started soonest to improve the sanitary condition in the residential areas.

Adequate number of waste collection vehicles and waste containers should be procured for the waste collection work. GWMC should start the waste collection and transportation immediately after the allocation of necessary number of waste collection vehicles and waste containers in each zone in 2016. The cost for the procurement of waste collection and transportation equipment is estimated at Rs. 5,897 million at current prices.

6.2 Improvement of Efficiency of Waste Collection System

Currently, the waste collection and transportation system including type of waste collection and transportation vehicles and size of waste containers is inappropriate and outdated. For improvement of the current system, the type, size and deployment of collection vehicles and containers, as well as the road condition in the city, need to be taken into consideration. For the allocation of waste collection vehicles and waste containers in each zone, the type and width of the streets and so on also need to be considered.

In addition, a waste collection and transportation manual has to be prepared by GWMC, which should serve as guidelines on the proper monitoring of the daily waste collection operation since feedbacks from the monitoring are necessary for updating the waste collection equipment deployed in each site. GWMC has to implement proper waste collection operation and monitoring works in 2016. The necessary cost for the work is estimated at Rs. 6,452 million at current prices.

6.3 Setup of Proper Operation and Monitoring Systems for Waste Collection and Transportation

There are approximately 800 illegal dumping sites in the city. Wastes are scattered around the waste containers. The reduction of public sanitation risk in residential areas due to insufficient waste collection service is thus required.

Clean-up of the illegal dumping sites and the wastes scattered around the containers is required to be conducted. Formation of the clean-up teams and procurement of the necessary vehicles for deployment in the illegal dumping sites are necessary to eliminate all of these sites in 3 years starting from 2016.

The clean-up work is to be made separately from the waste collection and transportation work. Once an illegal dumping site is cleared, not only monitoring but also public awareness campaigns are required. GWMC should start the clean-up work in 2016. The cost for implementing the work is estimated at Rs. 24 million at current prices.

7. RECOMMENDATIONS

7.1 Securing Budget for the Procurement of a Sufficient Number of Waste Collection Vehicles and Containers

To achieve 100% of waste collection and transportation rate in the 98 UCs based on the schedule, a sufficient number of waste collection and transportation vehicles, as well as the appropriate type of waste collection and transportation vehicles and waste collection containers shall be deployed in each target area. Timely appropriation and/or provision of the necessary budget for waste collection and transportation equipment, as well as execution of the necessary works based on the implementation schedule are thus required.

7.2 Establishment of Effective and Efficient Waste Collection and Transportation System

The formulation of an effective and efficient transportation system shall be based on the detail design of waste collection vehicles and containers as well as the allocation plan. Once the waste collection and transportation work starts, a system is necessary for updating the allocation plan of waste collection vehicles and containers flexibly according to the implementation of waste collection operation.

7.3 Securing Budget for the Clean-up of Illegal Dumping Sites

For eliminating all of the illegal dump sites in the 64 UCs, a sufficient number of vehicles for the clean-up work are necessary. The budget for the work shall be ensured in order to achieve the target. The location and waste amounts at the illegal dumping sites shall also be clarified before implementing the clean-up work.

Once the illegal dumping sites are cleared, GWMC should institute measures to discourage and/or prevent the reformation of new illegal dumping sites. Such measures include the installation of signboards and implementation of sanitation awareness campaigns with the surrounding residents. Sanitation and cleanliness of the eliminated illegal dumping sites and the surrounding areas shall be maintained through monitoring and cleaning by sanitary workers.

PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

DRAFT FINAL REPORT

VOLUME 2

SUPPORTING REPORT

SECTION C

FINAL DISPOSAL

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SECTION C
FINAL DISPOSAL

1. INTRODUCTION

The former disposal site of approximately 4 ha locates along the Grand Trunk Road (G.T. Road) in the south of Gujranwala City finished landfill operation in the end of February 2014. Since then, the site has not been closed properly to the risks of safety and environmental degradation to the surrounding area.

The existing disposal site in Gondlanwala at about 8 km north-northwest is used as a temporary landfill site until the new sanitary landfill facilities become operational. This temporary disposal site currently receives domestic waste collected from the 64 urban union councils in Gujranwala City and the landfill site has started to become a cause of environmental pollution in the surrounding area. The lifetime of this site is estimated to finish by the end of December 2016.

In view of the situation of urgent need of new final disposal facilities, the site in Bhakhraywali was proposed as the candidate site for development of a new sanitary site for Gujranwala. EIA and site procurement are now in progress.

Under the circumstances described above, the priority project for final disposal plan is formulated based on the following areas:

- Development of New Sanitary Landfill Facilities at Bhakhraywali
- Improvement of Existing Landfill in Gondlanwala
- Safe Closure of Former Landfill in Chianwali

2. DESCRIPTION AND EVALUATION OF CURRENT CONDITION

2.1 Overview of Final Disposal in Gujranwala

The old disposal site of approximately 4 ha utilised the lowlands along the Grand Trunk Road (G.T. Road) located in Chianwali at about 7 km south of Gujranwala City. Landfill operation, open dumping, started at the end of 2006 and finished at the end of February 2014. Landfill operation is no longer carried out but the site has not been closed properly to ensure safety and environmental degradation in the surrounding area.

The existing disposal site utilises the abandoned borrow pit in Gondlanwala at about 8 km north-northwest from the city centre of Gujranwala. The site is used as a temporary landfill site until the new sanitary landfill facilities become operational. Landfill operation started in March 2014 and this temporary disposal site currently receives domestic waste collected from the 64 urban union councils in Gujranwala City. The landfill operation carried out is the open dumping method and the landfill site has started to become a cause of environmental pollution in the surrounding area.

Engineered landfill facilities or sanitary landfill facilities have not yet been developed for the City of Gujranwala until now. In view of the situation of solid waste management (SWM) being practiced without an appropriate landfill site in Gujranwala, the Urban Unit (UU) and CDGG launched the project for development of new final disposal facilities in 2012. The UU, SWM team visited Gujranwala in September 2012 and carried out a site selection survey intensively to identify the suitable site for development of sanitary landfill facilities and prepared the report. Then the report was reviewed and revised in March 2014 by UU. According to the report entitled *"Landfill Site Identification & Evaluation Report"*, the site in Bhakhraywali is proposed as the candidate site for development of a new sanitary site for Gujranwala. The site selection procedures and the progress status of topographical and geotechnical surveys will be delineated later in **Subsections 2.4.8**.

Figure C.2.1 shows the location of the closed disposal site in Chianwali, the existing disposal site in Gondlanwala and the candidate landfill site in Bhakhraywali. **Photo C.2.1** shows the current status of these three disposal sites.

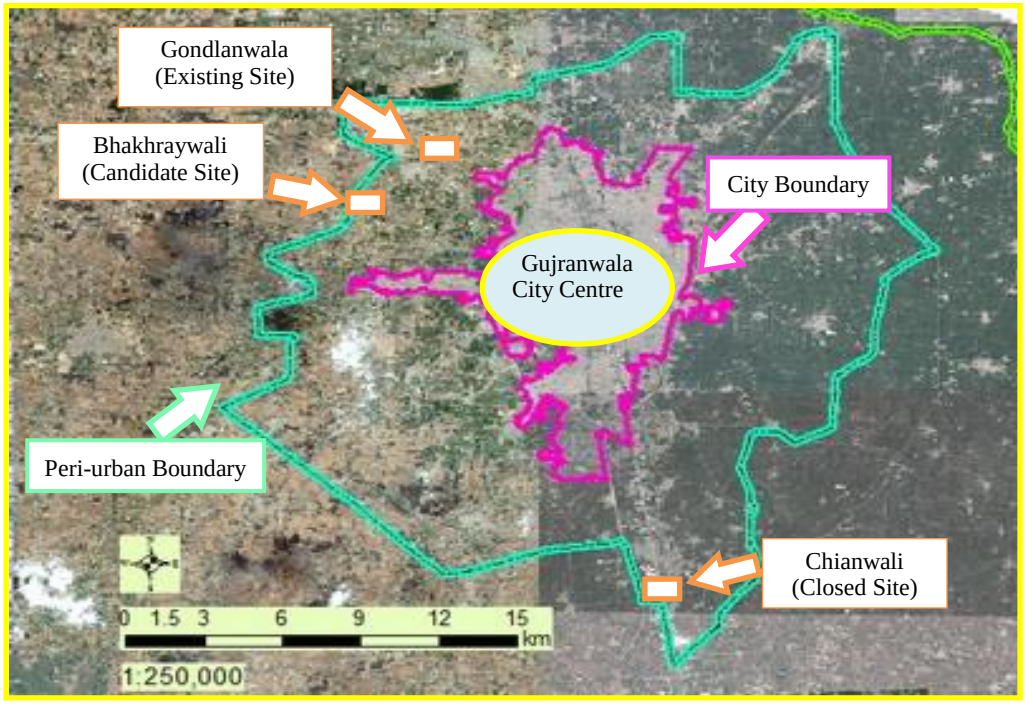


Figure C.2.1 Location Map of Final Disposal Sites

Photo C.2.1 Current Status of Final Disposal Sites

2.2 Final Disposal Operation

2.2.1 Operation Status of Existing Final Disposal Site in Gondlanwala

The abandoned borrow pit in Gondlanwala site having the approximate area of 4.7 ha and the depth of 8-9 m is currently used as the temporary landfill site. Landfill operation started in March 2014. The site is expected to be used for 2 to 3 years for the estimated volume of about 400,000 m^3. Landfill work, open dumping, is carried out actively and the available landfill area is decreasing day by day. The loaded waste amount of each vehicle is weighed by the weighbridge installed by the Project in connection with the survey work of this project. As of September 2014, more or less 400 tons per day in average including the waste amount from the clean-up work of the illegal dumpsites in the town area is carried into the landfill site. In the records of the weighbridge, the maximum incoming waste amount up to now has become 665 tons per day on 30 September 2014. Then, the waste is unloaded onto the top of the landfill area and spread by two units of tractor shovels.

The landfill work is carried out by the open dumping method, so that environmental degradation especially groundwater contamination, breeding of pests such as flies, etc., have become significant problems. GWMC is taking measures for earth covering, draining contaminated water at the bottom of the landfill area and spraying insecticides for controlling waste dumping operation.

Waste pickers, most of them look like under 18 years old male, collect recyclable materials at the waste unloading area and in the slope where wastes slide down to the bottom of the landfill. The number of waste pickers was about 20 people, initially, but about 35-40 people divided into three groups in worked daily in September 2014. Health hazards and risk of recovery operation is a matter of concern. The waste picker survey including the waste pickers working in town was conducted in December 2014 and the survey method and results are described in ***Volume 2 Supporting Report, Section D, Intermediate Treatment and 3R Promotion***.

Photo C.2.2 shows the current operation status described above.

Disposal Site, March 2014 | Unloading Waste, March 2014 | Waste Pickers & Recyclables, Sept. 2014

Disposal Site, Sept. 2014 | Weighbridge, Sept. 2014 | Water Pollution, Sept., 2014

Photo C.2.2 Operation Status of Gondlanwala Final Disposal Site as of September 2014

Surface water ponding at the bottom of the landfill is contaminated, causing groundwater contamination. There are three farmer houses within the distance of 500 m from the Gondlanwala disposal site as shown in **Figure C.2.2**. The total number of people residing in the three houses is about 50. They live on breeding of about 150 livestock and agriculture in the area.

Every house uses groundwater for daily living, agriculture and livestock. Every house uses groundwater from shallow and deep aquifers by hand pump and tube well. Seasonal water quality tests have been conducted in this project and the first water sampling was done in September 2014, taking groundwater and surface water samples from 10 sampling points including the wells of these three houses. Reference shall be made to the results of water quality tests delineated in **Subsection 2.4.5**.

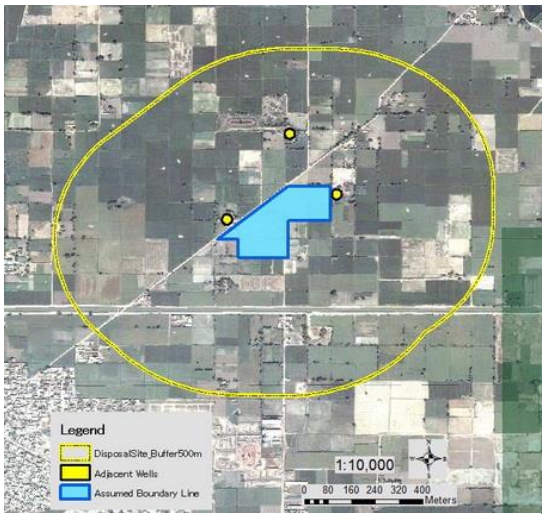


Figure C.2.2 Location of Wells in and around the Gondlanwala Disposal Site

2.2.2 Situation of Closed Chianwali Final Disposal Site

The Chianwali disposal site was used from the end of December 2006 to February 2014. The waste dumped during the period of approximately 7 years was left without any soil cover. The site is located just along the G.T. Road. Therefore, in addition to the risk of groundwater contamination, visual pollution to landscape and waste scattered by wind are causing the negative environmental impacts.

The record of the number of incoming vehicles to Chianwali available from CDGG was only for 4 months as shown in **Table C.2.1**. Only arm-roll vehicles hauled waste to the disposal site and the tractor trolleys disposed waste at the open spaces in the town area due to long hauling distance problem, more than 15 km from the city centre, for this type of vehicle.

Table C.2.1 Record of Incoming Vehicles (Arm-Roll Truck) to Chianwali Disposal Site

Vehicle Type	Arm-Roll Truck			
Month/Year	November 2013	December 2013	January 2014	February 2014
Total No. of Trips per Year	2,600	2,137	2,062	2,001

Source: Record of SWM Section, CDGG

There were no incoming vehicle records available for the period before November 2013. However, the vehicle list from the fiscal year 2005/2007 is available and the data shown in **Table C.2.2** were used for the estimation of waste disposal amount from the beginning of landfill operation in December 2006 to the end of landfill operation in February 2014. The average loading weight of arm-roll was obtained from the actual weighing of waste record at the private weighbridge in May 2014. Accordingly, the estimation of waste disposal amount was carried out by the factors of average loading weight of arm-roll truck, number of functional vehicles, and the annual operation ratio of the vehicles in each year.

Table C.2.2 Number of Functional Vehicles in Fiscal Years 2006-2007 to 2012-2013

Fiscal Year	2006-2007	2007-2008	2008-2009	2009-2011	2011-2012	2012-2013
No. of Functional Arm-Roll Truck	7	11	22	28	28	28
No. of Functional Tractor Trolley	43	43	43	37	37	37
Total No. of Functional Vehicles	50	54	65	65	65	65

Source: Processed data of Vehicle List of SWM Section, CDGG

Due to unavailability of operation days or the operation rate of vehicles in each year, the estimation was made on the assumption based on the interview to the GWMC operation section that the operation rate of vehicles is 70%.

The result of calculation of annual waste disposal amount at Chianwali is given in **Table C.2.3** and the cumulative waste disposal amount is shown in **Figure C.2.3**. The cumulative waste amount disposed at Chianwali had reached 341 thousand tons during the landfill operation of 7 years and 3 months. The accumulated waste volume is estimated at more or less 310 thousand cubic metres assuming that the bulk density of filled waste layer is 1.1 ton/m^3 obtained from the bulk density survey conducted in Chianwali and Gondlanwala disposal sites (see **Subsection 2.4.6** in detail).

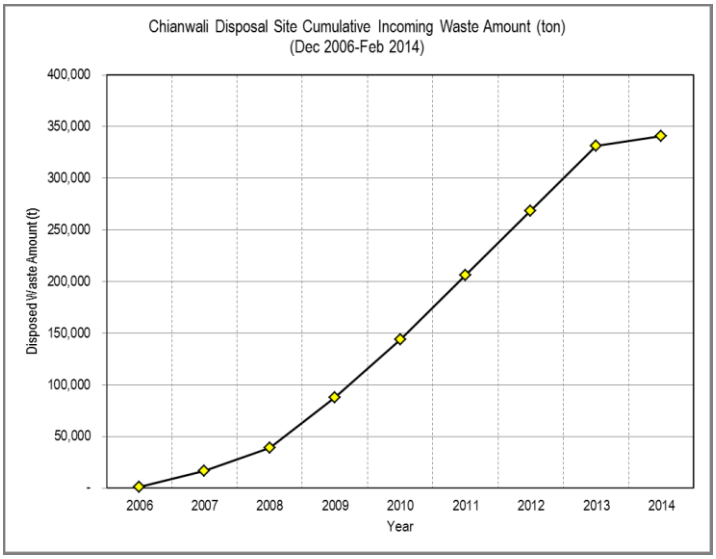


Figure C.2.3 Cumulative Waste Disposal Amounts at Chianwali

Table C.2.3 Annual and Cumulative Waste Disposal Amounts at Chianwali

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Disposal Amount (1,000 ton/year)	1.3	15.6	22.2	49.0	55.6	62.3	62.3	63.1	9.6
Cumulative Amount (1,000 ton)	1.3	16.9	39.1	88.1	143.7	206.0	268.3	331.4	341.0

2.2.3 Waste Disposal Amount of Existing Gondlanwala Final Disposal Site

Landfill operation at Gondlanwala started in March 2014. Since then, the number of incoming vehicles had been recorded manually by the inspector until 8 May 2014. Recording of loading weight started from 9 May 2014 at a private weighbridge located along the way to Gondlanwala.

A weighbridge was later installed under the scheme of the Project at an area adjacent to the Gondlanwala landfill site. Weighing of incoming waste amount was then made continuously from 2 September 2014 at the weighbridge of Gondlanwala disposal site and digital recording is now available. Since 1 October 2014, the monthly weighbridge data has been processed and analysed through the Incoming Waste Amount Survey under the Project activities. The incoming waste amount at Gondlanwala was estimated based on the data recorded from the sources mentioned above.

Monthly incoming waste amounts to the disposal site and the cumulative landfill waste amounts are shown in **Table C.2.4** and the graphs in **Figure C.2.4** and **C.2.5**. The monthly incoming waste amounts to the disposal site from March to June 2014 show less than 10,000 tons per month. The incoming waste amount had increased from July at more than 20% due to the commencement of two-shift operation and clean-up of discarded wastes in the town area. In September, the incoming waste amount was more than 13,000 tons per month. In October 2014, the incoming waste amount transported to the disposal site jumped up to more than 16,000 tons/month due to additional Eid waste for about one week. Landfill waste amount has been accumulating day by day at the Gondlanwala disposal site and the filled waste in the past 12 months from March 2014 to February 2015 is estimated at 149,000 tons. Considering the result of the bulk density survey described in **Subsection 2.4.6** and the estimated lifetime of Gondlanwala disposal site, the bulk density is assumed at 0.9 ton/m^3. Consequently, with the assumed bulk density, the present cumulative landfill volume is estimated approximately at 166,000 m^3. The landfill area is secured at 4.7 ha at present. GWMC is planning to secure the adjacent land based on the offer of the landowner. After securing the adjacent land, the total landfill area will become 6.4 ha and available landfill volume will be 510,000 m^3. The balance volume of 344,000 m^3 will be filled up in 22 months with the monthly incoming waste of 14,000 tons or 15,600 m^3 and the lifetime of the landfill site will end in December 2016.

Table C.2.4 Monthly Annual and Cumulative Waste Disposal Amount at Gondlanwala

Month	Monthly Waste Disposal Amount at Gondlanwala Disposal Site (ton/month)	Cumulative Waste Disposal Amount at Gondlanwala Disposal Site (ton)
March 2014	9,980	9,980
April	9,894	19,874
May	9,628	29,502
June	9,588	39,090
July	12,693	51,783
August	11,767	63,550
September	13,159	76,708
October	16,734	93,442
November	12,688	106,130
December	12,976	119,106
January 2015	15,239	134,345
February	14,799	149,144

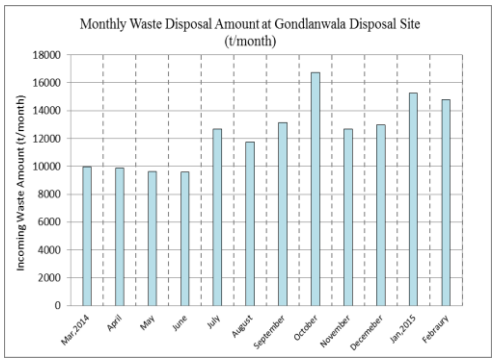


Figure C.2.4 Monthly Waste Disposal Amount at Gondlanwala

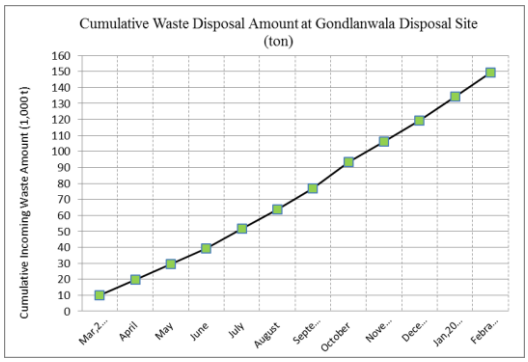


Figure C.2.5 Cumulative Waste Disposal Amount at Gondlanwala

2.2.4 Fluctuation of Incoming Waste Amount at Gondlanwala Final Disposal Site

Daily incoming waste amounts in September 2014 are shown in **Table C.2.5** and the graph in **Figure C.2.6**. The daily incoming waste fluctuates in the range of approximately 390-670 ton/day. On average, the incoming waste amounts on Mondays show more than the incoming waste of other days of the week since GWMC does not carry out waste collection on Sundays except for the requirement of special collection. The average incoming waste amount on Mondays reaches approximately 121% of the working-day average waste amount of the month followed by Wednesdays at 113%.

Table C.2.5 Daily Incoming Waste Amount at Gondlanwala Disposal Site (September 2014)

Day of the Week	1st Week (1-7) (t/d)	2nd Week (8-14) (t/d)	3rd Week (15-21) (t/d)	4th Week (22-28) (t/d)	5th Week (29-30) (t/d)	Total (t/week)	Average Incoming Waste Amount by Day of the Week (t/d)	Ratio to the Working-day Average (%)
Monday	581	606	589	574	588	2,938	588	120.6
Tuesday	514	416	562	392	665	2,548	510	104.6
Wednesday	541	583	470	601		2,194	549	112.6
Thursday	248	469	496	484		1,697	424	87.0
Friday	303	420	497	556		1,776	444	91.1
Saturday	335	537	451	446		1,769	442	90.7
Sunday			236			236	236	48.5
Total	2,522	3,032	3,301	3,052	1,252	13,159	-	
Working-day Average Incoming Waste Amount by Day of the Week (t/d), 27days							487	
Daily Average Incoming Waste Amount (t/d), 30days							439	

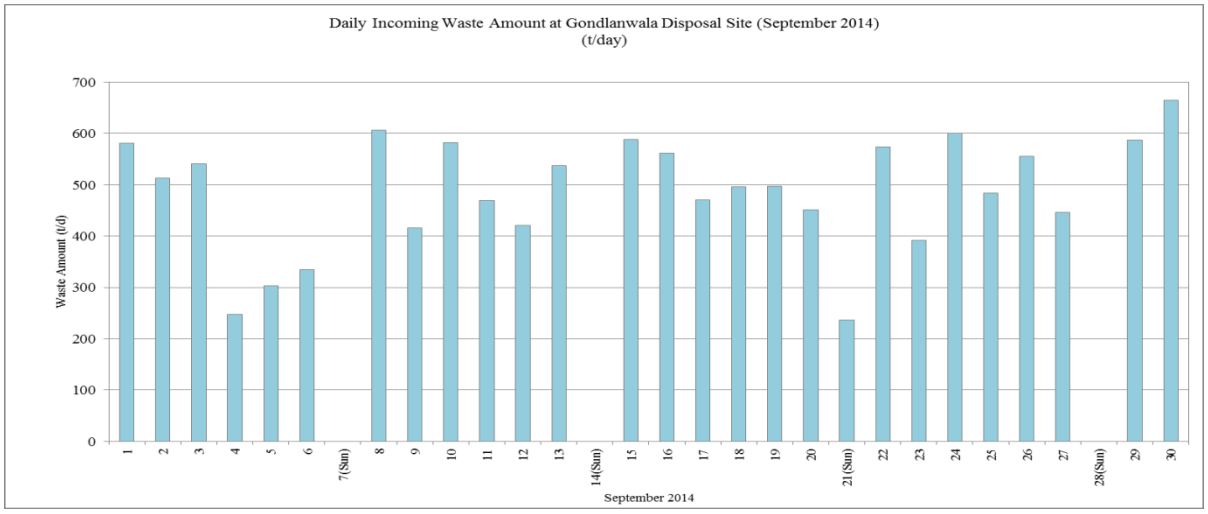


Figure C.2.6 Daily Incoming Waste Amount at Gondlanwala Disposal Site (September 2014)

2.2.5 Incoming Number of Vehicles per Day to the Gondlanwala Disposal Site

Collected waste is carried to the disposal site by tractor trolley and arm-roll trucks equipped with $5m^3$ or $10m^3$ containers. **Figure C.2.7** shows the daily number of trips by arm-roll truck and tractor trolley recorded in February 2015. In total, the incoming number of vehicles to the disposal site reached approximately 5,100 trips. The incoming number of vehicles varied from the lowest recorded of 156 trips in 20 February to the highest recorded of 244 trips in 27 February. However, on average, the total number of 170 to 180 trips per day was performed by arm-roll trucks and the tractor trolleys. Among the total number of trips, about 75% of trips were performed by arm-roll trucks and the rest or 25% of trips was performed by tractor trolleys. As a matter of course, as well as the fluctuation of incoming waste amount described above, the number of trips of incoming vehicles increase on Mondays and Wednesdays. GWMC had started to dispatch $1m^3$ mini-dumpers since December 2014 and the wastes collected by mini-dumpers were transported to the disposal site by arm roll trucks.

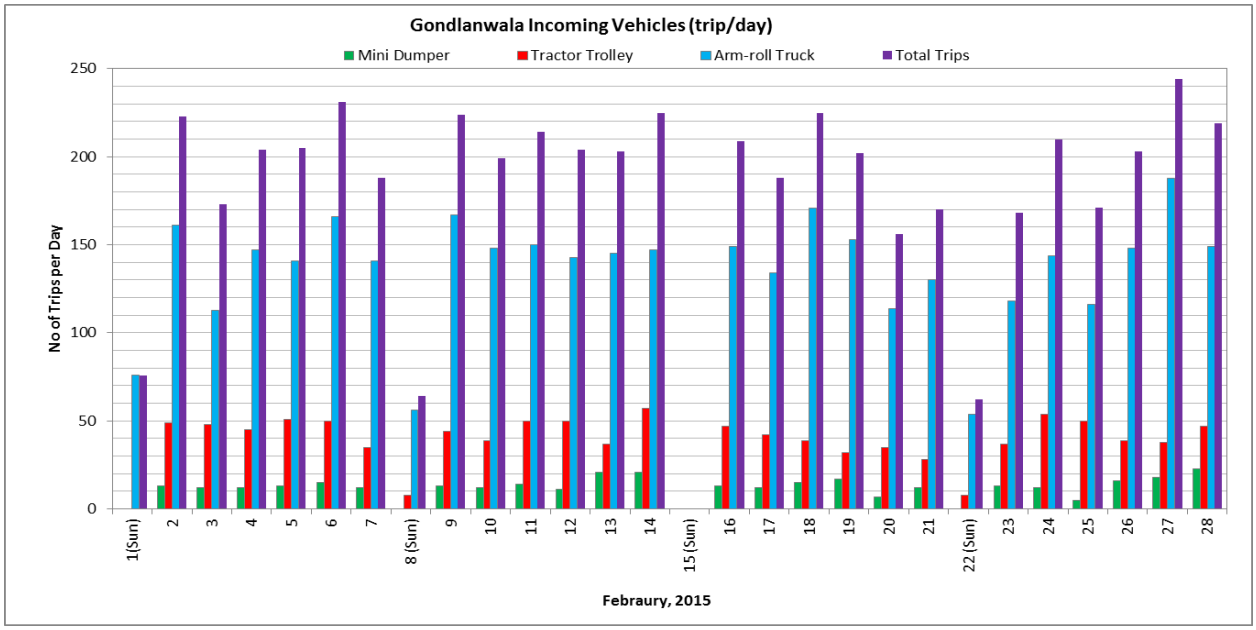


Figure C.2.7 Daily Number of Incoming Vehicles by Arm-Roll Truck and Tractor Trolley to Gondlanwala Disposal Site (February 2015)

2.2.6 Existing Landfill Machine

Two units of tractors with front end loading bucket are operated at the landfill site to push and spread waste unloaded from the incoming vehicles. The tractors, Model New Holland Diesel Agriculture Tractor, 105 HP, were procured in 2008. Due to aging of the vehicles after 7 years of operation, frequent maintenance and repair is required. Each vehicle consumes 30 litres of fuel daily and the annual operation cost is estimated at about Rs. 2 million. **Photo C.2.3** shows an existing landfill tractor.

Photo C.2.3 Landfill Tractor with Front Loading Bucket

The incoming vehicles unload waste on the top of the landfill layer in the public roadside, and then the waste is pushed away by two units of tractor shovel into the bottom of the landfill area. Earth covering on to the waste layer is carried out only

intermittently. Environmental impacts such as odour problem and breeding of flies occur under the inappropriate practice of landfill work. In addition, leachate from the landfill layer ponding in the bottom of the landfill area during the monsoon season might be causing groundwater contamination.

2.2.7 Landfill Operation Staff

Landfill operation is carried out by staff under the Senior Landfill Manager. The organizational structure of landfill operation is as shown in **Figure C.2.8**. The post of Operation General Manager is vacant as of end of July 2015. Besides the post shown in Figure, the sanitary workers and security guards are dispatched to the disposal site and the current total number is 17 people.

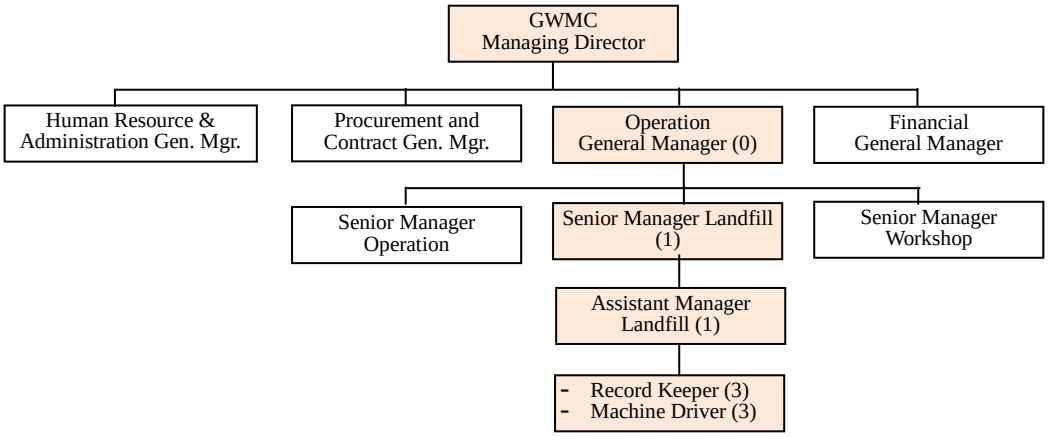


Figure C.2.8 Organizational Structure for Landfill Operation

2.3 Topographic Survey of Closed and Existing Final Disposal Sites

The contract for the topographic survey was signed on 12 September 2014. The contractor has finished the field work and the mapping work by the end of November. The final products of topographic map, profiles and cross sectional drawings were submitted to the JICA Project Team in December 2014. The topographic survey was carried out as shown in the following outline.

2.3.1 Purpose of the Work

The purpose of the topographic survey is to provide the materials for the study, design and planning of the final disposal site of the Project envisaged under the solid waste management system for Gujranwala City.

2.3.2 Location of the Survey Site and Survey Area

The locations of the topographic surveys and the survey area are the following two sites:

- Closed landfill site at Chianwali, Site Area: 6 ha (Survey Area: approximately 8 ha)
- Existing landfill site at Gondlanwala, Site Area: 5 ha (Survey Area: approximately 7 ha)

2.3.3 Output of the Survey Work

The Contractor is to submit the following results of the survey work under the contract.

- One (1) set of original prints of topographic map(s) per site, which shall include all spot elevations, contour lines and all the surveyed items.
- One (1) set of original prints of profile and cross sections per site, which shall include major spot elevations and all the surveyed items. All original prints in ink shall be duly reviewed, dry-sealed and signed by a licensed Chief Geodetic Expert.
- Four (4) sets of copies of topographic map(s), profiles and sections per site.

- Two (2) sets of CD-ROM containing all the survey maps and records in digital form.
- All field books, worksheets, field notes, sketches, traverse and levelling computations.
- Preliminary design drawings and quantities of works of the closure plan at Chianwali site and the improvement plan of Gondlanwala as instructed and provided under the conceptual plan of the JICA Project Team.

2.3.4 Results of the Topographic Survey

The contractor submitted the outputs of the survey work including the topographic map, profile and cross-sections for Gondlanwala and Chianwali disposal site. Those output drawings were used for preparation of the preliminary design including the layout plan and cross section plan for the improvement works for Gondlanwala and safe closure work for Chianwali as shown in the design drawing in **Section 5.3.**

2.4 Geotechnical Survey of Closed and Existing Final Disposal Sites

The contract for the geotechnical survey was signed on 6 September 2014. The contractor started the field work on 12 October and completed the boring test by the end of October 2014. The results of boring test and the laboratory test were submitted to the JICA Project Team in December 2014. The geotechnical survey was carried out as shown in the following outline.

2.4.1 Purpose of the Work

The geotechnical survey shall be conducted for the boring tests, permeability tests, field reconnaissance and literature review. The objectives of the geotechnical survey are to examine the bearing capacity for the foundation design of structures, to examine the underground permeability for the measures against infiltration of leachate, and to grasp the geological conditions of the site and the surrounding area.

2.4.2 Location of the Survey Site and Contents of the Survey Work

The locations of the geotechnical surveys and the contents of the survey work are described as follows:

- Survey of the closed landfill site at Chianwali and the existing landfill site at Gondlanwala;
- Number of Boreholes: 5 boreholes at the closed landfill site, and 5 boreholes at the existing landfill site;
- Boring Depth: 30m each (If N-values are more than 50 for consecutive 5m, boring shall be stopped.);
- Standard Penetration Test and N-value: every 1m at each borehole;
- Groundwater Table: at each borehole; and
- Permeability Test: 3 holes at the closed landfill site and 3 holes at the existing landfill site.

2.4.3 Output of the Survey Work

The report to be submitted shall consist of one (1) original plus four (4)copies, digital files of the report and all the processing files in CD-ROM (2 sets). The report shall be described with the methodology, procedures, survey/test results, evaluation of the survey/test results including, but not limited to, the following contents:

- Date and location of boring tests (location map scale: 1:25,000 or 50,000), elevation & coordinate of boreholes, maps showing the locations of the boreholes (scale: 1:1,000), description of the geographical and geological conditions and sub-surface stratigraphy of the site and the surrounding area;
- Borehole logs, water table, profile and cross sections of borehole logs, soil classifications, N-values;
- Recommendations on foundation type for structures and permeability;
- Photographs showing scenes of the work and soil samples in core boxes; and

- Copy of field book(s).

2.4.4 Result of the Survey Work

The results of the geotechnical survey for both sites in Gondlanwala and Chianwali were summarized with the main points by extracting the conclusions of the survey report submitted by the Contractor as shown in the following subsections.

(1) Conclusion of Geotechnical Survey in Gondlanwala

The results of survey work and geotechnical conditions of Gondlanwala existing disposal site are concluded as follow. And the results were incorporated for the conceptual design of improvement work of the existing disposal site.

- Five boreholes (BH) drilled at the site reveal that the main soil type at the site comprises of silty to fine sand which is overlain by a thin layer of silty clay and clayey silt. (See **Figure C.2.9** for the boring logs.)
- Water table was encountered in the boreholes at about 9 m depth from the ground surface.
- Spread (square and strip type) foundations placed at a minimum depth of 0.75 m below NSL can be adopted.
- The bearing capacity should be adopted to develop foundations for 1 to 5 m wide.
- The results of the field permeability tests conducted at 10 to 20 ft depths in the boreholes suggest that the coefficient of permeability (k) varies from 13.6×10^{-4} to 27.2×10^{-4} cm/sec. This indicates a little high permeability for the design to prevent leachate infiltration into underground.
- The permeability tests show complete water loss at 20 ft (6 m) depth in the boreholes. It is therefore recommended to design a suitable lining for sanitary landfill system to save surface and ground water.
- The evaluation of liquefaction potential of the sands of subsurface at the site indicates that the sands will not liquefy under the Zone-2A earthquake.
- The chemical testing reveals that the aggressive chemicals are present in low proportions in the subsoil as well as in the groundwater. Therefore, Ordinary Portland Cement (OPC) should be used in all the foundation construction and below ground construction works.

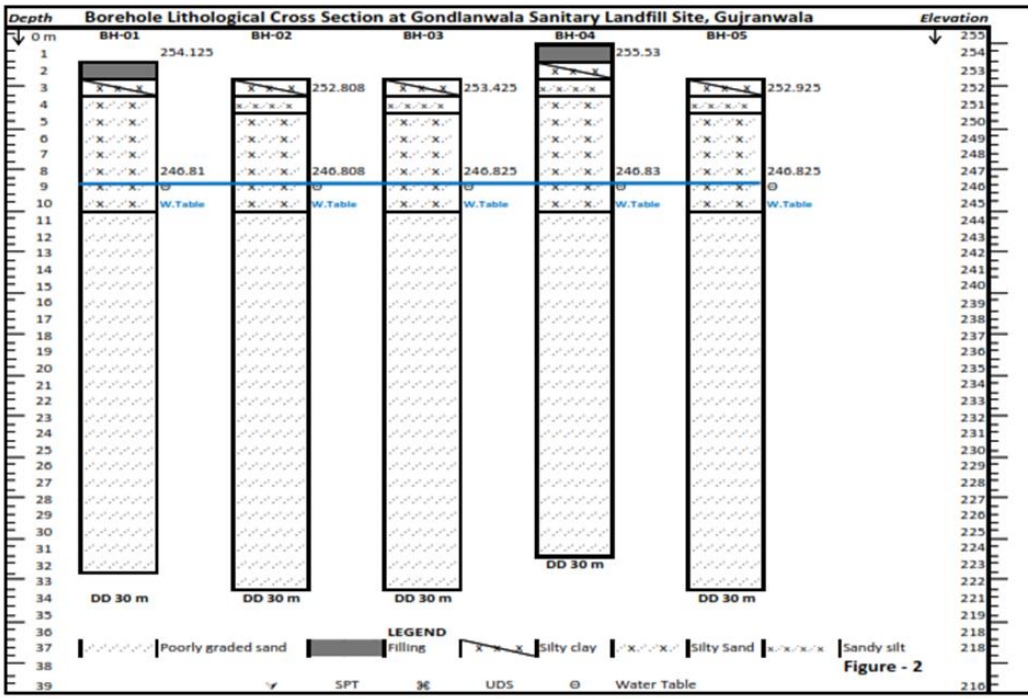


Figure C.2.9 Boring Logs at Gondlanwala Existing Disposal Site

Source: Geotechnical Survey Report of Gondlanwala, November 2014, Lean & Green (pvt) Ltd.

(2) Conclusion of Geotechnical Survey in Chianwali

The results of survey work and geotechnical conditions of Chianwali former disposal site are concluded as follow. And the results were incorporated for the conceptual design of safe closure work of the former disposal site

- Six boreholes were drilled at the site exposed the main soil type comprise of old cohesive fill and silty clay, which is underlain by silty to fine sand. (See **Figure C.2.10** for the boring logs.)
- The groundwater was encountered in all the boreholes at an average depth of 6.4 m from ground surface.
- The field and the laboratory data showed that the old fill and clay layer at the site is capable to support light structures placed at shallow depth after removal of garbage or waste materials.
- Spread (square and strip type) foundations, placed at a minimum depth of 0.75 m below NSL can be adopted.
- The results of the field permeability tests conducted at 10 to 20 ft depths in the boreholes revealed that the coefficient of permeability (k) varies from 4.41×10^{-4} to 84.77×10^{-4} cm/sec. This indicates a little high permeability for the design to prevent leachate infiltrate into underground.
- The evaluation of liquefaction potential for subsurface sands at the site indicates that it will not liquefy under the Zone-2A earthquake.
- The chemical testing reveals that the aggressive chemicals are present in low proportions in the subsoil as well as in the groundwater. Therefore, Ordinary Portland Cement (OPC) should be used in all the foundation construction and below ground construction works.

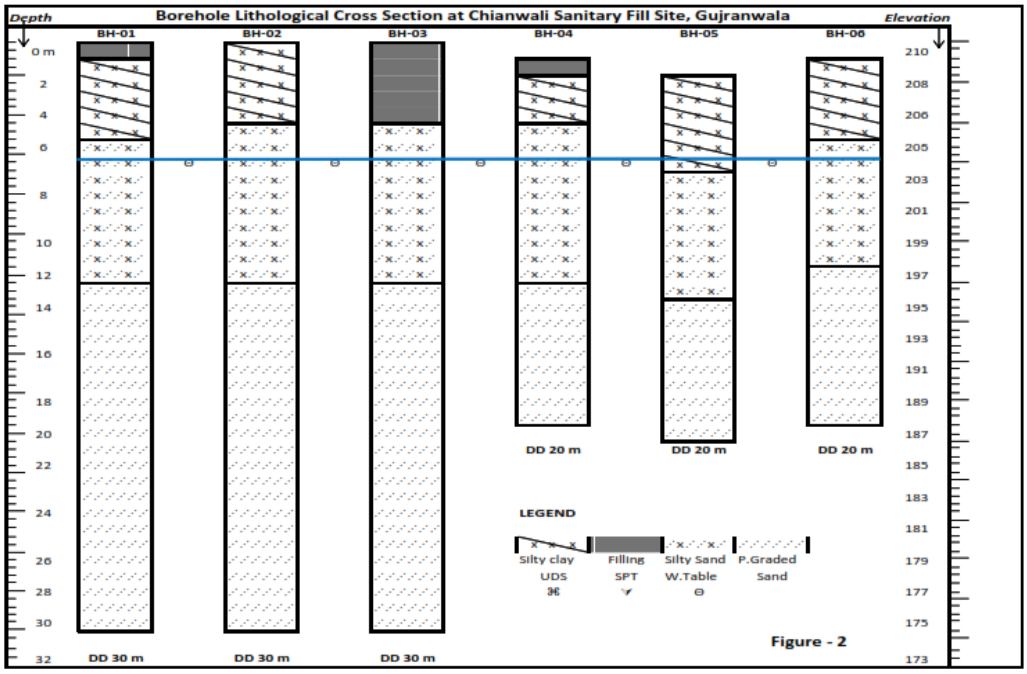


Figure C.2.10 Boring Logs at Chianwali Former Disposal Site

Source: Geotechnical Survey Report of Chianwali, November 2014, Lean & Green (pvt) Ltd.

2.5 Water Quality Survey of Closed and Existing Final Disposal Sites

The contract for the water quality survey was signed on 6 September 2014. The water quality survey was carried out in three (3) seasons. The contractor conducted water sampling at the end of September 2014 for the monsoon season and at the end of January 2015 for the winter season. The third survey is scheduled in May 2015. As many as 14 parameters were checked in the first water quality test, such as Temperature, Turbidity, Electric Conductivity, pH, Nitrogen, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Suspended Solid, Cadmium, Lead, Chromium, Selenium, Arsenic, and Total Mercury. Ten samples were taken in each site: 5 surface water samples and 5 groundwater samples in Chianwali, and 3 surface water samples and 7 groundwater samples in Gondlanwala. Locations of sampling are shown in **Figure C.2.11** to **Figure C.2.14**, and samples were analysed in SGS Pakistan Private Limited, a private laboratory in Lahore. Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial and the Pakistan National Standards for Drinking Water Quality were used as to surface water and groundwater respectively. The water quality survey is carried out as shown in the following outline.

2.5.1 Purpose of the Work

The purpose of this survey work is to carry out water quality tests of groundwater and surface water samples in the surrounding area of the closed landfill site in Chianwali and the existing landfill site in Gondlanwala and assess the present status in view of water quality.

2.5.2 Location of the Survey Site and the Contents of the Survey Work

The locations of the water quality surveys and the contents of the survey work are as shown below. The work shall include all works, such as mobilisation of manpower, vehicles, and instruments for sampling (e.g., sampling tool, analytical instrument, laboratory, etc.), implementation of water quality tests, and reporting of the work.

- Survey site at the closed landfill site at Chianwali and the existing landfill site at Gondlanwala including the surrounding area.
- Five (5) surface water samples and five (5) groundwater samples in and surrounding area of the landfill site per survey site per season. (The groundwater samples are taken from the shallow wells of 18 to 21m in depth and from the deep wells of 21 to 60m in depth.)
- Water quality parameters for testing: water temperature, pH, electric conductivity, turbidity, BOD_5, COD, SS, Total-N, and heavy metals (R-Hg, T-Hg, Cd, Pb, Cr^{6+}, As and Se).

2.5.3 Output of the Water Quality Survey Work

The report shall be prepared in English and submitted in one (1) original and four (4) sets of hard copies. Digital files of the report and all the processing files shall be saved in CD-ROM and submitted to the JICA Project Team. The report shall include, but not limited to, the following:

- Location map and survey area map;
- Work method;
- Work results; and
- Photographs.

2.5.4 Result of the Survey Work

(1) Water Quality Survey in the First Season (September 2014)

The first water sampling was conducted on 30 September 2014 at the pre-determined sites in Gondlanwala and Chianwali. The detailed analysis of water quality parameters shall be carried out after collection of the results of three seasons. The findings from the first survey result are summarised as follows.

In Gondlanwala, the ponding surface water in the bottom of the landfill area is polluted by leachate but the water pollution level is still lower than that of leachate from the landfill site used for years. Most of the water samples of wells are high in Electric Conductivity probably caused of soluble substances dissolved in groundwater. In Chianwali, similar to the results of well water analysis of Gondlanwala, the Electrical Conductivity of well water shows higher value. One of the hand pump wells shows very high Arsenic contamination. Reference shall be made to the following **Table C.2.6** and **Table C.2.7** for the laboratory test results and the location of sampling points.

(2) Water Quality Survey in the Second Season (January and February 2015)

The second sampling was carried out on 29 January 2015 at Chianwali and 12 February 2015 at Gondlanwala. All samples were collected at the same locations of the first sampling (see **Figure C.2.11** to **Figure C.2.14**). The results of the second season water quality test are shown in **Table C.2.8** and **Table C.2.9.** Two new parameters, Phosphorous and Chlorides, were added to the laboratory analysis to search for the reason of high electric conductivity in the result of the first sampling. Analysis was made in the same laboratory as the first sampling. A summary of the second water sampling test is described below.

<u>Gondlanwala</u>

- Surface water in the disposal site is contaminated by the influence of leachate (refer to Sampling ID: GSW-1).
- Groundwater samples near the disposal site, which are GGW-1, GGW-2, GGW-3 and GGW-4, are under the standard except Turbidity and no serious water contamination is found so far. However, since the Electric Conductivity is high, some kind of ion must be dissolved. It is not sure whether this situation (High Electric Conductivity) is because of the disposal site or not according to the first and second sampling.

Chianwali

- The result of three surface water samples around the disposal site, which are CSW-1, CSW-2, and CDW-3, shows high BOD and COD compared to the standard. It may be because the sampling points are drainage of neighbourhood area, and discharged water may inflow.
- Less possibility that surface water is polluted because of leachate from the disposal site because the result of BOD and COD of downstream water (CSW-2) is not significantly high compared to the result of upstream water (CSW-1).
- Electric Conductivity is relatively high in Chianwali, such as over 1,800µS/cm in CGW-2. The reason is not sure but hypothetically some kind of ion must be dissolved.
- Less possibility that groundwater is polluted because of leachate from the disposal site since the results of the nearest groundwater sample of disposal site, CGW-3, are all under the standard.

(3) Water Quality Survey in the Third Season (May 2015)

The third water sampling was carried out at Chianwali on 26 May 2015. All samples were collected at the same locations of the first/second sampling locations (see **Figure C.2.11** to **Figure C.2.14**). The results of the third season water quality test are shown in **Table C.2.10** and **Table C.2.11.** Analysis was made at the same laboratory as the first/second water test. A summary of the third water sampling test is described below.

Gondlanwala

- All the surface water quality parameters are within the effluent standards.
- Turbidity of the groundwater samples of GGW-2, GGW-4, GGW-6 and GGW-7 exceed the National Standards for Drinking Water Quality.
- Electric Conductivity of all the groundwater sampling points is relatively high exceeding 1,000µS/cm.

Chianwali

- All the result of three surface water samples around the disposal site, which are CSW-1, CSW-2, and CDW-3, shows the values within the effluent standard.
- The value of Turbidity and Total Suspended Solids of CGW-4 show at 12 mg/lit and 7 mg/lit respectively, which exceed the drinking water standard value.
- Electric Conductivity shows high value at CGW-2 well. The reason might be some kind of ion dissolved in groundwater. BOD^5 of the deep well, CGW-3, shows a sign of contamination.

(4) Comparison of Water Quality Test Results of Three Seasons

Gondlanwala

Surface water sample of GGW-1, leachate from the dump site, has reduced the water contamination level from 607mg/lit to 119mg/lit in terms of COD. Meanwhile, pH value has increased from 8.6 to 9.2 showing the transition of waste decomposition. Turbidity of three season samples of the shallow wells, GGW-2, GGW-4 and GGW-6, exceeds the drinking water standards of 5 NTU. Electric Conductivity of most of the groundwater samples are relatively high exceeding 1,000µS/cm. Animal husbandry nearby the wells would be a cause of groundwater contamination. Significant water pollution due to the influence of the existing disposal site could not be confirmed from the three season water quality test results.

Chianwali

Surface water sampling point of the drainage ditch, CSW-1, CSW-2 and CSW-3, are contaminated by sewage from the surrounding area resulting high values of COD and BOD_5. Groundwater contamination is observed at the sampling point of CGW-2, which exceeds the standard values by

Turbidity and Arsenic. In addition, the value of Electric Conductivity is also high at more than 1,800µS/cm in three seasons. However, significant water pollution due to the influence of the former disposal site could not be confirmed from the three season water quality test results.

Table C.2.6 Water Quality Test Result in the Surrounding Area of the Existing Landfill Site in Gondlanwala (First Sampling)

(Water Sampling Date: 30 September 2014)

Sampling Point ID				GSW-1	GSW-2	GSW-3	GGW-1	GGW-2
Sample Water Source	Units	Standard		Landfill Site	Irrigation Tributary	Irrigation Main Canal	Tube Well	Hand Pump Well
		SW*	GW**					
Depth of Well (Feet)				N/A	N/A	N/A	90	65
Temperature	℃	40	-	30.0	29.0	28.0	30.0	30.0
Turbidity	NTU	-	<5	39.0	19.0	27.0	1.0	*11.0*
Electric Conductivity	µS/cm	-	-	3,870	271	218	1165	1,216
pH	-	6-10	6.5-8.5	8.59	6.59	6.73	6.87	7.12
Kjeldahl Nitrogen (TKN)	mg/L	-	3	15.93	0.28	0.58	0.58	0.58
COD_{Cr} (Cr^{3+})	mg/L	150	-	*607.0*	10.0	13.0	<5.0	17.0
BOD_5	mg/L	80	-	*152.0*	<3.0	4.0	<3.0	<3.0
Suspended Solids (TSS)	mg/L	150	-	65.0	26.0	21.0	<5.0	35.0
Cadmium (Cd)	mg/L	0.1	0.01	<0.003	<0.003	<0.003	<0.003	<0.003
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium (Cr)	mg/L	1.0	≤ 0.05	0.013	<0.005	<0.005	<0.005	<0.005
Selenium (Se)	mg/L	0.5	0.01	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic (As)	mg/L	1.0	≤ 0.05	0.038	<0.005	<0.005	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sampling Point ID				GGW-3	GGW-4	GGW-5	GGW-6	GGW-7
Sample Water Source	Units	Standard		Tube Well	Hand Pump Well	Tube Well	Hand Pump Well	Tube Well
		SW*	GW**					
Depth of Well (Feet)				65	65	150	70	125
Temperature	℃	40	-	29.0	28.0	28.0	28.0	28.0
Turbidity	NTU	-	<5	1.0	1.0	<0.20	*14.0*	2.0
Electric Conductivity	µS/cm	-	-	1408	966	1317	1114	115
pH	-	6-10	6.5-8.5	7.69	7.02	6.85	7.61	7.23
Kjeldahl Nitrogen (TKN)	mg/L	-	3	0.28	0.28	0.28	0.28	0.28
COD_{Cr} (Cr^{3+})	mg/L	150	-	<5.0	<5.0	<5.0	9.0	<5.0
BOD_5	mg/L	80	-	<3.0	<3.0	<3.0	<3.0	<3.0
Suspended Solids (TSS)	mg/L	150	-	<5.0	<5.0	<5.0	7.0	<5.0
Cadmium (Cd)	mg/L	0.1	0.01	<0.003	<0.003	<0.003	<0.003	<0.003
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Selenium (Se)	mg/L	0.5	0.01	0.006	0.005	<0.005	<0.005	<0.005
Arsenic (As)	mg/L	1.0	≤ 0.05	<0.005	<0.005	0.007	<0.005	0.008
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Note: The italic figures in a grey coloured cell indicate over the standard.

* The standard for surface water samples: Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial effluents.

**Pakistan National Standards for Drinking Water Quality are used as reference to groundwater.

Table C.2.7 Water Quality Test Result in the Surrounding Area of Closed Landfill Site in Chianwali (First Sampling)

(Water Sampling Date: 30 September 2014)

Sampling Point ID				CSW-1	CSW-2	CSW-3	CSW-4	CSW-5
Sample Water Source	Units	Standard		Drainage	Drainage	Drainage from landfill site	Irrigation Canal	Irrigation Canal
		SW*	GW**					
Temperature	℃	40	-	30.0	29.0	30.0	24.0	26.0
Turbidity	NTU	<5	<5	16.0	89.0	19.0	12.0	21.0
Electric Conductivity	µS/cm	-	-	1639	1530	1608	111	185
pH	-	6-10	6.5-8.5	6.87	7.27	7.27	6.97	6.51
Kjeldahl Nitrogen (TKN)	mg/L	-	3	8.40	9.85	5.50	0.28	0.28
COD_{Cr} (Cr^{3+})	mg/L	150	-	*341.0*	*508.0*	*292.0*	<5.0	27.0
BOD_5	mg/L	80	-	*165.0*	*178.0*	*151.0*	<3.0	7.0
Suspended Solids (TSS)	mg/L	150	-	39.0	45.0	18.0	17.0	*185.0*
Cadmium (Cd)	mg/L	0.1	0.01	<0.003	<0.003	<0.003	<0.003	<0.003
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.005	<0.005	<0.005	0.011	<0.005
Selenium (Se)	mg/L	0.5	0.01	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic (As)	mg/L	1.0	≤ 0.05	0.009	0.012	0.008	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sampling Point ID				CGW-1	CGW-2	CGW-3	CGW-4	CGW-5
Sample Water Source	Units	Standard		Tube Well	Hand Pump Well	Tube Well	Tube Well	Hand Pump Well
		SW*	GW**					
Depth of Well (Feet)				200	65		80	60
Temperature	℃	40	-	24.0	28.0	24.0	26.0	26.0
Turbidity	NTU	<5	<5	2.0	<0.20	1.0	1.0	<0.20
Electric Conductivity	µS/cm	-	-	564	1854	330	798	332
pH	-	6-10	6.5-8.5	7.05	6.92	6.73	7.02	6.89
Kjeldahl Nitrogen (TKN)	mg/L	-	3	0.28	0.28	0.28	0.28	0.28
COD_{Cr} (Cr^{3+})	mg/L	150	-	<5.0	<5.0	<5.0	<5.0	<5.0
BOD_5	mg/L	80	-	<3.0	<3.0	<3.0	<3.0	<3.0
Suspended Solids (TSS)	mg/L	150	-	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium (Cd)	mg/L	0.1	0.01	<0.003	<0.003	<0.003	<0.003	<0.003
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Selenium (Se)	mg/L	0.5	0.01	0.005	<0.005	<0.005	0.007	<0.005
Arsenic (As)	mg/L	1.0	≤ 0.05	0.014	*0.190*	<0.005	<0.005	0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Note: The italic figures in a grey coloured cell indicate over the standard.

* The standard for surface water samples: Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial effluents.

**Pakistan National Standards for Drinking Water Quality are used as reference to groundwater.

Table C.2.8 Water Quality Test Result in the Surrounding Area of the Existing Landfill Site in Gondlanwala (Second Sampling)

(Water Sampling Date: 29 January 2015)

Sampling Point ID				GSW-1	GSW-2	GSW-3	GGW-1	GGW-2
Sample Water Source	Units	Standard		Landfill Site	Irrigation Tributary	Irrigation Main Canal	Tube Well	Hand Pump Well
		SW*	GW**					
Depth of Well (Feet)				N/A	N/A	N/A	90	65
Temperature	℃	40	-	18.1	18.1	17.9	18.3	18.4
Turbidity	NTU	-	<5	202	71	108	*13*	*11.2*
Electric Conductivity	µS/cm	-	-	4440	1919	380	1302	1745
pH	-	6-10	6.5-8.5	7.84	7.89	7.25	7.43	7.51
Kjeldahl Nitrogen (TKN)	mg/L	-	3	91.11	41.55	1.78	0.29	0.59
COD_{Cr} (Cr^{3+})	mg/L	150	-	*361*	139	149	<5.0	9
BOD_5	mg/L	80	-	129	37	44	<3.0	3
Suspended Solids (TSS)	mg/L	150	-	93	39	64	7	7
Cadmium (Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium (Se)	mg/L	0.5	0.01	0.008	0.009	0.012	0.008	0.022
Arsenic (As)	mg/L	1.0	≤ 0.05	0.012	0.006	<0.005	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	4.3	3.82	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	428.9	130.99	23.24	82.39	109.86
Sampling Point ID				GGW-3	GGW-4	GGW-5	GGW-6	GGW-7
Sample Water Source	Units	Standard		Tube Well	Hand Pump Well	Tube Well	Hand Pump Well	Tube Well
		SW*	GW**					
Depth of Well (Feet)				65	65	150	70	125
Temperature	℃	40	-	18.1	18.5	19.3	18.5	18.8
Turbidity	NTU	-	<5	*7*	*7*	1.9	*15*	2.1
Electric Conductivity	µS/cm	-	-	1336	1655	1436	1128	1098
pH	-	6-10	6.5-8.5	7.67	7.43	7.47	7.65	7.51
Kjeldahl Nitrogen (TKN)	mg/L	-	3	0.59	0.89	<0.1	0.59	<0.1
COD_{Cr} (Cr^{3+})	mg/L	150	-	<5.0	<5.0	<5.0	8	<5.0
BOD_5	mg/L	80	-	<3.0	<3.0	<3.0	<3.0	<3.0
Suspended Solids(TSS)	mg/L	150	-	<5.0	<5.0	<5.0	7	<5.0
Cadmium(Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead(Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium(Cr)	mg/L	1.0	≤ 0.05	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium(Se)	mg/L	0.5	0.01	0.01	<0.005	<0.005	<0.005	<0.005
Arsenic(As)	mg/L	1.0	≤ 0.05	<0.005	0.006	<0.005	<0.005	0.011
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	80.28	139.02	95.71	82.39	68.91

Note: The italic figures in a grey coloured cell indicate over the standard.

* The standard for surface water samples: Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial effluents.

**Pakistan National Standards for Drinking Water Quality are used as reference to groundwater.

Table C.2.9 Water Quality Test Result in the Surrounding Area of the Closed Landfill Site in Chianwali (Second Sampling)

(Water Sampling Date: 12 February 2015)

Sampling Point ID				CSW-1	CSW-2	CSW-3	CSW-4	CSW-5
Sample Water Source	Units	Standard		Drainage	Drainage	Drainage from landfill site	Irrigation Canal	Irrigation Canal
		SW*	GW**					
Temperature	℃	40	-	18.6	18.4	18.2	18.3	18.1
Turbidity	NTU	<5	<5	85	93	243	11	10
Electric Conductivity	µS/cm	-	-	2080	2140	180	548	492
pH	-	6-10	6.5-8.5	7.19	7.24	7.91	7.6	8.47
Kjeldahl Nitrogen (TKN)	mg/L	-	3	36.2	18.4	15.13	1.78	0.29
COD_{Cr} (Cr^{3+})	mg/L	150	-	*276*	*255*	*257*	15	11
BOD_5	mg/L	80	-	*83*	79	*112*	4	5
Suspended Solids (TSS)	mg/L	150	-	34	61	121	29	7
Cadmium (Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.002	<0.002	<0.02	<0.02	<0.02
Selenium (Se)	mg/L	0.5	0.01	0.017	0.012	0.01	0.009	0.008
Arsenic (As)	mg/L	1.0	≤ 0.05	0.005	<0.005	<0.005	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	0.56	0.67	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	228.18	230.29	179.58	8.45	8.45
Sampling Point ID				CGW-1	CGW-2	CGW-3	CGW-4	CGW-5
Sample Water Source	Units	Standard		Tube Well	Hand Pump Well	Tube Well	Tube Well	Hand Pump Well
		SW*	GW**					
Depth of Well (Feet)				200	65		80	60
Temperature	℃	40	-	18.9	18.1	19.1	18.4	18.2
Turbidity	NTU	-	<5	3.3	*13*	1.7	2	2.9
Electric Conductivity	µS/cm	-	-	573	1806	317	851	304
pH	-	6-10	6.5-8.5	7.89	7.23	8.1	7.63	8.02
Kjeldahl Nitrogen (TKN)	mg/L	-	3	<0.1	0.59	<0.1	0.59	0.89
COD_{Cr} (Cr^{3+})	mg/L	150	-	<5.0	6	<5.0	<5.0	<5.0
BOD_5	mg/L	80	-	<3.0	<3.0	<3.0	<3.0	<3.0
Suspended Solids (TSS)	mg/L	150	-	<5.0	7	<5.0	<5.0	<5.0
Cadmium (Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium (Se)	mg/L	0.5	0.01	<0.005	0.021	<0.005	0.017	0.015
Arsenic (As)	mg/L	1.0	≤ 0.05	0.024	<0.005	<0.005	21.12	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	9.57	145.78	3.82	21.12	6.33

Note: The italic figures in a grey coloured cell indicate over the standard.

* The standard for surface water samples: Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial effluents.

**Pakistan National Standards for Drinking Water Quality are used as reference to groundwater.

Table C.2.10 Water Quality Test Result in the Surrounding Area of the Existing Landfill Site in Gondlanwala (Third Sampling)

(Water Sampling Date: 26 May 2015)

Sampling Point ID				GSW-1	GSW-2	GSW-3	GGW-1	GGW-2
Sample Water Source	Units	Standard		Landfill Site	Irrigation Tributary	Irrigation Main Canal	Tube Well	Hand Pump Well
		SW*	GW**					
Depth of Well (Feet)				N/A	N/A	N/A	90	65
Temperature	℃	40	-	20.9	23.2	23.6	21.5	20.7
Turbidity	NTU	-	<5	17.3	31.7	271	4.9	*13.2*
Electric Conductivity	µS/cm	-	-	2100	201	157.5	1246	1672
pH	-	6-10	6.5-8.5	*9.2*	8.22	8.22	7.7	8.21
Kjeldahl Nitrogen (TKN)	mg/L	-	3	4.27	0.37	3.43	0.185	0.37
COD_{Cr} (Cr^{3+})	mg/L	150	-	119	9	29	<5.0	<5.0
BOD_5	mg/L	80	-	29	0	5	<2.0	<2.0
Suspended Solids (TSS)	mg/L	150	-	13	22	111	<5.0	9
Cadmium (Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium (Se)	mg/L	0.5	0.01	<0.005	<0.005	<0.005	0.008	<0.009
Arsenic (As)	mg/L	1.0	≤ 0.05	<0.024	<0.005	<0.005	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	0.152	0	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	256.48	5.65	3.77	8.863	122.58
Sampling Point ID				GGW-3	GGW-4	GGW-5	GGW-6	GGW-7
Sample Water Source	Units	Standard		Tube Well	Hand Pump Well	Tube Well	Hand Pump Well	Tube Well
		SW*	GW**					
Depth of Well (Feet)				65	65	150	70	125
Temperature	℃	40	-	20.6	22	21.9	20.7	20.5
Turbidity	NTU	-	<5	1	*13.1*	1.1	*23.7*	*9.7*
Electric Conductivity	µS/cm	-	-	1270	1334	1361	1003	1042
pH	-	6-10	6.5-8.5	8.11	7.84	7.99	8.12	7.83
Kjeldahl Nitrogen (TKN)	mg/L	-	3	0.185	0.185	0.185	0.185	0.185
COD_{Cr} (Cr^{3+})	mg/L	150	-	<5.0	<5.0	<5.0	<5.0	<5.0
BOD_5	mg/L	80	-	<2.0	<2.0	<2.0	<2.0	<3.0
Suspended Solids(TSS)	mg/L	150	-	<5.0	7	<5.0	13	<6.0
Cadmium(Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead(Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium(Cr)	mg/L	1.0	≤ 0.05	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium(Se)	mg/L	0.5	0.01	0.01	<0.005	<0.025	<0.005	0.01
Arsenic(As)	mg/L	1.0	≤ 0.05	<0.005	0.006	<0.005	<0.005	0.01
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	84.86	147.1	96.18	73.55	66

Note: The italic figures in a grey coloured cell indicate over the standard.

* The standard for surface water samples: Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial effluents.

**Pakistan National Standards for Drinking Water Quality are used as reference to groundwater.

Table C.2.11 Water Quality Test Result in the Surrounding Area of the Closed Landfill Site in Chianwali (Third Sampling)

(Water Sampling Date: 26 May 2015)

Sampling Point ID				CSW-1	CSW-2	CSW-3	CSW-4	CSW-5
Sample Water Source	Units	Standard		Drainage	Drainage	Drainage from landfill site	Irrigation Canal	Irrigation Canal
		SW*	GW**					
Temperature	℃	40	-	23.3	23.2	23.6	23.4	23.5
Turbidity	NTU	<5	<5	23.1	43.7	18	233	261
Electric Conductivity	µS/cm	-	-	1924	1794	1619	148.2	147.3
pH	-	6-10	6.5-8.5	7.7	7.68	7.79	8.27	8.25
Kjeldahl Nitrogen (TKN)	mg/L	-	3	3.9	2.78	0.55	4.45	4.27
COD_{Cr} (Cr^{3+})	mg/L	150	-	125	85	61	40	30
BOD_5	mg/L	80	-	33	21	17	6	5
Suspended Solids (TSS)	mg/L	150	-	55	27	27	135	125
Cadmium (Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium (Se)	mg/L	0.5	0.01	<0.005	<0.005	<0.005	<0.005	0.008
Arsenic (As)	mg/L	1.0	≤ 0.05	0.007	0.01	<0.005	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	2.86	4.19	3.62	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	254.6	214.99	147.1	5.65	3.77
Sampling Point ID				CGW-1	CGW-2	CGW-3	CGW-4	CGW-5
Sample Water Source	Units	Standard		Tube Well	Hand Pump Well	Tube Well	Tube Well	Hand Pump Well
		SW*	GW**					
Depth of Well (Feet)				200	65		80	60
Temperature	℃	40	-	23.1	22	22.3	22.2	20.4
Turbidity	NTU	-	<5	3.9	2.1	0.9	12.3	1.1
Electric Conductivity	µS/cm	-	-	432	1893	310	793	263
pH	-	6-10	6.5-8.5	8.11	7.76	8.15	7.66	7.96
Kjeldahl Nitrogen (TKN)	mg/L	-	3	0.185	0.185	0.185	0.37	0.19
COD_{Cr} (Cr^{3+})	mg/L	150	-	<5.0	<5.0	<5.0	<5.0	<5.0
BOD_5	mg/L	80	-	<2.0	<2.0	77	<2.0	<2.0
Suspended Solids (TSS)	mg/L	150	-	<5.0	<5.0	<5.0	7	<5.0
Cadmium (Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium (Se)	mg/L	0.5	0.01	0.009	<0.005	0.006	0.024	0.01
Arsenic (As)	mg/L	1.0	≤ 0.05	0.006	0.018	<0.005	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	4.71	177.27	3.77	18.85	3.77

Note: The italic figures in a grey coloured cell indicate over the standard.

* The standard for surface water samples: Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial effluents.

**Pakistan National Standards for Drinking Water Quality are used as reference to groundwater.

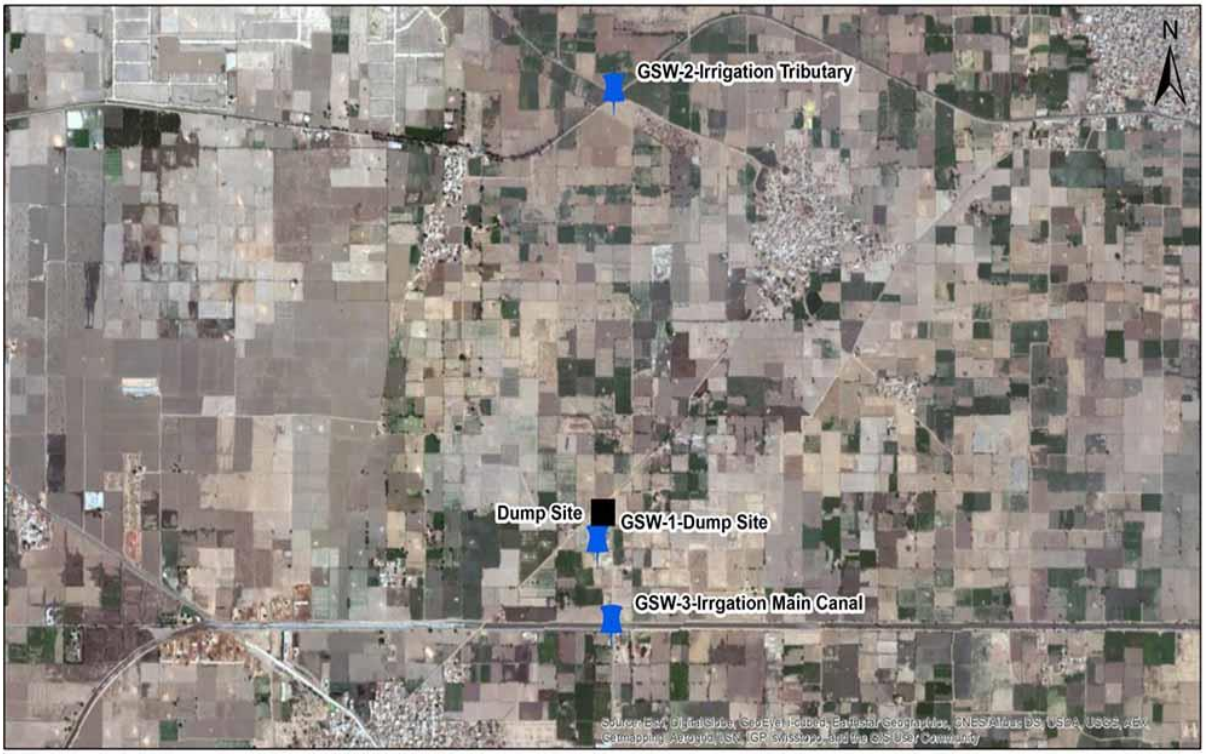


Figure C.2.11 Location of Water Quality Sampling Points in Gondlanwala (Surface Water)

Source: Water Quality Survey Report (Season 3), ISWM Plan, Gujranwala, July 2015, Lean & Green (pvt) Limited

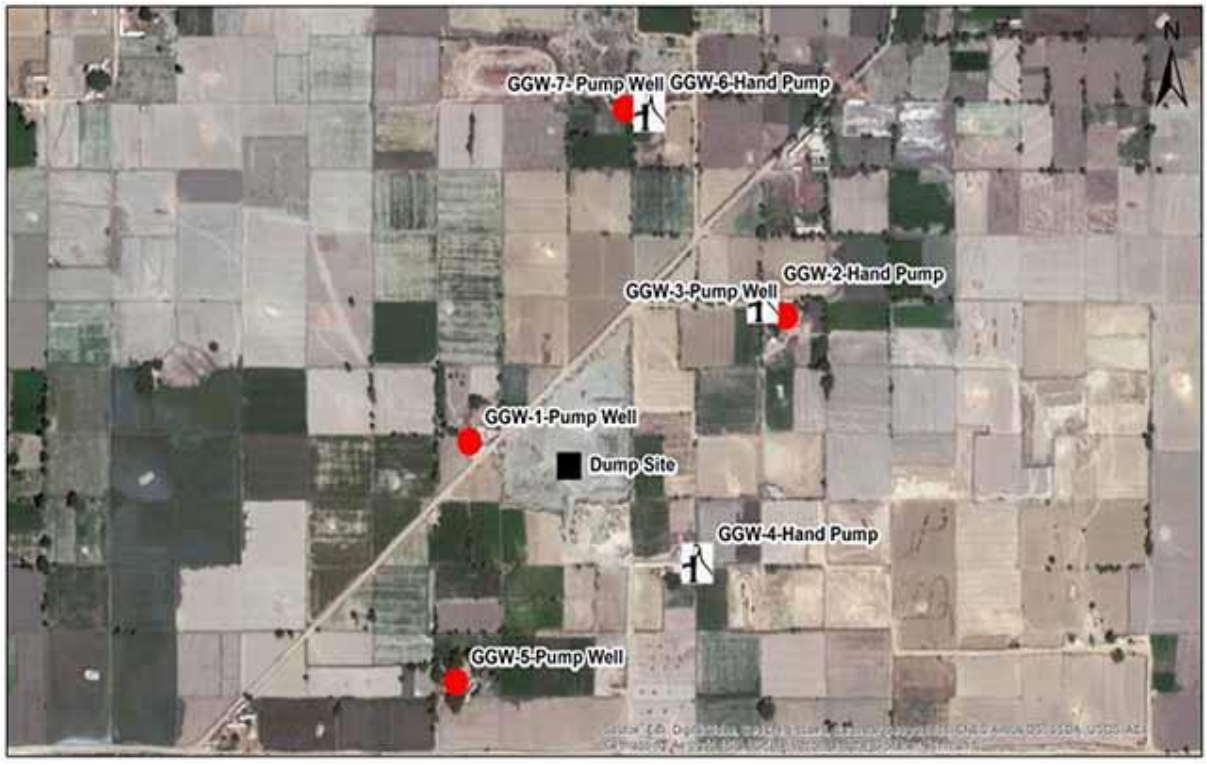


Figure C.2.12 Location of Water Quality Sampling Points in Gondlanwala (Groundwater)

Source: Water Quality Survey Report (Season 3), ISWM Plan, Gujranwala, July 2015, Lean & Green (pvt) Limited

Figure C.2.13 Location of Water Quality Sampling Points in Chianwali (Surface Water)

Source: Water Quality Survey Report (Season 3), ISWM Plan, Gujranwala, July 2015, Lean & Green (pvt) Limited

Figure C.2.14 Location of Water Quality Sampling Points in Chianwali (Groundwater)

Source: Water Quality Survey Report (Season 3), ISWM Plan, Gujranwala, July 2015, Lean & Green (pvt) Limited

2.6 Landfill Waste Bulk Density Survey

2.6.1 Purpose of the Survey

The purpose of the survey is to find out the bulk density of landfill waste which will be used for the Bhakhraywali landfill planning. Specific objective of the survey is as follows:

- To estimate the bulk density of solid waste at the dumping sites, i.e., the closed dumpsite in Chianwali and the existing dumpsite in Gondlanwala.

2.6.2 Outline of the Survey

The survey was carried out on 10 February 2015. One excavator and three tractor trolleys were dispatched for the survey. In each site, landfill waste from three sampling pits, approximately 2m (Width) × 2m (Length) × 2m (Depth), were excavated and loaded onto the tractor trolleys. The net weights of the loaded wastes or the excavated weight were measured at the weighbridge installed by the Project. On the other hand, each excavated pit was measured as to width, length and depth to calculate the excavated volume.

2.6.3 Calculation of the Bulk Density

The data were processed for both Chianwali and Gondlanwala sites. **Table C.2.12** shows the calculated bulk density of both sites. The bulk density at Chianwali is higher than that of Gondlanwala.

Table C.2.12 Calculated Bulk Density at Chianwali and Gondlanwala

Sr. No.	Sample	Volume (m^3)		Waste Amount (kg)		Bulk Density (kg/m^3)	
		Chianwali	Gondlanwala	Chianwali	Gondlanwala	Chianwali	Gondlanwala
1	Pit 1	4.0	4.5	4,880	3,100	1,211	693
2	Pit 2	2.2	4.9	2,200	3,680	999	756
3	Pit 3	3.7	4.9	4,040	2,760	1,095	559
Average		3.3	4.8	3.706	3,180	1,121	668

2.6.4 Conclusions and Recommendations

The results of the survey revealed that the Chianwali waste layer is comparatively consolidated as compared to that of the Gondlanwala waste layer. Chianwali started operation in the end of December 2006 and closed in February 2014 while the site in Gondlanwala became operational in March 2014. This difference of elapsed time in each site brought the difference of bulk density of the landfill waste layer because of consolidation. In other words, the average bulk density of each site is depicted as follows:

Chianwali (1,121 kg/m^3) > Gondlanwala (668 kg/m^3)

From the results of this survey, it is recommendable to adopt the bulk density of 1.0 t/m^3 for the design of sanitary landfill facilities in Bhakhraywali while the bulk density of 0.9 t/m^3 is appropriate for the shorter time landfill period of about 3 years at Gondlanwala disposal site.

2.7 Incoming Waste Composition Survey

2.7.1 Purpose of the Survey

The waste composition data plays a crucial role in planning and designing of solid waste system. The specific objectives of the incoming waste composition survey are as follows:

- To determine the composition of waste collected from Gujranwala waste collection area and hauled to Gondlanwala for disposal; and

- To estimate the potential of resource or recyclable materials mixed in the incoming waste at the existing disposal site in Gondlanwala.

The results of the survey are very beneficial in determining the quantity of material available for recovery from disposal site and determining the future needs for recycling facility(s) and intermediate treatment facilities.

2.7.2 Outline of the Survey

(1) Period of the Survey

The incoming waste composition survey was conducted from 9-12 December 2014 (4 days). Drilling was conducted by the survey team at the disposal site on 8 December 2014. The survey was carried out only for once during the period of the project.

(2) Location of the Survey

The incoming waste composition survey was conducted at the Gondlanwala disposal site.

(3) Samples for Waste Composition Analysis

The whole city area (64 union councils) was considered for the survey since the SWM services are being provided currently by GWMC in this area. A total of 10 waste samples were taken from each vehicle coming from the subject areas. **Table C.2.13** shows the total number of samples and sampling areas.

Table C.2.13 Sampling Area and Number of Samples for Survey

Sampling Area	No. of Sampling Area	No. of Samples per Area	Total No. of Samples
	A	B	A × B
High Income Group Area	1	2	2
Middle Income Group Area	2	2	4
Low Income Group Area	2	2	4
Total			10

(4) Survey Team Composition

A team comprising of two waste managers, one research associate and nine (9) survey assistants conducted the incoming waste composition survey under the instruction of the JICA Project Team staff in charge.

(5) Survey Method

The incoming waste composition survey method was developed under the following the requirements in the Terms of Reference of the Waste Amount and Composition Survey (WACS) contract and the instructions of the JPT taking the site conditions into consideration . In total, the composition of 1,564 kg of waste from 10 areas was analysed in the course of the survey. The waste was sorted into 16 pre-determined different fractions. The procedure of the survey is as shown in **Figure C.2.15.**

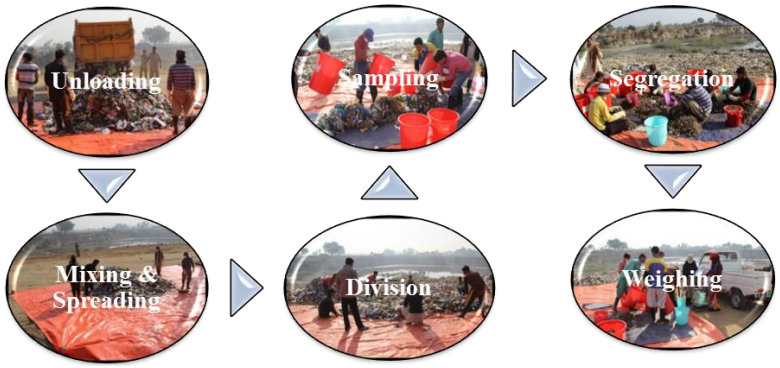


Figure C.2.15 Incoming Waste Composition Survey Procedures

2.7.3 Output of the Survey

The results of ten (10) samples subjected to the waste composition survey are summarised in **Table C.2.14**.

Table C.2.14 Results of the Incoming Waste Composition Survey at Gondlanwala

Sr. No.	Item	Average of Each Income Group Sample (%)			Weighted Averages (%)
		High Income (2 samples)	Middle Income (4 samples)	Low Income (4 samples)	
1.	Kitchen Waste	32.39	28.38	25.73	27.98
2.	Paper (recyclable)	1.07	0.94	1.88	1.24
3.	Paper (other paper)	13.72	9.18	8.04	9.29
4.	Textile	7.52	9.42	11.19	9.76
5.	Grass & Wood	3.32	2.45	6.98	3.90
6.	Plastic (recyclable)	2.12	1.18	1.62	1.41
7.	Plastic (non-recyclable)	10.06	8.11	6.45	7.80
8.	Leather & Rubber	0.56	0.32	2.50	1.00
9.	Metal (recyclable)	0.15	0.16	0.15	0.16
10.	Metal (non-recyclable)	-	-	-	-
11.	Bottle & Glass (recyclable)	0.07	0.50	0.63	0.49
12.	Bottle & Glass (non-recyclable)	0.29	0.00	0.00	0.03
13.	Ceramic, Stone & Soil, etc.	6.85	7.67	5.14	6.83
14.	Domestic Hazardous Waste	0.08	0.04	0.03	0.04
15.	Sieve Remaining	15.84	17.76	13.45	16.27
16.	Miscellaneous	5.95	13.89	16.22	13.80
TOTAL		100.00	100.00	100.00	100.00

2.7.4 Findings from the Survey

The weighted average percent composition of Gujranwala waste being disposed is shown in **Figure C.2.16**. At Gondlanwala, the kitchen waste account for 28% of total waste, thereby representing the largest fraction and followed by sieve remains with 16%, miscellaneous with 14% and non-recyclable paper with 9%. Only very small amounts of recyclables (paper 1.24%, plastic 1.41% and glass 0.49%) were found in waste at the Gondlanwala disposal site. The composition of domestic hazardous waste in the waste reaching Gondlanwala is almost negligible (0%). It shall be noted that most of the fraction of sieve remaining and miscellaneous is organic waste mixed with kitchen waste and animal droppings (donkey cart and horse cart).

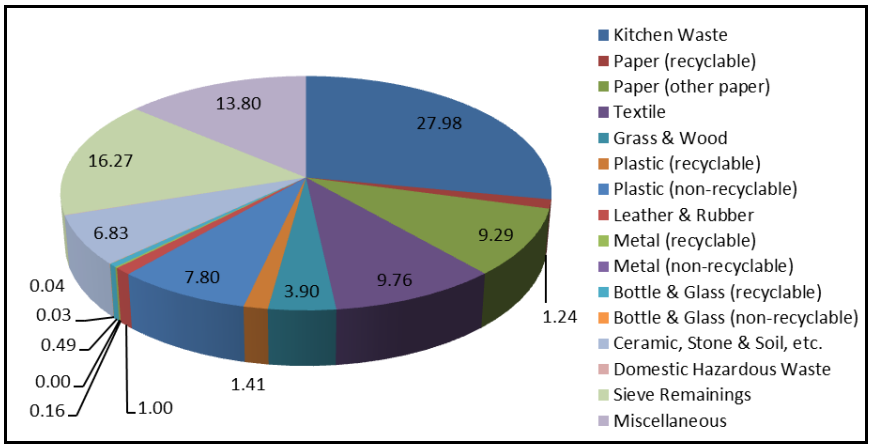


Figure C.2.16 Average Waste Composition of Incoming Waste at Gondlanwala

2.7.5 Conclusions

The following conclusions can be drawn from the analysis of the incoming waste composition survey conducted at the Gondlanwala disposal site.

- The incoming waste for disposal at Gondlanwala has 32% of organic waste represented by kitchen waste, grass and wood. The organic waste ratio becomes more than 50% in case sieve remaining and miscellaneous wastes are included. These wastes have a high potential of waste reduction or waste diversion for final disposal by means of biodegradable treatment if GWMC manages to collect organic waste separately.
- The combustible waste ratio represented by plastics, paper, etc., account for almost 34%. As well as organic waste, these combustible wastes have a high potential for waste reduction and heat recovery by treatment as a resource for renewable energy projects.
- The amount of dry recyclables or resource materials hauled to Gondlanwala is considerably low at only 4%. Most of the recyclables have already been sorted at sources by dwellers and at the waste discharge points at waste containers by the waste pickers and sold in the recycling market. Consequently, the option for construction of centralised material recovery facilities of mixed waste is negative.

2.8 Current Status of Planning of Final Disposal Site by Pakistani Side

This subsection describes the activities related with the selection of candidate final disposal site by referring to the site selection report prepared by UU.

2.8.1 Implementation Status of Selection of Final Disposal Site

(1) Background of Landfill Site Selection

Gujranwala City has not developed engineered landfill facilities or sanitary landfill facilities until now. The city and districts are working for the collection and transportation of solid waste but unfortunately there is no proper way of final waste disposal. Waste is being disposed of indiscriminately in open plots and pits in and outside of the urban areas.

In order to secure a safe final disposal site, the Urban Unit (UU) in collaboration with CDGG conducted the study called *"Landfill Site Identification and Evaluation Report"* in Gujranwala. The UU SWM team visited Gujranwala in September 2012 to carry out the site selection survey intensively to identify the suitable site for sanitary landfill facilities and prepared the report. The report was reviewed and revised in March 2014 for the final report.

The report recommended four (4) suitable sites for developing the sanitary landfill facilities with the top rank given to the site in Bhakhraywali. The following paragraphs summarise the site selection report prepared by UU in March 2014.

(2) Summary of Landfill Site Identification and Evaluation Report, March 2014

(a) Basic Concept for Selection of Landfill Site

Landfill site selection is a very important process for the successful operation and final waste disposal without environment degradation. Landfill site selection involves an extensive evaluation process in order to identify the optimal available disposal location. The selected location must be in accordance with the basic government rules and regulations, and also take into cognizance how to cater the important factors like health, economic, environmental and social. In fact, many researchers have used different criteria for landfill site selection that varies with respect to region and facilities.

Following are the major factors considered during the landfill site selection:

- Airports: If a landfill is located within a specified distance, for example, 2km*, of an airport, the owner or operator must demonstrate that the landfill will not present a bird hazard to aircrafts. Note:* Punjab Waste Management Act 2013, Article (g), 26. Standard for Landfill.
- Flood plains: For landfills located on a 100-year flood plain, the owner or operator must demonstrate that the landfill will not restrict the flow of a 100-year flood, reduce the storage capacity of the flood plain, or result in the washout of solid waste.
- Wetlands: New landfill and lateral expansions cannot be located in wetlands except where there is no practical alternative.
- Fault zones: New landfills and lateral expansions must not be located within 200 feet of a fault zone.
- Seismic zones: New landfills and lateral expansions are restricted in areas susceptible to ground motion resulting from earthquakes.
- Unstable areas: Unless it can be demonstrated otherwise, landfill must not be located in areas susceptible to natural or human-induced events or forces capable of impairing the integrity of landfill components. Examples of unstable areas are those with poor foundation conditions, areas susceptible to mass movements (landslide, rock-fall, etc.), and areas with karst terrains (sinkholes).

Apart from the above, many other factors are also taken into consideration prior to the selection of potential site for the Landfill.

(b) Methodology

The identification and final selection of landfill site is a very complex task and requires qualified and trained personnel. Despite the various limitations, the Urban Unit devised a simple but effective methodology to select a suitable landfill from the proposed sites in Gujranwala. The following steps are applied:

Negative Mapping

Unsuitable sites are eliminated from the selection list after further evaluation of all candidate sites.

Positive Mapping

The identification and selection of an appropriate site for a landfill depends upon several criteria. This selection according to the set criteria is called positive mapping. The positive mapping process includes the following two steps:

- Setting up of the site selection criteria; and

- Investigation of sites against the site selection criteria via site survey.

The above-mentioned steps can be explained as follows.

Setting of Scoring Criteria

The survey of the landfill site was commenced with a careful desk study leading to a specific sitting criteria presented in **Table C.2.15**. The evaluation factors including geographical and environmental aspects are the basic factors in setting up the criteria along with other socio-economic limitations. Those factors are determined basically by UU in compliance with the requirements prescribed in Article 26, Standards for Landfill, Chapter- IX, Punjab Waste Management Act of 2013. The scoring of each factor was determined in consideration of the importance of the factor in technical and environmental aspects for the construction of disposal facility. Then, the field survey was carried out to verify the condition of each factor shown in the following table.

Table C.2.15 Site Selection Scoring Criteria

Classification	Factors	Marks	Reference
Area	Size and capacity of the landfill	10	For factors having the total mark of 10: 10 = Most suitable for landfill site 5 and above = Suitable for landfill site Below 5 = Not suitable for a landfill
Location	Transfer distance	10	
	Access road to the landfill	10	
	Distance from Restricted Zone	10	
	Availability of onsite soil cover	5	
	Municipal facilities	5	
	Sub-Total	*50*	
Environment	Main Irrigation network 500 m	10	
	Nearby environmentally sensitive area (within 500 m)	10	
	Perennial Stream within 300 m	5	
	Impact to ecosystem	5	For factors having the total marks 5: 5 = most suitable for landfill site 3 and above = Suitable for landfill site Below 3 = Not suitable for landfill
	Sub-Total	*30*	
Society	Residential areas and other facilities	5	
	Historical and cultural heritage	5	
	Sub-Total	*10*	
Economy	Construction cost (including appurtenant facilities)	10	
	Sub-Total	*10*	
Total		100	

Source: The Urban Unit, Landfill Site Identification and Evaluation Report, March 2014.

Note: Each evaluation item has its own criteria for scoring. For example, the scoring criteria of the item "Transfer distance" from the city centre are set as follows. Mark 10: Less than 10km, Mark 9: 11~15km, Mark 8:16~20km, Mark 7:21~25km.

(c) Site Survey

A detailed site selection survey was conducted by the Urban Unit team in Gujranwala through the site visit of all possible potential sites around the city at all 8 major roads connecting with Gujranwala bypass. A landfill sitting selection criteria was established considering the important factors and parametres on which all the sites were scrutinised and evaluated in subsequent steps. During the survey, the coordinate of each site was determined using Global Positioning System (GPS) as shown in **Figure C.2.17**. Further, using the Geographic Information System (GIS) tool, sites were identified with measuring the distance from major road.

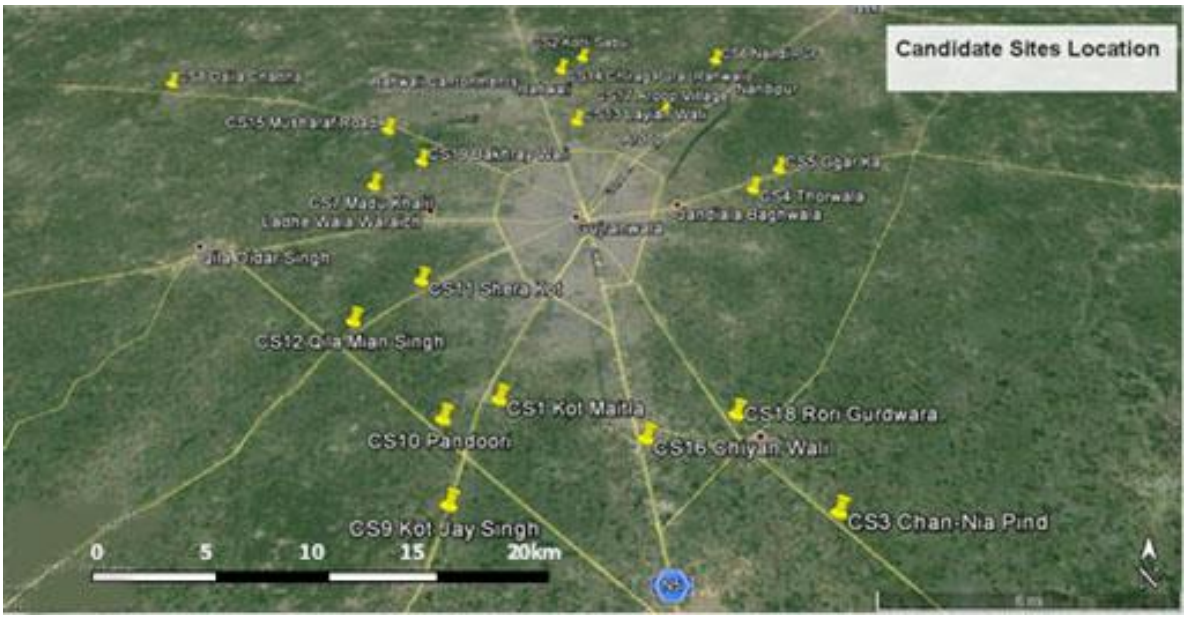


Figure C.2.17 Location of Candidate Sites

Source: Landfill Site Identification and Evaluation Report, March 2014, The Urban Unit

(d) Evaluation of Candidate Site

Firstly, all the identified and potential candidate sites were analysed against the set criteria for selection. Secondly, each site was evaluated through the scoring system in **Table C.2.15** and the computed results are as presented in **Figure C.2.18**. For example, if a site is available for the construction of a landfill or has lower groundwater table, it will have more marks as compared to availability of the site although it is not confirmed by the owner or having a considerably higher groundwater table leading to the chances of groundwater contamination. This process is called ranking system through which all the potential sites selected via negative mapping are ranked according to their own properties. The ranking system suggests that if a proposed site is used for agricultural purposes it will get lesser marks in the category of land use, in case of barren or any other suitable land is available. The total marks allocated to each site decide the final ranking. **Table C.2.17** and **Table C.2.18** show the details of scoring of each site.

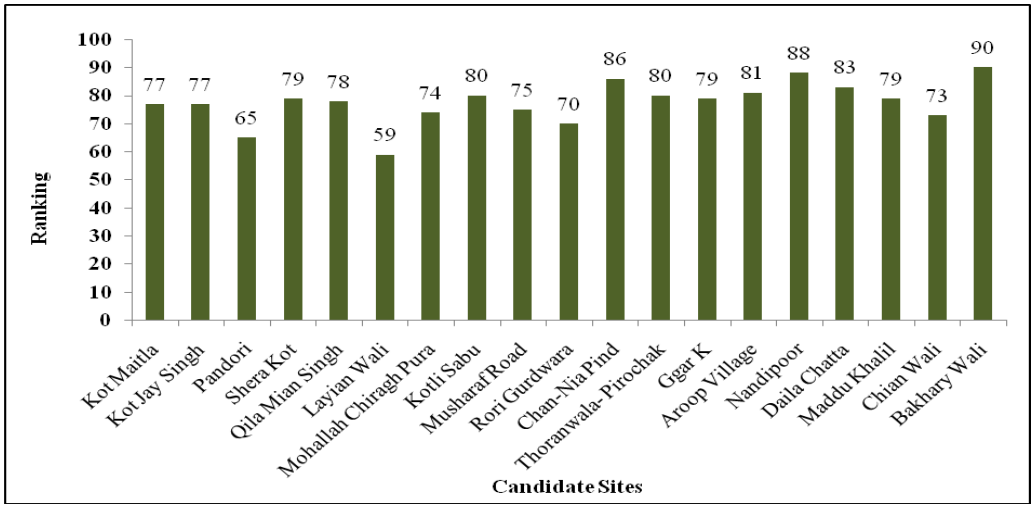


Figure C.2.18 Ranking of Candidate Sites according to the Set Criteria

Source: The Urban Unit, Landfill Site Identification and Evaluation Report, March 2014.

(e) Conclusion and Recommendations of the Report

In Gujranwala, landfill site selection is very difficult because areas surrounding the city are densely populated and comprise very fertile agricultural land. That is why no barren land is available in the adjoining areas. Therefore, in the existing scenario, the four (4) top-ranked sites out of the 19 were selected after visiting, studying, evaluating and identifying according to the criteria set by the team of Urban Sector Planning & Management Services Unit (Pvt.) Ltd. in collaboration with the Urban Unit. The result of site selection study is deemed appropriate in terms of evaluation indicators and the scoring criteria. Basic information of the following four top-ranked sites is outlined below.

(i) Bhakhraywali

(ii) Nandipur

(iii) Chan-Nia Pind

(iv) Daila Chatta

Table C.2.16 Outline of Top-Ranked Sites for Final Disposal of Waste in Gujranwala

Site Name	Bhakhraywali	Nandippur	Chan-Nia Pind	Daila Chatta
Land Ownership	Private	Private	Private	Private
Land Status	Borrow Pit and Agricultural Land	Agricultural Land	Agricultural Land	Agricultural Land
Land Area	25.3 ha	14.2 ha	10.1 ha	14.1 ha
Location (GPS Coordinates)	32011.150 N 74006.187 E	32016.098 N 74015.606 E	32000.682 N 74016.674 E	32014.902 N 73057.552 E
Direction from City Centre	North - West	North - East	West - South	North - West
Main road passing by the site	Alipur Chatha Road	Sialkot Road	Main Emanabad Road	Alipur Chattha Road
Distance from City Centre	11 km	18 km	14 km	22 km

All of these sites are recommended for further study, which shall include Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA).

Among the four sites, the site in Bhakhraywali obtained the highest comprehensive evaluation including environmental, social, economic aspects, etc. Especially, the condition of access road distance of 2km from the main road and the site area of approximately 25ha are advantageous against other selected sites.

Followed by the conclusion of the site final report of "Landfill Site Identification and Evaluation Report" in March 2014, CDGG announced the Bhakhraywali site as the candidate site of final disposal facilities. Then, CDGG through GWMC, proceeded with the procurement process. The draft EIA report was submitted to the UU in March 2015 and the summary of the draft EIA report is presented in ***Volume 2 Supporting Report, Section H, Environmental and Social Considerations***.

The EIA report was submitted to EPD in May 2015. After filing EIA report to EPD, a letter for confirmation of completeness for purpose of initiation of review process under Regulation 9 (1) (a) of the IEE/EIA Regulation, 2000 was marked on dated 03 June 2015. According to this letter EPD reserves the right to require the proponent to submit additional information at any stage during the review process.

For Public hearing, approved notice form agency has been publicised 30 days before in English and Urdu national and local newspaper on dated 14 July, 2015 for hearing on 17 August 2015 at 11:00 AM in Rachna Pearl Hotel, GT Road Gujranwala, as required under section 12 (3) of Punjab Environment Protection Act, 1997 (amended 2012) and also under IEE/EIA Regulation, 2000. The EIA for construction of Bhakhraywali SLF facilities is in the public consultation in addition to the further review by the agency for final approval

Regarding the future landfill site at Bhakhraywali, the site was advertised as the proposed landfill site but the site has not been procured yet due to delay of payment from the government subsidies. If the start of construction work is delayed, the new landfill facilities will not be completed within the lifetime of the temporary disposal site in Gondlanwala. This will thus require other provisional landfill sites.

As of September 2015, the negotiation for the land procurement has been completed and agreed between GWMC and eleven landowners. GWMC is scheduling to complete the contract signing and payment immediately after execution of the project budget.

Table C.2.17 Scoring Results of Each Candidate Site (1/2)

Comparison Matrix of Candidate Sites											
Classification	Factors	Marks									
		Total	Kot Maitla	Kot Jay Singh	Pandori	Shera Kot	Qila Mian Singh	Layian Wali	Mohallah Chiragh Pura	Kotli Sabu	Musharaf Road
Area	Size and capacity of the landfill	10	2	2	2	2	2	2	2	8	2
Location	Transfer distance	10	9	7	8	7	8	10	9	8	8
	Access road to the landfill	10	7	8	7	8	9	3	4	5	7
	Distance from restricted zone	10	10	10	10	10	10	10	10	10	10
	Availability of onsite soil cover	5	4	5	4	4	5	4	5	5	5
	Municipal facilities	5	5	5	5	5	5	5	5	5	5
	Sub-Total	50	37	37	36	36	39	34	35	41	37
Environment	Main Irrigation network 500 m	10	8	7	4	8	8	2	9	7	5
	Nearby environmentally sensitive area	10	8	8	3	8	6	6	7	8	8
	Perennial Stream within 300 m	5	4	4	3	4	4	3	4	5	4
	Impact to ecosystem	5	5	5	3	5	3	4	5	5	4
	Sub-Total	30	25	24	13	25	21	15	25	25	21
Society	Residential areas and other facilities	5	2	3	4	4	4	3	3	3	4
	Historical and cultural heritage	5	5	5	5	5	5	5	5	5	5
	Sub-Total	10	7	8	9	9	9	8	8	8	9
Economy	Construction cost incl. secondary infrastructure like access road	10	8	8	7	9	9	2	6	6	8
	Sub-Total	10	8	8	7	9	9	2	6	6	8
Total		100	77	77	65	79	78	59	74	80	75

Source: The Urban Unit, Landfill Site Identification and Evaluation Report, March 2014.

Table C.2.18 Scoring Results of Each Candidate Site (2/2)

Comparison Matrix of Candidate Sites												
Classification	Factors	Marks										
		Total	Rori Gurdwara	Chan-Nia Pind	Thoranwala- Pirochak	Ggar K	Aroop Village	Nandipoor	Daila Chatta	Maddu Khalil	Chianwali	Bhakhraywali
Area	Size and capacity of the landfill	10	2	8	2	2	2	9	7	2	2	10
Location	Transfer distance	10	9	8	9	9	8	8	7	9	9	9
	Access road to the landfill	10	6	6	7	7	8	8	8	9	9	10
	Distance from restricted zone	10	10	10	10	10	10	10	10	10	10	10
	Availability of onsite soil cover	5	4	4	4	4	5	4	5	5	3	4
	Municipal facilities	5	5	5	5	5	5	5	5	5	5	5
	Sub-Total	50	36	41	37	37	38	44	42	40	38	48
Environment	Main Irrigation network 500m	10	8	9	9	9	9	8	8	5	5	8
	Nearby environmentally sensitive area (within 500 m)	10	8	10	10	9	8	10	8	8	5	9
	Perennial Stream within 300m	5	3	4	5	5	4	5	4	3	3	3
	Impact to ecosystem	5	5	5	5	5	5	5	5	4	4	4
	Sub-Total	30	24	28	29	28	26	28	25	20	17	24
Society	Residential areas and other facilities	5	3	5	3	3	3	3	3	5	3	3
	Historical and cultural heritage	5	1	5	5	5	5	5	5	5	5	5
	Sub-Total	10	4	10	8	8	8	8	8	10	8	8
Economy	Construction cost incl. secondary infrastructure like access road	10	6	7	6	6	9	8	9	9	10	10
	Sub-Total	10	6	7	6	6	9	8	9	9	10	10
Total		100	70	86	80	79	81	88	83	79	73	90

Source: The Urban Unit, Landfill Site Identification and Evaluation Report, March 2014.

2.8.2 Implementation Status of Topographic and Geotechnical Survey on a Candidate Final Disposal Site in Bhakhraywali

The contractor hired by the UU completed the field work for the topographic survey and geotechnical survey of Bhakhraywali in September 2014. Outputs of these surveys were submitted to the UU in February 2015.

2.9 Relevant Laws, Regulations and Guidelines on Waste Disposal Plan

The Punjab Provincial Government has been preparing the institutional system of solid waste management through formulation of the policies and enactment of laws, rules and regulations, guidelines, manuals, etc. The major government policies, laws, guidelines, etc., are listed below:

- National Environmental Policy 2005;
- National Sanitation Policy 2006;
- Guidelines for Processing and using Refuse Derived Fuel (RDF) in Cement Industry, 2012, Pakistan Environmental Protection Agency, Ministry of Climate Change;
- Punjab Waste Management Act 2013 (Draft);
- Punjab Municipal Solid Waste Management Guidelines 2007 and 2011;
- Solid Waste Management Manual, The Urban Unit; and
- Design and Operation of Sanitary Landfill, The Urban Unit.

Among others, the Punjab Municipal Solid Waste Management Guidelines of 2011 (hereinafter referred to as "Punjab MSWM Guidelines 2011") describes the requirement for planning, design and operation of each system composing solid waste management. The major technical requirements of waste disposal are stipulated in Chapter 8, Disposal (Landfilling). There are several unclear provisions in the Punjab MSWM Guidelines 2011; however, the provisions for major items are summarised in the following subsections.

2.9.1 General Requirements

The major general requirements for landfill planning stated in the Punjab MSWM Guidelines 2011 are summarised as follows:

- Preferably, landfills should be for non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing.
- Land-filling of mixed waste should be avoided unless the same is found unsuitable for waste processing.
- The landfill plan shall be prepared/described with the following:
    - Collection and transport routes, collection area, transfer station if any, the number, types and capacities of the incoming vehicles;
    - Design period of the landfill, all landfill machineries and equipment, sources of the covering materials, operating hours, number of working days, number of workers for each activity;
    - Hydro-geological condition, highest water levels, water quality for groundwater and surface water, topography, public and private water wells within one kilometre radius of the landfill site;
    - Subsurface conditions, soil permeability and landslide areas, sink holes, fault areas, foundation analysis to support the loads and stress from the landfill and sub-grade settlement after land-filling; and

  - Design of the site plan with details for particular activities and other appurtenant facilities such as onsite roads and traffic system, office building, weighing scale house, staff house, maintenance shop, parking area, truck wash bay, entrance-exit gate, fence, landscaping, utilities, and specifies types and number of machinery and equipment.
- Landfill site selection shall follow the "Minimum Site Selection Criteria for Landfill Site" in Annex-V of the Guidelines.
- Separation distance considered as the factor for site selection or the site plan is stated as follows:
  - The distance between the active disposal area and the nearest residential, institutional, commercial or industrial building is recommended to be a minimum of 1000 m;
  - The distance between the active disposal area and the nearest property boundary should be a minimum of 100 m; or
  - The distance between the active disposal area and the nearest bank top or any surface water course or to any off-site well should be a minimum of 100 m; and
  - All landfill sites should be provided with the designated areas for separation, handling and storage of recyclable, compostable or reusable materials, bulky metallic objects, white goods, tires, batteries, and, where applicable, source separated materials such as yard wastes, glass, metals, plastics, paper, cardboard, etc. Source separated hazardous waste shall be stored and managed in accordance with the Hazardous Waste Regulations.

2.9.2 Classification of Landfill

The Punjab MSWM Guideline 2011 classifies a landfill based on the tonnage of incoming waste amount per day shown as follows:

- Class A: Receiving a daily municipal solid waste of more than 1000 tons
- Class B: Receiving a daily municipal solid waste of 500-999 tons
- Class C: Receiving a daily municipal solid waste of 100-499 tons
- Class D: Receiving a daily municipal solid waste of less than 100 tons

2.9.3 Distance of Groundwater Table from the Bottom of Landfill

The Punjab MSWM Guidelines 2011 states the distance from the bottom of landfill to groundwater table as "The bottom of landfill trench shall be higher than the groundwater table and not less than 3 metres unless special design of the hydrostatic uplift control is provided, or consult the Punjab EPD for specific guidance". On the other hand, the provision in a, (b), (2), 26, "Standards for Landfills" in Punjab Waste Management Act 2013 (draft) states that "the bottom of the landfill shall be at least ten metres above the ground water level". This discrepancy shall be studied and clarified. In this connection, the final revision of the technical guideline for final disposal in Japan, Ministerial Ordinance No. 3, 21st of February, 2013, Ministry of the Environment, do not state the distance or separation of groundwater table from the bottom of the landfill. However, it states that firm and durable facilities such as water conduit to collect and discharge groundwater shall be installed if there is a risk of damage to groundwater shielding facilities.

2.9.4 Landfill Liner System

The Punjab MSWM Guidelines 2011 states that all landfill liners shall consist of the following components:

- Sub-base (The lowest point of the excavated area upon which the liner system is to be placed.)
- Base (above the sub-base with a minimum 300 mm thickness)

- Bottom liner and leak detection system (The system shall provide for the detection and collection of a leak through the composite liner system. The flexible membrane must be manufactured of high density polyethylene (HDPE) of a minimum 60 mil thickness.)
- Soil liner component (The soil liner shall not be less than 1000 mm in depth. The soil liner shall be constructed to ensure that the minimum permeability of the compacted soil is 1×10^{-7} cm/sec or less; the soil may be amended, if required, with an admixture such as bentonite clay.)
- Flexible membrane liner [The Flexible Membrane Liner (FML) component of the liner must be manufactured of high density polyethylene (HDPE) of a minimum 60 mil thickness.]
- Leachate collection layer (The Leachate Collection Layer shall not exceed a leachate depth in this layer of 300 mm. A minimum 300 mm thickness cushion layer should be placed above the leachate collection layer.)

2.9.5 Leachate Management System

The Punjab MSWM Guidelines 2011 states that leachate management system should be installed based on the following requirements:

- The leachate management system should consist of the facilities for collection, control, treatment, discharge and monitoring of leachate from the landfill site;
- The leachate management system should be separate from the storm water drainage system;
- The leachate management systems should be functional year round and effective during the lifespan of the landfill;
- Leachate flow, both instantaneous and total flows, must be recorded; and, the system should have the adequate storage capacity for discharge control; and
- All leachate which would be harmful if discharged into the surrounding environment shall be treated to remove pollutants and tested prior to discharge.

2.9.6 Landfill Gas Management

The Punjab MSWM Guidelines 2011 states the requirements of landfill gas management as follows:

- Venting and/or gas collection systems must be installed to control and monitor gas generation in the landfill;
- All new landfills must be assessed for viability of energy recovery from gas generation; and
- Landfill gas management systems shall be evaluated on a case by case basis.

2.9.7 Surface Water Management

The Punjab MSWM Guidelines 2011 states the requirements of surface water management as follows:

- Surface water management systems should be designed to:
- divert surface and storm water from the landfill area;
- control run-off discharge from the facility;
- control erosion, sedimentation, siltation, and flooding; and
- minimise the generation of leachate.
- All surface water management systems should be hydraulically separate from the leachate management system.

2.9.8 Groundwater Management

The Punjab MSWM Guidelines 2011 states the requirements of groundwater management as follows:

- Groundwater must be carefully managed to avoid contamination by leachate or surface water discharges;
- The seasonal high groundwater table must be maintained at a minimum of 1000 mm below the bottom liner;
- Groundwater lowering system must be provided for positive drainage of groundwater or lowering of groundwater level;
- The distribution of groundwater monitoring wells should depend on the hydrogeological conditions of the landfill for the installation of a sufficient number of wells and function to take potential contamination samples, background level samples and multilevel samples. At least three monitoring wells shall be installed at hydraulically lower reaches of groundwater flow direction; and
- The monitoring wells must be retained throughout the lifespan of the facility.

2.9.9 Landfill Operation

The Punjab MSWM Guidelines 2011 states the requirements of landfill operation as follows:

- All new landfills shall have disposal waste monitoring systems through inspection and weighing of waste to be landfilled.
- General matters for landfill operation require that:
- Soil cover should be placed at least once per day or more often as required;
- Landfill should have constant supervision throughout the operation hour;
- All loads must be inspected prior to unloading;
- Landfill shall accept only the approved waste;
- Dust and litter must be controlled;
- Exposed areas must be stabilised to prevent erosion and sedimentation;
- Vectors must be controlled as required;
- Appropriate signage must be placed at the entrance to the landfill indicating the name of the landfill, hours of operation, emergency contact, and the waste type acceptable for disposal; and,
- Operation and maintenance manual shall be prepared including the document for approval of landfill, operational requirements, landfill method, contingency plan, records, report, etc.

2.9.10 Environmental Pollution Control

The Punjab MSWM Guidelines 2011 include the following systems for environmental pollution control:

- Capping system;
- Landfill gas management system;
- Leachate management system; and
- Regular monitoring points for settlement, groundwater quality, leachate and gas sampling.

2.9.11 Financial Provision

The Punjab MSWM Guidelines 2011 states the financial provision for various after use options for the cost of restoration, aftercare, maintenance, land, site development and environmental protection through the income sources, such as:

- Income from incoming waste and gas utilisation (if applicable); and
- Income from after use.

2.9.12 Closure Plan

The Punjab MSWM Guidelines 2011 states the requirements for the closure plan specifically the following:

- Total waste volumes and tonnage, and life of the landfill (i.e., closure date);
- Closure layout plan showing the final elevation, contours of the landfill, surface water diversion and drainage controls;
- Final cover design including the depth and permeability of barrier layers and drainage layers, topsoil information, vegetation cover and erosion prevention controls;
- Procedures for notifying the public regarding the closure and the alternative waste disposal facilities;
- Procedures for the control of rodents, nuisance, and wildlife;
- Proposed land use after closure;
- Plan and accompanying design for the collection, storage and treatment/use of landfill gas for a minimum of 25 years;
- Plan for operation of required pollution control engineering works such as leachate collection and treatment systems, for a minimum post-closure period of 25 years;
- Monitoring plans for groundwater, surface water and landfill gas, erosion and settlement for a minimum post-closure period of 25 years; and
- Estimated cost, updated annually, to carry out closure and post-closure activities for a minimum period of 25 years.

2.10 Evaluation of Final Disposal Condition

The problems and issues in relation to final disposal activities under the current situation are summarised in **Table C.2.19**. These items will be the basic elements to develop the plans, programmes and projects to comprise the final disposal plan in the Integrated Solid Waste Master Plan in Gujranwala.

Table C.2.19 Identification of Problems and Issues in Final Disposal

Problem	Description of Problem	Issues for Solving the Problems
1. Solid waste management without sanitary landfill facilities	Gujranwala City has never developed sanitary landfill facilities and the disposal sites tentatively used in the past have caused environmental degradation in the surrounding area. The existing landfill site in Gondlanwala procured for provisional use was not developed to function as an engineered sanitary landfill facility and with the continued inappropriate landfill operation by open dumping, the surrounding area is facing the problem of environmental degradation.	Urgent development of sanitary landfill facilities should be made so as not to cause secondary pollution from the landfill site. To solve this problem, a site selection study for new landfill facilities has been carried out by the Urban Unit, and the site in Bhakhraywali was selected for the proposed construction site. EIA study and obtaining approval is one of them and the EIA study is now underway.
2. Delay of procurement procedures for proposed landfill site in Bhakhraywali	The site in Bhakhraywali was advertised as the proposed landfill site but the site has not been procured yet due to delay of payment. This will cause the delay of construction work. If the start of construction work is delayed, the new landfill facilities will not be completed within the lifetime of the temporary disposal site in Gondlanwala. This will thus require other provisional landfill sites.	Procurement of the proposed landfill site through coordination among the relevant agencies of the government should be required for accelerating the procurement process. Immediate action by CDGG/GWMC is required to appeal the urgency of the project and the necessity to avoid further environmental degradation in order to increase the priority of subsidy payment by the provincial government agency(s).
3. No development work of landfill facilities of the existing landfill site in Gondlanwala	The existing landfill site in Gondlanwala utilises the abandoned borrow pit without facility development. Most of the troubles in landfill operation occur due to inappropriate site condition, which bring about environmental degradation especially groundwater contamination, breeding of pests such as flies, etc. to the surrounding area.	Implementation of rehabilitation work to install and/or construct the facilities should be carried out for mitigating environmental pollution.
4. Inappropriate landfill operation and management at the existing landfill site in Gondlanwala	Landfill management was not properly implemented at the existing landfill site in Gondlanwala. As a result, the existing landfill site might be causing a negative impact on the environment of the surrounding area.	Minimising the environmental impact of the existing landfill site should be implemented through emergency measures and introduction of landfill operation and maintenance manual, procurement of sufficient number of landfill machines, equipment, materials and deployment of staff.
5. Not proper closed/abandoned landfill site in Chianwali	The Chianwali landfill site was not closed properly and thus causing secondary pollution to the surrounding area. The site is located just along the G.T. Road. Therefore, in addition to the risk of groundwater contamination, visual pollution to landscape and waste scattered by wind are causing the negative environmental impacts.	Mitigating the environmental impacts should be required through implementation of safe closure work of the landfill site. According to Punjab Municipal Waste Management Guidelines 2011, "Closure Plan", Chapter 8, the post-closure maintenance and monitoring works shall be provided for a minimum period of 25 years.

3. PLANNING DIRECTIONS OF FINAL DISPOSAL PLAN

Waste disposal shall be provided as the last process of solid waste management to dispose waste for storing eternally and for stabilising the waste of no value for resource materials and/or waste conversion for further use and protect the surrounding area from secondary pollution.

3.1 Objective

Waste disposal shall be provided as the last process of solid waste management to dispose waste for storing eternally and for stabilising the waste of no value for resource materials and/or waste conversion for further use and protect the surrounding area from secondary pollution.

3.2 Planning Policy

- The development plan of final disposal facilities shall be formulated with the period until 2030 for the final target year of the master plan.
- Only treated or residual municipal solid waste shall be the objective waste acceptable to the final disposal facility of Gujranwala.
- Among the several types of final disposal facilities, the sanitary landfill facility is superior to any other type for disposal of municipal solid waste from technical, economic and environmental viewpoints. Hence the final disposal plan shall formulate the development plan for construction and operation of new sanitary landfill facilities in Bhakhraywali.
- The improvement plan of the existing landfill in Gondlanwala and the safety closure plan of the former landfill site in Chianwali shall be included as an integral part of the final disposal plan.

3.3 Planning Strategy

- The development work of new sanitary landfill shall be carried out by stage-wise construction work in consideration of the financial capacity of the project proponent.
- The improvement plan of the existing landfill site and the safety closure of the former landfill site shall be carried out to attain the satisfactory level for mitigating the current negative impacts in consideration of economic efficiency.

4. FORMULATION OF FINAL DISPOSAL PLAN

4.1 Urgent Improvement of the Current Landfill Operation in Gondlanwala

In the site visits, the JICA Project Team observed that the landfill operation started in March 2014 at the landfill site in Gondlanwala has a potential risk of environmental degradation. It is needless to say that the improvement plan of the provisional landfill in Gondlanwala is due to be included as one of the major projects to compose the final disposal plan for tackling the immediate measures against the current situation of environmental impacts.

In view of this situation, prior to the formulation of the master plan, the JICA Project Team decided to prepare a brief proposal, "*Proposal on Urgent/Preliminary Improvement of Gondlanwala Dump Site,*" for the improvement work of landfill in Gujranwala and submitted it to GWMC on the 7th of April 2014. The proposal contains several key measures to be taken by the GWMC for reducing the environmental impacts immediately. The following items describe the contents of the proposal, and the subsequent recommendations taking into consideration the situation thereafter.

4.1.1 Proposal Submitted for Urgent Improvement of Gondlanwala Landfill Site

The proposal presents the measures for improving the existing open dumpsite at Gondlanwala to mitigate possible groundwater pollution and scattered dust and offensive odour taking place in the vicinity. The improvement work of the Gondlanwala Dump Site will be prepared as a part of the action plan in the Master Plan. However, since the action plan will be formulated in the end of the Project period according to the Project Schedule, it is predictable that such negative impacts at Gondlanwala will become worse in the latter stage. In order to avoid worse condition of the dump site, this paper urges immediate actions to tackle with the implementation of improvement work as urgently and preliminarily required. The urgent/preliminary improvement work of the open dump site consists of the following measures.

(1) Improvement of Existing Ramp or Approach Road and Construction of Unloading Area

The ramp leading to the bottom of the dump site is partly collapsed (see **Photo C.4.1**) due to rainwater and the collapse of side slope will become a cause of incoming vehicles falling from the ramp. This collapse will become worse when the rainy season starts. The following measures will be effective to prevent the slope from collapsing:

- Bring clayey earth from the other corner of the dumpsite or purchase it from a nearby borrow pit;
- Fill the collapsed slope area shown in **Photo C.4.1** and **Figure C.4.1** with clayey earth and perform watering to bind the sand or remove voids in the filled earth to accelerate its stability;
- Tamper the slope well by machine or by hand; and
- Seed the slope area by fast-growing type of weeds to prevent erosion of the surface soil.

(2) Filling Water Area in the Dumpsite by Clayey Earth

The bottom of dumping area is filled with water and it may cause groundwater contamination in the course of waste dumping in the water area. It is assumed that the existing water table will rise by 1.5m or so, and dumped waste soaked in water will generate methane gas under the anaerobic condition. To avoid dumping waste in the water area, the following measures will be effective:

- Bring clayey earth from the other corner of the dumpsite or purchase it from a nearby borrow pit and put it onto the bottom of the dumping area; and

- Fill the earth at least 2.0 m above the existing water table and compact well to minimise infiltration of contaminated water or leachate into the underground.

(3) Temporary Leachate Control System

Leachate in the dumping area shall be collected by leachate mains to be installed on the bottom of the dumping area and conveyed to a leachate pond to be constructed in the corner of dumpsite at the place shown in **Photo C.4.2** and **Figure C.4.1**. Leachate in the pond shall be circulated in the dumpsite by a temporary pump and hose for reducing leachate amount by evaporation. Major work items are described as follows:

- Place the leachate mains of 200 mm dia. or larger diameter PVC (Polyvinyl-Chloride) or HDPE (High Density Polyethylene) perforated pipes on the bottom of the dumpsite with a minimum slope of 5/1,000. The end of the leachate mains shall be connected to the leachate pond;
- Cover the leachate mains with gravel, as shown in the attached **Figure C.4.1**;
- Construct an earthen pond lined with concrete or HDPE with the storage volume of minimum $100m^3$; and
- Install a temporary pump unit and hose in the pond for circulation of leachate within the dumpsite area and operate a submerged pump. The pump unit shall be operated for 1-2 hours after the daily landfill operation is finished to lower the water level in the leachate pond and withdraw the leachate effectively.

(4) Waste Dumping on the Bottom of Dumpsite

Waste dumping from the top of the dike has the risk of vehicles falling to the dumpsite. Waste dumping or unloading of waste shall be carried out from the bottom of the dumpsite. To unload the waste on the bottom of the dumpsite, the following works, at least, shall be required:

- Construct a temporary approach road leading to the landfill area. The minimum width shall be 3 m roadway with one (1) metre shoulders;
- Construct a platform or working area for unloading and turning of the vehicles with the minimum dimension of 15m by 15m wide; and
- Designate the working area for landfill work within the low earthen dike cell constructed with 1 to 2 m high and for the volume of approximately one (1) month landfill work.

(5) Regular Earth Covering onto the Dumped Waste

Regular earth covering is effective for minimising breeding of vectors, especially flies and also reducing the offensive odour. Unloaded waste in the working cell shall be spread horizontally and compacted well. Regular earth covering by soil excavated from the north-east side of the dumping area would be available.

(6) Control of Waste Pickers

Waste pickers pick out recyclable materials from the dumpsite. They sometimes disturb the unloading and landfill work. They are by themselves at risk working in the waste dumping area. Banning of recovery work is preferable but if not possible, they may be allowed after the waste dumping hours for the day.

4.1.2 Additional Proposal for Urgent Improvement of Gondlanwala Landfill Site

(1) Measures to Lower the Ponding Water Level at the Bottom of Landfill Area

Stagnant leachate water at the bottom of the landfill area has raised the water level in September due to heavy rainfall during the monsoon season. Rise of water level in the landfill area causes the leachate flow into the groundwater aquifer in the peripheral zone and bring about the risk of groundwater contamination. If the groundwater level in the peripheral area is higher than that of the landfill site, the groundwater in the surrounding wells receive fresh groundwater recharge from the outer zone. Therefore, the measures to lower the water level (groundwater table) in the landfill area by installation of a pumping system and its operation are effective to direct the groundwater flow from the peripheral zone to the side of the landfill site. The system shall be comprised of a pump well, leachate drainage piping, and the leachate circulation and evaporation system. The water level in the pump well must be targeted to maintain approximately 1m lower than the bottom elevation of the landfill site by the water level in the pump well. With too much pumping below the water level in the pump well, the groundwater level will drop too low in the peripheral zone and will cause dry-up of, especially, the hand pump wells.

(2) Pest Control, Odour Control and Dust Control

Currently, in the landfill site, the adjacent house, operators of weighbridge, collection vehicle drivers, etc., are suffering from the outbreak of flies, offensive odour and dust. The situation is unsanitary and the risk of health hazard occurs. These environmental conditions must be improved immediately based on the following recommendations:

- Eradicate the flies by spraying environment-friendly pesticide;
- Conducting regular soil cover, at the same time, to eliminate the breeding sites of flies and to prevent generation of offensive odour;
- Periodic spraying onto the unloading waste by deodorant agent made from useful bacteria like lactic acid, enzymes, etc., to decompose offensive odour substance; and
- Periodic spraying of water to the approach road of vehicles and the weighbridge site to prevent the dust from winding up.

As of March 2015, some of the operational measures of the proposed urgent project for earth cover, pest control, etc. have been carried out by GWMC for controlling the waste dumping operation. However, it has not yet implemented the urgent improvement work which requires a relatively large amount of money due to shortage of funds of GWMC. The proposal still remains the same for implementing immediately the improvement work through funding with a special budget, if available. In the meantime, more effective measures will be proposed as a part of the project under the short-term development plan of final disposal.

Photo C.4.1 Collapse of Gondlanwala Landfill Site

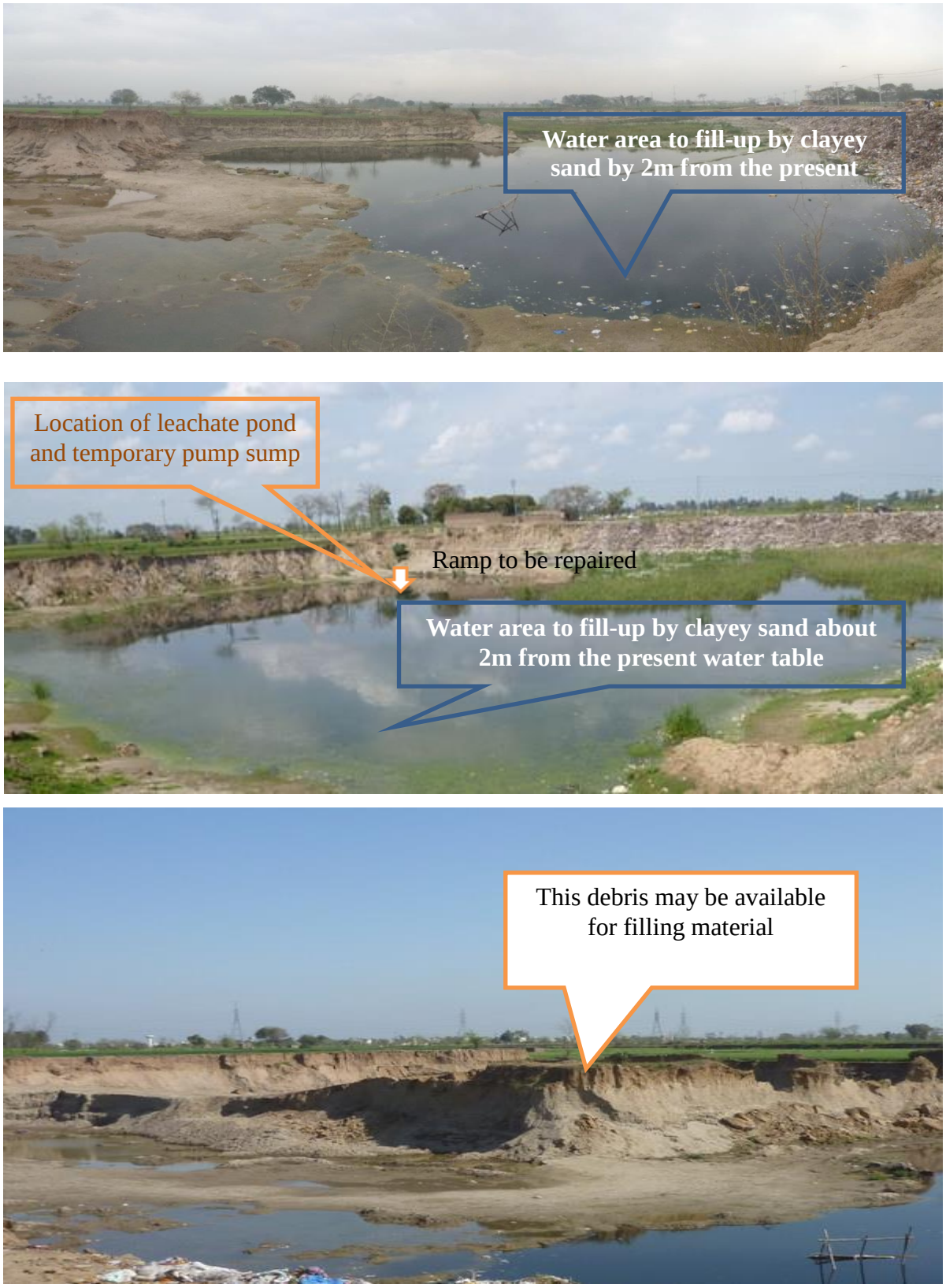


Photo C.4.2 Leachate Condition of Gondlanwala Landfill Site

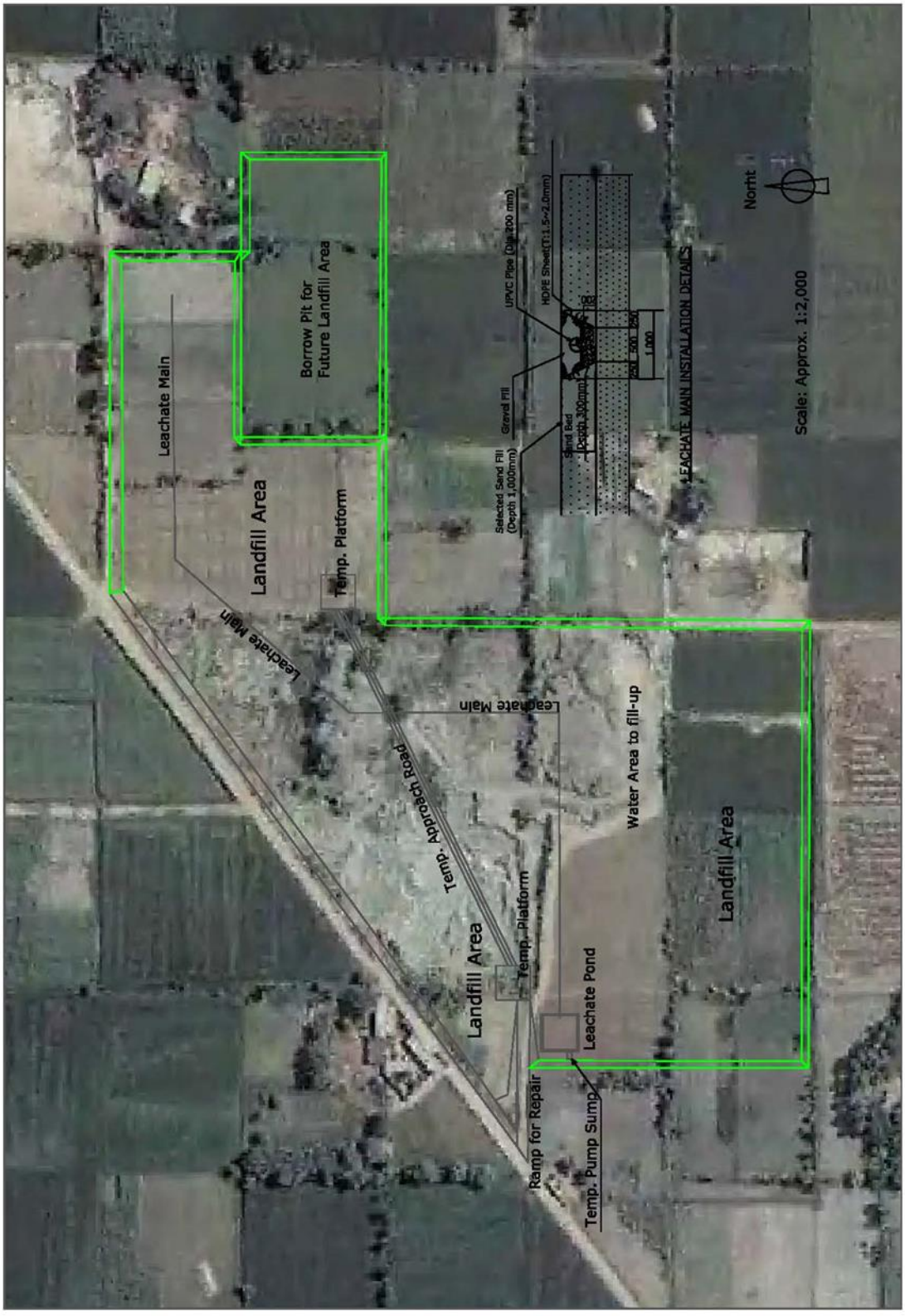


Figure C.4.1 Urgent Improvement Plan for Gondlanwala Landfill Site

4.2 Development of Alternatives for Final Disposal Plan

4.2.1 Waste Disposal Amount

Waste disposal amount is computed in accordance with the integrated municipal solid waste management flow. More concretely, the waste disposal amount is calculated from the waste generation amount presented in **Section A, Waste Amount Composition Analysis** by reducing the following waste amounts:

- Un-collected waste amount;
- Waste generation prevention amount;
- Resource recovery amount by waste pickers in town and recycling industries;
- Organic waste recovery by home, community and central composting; and
- Combustible waste recovery by RDF plant.

The estimation of waste disposal amount is carried out in three (3) cases, i.e., 1) waste disposal amount with 3R activities and intermediate treatment; 2) waste disposal amount without 3R and intermediate treatment; and 3) waste disposal amount without any new project (Zero option). The result of computation is summarised in **Table C.4.1**. From the table, the daily waste disposal amount of 406 t/d in 2014 increases drastically up to 2,013 t/d or 2,724 t/d in 2030 by the cases of with/without the activities of 3R and intermediate treatment. Meanwhile, the annual waste disposal amount of 148,000 t/year in 2014 increases to 735,000 t/year or 994,000 t/year for the cases of with/without 3R and intermediate treatment.

Table C.4.1 Estimated Waste Disposal Amount by Cases

Daily Waste Disposal Amount (t/d)																	
Case	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
With 3R	406	500	658	833	1,035	1,133	991	1,105	1,227	1,359	1,500	1,612	1,724	1,848	1,981	2,115	2,013
Without 3R	406	500	658	833	1,035	1,133	1,241	1,356	1,478	1,610	1,752	1,888	2,027	2,182	2,353	2,528	2,724
Without Projects	406	406	406	406	406	406	406	406	406	406	406	406	406	406	406	406	406
Annual Waste Disposal Amount (1,000 t/year)																	
UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
With 3R	148	183	241	304	378	414	363	403	448	496	549	589	629	674	725	772	735
Without 3R	148	183	241	304	378	414	454	495	540	588	641	689	740	797	861	923	994
Without Projects	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148

Source: JICA Project Team

4.2.2 Annual Landfill Volume

The landfill volume is estimated through conversion of waste amount in ton to volume in cubic metre (m^3) by the bulk density of filled waste layer obtained from the bulk density survey conducted at Chianwali and Gondlanwala disposal site. As mentioned earlier, the bulk density of 0.9 ton/m^3 was used for estimating the residual lifetime of the Gondlanwala disposal site. The bulk density of 1.0 ton/m^3 is used for the design of proposed Bhakhraywali landfill facilities considering the longer lifetime compared with that of the Gondlanwala site. Then, the cover soil volume of 20% to the waste volume is added to estimate the total landfill volume.

The result of landfill volume computation is tabulated in **Table C.4.2** for the annual waste disposal volume together with the cover soil volume. The annual landfill volume is also divided into the two disposal sites: at Gondlanwala (2014-2017) and at Bhakhraywali (2018-2030). In addition, the landfill volume of Gondlanwala disposal site in 2014 has adjusted with the volume for 10 months since the landfill operation started in March 2014. In Gondlanwala disposal site, the annual waste disposal

volume including waste disposal volume and cover soil volume increases from 148,000 m^3/year in 2014 to 365,000 m^3/year in 2017. In Bhakhraywali disposal site, the landfill volume of 453,000 m^3/year in 2018 increases up to 882,000 m^3/year or 1,193,000 m^3/year in 2030 for with/without the 3R and intermediate treatment cases.

Table C.4.2 Estimated Annual Landfill Volume by Cases

Annual Waste Disposal Volume (1,000 m^3/year)																	
Case	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
With 3R. (Gondlanwala)	123	183	241	304													
With 3R (Bhakhraywali)					378	414	363	403	448	496	549	589	629	674	725	772	735
Without 3R. (Bhakhraywali)					378	414	454	495	540	588	641	689	740	797	861	923	994
Without New Projects	123	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
Annual Cover Soil Volume (1,000 m^3/year)																	
UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
With 3R. (Gondlanwala)	25	37	48	61													
With 3R (Bhakhraywali)					76	83	73	81	90	99	110	118	126	135	145	154	147
Without 3R. (Bhakhraywali)					76	83	91	99	108	118	128	138	148	159	172	185	199
Without New Projects	25	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Annual Landfill Volume (1,000 m^3/year)																	
With 3R. (Gondlanwala)	148	219	289	365													
With 3R (Bhakhraywali)					453	496	435	484	538	595	659	706	755	809	870	926	882
Without 3R. (Bhakhraywali)					453	496	545	594	648	705	770	827	888	956	1,033	1,107	1,193
Without New Projects	148	178	178	178	178	178	178	178	178	178	178	178	178	178	178	178	178

Source: JICA Project Team

Note: The landfill volume of Gondlanwala in 2014 has adjusted with the volume for 10 months since the landfill operation started in March 2014.

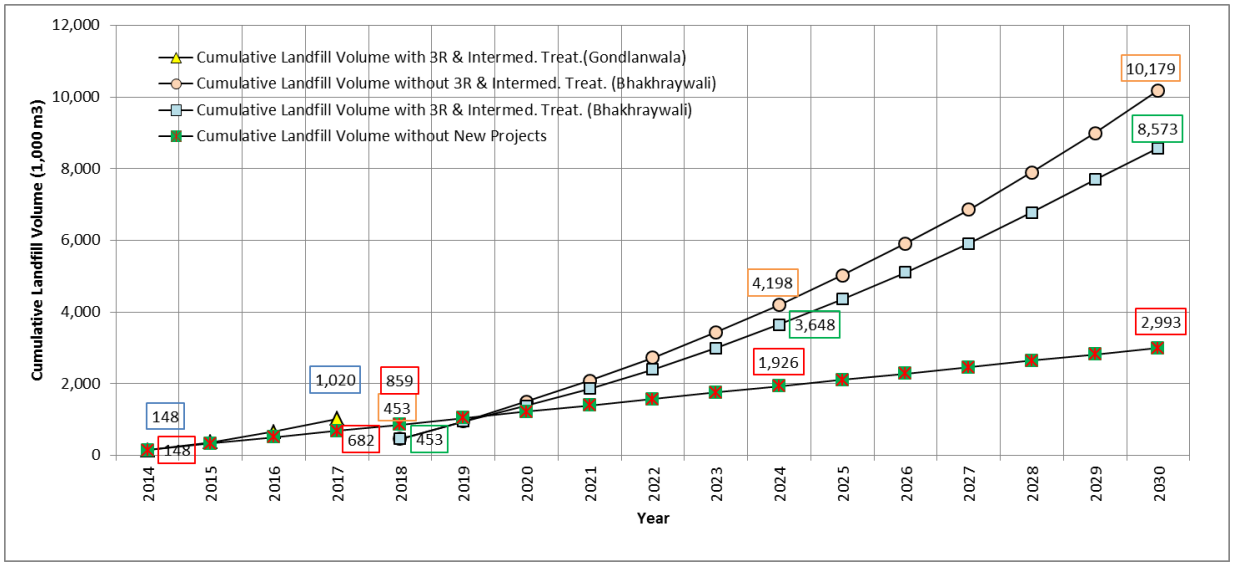
4.2.3 Cumulative Landfill Volume

The cumulated annual landfill volume for each year is as shown in **Table C.4.3** and the annual trend graph is shown in **Figure C.4.2**. The cumulative landfill volume at Gondlanwala disposal site will become 1.0 million cubic metres in the end of 2017. The cumulative landfill volume for with/without 3R and intermediate treatment during the period from 2018 to 2030 will become 8.6 million cubic metres and 10.2 million cubic metres respectively. In case of "Zero Option" or no implementation of new projects, the cumulative landfill volume will become about 3 million cubic metres.

Table C.4.3 Estimated Cumulative Landfill Volume by Cases

Cumulative Landfill Volume (m^3)																	
Case Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
With 3R. (Gondlanwala)	148	367	656	1,020													
With 3R (Bhakhraywali)					453	948	1,381	1,863	2,399	2,992	3,648	4,351	5,103	5,909	6,775	7,697	8,573
Without 3R. (Bhakhraywali)					453	948	1,491	2,083	2,728	3,431	4,198	5,022	5,907	6,860	7,889	8,992	10,179
Without New Projects	148	326	504	682	859	1,037	1,215	1,393	1,571	1,748	1,926	2,104	2,282	2,460	2,637	2,815	2,993

Source: JICA Project Team



Source: JICA Project Team

Figure C.4.2 Increasing Trend of Cumulative Landfill Volume by Cases (1,000 m^3)

4.2.4 Landfill Development Plan

(1) Available Landfill Volume and Lifetime of Disposal Site

The available landfill volume for Gondlanwala and Bhakhraywali disposal site are computed at 510,000 m^3 and 1,600,000 m^3, respectively for filling up the existing ground level. Judging from the available landfill volume of each site, the lifetime of Gondlanwala disposal site will end in 2016 based on the cumulative landfill volume indicated in **Table C.4.3** or in **Figure C.4.2** above. On the other hand, the lifetime of Bhakhraywali which started landfill in 2018 will end in 2021 for the cases of with/without 3R and intermediate treatment. Development alternatives of landfill sites are proposed in the following subsections based on the estimated lifetime of each disposal site described above.

(2) Alternative Landfill Development for Gondlanwala Site

The alternative landfill development of Gondlanwala is prepared to accommodate waste disposal up to the end of 2017 when the Bhakhraywali landfill site will become operational in 2018. The following four options in **Table C.4.4** are proposed for the Gondlanwala site taking into account the circumstance of the neighbouring area.

Table C.4.4 Landfill Development Options for Gondlanwala

Options	Existing Site	New Site	Waste Transfer
Option-1	Landfill waste up to the ground level with 510,000 m^3. Piling up about 8 m high from the ground level to accommodate another 510,000 m^3. Total 1,020,000 m^3 to dispose waste until the end of 2017.	None	None
Option-2	Landfill waste up to the ground level with 510,000 m^3. Piling up about 3 m high from the ground level to accommodate about 180,000 m^3. Total 690,000 m^3 to dispose waste until the middle of 2016.	Procure about 8 ha of land and use 80% of the area for landfill. Landfill 3m deep from the ground level and pile up 3m waste layer above the ground to receive waste from the middle of 2016 to the end of 2017.	None
Option-3	Same as Option-1	None	Transfer waste to the Bhakhraywali disposal site after completion of the landfill facilities.
Option-4	Landfill waste up to the ground level by the volume of 510,000 m^3.	None	Use the open space of Bhakhraywali landfill site for temporary storage for 1-2 years then transfer waste to the Bhakhraywali landfill site after completion of the landfill facilities.

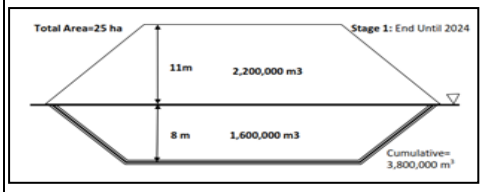
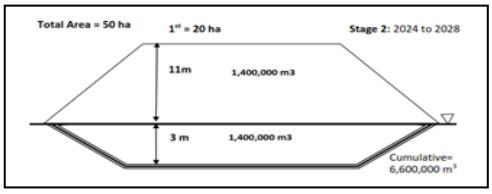
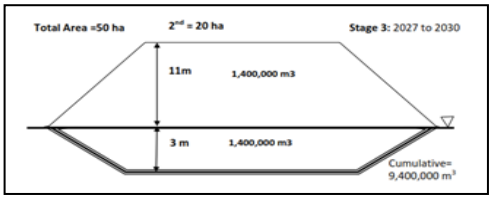
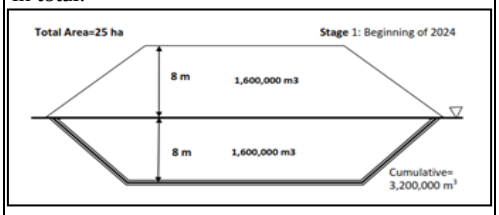
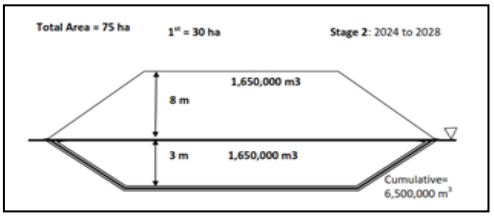
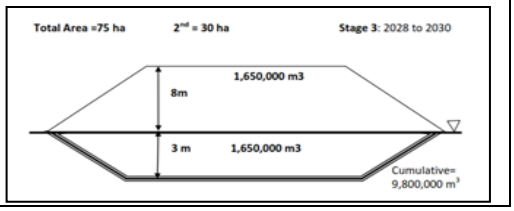
Source: JICA Project Team

The options were evaluated from environmental, technical and economic aspects and concluded that Option-4 is the most realistic and preferable followed by Option-3. Option-4 implicates the operational uncertain factors depending on the development schedule and work plan of the Bhakhraywali landfill facilities. If the timing of the development work cannot accept the temporary waste storage, then Option-3 will be practiced.

(3) Alternative Landfill Development for Bhakhraywali Site

The alternative landfill development of Bhakhraywali is prepared to accommodate waste disposed from 2018 to 2030 until the end of the Master Plan period. The two options in **Table C.4.5** are proposed for the Bhakhraywali site taking into account the circumstance of the neighbouring area.

Table C.4.5 Landfill Development Options for Bhakhraywali

Options	Existing Site	New Site
Option-1	**Stage-1:** Development: Landfill waste up to the ground level with the volume of 1,600,000 m3. Piling up about 11 m high from the ground level to accommodate another 2,200,000 m3. Disposed waste until the middle of 2024 is 3,800,000 m3 in total. 	Procurement of 50 ha of land and use 80% or 40 ha for the landfill area. Landfill 3 m deep down from the ground level and pile up 11 m from the ground level. **Stage-2:** Development: Development of 20 ha landfill area to secure new volume of about 2,800,000 m3or the cumulative volume of 6,600,000 m3 to accommodate landfill from the middle of 2024 to the middle of 2027.  **Stage-3:** Development: Development of 20 ha landfill area to secure 2,800,000 m3or the cumulative volume of 9,400,000 m3 to accommodate landfill from the middle of 2027 to 2030 and after. 
Option-2	**Stage-1:** Development: Landfill waste up to the ground level with the volume of 1,600,000 m3. Piling up about 8 m high from the ground level to accommodate another 1,600,000 m3. Disposed waste until the beginning of 2024 is 3,200,000 m3 in total. 	Procurement of 75 ha of land and use 80% or 60 ha for the landfill area. Landfill 3 m deep down from the ground level and pile up 8 m from the ground level. **Stage-2:** Development: Development of 30 ha landfill area to secure new volume of about 3,300,000 m3 or the cumulative volume of 6,500,000 m3 to accommodate landfill from the beginning of 2024 to the middle of 2027.  **Stage-3:** Development: Development of 30 ha landfill area to secure 3,300,000 m3 or the cumulative volume of 9,800,000 m3 to accommodate landfill from the middle of 2027 to 2030 and after. 

Source: JICA Project Team

The respective options are feasible from the environmental, technical and economic aspects. However, Option-1 is superior to Option-2 from the viewpoint of possibility of land procurement and environmental issues. The rapid increase of incoming waste to the disposal site caused difficulties for the waste disposal plan. The best option of the disposal plan would be the implementation of more active 3R and intermediate plan to divert waste from the waste disposal through the financial support of the Punjab Government.

4.2.5 Development of Design Alternatives for Final Disposal

The final disposal plan includes improvement plan of the existing disposal site in Gondlanwala and safety closure of Chianwali disposal site in addition to the construction of landfill facilities in Bhakhraywali. The plan for Gondlanwala and Chianwali shall be formulated to the satisfactory level to mitigate current and future possible negative impacts in consideration of economic efficiency. Accordingly, the alternative study for the sites in Gondlanwala and Chianwali is not conducted in this subsection and the following discussions are the matters related with development of the landfill facilities in Bhakhraywali.

The waste management hierarchy begins with waste discharge. Final disposal is the last preferable option for storing eternally and safely the waste of no value. Landfill type is classified by the kind of waste to be disposed. The landfill types for municipal solid waste generally practiced in the developing countries can be divided into the following:

- Open dump site;
- Controlled open dump site; and
- Engineered landfill.

The definition of the landfill types listed above is different by countries and clear technical standards are not established.

There are several legal frameworks in the world stipulating landfill types and technical standards. According to the Directive 1999/31/EC on the landfill of waste, landfill types are divided into the three classes given below.

- Landfill for hazardous waste;
- Landfill for non-hazardous waste; and
- Landfill for inert waste.

The type of landfill for non-hazardous waste is intended for municipal solid waste. The said division of landfill type is also prescribed in the Waste Management Law in Japan, namely; the landfill types are:

- Stabilisation type;
- Management type; and
- Closed type.

The management type is applied for municipal solid waste in Japan and constructed by most of the local governments for final disposal facilities.

In Pakistan, the landfill types are categorised under the Punjab Municipal Solid Waste Management Guidelines. The types are divided by the tonnage of waste amount received as follows:

- Class A: Daily municipal solid waste of more than 1,000 tons
- Class B: Daily municipal solid waste of more than 500 tons and less than 1,000 tons
- Class C: Daily municipal solid waste of more than 100 tons and less than 500 tons
- Class D: daily municipal solid waste of less than 100 tons. (Stabilisation type)

The Guidelines also stipulates the requirements for landfill liner system, leachate management system, final cover system, etc., which shall be applied for municipal waste landfill. Requirements stated in the Guidelines are comparatively strict and the requirements are equivalent to the landfill type called for sanitary landfills practiced at many local governments in Japan.

4.3 Evaluation of Design Alternatives

Evaluation of final disposal alternatives generally begins with the construction of site alternatives. For this project, the landfill site selection survey conducted for 19 sites as delineated in **Section 2.8** has selected Bhakhraywali as the construction site of landfill facilities. The selected construction site is superior to other sites in terms of geographical, technical and environmental point of view and considered appropriate for the proposed construction site. Accordingly, the evaluation of the construction site alternative is not discussed anymore under this subsection.

The type of landfill for municipal solid waste has almost no option and the sanitary landfill becomes the most preferable options as mentioned in **Subsection 4.2.5**. However, there are some levels or grade of sanitary landfill system for consideration in the course of design of landfill facilities as discussed in the following subsections.

4.3.1 Level of Sanitary Landfill Facilities

The level of Sanitary landfill can be defined or classified by the function of the facilities constructed and operation and maintenance procedures. Four levels of sanitary landfill are proposed, as follows:

- Level 1: Incoming waste recording and unloading control
- Level 2: Level 1 plus regular cover soil
- Level 3: Level 2 plus effluent control of leachate
- Level 4: Level 3 plus leachate treatment system

Level 1: Incoming waste recording and unloading control

The minimum requirements of the Level 1 landfill are the impermeable liner system for landfill waste containment, recording of incoming waste by weighbridge and control of waste unloading to the designated landfill area for the day.

Level 2: Level 1 plus regular cover soil

The minimum requirements of Level 2 are regular and daily filling with cover soil as the most preferable operation, in addition to the facilities and operation meeting the requirements of Level 1 landfill.

Level 3: Level 2 plus effluent control of leachate

The minimum requirements of Level 3 are the effluent control system of leachate including installation of leachate collection system and leachate pond, in addition to the facilities and operation meeting with the requirements of Level 2 landfill.

Level 4: Level 3 plus leachate treatment system

The minimum requirements of Level 4 are the leachate treatment system in addition to the facilities and operation meeting the requirements of Level 3 landfill.

The selection of sanitary landfill level among those defined above is made basically depending on the probable environmental impact of the landfill site to the natural and social conditions in the surrounding area. The area surrounding the proposed site in Bhakhraywali is agricultural area and the nearest residential area is located at approximately 1 km away from the proposed site. Based on the conditions mentioned above, the function of landfill facilities and operation for Level 3 landfill will be proposed to satisfy the requirements for a new sanitary landfill from the environmental and economic viewpoints.

4.3.2 Design Option for Semi-Aerobic Sanitary Landfill

Article 26 of The Punjab Waste Management Act of 2013 prescribes in the "Standards for Landfill" that the technical design of landfill shall meet the standards required by the authorised office and some of the technical requirements are specified. The design of Bhakhraywali sanitary landfill complies basically with the requirements specified under Article 26.

Furthermore, the Bhakhraywali sanitary landfill facilities shall have the function to facilitate semi-aerobic type landfill. The semi-aerobic type landfill can promote decomposition of organic waste for prompting early stabilisation and reducing generation amount of methane. In order to have the function of semi-aerobic landfill, the installation of leachate collection system, leachate pond, leachate pump well, and landfill gas vents is required. In particular, the size of the leachate collection conduit or pipes shall be large enough to entrain air into the conduit or the pipes in addition to the special design at the outlet section of the leachate collection system to the leachate pond designed to open to the air intermittently.

4.4 Identification of Project Components for Final Disposal Plan

4.4.1 Project Components for Final Disposal Plan

The project components for final disposal are formulated to tackle the measures against the problems and issues defined in **Subsection 2.4.11.** The problems and issues pointed out three areas for taking measures for the final disposal plan. The first priority is given to the development of sanitary land facilities. The Urban Unit (UU) carried out the study for landfill site selection and prepared the report as described in **Section 2.4**. The evaluation factors for siting adopted in the report composed of the key items derived from the provisions in "Punjab Waste Management Act 2013". These evaluation factors are the field of area size, location, environment, society and economy, and so forth. Studying the site selection procedures and the conclusions of the report, it is considered that the site at Bhakhraywali is the most feasible site for development of sanitary landfill facilities.

The second priority is given to the improvement work of Gondlanwala existing disposal site and lastly to the safety closure of Chianwali disposal site. The plan is formulated in 3 phases, short-term from 2016 to 2018, mid-term from 2019 to 2024, and long-term from 2025 to 2030 as shown in the contents of the projects summarised in the following subsections. The project locations of the three sites are shown in the **Figure C.4.3** to **Figure C.4.6.**

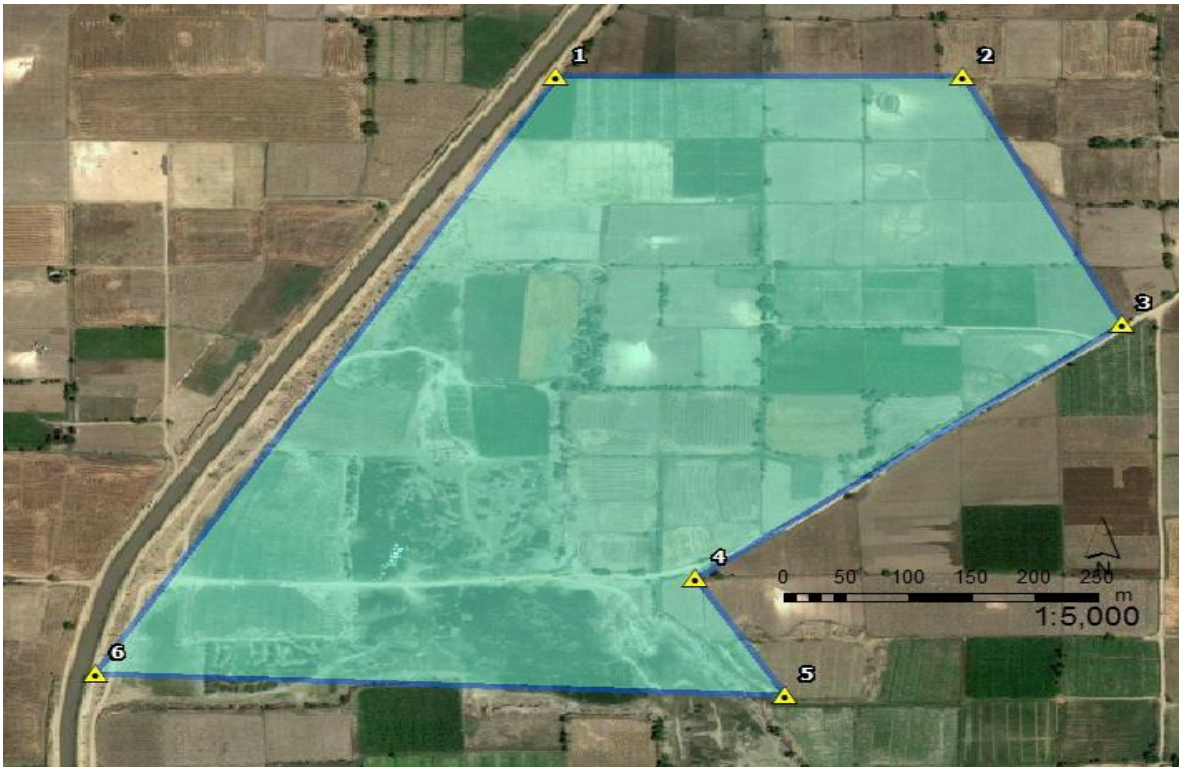


Figure C.4.3 Location of Bhakhraywali Sanitary Landfill Development Project

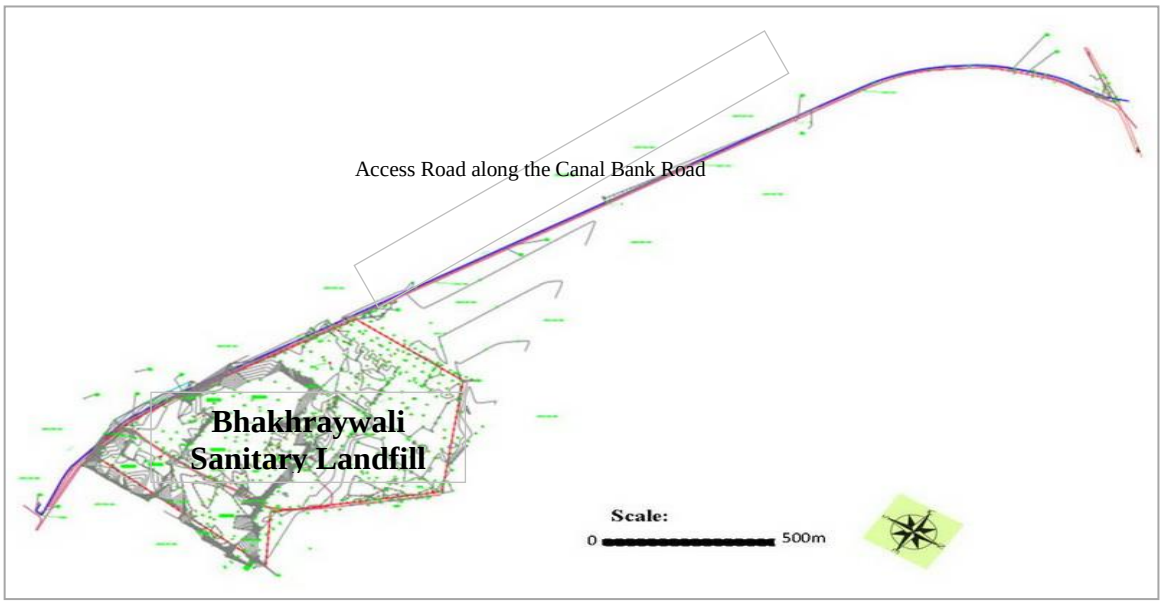


Figure C.4.4 Access Road of Bhakhraywali Sanitary Landfill Facility

Figure C.4.5 Location of Gondlanwala Disposal Site Improvement Project

Figure C.4.6 Location of Chianwali Safe Closure Project

4.4.2 Short-Term Plan (2016-2018)

Outline of the activity of final waste disposal plan in the Short-Term period is stated in the following paragraphs. The detail activities of each project and plan shall refer to the description in **Section 5 Formulation of the Action Plan**.

(1) Procurement of Sanitary Landfill Site

Approximately 25 ha of land in Bhakhraywali have already been taken through the official procedures for procurement. However, the contract has not yet been signed with the land owners due to delay of funding for the procurement. GWMC shall include the procurement cost into the budget for the fiscal year 2015/2016 which will be submitted to the Punjab Government for approval. All the land procurement process must be completed by the end of 2015 to proceed to the engineering design of sanitary landfill facilities.

(2) Engineering Service for Sanitary Landfill Facilities (Stage 1)

The engineering service fee also shall be included in the budget for 2015/2016 fiscal year. GWMC shall prepare the tender and contract documents in advance for hiring an engineering service company and proceed to the contract signing upon completion of the land procurement contract signing. Engineering design and tender documents must be completed in 6 months to proceeds with the tender call by the middle of 2016. The engineering service includes the following services:

- Engineering design of sanitary landfill facilities;
- Construction cost estimates by the form of priced bill of quantities;
- Preparation of tender documents for construction work contract;
- Supporting of tender evaluation; and
- Construction supervisory services.

(3) Construction of Sanitary Landfill Facilities (Stage 1) in Bhakhraywali

The sanitary landfill facility shall be constructed within the 25 ha site area. The actual area of landfill containment shall be 20 ha, approximately. The construction work takes the period of 15 to 18 months. All the construction work must be completed by the end of 2017 or the latest, in early 2018. The major components of the construction work include the following:

- Improvement of access/exit road along the main canal;
- Earthworks for the construction of slopes of containment, intermediate dike, approach road, maintenance road, soil liner, etc.;
- Installation of geomembrane impermeable liner;
- Leachate collection system, leachate pond and leachate circulation system;
- Installation of landfill gas vent system;
- Building works including site office & storage, weighbridge house, guard house, etc.
- Installation of weighbridge system;
- Power supply and lighting work; and
- Appurtenant facilities including perimeter fence, gates, relocation of water channel, landscaping, etc.

(4) Procurement of Landfill Machine

Additional machine for landfill operation at Gondlanwala disposal site is procured in 2016 and the landfill machines to be dispatched to the Bhakhraywali landfill site will be supplemented in 2017. The number of landfill machines will increase responding to the incoming waste amount for disposal. Required number of all the types of landfill machine and the procurement schedule is

tabulated in **Table C.4.6**. As shown in the table, the landfill machine to be procured during the Short-Term period is the following combination:

- One (1) unit of wheel loader in 2016;
- One (1) unit of excavator in 2016; and
- Two (2) units of bulldozer (chain dozer).

Table C.4.6 Schedule of Required Number of Landfill Machine

Basic Information	Year				
	2014	2016	2018	2024	2030
Incoming Waste Amount (t/d)	406	658	1,035	1,500	2,013
Required No. of Machine	3	5	7	11	17
Required No. of Procurement		2	2	4	6
Required No. of Replacement				3	4
Procurement Schedule	Year				
	2014	2016	2017	2023	2029
Existing machine (Bucket Tractor)	3				
Bulldozer (Chain Dozer)			2	2	3
Wheel Loader		1		1	2
Excavator		1		1	1
Replacement (Bucket Tractor)				3	
Replacement (Bulldozer)					2
Replacement (Wheel Loader)					1
Replacement (Excavator)					1

(5) Operation and Maintenance of Landfill Facilities

Operation and maintenance work at Bhakhraywali disposal facilities shall be started in the beginning of 2018.

Even though the facilities have functions for the sanitary landfill, the satisfactory landfill will not be realised if the operation and maintenance works will not meet the requirements. An operation and maintenance plan shall be prepared based on the requirements of the technical guidelines and/or the operation and maintenance manuals for sanitary landfill. In order to carryout operation and maintenance properly to maintain the functionality of the sanitary landfill, the following are the major items to be specified for the operation and maintenance plan which shall be prepared in advance to the start of landfill operation at the Bhakhraywali landfill site.

- Policy and Strategies for the Better Management of Sanitary Landfill
- Incoming Waste Management
- Landfill Operation Management
- Landfill Facility Management

The operation and maintenance staff required for the sanitary landfill will consist of the following posts and the number of staff shown in **Table C.4.7.** The landfill operation and maintenance carried out by 17 staff at present will require 36 persons in 2030.

Table C.4.7 Operation and Maintenance Staff for Sanitary Landfill Management

Operation and Maintenance Staff	Present	2018	2024	2030
Senior Operation Manager	1	1	1	1
Landfill Manager[*1]	1	1	1	1
Assistant Landfill Manager[*1]	1	1	1	1
Data Entry Operators	3	3	3	3
Mechanical & Electrical Supervisor	1	1	1	1
Field Supervisor	1	4	4	4
Landfill Machine Operator	3	7	11	17
Security Guard	2	4	4	4
Sanitary Worker	4	4	4	4
Total	17	26	30	36

Note: [*1] This stands for the staff belonging to the GWMC head office.

(6) Improvement Work of the Existing Landfill in Gondlanwala

Improvement work shall be implemented immediately after funding by the Punjab Government or the latest in the beginning of 2016.

Improvement work is aiming at providing the required minimum functionality to the existing disposal site for upgrading the landfill operation. The improvement work consists of the following major works:

- Backfilling the bottom of the landfill area by clayey sand;
- Rehabilitation of ramp and construction of intermediate dike, approach road and unloading area in the bottom of the landfill area;
- Installation of leachate collection mains, leachate pond and leachate circulation system;
- Installation of landfill gas vent system; and
- Improvement of existing access road.

(7) Safety Closure of the Landfill Site in Gondlanwala

Safe closure work of Gondlanwala is scheduled to be carried out in 2018 after the completion of the Bhakhraywali disposal facilities.

The disposal site where landfill activities have been completed shall be closed properly for the safe storage of filled waste and prevention of pollution by leachate or methane gas resulting from the decomposition and degradation of the waste. The safe closure plan is composed of the physical closure of facilities of the landfill site focussing on the post-closure use of the land, and the post-closure monitoring and management activities to be proposed later in this subsection. The major facilities of Gondlanwala disposal site will be constructed under the improvement work in 2016. The items for safe closure work will be the following:

- Construction of maintenance road;
- Construction of perimeter fence and gates;
- Installation of landfill gas vent system; and
- Final earth cover.

(8) Safety Closure of the Landfill Site in Chianwali

Safe closure of Chianwali disposal site is scheduled to be carried out in 2018. The concept of safe closure of the landfill site in Chianwali is the same with that of the Gondlanwala disposal site. Since the landfill operation in Chianwali has been continuing without any appropriate landfill facilities, the major facilities required for safe closure of the site shall comprise of the following works:

- Grading, levelling and transferring waste layer;
- Construction of maintenance road;
- Improvement of existing fence and installation of entrance gate;
- Installation of leachate collection pipes;
- Construction of leachate pond, leachate circulation pump well and circulation pipes;
- Construction of monitoring wells; and
- Final earth cover.

(9) Monitoring of Final Disposal in Bhakhraywali

Monitoring of landfill of Bhakhraywali disposal site is carried out in parallel with the operation and maintenance work scheduled to start in 2018.

The monitoring work consists of the activities of regular monitoring of landfill facilities and observation of the parameters related with stability of filled-waste layer. The environmental

monitoring plan for the regular monitoring and test of environmental quality parameters is proposed separately under ***Volume 2, Supporting Report Section H: Environmental and Social Considerations***, accordingly, the monitoring work describes herein do not include those activities related with monitoring of the environmental quality parameters. The monitoring work of final disposal in Bhakhraywali shall be carried based on the following items.

- Monitoring of landfill facilities, machine and equipment, and
- Monitoring of status of stability of landfill layer including the rate of subsidence of landfill layer and temperature of landfill layer.

(10) Post-Closure Monitoring of Gondlanwala and Chianwali

The post-closure monitoring activities for Gondlanwala and Chianwali shall start right after the completion of the safe closure work at the respective sites at the end of 2018.

The post-closure monitoring for the respective sites shall be carried out in compliance with the activities for the facility management stated in **(5), Operation and Maintenance of Landfill Facilities** and for the monitoring work stated in **(9), Monitoring of Final Disposal in Bhakhraywali.**

4.4.3 Mid-Term Plan (2019-2024)

(1) Operation and Maintenance of Landfill Facilities

The operation and maintenance of the sanitary landfill facilities shall be in accordance with the requirements stated in **Subsection 4.4.2 (5), Operation and Maintenance of Landfill Facilities**, in the Short-Term Period.

(2) Monitoring of Final Disposal in Bhakhraywali

Monitoring of the final disposal activities shall be in accordance with the requirements stated in **Subsection 4.4.2 (9), Monitoring of Final Disposal in Bhakhraywali**, Short-term Period.

(3) Post-closure Monitoring of Gondlanwala and Chianwali

Monitor and maintain the closed sites in accordance with the requirements stated in **Subsection 4.4.2 (10), Post-closure Monitoring of Gondlanwala and Chianwali**.

(4) Engineering Service for Sanitary Landfill Facilities (Stage 2)

Engineering service shall be carried out in or before 2021. The site shall be divided into three sections for the phased development of Stage 2 to Stage 3 sanitary landfill facilities. Then the engineering service shall be carried out for the area of Stage 2 sanitary landfill facilities. The engineering company shall carry out the services in accordance with the requirements stated in **Subsection 4.4.2 (2) Engineering Service for Sanitary Landfill Facilities (Stage 1)**, Short-Term Period.

(5) Construction of Sanitary Landfill Facilities (Stage 2)

GWMC shall call the tender for the construction of Stage 2 Sanitary landfill facilities in 2021 and complete the facilities by the end of 2022. The construction work shall be carried out in accordance with the requirements stated in **Subsection 4.4.2 (3), Construction of Sanitary Landfill Facilities (Stage 1)**.

(6) Procurement of Additional Landfill Machine

Procurement of additional landfill machine is required to dispose of the increased incoming waste amount. In addition, the superannuated landfill machines shall be replaced as well. The types of landfill machines and the number of units for procurement are listed as follows:

- Two (2) units of Bulldozer (Chain Dozer);
- One (1) unit of Wheel Dozer;
- One (1) unit of Excavator; and
- Three (3) units of Bucket Tractor for replacement.

(7) Site Selection of Sanitary Landfill Site (Stage 2 and Stage 3)

Prior to the commencement of the activities of **Subsection 4.4.2 (4) Engineering Service for Sanitary Landfill Facilities (Stage 2)**, GWMC shall procure the land of 50-75 ha for development of Stage 2 to Stage 3 sanitary landfill facilities in the adjacent area or the area nearby the Stage 1 site. The site selection must be started in or before 2020 and completed in the middle of 2020.

(8) Procurement of Sanitary Landfill Site (Stage 2 and Stage 3)

Procurement of site for development of sanitary landfill facilities for Stage 2 and Stage 3 shall be completed by the end of 2020 to enable the start of engineering services on time.

4.4.4 Long-Term Plan (2025-2030)

(1) Operation and Maintenance of Landfill Facilities

Operation and maintenance of the sanitary landfill facilities shall be in accordance with the requirements stated in **Subsection 4.4.2 (5), Operation and Maintenance of Landfill Facilities**, Short-Term Period.

(2) Monitoring of Final Disposal in Bhakhraywali

Monitoring of the final disposal activities shall be in accordance with the requirements stated in **Subsection 4.4.2 (9), Monitoring of Final Disposal in Bhakhraywali**, Short-Term Period.

(3) Post-Closure Monitoring of Gondlanwala and Chianwali

Monitoring and maintenance of the closed sites shall be in accordance with the requirements stated in **Subsection 4.4.2 (10), Post-Closure Monitoring of Gondlanwala and Chianwali**.

(4) Engineering Service for Sanitary Landfill Facilities (Stage 3)

Engineering service shall be carried out in or before 2025 for Stage 3 sanitary landfill facilities. The engineering company shall carry out the services in accordance with the requirements stated in **Subsection 4.4.2 (2), Engineering Service for Sanitary Landfill Facilities (Stage 1)**, Short-Term Period.

(5) Construction of Sanitary Landfill Facilities (Stage 3)

GWMC shall call the tender for construction of Stage 3 Sanitary landfill facilities by the middle of 2025 and complete the facilities by the end of 2027. The construction work shall be carried out in accordance with the requirements stated in **Subsection 4.4.2 (3), Construction of Sanitary Landfill Facilities (Stage 1).**

(6) Replacement and Procurement of Landfill Machinery

Procurement of additional landfill equipment is required for disposal of the increased incoming waste amount. In addition, the superannuated landfill equipment shall be replaced as well. The types of landfill equipment and the number of units for procurement are listed as follows:

- Five (5) Bulldozers (Chain Dozers) including two (2) replacements;
- Three (3) Wheel Dozers including one (1) replacement; and
- Two (2) Excavators including one (1) replacement.

4.5 Implementation Schedule of Final Disposal Plan

The implementing schedule is divided into three phases. There are many activities concentrated in Short-Term period from 2016 to 2018 including the construction of Bhakhraywali sanitary landfill facilities, improvement work and safe closure of Gondlanwala disposal site and safe closure of Chianwali disposal site. The operation and maintenance of Bhakhraywali sanitary landfill will also start in this period, as shown in **Figure C.4.7.**

The major activities in the Mid-Term period from 2019 to 2024 are the operation and maintenance of the sanitary landfill facilities in Bhakhraywali and post-closure monitoring for Gondlanwala and Chianwali sites. Furthermore, the activities for procurement of new landfill and the development of Stage 2 landfill facilities are carried out.

During the Long-Term period from 2025-2030, the major activities are the operation and maintenance of the sanitary landfill facilities in Bhakhraywali and post-closure monitoring for Gondlanwala and Chianwali sites. The activities for development of Stage 3 landfill facilities are also scheduled in this period.

4.6 Project Cost of Final Disposal Plan

Table C.4.8 shows the project cost for the Master Plan and **Figure C.4.8** shows the Project Cost and Responsibility under the Final Plan. The estimated total cost of the final disposal plan for 15 years is estimated at Rs. 4,883 Million.

Figure C.4.7 Implementation Schedule of the Final Disposal Plan

Table C.4.8 Implementation Cost of the Final Disposal Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 2: Final Disposal Plan																	
Short-Term Plan																	
S-2-1	Procurement of Sanitary Landfill Site	150,000	150,000														
S-2-2	Engineering Service for Sanitary Landfill Facilities (Stage 1)	99,680	49,840	49,840													
S-2-3	Construction of Sanitary Landfill Facilities (Stage 1) in Bhaikhrywall	996,802	492,751	504,051													
S-2-4	Procurement of Landfill Machinery	70,350	31,500	38,850													
S-2-5	Operation and Maintenance of Landfill Facilities	72,151	18,659	21,859	31,633												
S-2-6	Improvement Work of the Existing Landfill in Gondianwala	55,902	55,902														
S-2-7	Safe Closure of the Landfill Site in Gondianwala	26,196			26,196												
S-2-8	Safe Closure of the Landfill Site in Chianwali	34,544			34,544												
S-2-9	Monitoring of Final Disposal in Bhaikhrywall	GWMC															
S-2-10	Post-Closure Monitoring of Gondianwala and Chianwali Landfill Sites	GWMC															
	Sub-Total	1,505,625	798,652	614,600	92,363												
Mid-Term Plan																	
M-2-1	Operation and Maintenance of Landfill Facilities	268,857				32,831	31,647	32,883	33,637	94,533	43,786						
M-2-2	Monitoring of Final Disposal in Bhaikhrywall	GWMC															
M-2-3	Post-closure Monitoring of Gondianwala and Chianwali Disposal Sites	GWMC															
M-2-4	Engineering Service for Sanitary Landfill Facilities (Stage 2)	97,408						48,704	48,704								
M-2-5	Construction of Sanitary Landfill Facilities (Stage 2)	996,802						492,751	504,051								
M-2-6	Procurement of Additional Landfill Machinery	87,450								87,450							
M-2-7	Site selection of Sanitary Landfill Site (Stage 2 - Stage 3)	GWMC															
M-2-8	Procurement of Sanitary Landfill Site (Stage 2 - Stage 3)	300,000					300,000										
	Sub-Total	1,750,548				32,831	331,647	574,008	586,392	181,983	43,786						
Long-Term Plan																	
L-2-1	Operation and Maintenance of Landfill Facilities	357,879										44,779	45,786	106,567	50,431	51,606	58,710
L-2-2	Monitoring of Final Disposal in Bhaikhrywall	GWMC															
L-2-3	Post-closure Monitoring of Gondianwala and Chianwali Landfill Sites	GWMC															
L-2-4	Engineering Service for Sanitary Landfill Facilities (Stage 3)	97,408										48,704	48,704				
L-2-5	Construction of Sanitary Landfill Facilities (Stage 3)	996,802										492,751	504,051				
L-2-6	Replacement and Procurement of Landfill Machinery	174,300														174,300	
	Sub-Total	1,626,389										586,234	598,521	106,567	50,431	226,906	58,710
	Grand Total	4,882,562	798,652	614,600	92,363	32,831	331,647	574,008	586,392	181,983	43,786	586,234	598,521	106,567	50,431	226,906	58,710

Programme No.	WBS No.	WBS	Budgetary Arrangment (Required=●)	Total Budget (Thousand Rs.)	Responsibility Assignment Matrix: M=Main Responsibility, S=Sub Responsibilities, B=Budgetary Arrangement, L=Legal Action, P=Participation in Discussions																
					GWMC/Operation Unit	GWMC/P&C Unit	GWMC/Financial Unit	GWMC/HR & Administration Unit	City District Government Gujranwala (CDGG)	The Urban Unit, Government of the Punjab	P&D Dept., Government of the Punjab	Local Gov't Dept., Government of the Punjab	Environment Protection Department (EPD)	Donor Organisations	Private Contractor/Consultant	Recyclers	CBOs & NGOs	Waste Pickers	PAPs around Gondianwala Disposal Site	PAPs around Bhakhraywall Disposal Site	Gujranwala Citizens
Programme 2: Final Disposal Plan																					
Short-Term Plan																					
	S-2-1	Procurement of Sanitary Landfill Site	●	150,000	S	M	B		L		B					P			P	P
	S-2-2	Engineering service for Sanitary Landfill Facilities (Stage 1)	●	99,680	M	B	B				B				M						
	S-2-3	Construction of Sanitary Landfill Facilities (Stage 1) in Bhakhraywall	●	996,802	M	B	B		L		B		L		M		P			P	P
	S-2-4	Procurement of Landfill Machine	●	70,350	M	B	B				B				M						
	S-2-5	Operation and Maintenance of Landfill Facilities	●	72,151	M	B	B	S			B		L				P			P	P
	S-2-6	Improvement work of the Existing Landfill in Gondianwala	●	55,902	M	B	B				B						P			P	P
	S-2-7	Safety Closure of the Landfill Site in Gondianwala	●	26,196	M	B	B				B						P			P	P
	S-2-8	Safety Closure of the Landfill Site in Chianwall	●	34,544	M	B	B				B						P			P	P
	S-2-9	Monitoring of Final Disposal in Bhakhraywall		GWMC	M				S				L				P			P	P
	S-2-10	Post-closure Monitoring of Gondianwala and Chianwall Disposal Sites		GWMC	M				S				L				P			P	P
		Sub-Total		1,505,625																	
Mid-Term Plan																					
	M-2-1	Operation and Maintenance of Landfill Facilities	●	268,887	M	B	B	S			B		L				P			P	P
	M-2-2	Monitoring of Final Disposal in Bhakhraywall		GWMC	M				S				L				P			P	P
	M-2-3	Post-closure Monitoring of Gondianwala and Chianwall Disposal Sites		GWMC	M				S				L				P			P	P
	M-2-4	Engineering Service for Sanitary Landfill Facilities (Stage 2)	●	97,408	M	B	B				B				M						
	M-2-5	Construction of Sanitary Landfill Facilities (Stage 2)	●	996,802	M	B	B		L		B		L		M		P			P	P
	M-2-6	Procurement of Additional Landfill Machine	●	87,450	M	B	B				B				M						
	M-2-7	Site selection of Sanitary Landfill Site (Stage 2 - Stage 3)		GWMC	S	M			L								P			P	P
	M-2-8	Procurement of Sanitary Landfill Site (Stage 2 - Stage 3)	●	300,000	M	B			S		B				P						
		Sub-Total		1,750,548																	
Long-Term Plan																					
	L-2-1	Operation and Maintenance of Landfill Facilities	●	357,879	M	B	B	S			B		L				P			P	P
	L-2-2	Monitoring of Final Disposal in Bhakhraywall		GWMC	M				S				L				P			P	P
	L-2-3	Post-closure Monitoring of Gondianwala and Chianwall Disposal Sites		GWMC	M				S				L				P			P	P
	L-2-4	Engineering Service for Sanitary Landfill Facilities (Stage 3)	●	97,408	M	B	B				B				M						
	L-2-5	Construction of Sanitary Landfill Facilities (Stage 3)	●	996,802	M	B	B		L		B		L		M		P			P	P
	L-2-6	Replacement and Procurement of Landfill Machine	●	174,300	M	B	B				B				M						
		Sub-Total	●	1,626,389																	
		Grand Total		4,882,562																	

Figure C.4.8 Project Cost and Responsibility under Final Disposal Plan

5. FORMULATION OF THE ACTION PLAN

5.1 Selection of the Priority Project

The priority projects are defined as the projects proposed for the short-term period of the Master Plan, which will be developed to the action plans in this chapter. Based on the detail discussions described in previous **Chapter 4,** the following projects are thus selected as the priority projects:

1. Project for Procurement of Sanitary Landfill Site
2. Project for Engineering Service for Sanitary Landfill Facilities (Stage 1)
3. Project for Construction of Sanitary Landfill Facilities (Stage 1) in Bhakhraywali
4. Project for Procurement of Landfill Machinery
5. Project for Operation and Maintenance of Landfill Facilities
6. Project for Improvement Work of the Existing Landfill in Gondlanwala
7. Project for Safe Closure of the Landfill Site in Gondlanwala
8. Project for Safe Closure of the Landfill Site in Chianwali
9. Project for Monitoring of Final Disposal in Bhakhraywali
10. Project for Post-Closure Monitoring of Landfill Sites in Gondlanwala and Chianwali

5.2 Project for Procurement of Sanitary Landfill Site

Negotiation of acquisition of the construction site has been made and they have almost reached agreement for the transaction at this stage, but the site boundary line shown in **Figure C.4.3** is suspected the credibility of the border because there is a part that is not along the lot of the existing farmland. Confirmation of the site boundary line shall be carried out again under the presence of the landlord(s) for the witness and acceptance of the site boundary for preparation in advance for proceeding the signing of the acquisition contract and payment immediately after approval of the 2015/2016 budget.

The road of both sides of banks along the irrigation canal, irrigation bank road, from Ali-Pur Chatha Road shown in **Figure C.4.4** is used for an access road. The road will be used with one-way traffic for the south side of the irrigation canal for access road and the north side road of the irrigation canal for exit road. The width of existing bridge over the irrigation canal is narrow and not suitable for the passage of large vehicles. A new bridge with a minimum 40tons traffic load will be constructed to cross the irrigation canals. In addition, from the fact that the north side of the irrigation bank road is narrow in several sections, the field survey shall be conducted out carefully to determine the boundary for the road improvement work. Permission of Irrigation Department is a must for the road improvement work, construction of bridge and use of the road for the purpose of waste management services. By the end of July 2015, an application document has submitted for obtaining the approval. All the processes for the approval and/or agreement must be completed until the execution of the project budget will be possible. And, all the procurement procedures must be completed by the middle of 2016 when the construction work will be commenced.

5.3 Project for Engineering Service for Sanitary Landfill Facilities (Stage 1)

GWMC will organize a project management unit (PMU) deployed by a chief engineer, two assistant engineer and two office clerks. The PMU will conduct firstly the consulting service contract with an engineering service company for performing a role of the project consultant. The consultant will

conduct, on behalf of the project proponent, a series of step-wise works required for implementation and management of the construction project of Bhakhraywali sanitary landfill facilities. The consultant will also advice, assist and support the project proponent to make timely and appropriate approval required from time to time in the course of implementation of the project. The project for engineering service shall be started at the latest in the beginning of 2016 and complete the design related work by the middle of 2016. Thereafter, the construction supervisory services will be mobilised and continued until the end of the completion of the construction work in the first quarter of 2018. Construction project of Bhakhraywali will be implemented mainly by the three parties, GWMC, consultants and contractors, by performing their own roles given in each step of the implementation process presented in **Figure C.5.1**.

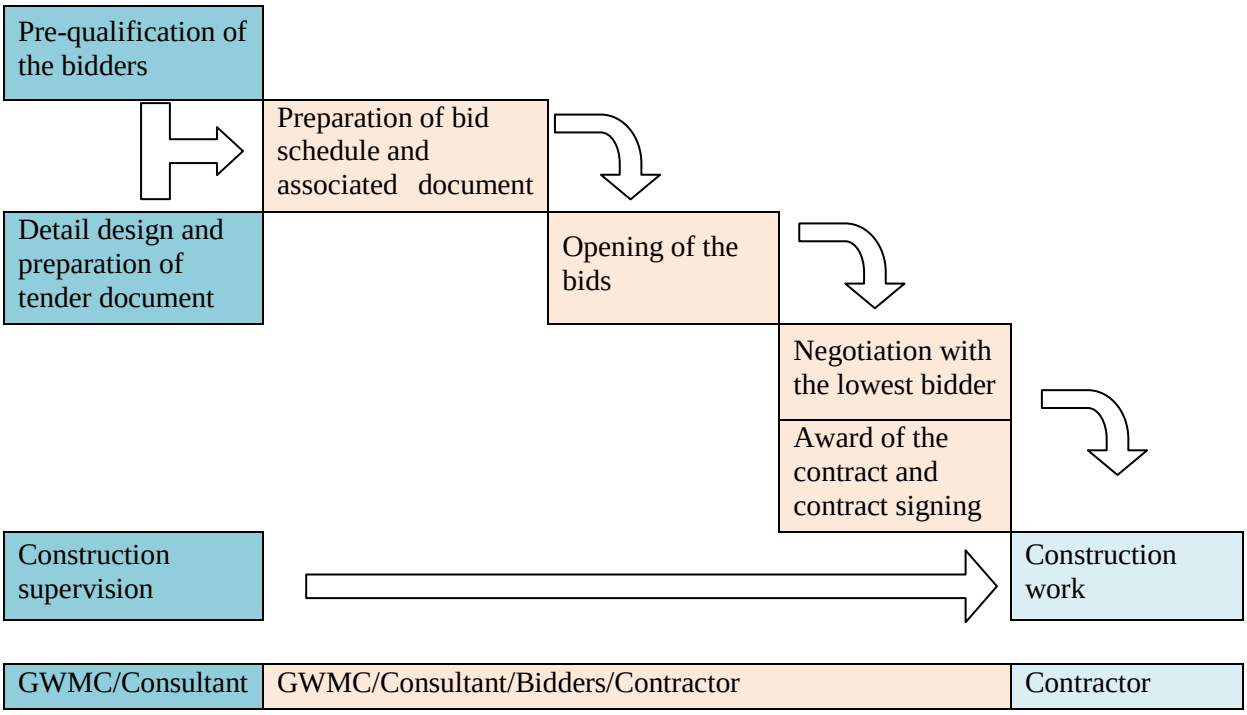


Figure C.5.1 Flow Chart for Implementation of Bhakhraywali SLF Project

5.3.1 Preliminary Design and Detail Design

In order to secure the cumulative landfill volume of 9 million to 10 million cubic metres (m^3) at 2030 by the 3 stage development plan as shown in the Master Plan, the design landfill volume for the 1st stage development shall have the landfill capacity approximately in the range of 3-3.5 million m^3. The design is carried out for the purpose of performing an appropriate landfill facility capable of controlling the negative impacts on the environment and society by the function of the sanitary landfill facilities. The construction site lies along the main irrigation canal and the canal bank road is used for the access road for farm land in the adjacent area. By providing a buffer zone along the canal bank road, it is effective to mitigate the probable environmental impacts of the disposal site. More than half of the construction site is a borrow pit of about 9m lower than the surrounding ground level and the lower section is ponding. These conditions mentioned above shall be taken into consideration in practicing the conceptual design.

The consultant shall perform the preliminary design based on the conceptual design of the Action Plan that is presented in the following subsections together with the descriptions of the facilities and specifications required for the sanitary landfill facilities. The preliminary design must be subject for approval by the project proponent, GWMC. Based on the approved preliminary design drawings, the consultant prepares the detail design drawings that make up the tender document to facilitate accurate cost estimates for the construction contract tender. The detail design work includes preparation of quantity take-off, unit cost analysis, priced bill of quantities, design criteria, report and calculation in addition to the tender drawings.

(1) Improvement of Access Road along the Irrigation Canal

Description	Canal bank road along the main irrigation canal is used for the access road of Bhakhraywali SLF site for connecting with Ali-Pur Chatha road. Improvement work of Canal Bank Road is carried out to secure an all-weather access road for large waste collection vehicles.
Specifications/ Dimension	Total length for improvement:5,200m for both side of the canal,
	Stripping of existing road: 7,020 m^3, 30 cm deep for both side of the canal
	Reconstruction of subbase: 23,400 m^2, 30 cm deep for both side of the canal
	Asphalt concrete pavement: 20.800 m^2 , 50mm thick for both side of the canal
	Bridge crossing the irrigation canal, 8m(W) x 20m (L) for 40 ton traffic load,

(2) Earth Work

Description	Earth work for excavation, filling and compaction work is carried out to construct waste containment, intermediate dike, approach road, perimeter road and for constructing other associated facilities.
Specifications/ Dimension	Excavation of containment for waste: 648,000 m^3
	Earth fill at water ponding area: 177,000 m^3
	Earth fill and compaction for intermediate dike: 6,600 m^3
	Earth fill and compaction for approach road: 7,040 m^3

(3) Pavement Work for Roads

Description	Entrance road and parking area are subjected for asphalt concrete pavement while approach road, intermediate dike and perimeter road are subjected for compacted gravel pavement.
Specifications/ Dimension	Asphalt concrete pavement for entrance road: 1,000 m^2, 5m (W) x 50mm thick
	Asphalt concrete pavement for parking area: 1,460 m^2, 30mm thick
	Compacted gravel pavement for perimeter road: 6,000 m^2, 3m(W) x 15cm thick
	Compacted gravel pavement for approach road and intermediate dike: 3,100m^2, 3m (W) x 15cm thick

(4) Impermeable Layer Work

Description	Double liner system comprised of clayey soil liner or bentonite mixed soil liner and geomembrane (HDPE) liner is installed for the impermeable layers in the bottom and the slope of the waste containment structures for preventing infiltration of leachate into underground.
Specifications/ Dimension	Bottom clayey soil liner:153,400 m^2,60cm depth, permeability less than $1x10^{-7}$cm/sec
	Bottom HDPE sheet liner: 153,400m^2, 1.5mm or 60Mil thick
	Slope HDPE sheet liner: 44,000m^2, 1.5mm or 60Mil thick,

(5) Installation of Leachate Collection & Circulation System

Description	Leachate collection system comprised of reinforced concrete main conduit and lateral pipe is installed in the bottom of waste containment. The leachate collection conduit and lateral pipe is covered with crushed stone and gravel to prevent foreign matters entering into the conduit/pipe. Leachate circulation system comprised of leachate storage pond, pump sums, circulation pumps, leachate circulation force main with spray nozzles is installed for evapotranspiration of leachate within the landfill site to structure the closed system.
Specifications/ Dimension	Trenching work for installation of leachate collection conduit/pipe: 13,800 m^3
	Reinforced concrete main conduit: 0.6m (W) x0.7m (D) x 1,260m (L)
	Perforated PE lateral pipes: Dia. 150mm x 4,500m
	Gravel layer, 25-50mm : 55,300m^3 for main conduit and lateral pipes
	Crushed stone layer, 37.5-90mm: 15,700 m^3 for main conduit and lateral pipes
	RC Junction pit for main conduit: 6 places, 2.0 (W) x 2.0 (L) x3.0 (Avg. D) m
	RC Leachate circulation pump well: 2.5(W) x 3.5 (L) x 3.9(D) m
	Leachate circulation pump equipment: 2units x 15kW each, including sensors & panel
	Leachate circulation force main (PVC): Dia. 150mm x 1,800m incl. spray nozzles
	Estimated leachate flow: 430m^3/day (mean), 1,550m^3/day (Maximum)

Reference Information: Estimation of Leachate Flow

A. Weather Data

The data concerning the weather factors including temperature, rainfall and evaporation is the basic for the estimation of leachate volume being generated from the landfill. Therefore, the rainfall and temperature data of Sialkot station/observatory from 1994 to 2013 and the evaporation data from WRRI (Water Resources Research Institute) field station, NARC (National Agricultural Research Centre) over the years from 1988 to 2011 were collected. Based on these data, the month-wise average for each weather condition was calculated as shown below.

Monthly Average Weather Data in the Past

Month	Rainfall (1994-2013)	Evaporation (1988-2011)	Temperature (1994-2013)		
	Monthly Avg. Rainfall	Monthly Avg. Evaporation	Monthly Avg. of Daily Max. Temp.	Monthly Avg. of Daily Min. Temp.	Avg. Temp. (^{0}C)
	(mm/month)	(mm/day)	(^{0}C)	(^{0}C)	
1	44.5	1.5	17.4	5.2	11.3
2	52.6	2.4	21.1	8.3	14.7
3	41.0	3.5	26.8	13.2	20.0
4	27.2	5.0	33.3	18.2	25.8
5	17.4	8.1	38.6	23.1	30.8
6	71.1	8.4	38.8	25.5	32.2
7	305.5	5.9	33.2	25.6	29.4
8	305.3	4.6	33.1	25.3	29.2
9	76.4	5.0	33.1	23.4	28.2
10	32.8	7.1	31.0	17.6	24.3
11	9.0	2.3	26.2	10.8	18.5
12	13.7	1.4	20.4	6.1	13.2
Total	996.7	55.3	353.0	202.3	277.6
Avg.	83.1	4.6	29.4	16.9	23.1
Max	305.5	8.4	38.8	25.6	32.2
Min	9.0	1.4	17.4	5.2	11.3

Parameter	Formula	Calculated Value	Reference Formula Name
Effective Evapotranspiration (ET)	$ET = P - CP^2$ where: P = Total annual rainfall over the watershed = 996.75 mm C = 1 / (0.8 + 0.14T)1000 = 0.000247893 Where: T = Average annual temperature = 23.1 ^{0}C	750.50 mm/yr	Method Coutagne $ET = P - (P^2 / (0.8 + 0.14T))$ Where: P = Annual precipitation in mm T = Mean annual temperature in ^{0}C

B. Leachate Catchment Area

The total leachate catchment area of Bhakhraywali landfill was estimated to about 200,000 m^2 (20 hectares). According to final disposal plan, land filling will be done in two sections.

Section	Area (m^2)
1	Completed Landfill Area (A2) = 100,000 m^2
2	Landfill Area in Progress (A1) = 100,000 m^2

C. Estimation of Leachate Flow Rate from Bhakhraywali Landfill Site

C.1 Rainfall within Catchment Area

Parameter	Formula	Calculated Value	Reference Formula
Total Rainfall (RF)	RF = I*A/1000 where: I = Rainfall = 996.75 mm/year A = Total Landfill Area = 200,000 m^2	199349.6 m^3/year	Total precipitation volume = Average monthly precipitation * Total area

C.2 Yearly Leachate Generation Amount

Parameter	Formula	Calculated Value	Reference Formula
Leachate Generation Flow (Q)	Q = (I-E)*A/1000-So where: I = Rainfall = 996.75 mm/yr E = Effective evapotranspiration = 751 mm/yr A = Total landfill area = 200,000 m^2 So = Surface stormwater run-off from the landfill area = 1 (Assuming)	49249 m^3/yr	Water Balance Equation Lo = [ER(A) + LW + IRCA + ER(l)] - [aW] where: Lo = leachate produced (m^3) ER = effective rainfall (use actual rainfall (R) for active cells) (m) A=area of cell (m^2) LW= liquid waste (also includes excess water from sludge) (m^3) IRCA = infiltration through restored and capped areas (m)l= surface area of lagoons (m^2) a=absorptive capacity of waste (m^3/t) W=weight of waste deposited (t/a) Water Balance Equation L = P-ET-R Where, L: Denotes the leachate generated P: Volume of precipitation ET: Evapotranspiration loss R: Volume of surface runoff L v = P + S - E – AW Where Lv is the leachate volume, P is the precipitation volume, S is the volume of pore liquid squeezed from the waste, E is the volume lost by evaporation and AW is the volume of liquid lost through absorption in waste.

C.3 Daily Leachate Generation Amount

Parameter	Formula	Calculated Value	Reference Formula
Leachate Volume in the Landfill Area in Progress (Q1)	Q1=C1/1000*I*A1 where: A1 = Landfill area in progress = 100,000 m^2 I = 9.855161 (Using Max Rain fall month in 1994-2013 average) C1 = Run-off coefficient of leachate in the landfill area in progress = C1=1-(E1/I) = 0.787 where: E1 = 2.1	775.6 m^3/day	Rational Method Q = CIA Q = Runoff (m^3/sec) C = Runoff coefficient I = Design rainfall intensity (mm/hr) A = Area of landfill surface
Leachate Volume in the completed Landfill Area (Q2)	Q2=C2/1000*I*A2 where: A2 = Completed landfill area = 100,000 m^2 C2 = Run-off coefficient of leachate in the completed landfill area = C1*(1-((1000*So/A2)/I-E1)) = 0.786 where: So = Surface storm water run-off from the landfill area = 1	774.6 m^3/day	Rational Method Q = CIA Q = Runoff (m^3/sec) C = Runoff coefficient I = Design rainfall intensity (mm/hr) A = Area of landfill surface

C.4 Average and Maximum Leachate Generation Amount

Parameter	Formula	Calculated Value	Reference Formula
Average Leachate	Q (Avg.) = (1/1000) I (C1A1+C2A2)	430 m^3/day	Rational Method

Parameter	Formula	Calculated Value	Reference Formula
Flow	where: I = Average rainfall = 2.7 mm/day C1 = Run-off coefficient of leachate in the landfill area in progress = 0.787 A1 = Landfill area in progress = 100,000 m^2 C2 = Run-off coefficient of leachate in the completed landfill area = 0.786 A2 = Completed landfill area = 100,000 m^2		Q = CIA Q = Runoff (m3/sec) C = Runoff coefficient I = Design rainfall intensity (mm/hr) A = Area of landfill surface
Maximum Leachate Flow	Q (Max) = (1/1000) I (C1A1+C2A2) where: I = Maximum rainfall = 9.9 mm/day	1,550 m^3/day	Rational Method Q = CIA Q = Runoff (m3/sec) C = Runoff coefficient I = Design rainfall intensity (mm/hr) A = Area of landfill surface

(6) Installation of Gas Vent

Description	Install a landfill gas vent system. The system is comprised of crushed stone gabions and vertical self-supported perforated pipes for the initial set up. Then, the vertical pipes are extended and connected to the horizontal pipes as landfill layer increases, and remove landfill gases generated in the waste layer.
Specifications/ Dimension	Crushed stone gabion: 217 sets, 1.0m (W) x 1.0m (L) x1.0m (H) per set
	Vertical gas vent pipes: 217 sets, 4.0m (L) x Dia. 150mm perforated PVC pipe per set

(7) Building Work

Description	RC structure buildings are constructed for the associated facilities. Those buildings include site office & storage, weighbridge house and guard house.
Specifications/ Dimension	Site Office & Storage: 8.0m (W) x 24.0m (L), RC structure
	Weighbridge House: 4.0m (W) x 4.0m (L), RC structure
	Guard House: 2.0m (W) x 4.0m(L)

(8) Weighbridge Equipment

Description	Weighbridge equipment is installed for measuring incoming waste amount together with the information of vehicle types, collection area, etc. necessary for analysis of present SWM activities.
Specifications/ Dimension	Digital type load cell for 40 ton loading weight: 1 unit
	Scale foundation and platform: 1unit, 3m (W) x 12m (L)
	Computerized measuring device: 2 units including backup unit
	Software for statistical analysis of the record: 1 unit
	Stabiliser and UPS for minimum 3 hour operation: 1unit

(9) Power Supply and Lighting

Description	Installation of power supply system from the public line and wiring within the compound in addition to the indoor/outdoor lighting.
Specifications/ Dimension	Installation of power supply line to the site: 1 system
	Lighting for site office, weighbridge house and guard house: 1 system
	Outdoor lighting: 8 sets
	Gate lamps: 2 sets

(10) Associated Works

Description	Associated facilities/equipment are procured for performing sanitary landfill operation as intended.
Specifications/ Dimension	Perimeter fence: 2.0m (H) x 2,160m (L), chain link fence or brick wall fence
	Entrance/Exit gate:2 sets, 2.5m (H) x 6.0m (W) each
	Relocation of irrigation channel: 0.3m (w) x 0.3m (D) x 830m (L), RC channel
	Monitoring well-Shallow well: Dia.150mm x 20m (D) x 2 wells, incl. water sampling device

	Monitoring well-Deep well: Dia.150mm x 60m (D) x 2 wells, incl. water sampling device
	Washing bay with access road: 30.0m (w) x 30.0m (L), RC structure for wall & slab
	Garage for landfill machine: 24.0m (W) x 8.0m (L), asphalt pavement and RC roofing
	Landscaping and planting plants: 35,100 m^2

The conceptual design drawings of Bhakhraywali SLF facilities are presented from **Figure C.5.2** to **Figure C.5.5**.

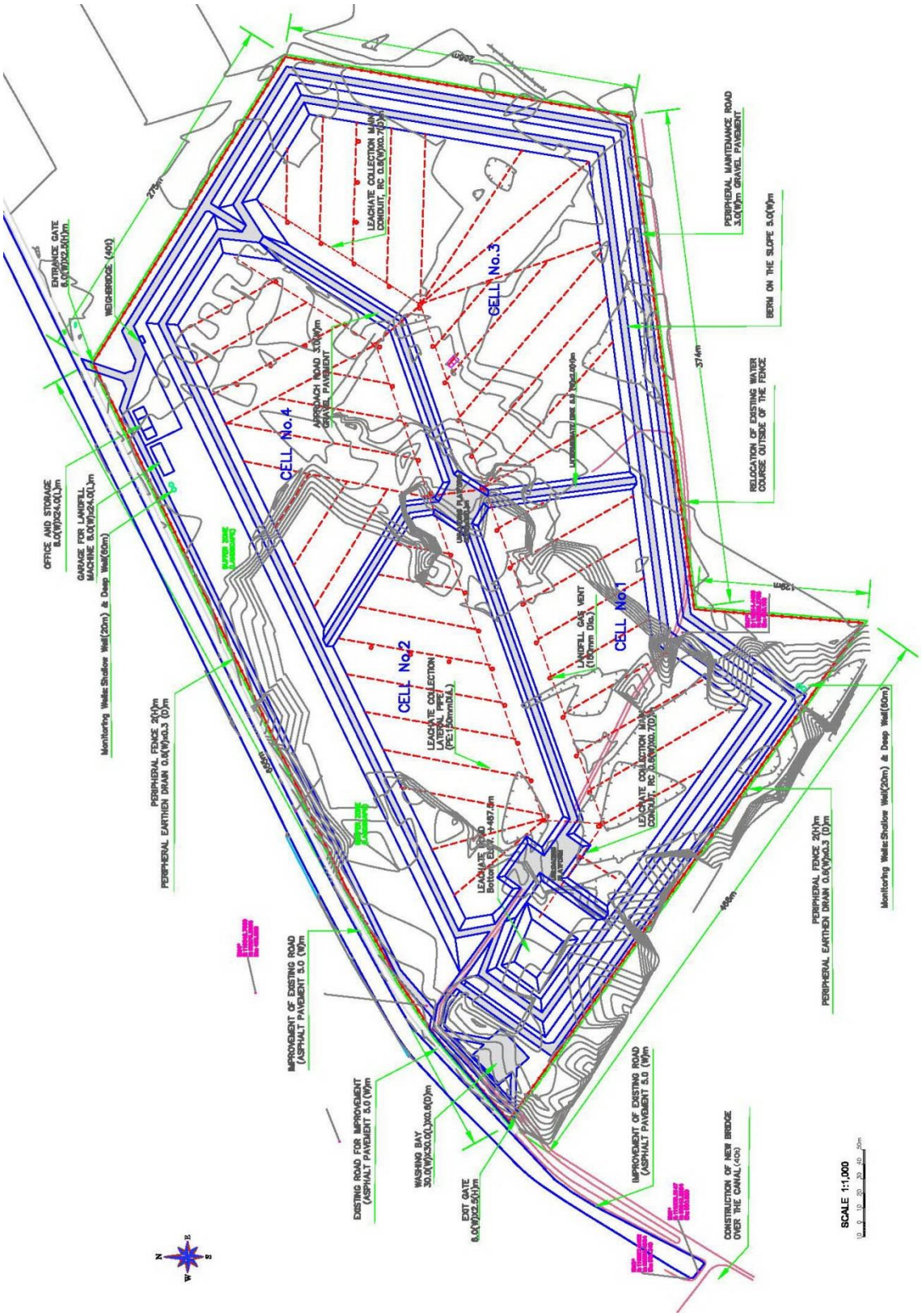


Figure C.5.2 Layout Plan of Bhakhraywali SLF Facilities

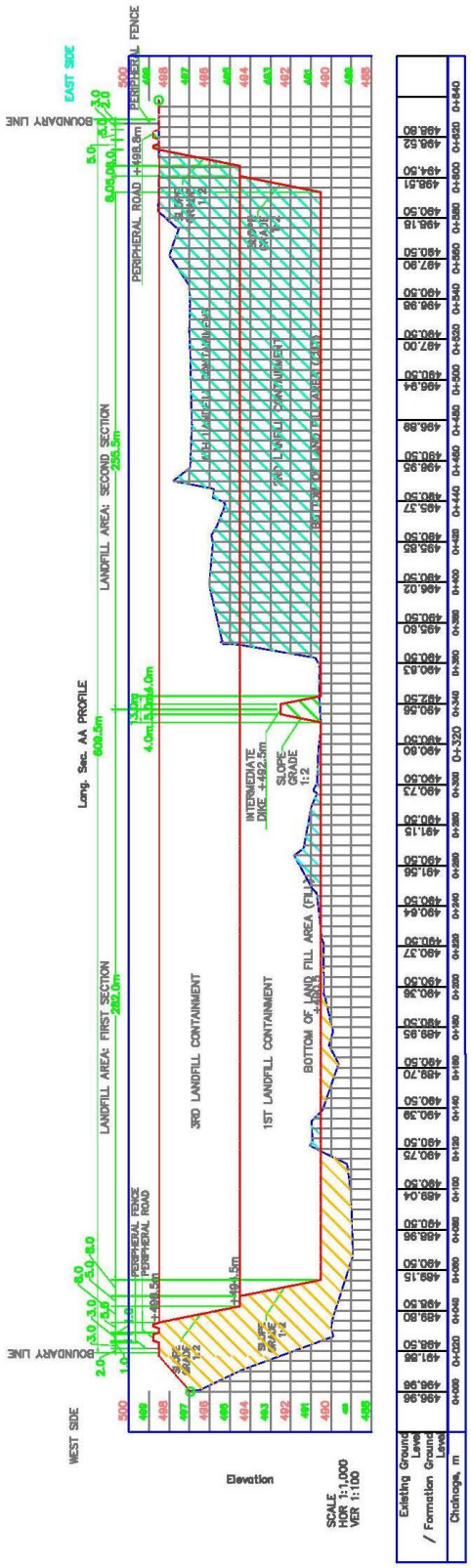


Figure C.5.3 Profile of Bhakhraywali SLF Facilities

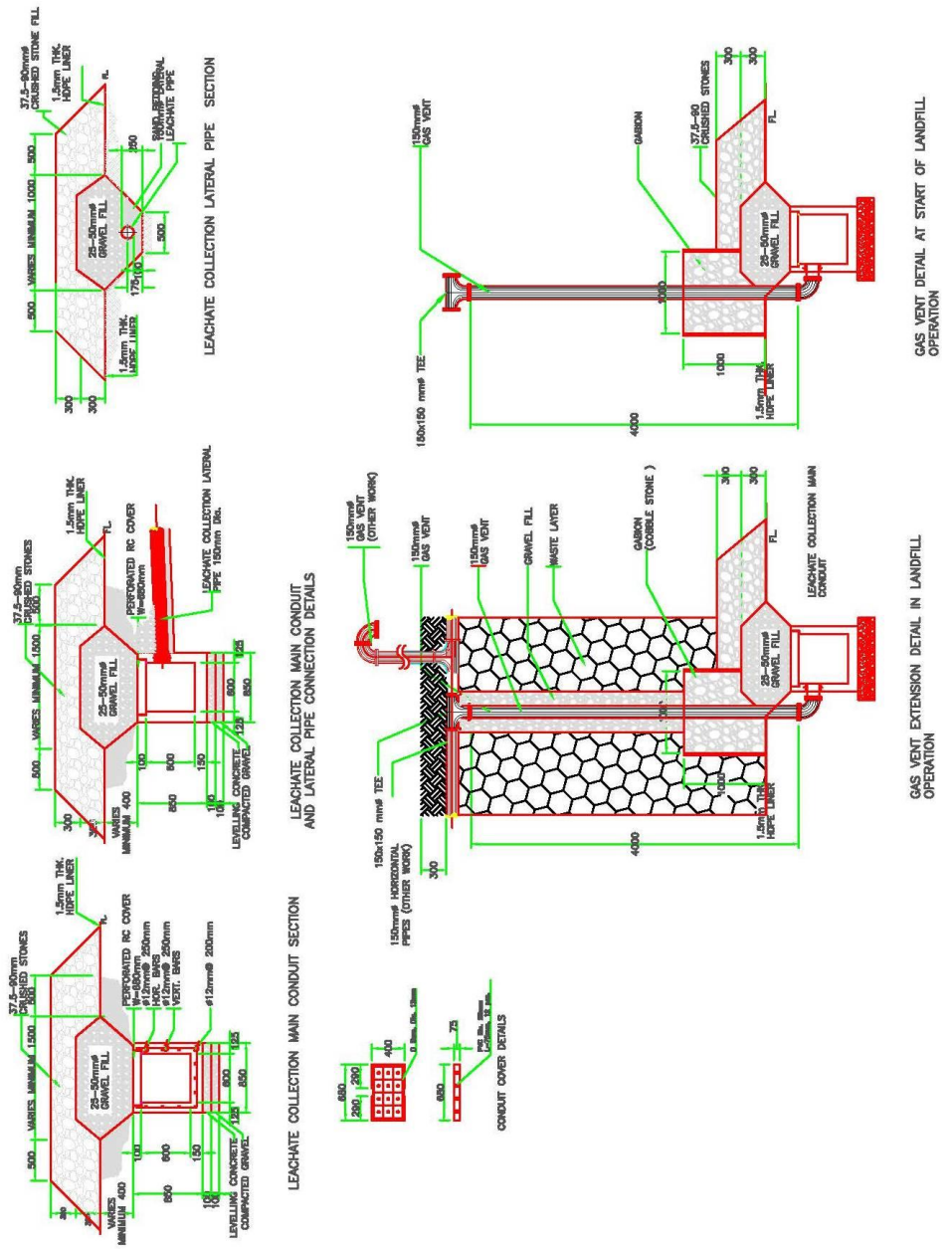


Figure C.5.4 Details of Major Facilities of Bhakhraywali SLF Facilities

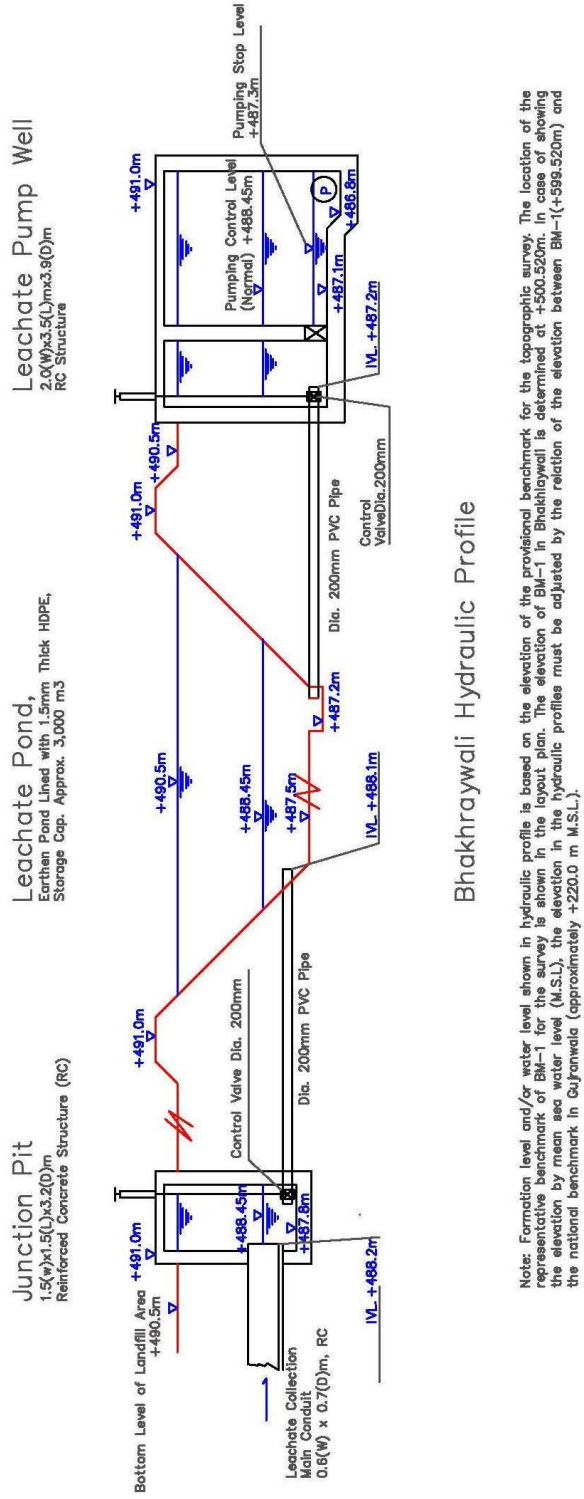


Figure C.5.5 Hydraulic Profile of Leachate Circulation System in Bhakhraywali SLF

5.3.2 Preparation of Tender Document

The consultants shall prepare the document of competitive bid for the construction of Bhakhraywali sanitary land facilities in the final stage of the design work. The tender document includes the following:

- Notice of pre-qualification announcement;
- Instruction to the tender;
- Contract document form;
- General conditions of contract and special provisions;
- Tender drawing;
- Technical specifications; and
- Tender schedule and bill of quantities.

In preparation of the contract document form and general conditions of contract, it is preferable to take into consideration the conditions of standard contract form of GWMC as much as possible.

5.3.3 Preparation of Bill of Quantities

The work for calculation of bill of quantities will be commenced with preparation of construction quantity take-off sheets of the facilities, equipment, devices and temporary works required to construct, install and procure for completing the construction work as intended in the design. Each item composing the bill of quantities shall be itemised to coincide with the regular payment items for the work done. The consultant also prepares the unit cost analysis/estimates for each item of the bill of quantities with reference to the latest market price announced by the government and the quotation from the manufacturers. The unit price must be clearly state the unit base and be separated with the costs for materials, labour, depreciation cost or rental fee, de re, The outputs under the work for preparation of bill of quantities include the following:

- Preparation of quantity take-off sheets;
- Preparation of unit cost analysis sheets;
- Preparation of bill of quantities without price for the tender document; and
- Preparation of priced bill of quantities, the engineer's estimate to the project proponent.

5.3.4 Support for Tender Evaluation

The consultant will carry out the following services in each process from pre-qualification of the interesting bidders until the signing of the construction work contract:

- Assist the project proponent for announcement of the prequalification and tender;
- Preparation of prequalification criteria and prequalification of the interesting bidders;
- Preparation of tender evaluation criteria and tender evaluation;
- Numerical check of the tender schedule and unit price of the lowest bidder; and
- Assist the project proponent for the tender negotiation.

5.3.5 Construction Supervision

The consultant will carry out the following services in the construction stage to assist/advice GWMC and the contractor to perform the construction work in accordance with the drawings, specifications and the construction time schedule:

- Evaluation of the construction plan prepared by the contractor;

- Evaluation of construction work drawings including drawings prepared by the contractor;
- Monitoring/Inspection of construction work for construction quantity and workmanship;
- Monitoring of progress of the construction work;
- Evaluation of the periodical payment document and report to the project proponent;
- Hold weekly/monthly meeting with the contractor;
- Preparation of punch list for project completion inspection and final check;
- Check of the as built drawings; and
- Assist the project proponent for issuance of the project completion certificate.

5.4 Project for Construction of Sanitary Landfill Facilities (Stage 1) in Bhakhraywali

Development of sanitary landfill facilities is divided into 3 stages under the Master Plan period from 2016 to 2018. In the first stage development or the action plan in other words, the landfill containment of 20 hectares is constructed together with the associated facilities. In addition, improvement of the existing canal bank road on both sides of the main irrigation canal and construction of new bridge are included in the first stage development work. The construction work period will take 15 to 18 months and the contractor shall complete the construction work by the end of 2017 or at the latest by the first quarter of 2018. The contractor shall construct, install and procure all the works presented in **Section 5.3** in addition to fulfilling the liabilities presented in the following subsection.

5.4.1 Implementation of Construction Work

(1) General Obligation of the Contractor

The contractor shall carry out the construction properly in accordance with the contract document including the contract drawings, technical specifications, contract agreement, etc. For the purpose, the contractor shall provide all supervision, labor, materials, plant and contractor's equipment, which may be required to complete the construction work.

Change order and/or extra work order may be issued by the project proponent/consultant for the variation order. The contractor shall carry out the works of variation order upon agreement with the project proponent for the time frame and the additional payment.

During implementation of the construction work, the contractor and his subcontractors shall abide at all times by all labor laws including safety measures, environmental laws, and other relevant laws, regulation and rules. In addition, the contractor shall carry out all instructions of the project proponent/consultant that comply with the contract agreement.

The Contractor shall commence the works on the start date and shall carry out the works in accordance with the construction work schedule submitted by the contractor, as updated with the approval of the project proponent/consultant, and complete all the works by the completion date stipulated under the contract agreement.

(2) Submittals by the Contractor

The contractor shall prepare and submit for approval the following document in the course of implementation of the construction work:

- Construction work plan including organization, procedures, methods, safety measures, time schedule, construction machine/equipment list, staff deployment, etc.;
- Construction work drawings, shop drawings, construction procedures as required;
- Monthly progress report including the planned and actual work done;

- Periodical payment bill including paid/balance amount;
- Project completion report; and
- As built drawings.

(3) Preparation of Periodical Meeting Document

Monthly or weekly meetings will be held by the project proponent/consultant. The contractor shall prepare the presentation papers for the meeting with the following subjects:

- Progress of the construction work including the work done this month and the works for next month;
- Progress of work in terms of received payment;
- Problems and issues for implementing the works; and
- Other topics as required.

5.4.2 Management of Construction Work and Workmanship

The Contractor shall be responsible for management of all activities and the workmanship of the construction work throughout the construction period. The major objective issues of construction management include the components shown below:

- Execution of works meeting with the requirements of the drawings, specifications, and the associated contract document for quality management and workmanship;
- Keep up the construction time schedule to complete the project as scheduled;
- Compliance of labour laws for safety of construction site and health of the staff;
- Deployment of sufficient and capable staff and labour for human resource management;
- Compliance of the environmental related laws and approved EIA for controlling pollution; and
- Keep clean the construction site and disposal of construction waste.

5.5 Project for Procurement of Landfill Machinery

5.5.1 Preparation of Tender Document

In total, seven (7) units of landfill machine are required in 2018. There are three (3) existing landfill machine, bucket tractors, as of May 2015. Accordingly, four (4) units of landfill machine shall be procured in 2017 and the machines shall be delivered at site by the beginning of 2018. Preparation of the tender documents will be carried out by the consultant hired for the procurement of landfill machine. The required tender document will be similar to the document prepared for the construction work of Bhakhraywali SLA facilities presented in Section 5.3.2, namely, the listed in the following:

- Notice of pre-qualification announcement;
- Instruction to the tender;
- Contract document form;
- General conditions of contract and special provisions;
- Technical specifications; and
- Tender schedule.

In preparation of the procurement contract document form and general conditions of contract, utilisation of the standard contract form of GWMC will be preferable.

5.5.2 Procurement and Inspection

During the short-term period from 2016 to 2018, the procurement of landfill machine will be executed twice in 2016 and in 2017 as shown in **Table C.5.1**. The landfill machine shall be inspected at the delivery at site and instructed the operation by the supplier/manufacturer.

Table C.5.1 Procurement Schedule and Specifications of Landfill Machinery

Procurement Schedule	2016	2017	Specifications
Wheel Loader	1		Bucket Size 3.3m^3, Output Capacity 149kW or 202hp
Excavator	1		Bucket Size 1.5 m^3, Output Capacity 200kW or 272hp
Bulldozer		2	Chain Dozer, Blade Width 3.9m or wider, Output Capacity 165kW or 220hp

5.6 Project for Operation and Maintenance of Landfill Facilities

5.6.1 Preparation of Operation and Maintenance Manual

Landfill operation is scheduled to start in the beginning of 2018 at Bhakhraywali. Accordingly, a landfill plan and a landfill operation and maintenance manual shall be prepared in advance to the commencement of the landfill operation. The manual shall be prepared based on the stipulations of the relevant rules, regulations and guidelines in consideration of the specific conditions of the Bhakhraywali landfill site. In order to conduct appropriate landfill operation with the functionality of the sanitary landfill, the items, but not limited to the following example as given in **Figure C.5.6**, shall be specified in the landfill operation and maintenance manual.

Some details of sanitary landfill operation and maintenance have shown in the next **Subsection 5.6.2 Landfill Operation and Maintenance of Landfill Facilities** as the practical procedures.

1. Policy and Strategies for the Better Management of Sanitary Landfill
- 1.1 Strategies for Better Management of Waste Disposal
- 1.2 Basic Conditions for Operation and Maintenance of Sanitary Landfill
- 1.3 Short-term plan and annual plan

2. Incoming Waste Management
- 2.1 Rationale for Management of Incoming Wastes
- 2.2 Measuring of the Incoming Wastes
- 2.3 Items for Monitoring, Recording and Inspection
- 2.4 Unacceptable Wastes
- 2.5 Forms of Incoming Waste Recording

3. Landfill Operation Management
- 3.1 Necessity of Landfill Management
- 3.2 General Work of Landfill Management
- 3.3 Landfill Management
- 3.4 Information on Landfill Work and Documentation

4. Landfill Facility Management
- 4.1 Rational for Facility Management
- 4.2 Weighbridge Facility
- 4.3 Solid Waste Containment Facility
- 4.4 Stormwater Drainage Facility
- 4.5 Liner System
- 4.6 Leachate Collection and Circulation Facilities
- 4.7 Access Road and Approach Road in the Landfill Area
- 4.8 Landfill Gas Venting System
- 4.9 Buildings
- 4.10 Other Appurtenant Facilities

5. Environmental Management·(Specified under the E&S Monitoring Plan)
- 5.1 Necessity for Environmental Management
- 5.2 Monitoring of Groundwater and Surface Water Quality
- 5.3 Monitoring of Landfill Gases
- 5.4 Monitoring of Offensive Odour
- 5.5 Monitoring of Noise and Vibration
- 5.6 Monitoring of Vectors and Scattering Wastes

6. Post Closure Management of Landfill Site
- 6.1 Overview of Management of Post Closure Landfill Site
- 6.2 Control of Leachate and Landfill Gas
- 6.3 Control of Land Subsidence
- 6.4 Monitoring the State of Stabilisation of Landfill
- 6.5 Utilisation and Management of Post Closure Landfill Site

7. Information Management and Administrative Structure
- 7.1 Management of Waste Disposal Information
- 7.2 Administrative Structure

Figure C.5.6 Contents of Landfill Operation and Maintenance Manual (Example)

5.6.2 Landfill Operation and Maintenance of Landfill Facilities

In order to carry out appropriate landfill operation and maintenance of the landfill facilities, the key issues are input of capable human resource, sufficient number of staff and landfill machine/equipment and adequate financing for operation and management. Some of the key factors and major activities for the landfill operation and maintenance of Bhakhraywali landfill facilities are as described in the following subsections.

(1) Staffing for Operation and Maintenance of Bhakhraywali SLF Facilities

In 2018, the landfill activity is carried out by 26 staff under the responsibility tabulated as shown in **Table C.5.2** below.

Table C.5.2 Operation and Maintenance Staff and Their Responsibilities of Bhakhraywali SLF Facilities

Operation and Maintenance Staff	Required No. in 2018	Work Responsibility
Senior Operation Manager	1	Overall waste disposal activities including planning
Landfill Site Manager	1	Landfill operation, maintenance of facilities and assist Sr. Ope. Mgr.
Assistant Landfill Site Manager	1	Field work for landfill activities and assist Landfill Site Mgr.
Data Entry Operators	3	Disposal waste recording and analysis
Mechanical & Electrical Supervisor	1	Landfill machine, equipment and power supply maintenance
Field Supervisor	4	Monitor and supervising landfill operation and facilities/equipment
Landfill Machine Operator	7	Operator of landfill machine and regular check
Security Guard	4	Guard man of waste disposal site
Sanitary Worker	4	Multi-task ordered by Site Assistant Mgr.
Total	26	

(2) Basic Conditions of Landfill Operation

Landfill operation and maintenance shall be carried out based on the operation and maintenance manuals which shall be standardized by at least the following activities.

- Type of acceptable waste
- Waste receiving hours
- Landfill operation hours
- SLF operation and administration staff:
- Landfill machine, equipment and tools
- Source of cover soil and temporary stock yard in the waste disposal site

(3) Measuring Incoming Waste Amount

The following items shall be measured by the truck scale and recorded:

- Quantity of incoming wastes by collection area, waste generation sources, type of waste, special waste or domestic hazardous waste and by each vehicle;
- Quantity of cover material delivered to the site and stock in the yard; and
- All the waste amount and cover materials shall be put in order as a database for analysing the performance of waste disposal activities and/or the collection and transportation activities.

(4) Management of Landfill Work in General

General matter for conducting landfill work is specified as follows:

- Finish all the landfill works within the working hour for the day by spreading, compacting, grading and covering earth;
- Landfill work shall be carried out in daytime as a basic rule;
- The landfill area shall be installed with marking post/line to show the filling depth of waste and covering earth as required;

- The landfill area shall not be excavated or filled by waste exceeding the pre-determined landfill height unless planned prior to the landfill operation; and
- The progress of landfill work shall be recorded regularly by plans, drawings, topographic survey and/or by photos. Taking photos every three month from the regular monitoring spots will be effective for recording the progress of landfill work and the landfill rate to estimate the remaining landfill volume and the lifespan as well.

(5) Landfill Operation

The actual landfill operation shall be carried out in the following procedures with a reference illustration of **Figure C.5.7**.

- The existing Bhakhraywali landfill site forms a borrow pit and the landfill work is carried out from the west side of the landfill area. The sequence of landfill work at new landfill site may be carried out the divided cells/sections alternately as shown in the **Figure C.5.7**. The exposed surface of leachate collection facilities within the designated landfill area shall be covered with approximately one metre high waste layer to avoid damage by the traffic of landfill machines.
- Unloading area of solid waste shall be limited to a smaller area but allow accommodating enough space for obstructing the traffic of other vehicles. The unloading area or the landfill area for the day shall be determined and directed by the supervisor. Unloading of waste shall be normally made at the toe of the fill in consideration of movement and working efficiency of the landfill machines.
- Unloaded waste shall be transported, spread, levelled, and compacted within the landfill area for the day in accordance with the landfill plan.
- In order to avoid loose layer, minimising voids and maximising compaction, the waste depth of 30 cm per the layer of spreading/levelling will be effective. The loose layer shall not exceed a depth approximately 0.60m or two feet before compaction. Spreading and compacting waste shall be accomplished as rapidly as practicable to finish the landfill work within the working hour.

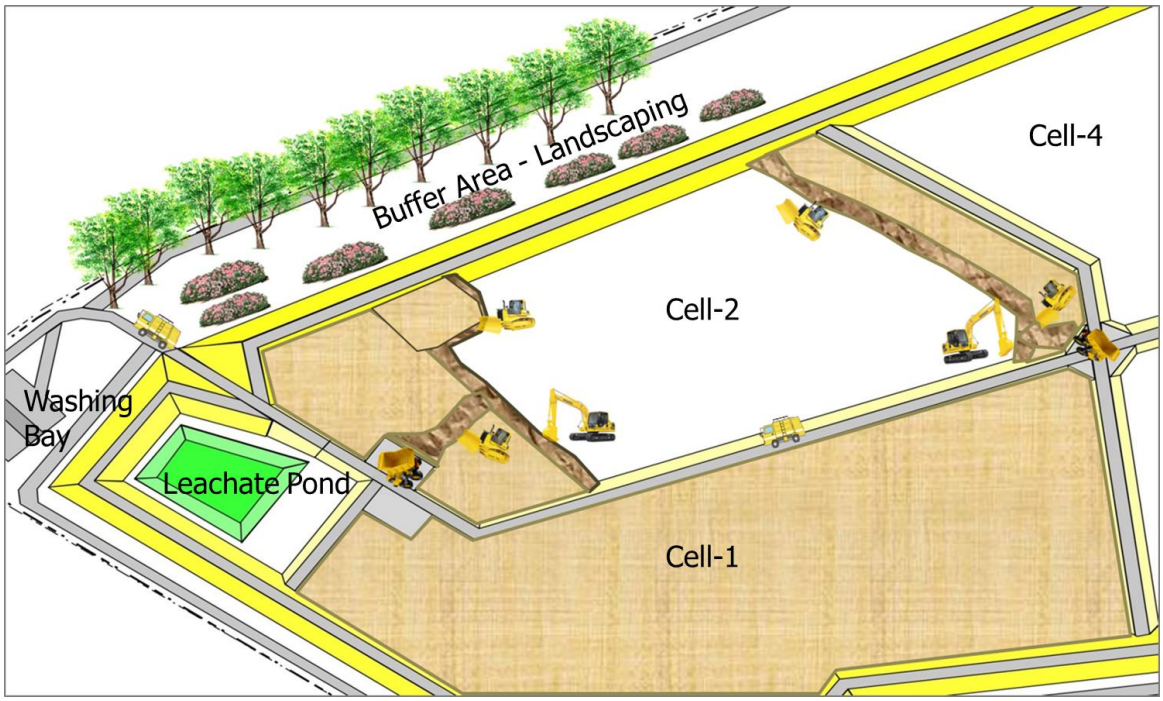


Figure C.5.7 Image of Landfill Work at Bhakhraywali SLF Site

(6) Landfill Operation Records and Reports

The landfill operation shall include recording and reporting of the following items:

- Daily weight or volume and type of incoming residual waste, special waste and acceptable waste carried-in by the individual collection and private operators;
- Daily or weekly or monthly logbook or files for operation of landfill machine & equipment and waste amount, volume and area of landfill and cover soil;
- Daily logbook or file of site conditions including damages by fire, explosion, landslide, earth quake, flood, typhoon and other calamities; and
- All the landfill operation records shall be summarised and incorporated as a part of SWM Annual Report and for the reports required by the authorities concerned.

(7) Regular Monitoring, Inspection, Maintenance and Repair of Facilities

Conducting an appropriate facility management is an essential part of maintaining the function of sanitary landfill facilities. All facilities and equipment comprising the waste disposal facility shall be regularly checked, inspected, repaired and preventive measures carried out to maintain their functionality according to plan. Regular maintenance includes monitoring, inspection and recording the status of the facilities and improve/or repair as required to maintain their functions. Accordingly, prevention of damages and maintenance of these facilities shall be carried out in consideration of the type of the facility constructed at site and maintaining the required functions as intended.

5.7 Project for Improvement Work of the Existing Landfill in Gondlanwala

5.7.1 Design of Improvement Work

Improvement work is carried out to provide the required minimum functionality to the existing disposal site for upgrading the landfill work. The main purpose of this improvement work is to change the existing open dumping method from the top of the landfill area to the method of unloading waste in the bottom of the landfill area and pile up the waste layer. The improvement work will be carried out mainly by GWMC and partly by the hired contractor for some special works. Based on this concept, the consultant shall prepare the work drawings in accordance with the conceptual design of the Action Plan which is presented in the following subsections together with the descriptions of the required facilities, specifications and dimension for improvement of the current landfill operation. The design work and the improvement work shall be immediately and complete the improvement work sooner as possible or the latest by the end of 2016. The conceptual design drawings of improvement work of Gondlanwala disposal site are presented from **Figure C.5.8** to **Figure C.5.10**.

(1) Improvement of Access Road

Description	The existing road from the intersection with the canal bank road to the disposal site is used for the access road. Total length of 620m shall be improved with subbase and surface pavement with asphalt concrete for 5m wide. .
Specifications/ Dimension	Total length for improvement:620m,
	Stripping of existing road: 1,020 m^3,
	Reconstruction of subbase: 3,410 m^2, 30 cm deep
	Asphalt concrete pavement: 3.100 m^2 , 50mm thick

(2) Earth Work

Description	Earth work for filling stagnant water area, construction of entrance/exit ramps to the bottom of the landfill area, approach road within the landfill area and unloading stages shall be carried out.
Specifications/ Dimension	Earth fill at water ponding area: 38,000 m^3
	Earth fill and compaction for intermediate dike: 770 m^3

	Earth fill and compaction for ramps, approach road and unloading stage: 9,610 m^3

(3) Pavement Work for Roads

Description	Subbase and surface gravel pavement shall be constructed for ramps, approach road, intermediate dike and unloading stage. The length of gravel pavement of the road will be 3m wide.
Specifications/ Dimension	Compacted gravel pavement for intermediate dike : 110$m^{2,}$ 3m(W) x 15cm thick per meter
	Compacted gravel pavement for entrance/exit ramps, unloading stage and approach road within the landfill area: 3,100m^2, 3m (W) x 15cm thick per meter for road surface pavement

(4) Installation of Leachate Collection & Circulation System

Description	Leachate collection system by reinforced concrete main conduit is installed in the bottom of landfill area. The leachate collection conduit is covered with crushed stone and gravel to prevent foreign matters entering into the conduit. In addition, the leachate evaporation system comprised of leachate pump well, lift pumps, leachate lift/circulation pipes and evaporation pond (existing shallow pond) shall be constructed to form the closed system.
Specifications/ Dimension	Trenching work for installation of leachate collection conduit: 1,590 m^3,
	Reinforced concrete main conduit: 0.6m (W) x 0.7m (D) x 480m (L)
	Gravel layer, 25-50mm : 6,350 m^3 for main conduit
	Crushed stone layer, 37.5-90mm: 1,640 m^3 for main conduit
	RC Junction pit for main conduit: 10 places, 1.5m (W) x1.5m (L) x 2.0m (Avg. D)
	RC Leachate lift pump well: 2.5m (W) x 3.0m (L) x 3.9m (D)
	Leachate lift pump equipment: 2units x 7.5kW each, including sensors & panel
	Leachate lift pipes and circulation main (PVC): Dia. 150mm x 980m incl. spray nozzles
	Estimated leachate flow: 130m^3/day (mean), 490m^3/day (Maximum)

(5) Installation of Gas Vent

Description	The landfill gas ventilating system comprised of crushed stone gabions and vertical self-supported perforated pipes are installed for the initial set up. The gas vent vertical pipes and horizontal pipes shall be extended and connected as the landfill depth increased and reached to the predetermined level.
Specifications/ Dimension	Crushed stone gabion: 125 sets, 1.0m (W) x 1.0m (L) x 1.0m (H) per set
	Vertical gas vent pipes: 125 sets, 4.0m (L) x Dia. 150mm perforated PVC pipe per set

(6) Power Supply and Lighting

Description	Installation of power supply system from the public line and wiring within the compound for power supply to the pump equipment, indoor/outdoor lighting.
Specifications/ Dimension	Installation of power supply line to the site: 1 system, 50m
	Installation of power supply for pump equipment and lighting: 1 system
	Outdoor lighting: 8 sets
	Gate Lamp: 1 set

(7) Associated Works

Description	Associated facilities/equipment are installed for improvement of landfill operation and the security of the landfill site.
Specifications/ Dimension	Perimeter fence: 2.0m (H) x 1,510m (L), chain link fence or brick wall fence
	Entrance gate: 1set, 2.5m (H) x 6.0m (W)
	Monitoring well-Shallow well: Dia.150mm x 20m (D) x 1 wells, incl. water sampling device
	Monitoring well-Deep well: Dia.150mm x 60m (D) x 1 wells, incl. water sampling device

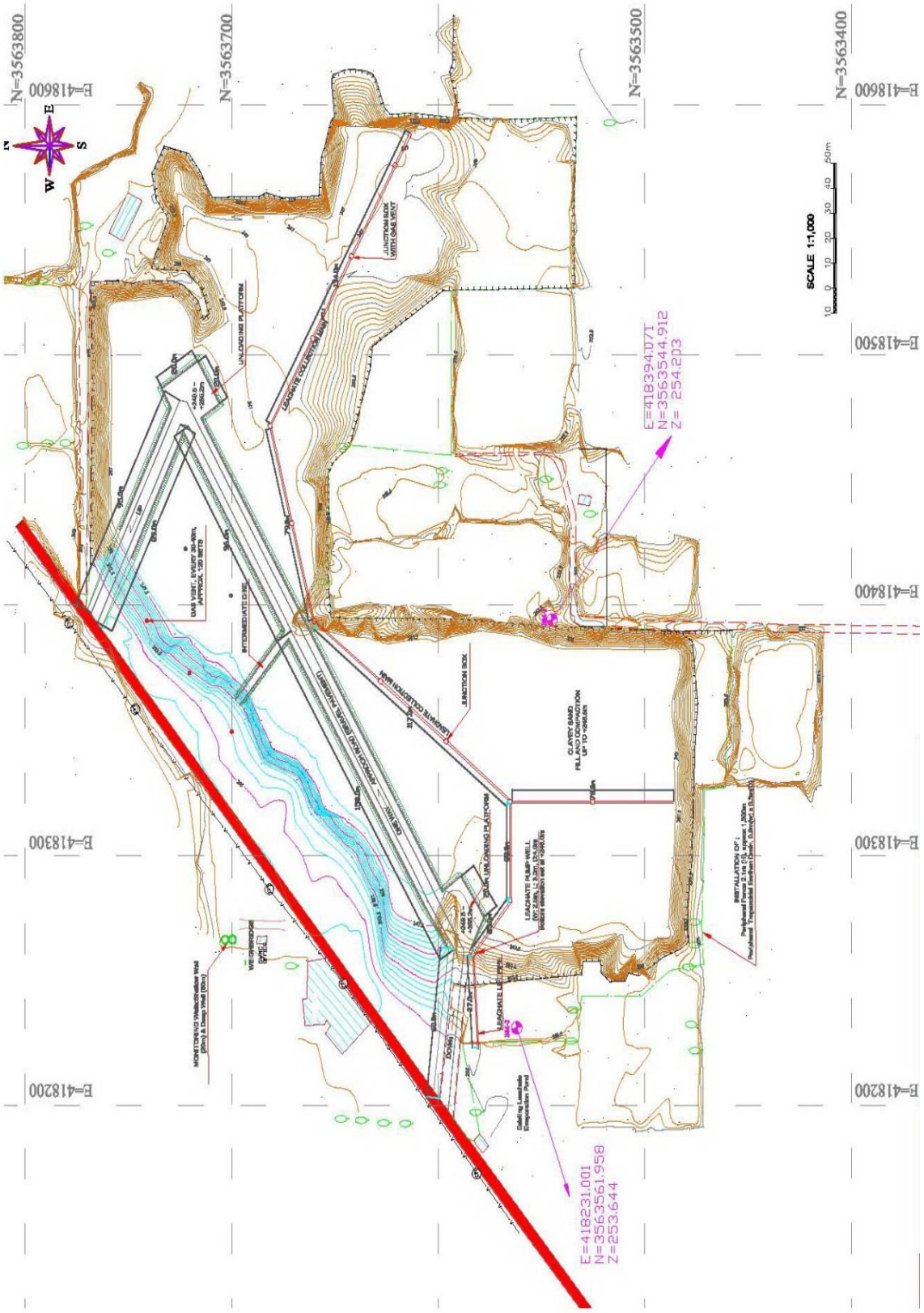


Figure C.5.8 Layout Plan of Improvement Work at Gondlanwala Existing Disposal Site

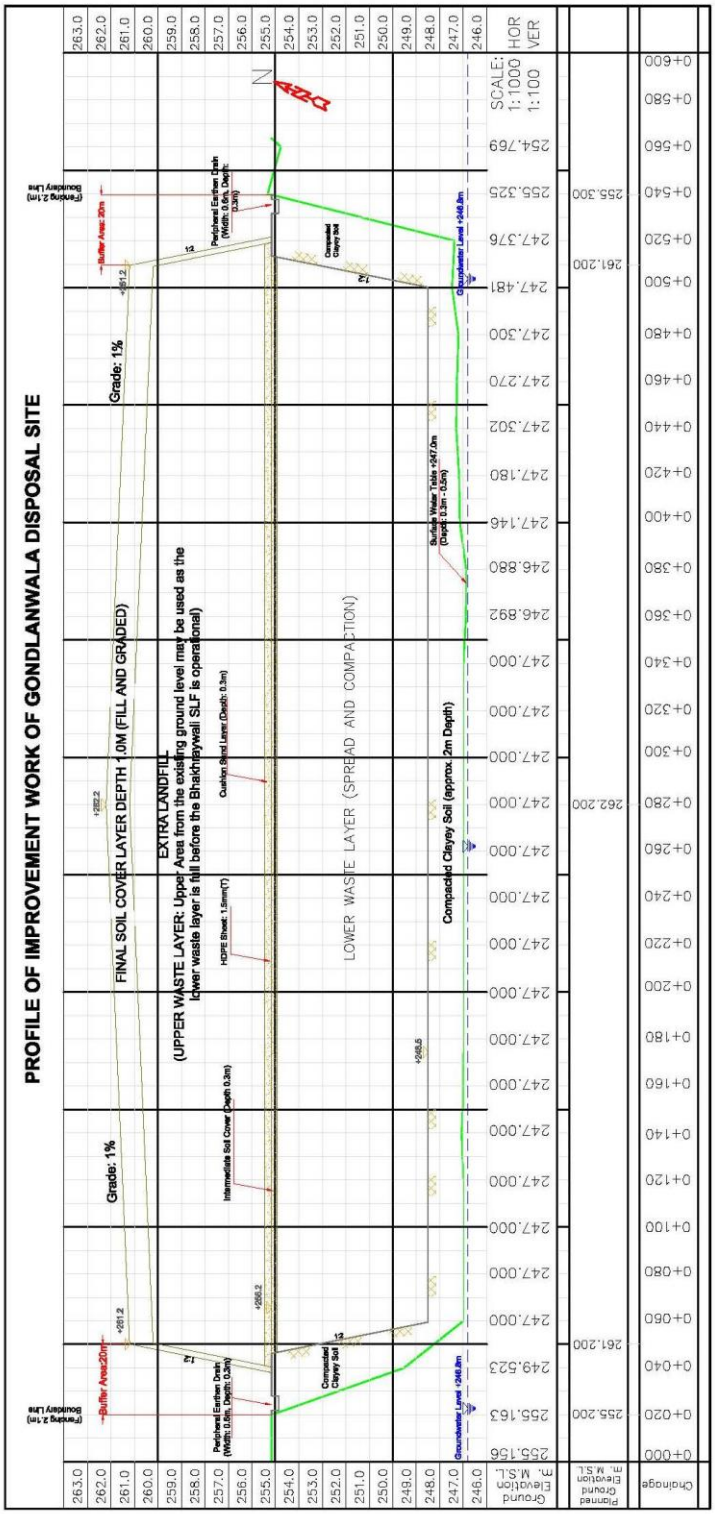
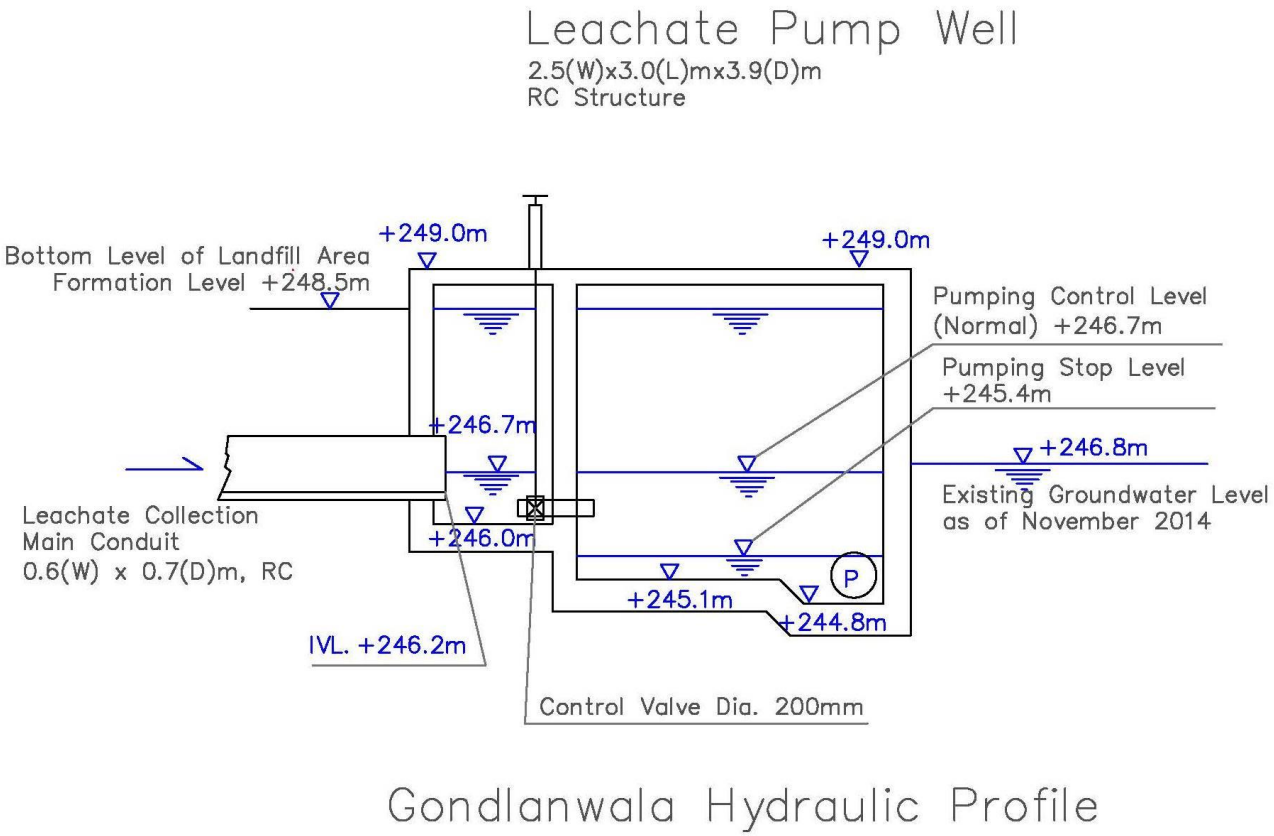


Figure C.5.9 Profile of Improvement Work of Gondlanwala Disposal Site



Note: Formation level and/or water level shown in hydraulic profile is based on the elevation of the provisional benchmark for the topographic survey. The location of the representative benchmark of BM-1 for the survey is shown in the layout plan. The elevation of BM-1 in Gondlanwala is determined at +254.203. In case of showing the elevation by mean sea water level (M.S.L), the elevation in the hydraulic profiles must be adjusted by the relation of the elevation between BM-1(+254.203) and the national benchmark in Gujranwala (approximately +220.0 m M.S.L.).

Figure C.5.10 Hydraulic Profile of Leachate Circulation System in Gondlanwala

5.7.2 Implementation of Improvement Work

The improvement work will be carried out mainly by GWMC staff responsible for landfill operation. The work will be carried out as free time or idling time and extra work of the staff. Some of the special works such as installation of leachate collection conduit, leachate pump well, piping, power supply, landfill gas venting system, etc. may be carried out by the construction contractor hired by GWMC as required. The improvement work to be conducted by the contractor(s) shall follow the requirements similar to the description in **Section 5.4**, the construction work of Bhakhraywali SLF facilities. Funding of this project shall be secured by the annual budget of GWMC or the project funding by the Punjab government.

5.8 Project for Safe Closure of Landfill Site in Gondlanwala

5.8.1 Design of Safe Closure Work of Gondlanwala Disposal Site

Safe closure work of Gondlanwala is scheduled in 2018 after Bhakhraywali SLF facilities become operational. If the proposed improvement work is carried out properly, it is not necessary to implement a special safe closure work except for requiring only for final cover soil and extension of gas vent pipes. Accordingly, the design of safe closure work of Gondlanwala will be carried out by GWMC with reference to the following description, specifications and dimension.

(1) Earth Work for Final Cover

Description	Earth work for excavation, filling, grading and transferring waste layer for levelling work to construct the maintenance road and other facilities. The earth work includes the final earth cover work.
Specifications/ Dimension	Dozing, grading and levelling: approx. 25,000m^3
	Final earth cover: approx. 50,000m^3

(2) Extension of Gas Vent

Description	The landfill gas venting system comprised of crushed stone gabions and vertical self-supported perforated pipes are installed for the initial set up. The gas vent vertical pipes and horizontal pipes shall be extended and connected as the landfill depth increased and reached to the predetermined level.
Specifications/ Dimension	Extension of vertical gas vent pipes: 125 sets, 2.0m (L) x Dia. 150mm perforated PVC pipe per set
	Horizontal gas vent pipes: Dia. 150mm x approx.1,510m perforated PVC pipes with fittings

(3) Perimeter Fence

Description	The site is an old borrow pit and it is difficult to install perimeter fence along the site boundary line shaped like a cliff. The perimeter fence will be installed after completion of landfill work accordingly.
Specifications/ Dimension	Perimeter fence: 2.0m (H) x 1,510m (L), chain link fence or brick wall fence

5.8.2 Implementation of Safe Closure Work of Gondlanwala Disposal Site

The safe closure work of Gondlanwala will be carried out mainly by the landfill operation staff of GWMC as free time or idling time and extra work of the staff. Some of the special works such as extension of gas vent pipes may be carried out by the construction contractor hired by GWMC as required. The closure work to be conducted by the contractor(s) shall follow the requirements similar to the description in 5.4, the construction work of Bhakhraywali SLF facilities. Funding of this project shall be secured by the annual budget of GWMC or the project funding by the Punjab government.

5.9 Project for Safe Closure of Landfill Site in Chianwali

5.9.1 Design of Safe Closure Work of Chianwali Disposal Site

Safe closure work is carried out to provide the required minimum facilities and work to the former Chianwali landfill site. The main purpose of this closure work is to facilitate safe closure of the former landfill site to mitigate the probable negative environmental impacts in the surrounding area. The closure work will be carried out mainly by GWMC and partly by the hired contractor for some special works. The consultant shall prepare the work drawings based on this conceptual design of the Action Plan which is presented in the following subsections together with the descriptions of the required facilities, specifications and dimension for safe closure of the former landfill site in Chianwali. The safe closure work of former disposal site in Chianwali will be implemented in parallel with the closure work of the existing Gondlanwala disposal site, which is scheduled in 2018. The conceptual design drawings of safe closure work of Chianwali former disposal site are presented from **Figure C.5.11** to **Figure C.5.13**.

(1) Earth Work

Description	Earth work for excavation, filling, grading and transferring waste layer for levelling work to construct the maintenance road and other facilities. The earth work includes the final earth cover work.
Specifications/ Dimension	Excavation and filling of waste layer: 11,850 m^3
	Dozing, grading and levelling: 29,900m^3
	Final earth cover: 29,900m^3

(2) Pavement Work for Roads

Description	Gravel pavement for perimeter/maintenance road for 5m wide and for 3m wide including turning area.
Specifications/ Dimension	Compacted gravel pavement for perimeter road: 2,275 m^2, 5m (W) x 15cm thick
	Compacted gravel pavement for perimeter road: 1.010 m^2, 3m (W) x 15cm thick

(3) Installation of Leachate Collection & Circulation System

Description	Leachate collection system comprised of perforated PVC pipes and gravel and crushed stone filter layer shall be installed to collect waste water leaching down to the lower area of the site. The collected leachate enters to the pump well for circulation within the site by leachate circulation force main and spray nozzles for evaporation to structure the closed system.
Specifications/ Dimension	Trenching work for installation of leachate collection pipe: 40m^3
	Perforated PE pipes: Dia. 150mm x 20m
	Gravel layer, 25-50mm : 80m^3 for leachate collection PE pipes
	Crushed stone layer, 37.5-90mm: 40m^3 for leachate collection PE pipes
	RC Leachate circulation pump well: 2.5m (W) x 3.0m (L) x 3.9m (D)
	Leachate circulation pump equipment: 2units x 7.5kW each, including sensors & panel
	Leachate circulation force main (PVC): Dia. 150mm x 690m incl. spray nozzles
	Estimated leachate flow: 70m^3/day (mean), 270m^3/day (Maximum)

(4) Installation of Gas Vent

Description	Install a landfill gas vent system. The system is comprised of crushed stone gabions and vertical self-supported perforated pipes connected with horizontal pipes for collection and transmitting gases. The vertical pipes are extended on to the ground surface and connect with the gas release pipe.
Specifications/ Dimension	Crushed stone gabion: 66 sets, 1.0m (W) x 1.0m (L) x 1.0m (H) per set
	Vertical gas vent pipes: 66 sets, 4.0m (L) x Dia. 150mm perforated PVC pipe with fittings per set
	Horizontal gas vent pipes: Dia. 150mm x 1,150m perforated PVC pipes with fittings

(5) Power Supply and Lighting

Description	Installation of power supply system from the public line and wiring within the compound to supply for the pump equipment and outdoor lighting
Specifications/ Dimension	Installation of power supply line to the site: 1 system
	Outdoor lighting: 8 sets
	Gate lamps: 2 sets

(6) Associated Works

Description	Associated facilities/equipment is installed for maintaining the site safe and mitigating the environmental pollution
Specifications/ Dimension	Repair of perimeter fence: 2.0m (H) x 130m (L), 2place, brick wall fence
	Entrance gate: 1set, 2.5m (H) x 6.0m (W)
	Monitoring well-Shallow well: Dia.150mm x 20m (D) x 1 well, incl. water sampling device
	Monitoring well-Deep well: Dia.150mm x 60m (D) x 1 wells, incl. water sampling device

5.9.2 Implementation of Safe Closure Work of Chianwali Disposal Site

The closure work will be carried out mainly by GWMC staff responsible for landfill operation. The work will be carried out as free time or idling time and extra work of the staff. Some of the special works such as installation of leachate collection pipes, leachate pump well, leachate circulation force main, power supply, landfill gas venting system, etc. shall be carried out by the construction contractor hired by GWMC as required. The closure work to be conducted by the contractor(s) shall follow the requirements similar to the description in **Section 5.4**, the construction work of Bhakhraywali SLF facilities. Funding of this project shall be secured by the annual budget of GWMC or the project funding by the Punjab government.

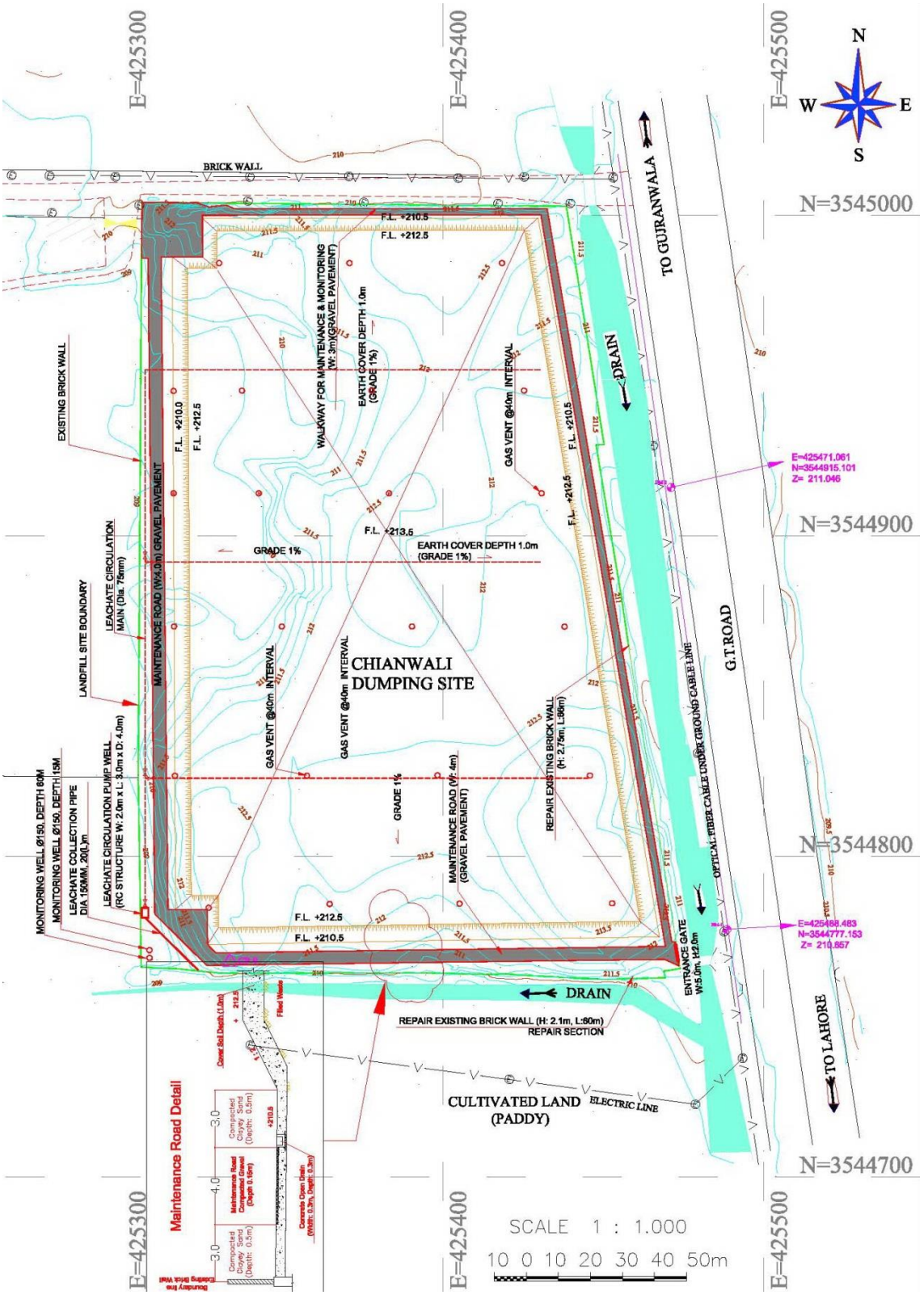


Figure C.5.11 Layout Plan of Safe Closure Work at Chianwali Former Disposal Site

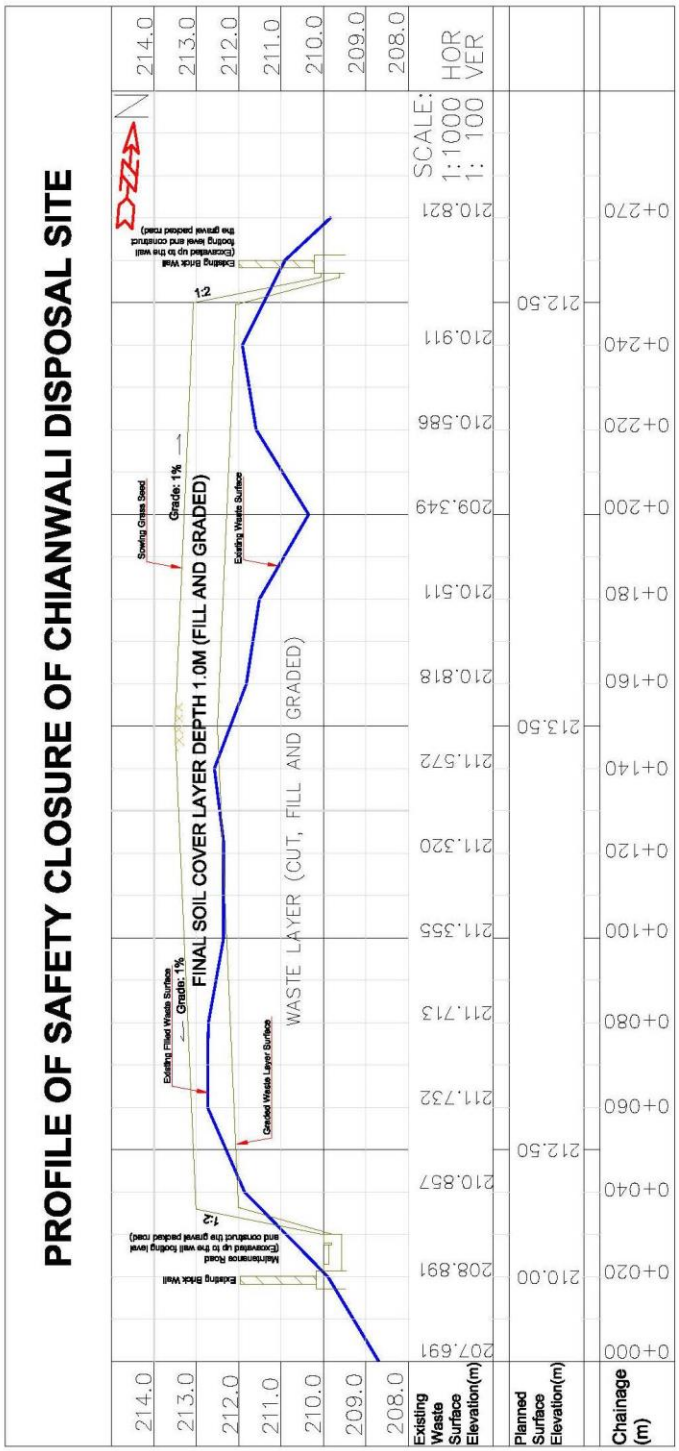


Figure C.5.12 Profile of Safe Closure Work at Chianwali Former Disposal Site

Figure C.5.13 Hydraulic Profile of Leachate Circulation System in Chianwali

5.10 Project for Monitoring of Final Disposal in Bhakhraywali

Monitoring of landfill work and waste disposal facilities are the integral part of operation and maintenance of final disposal activities. A series of activities for monitoring, inspection and restoration work play an important role in practicing the sanitary landfill operation. The monitoring plan being proposed hereunder consists of monitoring of landfill facilities and the environmental elements closely related with conducting waste disposal operation and evaluating the stability of landfill layer. The monitoring work will be commenced at the time of commencement of the landfill work in early 2018 and continue by the end of the life of the landfill site. The environmental monitoring related with compliance of EIA and the relevant laws, rules and regulations will be stated separately in ***Volume 1 Main Report, Section 5.4, Confirmation of Environmental and Social Considerations Systems and Organizations in Pakistan***.

5.10.1 Preparation of Monitoring Plan of Landfill Facilities

(1) Facility Monitoring Plan

GWMC shall prepare a monitoring plan having the following items of regular monitoring and inspection for the main landfill facilities and associated facilities.

- Access Road, Approach Road and Perimeter Road
- Waste Containment Facility,
- Storm Water Drainage system
- Impermeable Liner System
- Leachate Collection & Circulation System
- Landfill Gas Vent System
- Buildings
- Weighbridge Equipment
- Power Supply and Lighting System
- Perimeter Fence, Gate, Washing Bay, Monitoring Well, etc.
- Landscaping
- Landfill Machine and Equipment

The actual monitoring/inspection plan of each facility stated above shall be prepared with the following items for example for the waste containment facility.

- General Requirements for Management of Waste Containment Facility
- Prevention of Damage and Maintenance of Facility
- Monitoring/Inspection Plan (Regular Inspection, Method of Inspection, Items for Inspection)
- Evaluation of Inspection Result (Grading the level of countermeasures)
- Remedial Actions, Repair Plan and Implementation

(2) Monitoring of Status of Landfill

Landfill status shall be monitored by the major parameters but not limited to the following items:

- Incoming Waste Amount, Landfill Area and Volume for the Working Cell;
- Rate of Subsidence of Landfill Layer or Landfill Level Record;
- Raw Leachate Water Quality;
- Concentration of Oxygen, Methane gas Hydro Sulphide (H_2S),Ammonia (NH_3), etc.; and
- Temperature of landfill layer.

Among the monitoring items for the landfill status listed above, the rate of subsidence and temperature of landfill layer will be monitored during the post-closure period for evaluating stabilisation status. Monitoring of these two parameters will be carried out in accordance with the following procedures.

Monitoring of Landfill Layer Subsidence

- Subsidence of landfill layer shall be measured at least once in a year at the two representative locations.
- Subsidence rate is measured by the measuring rod fixed with about 40cm x 40cm subsidence plate installed on the final landfill surface, which is about 1m below the final top cover.
- Measuring shall be carried out with the divisions of the measuring rods and the level of measuring rod by survey equipment (auto level).
- Change of the annual subsidence records will be analysed for evaluation of the status of stabilisation of the landfill layer.

Monitoring of Landfill Layer Temperature

- Temperature landfill layer shall be measured at least twice in a year, winter and summer time, at the two representative locations.
- Gas vent will be used for measuring the landfill layer temperature by inserting a temperature probe or sensor into 3 levels, bottom, middle and upper levels.
- Change of the annual record of temperature will be analysed for evaluation of the status of stabilisation of the landfill layer.

Reference shall be made to ***Volume 2 Supporting Report, Section H, Environmental and Social Considerations*** for monitoring methods of leachate water quality and landfill gas quality.

5.10.2 Monitoring of Landfill Facilities and the Environment

Monitoring/Inspection of the landfill facilities, status of landfill and environmental monitoring will be carried out under the responsibilities of assistant landfill manager and landfill supervisors. Conducting a facility monitoring and inspection is an essential part of maintaining the function of sanitary landfill facilities. All facilities and equipment comprising the waste disposal facility shall be regularly, daily or weekly or monthly depending on the facility, checked, inspected, evaluated the measures, and repaired or restored for maintaining the functionality of the facilities and for the preventive measures. Impacts on environmental and social elements caused of the landfill facilities and landfill work will be monitored and evaluated separately under the activities of ***Volume 2 Supporting Report, Section H, Environmental and Social Considerations.***

5.11 Project for Post-Closure Monitoring of Gondlanwala and Chianwali Landfill Sites

After completion of safe closure work, the assistant landfill manager and his team staff carry out the post closure monitoring based on the requirements stated in the Landfill Operation and Maintenance Manual in which some of the details are described in the following paragraphs. The post-closure monitoring of the disposal sites in Gondlanwala and Chianwali will be mobilised in the beginning of 2019 after completion of the closure work by the end of 2018. In addition, the post closure monitoring for the environmental and social elements will be carried out in accordance with the requirements proposed under ***Volume 2 Supporting Report, Section H, Environmental and Social Considerations***.

5.11.1 Overview of Management of Post Closure Landfill Site

Post closure monitoring is carried out for the purpose to avoid the negative environmental impact and risks attributed to the closed landfill site. Accordingly, the administrator of the site must ensure that the public health and the environment are protected by instituting appropriate measures in monitoring,

analysing problems and restoration work of the abandoned landfill site. The overview for management of post closure monitoring will include but not limited to the following items.

- Basic Concepts of Safe Closure
- Disposal Site Stability Indicator
- Utilisation of Post-Closure Land
- Legal Process of Safe Closure of Disposal Sites
- Roles of Stakeholders

5.11.2 Control of Leachate and Landfill Gas

Generation of leachate and landfill gas continues for a considerably long period after closure of the landfill site. Operation, maintenance, monitoring and restoration work will be required for the purpose to limit the negative impacts from the closed site under control. The post monitoring team will be required to carry out the activities at least the following items.

- Operation and maintenance of leachate circulation system
- Maintenance of storm water drainage system and restoration as required
- Maintenance of landfill gas vent system and repair as required
- Monitoring of leachate water quality and landfill gas concentration (Refer to ***Volume 2 Supporting Report, Section H, Environmental and Social Considerations***)

5.11.3 Control of Land Subsidence

Monitoring the status of the facility and final soil cover and the measures shall be taken against influence by the subsidence caused by the decomposition of the waste layer. The major activities include the following.

- Monitoring and analysis of subsidence of original ground
- Monitoring and analysis of subsidence of waste/final cover layer
- Restoration of subsidence to meet with the requirements of post closure use of the site

5.11.4 Monitoring the State of Stabilisation of Landfill

Several parameters must be determined for evaluating the stabilisation status of the landfill site. The site abolition procedures will be made after ensuring the stabilisation of the landfill site. The following are the main parameters and activities for monitoring and evaluating the status of stabilisation.

- Preparation of closure criteria of landfill site
- Determine the parameters for monitoring the stabilisation (leachate waste quality, groundwater quality, landfill gas concentration, rate of subsidence of landfill site, etc.)
- Monitoring and analysis of the parameters
- Evaluation of the annual trends of monitoring record of the parameters

5.11.5 Utilisation and Management of Post Closure Landfill Site

Safe closure and maintenance plan is formulated in response to the purpose of utilisation of the disposal site in addition to closing the site safely against the probable pollution source. With regard to the post closure site use planning, as well as the maintenance work until ensuring the site stability, the management work during the period shall be carried out based on the following key activities.

- Preparation of post closure site plan in compliance with the land use plan of CDGG
- Evaluation of stabilisation parameters monitored
- Development of the site to meet with the post closure utilisation plan

5.12 Plan of Operations and Cost of Action Plan

Figure C.5.13 shows the implementation schedule of Final Disposal Action Plan or the short-term plan for the period from 2016 to 2018. The main projects during the period consists of construction of new sanitary landfill facilities in Bhakhraywali, improvement of existing disposal site in Gondlanwala, and safe closure of former disposal site in Chianwali. **Table F.5.3** shows the Estimated Cost of the Final Disposal Plan (Short-Term). The total cost is 1,506 Million Rs. and the annual costs of the 1st year, 2nd year and 3rd year are estimated at 799 Million Rs. 614 Million Rs. and 92 Million Rs. respectively.

Time Framework of the Action Plan		Short-Term Plan Period											
Year		2016				2017				2018			
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WBS for Short-Term Plan													
S-2-1	Procurement of Sanitary Landfill Site												
S-2-2	Engineering Service for Sanitary Landfill Facilities (Stage 1)												
S-2-2-1	Preliminary Design & Detail Design												
S-2-2-2	Preparation of Tender Document												
S-2-2-3	Preparation of Bill of Quantities												
S-2-2-4	Support for Tender Evaluation												
S-2-2-5	Construction Supervision												
S-2-3	Construction of Sanitary Landfill Facilities (Stage 1) in Bhakhraywall												
S-2-3-1	Implementation of Construction Work												
S-2-3-2	Management of Construction Work and Workmanship												
S-2-4	Procurement of Landfill Machine												
S-2-4-1	Preparation of Tender Document												
S-2-4-2	Procurement and Inspection												
S-2-5	Operation and Maintenance of Landfill Facilities												
S-2-5-1	Preparation of Operation and Maintenance Manual												
S-2-5-2	Landfill Operation and Maintenance of Landfill Facilities												
S-2-6	Improvement Work of the Existing Landfill in Gondlanwala												
S-2-6-1	Design of Improvement Work of Gondlanwala Disposal Site												
S-2-6-2	Implementation of Improvement Work of Gondlanwala Disposal Site												
S-2-7	Safety Closure of Landfill Site in Gondlanwala												
S-2-7-1	Design of Safety Colosure Work												
S-2-7-2	Implementation of Safety Closure Work												
S-2-8	Safety Closure of Landfill Site in Chianwall												
S-2-8-1	Design of Safety Colosure Work of Chianwall Disposal Site												
S-2-8-2	Implementation of Safety Closure Work of Chianwall Disposal Site												
S-2-9	Monitoring of Final Disposal in Bhakhraywall												
S-2-9-1	Preparation of Monitoring Plan of Landfill Facilities												
S-2-9-2	Monitoring of Landfill Facilities and the Environment												
S-2-10	Post-closure Monitoring of Gondlanwala and Chianwall Disposal Sites												

Figure C.5.14 Plan of Operations of the Final Disposal Plan (Short-Term)

Table C.5.3 Cost of Operations for the Final Disposal Action Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost		
			2016	2017	2018
Programme 2: Final Disposal Plan					
Short-Term Plan					
S-2-1	Procurement of Sanitary Landfill Site	150,000	150,000		
S-2-2	Engineering service for Sanitary Landfill Facilities (Stage 1)	99,680	49,840	49,840	
S-2-2-1	Preliminary Design & Detail Design	49,840	24,920	24,920	
S-2-2-2	Preparation of Tender Document				
S-2-2-3	Preparation of Bill of Quantities				
S-2-2-4	Support for Tender Evaluation				
S-2-2-5	Construction Supervision	49,840	24,920	24,920	
S-2-3	Construction of Sanitary Landfill Facilities (Stage 1) in Bhakhraywall	996,802	492,751	504,051	
S-2-3-1	Implementation of Construction Work	897,122	443,476	453,646	
S-2-3-2	Management of Construction Work and Workmanship	99,680	49,275	50,405	
S-2-4	Procurement of Landfill Machine	70,350	31,500	38,850	
S-2-4-1	Preparation of Tender Document	3,350	1,500	1,850	
S-2-4-2	Procurement and Inspection	67,000	30,000	37,000	
S-2-5	Operation and Maintenance of Landfill Facilities	72,151	18,669	21,859	31,623
S-2-5-1	Preparation of Operation and Maintenance Manual	72,151	18,669	21,859	31,623
S-2-5-2	Landfill Operation and Maintenance of Landfill Facilities				
S-2-6	Improvement work of the Existing Landfill in Gondianwala	55,902	55,902		
S-2-6-1	Design of Improvement Work of Gondianwala Disposal Site	5,082	5,082		
S-2-6-2	Implementation of Improvement Work of Gondianwala Disposal Site	50,820	50,820		
S-2-7	Safety Closure of the Landfill Site in Gondianwala	26,196			26,196
S-2-7-1	Design of Safety Closure Work	2,381			2,381
S-2-7-2	Implementation of Safety Closure Work	23,815			23,815
S-2-8	Safety Closure of the Landfill Site in Chianwali	34,544			34,544
S-2-8-1	Design of Safety Closure Work of Chianwali Disposal Site	3,140			3,140
S-2-8-2	Implementation of Safety Closure Work of Chianwali Disposal Site	31,404			31,404
S-2-9	Monitoring of Final Disposal in Bhakhraywall	GWMC			
S-2-9-1	Preparation of Monitoring Plan of Landfill Facilities	GWMC			
S-2-9-2	Monitoring of Landfill Facilities and the Environment	GWMC			
S-2-10	Post-closure Monitoring of Gondianwala and Chianwali Disposal Sites	GWMC			
	Total (Short-Term)	1,505,625	798,662	614,600	92,363

6. CONCLUSION

6.1 Transition from Open Dumping to Sanitary Landfill

In Gujranwala, waste disposal by open dumping executed continuously in the past disposal site including the current disposal site have caused environmental and social problems in the surrounding area. In order to improve this situation, the implementation of mitigation measures is required against the negative impacts on the environment and society through the construction and appropriate operation and maintenance (O&M) of engineered landfill facilities. As for the engineered landfill, it shall be an appropriate measure to structure the final disposal system based on the sanitary landfill conforming to the design criteria of developed countries in addition to the provisions of the Punjab Waste Management Act 2013 (Draft) and the Punjab Municipal Solid Waste Management Guideline 2011.

6.2 Implementation of Phased Development of Bhakhraywali Sanitary Landfill Facility

Residual waste or the waste after recovery of resource materials shall be the waste for disposal at the newly developed sanitary landfill site. The reduction of final disposal waste amount or the increase of Waste Diversion Rate could be achieved to extend the economic life of the final disposal site. However, due to the increase in the amount of disposed waste with the future improvement of waste collection rate, the economic life of the new final disposal site is assumed to be 6-7 years.

Therefore, the waste disposal development plan until 2030 is proposed to be carried out stepwise by implementing it in 3 phases. In addition to the procurement of 25ha of land for Bhakhraywali at the initial stage, the site of 50ha for facility development of the second and third phases shall be carried out to ensure the landfill site for the incoming waste amount up to 2030.

6.3 Planned Landfill Height of Bhakhraywali Sanitary Landfill

If the adjacent area is procured for a wider Bhakhraywali sanitary landfill site, the location would be closer to the residential area. Therefore, a method to increase the landfill height is proposed to minimise the acquisition area as well as maximise the effective use of the site. Increasing the landfill depth of the subsurface direction would be limited due to the relation of groundwater table. Accordingly, the increase of landfill height from the original ground surface is proposed to meet the proposal.

In the plan, the total landfill height including the final soil cover layer is proposed at 11m from the original ground surface level. By the facility design, the sanitary landfill having the function of semi-aerobic landfill layer will enable achievement of early stabilization and consolidation. In addition, adequate compaction of waste layer in the landfill work will increase the filled waste bulk density and suppress the landfill height as well.

6.4 Implementation of Improvement of Gondlanwala Existing Disposal Site and Safe Closure of Chianwali Former Disposal Site

Environmental and social impacts, although not so significant, have arisen in the surrounding area of the existing Gondlanwala disposal site and the former Chianwali disposal site. It is, however, possible to mitigate the negative impacts with the safe closure of the Chianwali disposal site and improvement of the existing Gondlanwala disposal site in accordance with the proposed action plan.

7. RECOMMENDATIONS

7.1 Priorities in the Component Item of Final Disposal Plan

In Gujranwala, no engineered landfill has yet been developed. Therefore, there have been situations that led to the deterioration of the environment in the vicinity of final disposal sites. Even now, deterioration of the environment is taking place in the vicinity of the existing Gondlanwala disposal site and the former disposal site in Chianwali.

In consideration of the constraints in financial and human resources of GWMC, it is recommended that implementation of the final disposal plan shall be carried out in the following order and the schedule shown in **Figure C.5.14**.

- Development of the new Bhakhraywali sanitary landfill project facilities shall start in the beginning of 2016;
- Improvement of the existing Gondlanwala Disposal Site shall start in the beginning of 2016; and
- Safe Closure of the former Chianwali Disposal Site shall start in the beginning of 2018.

7.2 Procurement of Final Disposal Site for Second and Third Phases

Landfill volume of the first phase of the final disposal sites is planned at 3.8 million cubic metres including the volume of above-ground layer of 11m. According to the estimation of cumulative annual landfill volume, however, the landfill site will become full in mid-2024. Therefore, construction of the second phase of final disposal facilities must be completed by that time in order to start operation of the facilities. After the start of operation of the first phase disposal site in 2018, GWMC shall start action to immediately procure new disposal sites including the sites for the second phase and the third phase. Then, the actions are to be followed by the step-wise activities for design, construction contracting and the construction work in preparation for the commencement of operation of the second phase final disposal site in the middle of 2024.

7.3 Key Points in Design and Construction of Bhakhraywali Sanitary Landfill Facility

The new final disposal site in Bhakhraywali shall be designed, constructed and maintained as a sanitary landfill facility in compliance with the requirements of the Punjab Waste Management Act 2013, the Punjab Municipal Solid Waste Management Guidelines 2011, other rules and regulations, and the authorised international standards. Particularly, for the important technical matters, the following points are recommended to be studied and understood fully for implementation of the project.

- Infiltration of leachate into the ground from the bottom of landfill area. The slope shall be protected by an impermeable lining system composed of soil liner (more than 60cm) and HDPE (High Density Polyethylene) sheet (1.5mm or more), as well as protection layer against damage of the lining layer.
- Sanitary landfill must be designed and constructed as a structure having the function of semi-aerobic landfill. In order to keep the semi-aerobic condition, the leachate collection conduit shall have dimensions and features to have more than half of the cross section of the leachate collection conduit to entrain air layer. In addition, the downstream facilities, i.e., the leachate pond and leachate circulation pump well, shall have the structures and pumping water level to maintain more than half of the cross section of the conduit to maintain the air layer.
- Leachate in the conceptual design has become a closed system that does not discharge to the outside of the system by evapotranspiration through a leachate circulation system. As an important point of this system, the leachate pond shall have enough regulating capacity against the long-term heavy rain of the monsoon season. For ensuring the sufficient leachate flow regulating capacity, it is

recommended to carry out a simulation of leachate cumulate amount during the monsoon season including one month before and after the period. In addition, a control valve shall be installed at the inlet side of leachate pond to cope with an emergency case of exceeding the regulation capacity to enable temporary storage of leachate inside of the landfill site.

- In the conceptual design of the Master Plan, the rainwater drainage ditch is installed along the site boundary and the 30cm height polder is constructed along the edge of landfill containment area to prevent rainwater from flowing into the landfill area. In particular, the end section of the respective facilities shall be designed and constructed properly to have the function to prevent rainwater from entering the landfill area as intended.
- Part of the slope of the landfill containment is constructed of earth filled embankment. Sufficient compaction work under strict control shall be carried out for the construction of a stable embankment. Moreover, considering the adjustment work for the subsidence to complete within the construction period, it is recommended that the construction period of the embankment work by earth filling section is set in the early stages of the construction plan. Surplus soil is generated in earthwork (excavation and filling) for construction of the landfill facility. This surplus soil shall be stored temporarily in the Buffer Zone and used for cover soil material in landfill work.
- HDPE sheet or the equivalent material sheet must not be installed in all the height in one stage work. The sheet work shall be carried out by dividing it into two stages to prevent sliding of the sheet. Moreover, the installation work of sheet shall be subjected to a protective layer to prevent deterioration due to damage and ultraviolet rays. The protective layer is to be installed according to the progress of the landfill height, and the upper part is exposed. Protective paint against deterioration by ultraviolet rays shall be specified for application to the exposed portion of the sheet.

7.4 Appropriate Operation and Maintenance

Completion of the construction work is just the starting point for conducting a suitable landfill operation. The facility development will equip the features or functions for avoiding the main cause of secondary pollution and it must be ensured further through the suitable operation and maintenance of the landfill facilities and the works. To that end, operation and maintenance must be carried out strictly in accordance with the methods and procedures stated in the operation and maintenance manual. Efforts are also required to assign sufficient personnel and ensure the annual budget to sustain sanitary landfill operations.

7.5 Improvement of Environmental and Social Impacts in the Surrounding Area of Gondlanwala Existing Disposal Site and Chianwali Former Disposal Site

The financial burden of GWMC would increases for a while with the implementation of the action plans as well as the collection and transportation of waste. Improvement of the existing Gondlanwala disposal site and safe closure of the former Chianwali disposal site shall be carried out in consideration of maximising the prevention of environmental and social impacts which will depend on the GWMC financial status as well as the financial support from the Punjab provincial government and the central government. In particular, implementation of regular soil cover, odour control, pest control and dust control, as well as prevention of groundwater contamination at the existing Gondlanwala disposal site and implementation of final soil cover for the former Chianwali disposal site are effective for improving the negative environmental and social impacts arising in the surrounding area.

PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

DRAFT FINAL REPORT

VOLUME 2

SUPPORTING REPORT

SECTION D

INTERMEDIATE TREATMENT AND 3R PROMOTION

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SECTION D

INTERMEDIATE TREATMENT AND 3R PROMOTION

1. INTRODUCTION

This **Section D** deals with the planning of the intermediate treatment and 3R concept of waste reduction, recovery, and recycling. Although basic solid waste management services can be performed in waste collection, transportation and final disposal, intermediate treatment and 3R are required for the purpose of establishing an integrated solid waste management system for local government units. With the introduction of intermediate treatment facilities and 3R encompassing waste amount reduction and diversion, the solid waste management system will be effective and efficient as a whole, especially, towards an environmentally sound system that could mitigate the impacts of climate change.

The reduction of solid waste amount, recovery of recyclable materials and reuse at generation sources can reduce waste amounts for collection, transportation and final disposal, and would lighten the cost burden of GWMC on solid waste management services. Moreover, they will be a useful measure for saving finite resources. As for the benefit of intermediate treatment, the reduction of waste volume and early stabilisation are expected of the residual wastes for disposal and waste diversion as a whole.

The intermediate treatment and 3R plans are formulated and developed in the Master Plan of Integrated Solid Waste Management (ISWM) for Gujranwala City. The intermediate treatment and 3R promotion plans will incorporate the necessary actions, programmes and projects for the improvement of solid waste management services of Gujranwala for the period from 2016 to 2030. After **Chapter 1** "Introduction" in this Supporting Report for Section D, **Chapter 2** is for "Description and Evaluation of Current Condition", and "Planning Directions of Intermediate Treatment and 3R Promotion Plan" is mentioned in **Chapter 3**, "Formulation of Intermediate Treatment and 3R Promotion Plan" is mentioned in **Chapter 4**, and **Chapter 5** discusses the "Formulation of the Action Plan".

Development of the intermediate treatment and the 3R Promotion plan as described in this Section were carried out based on the planning objectives, policies and strategies described in Chapter 3 of this Section D Supporting Report, as the basic rule for integration and consistency with the other plans and programmes to establish a comprehensive solid waste management system for Gujranwala. To formulate the intermediate treatment and 3R promotion plans, therefore, the minimum system that would bring the maximum level of output to improve the solid waste management system proposed in the following subsections was considered, including the current financial situation of Gujranwala.

2. DESCRIPTION AND EVALUATION OF CURRENT CONDITION

2.1 Waste Picker Survey

The Waste Picker Survey is one of the field surveys within the framework of the Project carried out by JICA. Recycling of municipal solid waste in Pakistan relies largely on the informal recovery of resource materials by the waste pickers, junk shops and waste dealers, which render valuable services to society by recovering unusable wastes for productive resources. Nevertheless, little is known about the activities of waste pickers. One of the reasons is that waste traders are understandably very cautious in keeping their business confidential. Another reason is the difficulty in earning the trust of waste pickers and waste dealers.

There is an air of secrecy around waste pickers. Quantitative data on solid waste management in Gujranwala City has been scarce and the recycling rates are unreliable. The waste picker survey was focused on gathering information from the waste pickers in Gujranwala City and the existing disposal site with regard to their recycling activities.

2.1.1 Objective of the Survey

The main objective of the survey was to collect information and to analyse the current activities of waste pickers in Gujranwala City and at the Gondlanwala disposal site.

2.1.2 Method of the Survey

The questionnaire was structured based on the contents of the Inception Report of the JICA Project Team and included the following three (3) parts:

1) General information about the waste pickers;
2) Current recycling situation and recovery amount of recyclables by the waste pickers, and their health and safety issues; and
3) Future concerns of waste pickers regarding their job.

The survey was carried out in December 2014.

The breakdown of sample size for the waste picker interview survey is given in **Table D.2.1**.

Table D.2.1 Breakdown of Sample Size for Waste Picker Survey

Item No.	Location		No. of Samples	
1	Gondlanwala Disposal Site			20
2	Gujranwala City	Low Income Area	5	20
		Middle Income Area	10	
		High Income Area	5	
Total				40

Source: GWMC, JICA Project Team

2.1.3 Results of the Survey

The survey data was evaluated as to the recovery amount and selling price of recyclables collected by the sample groups of waste pickers surveyed in Gujranwala City and at the Gondlanwala disposal site.

(1) Gujranwala Town Areas

Evaluated were the average amount of each kind of recyclable collected per waste picker per day, unit price of each recyclable, average selling price of each recyclable in the city, and the range of unit price and selling price of each kind of recyclable.

The waster pickers in Gujranwala City segregate the recyclables collected per day according to type and selling price. The recyclable easily collected from the waste is cardboard, i.e., 37 kg/day per waste picker on average.

More cardboard, paper (others), plastics (PET and other), metals (steel and others) and hair are recovered in the town area as compared to the recyclables recovered at the Gondlanwala disposal site. Waste pickers in the town area do not segregate rubber and broken glasses, but they segregate or recover food waste.

(2) Gondlanwala Disposal Site

Evaluated were the average amount of each kind of recyclable collected per waste picker per day at the Gondlanwala disposal site, the unit price of each recyclable, the average selling price of each recyclable, and the range of unit price and selling price of each recyclable. The amounts of recyclable collected from the waste at Gondlanwala disposal site are large. Recovered quantities of shoes and glass bottles amount to 20 kg/day and 33 kg/day, respectively, per waste picker on average, but the selling amount of hairs is the highest among the other recyclables, i.e., 772 Rs./day.

Recovery amount of glass bottles, shoes and bones at the Gondlanwala disposal site is more as compared to that in the town area while rubber and broken glasses are recovered only at the disposal site. None of the disposal site waste pickers is involved in food waste recovery.

Table D.2.2 shows the results of comparison between survey samples in Gujranwala City and Gondlanwala disposal site.

Table D.2.2 Results of Comparison between Survey Samples in Gujranwala City and Gondlanwala Dumping Site

Categories of Recyclables	Recovery Amount (kg/day/waste picker)		Average Unit Price (Rs./kg/waste picker)		Average Sold Amount (Rs./day/waste picker)		Unit Price Range (Rs./kg/waste picker)		Sold Amount Range (Rs./day/waste picker)	
	GC*	GDS**	GC	GDS	GC	GDS	GC	GDS	GC	GDS
Cardboard	37	15	8	7	253	105	4-10	6-7	40-1,000	36-175
Paper (other)	13	2	8	30	83	60	5-15	30	75-100	60
Plastic (PET)	13	12	26	20	322	239	20-30	20-22	125-750	100-540
Plastic (other)	19	10	8	16	306	143	8-30	7-22	80-1200	80-240
Glass (bottles)	24	33	3	3	88	122	2-5	2-4	8-320	30-600
Glass (broken)	0	29	0	3.5	0	98	0	3-4	0	60-200
Metal (others)	11	1	44	80	400	80	30-80	80	60-750	80
Metal (steel)	3	2	25	35	75	70	25	35	75	70
Shoes	9	20	5	4	55	83	3-15	3-7	6-180	15-200
Rubber	0	6	0	5	0	29	0	3-7	0	15-42
Bones	10	11	8	9	91	106	5-10	5-10	25-400	20-200
Food Waste	10	0	15	0	165	0	10 to 22	0	75-440	0
Total	149	141			2,638	1,907				

Note: * GC: Gujranwala City, ** GDS: Gondlanwala Dumping Site
Source: GWMC, JICA Project Team

2.1.4 Conclusion

The total recovery amount by 20 waste pickers in Gujranwala City is 1,084 kg/day, which is greater than the recovery amount by 20 waste pickers at the Gondlanwala disposal site, i.e., 1,264 kg/day. The

average recovery amount per waste picker in the city is 82 kg/day; whereas, at the Gondlanwala disposal site the recovery amount per waste picker is 55 kg/day. The average monthly income of waste pickers at the Gondlanwala disposal site is 30,000 Rs./month which is almost the same as that of the waste pickers in the city, i.e., 29,500 Rs./month.

The results of this survey reveal that the recovery of resource materials in waste is carried out actively with the involvement of waste pickers, junk shops and dealers. If the resource materials recovered directly from the large waste generators to the dealers or to the factories is added, the recovery amount in the current recycling market in Gujranwala is estimated at round 70 ton/day (approximately 800 pickers x 82kg/day waste in city and 60 pickers x 55kg/day waste at dumpsite). The amount recovered by the waste pickers in addition to the material recycling is contributing to the waste diversion or reduction of landfill amount.

Thousands of people are engaged in waste linked businesses throughout the city and elsewhere. The waste pickers play an important role in the segregation and recovery of resource materials from discarded waste and add to the promotion of recycling and reuse of recyclable waste. The survey showed that the majority of households discard hazardous wastes together with other wastes. Those hazardous wastes are corrosive, toxic, ignitable or reactive and may cause injury or poisoning, particularly, to children and people who sort the waste. The waste pickers never wear protective gears against injury or sickness.

2.2 Overview of Intermediate Treatment and 3R Promotion in Gujranwala

Activities related to the intermediate treatment and 3R in Gujranwala have been surveyed to collect related information through interview with concerned persons and exploratory investigations.

In Gujranwala, there is no formal intermediate system or 3R (Reduce, Reuse, Recycle) system. Informal activities take place at various steps from the source to the final disposal site through waste-related activities (See **Figure D.2.1**). Recycling (resource recovery) has been widely done mostly through the residents, sanitary workers and waste pickers. Segregation at source and resource recovery by waste pickers has been discussed in the preceding **Section 2.1**, and private recycle shops and dealers are described in this **Section 2.2.** Under such circumstances, it is found that there are no laws and regulations related to 3R activities in Punjab, to support GWMC's 3R activities and promotion.

2.2.1 Segregation at Household

The segregation of recyclables such as plastics, newspaper, cardboard, food waste, cans and PET bottles is done mainly by the maids and children who sell them to street hawkers, private recycle shops or dealers for their supplementary income or snacks. Some private recycle shops hire workers to collect recyclables in residential areas by moving from one street to another with hand pulled carts, bicycles and motorcycles.

2.2.2 Segregation at Commercial Area

Owners or employees of commercial shops segregate recyclables such as cardboard, paper, plastic and so on, and sell them to private recycle shops or dealers. In some areas, the private recycle shops go to these commercial shops to buy the recyclables.

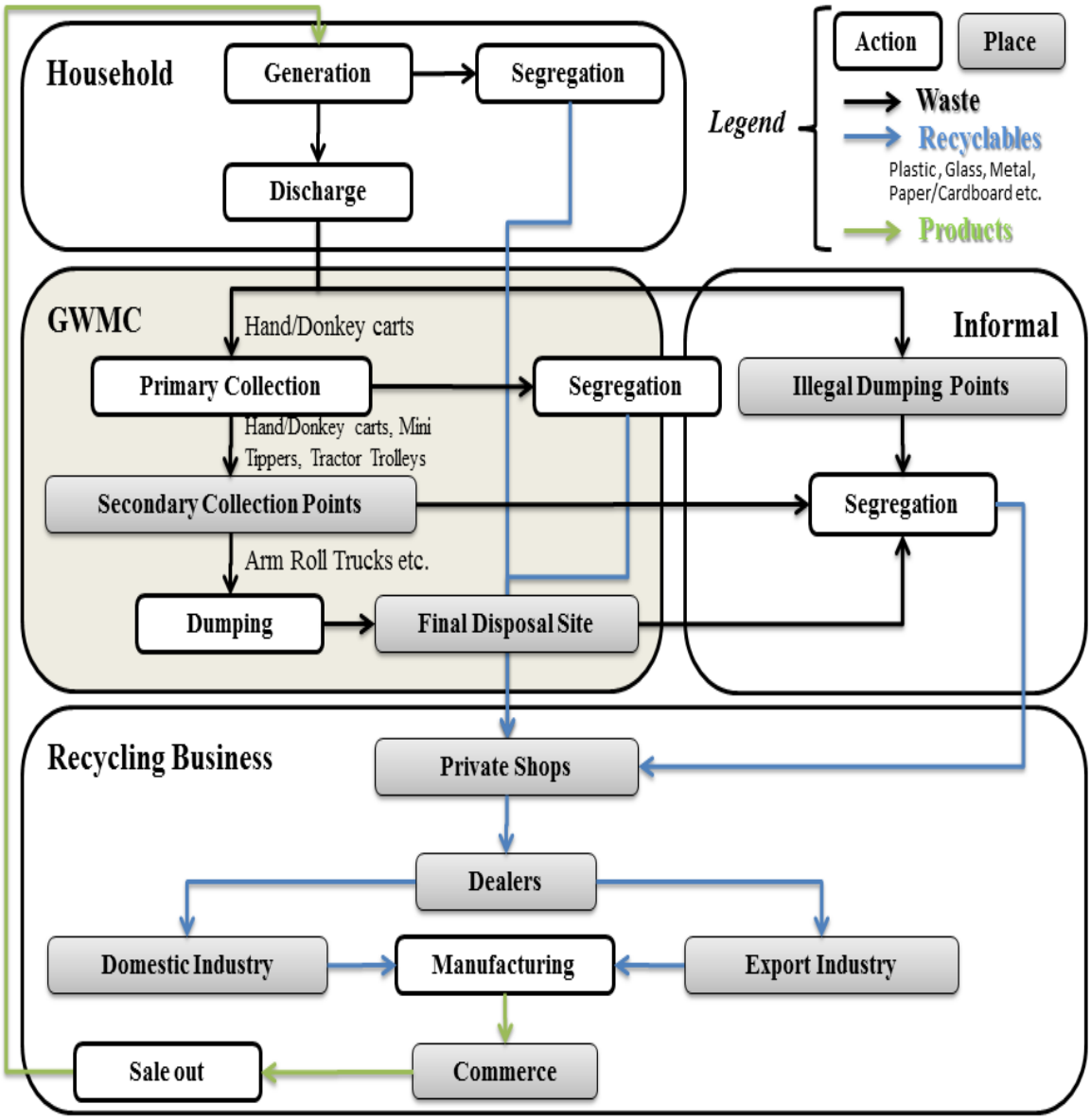

Figure D.2.1 Material Flow of Recyclables in Gujranwala

2.2.3 Waste Picking

There are two types of private waste pickers in Gujranwala. Most of the waste pickers are males of all ages. The first group works in the street, and near containers at collection points and transfer stations, move from street to street of the city as well as the open plots full of illegally-dumped waste in urban areas. The second group works at the final disposal sites.

The first group segregates and collects recyclables such as plastics, glass, cardboard, metals and so on, and sell them to private recycle shops or dealers. Since they have their own territories, the same waste pickers work at the same containers every day. In some areas, waste pickers sometimes collaborate with GWMC sanitary workers to transfer waste from hand carts or donkey carts to containers.

On the other hand, the second group segregates and collects the recyclables, carries them to the city and sell them to private recycle shops or dealers because there are no shops near the final disposal site. Since they gather the recyclables from trucks or trolleys full of waste, they interfere with GWMC's dumping work. In addition, they are at risk of being injured. In fact, almost all of them complain about not only the bad odour but also the danger of broken glasses and hospital wastes mixed in municipal solid waste.

Since no one has protective equipment such as boots, gloves, masks, and so on, some of them have experienced getting injured by broken glasses. It is then necessary to consider possible methods to protect them from getting injured and to provide means of earning for their living. Waste picking activities are shown in **Photo D.2.1**, **Photo D.2.2** and **Photo D.2.3**, and recyclables collected by waste picking are presented in **Photo D.2.4**. On the other hand, the second group segregates and collects the recyclables, carries them to the city and sell them to private recycle shops or dealers because there are no shops near the final disposal site. Since they gather the recyclables from trucks or trolleys full of waste, they interfere with GWMC's dumping work. In addition, they are at risk of being injured. In fact, almost all of them complain about not only the bad odour but also the danger of broken glasses and hospital wastes mixed in municipal solid waste. Since no one has protective equipment such as boots, gloves, masks, and so on, some of them have experienced getting injured by broken glasses. It is then necessary to consider possible methods to protect them from getting injured and to provide means of earning for their living. Waste picking activities are shown in **Photo D.2.1,**

Photo D.2.1 Waste Picking at a Container, UC No. 41

Photo D.2.2 Waste Picking in an Open Plot, UC No. 6

Photo D.2.3 Waste Picking at the Final Disposal Site and Collected Recyclables, UC No. 131

Photo D.2.4 Recyclables Collected by Waste Picking, UC No. 131

Some GWMC sanitary workers also segregate and collect the recyclables directly from domestic waste and sell them to the private recycle shops or dealers as the waste pickers do. This is partially because GWMC does not prohibit the sanitary workers from collecting the recyclables during working hours.

Based on the results of hearing survey with waste pickers in April 2014, total number of waste pickers at containers and the final disposal site is estimated at 433 (See **Table D.2.3**). In addition, there are many waste pickers moving around Gujranwala City. Therefore, the estimated number of waste pickers may exceed 800. Regarding the amount of recyclables treated by waste pickers, it can be presumed to be around 70 tons per day assuming that the average collection amount is 82 kg/day-waste picker and 55 kg/day-waste picker in Gujranwala City and Gondlanwala disposal site, respectively, based on the waste pickers survey conducted by GWMC and the JICA Project Team in December 2014.

Table D.2.3 Number of Waste Pickers at Container and Final Disposal Sites

Town / Road / Place	Number of Containers*	Number of Waste Pickers
Aroop Town	48	89
Khiali Town	57	114
Nandipur Town	51	95
Qila Didar Singh Town	40	68
G.T. Road	5	10
Chianwali Final Disposal Site	0	2
Gondlanwala Final Disposal Site	0	55**
Total	201	433

Note: * The number of containers was estimated in April 2014.
**The number of waste pickers of 55 is based on the Waste Picker Survey in 2014.
Source: Results of interview survey with waste pickers, GWMC and JICA Project Team

2.2.4 Other 3R Activities

Based on the interview with residents, the following facts regarding 3R were revealed:

- Almost all people get free plastic bags (mainly polyethylene) instead of bringing their bags when shopping.
- When people have troubles with their electronics or furniture, they tend to take actions based on 3R policy; that is, they firstly try to repair them, then handover and/or sell them out. In case of combustible materials, they stock and use them as fuel in winter.

2.3 Existing Recycling Firms in Gujranwala

In Gujranwala City, informal sector activities are very active as described in **Section 2.2**. In order to evaluate the system of segregation, collection and treatment/disposal of recyclables and abilities of related contractors, types of recyclable materials, degree of utilisation and penetration to residents, and presence or absence of markets in Gujranwala have been surveyed. Regarding the markets, size and operating structure related to firms and problems have also been examined.

2.3.1 Recycle Private Shops and Dealers

There are more than 700 private recycle shops and dealers in Gujranwala City. Basically, private recycle shops (see **Photo D.2.5**) collect recyclables from households, commercial establishments, waste pickers, street hawkers (see **Photo D.2.6**) and sanitary workers. They collect all sorts of recyclables including paper/cardboard, all types of metal, glass, plastic, bread and shoes. They also sell the recyclables to specified recycle dealers after collecting a certain amount. On the other hand, recycle dealers purchase the recyclables from recyclable shops and industrial establishments, etc., located not only in Gujranwala City but also all over Pakistan or other countries, and sell them to industrial establishments. Most of them are specialised dealers but some are general ones. In addition, it is said that there are brokers called "middlemen" who play the role of mediator between dealers and factories without treating the recyclables directly.

Regarding the price of recyclables, although it depends not only on kind of recyclables but on quality, recyclables are sold at a small profit.

Photo D.2.5 Private Recycle Shop, UC No. 54

Photo D.2.6 Street Hawkers in Peri-Urban Area, UC No. 117

(1) Targeted Recyclables

Private recycle shops and dealers treat cardboard, food waste, glass, leather, metals (aluminium, brass, copper, iron, lead, silver, tin), paper, plastics, rubber, shoes, etc. Almost all of the private shops deal with cardboard/paper, plastics and metals. Approximately half of the shops deal with food waste and glass. In contrast, approximately 70% of dealers treat exclusively metals followed by plastics (ca. 20%) and paper (ca. 15%).

(2) Price of Recyclables

Purchase prices of private recycle shops and dealers are given in **Table D.2.4**.

Table D.2.4 Price of Recyclables

Unit: Rs./kg

Item	Price Range	Item	Price Range
Cardboard	7-17	Metal	25-650
Food waste	17-18	Aluminium	100-200
Glass	1-5	Brass	120-565
Leather	17	Copper	550-650
Paper	8-20	Iron	25-45
Plastic	11-80	Lead	105
Rubber	3-4	Silver	142-175
Shoe	5-38	Tin	30

Source: Interview with private recycles shops and dealers, GWMC and JICA Project Team

(3) Profit

Regarding profit of recycle private shops and dealers, there are few direct answers from them. Based on their answers about rough transaction amount and purchase/selling prices, their profit can be estimated at between 5,000 and 125,000 Rs./month. Average profit is estimated at 30,000 Rs./month.

(4) Number of Employees

Almost all recyclable dealers hire less than 10 people at a maximum. Some owners operate their shops by themselves.

(5) Site Location

Table D.2.5 shows the minimum number of private recycle shops and dealers counted by field survey. Regarding private shops, all urban UCs except No. 4 and No. 42 have at least one shop. On the other hand, dealers operate only in about 40% of urban UCs and tend to be located in UCs with many private shops. Regarding the peri-urban UCs, there are some private recycle shops in UC No. 114, UC No. 117 and so on. However, there are no recyclable dealers in the peri-urban UCs.

Table D.2.5 Number of Recyclable Shop and Dealers in UCs

UC No.		Shop	Dealer	Total	UC No.		Shop	Dealer	Total
Aroop Town	4		1	1	Khiali Town	28	8		8
	5	6		6		29	7		7
	6	4	2	6		30	8		8
	7	3		3		31	10	1	11
	8	9	2	11		32	7		7
	9	11	2	13		33	8		8
	10	10	9	19		34	7	250	257
	11	6		6		35	11	1	12
	12	5		5		36	8		8
	13	8	2	10		37	6		6
	14	5		5		38	4	1	5
	56	2		2		47	13		13
	57	2		2		48	7	1	8
	61	9	2	11	Qiladidar Singh Town	3	2		2
	62	6		6		39	4		4
	63	5		5		40	9		9
	64	12		12		41	5		5
Nandipur Town	1	4		4		42		12	12
	2	6	1	7		43	8	10	18
	15	3		3		44	3		3
	16	1		1		45	4	1	5
	17	12		12		46	6	1	7
	18	9		9		49	10	2	12
	19	6		6		50	10	1	11
	20	7	1	8		51	3		3
	21	6		6		52	4		4
	22	6	1	7		53	5		5
	23	5		5		54	10	3	13
	24	6		6		55	1		1
	25	7	1	8		58	7	1	8
	26	3		3		59	5		5
	27	8		8		60	6	3	9
Total							398	312	710

Source: JICA Project Team

(6) Open Hours

Most of the shops and dealers open at around 8 a.m. and close at around 5 p.m. everyday except on Fridays.

(7) Year of Operation

Year of operation depends on the shop and dealer such as 2 to 35 years. The average is estimated to be about 10 years. Since there are no necessary qualifications to start a business, it seems to be relatively easy to start operations.

2.3.2 Scrap Market

It has been confirmed that a scrap market focusing on metals exists in UC No. 34 in Gujranwala City. The market is a kind of association composed of about 250 recyclable dealers in UC No. 34. The association has a board of directors, president, finance head, secretary and so on. Some of the dealers are registered with the Gujranwala Chamber of Commerce and Industry, even though it is not necessary. Although the transaction volume is not revealed, this market purchases metal scraps from all over the country and sell them to factories in Gujranwala City. Middlemen described above play the role of mediation between the scrap dealers and the factories.

2.3.3 Factory

Recycle status in factories in Gujranwala City and surrounding areas were surveyed. Almost all of the factories sell or give their recyclable waste (scrap metal, slag, plastic scrap, plaster, etc.) to recycle dealers or applicants. Some factories recycle their generated recyclable waste in their factories or purchase recyclables from dealers or other factories in order to utilise as their feedstock. Typical industries and recyclables are listed in **Table D.2.6** and scrap metal from factories is shown in **Photo D**.2.7.

Table D.2.6 Typical Industries, Recyclables, Destinations and Final Products

Industry Sector	Recyclables	Destination	Final Products
Chemicals	Plastic drum, Metal drum	Dealer	Reuse
Ceramics	Mould	Own factory	Filling material
Food	Plastic bag* (low density polyethylene (LDPE) bag, or polythene bag)	Dealer	Plastic crystals/pallets
Foundry Works	Combustion residue	Applicant	No use (waste)
Gas Appliances	Metal (Iron, Silver, Steel)	Dealer	Remoulding and rerolling
Marble	Small cuttings of marble	Dealer	Basement material
Paper	Paper	Dealer	Recycling
Plastic	Plastic*	Dealer	Plastic crystals/pallets
Sanitary Fittings	Metal (Brass)	Dealer	Remoulding
Spare Parts	Metal (Aluminium, Brass, Copper, Iron, Steel)	Dealer Other Factory	Spare parts, e.g., nuts, bolts, etc.
Utensil	Metal (Iron, Brass, Steel) Metal (Aluminium) Plastic (Becolite)	Dealer Own furnace Factory workers	Kitchen ware and spare parts, sanitary fittings spare parts

Note:* According to the interview results with industrialists and recyclable manufactures, plastic bag and plastic in the above table is not made of poly-vinyl chloride in Gujranwala. However, there may be no law or regulation to prohibit the use of poly-vinyl chloride in the country.
Regarding plastics, there are some notifications which may be called the prohibition of non-degradable plastic products (manufacturing, sale and usage) of polyethylene, polypropylene or polystyrene, Regulation 2013 ("Extraordinary Published by Authority, Part-II Statutory Notifications (S.R.O), Government of Pakistan Environmental Protection Agency, Islamabad, 2013", and "The Punjab Gazette published by the Authority, Law & Parliamentary Affairs Department, 2002).

Photo D.2.7 Metal Scraps from a Factory of Small Industrial Estate (SIE) (II)

2.3.4 NGO

There are three (3) NGOs related to the environment sector in Gujranwala, namely; Organization Pan Environment (OPE), Gujranwala Environmental Organization (GEO) and Social Transmission & Environmental Protection Society (STEPS). One of them, OPE, carried out a pilot project for composting as part of a waste collection program financially supported by an international NGO named Water Aid. In particular, from May 2011 to January 2012, OPE had collected domestic waste and segregated organic waste from the waste in part of UC No. 8. The number of covered households (HH) and population was about 1,800 and 15,000, respectively. After segregation, organic wastes were transported to UC No. 38 about 10km away from UC No. 8 for composting. OPE adopted the pile method for composting under the technical cooperation of the University of Agriculture Faisalabad. The number of members related to this project was 13, i.e., 11 for sanitary workers and 2 for social mobilisers. During the first 6 months, OPE provided the door-to-door collection service for free and started to charge 50 Rs./month/HH after 6 months. Since the collection rate of waste discharge fee was only 25%, OPE could not continue to provide the service after funding stopped. With regard to composting, OPE collected organic waste of about 900 kg/day and produced compost with 25% of weight recovery rate. OPE gave compost free of charge and sometimes sold them at 20 Rs./kg. Reasons for the failure in the marketing of compost were: (1) OPE does not have a licence for the sale of compost; and (2) Farmers want immediate results. While compost gives results in 5-6 years, chemical fertilizers give more yield of crops and immediate results. Therefore, the demand of compost is not much at present.

GEO has been entrusted the project of installation of dust bins by the Environmental Protection Department (EPD). Dust bins were installed outside government offices, colleges and adjoining streets of UC No. 90 and No. 54, and small dust bins were distributed free of charge to shopkeepers. The project was completed in almost 2 months. GEO also printed awareness messages on $5m^3$ waste containers placed in different UCs of the city. STEPS conducted an awareness campaign related to environment in a school of Gujranwala.

2.3.5 Private Composting

In one of the largest parks in Gujranwala City named Gulshan Iqbal Park, composting has been practiced for more than 23 years. After establishment of 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.

Pit and open heap/pile method of composting is being practiced. In the open heap/pile method, cow dung, dry crushed leaves and earth are mixed at the ratio of 3:2:14. Periodic sprinkling of 5% DAP (Di-Ammonium Phosphate) solution is done on the pile. In the pit method of composting, 2 feet high layer of leaves of eucalyptus tree in the park are placed in the pit and periodic sprinkling of 5% DAP is also done.

The process is completed in 3 pits. After every 3 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 were grown using this compost in 2014. PHA has a plan to expand composting into the other parks in Gujranwala City. **Photo D.2.8** shows the interview with the administrator of the Gulshan Iqbal Park regarding their composting activity.

Photo D.2.8 Interview on Composting with the Administrator of Gulshan Iqbal Park, Gujranwala

2.3.6 Farmer

In Gujranwala District, large cultivated lands spread in the peri-urban UCs. **Table D.2.7** shows the cultivated area of each crop in Gujranwala City and Sadar Tehsil. The major crop occupies approximately 95% with rice and wheat. On average, fertilizer consumption amount of wheat is 100 kg of urea, 75 kg of DAP (Di-Ammonium Phosphate) and 50 kg of potassium per acre. On the other hand, the amount for rice is 100 kg of urea and 50 kg of DAP per acre. The total fertilizer consumption of crops is estimated to be approximately 50,307 tons per year in Gujranwala City and Sadar Tehsil. It was revealed through interview with the Managing Director (MD) of Lahore Compost Company that 6-7 bags of 50kg are required per acre. The total compost consumption for crops is estimated to be 110,291 tons per year in Gujranwala City and Sadar Tehsil. As shown in the table, for example, unit price per acre of chemical fertilizers application for wheat becomes 11,300 Rs./acre and unit price of compost application for wheat becomes 1,750 Rs./acre. Compost is cheaper than the chemical fertilizer. So far, there is no data available for chloride ion concentration in compost in Gujranwala. However, it is assumed that since the salt in compost comes from food waste, the salinity of a dish to become delicious will be less than 1%, and there are not large amounts of food waste mixed in the total amount of organic waste.

The interview survey conducted in peri-urban areas with the local farmers showed that they are well aware about the benefits of applying organic fertilizer or compost for healthy and eco-crops. The organic fertilizer produced by cow dung is used as a base fertilizer after cropping or before seeding by the interviewee farmer. The cow dung softens the soil and the farmers use it in combination with chemical fertilizers for more yield in a shorter time. The farmers want to see the effects of compost application on test yards at the compound of the proposed compost plant in Gujranwala. In addition, it was revealed through some interviews with farmers that they do not want to start utilising compost without verification tests by authorised public institutions.

Table D.2.7 Comparison of Cost and Consumption of Chemical Fertilizers and Compost Application on Crops in Gujranwala City and Sadar Tehsil (2013-2014)

Crop Type	Cultivated Area		Quantity of Chemical Fertilizer Required (tons)	Estimated Cost of Chemical Fertilizers Application (Rs.)	Quantity of Compost Required (tons)	Estimated Cost of Compost Application (@ 7 bags/acre) (Rs.)
	(acre)	Ratio (%)				
Wheat	139,408	44.2	27,882	1,575,310,400	48,793	243,964,000
Rice	159,892	50.7	20,466	1,674,868,700	55,962	279,811,000
Vegetables	4,070	1.3	1,018	57,387,000	1,425	7,122,500
Sugarcane	180	0.1	45	2,506,500	63	315,000
Maize	189	0.1	43	2,475,900	66	330,750
Fodder	11,378	3.6	853	48,356,500	3,982	19,911,500
Total	315,117	100.0	50,307	3,360,905,000	110,291	551,454,750

Source: Agriculture Department Gujranwala

Although more precise recycle rate cannot be calculated at this stage without the whole result of WACS (Waste Amount and Composition Survey), it can be said that the recycle rate has already reached a certain figure and that there are less recyclables distributed in the informal recycle sector at the final disposal site.

Currently, there are no formal activities related to intermediate treatment and 3R although it was observed that an appreciable extent of informal activities regarding intermediate treatment and 3R are carried out. Therefore, it is important to design the systems of utilisation of non-recycled waste with minimising effect to the informal activities.

2.4 Lahore Compost Company and D.G. Khan Cement Company

There are companies for composting and RDF production, namely; the Lahore Compost Company and D.G. Khan Cement in Lahore, Punjab. The JICA Project Team visited the plants and equipment of the Lahore Compost Company and D.G. Khan Cement together with members of GWMC in 2014 and 2015. Salient features of the plants are summarised in **Table D.2.8** and some photos of the on-going Lahore Compost Plant are shown in **Photo D.2.9** and **Photo D.2.10.**

Compost produced at the Lahore Compost Plant seems not to go well because it was observed that a half or more of the compost products were remaining unsold. One of the reasons seems to include that the trust of the users (farmers and inhabitants) about the compost is not obtained, according to the interview survey. Interview results with the Lahore Compost Company and D.G. Khan Cement Company are also shown in the table below.

Table D.2.8 Salient Major Features of the Lahore Compost Company and D.G. Khan Cement

Project Name	Project Overview	Descriptions
Lahore Compost Plant	Contracting parties	City District Government Lahore and Lahore Compost Company (pvt.) Ltd. (LCL)
	Description of service	Establishment of compost plant
	Operation capacity	1,000 tons/day
	Total plant area	25 acres
	Cost of raw material	Raw material, i.e., municipal solid waste is given free of cost to Lahore Compost and it shares 10% of its profit to LWMC,
	Description of staff involved	Project manager, supervisor, mechanics, engineers, biochemist, marketing representative, labourers, etc.
	Description of equipment	Imported plant from Belgium of Rs. 300 million containing all equipment sorting conveyors, trammel screen, shredder, turner, bagging unit
	Start of operation	March 2006
	Contract period	25 years
	Compost preparation time	60~90 days
	Production amount	200-250 ton/day of compost and approximately 250 ton/day of RDF
	Present status	In operation

Project Name	Project Overview	Descriptions
	Major merits of compost*/RDF	• Compost is cheaper than other chemical fertilizers, and is useful in long term for soils and crops, increasing the soil porosity and nutritional supply of plants. Compost is environmental friendly. • Compost can reduce waste amounts on the landfill site drastically. • RDF is cheaper than other fuel types. • RDF reduces waste amounts and a burden on the landfill site, and increases its life span.
	Major points to be addressed*	• The bulk density of Lahore compost products was simply measured at the office of GWMC and the results reveal more than 1.0 t/m^3, which may be higher than the density of real compost. • Organic matter of the Lahore compost is around 15% which is smaller than 35 to 40% of organic matter in Japan in general. It is advised that quality of Lahore compost should be improved in terms of high organic contents. • Although the LCL has a licence for compost production from the Agricultural Department Directorate of Soil Fertility Punjab, it is suggested that quality control of Lahore compost should be improved. • Aside from quality control of Lahore compost, IEC programmes on effectiveness and safety of Lahore compost is further needed for the farmers. • Although the LCL has currently a contract for RDF sale with Lafarge Group, the LCL may need to consider contracts with other enterprises to expand the market for RDF.
D.G. Khan Cement RDF Plant	Contracting parties	Lahore Waste Management Company and D.G. Khan Cement Company (Pvt.) Ltd. (DGKCC)
	Description of service	Establishment of Refuse Derived Fuel (RDF) plant
	Operation capacity	700-800 ton/day
	Cost of raw material	Raw material, i.e., municipal solid waste is sold at Rs. 52/ton to D.G. Khan Cement Company
	Total plant area	45 acres
	Description of staff involved	Project manager, plant engineer, supervisor, labourer, mechanics, etc.
	Description of equipment	Imported equipment plant from Germany containing shredder, magnetic separator, vibratory screen, wind shifter and baler unit.
	Start of operation	2013
	Total Cost	Rs. 1.5 billion. (total construction cost including equipment) Operation and maintenance cost: Rs. 200,000-300,000/month; Production cost: Rs. 100/ton; Transportation to Kallar Kahar: Rs. 900/ton; Operation cost: Rs. 1,000-1,200/ton; Selling price of RDF material: Rs. 53/ton
	Production amount	280-320 ton/day of RDF
	Operation status	Under operation
	Major merits of the Plant*	• RDF is cheaper than other fuel types and contributes to the reduction of waste amount incoming to the final landfill site and thus prolonging its life span. • RDF has the advantage of lighter combustible fluff after bailing to transport them to their own plant at Kallar Kahar. • The owner company of Nihat Group which has more than 25 industries in the country uses the RDF at their own kilns. • An energy pilot project for waste biogas is in progress and DGKCC intends to produce electric energy for plant use which depends on feasibility. For this reason, DGKCC does not need to search for other markets of RDF to meet their fuel demand.
	Major points to be addressed*	• Currently a big amount of organic waste is being landfilled. • Only some number of cement companies such as Lafarge, DGKCC, Lucky Cement, etc. use RDF materials in their kiln in combination with other fuels. • As RDF that contains plastics, rubbers and leathers, etc. produces toxic gases on burning, proper operation and management of the combustion temperature should be crucial for the air pollution control technology.

Source: Interview results with Lahore Compost Company (Pvt) Ltd. and D.G. Khan Cement ((Pvt) Ltd.
Note: Actual operation of the Lahore Compost Plant started in March 2006.
* Means the results of the interview with Lahore Compost Company (Pvt) Ltd. and D.G. Khan Cement ((Pvt) Ltd

	
Existing Mehmood Mooti landfill (Lahore) and compound of Lahore Compost Plant	Storehouse and bagging unit next to the compost & RDF plant
	
Primary sorting process and magnetic separator for compost & RDF	Trammel screen for composting
	
Sorting process for RDF	Compost windrows (centre) and organic materials from parks (right)
	
RDF materials	Organic compost product

Photo D.2.9 Composting Operation of Lahore Compost Plant

	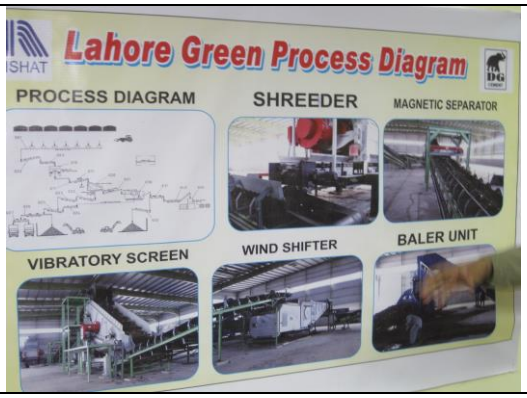
RDF Product Plant	Presentation on RDF material processing
	
Input waste into the RDF plant	Magnetic separator
	
Main Equipment (vibratory screen, wind shifter, baler unit)	Vibratory Screen
	
Wind Shifter	RDF material before baler unit

Photo D.2.10 RDF Production of D.G. Khan Cement

2.5 Evaluation of Intermediate Treatment and 3R Promotion Condition

The problems and issues in relation to intermediate treatment and 3R (Reduce, Reuse, Recycle) activities under the current situation are summarised in **Table D.2.9**. These items will be the basic elements to develop the plans, programmes and projects to compose the Intermediate Treatment and 3R Promotion Plan in the Integrated Solid Waste Master Plan in Gujranwala.

Table D.2.9 Identification of Problems and Issues in Intermediate Treatment and 3R Promotion

Problems	Description of Problem	Issues for Solving the Problems
1. Absence of formal intermediate treatment and 3R facilities	Gujranwala City has not developed intermediate treatment or 3R facilities until now.	GWMC should introduce formal intermediate treatment and 3R facilities with consideration on not only budget but also the awareness of residents. To determine the necessary and sufficient facilities, the result of WACS shall be fully considered.
2. Lack of awareness of residents on intermediate treatment and 3R	People who do not want to get little money from recyclables are not interested in the segregation of waste. In addition, almost all people neither bring bags for shopping nor conduct pre-treatment like pressing and dewatering. On the other hand, GWMC has not started educational programmes for intermediate treatment and 3R.	GWMC should raise the residents' awareness regarding the intermediate treatment and 3R. Even if there are enough facilities and systems related to the intermediate treatment and 3R, they will not be effective without the consciousness of the residents.
3. Health Risk of Waste Pickers	Waste pickers never wear protective equipment like shoes, masks, gloves and helmets to protect themselves from injury or sickness. Although they sometimes disturb operation like unloading and collecting, GWMC should not oversimplify this problem. It cannot be solved by prohibiting their activities since they do not have any other means to earn a living except waste picking at present.	Instead of imposing a limit on their work to improve operation efficiency, GWMC should provide alternative opportunities when they make a living. The countermeasure for Problem 1 in this table must be considered first to determine the countermeasure for this problem.
4. Ambiguous flow of recyclables	Although there are no formal facilities and systems for the intermediate treatment and 3R in Gujranwala City, there are so many people involved in the recovery of recyclables. There seem so many flows of recyclables, and the amount of recyclables in each flow or point cannot be identified at this moment.	In order to set reasonable goals of intermediate treatment and 3R plan, it is necessary to grasp the current situation quantitatively or the recovery rate. It is also needed to measure the effect of several plans related to intermediate treatment and 3R. Therefore, GWMC should take measures to calculate the recovery rate periodically.
5. Not well known quality & effect of compost products of the Lahore Compost / RDF Plant	Compost produced at the Lahore Compost Plant seems not to go well because a half or more of the compost products seem to remain unsold. The users do not trust the safety and quality of compost produced at the plant.	A regular quality control in the compost production process should be carried out. A periodical quality inspection system by the public institutions or agencies should also be established for certification of the compost products. Additionally, it is needed to perform a continuous IEC activity on the needs of 3R and running the compost plant for the integrated solid waste management project in Gujranwala.
6. Lack of laws and regulations related to 3R	There is no enforced legal system such as laws and regulations on SWM and 3R activities in Gujranwala, Punjab, to support GWMC's 3R activities and promotion.	As legal background to organize or ask the waste generators or recycling people to join the programs on SWM, recycling laws are needed to be legislated due to the weak legal status of the concerned organizations and sectors for 3R activities.

3. PLANNING DIRECTIONS OF INTERMEDIATE TREATMENT AND 3R PROMOTION PLAN

3.1 Objective

The objective of the Intermediate Treatment and 3R Promotion Plan is for reduction of domestic waste generation, recovery of resources, reuse, recycling, intermediate treatment and resource circulation.

3.2 Planning Policy

- The development plan of intermediate treatment and 3R promotion activities shall be formulated in 2030 as the final target year of the master plan.
- The plans should be implemented with consideration for not only limited budget but also informal activities related to intermediate treatment and 3R promotion.
- The intermediate treatment plan shall be implemented through privatisation while the municipal solid waste management in collection, transportation and disposal shall be carried out and managed by the GWMC.

3.3 Planning Strategy

- The appropriate quality control of compost shall be indispensable to maintain the proposed central compost and RDF plant to be operated by a new compost company of Special Purpose Vehicle in Gujranwala.
- The awareness raising and IEC campaign on the intermediate treatment and 3R promotion activities shall be exercised upon public, schools and stakeholders in Gujranwala by leading of GWMC continuously.
- The recycling law shall be enacted or legislated to promote 3R activities and formalise the rapidly growing informal resource recovery activities.

4. FORMULATION OF INTERMEDIATE TREATMENT AND 3R PROMOTION PLAN

As stated earlier in **Chapter 2**, the intermediate and treatment and 3R (Reduce, Reuse, Recycle) of current condition were studied and evaluated in **Section 2.5** including existing 3R activities in the city and peri-urban area, and current problem identification. Then, the planning directions of the master plan were described in terms of objectives, planning policies and strategies in **Chapter 3**. Based on the results of the study on the Project, the Intermediate Treatment and 3R Promotion Plan will be formulated in consideration of the applicable technology in Gujranwala, the Punjab Province and with the involvement of stakeholders through the utilisation of existing functions to the maximum extent including improvement.

4.1 Development of Alternatives for Intermediate Treatment and 3R Plan

4.1.1 Intermediate Treatment Plan

(1) Outline of Proposed Intermediate Treatment Plan

Considering the overall financial constraint against the solid waste management by GWMC, the ISWM Master Plan is to be formulated with the required minimum system to be developed, especially, for waste collection services and waste disposal. However, as stated by the Managing Director of GWMC, the development of intermediate treatment shall be a privatisation option at this stage. The intermediate treatment facilities are indispensable for the establishment of an integrated solid waste management system for Gujranwala City. Therefore, studies should be carried out for several intermediate treatment options towards future development in consideration of the result of waste composition analysis, as described in the following subsections. The flowchart of selection of the intermediate treatment and 3R activities is shown in **Figure D.4.1.**

(2) Proposed Technical Options of Intermediate Treatment

In view of the technical options commonly discussed nowadays among the people concerned, the six (6) technical options including Option 1, No Treatment; Option 2, Composting; Option 3, MRF (Material Recovery Facility); Option 4, Incineration; Option 5, RDF; and Option 6, Biogas were selected and considered for evaluating the most appropriate intermediate treatment facilities for Gujranwala, Punjab. These technical options were evaluated according to factors such as waste characteristics, progress and process of "waste to compost, to energy" projects in Gujranwala City, practices in other countries, quantitative economic factor, etc. The following descriptions present the development of the plan and the evaluation for selecting the best option of intermediate treatment facility.

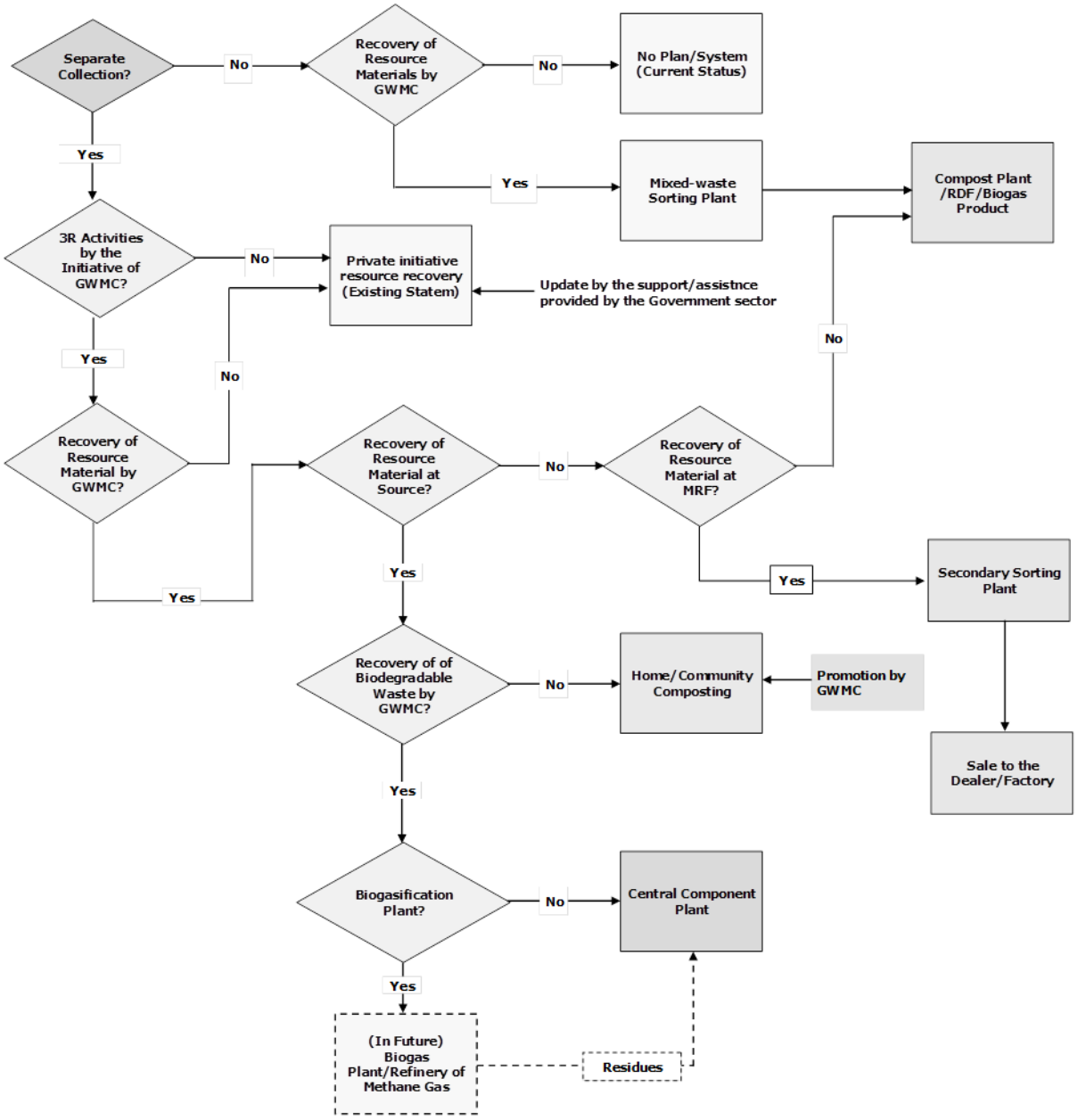

Figure D.4.1 Flowchart of Selection of Intermediate Treatment and 3R Activity

(3) Qualitative Evaluation of Intermediate Treatment Options

There are many technical methods of intermediate treatment of municipal waste although some of them are effective only for small scaled systems and some other options are technically sophisticated. Considering the waste characteristics, the waste amount for treatment and the technologies discussed with the people concerned, the following five (5) technical options including composting, MRF, incineration, RDF, and biogas were selected to further study as possible intermediate treatment facilities for Gujranwala City, Punjab. Among these 5 potential options, general descriptions of respective potential options will be mentioned below.

Composting Option

Higher ratio of food waste, biodegradable waste, at more than 62% of municipal waste in Gujranwala, composting will be the most practical means for intermediate treatment. In Punjab, 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 (refer to details in **Table D.2.8**).

Introduction of composting in Japan: Methanisation in Japan started only in recent years especially in food industry, for recycling of leftover food to comply with the Foodstuff Recycling Law enforced in 2000. Waste amount treated with methanisation is only 0.05% by 27 facilities and the largest plant treats about 12 tons per day. On the other hand, waste amount treated with composting reached 0.24% by 77 facilities and the largest plant treats about 30 tons per day in Japan. In some cases, methanisation is practiced more popularly in farms where breeding hogs or cowshed use farm waste together with excrements of pigs and/or cattle. The information of technological reliability and the installed number of plants are still not enough to evaluate introduction of large scale methanisation plants for treatment of biodegradables in municipal waste. In Japan, composting of municipal waste is not a popular method for treatment of municipal waste. However, the number of composting facilities has been increasing recently and the farmers in Japan are paying attention to compost for organic farming.

Introduction of composting in Indonesia: In Surabaya, Indonesia, the breathing or ventilation type container such as the plastic basket lined with geo-textile is used for the home method composting to put in raw wastes discharged from kitchens, etc., together with seeding material for composting. One of the seeding materials called "composting kit" made from Lacto-base bacteria solution composed of fermented soy beans, yoghurt, yeast, etc., which are effective for fermentation, decompose organic wastes into compost without rotting and reduce offensive odour generated in the anaerobic composting processes. After a couple of months, the input waste could be discharged from the container and buried into the ground or piled up for final maturation. The matured organic waste, compost, could be used by residents for their gardens or parks in the region.

In Surabaya, the NGO, PUSDAKOTA, established by the Surabaya University is planning to collect home-made compost in return for money. The NGO also plans to guide the people, depending on the compost quality, on how to input organic waste, maintain the compost container, etc., for the purpose of improving the compost quality. The price of compost brought by the residents depends on the compost quality and this pricing system gives incentive to the people for producing a better quality of compost at home. This method shall be studied to search for the possibility of its introduction in the area especially in the high income group houses with gardens wide enough for home composting.

Susun Method for Community Level Composting; PUSDAKOTA as a counterpart of Kitakyushu International Techno-Cooperative Association in Japan (KITA) has been implementing the community level composting since 2006 in conjunction with the activities of the waste bank system mentioned above. The Susun Method also uses the breathing type or basket plastic containers. Raw organic waste together with native microorganisms is put into the plastic basket lined with geo-textile and then the plastic baskets are piled up to appropriate heights and widths to easily handle the containers manually. Pre-fermented compost taken out from the plastic basket is shredded and piled up to 1-1.5m compost pile for maturation. Tuning of the compost pile, measurement of temperature and adjustment of moisture is carried out in every two days depending on the conditions. Control of composting processes through the efforts of the staff of the community group results in a better quality of compost produced and the system to return the profit derived from the recyclable waste is being established.

Introduction of composting in Bangladesh: Waste composition in Dhaka City Corporation (DCC), the capital of Bangladesh, is very similar to that of Na where the majority contains organic waste. DCC has not taken effective measures against organic waste for many years mainly due to financial difficulties. Under the circumstances, Waste Concerns, the registered NGO, constructed a middle-scale compost plant with the capacity of 130 tons per day and started operations in the beginning of 2009 to produce compost from biodegradable wastes collected from markets upon approval of DCC. This plant was approved by the Government of Bangladesh and by the CDM Executive Board of UN for the CDM 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. Composting by the central method could be started firstly with composting of organic wastes from public markets and the second step could make use of kitchen waste or food waste from the households, restaurants and hotels through establishment of waste segregation and separate collection systems. In addition, the study shall be carried out to discover the possibility of linkage between the government and the private sectors since the cooperation of these parties will be a key to the development of a central compost plant.

Introduction of composting in Kenya: Least cost composting methods of biodegradable will be developed taking into consideration of the premises. The proposed Task Force under DoE shall prepare the implementation plan to promote home composting and community level composting, and explore the possibilities for central composting. Implementation of home composting in the pilot residential areas to provide training, instructions, information for home composting and expansion to the neighbouring areas, evaluation of effectiveness of home compost, community compost and central compost for continuation of the programmes. Analysis of data on demand and supply of compost in Na and the surrounding areas for ensuring that compost derived from waste is supplied for farming and gardening.

MRF (Material Recovery Facility) Option

Objective waste is sorted waste for recycling of metal, glass, paper, plastics, and other valuables, and the recyclables are stored at the open space or small scaled house. Small scaled composting is also managed by community people and the compost is used for residents' gardening. Recyclables are sold to junkshops, recyclable shops, etc.

Introduction of MRF in Thailand: The bank for recyclable waste or the waste bank was established for the segregated recyclable wastes such as paper, glass, plastics and metal recovered directly from the waste generation sources by the residents and/or from the community activities. The recovered recyclables are sold at the bank and the junkshops or the recyclers purchase the recovered waste from the bank. The system is being practiced mainly in schools and communities in the local municipalities in Thailand.

The profits from selling the valuable wastes from the houses are returned to the people who bring the valuable waste, and the community-based organizations for their operating funds. For example, the profits are used for the procurement of stationery and text materials in the schools and the costs for improvement of the environment in the communities. In addition, some parties use the profits to hire waste pickers and deploy them to operate and maintain the recyclable waste storage facilities after training on segregation methods.

According to the report "Waste Minimisation 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. The report introduces several good practice community activities. In the Suksan-26 community, they started their own solid waste management programmes for segregation of waste at waste generation sources and composting programmes. The results of this programme brought about reduction of waste disposal amount and income generation through marketing the recovered recyclable wastes and compost products. In Lumphun Municipality, residents discharge organic waste at the storage provided by the local authority for composting and reduced 50% of waste for final disposal. In Phitsanulok Municipality, many communities have conducted composting programmes and provided the composting techniques to other communities. In Rayong Municipality, they are trading recyclable waste with eggs as substitute for cash payment.

Introduction of MRF in the Philippines: The establishment of a materials recovery facility (MRF) 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 barangays (villages) with the participation of

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 and the valuable wastes brought to the MRFs are very few.

Incineration Option

Objective waste is combustible.

Introduction of incineration in Japan: The intermediate treatment practiced by 1,817 facilities of the local government units in Japan was implemented in fiscal year 2007. In Japan, municipal solid waste amount for treatment and disposal reaches approximately 150,000 tons per day. The incineration method is the most popular treatment method at 68% followed by recycling facilities, direct recycling, and bulky waste treatment facilities at 6%, 5% and 5% respectively. Waste incinerators are the major intermediate treatment facilities in Japan. Specifically, the reason is due to the government's policy notifying the local government units to take consideration of limited land area within the jurisdiction area and the necessity to reduce the waste volume for final disposal. In addition, the calorific value of waste in Japan is high enough and advantageous to introduce incineration plants in the local government units except for the municipalities in rural areas where agriculture is the major industry.

The three contents, water content, combustibles and ash, for the incinerator with power generation are 44.1%, 48.6% and 7.3 % respectively; while, the incinerator without power generation are 47.9%, 45.2% and 6.9 % respectively. With regard to the average calorific value computed from the three contents, the incinerator with power generation indicates more than 8,000 kJ/kg waste, while the incinerator without power generation indicates more than 7,500 kJ/kg waste in Japan.

RDF (Refuse-Derived-Fuel) 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 a waste technology. RDF processing facilities are normally located near a source of municipal solid waste and, while an optional combustion facility is normally close to the processing facility, it may also be located at a remote location. A comprehensive review is now available on RDF production, quality standards and thermal recovery.

Introduction of RDF in Europe: RDF can be used in a variety of ways to produce electricity in coal power plants such as the cement kiln industry, where the strict standards of the Waste Incineration Directive are met. RDF can also be fed into plasma arc gasification modules, pyrolysis plants and where the RDF is capable of being combusted cleanly or in compliance with the Kyoto Protocol, RDF can provide a funding source where unused carbon credits are sold on the open market via a carbon exchange. However, the use of municipal waste contracts and the bankability of these solutions is still a relatively new concept, thus RDF's financial advantage may be debatable. (https://en.wikipedia.org/wiki/Refuse-derived_fuel)

Introduction of RDF in England: The city of Manchester, in the northwest of England, is in the process of awarding a contract for the use of RDF which will be produced by proposed mechanical biological treatment facilities as part of a huge PFI contract. The Greater Manchester Waste Disposal Authority has recently announced that there is significant market interest in initial bids for the use of RDF which is projected to be produced in tonnages up to 900,000 tons per annum.

Introduction of RDF in Sweden: During spring 2008, Bollnäs Ovanåkers Renhållnings AB (BORAB) in Sweden, started their new waste-to-energy plant. Municipal solid waste as well as industrial waste is turned into refuse-derived fuel. The 70,000-80,000 tons RDF that is produced per annum is used to power the nearby BFB-plant, which provides the residents of Bollnäs with electricity and district heating.

Introduction of RDF in Israel: In the fall of 2013 a cornerstone-laying ceremony for the new Refuse Derived Fuel (RDF) plant in Israel took place at the Hiriya Recycling Park near Tel Aviv. The

future RDF plant will be operational for 20 years, hoping to convert 540,000 tons of annual waste into fuel. The fuel is produced by shredding and dehydrating municipal solid waste (MSW) with a waste converter.

Biogas Option

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.

(https://simple.wikipedia.org/wiki/Biogas)

Introduction of biogas 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 household level. "Evaluation of Bio-gas Initiative in Punjab", National Rural Support Programme (NRSP), August 2011.

Introduction of bio-gas in Japan: Generation of methane gas is carried out under the constant temperature of biodegradable liquid in the methanisation tank through bacterial reaction and it becomes difficult to enlarge the plant scale. In some cases, methanisation is practiced more popularly in farms where breeding hogs or cowshed use farm waste together with excrements of pigs and/or cattle. The information of technological reliability and the installed number of plants are still not enough to evaluate introduction of large scale methanisation plants for treatment of biodegradables in municipal waste. In Japan, composting of municipal waste is not a popular method for treatment of municipal waste. However, the number of composting facilities has been increasing in the last 10 years and the farmers in Japan are paying attention to compost for organic farming.

Table D.4.1 summarises the qualitative evaluation of the six (6) potential options for intermediate treatment which could be considered for the intermediate treatment facilities of Gujranwala City. As a whole, 1) waste characteristics; 2) higher water content due to high ratio of food waste commingled gives an advantage to composting in municipal waste; 3) actual performance results; and 4) GWMC's policy on intermediate treatment, are the keys to choose the best alternative shown in the table. Municipal waste incineration in Gujranwala City is disadvantageous. Considering the impacts to environment, Option 2: composting, and Option 5: RDF, are selected as the more environment-friendly intermediate treatment systems. As stated earlier, the development of intermediate treatment is obliged to take consideration of the privatisation. As for sales and marketing of the RDF products of the proposed Gujranwala compost/RDF company, it is necessary for GWMC/SPV to push forward the contract negotiation with the existing or new cement companies in near future (by year 2019). The costs for investment, operation and maintenance in Option 3, Option 4 and Option 6 seem not affordable to private companies for the intermediate treatment and 3R activities.

Table D.4.1 Qualitative Evaluation of Intermediate Treatment Options

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
Objective Waste	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	Cheaper	Moderate
	-	A	A	B	A	A
Environmental Aspect	Need removal of illegal waste disposals and pollutants in 64 UCs and 34 UCs	Odour in mis-operation	Odour in mis-operation	Need removal of pollutants from combustion gas emission	Need removal of pollutants from combustion gas emission	Odour in mis-operation Hard disposal of digestive liquid after having gasified.
	B	A	A	A	A	A
Applicability	-	Small towns to large cities	Small communities to middle cities	Small towns to large cities	Small towns to large cities	Villages /small towns in rural areas
	B	A	B	B	A	B
Actual Practical Experiences in Punjab	-	There is the Lahore Compost Company.	There is no MRF in Gujranwala.	There is no incineration plant for municipal waste treatment.	There are cement plants using RDF as fuel in D.G. Khan Cement Company, and Lafarge/Fauji Cement companies.	To date, NRSP* installed 197 biogas plants for cooking, reduce household expenses, etc. in the country.**
	B	A	B	B	A	A
Recommendations for application to Gujranwala solid waste intermediate treatment facilities	-	Highly applicable	Less attractive than composting & RDF.	More attractive composting & RDF than incineration.	Highly applicable	Not now. In particular, recommended in future in rural areas.
	-	A	B	B	A	B
Policy of GWMC	GWMC recommends Option 2: Composting, and Option 5: RDF, as the most practical/reliable intermediate treatment facilities through privatisation in Gujranwala.					
	-	A	B	B	A	B
Evaluation Results	-	**A**	**B**	**B**	**A**	**B**

Legend: : 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.

4.1.2 3R Promotion Plan

(1) Outline of Development of 3R Promotion Plan

The programmes under the 3R promotion plan were formulated basically with soft component programmes defining the roles, responsibilities and activities of each party including GWMC, waste generators and CDGG. The implementation of programmes should be carried out through the primary initiative and effort of GWMC while the intermediate treatment facility is to be owned and managed by the private sector and not GWMC. There are many programmes commonly

practiced in the world for 3R activities which can be categorised with waste generation source control, waste discharge control, waste recovery and reuse, and recycling of materials. These programmes are also applicable for the 3R activities in Gujranwala City. The programmes and activities will be performed mostly with the raising of awareness of waste generators and stakeholders through public campaigns, formal and school education, pilot projects and capacity development of the GWMC staff concerned. In fact, it is revealed that the recovery of recyclable materials is highly activated by the development of material recovery facilities. Each programme under the 3R promotion plan is as elaborated below.

(2) Proposed Technical Options of 3R Promotion

Basically, the 3R scheme is composed of many kinds of soft component programmes for waste reduction, recovery, re-use and recycling to promote 3R activities among the parties concerned. The plan should be implemented comprehensively with all the possibly effective programmes which are divided into the four categories summarised below. The 3R programmes in the four categories are inter-related, and should be implemented to achieve the goals of 3R.

- Waste Generation Source Control for Waste Reduction
- Waste Discharge Control for Recovery and Waste Diversion
- Recovery of Recyclables at Sources and Reuse
- Recycling of Recyclable Materials

(a) Waste Generation Source Control for Waste Reduction

The programmes under the waste generation source control target the activities to minimise the generation of waste through the production of durable goods and the avoidance of over-packaging in distribution and sale, and by motivating and changing the awareness of waste generators toward a lifestyle of resource and environmental conservation. These activities should be implemented in five sub-programmes: production control, distribution and sale control, consumer control, waste charge control, and commercial and institutional waste control.

(b) Waste Discharge Control for Recovery and Waste Diversion

Waste discharge control aims at reducing the amount of waste discharged by individual waste generation sources through self-disposal at the backyard, converting organic waste into compost, repair and reuse of broken instruments and appliances, and exchange or sale of reusable goods within the community. These activities should be carried out at the waste generation sources.

(c) Recovery of Recyclables at Sources and Reuse

Activities under this programme intend to enhance the recovery of recyclable materials through segregation at waste generation sources, recovery of recyclable materials before the waste is discharged to the waste collection service, securing the routes for recovery and trading of recyclable materials, etc. These activities require extensive participation of the stakeholders and the communities.

(d) Recycling of Recyclable Materials

Recycling industries or the recyclers or private shops/dealers should take the primary role in the activities of this programme by performing regular and constant recovery of recyclable materials and utilising the recovered materials for the production of goods. Gujranwala City has very activated formal and informal commercial and industrial societies for recycling of recyclable materials.

Figure D.4.2 shows the conceptual flow of the four programmes and sub-programmes for easier understanding of the 3R activities.

The increase of efficiency in recovering recyclable materials and securing a storage area, a distribution centre, networking, etc., are also indispensable for the sustainability of 3R activities. The following subsections explain these key elements and the proposed target level associated with the 3R Promotion Plan for Gujranwala City.

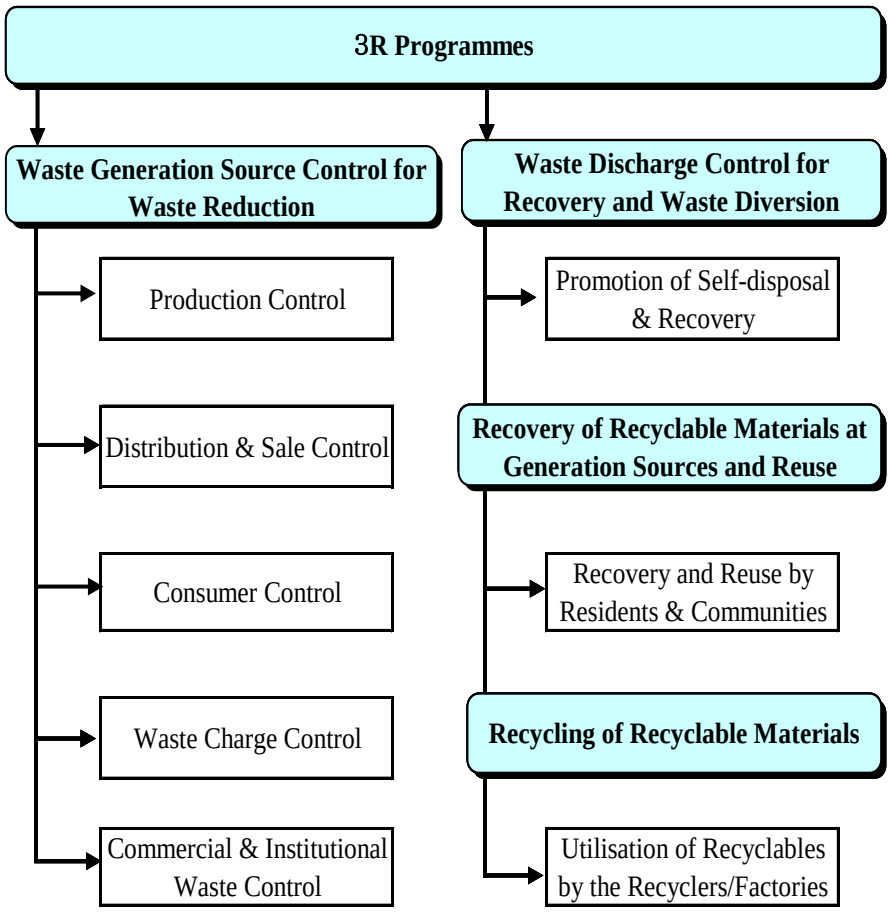

Figure D.4.2 Conceptual Flow of Implementation of 3R Programmes

(3) Technical Options of Resource Recovery

In the process of recovery of recyclable materials from municipal waste in Gujranwala, two technical options are considered depending on the waste segregation condition summarised in **Table D.4.2**. These technical options are described in the following paragraphs.

Table D.4.2 Technical Options for Recovery of Recyclable Waste

Technical Option	Segregation Condition	Remarks
Option 1	Mixed waste and recovery by sanitary workers and waste pickers in the course of collection services and final disposal.	Without the Project
Option 2	First and secondary segregation at generation sources, and final sorting at the Proposed Central Compost Plant before processing of compost and RDF product	With the Project

Note: While Option 1 does not change the current condition, Option 2 may be able to improve the current condition of SWM in the city economically and environmentally.

Option 1

This option is set in the highest hierarchy of resource recovery since the most challenging segregation activities at generation sources require the involvement or active participation of waste generators in the solid waste management system of the GWMC. Source separation is practiced partly in Gujranwala and street hawkers working in town collect the recyclable materials directly from the waste generators. Segregation at source shall be set up for a base as GWMC implements resource recovery from waste. Option 1 stands on the fact that waste as mixed is only waste but wastes as segregated become resources and are expectable for the recovery of more amounts of recyclable materials.

Option 2

Recyclable materials are picked out from mixed waste as in Option 1. However, the key players for recovery at the primary/secondary waste collections are the sanitary workers/waste pickers at the transfer stations/collection enclosures, as commonly practiced today in the course of waste collection service. Recovered recyclable wastes are then brought to the dealers handling waste. Final waste collection is carried out at sorting process at the Central Compost Plant. Due to the picking-out action for recyclable materials in the course of loading waste to the vehicles and sorting process at the Plant, the efficiency of waste collection as a whole is improved.

(4) Initiatives of GWMC for 3R Promotion Activities

In order to implement the 3R activities effectively and efficiently, GWMC shall take the primary role to set up the implementing policies, purposes, strategies, and the phased target levels in addition to the coordination role for the parties concerned, such as stakeholders, NGOs, and so on. It will be required to formulate the implementation plans and programmes of 3R including public campaign, school and formal education, the encouragement of residents, support/assistance, and the coordination to form a linkage among the residents, NGOs, other community groups, waste pickers and private shops and dealers in the city. A special task force shall be composed of experts in the field of solid waste management and social services and the office staff to support the expert staff.

(5) Enhancement of 3R Promotion Activities

More recyclable materials will be recovered as segregation is carried out at residential houses and workplaces of the establishments. For the purpose of recycling, the recovery of recyclable materials shall be enforced and enhanced as social activities. The segregation and recovery of recyclables at the waste generation sources will need the active participation of waste generators so that the following activities shall be included in the implementation of 3R including the enhancement of resource recovery:

- Demonstration of 3R at pilot areas (50-100 target households and communities) which shall involve the waste generators, waste pickers, private shops and so on;
- Demonstration of 3R at pilot workplaces (around 10 target markets/hotels/restaurants for organic wastes, and 50 establishments/shops/schools etc.) with the participation of all staff of establishments;
- Raising awareness through education and public campaign to encourage the participation of waste generators in the 3R activities;
- Support of GWMC on the recovery activities by providing transportation for recyclable materials to the private shops or to the recycling factories; and
- Promotion of recovery of food waste and biodegradable waste for home composting and community level composting.

As for the above, the number of the demonstration of 3R at both pilot areas and pilot workplaces is to be discussed and determined by GWMC. For instance, as a pilot UC of Zone 6, the pilot area has

50-100 households per group and 5 groups per UC. Similarly, the pilot workplace has around 10 markets/hotels/restaurants for organic wastes, and 50 establishments/shops/schools etc. for recyclables.

3R activities have not been promoted by GWMC since its establishment in 2014 up to today. However, there is an active operation of the private sector including street hawkers, waste pickers, junk shops, recyclers, households and GWMC sanitary workers in resource recovery. Mostly, the separated/stored recyclables by the householders are sold to the street hawkers, while the GWMC sanitary workers sell their segregated recyclable items to junk shops. Their activities are certified by the waste picker's survey report by the JICA Project Team in January 2015. The recovery amount of resource materials of Gujranwala City and Gondlanwala disposal site is estimated to be about 70 t/d out of the waste discharge amount, i.e., 476 t/d.

The discharge amount of resource materials is likely to increase in the coming future by provision of collection services in the uncollected and partially collected areas by GWMC due to increased vehicles and manpower.

(6) Flow of Recyclables in Gujranwala

Based on the Waste Picker Survey (2015) described in **Section 2.1** of this report and the municipal waste flow analysis for the Project, a flow of recyclables in Gujranwala is assumed as shown in **Figure D.4.4**.

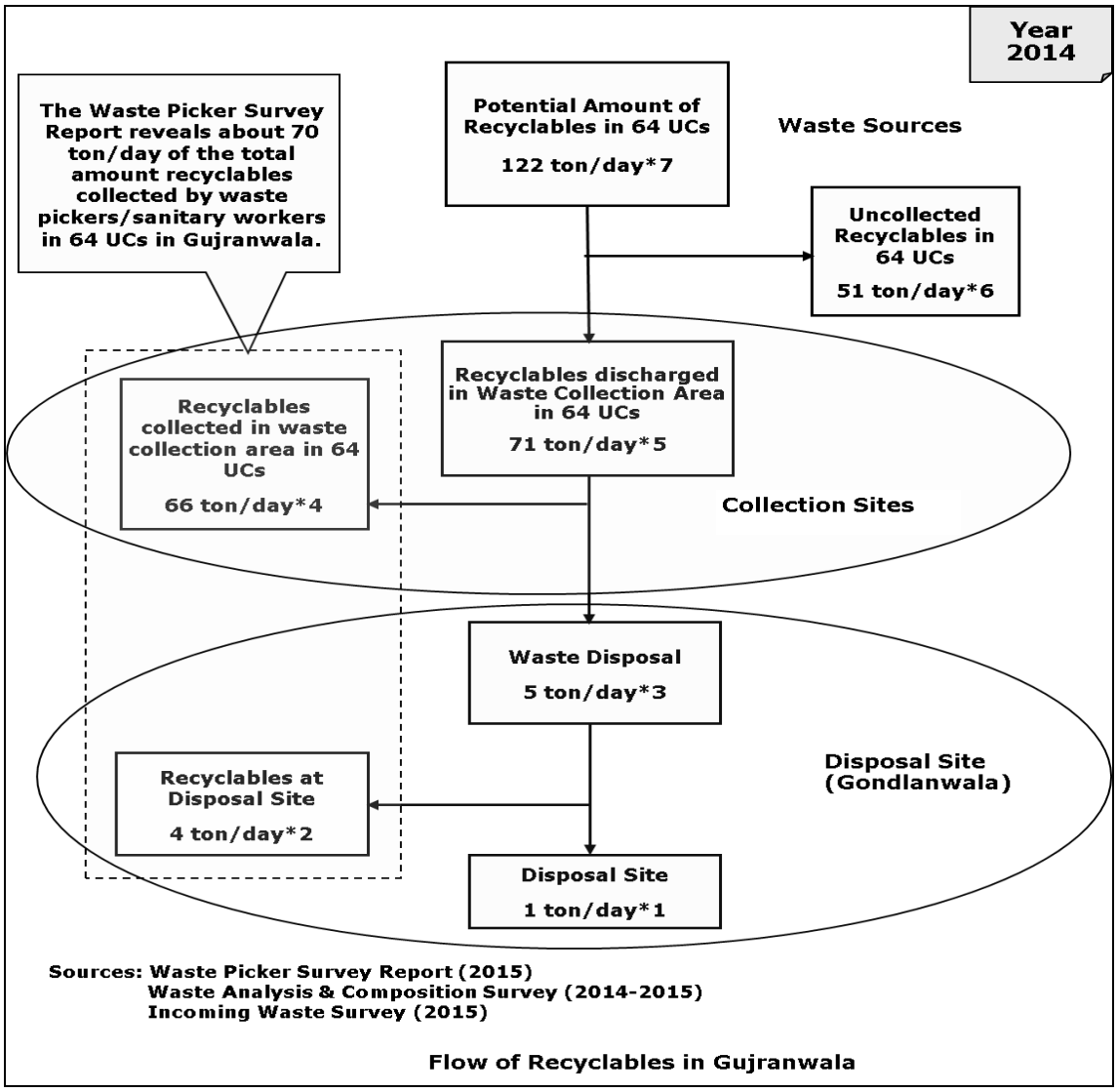

Figure D.4.3 Flow of Recyclables in Gujranwala

In the figure above, each recyclable amount in the flow is estimated based on the following conditions with *number in the flow.

*1: 1 t/d of assumed amount of recyclables disposed at the disposal site; *2: 4 t/d is 1% of 410 t/d of the present waste collection amount from the weighbridge record and the results of the waste picker survey; *3: 5 t/d is the sum of 4 t/d and 1 t/d; *4: 66 t/d is subtracting 4 t/d from 70 t/d; *5: 71 t/d is the sum of 66 t/d and 5 t/d; *6: 51 t/d is subtracting 71 t/d from 122 t/d; and *7: 122 t/d is a potential recyclable amount in 64 UCs derived from the proportion of measured waste amounts of 476 t/d (track-scaled of 410 t/d and waste pickers survey of 66 t/d) and estimated total generated waste amount of 878 t/d.

The total amount of recyclables collected by waste pickers is estimated at about 70 ton/day based on the Waste Picker Survey Report in 2015 in Gujranwala. From the total recyclable amounts of approximately 70 ton/day, the results of WACS (2014/2015) and records of weighbridge at Gondlanwala, approximately 122 ton/day of potential amount of recyclables is assumed to be collected in 64 UCs.

4.2 Evaluation of Alternatives

Two (2) technical alternatives are selected for the intermediate treatment facilities in Gujranwala, namely; Alternative-1: Central Compost and RDF Plant, and Alternative 2: No Intermediate Treatment Facility. The two alternatives are as compared below.

Table D.4.3 Technical Alternatives for Intermediate Treatment Facility and 3R

Technical Alternatives	Description	Remarks
Alternative-1: Central Compost and RDF Plant	The proposed Central Compost and RDF Plant were selected as an appropriate facility for Intermediate Treatment and 3R plan.	Composting process is to be demonstrated regularly as 3R activities for stakeholders.
Alternative 2: No intermediate treatment facility	If there is no intermediate treatment facility including 3R activities, cumulative disposal amount without the intermediate treatment and 3R plan may become about 9.36 million tons per year in 2030, which is bigger than the 8 million ton/year for with-the plan.	

Therefore, Alternative-1: Central Compost and RDF Plant with 3R Plan is required for the ISWM in Gujranwala as described below.

4.2.1 Community Compost and RDF Plant

(1) Simulation Study on Feasible Compost and RDF Amounts for the Proposed Plant in 64 UCs

Simulation results of the proposed Central Compost Plant including RDF production in Gujranwala are presented in **Table D.4.4**. The simulation was made in two (2) cases of each compost plant and RDF plant to study feasible compost amounts and RDF amounts at the plant as shown in the table. Basically, 250 tons/day of input waste amounts are derived based on the experience of the Lahore Compost Plant, and 20 tons/day are assumed as a small scaled amount for the compost plant for reference. Similarly, two (2) different cases for RDF plant are simulated at 250 tons/day and 500 tons/day. As the results, the case of 250 tons/day of input waste amounts for composting shows feasible but the case of 20 tons/day results in not feasible. On the other hand, for RDF production in either of the two cases, 250 tons/day and 500 tons/day, is not feasible. A subsidy may be necessary for the RDF promotion.

Table D.4.4 Simulation Results of Proposed Central Compost Plant and RDF Plant in Gujranwala

Proposed Intermediate Treatment Plant	Input Waste Amount (ton/day)	Production Amount (ton/day)	IRR Evaluation (%)	Remarks
Central Compost Plant	250	125	17.2	OK.
	20*	10	9.5	-
RDF Plant	250	100	N.G.	Subsidy may be required.
	500	200	N.G.	

Notes: N.G. means there is no computation result.
* An input of 20 ton/day waste amount was proposed to simulate IRR evaluation as a small scale initial production of composting but it was not feasible.
Base on the interview results with the Lahore Compost Company (LCC) or the D.G. Khan Cement Company (DGKCC), the rates of production amount by input amount at plant are given as approximately 50% for compost from the LCC and approximately 40% for RDF from the DGKCC, respectively.
The above simulation results are compiled in Appendix A of the Data Book.

(2) Location and Required Area of the Proposed Plant in 64 UCs

The proposed central compost and RDF plant is to be built adjacent to the proposed landfill site in Bhakhraywali that adjoin vacant land areas, according to the MD of GWMC. As described in ***Volume 2 Supporting Report, Section C, Final Disposal, Subsection 2.8.1, "Implementation***

Status of Section of Final Disposal Site", the following major factors are considered during the landfill site selection: airports, floodplains, wetlands, fault zones, seismic zones, unstable areas, and environmental degradation. Therefore, the current landfill site as a final sanitary landfill has been selected so carefully. The required land area of the proposed Gujranwala Central Compost and RDF Plant is to be about 7 hectares including land spaces for office, parking, workshop, storehouse, bagging unit, composting/RDF plant, windrows field, etc., as the final development scale of the Plant.

(3) Outline of the Proposed Central Compost and RDF Plant Plan

(a) Collection of Organic Materials by Separation at Source for the Plant

Organic waste is to be separated and collected by source separation of each household and this activity of separate collection system starts in 2019, based on the Waste Collection and Transportation Plan stated in **Supporting Report B**, **Section 4.2**., and **Subsection 4.2.2**. The separate collection systems are in the following five (5) ways: i) to install a $5m^3$ container in the main vegetable and fruit market and the Fazal fruit market, respectively; ii) to install a container of small capacity in a restaurant and a hotel; iii) to install a container of $0.8m^3$ with different painting colours for organic waste from a residential house at roadside; iv) to collect organic waste by door-to-door collection in every other day; and v) to install a container of $0.8m^3$ at park. These five collection ways of organic waste will be proposed for UC Zone 6 as the collection model zone managed by the GWMC among the present 8 waste collection zones in Urban UCs in the Action Olan of the Waste Collection and Transportation Plan. The containers are collected once they are full of waste. Although it is an arduous work for the residents to separate waste for the first time and it takes time for them to understand the separation of wastes in the right way, the city would become cleaner and this option is compatible with the 3R plan in the Master Plan.

(b) Challenge of Collection Rate of Organic Waste

The prediction of separation rate of organic waste is not easy but the separate collection is to start in 2019 in preparation for the commencement of operation of the compost plant in 2020. GWMC is challenging achievement of the waste separation rate of 100% by 2020 although complete separation of organic waste to 100% in only one year would be very difficult. However, it meets to challenge that according to WACS results, current mixed waste contains more than 60% of organic waste and the operation of the plant probably has no serious constraint. In addition, the involvement and cooperation of fresh markets, restaurants and hotels in the city will increase the organic waste rate input to the compost plant.

(c) Outline of the Proposed Plant

According to the proposed waste flow plan of the ISWM in Gujranwala City, the waste recovery amount with high organic content for the proposed central compost plant is designed to receive 250 tons/day of waste for the final sorting process, including market biodegradable wastes, starting from year 2020. The value of 250 tons/day of wastes could be derived from the actual organic waste recovery amount used in the Lahore Compost (Pvt.) Ltd. whose operation started in 2006 for the production of compost and RDF. The proposed central compost plant in Gujranwala is to be equipped with various types of equipment such as sorting conveyor, magnetic separator, trammel screen, and sieving screen at the plant, bagging unit near storehouse, turner at windrow, etc. Similarly, the same sorting unit and baling unit for 250 tons/day will also be used for the proposed RDF plant after enlargement of the proposed Gujranwala central compost plant in 2030.

Based on the 250 tons/day with higher organic contents accepted in the proposed plant and assumed 50% recovery rate and 80% working ratio, the central compost plant will target a final compost product, which is equivalent to 125 tons per day. The cost-benefit conventional

windrow-type composting process shall be applied for the central compost plant to be sited adjacent to the proposed final landfill site in Bhakhraywali. Considering cost, availability of construction site and the scale of a plant to analyse the effectiveness of large-scale composting in future, the central composting system shall be carried out with an enlargement work of one (1) plant. The initial plant with 125 tons per day compost product is scheduled to be constructed in 2019 and operations will start in 2020, although yearly production for the initial several years may be increased step by step. This plant shall be operated for around sixteen (16) years to study the appropriate running period of the design from the technical and economic points of view. After the ten (10) years in 2029, another enlargement plan of the proposed central plant for RDF (refuse derived fuels) production shall be planned and designed in 2029. In 2030, new production for the development of the proposed central compost plant is to be started for a total 500 tons per day including the input waste for compost of 250 tons/day and input waste for RDF of 250 tons/day in Gujranwala City.

The calorific value of residues of the compost product like those remaining on the screen is low and they are not used as raw material for RDF. It will thus be an operational matter of whether or not they will be returned or become compost again as part of the compost or disposed.

The investment cost and operation and maintenance cost shall be borne by privatisation through PPP (refer to **Table D.4.5**) under the BOT basis.

(d) Security of Compost Quality

It is also very important for GWMC and the company to operate the proposed Gujranwala central compost plant to promote to the people concerned through public information, education and communication (IEC) campaign that the compost produced in the plant is safe and reliable for farming as per verification test conducted by a public authority before the plant starts operation in 2020. Improvement of quality of the compost should thus be needed.

(e) Preliminary Cost Estimates for the Compost Plant

The equipment to be used at the plant will be considered based on the equipment of the Lahore Compost Plant. The total project cost for compost production estimated with the preliminary specifications is approximately Rs. 1,025 million up to the year of 2030. The initial investment cost in 2018-2019 is assumed at about Rs. 442 million and the second investment cost for enlargement in 2028-2029 is around Rs. 74 million including detailed design, and annual cost is about Rs. 46 million for operation and maintenance expenses.

(f) Licence of Compost Product

It is indispensable to assure and improve the quality of compost products periodically and officially to diffuse the use of compost as soil conditioner together with chemical fertilizer. The Lahore Compost Company (Lahore Compost (Pvt.) Ltd.) has a licence for compost production issued by the Soil Fertility Department, Agricultural Department Directorate of Government Punjab. The proposed SPV (special purpose vehicle) for the proposed Gujranwala central compost company shall therefore obtain a licence for its compost production from the same authority. With regard to the test certificate, there are some agencies and authorised private laboratories that perform quality assurance tests like the Pakistan Council of Scientific and Industrial Research (PCSIR).

(g) Test Farm for Quality Control of Compost at the Plant

It is proposed that in the proposed central compost plant in Gujranwala a small scaled pilot farm having approximately 1,000m^2 has to be set to test cropper's growth assay including the effect of compost and obstacles to crop cultivation as an effort toward quality control of compost.

According to the results of interview at the proposed landfill site in Bhakhraywali, farmers have experiential knowledge on the importance of compost and home-made cow dung at farmland as well as the benefits of not only home-made compost but also chemical fertilizers for short effect fertility of soil to increase the production rate of crops. Organic fertilizer produced with cow dung is used as the base fertilizer after cropping or before seeding. Cow dung softens the soil and the farmers use it in combination with chemical fertilizers for more yield in a short time. It is noted that the most important thing in the use of compost is the quality which can be trusted next to the price. It is therefore proposed that the farmers be invited to the pilot compost test farm provided in the complex of the compost plant to confirm the effectiveness of the compost produced from organic waste. By such means, the compost could be made acceptable to the farmers for use depending on the yield and quality of the crops as well as the price of compost.

While the Lahore Compost Plant puts the mixed waste amount of 1,000 tons per day, in Gujranwala, the proposed compost plant will receive 250 tons per day of highly collected organic waste after separation. For the production of a good product, it is proposed that quality control should be carried out for the removal of foreign matter, as well as management for controlling moisture content, composting temperature, oxygen concentration in compost heaps, maturation degree, etc. The effectiveness of compost will be tested for about one year period. However, the pilot farm will be extended more and continued to further crop cultivation for quality control of the compost, if the owner of the proposed compost plant, i.e., Special Purpose Vehicle (SPV) wishes.

(h) Necessity of Proper Quality Control of Compost

As stated above, the sale of compost products of the Lahore Compost (pvt.) Ltd. is not good. Based on the interview survey, it seems that the trust of farmers on the produced compost has not been obtained. In other words, management of periodical quality control of compost production and certification by public institutions or agencies are necessary. In addition, the result of the pilot compost test farm should be established to promote the sale of compost.

The introduction of the proposed Gujranwala central compost and RDF plant to be managed by the SPV would first require performance of a continuous information, education and communication (IEC) campaign on the need of 3R in order to obtain the trust of users and promote the use of compost through the establishment of an official quality assurance system that would produce compost that is effective and safe. These are the keys to the success of operating the compost plant sustainably in Gujranwala.

(i) Outline of the RDF Section Plant

The RDF project cost estimated with the preliminary specifications is approximately Rs. 140 million (the initial investment cost of about Rs. 44 million for 10 years). Annual cost is about Rs. 17 million of the administrative and maintenance expenses.

Raw materials of RDF consist of papers and plastics and are planned to be separated as combustibles in 2030 when the RDF plant starts operation. It is assumed that the amounts of papers and plastics are little in the rejected materials from the compost plant.

The RDF plant considered in this project is thought to be RPF (Refuse Paper & Plastic Fuel) rather than RDF, so that the mixture of chloride is very low compared with the raw material for RDF which is derived from municipal waste. In addition, chloride in waste plastics and papers may not be a serious problem at the cement plant.

RDF products will be sold to the cement factories. The current selling price of RDF products is Rs. 53 per ton by an ex-factory in LWMC. The transportation cost of RDF to the cement factory in Kallar Kahar is Rs. 900/ton and sold to the cement factory in Multan for Rs. 5,000/ton. In Gujranwala, the transportation cost is to be determined depending on conditions of the contract.

(j) Necessity of Quality Control of RDF

At the Lahore Compost Plant, a mixture of foreign matter is observed in the final product of RDF/RPF and this will reduce the calorific value. According to the waste segregation programme to be performed by GWMC in the master plan, well-segregated waste is supposed to be transported to the proposed Gujranwala compost/RDF plant for the start of RDF production in 2030. The segregation system is described in **Supporting Report Section B, Waste Collection and Transportation**. It is, therefore, noted as an experience learnt from the Lahore RDF/RPF plant, that the waste materials for paper and plastics after separation should be segregated again at the plant in Gujranwala.

(4) Salient Features of the Proposed Central Compost and RDF Plant by SPV

Salient features of the proposed Gujranwala central compost plant to be managed by the SPV (Special Purpose Vehicle) are shown in **Table D.4.5.**

Table D.4.5 Salient Features of Proposed Gujranwala Central Compost Plant by SVP

Project Name		Project Overview	Descriptions
Proposed Gujranwala central compost & RDF plant by SPV (Tentative only)		Contracting parties	GWMC, and a special purpose vehicle (SPV) for a central compost & RDF plant
		Location	In and around the proposed final landfill site in Bhakhraywali
		Selection of PPP*	BOT* basis between GWMC and the private sector is recommended.
	Compost Section	Total land area for the Plant	7 hectares
		Description of service	Establishment of compost plant in 2020 including RDF from 2030
		Operation period	2020 – 2035 (16 years: Service lifespan of the plant)
		Plant capacity	Input waste: 250 tons/day
		Description of staff involved	Project manager, supervisor, mechanics, engineers, biochemist, marketing representative, labour, etc.
		Description of equipment	Imported plant containing all equipment sorting conveyors, trammel screen, shredder, turner, bagging unit, etc.
		Description of facilities	Administrative office;screening, bagging & store unit; waste sorting unit; RFID and weight record room with weighbridge platform; windrow field; laboratory; guard office; car parking area; fencing; greenbelt zone; pilot farm; etc.
		Description of machinery	Wheel loader, tractor and trolley, stitching and bagging unit, generating set, etc.
		Compost preparation time	60~90 days
		Production amount	125 tons/day of compost
	Compost and RDF Section	Total plant area	7 hectares (no extension area for RDF, the same area as compost)
		Operation period	2030 -
		Description of service	Extension work for RDF section of the waste sorting house from 2030
		Plant capacity	Input waste 250 tons/day for compost, 250 tons/day for RDF
		Description of staff involved	Project manager, supervisor, mechanics, engineers, marketing representative, labour, etc.
		Description of additional equipment	Equipment of sorting line conveyors, baler, shredder, etc.
		Description of additional extension facilities	Extension work for waste sorting house for RDF production
		Production amount	125 tons/day of compost, 100 tons/day of RDF

Notes: This proposed Gujranwala Central Compost Plant is planned to have a composting section and an RDF section in the same plant site after the year 2030.
Construction of the proposed Gujranwala Central Compost Plant for producing compost and RDF may require an EIA/IEE (The Environment Protection Department (EPD) of Punjab will judge.)
*PPP (Public-Private-Partnership).

As shown in the table above, it is recommended that the required land area of 7ha as the final plant plan with RDF should be procured at the initial stage of the plant planning in 2019 because the price of the and would rise and financing would become more difficult as time passes by. Therefore, when the required land area of 7 ha can be bought at the planning stage, it should be bought in advance.

The general framework for the adaptation of PPP models for the proposed Gujranwala Central Compost & RDF Plant is referred to ***Chapter 4, Formulation of Institutional Strengthening and Organizational Plan, 4.3 Identification of Project Components for Institutional and Organizational Plan, Section G, Volume 2 Supporting Report, Draft Final Report***. As explained in the above **Subsection 4.3**, there are the study results on the selection of general framework for PPP for three (3) cases of the SWM service contracts by GWMC, namely; 1) collection and transportation service, 2) waste disposal sites, and 3) intermediate treatment service. In the case of collection and transportation service, GWMC has decided to continue providing collection and transportation services directly until year 2025 because of the following three current reasons: too little population for scale of economy to work; very cheap local cost compared to the outsourcing cost to a foreign company; and too low willingness to pay. For the final disposal, management of new landfill site, it is recommended that the direct management by GWMC shall be kept because the private sector accepts waste without limits keeping poorly managed landfills such as pollution of the local environment, contamination of local roads ad water courses by wheels of collection vehicles, and de-facto open dumping.

As to the intermediate treatment plan, the MD of GWMC expressed that GWMC intends that the proposed central compost and RDF plant managed by SPV in Gujranwala is to be established and managed by privatisation. Composting is globally well recognised as an environmental friendly practice with no side effect. Once residents realise its benefit and usefulness, it is possible for the private sector to make profit. In order to promote composting, public involvement is essential. The simulation results of economic internal rate of return (EIRR) as presented in **Subsection 4.2.1(1)** show that the establishment of a central compost plant will be feasible if the production capacity is satisfactory although the quality of the products should be assured. Therefore, for PPP as an optimum private sector involvement plan of the central compost and RDF plant in Gujranwala, BOT (Build-Operate-Transfer) basis is recommended. Following the case of Lahore Compost (Pvt.) Ltd. as a pioneer of a compost plant company under BOT basis in Pakistan, it is suggested that GWMC should provide the land and a certain amount of organic waste in turn for a certain percentage of the annual profit under a new contract company of the compost plant enterprise. The same can be applied to the RDF plant.

Figure D.4.5 shows a flowchart of composting and RDF production of the proposed central compost and RDF plant.

It is noted that after compost production, sales of compost should be recorded properly every day, namely; number of bags (5kg, 20kg, 50kg) sold and unsold by the market division of the SPV at the plant.

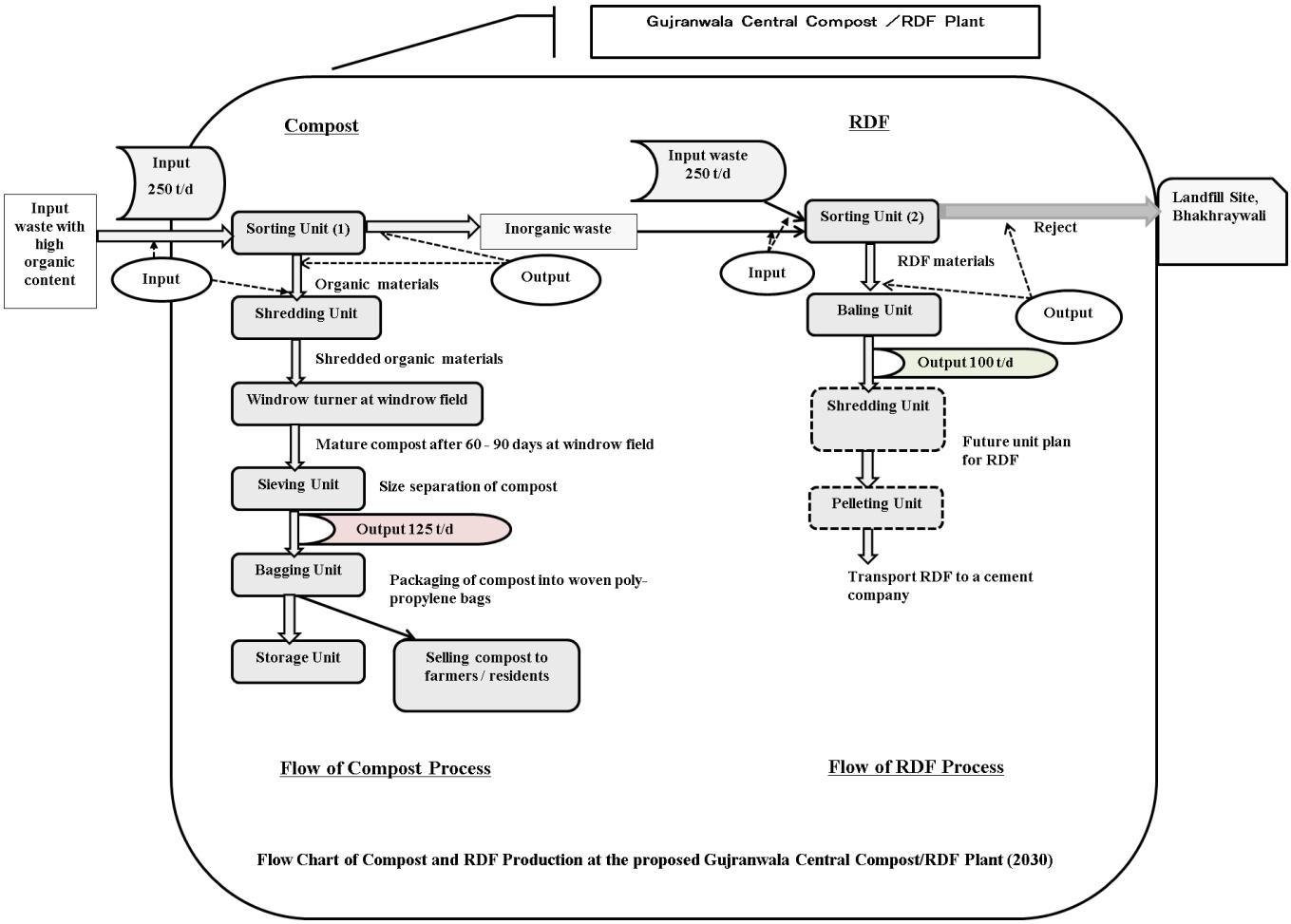

Figure D.4.4 Flowchart of Composting and RDF Production at the proposed Gujranwala Central Compost/RDF Plant

(5) Home and Community Composting in 34 UCs

Although home composting and community composting will not be conducted in the 64 UCs so much, but mainly carried out in the 34 UCs. Home composting is to be made in each house and community composting with group composting. Home and community composting in the 34 UCs is to be carried out through the self-disposal system in collaboration with the community level in Sadar Tehsil in Gujranwala. According to the proposed waste flow in 34 UCs, organic waste recovery amounts are to be produced for small-scaled composting starting from a small amount in 2019, less than 1 ton/day in 2023 to 1 ton/day in 2024 of the Mid-Term, and from 2 ton/day in 2025 to 5 ton/day in 2030 of the Long-Term. The new Gujranwala central compost company which will be fully responsible for the management of the new compost company is to be responsible for selling the compost products in coordination with GWMC. Therefore, the central compost plant enterprise shall provide advice to the related consumers such as households, communities, etc. in the 34 UCs. The Sadar Tehsil Municipal Administration (TMA) is to manage the activity of not only composting but also segregation of recyclable materials at sources and the primary waste collection in designated areas, and the community-based composting through IEC (Information, Education and Communication) campaign.

4.3 Identification of Project Components for the Intermediate Treatment and 3R Promotion Plan

4.3.1 Short-Term Plan (2016-2019; 3 years)

The Short-Term Action Plan consists of the following priority projects;

(1) Awareness and IEC Campaign on Resource Recovery

During the Short-Term Plan (2016-2018), the awareness raising and IEC (Information, Education and Communication) campaign on 3R (reduce, reuse, recycling) are to be conducted together with the action plan/project for development and implementation of educational programmes to enhance knowledge/awareness on SWM and 3R promotion, targeting primary school teachers, students, and the general public in Gujranwala under the Environmental Education and Public Awareness Raising Plan with GWMC. (Refer to the details of this project in the Action Plan in Chapter 5.)

(2) Conduct of Simplified WACS Implementation

The WACS is to be conducted once a year during the Short-Term Period (2016-2018) by GWMC. For the WACS, GWMC has a number of experienced staff who worked with JICA Study Team in the years of 2014 and 2015. The results and analysis of WACS are to be used as the basic data in the formulation of the waste collection, 3R, intermediate treatment and waste disposal plans for review, updating and formulation of the SWM Master Plan. (Refer to the details of this project in the Action Plan in Chapter 5.)

(3) Setup of PPP and Formation of a Committee of the BOD of GWMC

To establish a new compost company in Gujranwala, it is necessary for the SPV (Special Purpose Vehicle) to secure the processes of preparing for a private service contract under the BOT basis during the Short-Term Period (2016-2018). Details of the PPP setup and formation of a committee of the BOD of GWMC are described in the action plans for the Short-Term Plan (2016-2019) in Chapter 5.

(4) Implementation of Land Preparation by GWMC

The BOD of GWMC shall prepare the procurement plan for the land of the compost plant project owned by the SPV (approximately 7 ha) based on the Terms of Reference (TOR) which shall be prepared by the BOD of GWMC in 2017. The TOR should stipulate that the required land is to be procured and provided for the SPV by the BOD.

Details of this project are given Chapter 5.

(5) Engineering Service for Detailed Design of the Compost Plant by SPV

Based on the TOR, the engineering services for the detailed design of the compost plant project will be carried out in 2018 by an engineering consultant contracted under the SPV basis. The details are referred to the Action Plan of the Short-Term Plan in Chapter 5.

4.3.2 Mid-Term Plan (2019-2024; 6 years)

The Mid-Term Plan is composed of five (5) projects as discussed below.

(1) IEC Campaign on Resource Recovery at Source/Registration of Waste Pickers and Recycling Industries

During the Mid-Term Plan (2019-2024), the IEC campaign on resource recovery at source is to be conducted together with the Communication Unit of GWMC under the Environmental Education

and Public Awareness Raising Plan in the master plan of IWSM. The Communication Unit, a focal point of GWMC, is the leading agency on the necessity of the IEC campaign on 3R, resource recovery, targeting more primary school teachers and students and the general public in Gujranwala than the Short-Term Plan. This unit will serve as both information dissemination point and where the general public will make inquiries about solid waste management in GWMC. The details of staffing and costing of the Communication Unit are referred to **Chapter 5, Environmental Education and Public Awareness Raising Plan, Supporting Report Section E.**

As for the registration of waste pickers, it is required to organize the informal sector of waste picking by creating a centralised database of waste pickers and designing and issuing identity cards to them. It will help to authorise waste pickers to collect waste and therefore protect their source of living and against harassment from the police, municipal workers and the public. It will be possible to introduce the social security schemes for waste pickers, and education scholarship scheme for children of the waste pickers. This would help integrate the waste pickers into the door-to-door collection system of solid waste management.

(2) Purchase of Land Area for the Compost Plant

As stated in **Subsection 4.3.1(4)**, following the implementation of land preparation of the compost plant project by GWMC (approximately 7 ha), the BOD of GWMC is to settle the payment issue with the owners of the above land by the beginning of 2019 based on the TOR which will be prepared by the BOD of GWMC in 2017, so that the new compost company (the SPV) could start the construction work on the compost plant in the payment settled land area without any delay in implementation.

(3) Construction Work for the Gujranwala Compost Plant owned by SPV including Procurement of Equipment

The SPV shall order the contractor to start the civil and appurtenant works in the compost plant area in Bhakhraywali and complete them by the end of 2019. Procurement of equipment shall also be completed so that all the required buildings and appurtenant facilities including necessary equipment are ready for operation in 2020.

(4) Operation and Maintenance of the Compost Plant

The operation and maintenance (O&M) of the compost plant in Bhakhraywali shall be in accordance with the requirements stated in the O&M manuals (2020-2024). The manuals are to be prepared in the detailed design stage during the Short-Term Plan.

(5) Monitoring of Implementation of the Compost Plant

Monitoring of implementation of the compost plant facilities shall be in accordance with the requirements of the checklist of operation and maintenance work in the Mid-Term Plan (2019-2024). The checklist shall be prepared during the detailed design in 2018.

4.3.3 Long-Term Plan (2025-2030; 6 years)

The Long-Term Plan (2025-2030) consists of six (6) projects as follows:

(1) IEC Campaign for Resource Recovery at Source/Registration of Waste Pickers and Recycling Industries

Refer to the contents of **Subsection 4.3.2,** the Mid-Term Plan (1) in the Long-Term Plan.

(2) Engineering Services for Detailed Design of the RDF Plant owned by SPV

Engineering services including detailed design for the extension works of the waste sorting facility for RDF in Bhakhraywali and preparation of tender documents for contractor shall be carried out in 2028 in the Long-Term Period (2025-2030).

(3) Construction of the RDF Plant owned by SPV including Procurement of Equipment

Followed by the detailed design in item (2) above, construction of the extension works required for the additional part of the waste sorting facility in Bhakhraywali is to start in 2029 and completed by the end of 2029. In addition to the extension of civil works for the waste sorting facility for RDF production, the procurement of additional equipment for RDF production is to be carried out within the year 2029 so that the plant/facility will be ready to start RDF production in the year 2030.

(4) Operation and Maintenance of the Compost and RDF Plant

The operation and maintenance of the compost and RDF plant shall be in accordance with the requirements stated in the operation and maintenance manuals for the project after 2030. In order to conduct the operation and maintenance properly, the manuals shall be prepared in accordance with the requirement of the plant under the TOR for SPV basis.

(a) Monitoring of Implementation of the Compost and RDF Plant

Monitoring of the compost plant is to be carried out during the Long-Term Period. The maintenance work schedule is to start in 2025 in Bhakhraywali and RDF production is to commence in 2030. The monitoring work consists of the activities of regular observation of mainly safety of workers and environmental monitoring for the plant and windrow field, test farm, odour, waster drain, environmental and social consideration, etc., in the complex of the plant site, based on the environmental checkpoint sheet.

(b) Preparation and Enacting of Recycling Laws in Punjab, Pakistan

Even though policies, drafted acts, guidelines, regulations, and ordinances related to solid waste management exist as below, there is no recycling law in Gujranwala and Punjab, Pakistan.

- Trade Policy (2012-2015)
- The Municipal Punjab Waste Management Act (Draft) 2013
- Guidelines for processing and using refuse derived fuel (RDF) in cement industry (August 2012) PEPA, Ministry of Climate Change, (August, 2012)
- Punjab MSWM Guidelines (2011)
- Policy and Regulations on SWM– Pakistan (2010)
- Guideline for Solid Waste Management (Draft) June, 2005

Punjab prohibition on manufacture, sale use and import of polythene bags (black or any other polythene bag below 15 micron thickness) is in Ordinance No. IX of 2002 Feb. 18, 2002

From the perspective of residents, it seems that most of the residents are not aware of even the existence of laws and regulations. More frequent awareness raising and IEC campaigns should be conducted for the public including school students.

In Japan, the Ministry of Environment enforces several laws and regulations for establishing a recycling-based society. These laws are as follows:

(i) The Basic Environment Law (legislated in 1993, Nov.);

(ii) The Basic Act for Establishing the Sound Material-Cycle Society (legislated in 2000, June);

(iii) Waste Management and Cleansing Law (legislated in 1970, Dec.);

(iv) Law for Promotion of Effective Utilisation of Resources (legislated in 2006, Apr.);

(v) Container and Packaging Recycling Law (legislated in 1995, final legislation in 2006 Dec.);

(vi) Electric Household Appliance Recycling Law (legislated in 2003, Mar.);

(vii) Construction Material Recycling Act (legislated in 2000, May);

(viii) Food Recycling Law (legislated in 2000, June); and

(ix) Law on Promoting Green Purchasing (legislated in 2000, May).

As shown above, most of the recycling laws and acts in Japan were enacted in the year 2000 or later, while the Basic Environmental Law was legislated in 1993. In Punjab, therefore, it may take some time to legislate and enact recycling laws and acts after the Municipal Solid Waste Rules is legislated. Although awareness raising and IEC campaign on 3R must be exercised continuously, it is assumed that the recycling law will be legislated in the years of 2025 and 2026 of the Long-Term Period.

4.4 Implementation Schedule of Intermediate Treatment and 3R Promotion Plan

As mentioned in the previous subsections, the project components for the Intermediate Treatment and 3R Promotion activities in the Master Plan are formulated as shown in the following **Figure D.4.5**.

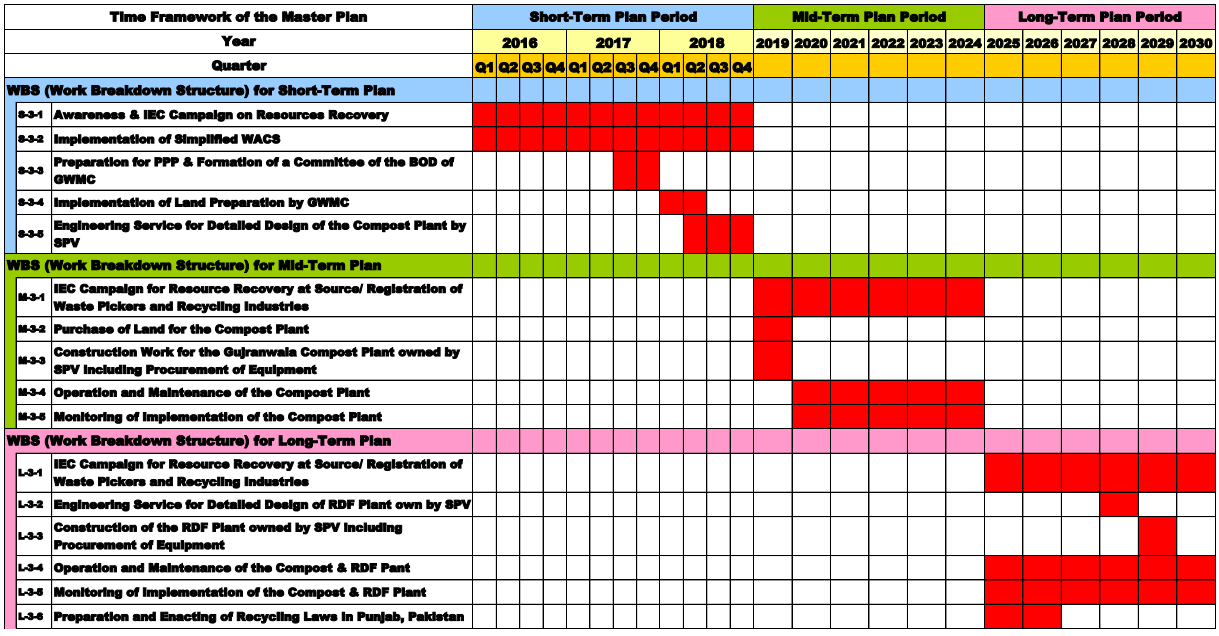

Figure D.4.5 Implementation Schedule of the Intermediate Treatment and 3R Promotion Plan

Note:* The project cost of 3R campaign activity should be counted in Section 4.7 Environmental Education and Public Awareness Raising Plan.

4.5 Project Cost of Economic and Financial Plan

Table D.4.6 shows the project cost for the Master Plan and **Figure D.4.6** shows the Project Cost and Responsibility under the Intermediate Treatment and 3R Promotion Plan.

Table D.4.6 Implementation Cost of Intermediate Treatment and 3R Promotion Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 3: Intermediate Treatment and 3R Promotion Plan																	
Short-Term Plan																	
S-3-1	Awareness & IEC Campaign on Resources Recovery	0	0	0	0												
S-3-2	Implementation of Simplified WACS	0	0	0	0												
S-3-3	Preparation for PPP & Formation of a Committee of the BOD of GWMC	BOD/GWMC	0	0	0												
S-3-4	Implementation of Land Preparation by GWMC	BOD/GWMC	0	0	0												
S-3-5	Engineering Service for Detailed Design of a Compost Plant by SPV	40,000	0	0	40,000												
	Sub-Total	40,000	0	0	40,000												
Mid-Term Plan																	
M-3-1	IEC Campaign on Resource Recovery at Source/Registration of Waste Pickers and Recycling Industries	0				0	0	0	0	0	0						
M-3-2	Purchase of Land for the Compost Plant	42,000				42,000	0	0	0	0	0						
M-3-3	Construction Work for the Gujranwala Compost Plant owned by SPV including Procurement of Equipment	360,000				360,000	0	0	0	0	0						
M-3-4	Operation and Maintenance of the Compost Plant	215,696				0	39,239	42,415	43,376	44,799	45,866						
M-3-5	Monitoring of Implementation of the Compost Plant	SPV				0	0	0	0	0	0						
	Sub-Total	617,696				402,000	39,239	42,415	43,376	44,799	45,866						
Long-Term Plan																	
L-3-1	IEC Campaign on Resource Recovery at Source/Registration of Waste Pickers and Recycling Industries	GWMC										0	0	0	0	0	0
L-3-2	Engineering Service for Detailed Design of RDF Plant owned by SPV	4,000										0	0	0	4,000	0	0
L-3-3	Construction of the RDF Plant owned by SPV including Procurement of Equipment	70,000										0	0	0	0	70,000	0
L-3-4	Operation and Maintenance of the Compost & RDF Plant	293,216										45,866	45,866	45,866	45,866	45,866	63,886
L-3-5	Monitoring of Implementation of the Compost & RDF Plant	SPV										0	0	0	0	0	0
L-3-6	Preparation and Enacting of Recycling Laws in Punjab, Pakistan	Gov. of Punjab										0	0	0	0	0	0
	Sub-Total	367,216										45,866	45,866	45,866	49,866	115,866	63,886
	Grand Total	1,024,911	0	0	40,000	402,000	39,239	42,415	43,376	44,799	45,866	45,866	45,866	45,866	49,866	115,866	63,886

Programme No.	WBS No.	WBS	Legal Action (Required=●)	Name of Act/Regulation/By-law	Budgetary Arrangement (Required=●)	Total Budget (Thousand Rs.)	Responsibility Assignment Matrix: M=Main Responsibility, S=Sub Responsibilities. B=Budgetary Arrangement, L=Legal Action, P=Participation in Discussions															
							GWMC/Operation Unit	GWMC/P&C Unit	GWMC/Financial Unit	GWMC/HR & Administration Unit	City District Government Gujranwala (CDGG)	The Urban Unit, Government of the Punjab	P&D Dept., Government of the Punjab	Local Gov't Dept., Government of the Punjab	Environment Protection Department (EPD)	Donor Organisations	Private Contractors	Recyclers	CBOs & NGOs	Waste Pickers	PAPs around Gondianwala Disposal Site	PAPs around Bhakhraywall Disposal Site	Gujranwala Citizens
Programme 2: Intermediate Treatment & 3R Promotion Plan																						
Short-Term Plan																						
	S-3-1	Awareness & IEC campaign on resources recovery			●	GWMC	M	B			S											P
	S-3-2	Conduct of simplified WACS implementation			●	GWMC	M	B										P	P	P		P
	S-3-3	Setting up for PPP & Formation of a Committee of the BOD of GWMC			●	BOD/GWMC	M															
	S-3-4	Implementation of land preparation by GWMC			●	BOD/GWMC	M		B													
	S-3-5	Engineering service for detailed design of the compost plant by SPV				40,000									L		P					
		Sub-Total				40,000																
Mid-Term Plan																						
	M-3-1	IEC campaign for resource recovery at source/ registration of waste pickers and recycling			●	GWMC	M	B			S							P	P	P		P
	M-3-2	Purchase of land area for the compost plant			●	42,000	M	S	B													
	M-3-3	Construction work for the Gujranwala compost plant owned by SPV including procurement of			●	360,000									L		P					
	M-3-4	Operation and maintenance of the compost plant			●	215,695											P					
	M-3-5	Monitoring of implementation of the compost plant			●	SPV									L		P					
		Sub-Total				617,695																
Long-Term Plan																						
	L-3-1	IEC campaign for resource recovery at source/ registration of waste pickers and recycling			●	GWMC	M	B				S						P	P	P		P
	L-3-2	Engineering service for detailed design of RDF plant own by SPV			●	4,000											P					
	L-3-3	Construction of the RDF plant owned by SPV including procurement of equipment			●	70,000									L		P					
	L-3-4	Operation and maintenance of the compost & RDF plant			●	293,216											P					
	L-3-5	Monitoring of implementation of the compost & RDF plant			●	SPV									L		P		P			
	L-3-6	Preparation and enacting of recycling laws in Pakistan				Pakistan	M			S	S											
		Sub-Total				367,216																
		Grand Total				1,024,911																

Figure D.4.6 Project Cost and Responsibility under the Intermediate Treatment and 3R Promotion Plan

The implementation cost of the project for intermediate treatment and 3R (reduce, reuse, recycle) promotion is shown in **Table D.4.6.** The project cost is estimated at approximately Rs. 1,025 million up to year 2030. The proposed cost for each term is summarised as follows:

Project Cost of Short-Term Period (2016-2018)	: Rs. 40 million
Project Cost of Mid-Term Period (2019-2024)	: Rs. 618 million
Project Cost of Long-Term Period (2025-2030)	: Rs. 367 million
Total	: Rs. 1,025 million

This cost estimate shall be made in collaboration with the BOD of GWMC and the Special Purpose Vehicle, Gujranwala Central Compost Company. It is assumed that Rs.1,025 million of the total project cost of the Intermediate Treatment and 3R Promotion Plan in the Master Plan consists of Rs. 42 million by local fund or GWMC's own resources and Rs. 983 million by Special Purpose Vehicle (SPV).

5. PROPOSAL FOR THE ACTION PLAN

5.1 Selection of the Priority Projects

The priority projects are defined as projects for the short-term period of the Master Plan which will be developed into the action plans in this chapter. Based on the detail discussions described in **Chapter 4,** the following projects are selected as the priority projects:

1. Project for Awareness and IEC (Information, Education and Communication) Campaign on Resource Recovery
2. Project for Implementation of Simplified WACS
3. Project for Preparation for PPP & Formation of a Committee of the BOD of GWMC
4. Project for implementation of land preparation by GWMC
5. Project for engineering service for detailed design of the compost plant by SPV

5.2 Project for Awareness and IEC Campaign on Resource Recovery

During the Short-Term Plan (2016-2018), the awareness raising and IEC (Information, Education and Communication) campaign on 3R (reduce, reuse, recycling) are to be conducted together with the Action Plan project for development and implementation of educational programmes to enhance knowledge/awareness on SWM and 3R Promotion, targeting primary school teachers and students, and the general public in Gujranwala, under the Environmental Education and Public Awareness Raising Plan. Therefore, this project is to be included in the same programmes as the development and implementation of educational programme under the Environmental Education and Public Awareness Raising Plan, by the Communication Unit of GWMC. Any monetary expenditure for the project for awareness and IEC campaign on resource recovery is included in the S.4.2 and S.4.3 of the Short-Term Plan of the Environmental Education and Public Awareness Raising Plan.

GWMC has an important role in 3R resource recovery during not only the Short-Term Plan (2016-2018), but also the Mid-Term Plan (2019-2014) and the Long-Term Plan (2015-2030). The Communication Unit will be the focal point of GWMC when it comes to public relations. This unit serves as both information dissemination point and where general the public makes inquires about solid waste management in GWMC. The details of staffing of the Communication Unit are referred to **Chapter 5, Environmental Education and Public Awareness Raising Plan, Supporting Report Section E**.

Proposed activities such as 1) development of manuals for environmental education programs at schools; 2) development of the education materials for school programme; 3) selection of target schools; and 4) implementation of the environmental education programmes at schools, are presented below (refer to **Chapter 5, 5.3, Environmental Education and Public Awareness Raising Plan, Supporting Report Section E**.

5.2.1 Targeting Primary School Teachers and Students

(1) Development of Manuals for Environmental Education Programme in Schools

It is proposed to develop manuals for the environmental education programme in schools. This manual will be used by the field staff who go out and give lectures to the elementary students and teachers. The contents shall include a) purpose of the manual and object of the programme; b) planning of the programme; c) carrying out the programme, and d) reference (data).

It should be written in a way that communication unit staff can learn how to develop or modify an attractive programme for elementary schools and carry out the lecture to interest students. It should also include any background information on proper SWM practice or 3Rs so that the staff can easily find right information.

The manual should be prepared by environmental managers, led by communication units.

(2) Development of the educational materials for school program

It is proposed to produce a short video clip, explaining overall SWM and 3Rs efforts in Gujranwala. The production of the video should be entrusted to a production company specialising in PR material production under supervision of the Communication Unit. The video should cover the current SWM in Gujranwala and issues to be solved.

Besides the video clip, a printed material should be developed fore use and distribution during the programme. The contents of the printed material should include proper SWM practices and promotion of 3Rs. It should be noted that topics should be dealt in a viewpoint of everyday life of target students/teachers. For the short term period, 75,000 copies will be necessary.

(3) Selection of Target Schools

The Communication Unit should select a target area or UC to implement the School Eenvironmental Education programme. The area should preferably coincide with that of other programmes; e.g., composting, to implement them effectively.

List all elementary schools in the area, both public and private, with number of students and contact information. Select target schools according to number of students and how cooperative are the schools. Then with careful coordination with school representatives, schedule a visit. Number of expected target schools and students for the short-term period is as follows: year 2016: 70 schools, 2,100 students, year 2017: 80 schools, 2,400 students, year 2018: 100 schools, 3,000 students.

(4) Implementation of the environmental education programs at schools

Based on the list of schools and schedule of the program developed in (3) above, coordinate with school principals or teachers in charge prior to carry out the program, to confirm how the program will be carried out, including, but not limited to, size of a room, availability of power and lights, and space to display materials, etc. For example, depending upon a school condition, a large number of students may be given a program in the same room, but later divided into 5 smaller groups to have detailed discussions. In general, it is more effective to have an environmental program in smaller groups for better control and give enough attention to each student thus give more meaningful program than in a large group.

5.2.2 Targeting General Public

(1) Development of Guideline for Environmental Education Programs for General Public

The development of a guideline or manual for environmental education program for the public is proposed. This guideline will be used by the field staff who go out and raise awareness among the public in periodical events like Earth day, and Eid-ul-fitr day. The contents will include a) purpose of the guideline and object of the program; b) planning the program; c) carrying out the program; and d) reference (data and contact information about possible collaborating partners).

The guideline should be written in a way that communication unit staff can plan how to develop or modify an attractive program for the general public. It should also include any background information on proper SWM practice or 3Rs so that the staff can easily find right information. Target population is different from that of school educational program, therefore, broader viewpoint is necessary when developing this guideline. For instance, budget allocation and how they are used in GWMC operation is a good information for adults who pay for his/her SWM. The manual should be prepared by environmental managers, led by communication units.

(2) Development of Educational Materials for the General Public

Some printed materials should be developed to be used and distributed during the program. The content of the printed material should include proper SWM practices and promotion of 3Rs, as well as information necessary to gain confidence among the general public on the GWMC's operation. Such information include budget allocation and how they are used in GWMC operation since it is vital information to gain confidence from the adults who pay for his/her SWM. For the short term period, 5,000 copies will be necessary.

Besides the printed materials, some displays which show waste flow in Gujranwala or items which can be recycled should be prepared, along with actual recyclable or recycled materials so that the general public can touch and easily understand them.

(3) Implementation of Environmental Education Programs in Periodical Events

Based on the list of schools and schedule of the program developed in 5.2.1(3) above, coordinate with school principals or teachers in charge prior to carrying out the program, to confirm how the program will be carried out, including, but not limited to, size of a room, availability of power and lights, and space to display materials, etc. For example, depending upon a school condition, a large number of students may be given a program in a same room, but later divided into 5 smaller groups to have detailed discussions. In general, it is more effective to have an environmental program in smaller groups for better control and give enough attention to each student thus give more meaningful program than in a large group.

In implementation, close coordination should be made among the other relevant bodies listed in the guideline prepared in (1) above. Coordination may include co-hosting awareness raising programs activities.

5.3 Project for Implementation of Simplified WACS

5.3.1 Objective of the Survey

The Solid Waste Amount and Composition Survey (hereinafter referred to as "WACS") was conducted in 2014 as a part of the study for the Integrated Solid Waste Management Master Plan for Gujranwala to identify the amount and composition of the different types of waste generated in Gujranwala City. The results and analysis of WACS are used for the basic data to formulate the waste collection, 3R, intermediate treatment and waste disposal plans for review, updating and formulation of the SWM Master Plan.

The WACS is to be conducted once in a year during the Short-Term Period (2016-2018) by GWMC. GWMC has a number of experienced staff for WACS who worked with the JICA Study Team in the years of 2014 and 2015; for instance, 5 waste managers and 3 research assistants. They will be the main members of GWMC to conduct the WACS 3 times during the Short-Term Period (2016-2018).

5.3.2 Waste Amount Survey

The survey items and contents for the waste amount survey are basically the same as the WACS conducted during the JICA Study in 2014 and 2015 as follows:

- Type of waste generation sources and number of samples;
- Union council classification;
- Survey method; and
- Survey result.

5.3.3 Waste Composition Survey

The survey items and contents for the waste composition survey (physical composition: wet base) are also basically the same as the WACS conducted during the JICA Study in 2014 and 2015 as follows:

- Type of waste generation sources and number of samples;
- Survey method; and
- Survey result.

5.3.4 Three-Component Analysis, Carbon and Nitrogen Analysis, and Moisture Contents Analysis

The survey items and contents for 3-component analysis, carbon and nitrogen analysis, and moisture contents analysis are also basically the same as the WACS conducted during the JICA Study in 2014 and 2015 as follows.

- Type of waste generation sources and number of samples,
- Survey method, and
- Survey result.

5.4 Project for Setup of PPP and Formation of a GWMC-BOD Committee

As mentioned in the previous Chapter 4, a new compost company which is tentatively called "Gujranwala Central Compost and RDF Plant" is proposed to start operation in 2020 during the Mid-Term Period (2019-2024) and, as a new company under the PPP system, BOT (build-operate-transfer) basis is recommended in the master plan.

In order to establish a new compost company in Gujranwala, it is necessary or crucial for the SPV (Special Purpose Vehicle) to follow the following stepped processes of preparing for the private service contract under BOT basis during the Short-Time Period (2016-2018):

- Step 1: Approval by the Board of Directors (BOD) of GWMC on the advertisement and approval of the Terms of Reference (TOR) for PPP and formation of a committee (it will take one month for Step 1);
- Step 2: Invitation for Expression of Interest (EOI) to participate in PPP, and formation of a committee and pre-qualification of bidder;
- Step 3: Shortlisting and verification of credentials of participating companies; preparation of tender documents;
- Step 4: Necessary bidding for SPV;
- Step 5: Holding a committee meeting to discuss and approve shortlisted companies;
- Step 6: Presentation by shortlisted companies to the BOD of GWMC;
- Step 7: Finalisation of an approved company;
- Step 8: Award of Contract;
- Step 9: Conduct of TOR by awarded SPV.

According to the MD of GWMC, the whole process above will take about 6 months (Step1 to Step 9) for this project and shall be put in the year of 2017 before preparation of the land area (7 ha) procured for the compost plant and engineering detailed design of the plant by the awarded company in 2018 in the short-term period. The awarded company becomes the SPV (Special Purpose Vehicle) in the contract period which will be defined in the TOR. Therefore, the SPV is to be used as the owner of the compost plant in this chapter from now on. All the required terms for the awarded SPV are to be defined in the TOR signed by both the GMWC and SPV definitely such as:

(1) GWMC's preparation of the required land area and its provision to the SPV by 2018;

(2) GWMC's provision of segregated raw wastes including organic matter to the SPV for the compost plant during the whole period of operation and maintenance activities;

(3) SPV's conduct of the detailed design of the compost plant project;

(4) Number of years of effectivity of the above conditions (1), (2) and (3) to be defined in the TOR (say 25 years or 30 years, or more);

(5) The new organization, staffing and salary system created and decided by the SPV shall not follow the system of GWMC;

(6) The implementation of each work item of the contract such as preparation and procurement of land area required by the SPV, engineering detailed design, construction works for the plant and appurtenance facilities;

(7) Conducted of operation and management of the SPV's plant;

(8) Monitoring of implementation of the compost plant including the conduct of necessary actions on the quality control of compost production from the Plant; and

(9) Any terms and conditions required in the TOR.

5.5 Project for Implementation of Land Preparation by GWMC

The BOD of GWMC shall prepare a procurement plan for the land of the compost plant project owned by SPV based on the TOR. The TOR should define that the required land is to be procured and provided to SPV by the BOD of GWMC, before the start and completion of construction work for the compost plant project in 2019 and the detailed engineering design services for the compost plant project in 2018. The land area of approximately 7 ha shall be located in flat farm fields and adjacent to the first phase compound of the final landfill site at Bhakhraywali as mentioned in the master plan. So far, there is no actual action taken by GWMC for the land because the development plan of the final landfill site is still in progress.

5.6 Project for Engineering Services for Detailed Design of Compost Plant by SPV

5.6.1 Assumed General Arrangement and Detailed Design of the SPV Project

Detailed design of the compost plant by SPV is to be started and completed within 2018. Effective performance monitoring requires that the SPV is responsible for the operation and management of the compost plant project and the BOD of GWMC maybe also required to conduct joint monitoring as to whether or not the service contract is actually and properly being delivered in a financially sound manner. It is suggested that this matter should be described in the TOR.

Although the contents of the TOR are not available at this moment and SPV is also not awarded yet, salient features of compost and RDF facilities required for design are here introduced and then general requirements for preparation of tender documents, bill of quantities, tender evaluation, and construction supervision are also presented for reference of SPV's project as follows. Some points to be addressed are also given below.

(1) Salient Features of Compost Facility for the SPV's Project

The required units of houses for composting and RDF production and other facilities and equipment are as follows:

<u>Buildings and facilities</u>

- Administration office
- Laboratory office

- RFID/weighbridge, platform and house
- Guardhouse
- Car parking area
- Overhead storage waste tank
- Perimeter fencing
- Steel skeleton structures
- Screen bagging and storage facility
- Waste sorting facility
- Windrow area
- Pilot farm for compost testing,
- Buffer zone and open and green area,
- Others like plastic sheets for windrow, drainage channels, tube well, generator, etc.
- Equipment and machinery
- Sorting line including hopper and conveyor (1) & (2)
- Shredder (1) & (2)
- Double refining trammel screen (1) & (2)
- Pre-treatment screen
- Self-propelled windrow turner
- Baler, pallet
- Wheel loader, tractor, trolley
- Others

(2) Preparation of Tender Documents

The SPV's engineering consultants shall prepare the documents for competitive bidding of the construction of the compost plant adjacent to the Bhakhraywali sanitary landfill facilities in the final stage of the design work. The tender documents shall include:

- Notice of Pre-qualification
- Instructions to Tenderer
- Contract document form
- General Conditions of Contract and Special Conditions of Contract
- Tender Drawings
- Technical Specifications
- Tender Schedule and Bill of Quantities

In the preparation of contract document forms and the general conditions of contract, it is preferable to take into consideration the conditions of standard contract form required in the TOR as much as possible.

(3) Preparation of Bill of Quantities

The Bill of Quantities shall also be prepared as defined in the TOR. The work for the calculation of the bill of quantities shall be commenced with the preparation of construction quantity take-off sheets of the facilities, equipment, devices and temporary works required to construct, install and procure for completing the construction work as intended in the design. Each item composing the bill of quantities shall be itemised to coincide with the regular payment items for the work done. The SPV's consultant also prepares the unit cost analysis/estimates for each item of the bill of quantities with reference to the latest market price announced by the government and the quotation

from the manufacturers. The unit price must be clearly state the unit base and be separated with the costs for materials, labour, depreciation cost or rental fee. The outputs under the work for preparation of bill of quantities include the following:

- Preparation of quantity take-off sheets;
- Preparation of unit cost analysis sheets;
- Preparation of bill of quantities without price for the tender document; and
- Preparation of priced bill of quantities, the engineer's estimate to the project proponent.

(4) Support for Tender Evaluation

The SPV's consultant shall carry out the following services in each process from pre-qualification of the interesting bidders until the signing of the construction work contract:

- Assistance to the project proponent of SPV on the announcement of prequalification and tender;
- Preparation of prequalification criteria and prequalification of the interested bidders;
- Preparation of tender evaluation criteria and tender evaluation;
- Numerical check of the tender schedule and unit price of the lowest bidder; and
- Assist the project proponent for the tender negotiation.

(5) Construction Supervision

The SPV's consultant shall carry out the following services in the construction stage to assist/advice SPV and the SPV's contractor to perform the construction work in accordance with the drawings, specifications and the construction time schedule:

- Evaluation of the construction plan prepared by the contractor;
- Evaluation of construction work drawings including drawings prepared by the contractor;
- Monitoring/inspection of construction work for construction quantity and workmanship;
- Monitoring of progress of the construction work;
- Evaluation of the periodical payment document and report to the project proponent;
- Holding of weekly/monthly meetings with the contractor;
- Preparation of punch list for project completion inspection and final check; and
- Checking of the as-built drawings.

5.6.2 Quality Control of SPV's Compost

As mentioned in the previous **Subsection 2.4 Table D.2.8** and **Subsection 2.5 Table D.2.9**, it is noted that the quality control of compost production of the Lahore compost project does not satisfy the farmer's requirement. In this context, the compost production of the SPV should be satisfactory for the farmer's needs and should be clearly described in the contractual agreement and the technical specifications between the SPV and the BOD of GWMC as stated in the TOR and summarised below:

- Organic matter in SPV compost should be 35%~45% or more and bulk density of compost products should be generally about 0.5~0.7 t/m^3.
- The SPV should search for the proper mix proportion of organic matter and cow dung used in SPV's mature compost. Since cow dung is more available in Gujranwala City and its surrounding area than in Lahore, it is expected that better mature compost with more organic contents can be produced in Gujranwala.
- It is also desired that the proposed pilot farm in the complex of SPV's plant should be managed and be well-organised by the SPV, and should also be open to public to demonstrate the effective results of compost in the field.

- The SPV shall get a licence for compost production from the Agricultural Department Directorate of Soil Fertility, Lahore, the Government of the Panjab. However, it is recommended that the control of SPV's compost quality should be maintained and improved sufficiently.
- Compost production should be recorded properly to measure how much kilogramme of compost is sold or not sold every day, including searching for a good marketing system on compost.
- Besides requiring quality control of SPV's compost, IEC programmes on the effectiveness and safety of SPV's compost is further needed to the famers/residents.

5.7 Plan of Operations and Cost of Action Plan

The implementation schedule of the Intermediate Treatment and 3R Promotion Action Plan or the short-term plan for the period from 2016 to 2018 is shown in **Figure D.5.1**. The main projects during the short-term plan period consists of 1) the conduct of Awareness and IEC campaign on resource recovery in UC Zone 6, a model zone for strengthening of waste collection, including waste separation at source; 2) conduct of simplified WACS implementation; 3) setup of PPP and formation of GWMC's BOD Committee; 4) implementation of land preparation by GWMC; and 5) engineering services for the detailed design of the compost plant by SPV.

Table D.5.1 gives the Estimated Cost of the Intermediate Treatment and 3R Promotion Plan (Short-Term Plan).

Time Framework of the Master Plan		Short-Term Plan Period											
Year		2016				2017				2018			
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WBS for Short-Term Plan													
S-3-1	Awareness & IEC campaign on resources recovery		■	■	■	■	■	■	■	■	■	■	■
S-3-1-1	Development of materials for environmental education programme in schools (refer to S-4-2-1 of WBS for Short-Term Plan, Environmental Education & Public Awareness Raising Plan)		■	■		■				■			
S-3-1-2	Development of the educational materials for school programme (refer to S-4-2-2 of WBS for Short-Term Plan, Environmental Education & Public Awareness Raising Plan)		■	■		■				■			
S-3-1-3	Selection of target schools (refer to S-4-2-3 of WBS for Short-Term Plan, Environmental Education & Public Awareness Raising Plan)		■			■				■			
S-3-1-4	Implementation of the environmental education programme at schools (refer to S-4-2-4 of WBS for Short-Term Plan, Environmental Education & Public Awareness Raising Plan)			■	■	■	■	■	■	■	■	■	■
S-3-1-5	Development of guideline for environmental education programmes for general public (refer to S-4-3-1 of WBS for Short-Term Plan, Environmental Education & Public Awareness Raising Plan)			■	■								
S-3-1-6	Development of the educational materials for general public (refer to S-4-3-2 of WBS for Short-Term Plan, Environmental Education & Public Awareness Raising Plan)			■	■	■				■			
S-3-1-7	Implementation of the environmental education programmes in periodical events (refer to S-4-3-3 of WBS for Short-Term Plan, Environmental Education & Public Awareness Raising Plan)			■			■	■			■	■	
S-3-2	Conduct of simplified WACS implementation	■				■				■			
S-3-2-1	Waste amount survey	■				■				■			
S-3-2-2	Waste composition survey	■				■				■			
S-3-2-3	Three component analysis, carbon and nitrogen analysis, and moisture contents analysis	■				■				■			
S-3-3	Setting up for PPP & Formation of a Committee of the BOD of GWMC							■	■				
S-3-3-1	Approval by the Board of Directions (BOD) of GWMC to advertise and approve the terms of reference (TOR) for PPP and Formation of a committee							■					
S-3-3-2	Invitation of expression of interest (EOI) for participating in PPP & Formation of a committee and pre-qualification of bidder							■					
S-3-3-3	Shortlisting and verification of credentials of participating companies / preparation of tender documents							■	■				
S-3-3-4	Necessary bidding for SPV							■	■				
S-3-3-5	Holding a committee meeting to discuss and approve shortlisted companies								■				
S-3-3-6	Presentation by an approved company								■				
S-3-3-7	Finalisation of an approved company								■				
S-3-3-8	Award of contract								■				
S-3-3-9	contract of TOR by awarded SPV								■				
S-3-4	Implementation of land preparation by GWMC									■	■		
S-3-5	Engineering service for detailed design of the compost plant by SPV										■	■	■
S-3-5-1	Assumed general arrangement and detailed design of the SPV project										■	■	■
S-3-5-2	Quality control of SPV's compost										■	■	■

Figure D.5.1 Plan of Operations of the Intermediate Treatment and 3R Promotion Plan (Short-Term)

Table D.5.1 Cost of Operations for Intermediate Treatment and 3R Promotion Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost		
			2016	2017	2018
Programme 3: Intermediate Treatment and 3R Promotion Plan					
Short-Term Plan					
S-3-1	Awareness & IEC Campaign on Resources Recovery	GWMC	0	0	0
S-3-2	Implementation of Simplified WACS	GWMC	0	0	0
S-3-3	Preparation for PPP & Formation of a Committee of the BOD of GWMC	BOD/GWMC	0	0	0
S-3-4	Implementation of Land Preparation by GWMC	BOD/GWMC	0	0	0
S-3-5	Engineering Service for Detailed Design of the Compost Plant by SPV	40,000	0	0	40,000
	Total (Short-Term)	40,000	0	0	40,000

6. CONCLUSION

The following are the conclusions for implementing the intermediate treatment and 3R Promotion plan formulated under the Master Plan and Action Plans for the project of ISWM Master Plan in Gujranwala. On the basis of the following conclusions in addition to the prescribed proposed methodologies and plans, the action plans for intermediate treatment and 3R Promotion would be implemented under the umbrella of GWMC.

(1) Private Sector Involvement in 3R Activities

3R activities have not been promoted by GWMC since its establishment in 2014 until the present. According to the waste picker's survey report by the JICA Study Team in January 2015, there is an active operation of the private sector including street hawkers, waste pickers, junk shops, recyclers, households and GWMC sanitary workers in resource recovery. The recovery amount of resource materials of Gujranwala City and Gondlanwala disposal site is estimated to be about 70 t/d out of waste discharge amount, i.e., 476 t/d. The discharge amount of resource materials is likely to increase in the coming future by GWMC's provision of collection services in the uncollected and partially collected areas due to the increased number of vehicles and manpower.

(2) Quality of Compost Product

The quality of compost product is the major determinant of its end use/application. During the visit to Lahore compost, it was observed that a large amount of compost remains stored in the warehouse due to its poor quality. The major reasons/causes are the use of mixed waste as input material for composting and the poor control of production process due to windrow composting in the open field. Due to the usage of mixed municipal waste as raw material for the composting process, it is difficult to maintain higher organic content in the final product.

(3) Awareness of Farmers on the Utilisation of Compost

According to the interview survey conducted with the local farmers in the peri-urban areas, they are well aware about the benefits of applying organic fertilizer or compost for healthy and eco-crops and the effectiveness of organic fertilizer produced by cow dung as a base fertilizer after cropping or before seeding. The cow dung softens the soil and the farmers use it in combination with chemical fertilizers for more yield in a shorter time.

Firstly, the farmers want to see the effects of compost application in the test yards at the compound of the proposed compost plant in Gujranwala. Then the compost would be acceptable to the farmers for use depending on the yield and quality of the crops, as well as the price of compost.

(4) Quality of RDF Product

The RDF is being produced by DG Khan Cement Company in Lahore. The same company is utilising the final product at its own cement plant in Kalar Kahar. Similarly, Lahore Compost Company produces RDF in the process of compost/RDF plant and sells RDF to Lafarge Cement Company. The quality of RDF produced by both companies is found to be poor. The use of mixed municipal solid waste with foreign matters as an input material is one of the causes of poor quality of RDF

(5) Institutional Status for 3R Activities

Currently, there is no legal system, law, regulation and guideline on SWM and 3R activities enforced in Pakistan. Although the Punjab Municipal Solid Waste Management Act of 2013 has some provisions/guidelines on this sector, this act is still in draft form and hence the current implementation of 3R activities is still poor. The existing legal documents; namely, the guidelines,

notifications and acts related to 3R are fragmented, so that there is a need to integrate them into a comprehensive recycling law. There should be some designated authority for the strong enforcement of this law.

7. RECOMMENDATIONS

The following are the recommendations for implementing the Intermediate Treatment and 3R Promotion Plan formulated under the master and action plans for the ISWM project in Gujranwala.

(1) Timely Implementation of PPP Contract of Compost Plant by SPV

GWMC should set up the PPP contract for SPV/Gujranwala Compost Company on priority basis under the supervision of the established committee. It would help to keep pace with the tentative schedule of intermediate treatment and 3R promotion plan and timely implementation of action plans.

(2) Public Participation and Upgrading Private Sector in 3R Activities

GWMC should promote 3R activities in the society through IEC as follows:

- GWMC involvement in 3R activities through promotion campaigns.
- Separation of recyclables at waste generation source, households, workplace, schools, etc.
- Support/assistance to the private actors (waste pickers, junk shops etc.)
- Registration of private actors for resource recovery.
- Licencing and collaboration with GWMC for promoting resource recovery.

(3) Utilisation of Organic Waste and Production Control for Standard Quality Compost

For the production of good quality compost, GWMC should start separate collection of waste (2 bins system – organics and other residual waste). The pre-treatment process should be installed at the compost plant to remove foreign matters from the segregated organic waste.

Moreover, the production process should be controlled by the key parameters including C/N ratio, moisture, temperature, oxygen, return ratio, etc. for producing better quality compost. Therefore, only source separated organic waste should be acceptable in the compost plant as an input material to ensure good quality of final product.

(4) Demonstration Farm for Compost Utilisation Promotion

GWMC/SPV may collaborate with Punjab Seed Corporation, Government of the Punjab. The company has its dealer network all over the Punjab including Gujranwala. In Gujranwala, it has more than 150 dealers. The SPV (Gujranwala Compost Company) can start some joint venture for the sale and promotion of compost with these dealers.

(5) Segregated Raw Material Input to the RDF Plant

Segregated raw material input into the RDF plant improves the quality of the final product. Installation of sorting unit as part of RDF plant is essential to the removal of foreign matter. In future, shredding and pelleting units should be added in the RDF plant to produce RDF pellets. This approach would promote the use of RDF without the combination of any other fuel. It would add value for its handling and selling to the cement industries.

(6) Enactment of By-law(s), Regulations and Manual for Promoting 3R Activities

There is a need to enact a separate comprehensive law dealing with and promoting intermediate treatment and 3R activities. In order to formalise the rapidly growing informal resource recovery activities, the Recycling Law should be enforced strictly. The law should state the enforcing

authority, procedures, roles of each actor manuals and penalties regarding resource recovery activities.

REFERENCES

1. National Rural Support Programme: "Renewable Energy: Evaluation of Biogas Initiative in Punjab", August 2011
2. Pakistan Environmental Protection Agency, Ministry of Climate Change, GOP: "Guidelines for Processing and Using Refuse Derived Fuel (RDF) in Cement Industry", August 2012

PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

DRAFT FINAL REPORT

VOLUME 2

SUPPORTING REPORT

SECTION E

ENVIRONMENTAL EDUCATION AND PUBLIC AWARENESS RAISING

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SECTION E

ENVIRONMENTAL EDUCATION AND PUBLIC AWARENESS RAISING

1. INTRODUCTION

Section E describes the in-depth analysis of the environmental education and public awareness raising aspect of Chapter 2, Chapter 3, Chapter 4 and Chapter 6 of the main report. The environmental education and public awareness raising aspect includes the description and evaluation of the current condition, the planning direction of the economic and financial plan, the formulation of the environmental education and public awareness raising plan, and the formulation of the action plans.

2. DESCRIPTION AND EVALUATION OF CURRENT CONDITION

2.1 Publication and Establishment Awareness Survey

2.1.1 Objective of the Survey

Awareness survey was planned to identify the current status of waste management practices by key stakeholders, including the following categories:

- Households (including households targeted in the waste amount and composition survey); and
- Business entities (markets, schools and universities, commercial establishment, restaurants, hotels, shops, factories, and hospitals).

2.1.2 Survey Method

The interview survey was conducted by a private contractor while some key components, such as sample numbers, target entities, and questionnaire forms were developed under close coordination among the counterpart personnel and the JICA Project Team.

This survey covered the following areas in Gujranwala City:

- Aroop
- Nandi Pur
- Khiali
- Qila Didar Singh
- Rural areas (outside of 64 urban UCs)

Number of samples required for the household survey was determined using multistage sampling methods, in which approximately 400 samples are required, giving 95 confident levels. These 400 samples were then distributed among the target areas depending upon income level since income greatly influences the type and volume of waste. The number of samples per area per income level is listed in **Table E.2.1** below.

Table E.2.1 Number of Samples for Public Awareness Survey

Town	Areas	*Income Level*			Samples	Proportion of Samples
		Low	*Middle*	*High*		
Aroop	A	12	20	10	85	All the selected households in the Waste Amount and Composition Survey (WACS) shall be included in this survey.
	B	13	20	10		
Nandi Pur	C	12	20	10	85	
	D	13	20	10		
Khiali	E	40	5		85	
	F	35	5			
Qila Didar Singh	G	15	25		85	
	H	20	25			
Rural	I	30			60	
	J	30				
Total		220	140	40	400 Households	

Likewise, the number of target commercial establishments was determined to represent the whole area of Gujranwala City as shown in **Table E.2.2**.

Table E.2.2 Number of Samples for Establishment of Awareness Survey

Category	Samples	Establishment to be Surveyed
Market	5	Major markets, sales
School	5	Number of enrolled students (1 university, 1 government college & school, 1 private college & school)
Commercial Establishment	7	Large Scale, Number of Employees, Floor size
Restaurant	5	Number of customers
Hotel	5	Number of rooms
Store	10	Floor size
Factory	10	Large-Scale, based on production
Hospital	3	Number of beds
Total	50	

Although survey items differ considerably since each entity has its own unique characteristics, the items summarised in **Table E.2.3** were decided to be included in the questionnaire, because the questions would give a comprehensive picture of awareness in waste management in the City.

Table E.2.3 Survey Items in the Questionnaire

Households	Commercial Establishments	
	General Establishments	Medical Institutions
Part 1: General Information		
- Location - General area description - Responsible entities for SWM - Existence of community groups, leadership	- Location - General area description - Responsible entities for SWM - Existence of community groups, leadership	- Location - General area description - Responsible entities for SWM - Existence of community groups, leadership
Part 2: Description of Interviewed Subject		
- Number of members - Type of dwelling - Unit rent or ownership - Household income	- Type of commercial activity - Number of employees - Floor area - Annual Sales	- Number of beds - Hospital specialisation
Part 3: Solid Waste Conditions		
- Waste containers used - Waste discharge habits - Discharge location - Separation and recycling - Waste collection system - Charge paid - Self treatment	- Waste containers used - Waste discharge habits - Discharge location - Separation and recycling - Waste collection system - Charge paid - Self treatment	- Waste containers used - Hazardous and non-hazardous waste separation - Discharge location - Waste collection system - Treatment system within the institutions (Self-treatment)
Part 4: Awareness on SWM Issues		
- Concept of SWM in the city - Willingness to pay to improve SWM	- Concept of SWM in the city - Willingness to pay to improve SWM	- Concept of SWM in the city - Willingness to pay to improve SWM

2.1.3 Results of the Awareness Survey

The survey was carried out from late September to November 2014 in which the results formed the basis in considering the following:

- Understanding the waste storage/discharge practices in planning the optimal waste collection system;
- Selecting target area for separate collection and implementation of awareness rising, public relations (PR), and environmental education to the public;
- Understanding the residents' awareness in environment/hygiene to plan the appropriate awareness rising, PR, and environmental education activities; and

- Considering appropriate fee system for waste collection services.

(1) Households

Table E.2.4 and **Table E.2.5** give general information about the respondents in the survey depending upon income group. Across the income group, there is no gender bias, and a major portion of the answer come from the master, wife, or children who are familiar with household matters very well. This makes the result of the survey very accountable.

Table E.2.4 General Information of Interviewee

Unit:%

		High income	Middle income	Low income	Rural area
1.1	Age				
	~19	2.6	0.7	2.5	3.3
	20~29	12.8	8.6	8.9	15.0
	30~39	15.4	18.7	12.1	21.7
	40~49	23.1	20.1	9.6	25.0
	50~	43.6	12.9	10.2	18.3
	N/A	2.6	38.8	56.7	16.7
1.2	Gender				
	Male	51.3	49.6	54.1	51.7
	Female	48.7	49.6	44.6	48.3
	NA	0.0	0.7	1.3	0.0
1.3	Number of your family members				
	~4	12.8	11.5	17.2	6.7
	5~7	41.0	41.7	31.2	30.0
	8~10	28.2	22.3	26.1	21.7
	11~	17.9	22.3	24.2	41.7
	NA	0.0	2.2	1.3	0.0
1.4	Does your house have an access of a car?				
	yes	76.9	78.4	21.0	20.0
	no	0.0	10.8	64.3	80.0
	NA	23.1	10.8	14.6	0.0
1.5	How many family members earn the living?				
	1	43.6	48.9	41.4	35.0
	2~3	41.0	26.6	44.6	48.3
	4~	10.3	19.4	7.0	16.7
	NA	5.1	5.0	7.0	0.0
1.6	How many of them have permanent job?				
	0	33.3	51.1	82.8	88.3
	1	20.5	20.1	5.1	0.0
	2~3	2.6	4.3	1.3	0.0
	4~	2.6	3.6	0.0	0.0
	NA	41.0	20.9	10.8	11.7
1.7	Average monthly income of your family (RS.)				
	~9,999	0.0	0.7	1.3	0.0
	10,000~29,999	0.0	1.4	7.6	1.7
	30,000~49,999	0.0	0.0	0.0	0.0
	50,000~	0.0	0.0	0.6	1.7
	NA	100.0	97.1	90.4	96.7
1.8	Expenditure of your family per two-week (RS.)				
	~9,999	0.0	13.7	22.3	65.0
	10,000~29,999	12.8	18.0	3.2	13.3
	30,000~49,999	5.1	5.0	0.0	3.3
	50,000~	2.6	2.2	0.0	0.0
	NA	79.5	60.4	74.5	18.3

Table E.2.5 Relation with Head of the House in the Survey

Group	Respondents	Male	Female	Relation with Master			Others
				Master	Wife	Children	
High Income	39	20 (51%)	19 (48%)	12	15	8	4
Middle Income	139	69* (50%)	69* (50%)	62	40	25	12
Low Income	157	85* (53%)	70* (43%)	75	53	21	8
Rural Area	60	31 (51%)	29 (48%)	22	17	20	1
Total	395	205* (52%)	187* (47%)	171	125	74	25

Note:* No gender was specified for one (1) respondent in middle income and two (2) respondents in low-urban income groups.

Table E.2.6 shows the response rate for each question in the survey. It is found that most of the questions have been given answers so that the data acquired is very useful. On the other hand, however, respondents were very reluctant to give information about financial matters, such as how much they are willing to pay for a service. Therefore, the data on financial matters should be dealt as reference only and should not be used as definite illustration of the situation on the ground.

Table E.2.6 Response Rate for Each Question (Households)

No.	Contents of the Question	High Income	Middle Income	Low Income	Rural Area
Q. No. 1	General Information on Interviewee (Number of respondents)	39	139	157	60
Q. No. 2	Waste Collection Services and Waste Discharge Behaviour				
2.1	Do you have waste collection services?	100%	100%	83%	100%
2.2	What do you usually use when you discharge wastes?	95%	97%	99%	95%
2.3	How much waste do you discharge per week	92%	86%	90%	92%
Q .No. 3	Recycling				
3.1	What do you do with used bottles?	100%	99%	100%	98%
3.2	What do you do with used cans?	82%	81%	96%	97%
3.3	What do you do with paper in your wastes?	92%	98%	99%	98%
3.4	In general, do you support the idea of recycling?	95%	81%	100%	100%
3.5	Do you use your kitchen wastes for any purpose?	100%	99%	100%	100%
3.6	Do you separate any other wastes? What do you do with them?	87%	99%	89%	98%
Q. No. 4.	Financial Matters				
4.1	Do you give tips/fees to the collection crew?	97%	97%	100%	100%
4.2	[To those who have waste collection services] How much Rupee per month, at maximum, could you pay?	36%	21%	2%	20%
4.3	How much do you pay for water supply per month?	18%	13%	8%	20%
4.4	How much, at most, could you pay for water supply supposing that you would not get water supply without paying that amount?	3%	33%	10%	27%
4.5	How much do you pay for electricity per month?	64%	75%	83%	97%
4.6	How much, at most, could you pay for electricity supposing that you would not get electricity without paying that amount?	8%	29%	10%	33%
4.7	What is the order of priority of the following items for your living condition?	100%	100%	92%	100%
Q. No. 5	Cleaning the city	97%	98%	96%	100%
5.1	Do you think public areas such as roads and parks are well kept clean?				
5.2	Who does clean the road in front of your premises and/or adjacent public area?	100%	100%	96%	100%
5.3	Keeping the city clean requires efforts of not only the city and the GWMC but also the general public. Are you willing to cooperate in some ways to keep the city clean?	100%	100%	96%	100%
5.4	Do you think a campaign to raise awareness of people for maintaining the city clean is effective?	100%	99%	96%	100%
5.5	Who do you think should have the initiative in keeping the city clean?	95%	98%	99%	100%
5.6	What problems do you find?	100%	100%	99%	100%

(a) Waste Collection Services/Waste Discharge Behaviour

In urban area, more than half of households have waste collection services. Of course, households with higher income receive a higher level of waste collection services; namely, door-to-door collection. On the other hand, close to 70% of households do not have waste collection services in rural areas (see **Table E.2.7**). It also shows that a majority of households have no issue about distance from waste collection point since most of them enjoy either door-to-door collection or curb-side collection.

Table E.2.7 Coverage and Type of Waste Collection Services

	High (urban)	Middle (urban)	Low (urban)	Rural
Door-to-Door collection	87%	82%	50%	22%
Curb-side collection	0%	7%	34%	12%
No Response	5%	0%	1%	0%
No Services	8%	11%	15%	67%

Figure E.2.1 shows the frequency of waste collection. As expected, daily collection is observed in high income groups with more than 60% of households serviced every day. The graph clearly shows the correlation with income level and frequency, i.e., the higher the income, the more frequent is waste collection. It can be noted that most of the households across the income group have multiple collection days in a week.

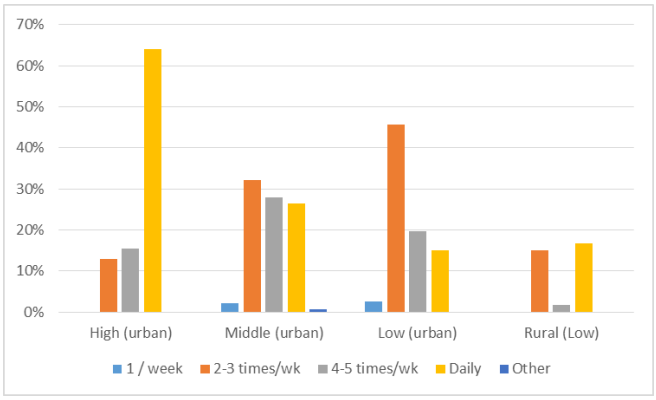


Figure E.2.1 Frequency of Waste Collection

When households encounter issues on waste collection services, such as insufficient waste collection (frequency) or waste collection at irregular time, a considerable number of households imply that they dispose their waste into public places (see **Table E.2.8**). Seven percent (7%) of middle income people dispose their waste at nearby waste containers when no prompt waste collection is provided. In other words, regular waste collection and awareness raising activity for proper SWM is badly needed to attain a hygienic condition in the community.

Table E.2.8 Behaviour when Issues are encountered on Waste Collection Service

	High (urban)	Middle (urban)	Low (urban)	Rural (Low)
Wait for next collection	60%	11%	3%	0%
Dispose at public places	40%	82%	97%	100%
Other (dispose at nearby container)	0%	7%	0%	0%

Other results on the question about Waste Collection Service and Waste Discharge behaviour are shown in **Table E.2.9**. Interestingly, all income groups showed similar tendency in these questions. For example, most residents across the income group receive waste collection service from GWMC and think the service has not improved in recent years. In particular, people cannot rely on regular collection service, or fix-time collection. On the other hand, a majority of residents use either plastic shopping bags or dustbins to dispose their waste.

Table E.2.9 Other Results of Questionnaire on Waste Collection Services and Waste Discharge Behaviour

Unit:%

No.	Questionnaire	High income	Middle income	Low income	Rural area
Q2.1	Who collects the waste?				
	1. Crew of a collection vehicle (Tractor Trolley).	0.0	0.0	0.6	0.0
	2. Waste collector with handcart / donkey cart.	92.3	89.2	67.3	32.2
	3. Street sweepers.	0.0	0.0	14.5	0.0
	4. NA	7.7	10.8	17.6	67.8
Q2.2	Where are they from?				
	1. GWMC	87.2	89.2	65.4	18.3
	2. Private company	5.1	0.0	2.5	0.0
	3. Individual (CSO: CBO, NGO)	0.0	0.0	12.6	15.0
	4. I don't know.	0.0	0.0	2.5	0.0
	5. NA	7.7	10.8	17.0	66.7
Q2.3	Do the waste collectors come at fixed time on specific days of the week?				
	1. Yes	53.8	33.1	34.0	11.7
	2. No	38.5	55.4	42.5	21.7
	3. I don't know.	0.0	0.0	1.3	0.0
	4. Some time	0.0	0.0	4.6	0.0
	5. NA	7.7	11.5	17.6	66.7
Q2.4	How do you feel about the trend of the collection services?				
	1. It is improved very much.	15.4	6.5	1.3	0.0
	2. It is improved to a certain extent.	7.7	31.7	34.6	6.7
	3. There is no particular improvement.	33.3	46.0	47.4	26.7
	4. It has got worse.	43.6	0.7	0.0	0.0
	5. NA	0.0	15.1	16.7	66.7
Q2.4.1	Why are you satisfied with the current waste collection system?				
	1. The frequency of collection is appropriate.	35.0	17.9	3.3	15.0
	2. Collection time is convenient for me.	5.0	2.8	9.9	0.0
	3. It helps keep my house clean.	7.5	3.4	8.3	0.0
	4. The waste collectors work hard.	0.0	10.3	24.3	0.0
	5. My waste collection point is close enough.	0.0	0.0	0.6	0.0
	6. The service is provided free of charge	0.0	5.5	7.2	1.7
	7. NA	52.5	60.0	46.4	83.3
Q2.4.2	What problems do you have with the current waste collection system? (Plural answer question)				
	1. The frequency of collection is very few.	7.5	14.0	13.8	6.3
	2. Collection time is irregular.	5.0	20.7	26.0	9.4
	3. Collection time is too early or too late.	0.0	6.0	0.0	0.0
	4. The behaviour of the waste collectors is bad.	0.0	0.0	0.6	0.0
	5. High tip/fee is required.	2.5	0.7	1.7	0.0
	7. Others	5.0	1.3	0.0	0.0
	8. NA	80.0	57.3	58.0	84.4
Q2.4.2.1	How far is your collection point from your house?	NA	NA	NA	NA
Q2.4.2.2	How far do you think it should be at farthest?	NA	NA	NA	NA
Q2.4.2.3	How much do you tip to the sweeper for one collection?	NA	NA	NA	NA
Q2.4.3	How do you deal with your wastes?				
	1. I burn them.	0.0	0.0	0.0	3.2
	2. I give the wastes to the sweepers	0.0	66.7	0.0	0.0
	3. I throw them away at public places, such as empty plots, along roads/streets, green belts etc.	2.6	33.3	14.6	64.5
	4. I dispose the waste at waste container.	5.1	0.0	1.9	0.0
	5. NA	92.3	0.0	83.4	32.3
Q2.4.3.1	Why don't you need waste collection services?				
	1. I do not feel the necessity of having waste collection services.	7.7	0.7	0.0	0.0
	2. NA	92.3	99.3	100.0	100.0
Q2.5	What do you usually use when you discharge wastes?				
	1. Plastic shopping bags	46.3	58.4	51.5	32.4
	2. Large plastic bags	0.0	0.0	0.5	0.0

Unit:%

No.	Questionnaire	High income	Middle income	Low income	Rural area
	3. Paper bags	0.0	0.0	0.5	0.0
	4. Dustbins	46.3	38.3	47.1	61.8
	5. Carton boxes	0.0	0.0	0.0	1.5
	7. Others(Specify)	2.4	0.6	0.0	0.0
	8. NA	4.9	2.6	0.5	4.4
Q2.6	How much waste do you discharge per week				
	1. ~9kg	2.6	25.9	15.3	20.0
	2. 10~29kg	66.7	50.4	68.2	51.7
	3. 30~49kg	20.5	7.9	6.4	13.3
	4. 50kg~	2.6	1.4	0.6	8.3
	5. NA	7.7	14.4	9.6	6.7

(b) Willingness to Pay for Waste Collection Services

Table E.2.10 gives a summary of the responses to two (2) questions: one is for the "willingness to pay" and the other is to find out if the residents are paying tips/fees in the current waste collection services.

Since the amount of money that one is willing to pay was asked from the respondents who want to avail themselves of GWMCs' waste collection service, no figure was given by the respondents who gave a "no answer" or "no" to the questions. In other words, the results of the survey on WTP should be dealt with as reference only since a very limited number of people answered this question. Actually, nobody in high income group answered this question. High income residents might have feared that much higher fees would be imposed in the future when GWMC starts to collect waste with fees.

Interestingly, however, people are much more inclined to give out information about tips they are currently paying for waste collection workers. In urban settings, close to 70 to 80% of residents gave out the figure and approximately 30% in rural setting gave out the figure.

Although the WTP figure is based on very limited number of respondents, the general trend is same across the income groups when the WTP figure and the current tip is compared. In general, close to 35–40% of residents in urban middle and low income groups pay either 1-50 Rs. or 51-100 Rs. a month. Nonetheless, people willing to pay 51-100 Rs./month dropped considerably while 0 Rs./month emerged in the willingness to pay questions. A similar trend can be said also for the rural population.

If GWMC will pursue the collection of operation cost from the residents directly, it should be emphasised to PR such information as the objectives, operation, and other environmental related activities to the public to gain their confidence and make them realise that a certain cost is necessary to properly manage SWM and make the city environment hygienically clean.

Table E.2.10 Behaviour when Issues Appear on the Waste Collection Service

Willingness-to-Pay		High (Urban)	Middle (Urban)	Low (Urban)	Rural (Low)
Wants waste collection service by GWMC	No Answer	36 (92%)	124 (89%)	131(83%)	21 (35%)
	Yes	0 (0%)	14 (10%)	26 (17%)	39 (65%)
	No	3 (8%)	1 (1%)	0 (0%)	0 (0%)
	Total	39 (100%)	139 (100%)	157 (100%)	60 (100%)

Current amount of tip paid for collection		High (Urban)	Middle (Urban)	Low (Urban)	Rural (Low)
If tip is given to collection worker	No Answer	1 (3%)	5 (4%)	0 (0%)	0 (0%)
	Yes	32 (82%)	96 (69%)	103 (66%)	17 (28%)
	No	6 (15%)	38 (27%)	54 (34%)	43 (72%)
	Total	39 (100%)	139 (100%)	157 (100%)	60 (100%)

(c) Recycling Behaviour

Figure E.2.2 to **Figure E.2.5** show residents' behaviour on recycling. These figures present the percentage of respondents who separate bottles, cans, and paper from other wastes. According to the result, bottles are relatively recognised worth separating from other waste across the income groups although more income seems to mean less interest in segregating bottles from other waste.

For the metal cans, middle income in urban area shows very little interest in separating them from other wastes, followed by the urban low income and rural low income. Paper, on the other hand, is fairly well segregated from the other wastes. Nonetheless, many of the segregated papers, like newspapers, are being used for other purposes such as wrapping material in shops.

Almost no one is separating kitchen waste from the other waste in all 4 groups. This suggests that much of the materials which can be used to make compost is going to landfill site and shortening its service life.

In all materials, one can say there are a lot of room to improve public participation in recycling activities. Segregation of recyclables from general waste should be one of the focuses of the topic in the environmental education.

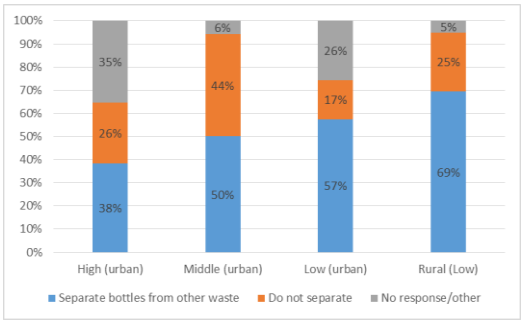


Figure E.2.2 Recyclable Separation (Bottles) by Income Group

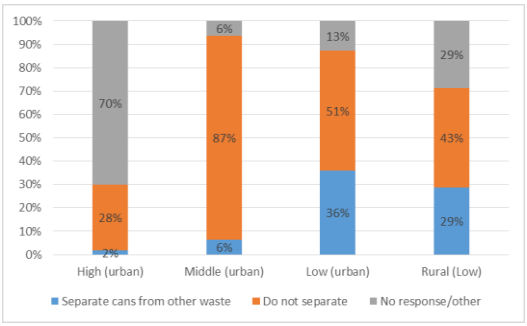


Figure E.2.3 Recyclable Separation (Cans) by Income Group

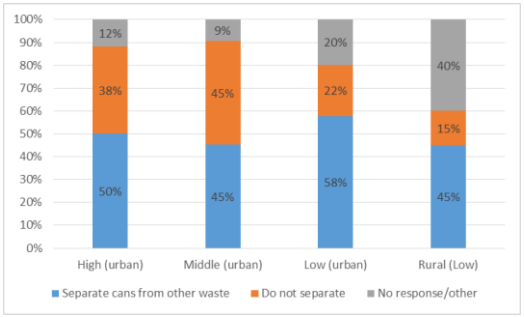


Figure E.2.4 Recyclable Separation (Papers) by Income Group

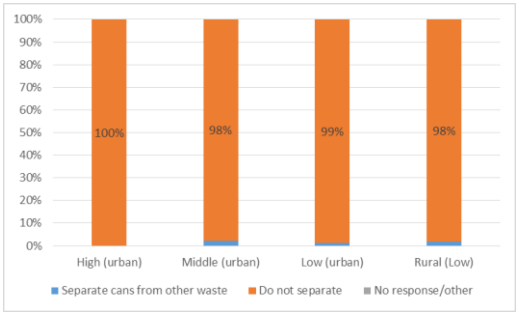


Figure E.2.5 Recyclable Separation (Kitchen Waste) by Income Group

Table E.2.11 shows other results for recycling behaviours. In general, high income group shows less interest in recycling than middle or low income groups. No answer was obtained for questions regarding prices of selling recyclables across the income group. However, recycling seems make sense on monetary benefit than community benefit. At the same time, many residents think their recyclables are too little to sell or make money, and simply give out to waste collectors. Lastly, most of recyclables are not separated, suggesting needs for strong awareness raising activities when promoting 3Rs.

Table E.2.11 Other Results on Questionnaire for Recycling Behaviour

Q.No.3		High income	Middle income	Low income	Rural area
3.1.1	What do you do with those bottles?				
	1. I give them to the waste collectors.	5.1%	1.4%	0.6%	0.0%
	2. I bring them to sell to a private company (Kabaria).	0.0%	0.7%	4.5%	21.7%
	3. I sell them to somebody who visits here time to time.	15.4%	38.1%	64.3%	43.3%
	4. Others(Maid takes them)	12.8%	7.2%	0.6%	0.0%
	5. NA	66.7%	53.2%	30.6%	35.0%
3.1.1.1	How much do you get for one kg of bottles on average?	NA	NA	NA	NA
3.1.2	How much do you get for one deposit bottle on average?	NA	NA	NA	NA
3.1.3	What do you do with other bottles?	NA	NA	NA	NA
3.1.3.1	How much do you get for one kg of bottles on average?	NA	NA	NA	NA
3.1.4	How much do you get for one deposit bottle on average?	NA	NA	NA	NA
3.1.5	Why don't you separate bottles?				
	1. There is no reason to separate them.	0.0%	33.1%	10.8%	25.0%
	2. It is troublesome to separate them.	0.0%	6.5%	5.7%	0.0%
	3. The waste collectors separate them.	0.0%	2.9%	7.6%	0.0%
	4. Others(Specify)	0.0%	1.4%	0.0%	0.0%
	5. NA	100.0%	56.1%	78.3%	75.0%
3.1.6	If you were required to separate bottles so that they can be recycled efficiently, would you do so?				
	1. Yes.	7.7%	7.9%	8.3%	20.0%
	2. No	12.8%	34.5%	9.6%	0.0%
	3. I don't know.	0.0%	0.7%	0.6%	0.0%
	4. NA	79.5%	56.8%	81.5%	80.0%
3.1.6.1	If community groups were going to introduce a system of collecting bottles in order to benefit society from recycling them, would you cooperate?				
	1. Yes.	0.0%	12.2%	68.8%	0.0%
	2. No.	80.0%	81.6%	18.8%	0.0%
	3. I don't know.	20.0%	4.1%	12.5%	0.0%
3.1.6.1.1	If you could sell used bottles, would you separate them?				
	1. Yes	0.0%	0.0%	20.0%	0
	2. No	100.0%	92.9%	60.0%	0
	3. I don't know.	0.0%	9.5%	0.0%	0
3.2.1	What do you do with separated cans?				
	1. I give them to the waste collectors.	0.0%	0.0%	0.0%	0.0%
	2. I bring them to sell to a private company (Kabaria).	0.0%	0.7%	0.0%	1.7%
	3. I sell them to somebody who visits here time to time.	2.6%	0.7%	7.6%	1.7%
	4. Others(maid takes them)	7.7%	0.0%	0.0%	0.0%
	NA	89.7%	98.6%	92.4%	96.7%
3.2.1.1	How much do you get for one kg of cans on average?	NA	NA	NA	NA
3.2.2	Why don't you separate cans?				
	1. There is no reason to separate them.	25.6%	14.4%	2.5%	5.0%
	2. It is troublesome to separate them.	15.4%	1.4%	3.2%	0.0%
	3. The waste collectors separate them.	0.0%	1.4%	5.1%	0.0%
	4. Others(quantity too small)	7.7%	1.4%	1.3%	0.0%
	NA	51.3%	81.3%	88.5%	95.0%
3.2.3	If you were required to separate cans so that they can be recycled efficiently, would you do so?				
	1. Yes	15.4%	11.5%	7.6%	3.3%
	2. No	20.5%	7.2%	1.3%	0.0%
	3. I don't know.	2.6%	1.4%	3.2%	0.0%
	4. Others(If bag provided)	2.6%	0.0%	0.0%	0.0%
	NA	59.0%	79.9%	87.9%	96.7%
3.2.3.1	If community groups were going to introduce a system of collecting cans in order to benefit society from recycling them,				

Q.No.3		High income	Middle income	Low income	Rural area
	would you cooperate?				
	1. Yes	0.0%	0.0%	42.9%	0.0%
	2. No	77.8%	66.7%	14.3%	0.0%
	3. I don't know.	11.1%	16.7%	28.6%	0.0%
	4. Others(if bag provided)	11.1%	0.0%	0.0%	0.0%
3.2.3.1.1	If you could sell cans, would you separate them?				
	1. Yes	0.0%	0.0%	66.7%	0.0%
	2. No	87.5%	100.0%	33.3%	0.0%
	3. I don't know.	0.0%	10.0%	0.0%	0.0%
3.3.1	How do you separate paper?				
	1. I separate only newspaper.	5.1%	0.0%	0.0%	1.7%
	2. I separate newspapers and other paper.	5.1%	1.4%	1.3%	0.0%
	3. I separate only cardboard.	0.0%	0.0%	0.6%	0.0%
	4. I separate cardboard from other paper.	0.0%	0.7%	0.0%	0.0%
	5. I separate only newspaper and cardboard.	0.0%	0.0%	0.0%	0.0%
	6. I separate newspapers and cardboard from other paper.	2.6%	0.7%	1.3%	0.0%
	7. I do not separate paper further.	17.9%	12.9%	0.0%	0.0%
	8. I don't know.	0.0%	0.0%	0.0%	0.0%
	9. Others(books)	2.6%	22.3%	51.6%	43.3%
	10. NA	66.7%	62.6%	44.6%	55.0%
3.3.2	What do you do with separated newspaper (and other paper)?				
	Newspaper				
	1. I give them to the waste collectors.	25.0%	0.0%	0.0%	0.0%
	2. I bring them to sell to a private company (Kabaria).	0.0%	0.0%	0.0%	0.0%
	3. I sell them to somebody who visits here time to time.	25.0%	100.0%	50.0%	0.0%
	4. Others	75.0%	0.0%	50.0%	100.0%
	Other paper				
	1. I give them to the waste collectors.	25.0%	0.0%	0.0%	0.0%
	2. I bring them to sell to a private company (Kabaria).	0.0%	0.0%	0.0%	0.0%
	3. I sell them to somebody who visits here time to time.	0.0%	100.0%	50.0%	0.0%
	4.Others	0.0%	0.0%	50.0%	0.0%
3.3.2.1	How much do you get for one kilogram of newspapers and other paper on average?	NA	NA	NA	NA
3.3.3	What do you do with separated cardboard (and other paper)?				
	Cardboard				
	1. I give them to the waste collectors.	0.0%	0.0%	0.0%	0.0%
	2. I bring them to sell to a private company (Kabaria).	0.0%	0.0%	0.0%	0.0%
	3. I sell them to somebody who visits here time to time.	0.0%	100.0%	0.0%	0.0%
	Other paper	0.0%	0.0%	0.0%	0.0%
	1. I give them to the waste collectors.	0.0%	0.0%	0.0%	0.0%
	2. I bring them to sell to a private company (Kabaria).	0.0%	0.0%	0.0%	0.0%
	3. I sell them to somebody who visits here time to time.	0.0%	100.0%	0.0%	0.0%
3.3.3.1	How much do you get for one kilogram of cardboard and (other paper) on average?	NA	NA	NA	NA
3.3.4	What do you do with separated newspapers, cardboard (and other paper)?				
	Newspaper				
	1. I give them to the waste collectors.	0.0%	0.0%	0.0%	0.0%
	2. I bring them to sell to a private company (Kabaria).	0.0%	0.0%	0.0%	0.0%
	3. I sell them to somebody who visits here time to time.	0.0%	0.7%	1.3%	0.0%
	Cardboard	0.0%	0.0%	0.0%	0.0%
	1. I give them to the waste collectors.	0.0%	0.0%	0.0%	0.0%
	2. I bring them to sell to a private company (Kabaria).	0.0%	0.0%	0.0%	0.0%
	3. I sell them to somebody who visits here time to time.	0.0%	0.7%	1.3%	0.0%
	Other paper	0.0%	0.0%	0.0%	0.0%
	1. I give them to the waste collectors.	0.0%	0.0%	0.0%	0.0%

Q.No.3		High income	Middle income	Low income	Rural area
	2. I bring them to sell to a private company (Kabaria).	0.0%	0.0%	0.0%	0.0%
	3. I sell them to somebody who visits here time to time.	0.0%	0.7%	1.3%	0.0%
	NA	97.4%	99.3%	98.7%	100.0%
3.3.4.1	How much do you get for one kilogram of newspapers, cardboard (and other paper) on average?	NA	NA	NA	NA
3.3.5	What do you do with separated paper?				
	1. I give them to the waste collectors.	0.0%	0.0%	0.0%	0.0%
	2. I bring them to sell to a private company (Kabaria).	0.0%	0.0%	0.0%	0.0%
	3. I sell them to somebody who visits here time to time.	10.3%	11.5%	0.0%	0.0%
	4. Others	7.7%	0.0%	0.0%	0.0%
	NA	82.1%	88.5%	100.0%	100.0%
3.3.5.1	How much do you get for one kilogram of paper?	NA	NA	NA	NA
3.3.6	Why don't you separate paper?				
	1. There is no reason to separate it.	30.8%	8.6%	5.1%	15.0%
	2. It is troublesome to separate it.	12.8%	5.8%	12.7%	0.0%
	3. The waste collectors separate it.	5.1%	28.8%	0.6%	0.0%
	4. Others(Specify)	5.1%	2.9%	3.8%	0.0%
	NA	66.7%	55.4%	77.7%	85.0%
3.3.7	If you were required to separate newspapers so that they can be recycled efficiently, would you do so?				
	1. Yes (Go to Q3.4.)	17.9%	27.3%	7.6%	15.0%
	2. No (Go to Q3.3.7.1.)	10.3%	7.9%	2.5%	0.0%
	3. I don't know.(Go to Q3.3.7.1.)	0.0%	0.7%	4.5%	0.0%
	4. Others (Specify)(Go to Q3.3.7.1.)	0.0%	2.9%	1.9%	0.0%
	5. NA	71.8%	61.2%	83.4%	85.0%
3.3.7.1	If community groups were going to introduce a system of collecting paper in order to benefit society from recycling them, would you cooperate?				
	1. Yes	0.0%	31.3%	14.3%	0.0%
	2. No	100.0%	62.5%	0.0%	0.0%
	3. I don't know.	0.0%	25.0%	57.1%	0.0%
	4. Others(Specify)	0.0%	0.0%	21.4%	0.0%
3.3.7.1.1	If you could sell paper, would you separate them?				
	1. Yes	0.0%	0.0%	18.2%	0.0%
	2. No	100.0%	85.7%	9.1%	0.0%
	3. I don't know.	0.0%	35.7%	27.3%	0.0%
	4. Others	0.0%	0.0%	18.2%	0.0%
3.4	In general, do you support the idea of recycling?				
	1. Yes	56.4%	42.4%	66.9%	80.0%
	2. No	17.9%	25.2%	3.2%	16.7%
	3. I don't know.	15.4%	12.9%	29.9%	3.3%
	4. Others	5.1%	0.7%	0.0%	0.0%
	5. Na	5.1%	18.7%	0.0%	0.0%
3.4.1	Why are you for recycling?				
	1. It saves resources.	4.5%	42.4%	11.4%	8.3%
	2. It can make waste management system more efficient.	9.1%	15.3%	23.8%	10.4%
	3. It can help extend the service life of the final disposal site.	4.5%	5.1%	2.9%	0.0%
	4. I can benefit by selling the recyclable wastes.	36.4%	64.4%	84.8%	93.8%
	5. Tips/fees for waste collection can be lowered.	9.1%	13.6%	1.0%	0.0%
	6. Others	36.4%	3.4%	0.0%	0.0%
3.4.2	Why are you against recycling?				
	1. It is troublesome.	57.1%	80.0%	20.0%	10.0%
	2. It requires more garbage containers.	0.0%	2.9%	0.0%	0.0%
	3. It is difficult to separate waste.	0.0%	8.6%	0.0%	40.0%
	4. I will have to pay more.	0.0%	0.0%	0.0%	0.0%
	5. It is not we but waste collectors who recycle wastes.	0.0%	0.0%	0.0%	0.0%

Q.No.3		High income	Middle income	Low income	Rural area
	6. Others	28.6%	14.3%	40.0%	50.0%
3.5.1	For what purpose do you use your kitchen waste?				
	1. To feed animals.	0.0%	0.0%	0.6%	1.7%
	2. NA	100.0%	100.0%	99.4%	98.3%
3.5.2	If you were required to discharge organic wastes separately from other wastes so that they could be used to make compost, would you cooperate?				
	1. NA	0.0%	100.0%	99.4%	100.0%
3.5.2.1	Why won't you cooperate?	NA	NA	NA	NA
3.6	Do you separate any other wastes? What do you do with them? For any items of 1 - 9 which you separate, please choose one of A - E.				
	A. We give them to the waste collectors together with other waste.	7.7%	20.9%	30.6%	5.0%
	B. Someone comes here to take them.	0.0%	0.7%	1.9%	0.0%
	C. Someone comes here to buy them.	0.0%	7.9%	11.5%	51.7%
	D. We bring or send them to a place where we can sell them.	0.0%	1.4%	12.1%	23.3%
	E. Others	20.5%	10.8%	24.8%	18.3%
	1. Glass	7.7%	19.4%	35.0%	15.0%
	2. Metal other than cans	2.6%	11.5%	17.2%	70.0%
	3. Garden waste	7.7%	1.4%	0.6%	0.0%
	4. PET	2.6%	5.0%	8.3%	55.0%
	5. Other Plastics	5.1%	8.6%	0.6%	0.0%
	6. Textile	87.2%	41.7%	2.5%	1.7%
	7. Wood	0.0%	0.7%	0.0%	0.0%
	8. Tires	0.0%	0.7%	0.0%	0.0%
	9. Others	0.0%	5.8%	26.1%	61.7%
	10. NA	12.8%	31.7%	11.5%	1.7%

(d) Cleanness of the City

Approximately 40 to 50 percent of residents view the public spaces in the city as clean, but another 30 to 40 percent of people answered "not clean". (See **Figure E.2.7**.)

When asked if they would cooperate in the effort to keep the city clean, almost all respondents answered "Yes." (See **Figure E.2.6**.)

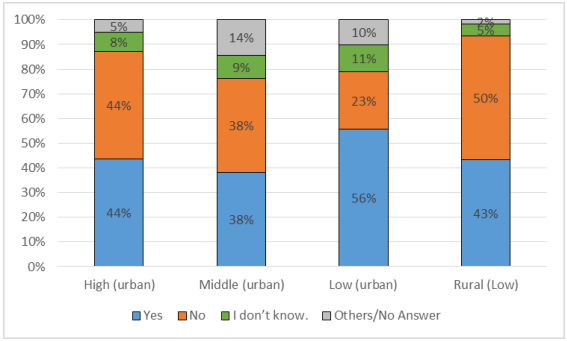


Figure E.2.6 Residents View on Cleanness of Public Space

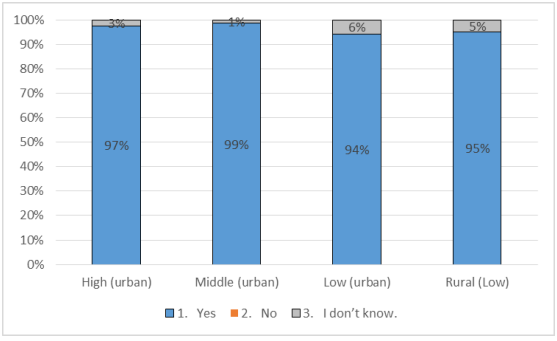


Figure E.2.7 Residents' Willingness to Cooperate in Keeping City Clean

Table E.2.12 shows the result of other questions in cleanness of the city. This section also revealed in impression the general public, across income group, holds about the SWM in the city. Many residents think governments, national or local, has primary responsibility in taking care of solid waste. Interestingly, though, lower income group recognises that SWM issue needs to be taken care of by individual residents than higher income group.

Table E.2.12 Other Results of Questions on Cleanness of the City

		High income	Middle income	Low income	Rural area
5.2	Who does clean the road in front of your premises and/or adjacent public area?				
	1. I or other family member does.	7.7%	38.1%	19.7%	83.3%
	2. The community does together.	0.0%	0.0%	0.6%	0.0%
	3. The GWMC does.	84.6%	77.0%	50.3%	10.0%
	4. A public company does.	2.6%	0.0%	0.0%	0.0%
	5. Nobody does.	0.0%	0.0%	9.6%	0.0%
	6. I don't know.	0.0%	2.2%	15.9%	6.7%
	7. Others	25.6%	0.7%	0.0%	0.0%
	8. NA	0.0%	0.0%	3.8%	0.0%
5.4	Do you think a campaign to raise awareness of people for maintaining the city clean is effective?				
	1. Yes.	92.3%	97.1%	89.2%	93.3%
	2. No.	7.7%	2.2%	0.0%	0.0%
	3. I don't know.	0.0%	0.0%	7.0%	6.7%
	4. NA	0.0%	0.0%	3.8%	0.0%
5.5	Who do you think should have the initiative in keeping the city clean?				
	1. National government.	43.6%	40.3%	34.4%	18.3%
	2. GWMC.	35.9%	40.3%	22.3%	10.0%
	3. Community.	10.3%	12.9%	7.0%	15.0%
	4. Each people.	23.1%	18.0%	42.7%	55.0%
	5. I don't know	2.6%	0.7%	0.0%	1.7%
	6. NA	5.1%	2.2%	0.6%	0.0%
5.6	What problems do you find?				
	1. People litters in public areas.	66.7%	64.0%	56.1%	21.7%
	2. Illegal dumping nearby causes offensive odour.	51.3%	20.1%	21.0%	25.0%
	3. Litter blocks the drainage.	64.1%	57.6%	90.4%	63.3%
	4. Burning waste nearby causes smoke.	61.5%	23.7%	0.6%	5.0%
	5. Nothing.	2.6%	3.6%	1.3%	16.7%
	6. Others	0.0%	1.4%	0.6%	1.7%
	7. NA	0.0%	0.0%	1.3%	0.0%

(2) Commercial Establishments (Business Establishments)

Interview surveys were also carried out for business establishments. The questionnaire includes the same or similar questions across the industry such as general information about the interviewees, recycling and financial matters. Some questions were, however, very different from industry to industry. For instance, additional questions for medical waste and general waste were asked for "hospitals" whereas generation of waste types were asked for "factories."

(a) Accountability on the Results of Survey

Table E.2.13 shows the response rate for each question by category. Since interview survey was employed, most of the questions were given some answers even if the answer was simply "No." Therefore, given the condition of the survey, most of the results can be considered as valid results.

A majority of the questions in the business establishment survey received some answers, meaning that most of the questions received a 100% response rate. **Table E.2.13** presents the questions which did NOT receive the 100% response rate. As one can see, questions and industry which did not give an answer in all categories are very limited, except for financial matters where all industries in one way or another were reluctant to answer the questions. In the following table, the shaded area represents the tendency of response.

Table E.2.13 Response Rate of Interviewees that did not Received 100%

	Recycle			
	Number of Questions			Percentage of >100% Response
	Total	100% response	> 100% response	
Store/Shop	7	4	3	60 - 80%
Market	7	6	1	20%
Office	5	4	1	85%
Factory	5	3	2	70 - 90%

	Waste Collection and Discharge Behaviour			
	Number of Questions			Percentage of >100% Response
	Total	100% response	> 100% response	
Market	5	3	2	90%
Office	5	3	2	85%
Hotel	5	4	1	80%

	Financial Matters			
	Number of Questions			Percentage of >100% Response
	Total	100% response	> 100% response	
Store/shops	4	1	3	0%
Market	4	3	1	80%
Institute	6	4	2	85%
Office	3	1	5	0 - 85%
Hotel	4	0	4	0 - 80%
Restaurant	6	1	5	0 - 60%
Factory	9	5	4	0 - 40%
Hospital	10	2	8	0 - 66%

	Cooperation in Waste Management			
	Number of Questions			Percentage of >100% Response
	Total	100% response	> 100% response	
Store/Shop	4	0	4	50 - 90 %
Market	1	2	2	80 - 90 %

(b) Waste Collection Services/Waste Discharge Behaviour

A large number of establishments have waste collection services. The establishments that do not have a waste collection service usually have their own disposal methods. (See **Table E**.2.14).

Satisfaction with the current waste collection service is shown in **Figure E.2.8**. Result of this question varies depending on business types where restaurants and hospitals have good ratio of satisfaction of the services while 70% of factory says “not satisfied.”

Table E.2.14 Availability of Waste Collection Service

	Store/ Shop	Market	Institution	Restaurant	Office	Hotel	Factory	Hospital
Yes	90%	90%	57%	100%	100%	60%	100%	100%
No	0%	10%	29%	0%	0%	20%	0%	0%
Don’t know	10%	0%	14%	0%	0%	20%	0%	0%

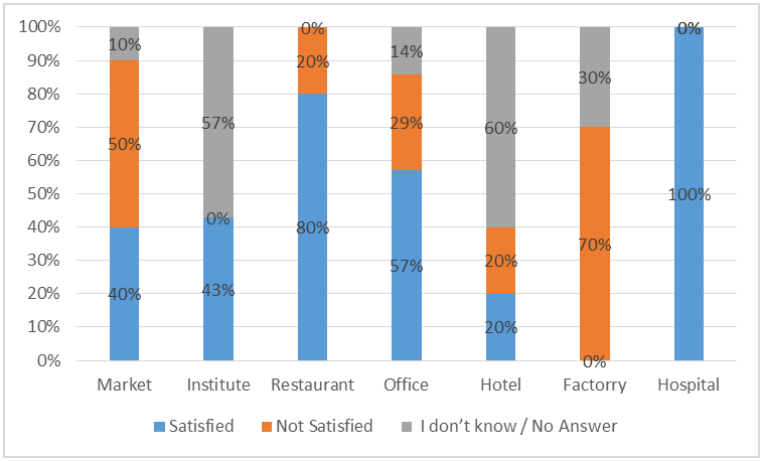


Figure E.2.8 Satisfactory Rate for Current Waste Collection Service

(c) Recycling Behaviour

Recycling practice among business establishments is very low. The only exception done at restaurants is bottle recycling (100%) and can (60%). (**Figure E.2.9** and **Figure E.2.10**). Many answered either they did not know or discharged with other types of waste. Especially for organic waste which can be used for animal feed or composting, a majority of the establishments discharge them with the other waste. (**Figure E.2.11**)

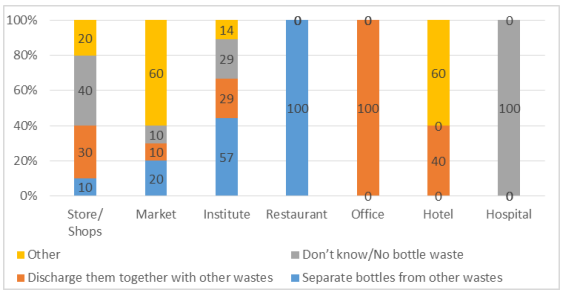


Figure E.2.9 Recyclable Separation (Bottles) by Business Establishment Type

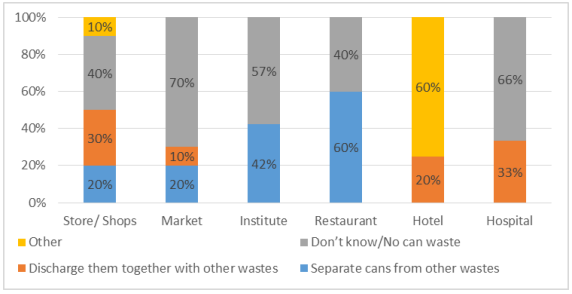


Figure E.2.10 Recyclable Separation (Cans) by Business Establishment Type

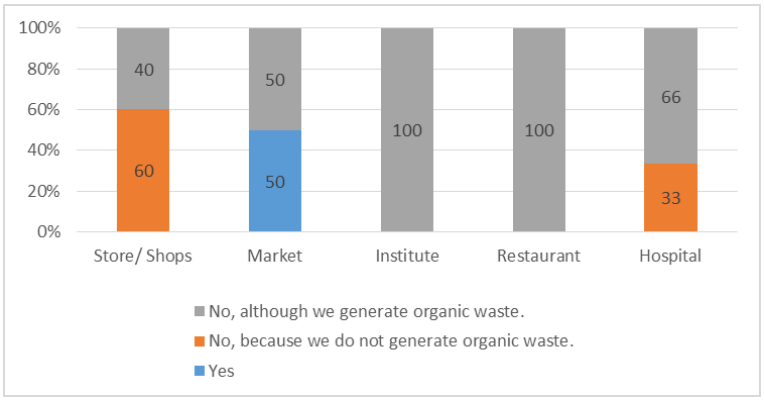


Figure E.2.11 Recyclable Separation (Organic Waste) by Business Establishment Type

(i) Markets

Table E.2.15 shows results of recycling behaviour for markets. No answer was obtained for questions regarding money matters. Markets do not have much interest in recycling for most of their recyclable wastes.

All tables in sections below contain only the item that received some response from the respondents in order to simplify the table. Therefore, some answer seems odd, like there is only 'yes' but no 'no' response in the question.

Table E.2.15 Results on Recycling Behaviour (Markets)

Q. No.	Questions	Response	Q. No.	Questions	Response
2.1.1	How much kilograms of bottles do you separate per week?	NA	2.4.2	How do you separate paper from other wastes?	
2.1.2	What do you do with those bottles?			1. We separate only cardboard (other paper is mixed with other wastes).	20%
	1. We bring them to a specific place where we can sell them.	10%		2. We separate newspaper and cardboard (other paper is mixed with other wastes).	10%
	2. We sell them to somebody who visits here time to time.	10%		3. NA	70%
	3. NA	80%	2.4.3	How much kilograms of newspaper (and other paper) do you separate per week?	NA
2.1.2.1	How much are bottles per kg?	NA			
2.1.3	Why don't you separate bottles?		2.4.4	What do you do with separated newspaper (and other paper)?	NA
	1. The waste collectors separate them.	100%			
2.1.4	If you were required to separate bottles so that they can be recycled efficiently, would you do so?		2.4.4.1	How much are they?	NA
			2.4.5	How much kilograms of cardboard (and other paper) do you separate per week?	NA
	1. No	10%	2.4.6	What do you do with separated cardboard (and other paper)?	
2.1.4.1	If community groups provide separate bins for bottles, in order to benefit society from recycling them, would you cooperate?			1. We bring it to a specific place where we can sell it.	10%
			2.4.6.1	How much are they?	NA
	1. No.	100%	2.4.7	How much kilograms of newspaper, cardboard (and other paper) do you separate per week?	NA
2.1.4.1.1	If you could sell separated bottles, would you be interested in separating them?		2.4.8	What do you do with separated newspaper, cardboard (and other paper)?	NA
	1. No	100%			
2.2	What do you do with bottles (glass) in your wastes?		2.4.8.1	How much are they?	NA
			2.4.9	How much kilograms of mixed paper do you separate per week?	NA
	1. We do not generate bottle waste.	10%			
	2. Others	10%	2.4.10.	What do you do with separated paper?	NA
	3. NA	80%	2.4.10.1	How much are they?	NA
2.2.1	How much kilograms of bottles do you separate per week?	NA	2.4.11	Why don't you separate paper?	40%
				1. There is no reason to separate it.	10%
2.2.2	What do you do with those bottles?	NA		2. It is troublesome to separate it.	30%
2.2.2.1	How much are bottles per kg?	NA		3. The waste collectors separate it.	20%
2.2.3	Why don't you separate bottles?	NA		4. Others	10%
2.2.4	If you were required to separate	NA	2.4.12	If you were required to separate	40%

Q. No.	Questions	Response	Q. No.	Questions	Response
	bottles so that they can be recycled efficiently, would you do so?			cardboard so that they can be recycled efficiently, would you do so?	
2.2.4.1	If community groups provide separate bins for bottles, in order to benefit society from recycling them, would you cooperate?	NA		1. Yes	60%
			2.4.12.1	If community groups provide separate bins for paper, in order to benefit society from recycling them, would you cooperate?	NA
2.2.4.1.1	If you could sell separated bottles, would you be interested in separating them?	NA	2.4.12.1.1	If you could sell separated paper, would you be interested in separating it?	
2.3.1	How much kilograms of cans do you separate per week?	NA	2.5.1	For what purpose do you separate them? 1. To feed animals.	NA
2.3.2	What do you do with separated cans? 1. We sell them to somebody who visits here from time to time.	10%	2.5.2	If you were required to discharge organic wastes separately from other wastes so that they could be used to make compost, would you cooperate?	100%
	2. Others	10%			
	3. NA	90%		1. Yes	80%
2.3.2.1	How much are cans per kg?	NA		2. No	20%
2.3.3	Why don't you separate cans?		2.5.2.1	Why won't you cooperate?	
	1. The waste collectors separate them.	100%		1. It is troublesome.	20%
2.3.4	If you were required to separate cans so that they can be recycled efficiently, would you do so?		2.6	Do you separate any other wastes? What do you do with them?	40%
				B. Someone comes here to take them.	20%
	1. No.	10%			
	2. NA	90%		C. Someone comes here to buy them.	30%
2.3.4.1	If community groups provide separate bins for cans, in order to benefit society from recycling them, would you cooperate?			E. Others	20%
				1. Glass	10%
				3. PET	50%
				4. Other Plastics	40%
	1. No.	100%		6. Wood	20%
2.3.4.1.1	If you could sell separated cans, would you be interested in separating them?		2.7	In general, is your market interested in recycling?	
	1. No.	100%		1. Yes	10%
2.4	What do you do with paper in your wastes?			2. No	30%
				3. I don't know.	60%
	1. We separate it from other wastes.	30%	2.7.1	Why are you interested in recycling?	
	2. We discharge it together with other wastes.	60%		1. It saves resources.	100%
				2. It can make waste management system more efficient.	100%
	3. Others	20%			
2.4.1	Who separate paper?		2.7.2	Why aren't you interesting in recycling?	
	1. The person who generates paper wastes throw away into specific dust bins for paper or at specific places.	33%		1. It is troublesome.	33%
				2. It is difficult to separate waste.	67%
	2. Our cleaning staff sorts waste to	33%		3. It is not we but waste collectors	33%

Q. No.	Questions	Response	Q. No.	Questions	Response
	separate paper.			who recycle wastes.	
	3. I don't know.	33%		4. Others	33%
	4. Others	33%			

Table E.2.16 show results of questions for waste collection service and discharge behaviour in Markets. As expected, all respondents discharge organic waste and newspaper/magazine waste. All respondents receive waste collection service from GWMC, but they think there are not enough workers to collect the waste.

Table E.2.16 Waste Collection Services and Waste Discharge Behaviour (Markets)

Q. No.	Questions	Response	Q. No.	Questions	Response
3.1	How many kg of waste are generated, including recycled wastes, per week on average?		3.4.4	Do the waste collectors come at fixed time on specific days of the week?	
				1. Yes.	55.6%
	0-299kg	10.0%		2. No.	44.4%
	300-599kg	30.0%	3.4.5	Do you treat wastes in some ways before discharging?	
	600-899kg	20.0%		1. Yes.	11.1%
	900-1199kg	20.0%		2. No.	88.9%
	1200-1499kg	10.0%	3.4.5.1	Which types of wastes do you treat in which way?	
	1500- kg	20.0%			
	NA	10.0%		A. We burn them.	100.0%
3.2	How many kg of wastes are discharged as wastes per week on average?			1. Organic waste	100.0%
			3.4.5.2	If some of wastes are burned, what do you do with the remained ash?	
	0-399kg	30.0%			
	400-799kg	40.0%		1. We discharge it together with other wastes.	100.0%
	800-1200kg	10.0%	3.4.6.1	Why are you satisfied with the current waste collection system? (Plural answer question)	
	1200kg-	10.0%			
	NA	10.0%		1. The frequency of collection is appropriate.	75.0%
3.3	What kinds of wastes do you discharge as wastes?			2. We can keep our place clean.	25.0%
				3. My waste collection point is close enough.	25.0%
	1. Organic waste	100.0%		4. The service is provided free of charge	50.0%
	2. Cardboard	10.0%	3.4.6.2	What problems do you have with the current waste collection system? (Plural answer question)	
	3. Newspaper, Magazines	100.0%			
	4. Paper other than cardboard, newspaper or magazines	70.0%		1. The frequency of collection is very few.	25.0%
	5. PET	10.0%		2. Others (There are less workers in market)	50.0%
	6. Plastics other than PET	70.0%			
	7. Cans	20.0%		How far is your collection point from your premises?	
	8. Bottles	10.0%	3.4.6.2.2	How far do you think it should be at farthest?	NA
	9. Wood	70.0%	3.4.7	What do you do with your wastes?	NA
3.4	Do you have waste collection services?		3.4.7.1	What do you do with remained ash?	NA
	1. Yes.	90.0%	3.4.8	Do you want waste collection services?	NA
	2. No.	10.0%		1. Yes (Go to Q3.4.8.1.)	10.0%
3.4.1	What do you do with your wastes?			NA	90.0%
	1. GWMC collects them.	100.0%	3.4.8.1	How much are you willing to pay per month in order to receive waste	NA
3.4.2	How are they collected?				

Q. No.	Questions	Response	Q. No.	Questions	Response
				collection services?	
	1. Curb side collection	44.4%	3.4.8.2	Why don't you need waste collection services?	NA
	2. Station collection	55.6%	3.5	What do you usually use when you discharge wastes?	
3.4.3	How often do you have waste collection services per week?			1. Big plastic bags.	10.0%
	1. Daily	66.7%		2. Dust bins.	10.0%
	2. 2 - 3 times.	11.1%		3. Others (Leave heap in front of shop)	80.0%
	3. 4 - 5 times.	22.2%			

Table E.2.17 shows the result of questions on financial matters and cooperation for waste management in markets. As in many other sectors, respondents were reluctant to give out information about money matters. In general, figures in question "how much are you giving tip" gave higher than figure given in a question "how much can you afford?" indicating respondents feels they are spending more than they should have. The table also shows that the markets are not so inclined to cooperate in waste management so much.

Table E.2.17 Result of Questions on Financial Matters and Cooperation for Waste Management (Markets)

Q.No.4	Financial Matters	Response	Q.No.5	Cooperation for Waste Management	Response
4.1	How much do you pay for waste collection services per month?	3,000 Rs.	5.1	[If bottles are sold] Do you charge deposit on some or all of bottles which you sell?	
4.2	If the market price of waste collection rose, how much, at maximum, could you afford to pay per month?	NA		2. No.	80.0%
				3. Others	10.0%
			5.1.1	How much is the deposit of one bottle?	NA
4.3	Do you also pay tips to the waste collectors?	NA	5.1.2	Approximately what percentage of bottles with deposits is returned?	NA
4.3.1	How much do you pay tips per month on average?	NA			
			5.1.3	Are you interested in introducing a deposit system?	
4.4	Do you pay tips/fees to the waste collectors?				
	1. Yes.	50.0%		1. No.	20.0%
	2. No.	30.0%	5.2	The communities were going to be encouraged to bring PETs to the box and the GWMC would come here to collect them once a week. Would you be interested in cooperating this scheme?	
	3. Others	90.0%			
4.4.1	How much do you pay tips/fees per month on average?				
	~100	40.0%			
	100~200	20.0%		1. No.	60.0%
	200~300	20.0%		2. I don't know.	30.0%
	400~	20.0%	5.2.1	Why are you willing to cooperate?	NA
4.4.2	Suppose that if you were required to pay waste management and if you reject to pay, wastes would be remained in your premises without collection. How much Rupees per month, at maximum, could you afford to pay?		5.2.2	Why aren't you willing to cooperate?	NA
			5.3	In some countries, markets/shops are encouraging the customers to reuse shopping bags. Would you be interested in this scheme?	
	~100	10.0%		1. Yes.	50.0%
	100~200	20.0%		2. I don't know.	30.0%
	200~300	10.0%		3. Other	10.0%
	NA	70.0%	5.4	Do you think there is something which your market/shop can do for good waste management?	NA

(ii) Schools

Table E.2.19 show results of recycling behaviour and waste collection & discharge behaviours in schools. Schools discharge a wide range of waste from PET bottles, cans, woods, and other type of waste. Even though some efforts were observed to start recycling, much of the separation depends on the cleaning workers.

Table E.2.18 Result of Questionnaire on Recycling (Schools)

Q.No.2	Recycling	Response	Q.No.2	Recycling	Response
2.1	What do you do with used bottles in your wastes?		2.3.4	What do you do with separated newspaper (and other paper)?	NA
	1. We separate bottles from other wastes.	57.1%	2.3.4.1	How much are they?	NA
	2. We discharge them together with other wastes.	28.6%	2.3.5	How much kilograms of cardboard (and other paper) do you separate per week?	
	3. Others (Cleaning staff takes them))	14.3%		Cardboard	10
2.1.1	Who separate bottles?			Other paper	8
	1. Our cleaning staff sorts wastes to separate bottles.	100.0%	2.3.6	What do you do with separated cardboard (and other paper)?	
2.1.2	How much kilograms of bottles do you separate per week?	5kg		Cardboard	
2.1.3	What do you do with those bottles?			1. We bring it to a specific place where we can sell it.	50.0%
	1. We bring them to a specific place where we can sell them.	75.0%		Other paper	
	2. We sell them to somebody who visits here time to time.	25.0%		1. We bring it to a specific place where we can sell it.	50.0%
	3. Others	25.0%	2.3.6.1	How much are they?	NA
2.1.3.1	How much is it?	12-100 Rs.	2.3.7	How much kilograms of newspaper, cardboard (and other paper) do you separate per week?	NA
2.1.4	Why don't you separate bottles?		2.3.8	What do you do with separated newspaper, cardboard (and other paper)?	NA
	1. There is no reason to separate them.	50.0%			
	2. Others	50.0%	2.3.8.1	How much are they?	NA
2.1.5	If you were required to separate bottles when you discharge them so that they can be recycled efficiently, would you do so?	NA	2.3.9	How much kilograms of mixed paper do you separate per week?	NA
			2.3.10.	What do you do with separated paper?	NA
2.1.5.1	If you were provided with garbage boxes for bottles by the city or GWMC to separate them from other wastes, would you cooperate in separating bottles?		2.3.10.1	How much are they?	NA
			2.3.11	Why don't you separate paper?	
				1. It is troublesome to separate it.	100.0%
			2.3.12	If you were required to separate office paper (paper for printing and photocopy) so that they can be recycled efficiently, would you do so?	
	1. Yes.	16.7%			
2.1.5.1.1	If you could sell separated bottles, would you be interested in separating them?	NA		1. Yes	100.0%
2.2	What do you do with cans in your wastes?		2.3.12.1	If you were provided with garbage boxes for office paper (paper for printing and photocopy) by the city or GWMC to separate it from other wastes, would you cooperate in separating it?	NA
	1. We separate steel cans from other wastes.	42.9%			
	2. We separate aluminium cans from other wastes.	28.6%			
			2.3.12.1.1	If you could sell used office paper (paper for printing and photocopy), would you be interested in separating it?	NA
	3. We do not generate can wastes.	57.1%			
2.2.1	Who separate cans?				
	1. Our cleaning staff sort wastes to separate cans.	100.0%	2.4	What do you do with your wastes from plants (branches, leaves, etc.)?	
2.2.2	How much kilograms of cans do you separate per week?	1-6		1. We separate them from other wastes.	14.3%

Q.No.2	Recycling	Response	Q.No.2	Recycling	Response
2.2.3	What do you do with separated cans?			2. We discharge them together with other wastes.	71.4%
	1. We give them to the waste collectors.	20.0%		3. Others	14.3%
	2. We bring them to a specific place where we can sell them.	20.0%	2.4.1	What do you do with separated plants wastes?	
				1. We give them to the waste collectors.	14.3%
2.2.3.1	How much are they?	NA	2.4.2	If you were required to separate wastes from plants from other wastes so that they can be used to make compost efficiently, would you do so?	
2.2.4	Why don't you separate cans?	NA		1. Yes.	71.4%
2.2.5	If you were required to separate cans so that they can be recycled efficiently, would you do so?	NA	2.5	Do you separate your organic wastes (referring to kitchen wastes or food wastes) for any purpose?	
				1. No, although we generate organic waste.	100.0%
2.2.5.1	If you were provided with garbage boxes for cans by the city or GWMC to separate them from other wastes, would you cooperate in separating cans?	NA	2.5.1	For what purpose do you separate them?	NA
			2.5.2	If you were required to discharge organic wastes separately from other wastes so that they could be used to make compost, would you cooperate?	
2.3	What do you do with paper in your wastes?	NA		1. Yes	85.7%
				2. No	14.3%
2.3.1	Who separate paper?		2.5.2.1	Why won't you cooperate?	NA
	1. Our cleaning staff sorts waste to separate paper.	100.0%	2.6	Do you separate any other wastes? What do you do with them?	
2.3.2	How do you separate paper from other wastes?			A. We give them to the waste collectors together with other waste.	42.9%
	1. We separate cardboard and other paper.	75.0%		B. Someone comes here to buy them.	14.3%
	2. We separate newspaper, cardboard and other paper.	25.0%		C. Others	42.9%
				1. PET	28.6%
2.3.3	How much kilograms of newspaper (and other paper) do you separate per week?	NA		2. Other Plastics	28.6%
				3. Wood	28.6%
				4. Others	14.3%

Table E.2.19 Result of Questionnaire on Waste Collection and Waste Discharge Behaviour (Schools)

Q.3	Waste Collection Services & Waste Discharge Behaviour	Response	Q.3	Waste Collection Services & Waste Discharge Behaviour	Response
3.1	How many kilograms of waste are generated, including recycled wastes, per week on average?	77 kg	3.5.5	Do you treat wastes in some ways before discharging?	75%
3.2	Do you deliver some of wastes (e.g. toxic and/or infectious wastes) to treatment plants?			1. Yes.	25%
				2. No.	75%
	1. No.	100%	3.5.5.1	Which type of wastes do you treat in which way?	
3.2.1	How many kilograms of wastes are delivered out of the university/college/school for treatment per week on average?			A. We burn them.	100%
3.3	How many kilograms of wastes are discharged as wastes per week on average?	30		1. PET	100%
			3.5.5.2	If some of wastes are burned, what do you do with the remained ash?	
3.4	What kinds of wastes do you discharge as wastes?				
	1. Organic wastes (kitchen wastes or food wastes)	100%		1. We bury it within our premises.	100%

Q.3	Waste Collection Services & Waste Discharge Behaviour	Response
	2. Wastes from plants	100%
	3. Newspaper, Magazines	14%
	4. Paper other than cardboard, newspaper or magazines	71%
	5. PET	71%
	6. Plastics other than PET	43%
	7.Bottles	29%
	8.Glass	14%
	9.Wood	29%
	10.Other	14%
3.5	Do you have waste collection services?	
	1. Yes.	57%
	2. No.	29%
	3. I don't know.	14%
3.5.1	What do you do with your wastes?	
	1. The GWMC collects them.	100%
3.5.2	How are they collected?	
	1. Door-to-door collection	25%
	2. Station collection	75%
3.5.3	How often do you have waste collection services per week?	
	1. Daily	75%
	2. 4 - 5 times.	25%
3.5.4	Do the waste collectors come at fixed time on specific days of the week?	
	1. Yes.	75%
	3. I don't know.	25%

Q.3	Waste Collection Services & Waste Discharge Behaviour	Response
3.5.6	Are you satisfied with the current waste collection system?	
	1. Yes	75%
	2. No	0%
	3. I don't know.	0%
	4. Others	25%
3.5.6.1	Why are you satisfied with the current waste collection system? (Plural answer question)	
	1. The frequency of collection is appropriate.	50%
	2. The waste collectors work hard.	25%
	3. Others	25%
3.5.6.2	What problems do you have with the current waste collection system? (Plural answer question)	NA
3.5.6.2.1	How far is your collection point from your premises?	NA
3.5.6.2.2	How far do you think it should be at farthest?	NA
3.5.7	What do you do with your wastes?	
	1. We burn them.	50%
3.5.7.1	What do you do with remained ash?	
	1. We bury it.	100%
3.5.8	Do you want waste collection services?	57%
	1. Yes	14%
	2. No	29%
3.5.8.1	How much are you willing to pay per month in order to receive waste collection services?	50
3.5.8.2	Why don't you need waste collection services?	
	1. We want to discharge waste as we like.	50%
	5. Others	100%
3.6	What do you usually use when you discharge wastes?	NA

Table E.2.20 shows the result on financial matters and cooperation in waste management in schools. As in other sectors, not much information was revelled on financial matters. It should therefore be taken as reference only since some conflicts can be found in the result, i.e., respondents prefer both paying tips to waste collectors and paying through taxation.

As for the cooperation for waste management, schools are willing to cooperate in promoting 3R activities.

Table E.2.20 Results of Questionnaire on Financial Matters and Cooperation in WM in Schools

Q.No.4	Financial Matters	Response	Q.No.5	Cooperation for Waste Management	Response
4.1	How much do you pay for waste collection services per month?	NA	5.1	Coping with wastes requires efforts of not only the city and the GWMC the general public. Do you think there is something which your university/college/school can do for good waste management?	
4.2	If the market price of waste collection rose, how much, at maximum, could you afford to pay per month?	NA			
4.3	Do you also pay tips to the waste collectors?	NA		1. Yes.	100%
4.3.1	How much do you pay tips per month on average?	NA	5.1.1	What do you think your university/ college/ school can do?	
4.4	Do you pay tips or fees to the waste collectors?	14%		1. Discharging wastes neatly.	43%
	1. Yes.	14%		2. Reusing wastes.	14%
	2. No.	71%		3. Recycling wastes.	43%
4.4.1	How much do you pay tips/fees per month on average?	1500 Rs.		4. Raising the environmental awareness of the students/pupils.	86%
4.4.2	Which do you prefer, to pay tips/fees or to pay tax for the waste collection services?			5. Providing information to the public.	14%
	1. To pay tips/fees.	100%	5.2	Do you think recycling at universities/ colleges/ schools can raise the environmental awareness of the students/pupils?	
4.4.2.1	Why do you prefer to pay tips/fees?				
	1. The waste collectors can benefit.	100%		1. Yes.	86%
	2. Tax would be unfair.	100%		2. I don't know.	14%
4.4.2.2	Which do you prefer, to pay tips/fees for the current collection service or to pay tax of the same amount of tips for a better collection services without problems?		5.3	Do you think universities/colleges/schools should cooperate with the country, city and/or GWMC in promoting recycling in the society?	
				1. Yes.	100%
	1. To pay tax.	100%			
4.4.3	Q1.4.3. Suppose that if you were required to pay waste management tax and if you reject to pay the tax, wastes would be remained in your premises without collection. How much rupees per month, at maximum, could you pay? (Be aware that you were not required to pay tips/fees to the collectors. What you would pay only tax.)	400 Rs.			
4.5	How much do you pay for water supply per month?	2,000 Rs.			
4.6	How much do you pay for electricity per month?	80,000 Rs.			

(iii) Offices

Table E.2.21 through **Table E.2.24** show all results from offices. Wastes from offices are similar to households, i.e., organics, PET, and other bottles. Offices obviously discharge papers. Waste management practice depends on the cleaning staff, and there is a room for improvement on how to deal with recyclable materials and how to discharge them.

Table E.2.21 Results on Recycling Behaviour (Offices)

Q.No.2	Recycling	Response	Q.No.2	Recycling	Response
2.1	What do you do with paper in your wastes?		2.2.4	If you were required to separate bottles so that they can be recycled efficiently, would you do so?	
	1. We discharge them together with other wastes.	100%			
2.1.1	Who separate paper?	NA		1. Yes.	25%
2.1.2	How do you separate paper from other wastes?	NA		2. I don't know.	50%
2.1.3	How much kilograms of newspaper (and other paper) do you separate per week?	NA	2.2.4.1	If community groups were going to introduce a system of collecting bottles in order to benefit society from recycling them, would you cooperate?	
2.1.4	What do you do with separated newspaper (and other paper)?	NA			
2.1.4.1	How much are they?	NA		1. Yes.	50%
2.1.5	How much kilograms of cardboard (and other paper) do you separate per week?	NA	2.2.4.1.1	If you could sell bottles, would you separate them?	
2.1.6	What do you do with separated cardboard (and other paper)?	NA		1. No	50%
			2.3	What do you do with used cans?	
2.1.6.1	How much are they?	NA		1. We discharge them together with other wastes.	29%
2.1.7	How much kilograms of newspaper, cardboard (and other paper) do you separate per week?	NA		2. We do not generate can wastes.	57%
2.1.8	What do you do with separated newspaper, cardboard (and other paper)?	NA		3. Others	14%
			2.3.1	How much kilograms of cans do you separate per week?	NA
2.1.8.1	How much are they?	NA			
2.1.9	How much kilograms of mixed paper do you separate per week?	NA	2.3.2	What do you do with separated cans?	NA
			2.3.2.1	How much are they?	NA
2.1.10	What do you do with separated paper?	NA	2.3.3	Why don't you separate cans?	
2.1.10.1	How much are they?	NA		1. The waste collectors separate them.	29%
2.1.11	Why don't you separate paper?	43%	2.3.4	If you were required to separate cans so that they can be recycled efficiently, would you do so?	
	1. There is no reason to separate it.	14%			
	2. The waste collectors separate it.	29%			
	3. Others	14%		1. Yes.	29%
2.1.12	If you were required to separate office paper (paper for printing and photocopy) so that it can be recycled efficiently, would you do so?		2.3.4.1	If community groups were going to introduce a system of collecting cans in order to benefit society from recycling them, would you cooperate?	NA
	1. Yes	43%			
	2. I don't know.	14%	2.3.4.1.1	If you could sell cans, would you separate them?	NA
2.1.12.1	If community groups were going to introduce a system of collecting office paper (paper for printing and photocopy) in order to benefit society from recycling it, would you cooperate?		2.4	Do you separate any other wastes? What do you do with them?	
				A. We give them to the waste collectors together with other waste.	29%
	1. Yes	14%			
2.1.12.1.1	If you could sell used office paper (paper for printing and photocopy), would you be interested in separating it?	NA		D. We bring or send them to a place where we can sell them.	29%
				E. Others	14%
2.2	What do you do with used bottles in your wastes?	0%		1. PET	43%
				2. Other Plastics	43%
	1. We discharge them together	57%		Others	14%

Q.No.2	Recycling	Response
	with other wastes.	
	2. We do not generate bottle waste.	14%
	3. Others	29%
2.2.1	How much kilograms of bottles do you separate per week?	NA
2.2.2	What do you do with those bottles?	NA
2.2.2.1	How much is it?	NA
2.2.3	Why don't you separate bottles?	
	1. The waste collectors separate them.	75%
2.5	In general, is your office interested in recycling?	
	1. Yes	43%
	2. No	43%
2.5.1	Why are you interested in recycling?	
	1. It can express our environmental awareness to the public.	33%
	2. It saves resources.	67%
	3. It can make waste management system more efficient.	100%
	4. It can help extend the service life of the final disposal site.	33%
	5. We can benefit by selling the recyclable wastes.	100%
2.5.2	Why aren't you interested in recycling?	
	1. It is troublesome.	100%
	2. It is difficult to separate waste.	33%
	3. It is not we but waste collectors who recycle wastes.	67%

Table E.2.22 Results on Waste Collection Services and Waste Discharge Behaviour (Offices)

Q.No.3	Waste Collection Services & Waste Discharge Behaviour	Response
3.1	How many kilograms of waste are generated, including recycled wastes, per week on average?	
	0-9	14%
	10-19	57%
	20-29	14%
	30-	14%
3.2	How many kilograms of wastes are discharged as wastes per week on average?	
	0-9	14%
	10-19	43%
	20-29	14%
	30-	14%
	NA	14%
3.3	What kinds of wastes do you discharge as wastes?	
	1. Organic waste	100%
	2. Cardboard	29%
	3. Newspaper, Magazines	14%
	4. Paper other than cardboard, newspaper or magazines	86%
	5. PET	43%
	6. Plastics other than PET	57%
	7. Cans	14%
	8. Bottles	14%
3.4	Do you have waste collection services?	
	1. Yes.	100%
3.4.1	Who collects them?	NA
3.4.2	How are they collected?	NA
3.4.5	Do you treat wastes in some ways before discharging?	
	1. Yes.	14%
	2. No.	86%
3.4.5.1	Which type of wastes do you treat in which way?	
	A. We burn them.	100%
	1. Organic waste	100%
	5. PET	100%
3.4.5.2	If some of wastes are burned, what do you do with the remained ash?	
	1. We bury it within our premises.	100%
3.4.6	Are you satisfied with the current waste collection system?	
	1. Yes	57%
	2. No	29%
	4. Others	14%
3.4.6.1	Why are you satisfied with the current waste collection system? (Plural answer question)	
	1. The frequency of collection is appropriate.	50%
	2. We can keep our place clean.	50%
	3. My waste collection point is close enough.	25%
	4. The service is provided free of charge	25%
3.4.6.2	What problems do you have with the current waste collection system?	
	1. Others	50%
3.4.6.2.1	How far is your collection point from	NA

Q.No.3	Waste Collection Services & Waste Discharge Behaviour	Response	Q.No.3	Waste Collection Services & Waste Discharge Behaviour	Response
3.4.3	How often do you have waste collection services per week?			your premises?	
			3.4.6.2.2	How far do you think it should be at farthest?	NA
	1. Daily	57%	3.4.7	What do you do with your wastes?	NA
	2 4 - 5 times.	29%	3.4.7.1	What do you do with remained ash?	NA
3.4.4	Do the waste collectors come at fixed time on specific days of the week?		3.4.8	Do you want waste collection services?	NA
			3.4.8.1	How much are you willing to pay per month in order to receive waste collection services?	NA
	1. Yes.	29%			
	2. I don't know.	71%	3.4.8.2	Why don't you need waste collection services?	NA
			3.5	What do you usually use when you discharge wastes?	NA

Table E.2.23 Results on Financial Matters (Offices)

Q.No.4	Financial Matters	Response	Q.No.4	Financial Matters	Response
4.1	How much do you pay for waste collection services per month?	NA	4.5	How much do you pay for water supply per month?	
4.2	If the market price of waste collection rose, how much, at maximum, could you afford to pay per month?	NA		0-99	14%
				99-199	43%
				200-	0%
4.3	Do you also pay tips/fees to the waste collectors?	NA		NA	0%
4.3.1	How much do you pay tips/fees per month on average?		4.6	How much do you pay for electricity per month?	100%
4.4	Do you pay tips/fees to the waste collectors?			0-19,999	14%
	1. No.	100%		20,000-39,999	14%
4.4.1	How much do you pay tips/fees per month of waste on average?	NA		40,000-	14%
4.4.2	Which do you prefer, to pay tips/fees or to pay tax for the waste collection services?	NA		NA	57%
4.4.3	Suppose that if you were required to pay waste management tax and if you reject to pay the tax instead of tips/fees, wastes would be remained in your premises without collection. How much Rupees per month, at maximum, could you afford to pay?	NA			

Table E.2.24 Results on Cooperation in Waste Management (Offices)

Q.No.5	Cooperation for Waste Management	Response
5.1	Coping with wastes requires efforts of not only the city and the GWMC but also the general public. Do you think there is something which your office can do for good waste management?	
	1. Yes.	100%
5.1.1	What do you think your office can do?	
	1. Discharging wastes neatly.	86%
	2. Minimising waste generation.	29%
	3. Reusing wastes.	14%
	4. Recycling wastes.	71%
	5. Providing information to the public.	14%
	6. Researching and development.	14%
5.2	A campaign to raise people's awareness of wastes is one of the ideas in order to involve the general public into waste management. Do you think your office would be interested in cooperating with the country, city or GWMC for such campaign?	
	1. Yes.	100%

(iv) Hotels

Table E.2.25 through **Table E.2.28** show all survey result from hotels. Type of waste discharged fells into a general trend of waste generation in other sectors. That is, hotels generate papers, organics, PET bottles, and other waste. Also cleaning staff takes care of much of separation tasks.

Table E.2.25 Results on Recycling Behaviour (Hotels)

Q.No.2	Recycling	Response	Q.No.2	Recycling	Response
2.1	What do you do with paper in your wastes?		2.4	Do you use your kitchen wastes for any purpose?	
	1. We separate them from other wastes.	20%			
	2. We discharge them together with other wastes.	60%	2.4.1	For what purpose do you use your kitchen waste?	NA
	3. Others	20%	2.4.2	If you were required to discharge organic wastes separately from other wastes so that they could be used to make compost, would you cooperate?	NA
2.1.1	Who separate paper?				
	1. Our cleaning staff sorts waste to separate paper.	100%			
2.1.2	How do you separate paper from other wastes?		2.4.2.1	Why won't you cooperate?	NA
	2. We separate newspaper, cardboard and other paper.	100%	2.5	Do you separate any other wastes? What do you do with them?	
2.1.3	How much kilograms of newspaper (and other paper) do you separate per week?	NA		A. We give them to the waste collectors together with other waste.	20%
2.1.4	What do you do with separated newspaper (and other paper)?	NA		B. We bring or send them to a place where we can sell them.	20%
2.1.4.1	How much are they?	NA		C. Others	60%
2.1.5	How much kilograms of cardboard (and other paper) do you separate per week?	NA		1. PET	40%
				2. Other Plastics	40%
2.1.6	What do you do with separated cardboard (and other paper)?	NA	2.6	In general, is your hotel interested in recycling?	0%
2.1.6.1	How much are they?	NA		1. Yes	20%
2.1.7	How much kilograms of newspaper, cardboard (and other paper) do you separate per week?	NA		2. No	80%
			2.6.1	Why are you interested in recycling?	
2.1.8	What do you do with separated newspaper, cardboard (and other paper)?	NA		1. It saves resources.	100%
				2. We can benefit by selling the recyclable wastes.	100%
	1. We bring it to a specific place where we can sell it.	100%	2.6.2	1. It is difficult to separate waste.	25%
2.1.8.1	How much are they?	NA		2. It is not we but waste collectors who recycle wastes.	25%
2.1.9	How much kilograms of mixed paper do you separate per week?	NA	2.3.1	How much kilograms of cans do you separate per week?	NA
2.1.10	What do you do with separated paper?	NA			
2.1.10.1	How much are they?	NA	2.3.2	What do you do with separated cans?	NA
2.1.11	Why don't you separate paper?	50%	2.3.2.1	How much are they?	NA
	1. There is no reason to separate it.	75%	2.3.3	Why don't you separate cans?	
2.1.12	If you were required to separate office paper (paper for printing and photocopy) so that it can be recycled efficiently, would you do so?	75%		1. Others	20%
			2.3.4	If you were required to separate cans so that they can be recycled efficiently, would you do so?	
	1. Yes	25%			
	2. No	25%	2.3.4.1	If community groups were going to introduce a system of collecting cans	NA
2.1.12.1	If community groups were going				

Q.No.2	Recycling	Response
	to introduce a system of collecting office paper (paper for printing and photocopy) in order to benefit society from recycling it, would you cooperate?	
	1. I don't know.	100%
	2. Others	100%
2.1.12.1.1	If you could sell used office paper (paper for printing and photocopy), would you be interested in separating it?	
	1. Yes	50%
	4. Others	50%
2.2	What do you do with used bottles in your wastes?	
	2. We discharge them together with other wastes.	40%
	5. Others	60%
2.2.1	How much kilograms of bottles do you separate per week?	NA
2.2.2	What do you do with those bottles?	NA
2.2.2.1	How much is it?	NA
2.2.3	Why don't you separate bottles?	
	2. It is troublesome to separate them.	50%
	3. The waste collectors separate them.	50%
2.2.4	If you were required to separate bottles so that they can be recycled efficiently, would you do so?	
	1. Yes.	40%
2.2.4.1	If community groups were going to introduce a system of collecting bottles in order to benefit society from recycling them, would you cooperate?	NA
2.2.4.1.1	If you could sell bottles, would you separate them?	NA
2.3.1	How much kilograms of cans do you separate per week?	NA
2.3.2	What do you do with separated cans?	NA
2.3.2.1	How much are they?	NA
2.3.3	Why don't you separate cans?	
	1. Others	20%
2.3.4	If you were required to separate cans so that they can be recycled efficiently, would you do so?	
2.3.4.1	If community groups were going to introduce a system of collecting cans in order to benefit society from recycling them, would you cooperate?	NA
2.3.4.1.1	If you could sell cans, would you separate them?	NA
	in order to benefit society from recycling them, would you cooperate?	
2.3.4.1.1	If you could sell cans, would you separate them?	NA
2.4	Do you use your kitchen wastes for any purpose?	
2.4.1	For what purpose do you use your kitchen waste?	NA
2.4.2	If you were required to discharge organic wastes separately from other wastes so that they could be used to make compost, would you cooperate?	NA
2.4.2.1	Why won't you cooperate?	NA
2.5	Do you separate any other wastes? What do you do with them?	
	A. We give them to the waste collectors together with other waste.	20%
	B. We bring or send them to a place where we can sell them.	20%
	C. Others	60%
	1. PET	40%
	2. Other Plastics	40%
2.6	In general, is your office interested in recycling?	0%
	1. Yes	20%
	2. No	80%
2.6.1	Why are you interested in recycling?	
	1. It saves resources.	100%
	2. We can benefit by selling the recyclable wastes.	100%
2.6.2	Why aren't you interested in recycling?	
	1. It is difficult to separate waste.	25%
	2. It is not we but waste collectors who recycle wastes.	25%

Table E.2.26 Results on Waste Collection Services and Waste Discharge Behaviour (Hotels)

Q.No.3	Waste Collection Services & Waste Discharge Behaviour	Response
3.1	How many kilograms of waste are generated, including recycled wastes, per week on average?	166 kg
3.2	How many kilograms of wastes are discharged as wastes per week on average?	180
3.3	What kinds of wastes do you discharge as wastes?	
	1. Organic waste	60%
	2. Cardboard	40%
	3. Newspaper, Magazines	20%
	4. Paper other than cardboard, newspaper or magazines	100%
	1. PET	60%
	2. Plastics other than PET	100%
	3. Cans	40%
	4. Bottles	20%
	5.Glass	40%
	6. Others (specify:)	20%
3.4	Do you have waste collection services?	
	1. Yes.	60%
	2. No.	20%
	3. I don't know.	20%
3.4.1	Who collects them?	
	1. A private individual which has a contract with us collects them.	67%
	2. The GWMC collects them.	33%
3.4.2	How are they collected?	
	1. Door-to-door collection	33%
	2. Curb side collection	33%
	3. Station collection	33%
3.4.3	How often do you have waste collection services per week?	
	1. Daily	67%
	2. 2-3 times or less.	33%
3.4.4	Do the waste collectors come at fixed time on specific days of the week?	
	1. No.	33%
	2. I don't know.	67%
3.4.5	Do you treat wastes in some ways before discharging?	
	2. No.	100%
3.4.5.1	Which type of wastes do you treat in which way?	
3.4.5.2	If some of wastes are burned, what do you do with the remained ash?	
3.4.6	Are you satisfied with the current waste collection system?	
	1. Yes	33%
	2. No	33%
	3. I don't know.	33%
3.4.6.1	Why are you satisfied with the current waste collection system?	
3.4.6.2	What problems do you have with the current waste collection system?	
3.4.6.2.1	How far is your collection point from your premises?	167%
3.4.6.2.2	How far do you think it should be at farthest?	167%
3.4.7	What do you do with your wastes?	
	1. We bring them to a specific place.	100%
3.4.7.1	What do you do with remained ash?	
3.4.8	Do you want waste collection services?	NA
3.4.8.1	How much are you willing to pay per month in order to receive waste collection services?	NA
3.4.8.2	Why don't you need waste collection services?	NA
3.5	What do you usually use when you discharge wastes?	
	1. Big plastic bags.	20%
	2. Dust bins.	20%
	3. Others	80%

Table E.2.27 Results on Financial Matters (Hotels)

Q.No.4	Financial Matters	Response	Q.No.4	Financial Matters	Response
4.1	How much do you pay for waste collection services per month?	15,000 Rs.	4.4.2	Which do you prefer, to pay tips/fees or to pay tax for the waste collection services?	NA
4.2	If the market price of waste collection rose, how much, at maximum, could you afford to pay per month?	NA	4.4.2.1	Why do you prefer to pay tips/fees?	NA
			4.4.2.2	Which do you prefer, to pay tips/fees for the current collection service or to pay tax of the same amount of tips/fees for a better collection services without problems	NA
4.3	Do you also pay tips/fees to the waste collectors?				
	1. No.	20%	4.4.2.3	Why do you prefer to pay tax?	NA
4.3.1	How much do you pay tips/fees per month on average?	NA	4.4.3	Suppose that if you were required to pay waste management tax and if you reject to pay the tax instead of tips/fees, wastes would be remained in your premises without collection. How much Rupees per month, at maximum, could you afford to pay?	417 Rs.
4.4	Do you pay tips/fees to the waste collectors?	NA			
4.4.1	How much do you pay tips/fees per month of waste on average?	NA			
			4.5	How much do you pay for water supply per month?	87,233
			4.6	How much do you pay for electricity per month?	152,500

Table E.2.28 Results on Cooperation in Waste Management (Hotels)

Q.No.5	Cooperation for Waste Management	Response
5.1	Coping with wastes requires efforts of not only the city and the GWMC but also the general public. Do you think there is something which your hotel can do for good waste management?	
	1. Yes.	80%
	2. I don't know.	20%
5.1.1	What do you think your hotel can do?	
	1. Discharging wastes neatly.	100%
	2. Minimising waste generation.	25%
	3. Recycling wastes.	75%
5.2	A campaign to raise people's awareness of wastes is one of the ideas in order to involve the general public into waste management. Do you think your hotel would be interested in cooperating with the country, city or GWMC for such campaign?	
	1. Yes.	100%

(v) Restaurants

Table E.2.29 through **Table E.2.33** show results from restaurants. Restaurants generate organic waste along with other usual waste, such as papers and plastics. On the other hand, GWMC collects waste from all the restaurants surveyed. Therefore, GWMC is in a position where it can ask for cooperation in improving waste management in the city.

Table E.2.29 Results on Waste Generation (Restaurants)

Q.No.2	Waste Generation	Response
2.1	What kind of waste does your restaurant produce?	
	Kitchen waste.	80%
	Jars/bottles (glass)	20%
	Plastics (film and other soft plastics)	60%
	Other waste	80%

Table E.2.30 Results on Recycling Behaviour (Restaurants)

Q.No.3	Recycling	Response	Q.No.3	Recycling	Response
3.1	What do you do with kitchen waste?		3.2.3	Why don't you separate bottles?	NA
	1. We discharge them together with other wastes.	100%	3.2.4	If you were required to separate bottles so that they can be recycled efficiently, would you do so?	NA
3.1.1	Who separate kitchen waste?	NA			
3.1.2	How do you separate paper from other wastes?	NA	3.2.4.1	If community groups were going to introduce a system of collecting bottles in order to benefit community from recycling them, would you cooperate?	NA
3.1.3	How much kilograms of newspaper (and other paper) do you separate per week?	NA			
3.1.4	What do you do with separated newspaper (and other paper)?	NA	3.2.4.1.1	If you could sell bottles, would you separate them?	NA
3.1.4.1	How much are they?	NA	3.3.1	How much kilograms of cans do you separate per week?	NA
3.1.5	How much kilograms of cardboard (and other paper) do you separate per week?	NA	3.3.2	What do you do with separated cans?	NA
3.1.6	What do you do with separated cardboard (and other paper)?	NA		1. We give them to the waste collectors.	0%
3.1.6.1	How much are they?	NA		2. We bring them to a specific place where we can sell them.	20%
3.1.7	How much kilograms of newspaper, cardboard (and other paper) do you separate per week?	NA		3. We sell them to somebody who visits here time to time.	0%
3.1.8	What do you do with separated newspaper, cardboard (and other paper)?	NA		4. Others	40%
			3.3.2.1	How much are they?	NA
3.1.8.1	How much are they?	NA	3.3.3	Why don't you separate cans?	NA
3.1.9	How much kilograms of mixed paper do you separate per week?	NA	3.3.4	If you were required to separate cans so that they can be recycled efficiently, would you do so?	NA
3.1.10.	What do you do with separated paper?	NA	3.3.4.1	If community groups were going to introduce a system of collecting cans in order to benefit community from recycling them, would you cooperate?	NA
3.1.10.1	How much are they?	NA			
3.1.11	Why don't you separate paper?	NA			
	1. There is no reason to separate it.	20%			
	2. It is troublesome to separate it.	40%	3.3.4.1.1	If you could sell cans, would you separate them?	NA
	3. The waste collectors separate it.	20%	3.4	Do you separate any other wastes?	
	5. Others	20%		A. Someone comes here to buy them.	80%
3.1.12	If you were required to separate office paper (paper for printing and photocopy) so that it can be recycled efficiently, would you do so?			1. PET	60%
				2. Other Plastics	20%
			3.5	In general, is your office interested in recycling?	
	1. Yes	20%		1. Yes	60%
	2. No	40%		2. No	40%
	4. Others	40%	3.5.1	Why are you interested in recycling?	
3.1.12.1	If community groups and/or groups were going to introduce a system of collecting office paper (paper for printing and photocopy) in order to benefit community from recycling it, would you cooperate?			1. It can express our environmental awareness to the public.	33%
				2. It saves resources.	67%
				3. It can make waste management system more efficient.	33%
	1. Yes	40%		4. We can benefit by selling the recyclable wastes.	67%
3.1.12.1.1	If you could sell used office paper (paper for printing and photocopy), would you be		3.5.2	Why aren't you interested in recycling?	

Q.No.3	Recycling	Response	Q.No.3	Recycling	Response
	interested in separating it?			1. It is troublesome.	50%
3.2	What do you do with used bottles in your wastes?			2. It is difficult to separate waste.	50%
3.2.1	How much kilograms of bottles do you separate per week?	2.5			
3.2.2	What do you do with those bottles?				
	1. We give them to the waste collectors.	20%			
	2. We bring them to a specific place where we can sell them.	20%			
	3. We sell them to somebody who visits here time to time.	60%			
	4. Others	20%			
3.2.2.1	How much is it?	25			

Table E.2.31 Results on Waste Collection Services and Waste Discharge Behaviour (Restaurants)

Q.No.4	Waste Collection Services & Waste Discharge Behaviour	Response	Q.No.4	Waste Collection Services & Waste Discharge Behaviour	Response
4.1	How many kilograms of waste are generated, including recycled wastes, per week on average?	212 kg	4.4.4	Do the waste collectors come at fixed time on specific days of the week?	
4.2	How many kilograms of wastes are discharged as wastes per week on average?	186		1. Yes.	80%
				2. I don't know.	20%
4.3	What kinds of wastes do you discharge as wastes?		4.4.5	Do you treat wastes in some ways before discharging?	
	1. Organic waste	100%		1. No.	100%
	2. Cardboard	20%	4.4.5.1	Which type of wastes do you treat in which way?	NA
	3. Newspaper, Magazines	60%			
	4. Paper other than cardboard, newspaper or magazines	80%	4.4.5.2	If some of wastes are burned, what do you do with the remained ash?	NA
	5. PET	20%	4.4.6	Are you satisfied with the current waste collection system?	NA
	6. Plastics other than PET	60%			
	7. Cans	20%		1. Others	20%
	8 Bottles	20%	4.4.6.1	Why are you satisfied with the current waste collection system?	
	9.Glass	20%			
	10.Other	20%		1. The frequency of collection is appropriate.	80%
4.4	Do you have waste collection services?			2. We can keep our place clean.	20%
	1. Yes.	100%		3. My waste collection point is close enough.	20%
4.4.1	Who collects them?			4. The service is provided free of charge	20%
	1. The GWMC collects them.	100%	4.4.6.2	What problems do you have with the current waste collection system?	
4.4.2	How are they collected?				
	1. Door-to-door collection	20%		1. The frequency of collection is very few.	0%
	2. Curb side collection	20%	4.4.6.2.1	How far is your collection point from your premises?	NA
	3. Station collection	60%			
4.4.3	How often do you have waste collection services per week?		4.4.6.2.2	How far do you think it should be at farthest?	NA
			4.4.7	What do you do with your wastes?	
	1. Daily	60%	4.4.7.1	What do you do with remained ash?	NA
	2. 4 - 5 times.	20%	4.4.8	Do you want waste collection services?	NA
	3. More than 5 times.	20%	4.4.8.1	How much are you willing to pay per month in order to receive waste collection services?	NA

Q.No.4	Waste Collection Services & Waste Discharge Behaviour	Response	Q.No.4	Waste Collection Services & Waste Discharge Behaviour	Response
			4.4.8.2	Why don't you need waste collection services?	NA
			4.5	What do you usually use when you discharge wastes?	
				1. Big plastic bags.	60%
				2. Dust bins.	40%
				3. Others	20%

Table E.2.32 Results on Financial Matters (Restaurants)

Q.No.5	Financial Matters	Response			Response
5.1	How much do you pay for waste collection services per month?	NA	5.4.2.1	Why do you prefer to pay tips/fincas?	
				1. The waste collectors can benefit.	20%
5.2	If the market price of waste collection rose, how much, at maximum, could you afford to pay per month?	NA	5.4.2.2	Which do you prefer, to pay tips/fincas for the current collection service or to pay tax of the same amount of tips/fincas for a better collection services without problems, if any, such as what you have mentioned in Q3.4.6.2.?	
5.3	Do you also pay tips to the waste collectors?	NA			
5.3.1	How much do you pay tips per month on average?	NA			
5.4	Do you pay tips/fincas to the waste collectors?			1. To pay tips/fincas.	20%
	1. Yes.	60%	5.4.2.3	Why do you prefer to pay tax?	NA
	2. No. (Go to Q5.4.3.)	40%	5.4.3	Suppose that if you were required to pay waste management tax and if you reject to pay the tax instead of tips/fincas, wastes would be remained in your premises without collection. How much Rupees per month, at maximum, could you afford to pay?	
5.4.1	How much do you pay tips/fincas per month of waste on average?				
5.4.2	Which do you prefer, to pay tips/fincas or to pay tax for the waste collection services?				
	1. To pay tips/fancies	20%			
			5.5	How much do you pay for water supply per month?	NA
			5.6	How much do you pay for electricity per month?	341,667

Table E.2.33 Results on Cooperation in Waste Management (Restaurants)

Q.No.6	Cooperation for Waste Management	Response
6.1	Coping with wastes requires efforts of not only the city and the delegations but also the general public. Do you think there is something which your office can do for good waste management?	
	1. Yes.	80%
	2. No.	20%
6.1.1	What do you think your office can do?	
	1. Discharging wastes neatly.	100%
	2. Recycling wastes.	75%
6.2	A campaign to raise people's awareness of wastes is one of the ideas in order to involve the general public into waste management. Do you think your office would be interested in cooperating with the country, city or delegation for such campaign?	
	1. Yes.	100%

(vi) Factories

Table E.2.34 through **Table E.2.37** shows the results of the survey for Factories. All of them generate solid waste, which are collected by either GWMC or private contractors, or in some cases, they take care of waste themselves, for example, by burning the waste and depositing the ash within the company premises.

Table E.2.34 Results on Overall Picture of Waste Generation and Discharge (Factories)

Q.No.2	Overall picture of waste generation & discharge	Response	Q.No.2	Overall picture of waste generation & discharge	Response
2.1	Type of Waste:		2.3	Nature of waste	
	1. Ash, combustion residue	10%		Solid	100%
	2. Waste similar to domestic waste	30%		Liquid	10%
	3. Scrapped Metal	50%	2.4	Characteristics	
	4. Paper & cardboard	10%		Organic	10%
	5. Plastics	50%		Inorganic	70%
	6. Scrap Rubber	10%		Non-biodegradable	10%
	7. Waste water	10%			

Q.No.3	Waste Separation and Recycling	Response	Q.No.3	Waste Separation and Recycling	Response
3.1	Who separate paper?		3.3	What do you do with used bottles in your wastes?	
	1. The person who generates paper wastes throws away into specific garbage containers for paper or at specific places.	10%	3.3.1	How much tons of bottles do you separate per week?	NA
			3.3.2	What do you do with those bottles?	NA
			3.3.2.1	How much is it?	NA
	2. Our cleaning staff sorts waste to separate paper.	10%	3.3.3	Why don't you separate bottles?	NA
	3. I don't know.	20%	3.3.4	If you were required to separate bottles so that they can be recycled efficiently, would you do so?	NA
	4. Others	60%	3.3.4.1	If community groups were going to introduce a system of collecting bottles in order to benefit society from recycling them, would you cooperate?	NA
3.2	How do you separate paper from other wastes?				
	1. We separate only cardboard (other paper is mixed with other wastes).	20%			
			3.3.4.1.1	If you could sell bottles, would you separate them?	NA
	2. I don't know.	70%			
	3. Others	10%	3.4	What do you do with used cans?	
3.2.1	How much tons of newspaper (and other paper) do you separate per week?	NA		1. We do not generate can wastes.	20%
			3.4.1	Who separate cans?	NA
3.2.2	What do you do with separated newspaper (and other paper)?	NA	3.4.2	How much tons of cans do you separate per week?	NA
3.2.2.1	How much are they?	NA	3.4.3	What do you do with separated cans?	NA
3.2.3	How much tons of cardboard (and other paper) do you separate per week?	NA	3.4.3.1	How much are they?	NA
			3.4.4	Why don't you separate cans?	NA
	Cardboard	4	3.4.5	If you were required to separate cans so that they can be recycled efficiently, would you do so?	NA
3.2.4	What do you do with separated cardboard (and other paper)?				
			3.4.5.1	If community groups were going to introduce a system of collecting cans in order to benefit society from recycling them, would you cooperate?	NA
	3. We sell it to somebody who visits here time to time.	20%			
3.2.4.1	How much are they?				
	Cardboard	15	3.4.5.1.1	If you could sell cans, would you separate them?	NA
3.2.5	How much tons of newspaper, cardboard (and other paper) do you separate per week?	NA	3.5	Do you separate any other wastes? What do you do with them?	
				A. Someone comes here to take them.	10%
3.2.6	What do you do with separated newspaper, cardboard (and other paper)?	NA		B. Someone comes here to buy them.	10%
				1. Metal other than cans	20%
3.2.6.1	How much are they?	NA		2. Garden waste	10%
3.2.7	How much tons of mixed paper do you separate per week?	NA	3.6	In general, does your factory support the idea of recycling?	

Q.No.3	Waste Separation and Recycling	Response	Q.No.3	Waste Separation and Recycling	Response
3.2.8	What do you do with separated paper?	NA		1. Yes	90%
3.2.8.1	How much are they?	NA		2. No	10%
3.2.9	Why don't you separate paper?	NA	3.6.1	Why are you for recycling?	
3.2.10	If you were required to separate cardboard so that it can be recycled efficiently, would you do so?	NA		1. It saves resources.	10%
				2. We can benefit from recycling.	80%
			3.6.2	Why are you against recycling?	
3.2.10.1	If community groups were going to introduce a system of collecting cardboard in order to society from recycling it, would you cooperate?	NA		Others	10%
3.2.10.1.1	If you could sell cardboard, would you be interested in separating it?	NA			

Table E.2.35 Results on Waste Collection Services and Waste Discharge Behaviour (Factories)

Q.No.4	Waste Collection Services & Waste Discharge Behaviour	Response	Q.No.4	Waste Collection Services & Waste Discharge Behaviour	Response
4.1.1	How are they collected?		4.1.3.1	Why are you satisfied with the current waste collection system?	NA
	1. Curb side collection	60%			
	2. Station collection	40%	4.1.3.2	What problems do you have with the current waste collection system?	
4.1.2	Do the waste collectors come at fixed time on specific days of the week?			1. The frequency of collection is very few.	57%
	1. No.	80%		2. Collection time is irregular.	43%
	2. I don't know.	20%	4.1.3.2.1	How far is your collection point from your premises?	NA
4.1.3	Are you satisfied with the current waste collection system?		4.1.3.2.2	How far do you think it should be at farthest?	NA
	1. No	70%			
	2. I don't know.	30%			

Table E.2.36 Results on Financial Matters (Factories)

Q.No.5	Financial Matters	Response
	Collected by Private Company	60%
	No Collection Services	40%
	Collected by GWMC	60%
	No Collection Services	40%
	A. Private Collection Services for Industrial Waste	40%
5.1	How much do you pay for industrial waste collection services per month?	73 Rs.
5.2	If the market price of waste collection rose, how much, at maximum, could you afford to pay per month? For industrial waste	350
5.3	Do you also pay tips to the waste collectors?	
	2. No.	60%
5.3.1	How much do you pay tips per month on average?	NA
5.4	How much do you pay for collection services of domestic wastes (or mixed wastes) per month?	
5.5	If the market price of waste collection rose, how much, at maximum, could you afford to pay per month? For domestic waste	
5.6	Do you also pay tips to the waste collectors?	
5.6.1	How much do you pay tips per month on average?	

Q.No.5	Financial Matters	Response
5.7	Do you pay tips/fees to the waste collectors?	
	1. No.	60%
5.7.1	How much do you pay tips/fees per month of waste on average?	NA
5.7.2	Which do you prefer, to pay tips/fees or to pay tax for the waste collection services?	NA
5.7.2.1	Why do you prefer to pay tips/fees?	NA
5.7.2.2	Which do you prefer, to pay tips/fees for the current collection service or to pay tax of the same amount of tips/fees for a better collection services without problems, if any, such as what you have mentioned in Q4.1.3.2.?	NA
5.7.2.3	Why do you prefer to pay tax?	NA
5.7.3	Suppose that if you were required to pay waste management tax and if you reject to pay the tax, wastes would be remained in your premises without collection. How much Rupee per month, at maximum, could you pay?	NA
5.8	Do you want waste collection services for industrial waste?	NA
	1. Yes.	10%
	2. No.	30%
5.8.1	How much are you willing to pay per month in order to receive waste collection services?	
5.8.2	Why don't you need waste collection services?	
	1. We want to discharge waste as we like.	20%
	4. We discharge only small amount of waste.	10%
	E. No Collection Services for Domestic Wastes	
5.9	Do you want waste collection services for domestic wastes?	
	1. Yes. (Go to Q5.9.1.)	10%
	2. No. (Go to Q5.9.2.)	30%
5.9.1	How much are you willing to pay per month in order to receive waste collection services for domestic wastes?	200
5.9.2	Why don't you need waste collection services?	
	1. We want to discharge waste as we like.	33%
	4. We discharge only small amount of waste.	67%

Table E.2.37 Results on Cooperation in Waste Management (Factories)

Q.No.6	Cooperation for Waste Management	Response	Q.No.6	Cooperation for Waste Management	Response
6.1	Do you think there is something which your factory can do for good waste management?		6.3	How do you give the priority on the management of your wastes?	
	1. Yes.	60%		1. We give very high priority.	30%
	2. No.	30%		2. We give moderate priority.	50%
	3. I don't know.	10%		3. We give little priority.	20%
6.1.1	What do you think your office can do?		6.4	Do you think good waste management could bring you a benefit?	
	1. Discharging wastes neatly.	100%		1. Yes, very much.	10%
	2. Recycling wastes.	67%		2. Yes, to a certain extent.	30%
	3. Providing information to the public.	33%		3. Yes, but a little.	10%
6.2	How is the trend of your cost for waste management?			4. No.	50%
	1. It is getting higher.	10%	6.5	Do you feel you need a support from the government of the country, city or GWMC or any other relevant organizations for the management of your waste?	
	2. It is relatively stable.	90%		1. Yes, we need technical support.	10%
				2. No, we don't.	90%

(vii) Hospitals

Table E.2.38 through **Table E.2.42** show the survey results from hospitals. Hospitals have set up a good system for waste management. For example, all of surveyed hospitals store their waste in storage facility. On the other hand, there is not much information available on waste separation or recycling of their general waste.

Table E.2.38 Results on In-House Collection System of Medical Wastes (Hospitals)

Q.No.3	In House Collection System for Medical Wastes	Response	Q.No.3	In House Collection System for Medical Wastes	Response
3.1	Specify the present medical waste collection system in your institution:		3.8	Are there (a) central waste collection point(s) in your institution?	
	1. We use a standard system with containers or coloured bags with labels.	100%		1. Yes, there is one waste collection point.	67%
3.2	Describe the present containers for collection of medical wastes in your institution:			2. Yes, there are more than one waste collection points.	33%
	1 We use bags.	100%	3.8.1	How is (are) this (these) central collection point(s) located? Are they (is it) (an) especially dedicated area(s) (i.e. separated from the other buildings)?	
3.3	Describe the present collection containers for the pathological wastes in your institution:			1. Yes.	100%
	1. We use bags.	33%	3.8.2	How often are (is) the collection point(s) disinfected?	
	2. Others	67%		1. Never.	100%
3.4	Describe the present collection containers for sharp materials in your institution:		3.8.3	Are they (is it) enclosed with fence and locked?	
	1. We use strong containers used only for sharp materials.	67%		1. Others (store house/room)	100%
	2. Others	33%	3.8.4	Describe the access to the collection point for the collection vehicles (trucks) and the procedure of waste loading.	
3.5	Specify the collection frequency			1. There is a free access for the vehicles. The waste is loaded manually.	33%

Q.No.3	In House Collection System for Medical Wastes	Response
	of the pathological wastes (of the departments) in your institution:	
	1. Once per day.	33%
	2. Others	67%
3.6	Describe the present collection system of hazardous waste (chemicals, medicine) in your institution:	
	1. There is no organized system of collection.	33%
	2. We keep the chemicals in their original packages and/or other containers which are not necessarily designed to store hazardous waste.	67%
3.7	Are there cool storage points for pathological wastes in your institution?	
	1. No.	100%

Q.No.3	In House Collection System for Medical Wastes	Response
	2. There is no direct access for vehicles. The waste is carried and loaded manually.	67%
3.9	Specify the area of storage for hazardous waste (chemicals, medicines).	
	1. We do not have an area exclusively dedicated for hazardous waste.	33%
	2. We have an area dedicated for the storage of hazardous waste.	67%
3.9.1	Tick any of 1. to 3. if appropriate.	
	1. The area has a separated system of drainage.	67%
3.10.	Is there any structure for the storage of radioactive wastes?	
	1. No, because we do not generate radioactive wastes.	100%
3.11	Which of the following phrases best represents the present medical waste management in your institution?	
	1. The present management is satisfactory from the internal point of view, but potentially poses a risk on the external environment.	100%
3.8	Are there (a) central waste collection point(s) in your institution?	
	1. Yes, there is one waste collection point.	67%
	2. Yes, there are more than one waste collection points.	33%

Table E.2.39 Results on Recycling (Hospitals)

Q.No.4	Recycling	Response
4.1	What do you do with used bottles in your wastes?	
	4. We do not generate bottle waste.	100%
4.1.1	Who separate bottle?	
	1. The person who generates bottle wastes throws away into specific garbage containers for bottles.	NA
4.1.2	How much kilograms of bottles do you separate per week?	NA
4.1.3	What do you do with those bottles?	NA
4.1.3.1	How much is it?	NA
4.1.4	Why don’t you separate bottles?	NA
4.1.5	If you were required to separate bottles when you discharge them so that they can be recycled efficiently, would you do so?	NA
4.1.5.1	If community groups were going to introduce a system of	NA

Q.No.4	Recycling	Response
4.3.2	How do you separate paper from other wastes?	NA
4.3.3	How much kilograms of newspaper (and other paper) do you separate per week?	NA
4.3.4	What do you do with separated newspaper (and other paper)?	NA
4.3.4.1	How much are they?	NA
4.3.5	How much kilograms of cardboard (and other paper) do you separate per week?	NA
4.3.6	What do you do with separated cardboard (and other paper)?	NA
4.3.6.1	How much are they?	NA
4.3.7	How much kilograms of newspaper, cardboard (and other paper) do you separate per week?	NA
4.3.8	What do you do with separated newspaper, cardboard (and other paper)?	NA
4.3.8.1	How much are they?	NA
4.3.9	How much kilograms of mixed paper do you separate per week?	NA

Q.No.4	Recycling	Response
	collecting bottles in order to benefit society from recycling them, would you cooperate?	
4.1.5.1.1	If you could sell separated bottles, would you be interested in separating them?	NA
4.2	What do you do with cans in your wastes? (Both options 1 and 2 can be ticked together.)	
	3. We discharge them together with other wastes.	33%
	4. I don't know.	66%
4.2.1	Who separate cans?	NA
4.2.2	How much kilograms of cans do you separate per week?	NA
4.2.3	What do you do with separated cans?	NA
4.2.3.1	How much are they?	NA
4.2.4	Why don't you separate cans?	
	1. There is no reason to separate them.	100%
4.2.5	If you were required to separate cans so that they can be recycled efficiently, would you do so?	
	1. Yes.	33%
4.2.5.1	If community groups were going to introduce a system of collecting cans in order to benefit society from recycling them, would you cooperate?	NA
4.2.5.1.1	If you could sell cans, would you separate them?	NA
4.3	What do you do with paper in your wastes?	
	2. We discharge them together with other wastes.	67%
	3. I don't know.	33%
4.3.1	Who separate paper?	NA
4.3.10	What do you do with separated paper?	NA
4.3.10.1	How much are they?	NA
4.3.11	Why don't you separate paper?	
	1. There is no reason to separate it.	67%
4.3.12	If you were required to separate paper (regardless types) so that they can be recycled efficiently, would you do so?	
4.3.12.1	1. Yes.	67%
	If community groups were going to introduce a system of collecting paper in order to benefit society from recycling them, would you cooperate?	NA
4.3.12.1.1	If you could sell used paper, would you be interested in separating it?	NA
4.4	What do you do with your wastes from plants (branches, leaves, etc.)?	
	1. We discharge them together with other wastes.	50%
	2. We do not generate wastes from plants.	50%
	3. Others	50%
4.4.1	What do you do with separated plants wastes?	NA
4.4.2	If you were required to separate wastes from plants from other wastes so that they can be used to make compost efficiently, would you do so?	
	1. Yes.	33%
4.4.2.1	Why won't you cooperate?	NA
4.5	Do you separate your organic wastes (referring to kitchen wastes or food wastes) for any purpose?	
	1. No, because we do not generate organic waste.	33%
	2. No, although we generate organic waste.	67%
4.5.1	For what purpose do you separate them?	NA
4.5.2	If you were required to discharge organic wastes separately from other wastes so that they could be used to make compost, would you cooperate?	
	1. Yes.	100%
4.5.2.1	Why won't you cooperate?	NA
4.6	Do you separate any other wastes? What do you do with them?	
	A. We give them to the waste collectors together with other waste.	100%
	1. PET	100%
	2. Other Plastics	33%

Table E.2.40 Results on Management of General Waste (Hospitals)

Q.No.5	Management of General Wastes	Response	Q.No.5	Management of General Wastes	Response
5.1	What kinds of general wastes do you discharge?		5.3	Are you satisfied with the current waste collection system?	
	1. Organic wastes	100%		1. Yes.	100%
	2. Wastes from plants	100%	5.3.1	Why are you satisfied with the current waste collection system?	
	3. PET	100%			
	4. Cans	33%	5.3.2	What problems do you have with the current waste collection system?	NA
5.2	Do you treat wastes in some ways before discharging?		5.3.2.1	How far is your collection point from your premises?	NA
	1. No.	100%			
5.2.1	Which type of wastes do you treat in which way?	NA	5.3.2.2	How far do you think it should be at farthest?	NA
			5.4	What do you usually use when you discharge general wastes?	
5.2.2	If some of wastes are burned, what do you do with the remained ash?			1. Big plastic bags.	100%
	2. We bury it within our premises.	33%		2. Carton boxes.	33%
	4. Other	67%			

Table E.2.41 Results on Financial Matters (Hospitals)

Q.No.6	Financial Matters	Response	Q.No.6	Financial Matters	Response
	Medical Wastes		6.6	Do you also pay tips/fees to the waste collectors?	NA
	Collected by Private Company	100%	6.6.1	How much do you pay tips/fees per month on average?	
	No Collection Services	100%			
6.1	How much do you pay for medical waste collection services per month?			A. Waste Collection Services by GWMC for Medical and/or General Wastes	NA
	1. Blood	67%	6.7	Do you pay tips/fees to the waste collectors?	
	2. Infectious agent, cultures, fungi	67%	6.7.1	How much do you pay tips/fees per month of waste on average?	NA
	3. Non anatomic waste that comes from the medical attention of patients and laboratories	33%	6.7.2	Which do you prefer, to pay tips/fees or to pay tax for the waste collection services?	NA
	4. Pathological waste	33%	6.7.2.1	Why do you prefer to pay tips/fees?	NA
	5. Sharp material (needles, surgical knives, etc.)	67%	6.7.2.2	Which do you prefer, to pay tips/fees for the current collection service or to pay tax of the same amount of tips/fees for a better collection services without problems	NA
	6. Hazardous waste (chemicals, medicine)	33%			
	Total Rupees/month	100%			
	If the previous information cannot be provided in detail, please give the total payment:	100%	6.7.2.3	Why do you prefer to pay tax?	NA
			6.7.3	Suppose that if you were required to pay waste management tax and if you reject to pay the tax, wastes would be remained in your premises without collection. How much Rupees per month, at maximum, could you pay? (Be aware that you were not required to pay tips/fees to the collectors. What you would pay only tax.)	
6.2	If the market price of waste collection rose, how much, at maximum, could you afford to pay per month?	25,000			
6.3	Do you also pay tips/fees to the waste collectors?			D.A No Collection Services for Medical Wastes	NA
	1. No.	33%	6.8	Do you want waste collection services for medical waste?	NA
	2. Others	67%			
6.3.1	How much do you pay tips/fees per month on average?		6.8.1	How much are you willing to pay per month in order to receive waste collection services?	NA
	B. Private Collection Services for		6.8.2	Why don't you need waste collection	NA

Q.No.6	Financial Matters	Response	Q.No.6	Financial Matters	Response
	General Wastes (or mixed wastes)			services?	
			6.9	Do you want waste collection services for general wastes?	
6.4	How much do you pay for general (or mixed) waste collection services per month?	NA	6.9.1	How much are you willing to pay per month in order to receive waste collection services for general wastes?	300
6.5	If the market price of waste collection rose, how much, at maximum, could you afford to pay per month?	NA	6.9.2	Why don't you need waste collection services?	NA
			6.10.	How much do you pay for water supply per month?	NA
			6.11	How much do you pay for electricity per month?	NA

Table E.2.42 Results on Cooperation in Waste Management (Hospitals)

Q.No.7	Cooperation for Waste Management	Response	Q.No.7	Cooperation for Waste Management	Response
7.1	Do you think there is something which your institution can do for good waste management?		7.4	How do you give the priority on the management of your wastes?	
	2. No.	100%		1. We give very high priority.	100%
7.1.1	What do you think your institution can do?	NA	7.5	Do you feel you need a support from the government of the country, city or GWMC or any other relevant organizations for the management of your waste?	
7.2	Do you think the medical institutions should cooperate with the country, city and/or GWMC in managing wastes?				
	1. Yes.	100%		1. Yes, we need financial support.	100%
7.3	How is the trend of your cost for waste management?			2. Yes, we need technical support.	100%
	1. It is getting significantly higher.	33%			
	2. It is getting higher.	67%			

2.1.4 Conclusion

In general, the public is not satisfied with the waste management services provided by GWMC, which resulted in the low awareness of SWM. Also, the limited data suggests that Resident's Willingness-to-Pay is very limited or even none.

Discharge behaviour has much room for improvement because the awareness on recycling is low. Although recycling and reusing bottles is somewhat much popular among the general public and restaurants, other recyclable materials show a considerably low recycling rate. This can be true for even the low-income group in rural areas.

Organic materials, which can be used to make compost and reduce the volume of waste sent to the final disposal site, are also not collected well.

Therefore, public relation activities should be carried out to disseminate the proper SWM practices expected to be performed by the public and the SWM practice carried out by GWMC.

2.2 Findings from the Interview with the District Officer for Environment

There is a District Officer for Environment in Gujranwala City who deals with environmental issues in general, such as nature/life, waste/resource, and energy and global warming. The interview with the District Officer revealed the following:

- There is no by-law, ordinance or directive for carrying out environmental education. However, a framework exists for higher education such as Doctor of Philosophy (Ph.D,), Master of Philosophy (M.Ph)/Master of Science (MS), and Bachelor of Science (BS) in Environmental Sciences.
- Collaboration with NGOs exists with, for example, Organization Pan Environment (OPE), Nayab Welfare Society, Gujranwala Environmental Organization, etc.
- Various media including brochures/textbooks, TV/radio/commercial programs, signboards, school curriculum, and public meetings are utilised in environmental education.
- Walks, seminars, activities at educational institutions, e.g., speech competition, essay writing, printed material distribution, or environmental club, and other activities are employed for environmental education/awareness raising.
- Priority should be placed on (a) recycling of plastics, metals, glass, cardboard and others; (b) composting from kitchen waste; and (c) animal/donkey waste.
- Community meetings are the best strategy for awareness in Gujranwala along with school education programmes. For mass communication, local cable channels can be very effective. Workshops and seminars will not work for Gujranwala.
- In Gujranwala at community level, education can be delivered by mosques (Imam Masjid). Moreover, different community groups on the basis of income should be educated through multiple awareness programmes/media.
- Feminist groups/representatives from local community should be selected to address awareness at household level. The contents of educational network may include major waste types, 3R concept, at source segregation, waste and economy correlation and use of cloth bags rather than plastic bags.
- There is no coordination or consultation from the Education Department while setting the curriculum.
- The Environment Department has conducted composting and recycling sessions in different schools on periodic basis. An awareness curriculum (books) in private schools under a project was also distributed. The awareness material includes story books regarding solid waste, composting, 3R concept, water conservation and solid waste management guidelines.

2.3 Evaluation of Environmental Education and Public Awareness Condition

Although the result of the awareness survey is not available yet, interviews with the District Officer and the Environment Officer indicate the lack of commitment in environmental education in the government, which appears to be the hindering issue. For instance, there is neither legal framework to carry out environmental education nor coordination among relevant bodies. The problems and issues under the current situation related to environmental education are as summarised in **Table E.2.43**.

Table E.2.43 Identification of Problems and Issues on Environmental Education and Public Awareness

Problem	Description of Problem	Issues for Solving the Problems
1. Poor coordination among government agencies and departments	There is a lack of coordination among departments including school education, GWMC and environment. Since awareness raising campaign or environmental education activity has been carried out without much coordination among relevant bodies, thus messages were not focused nor spread among target population.	Coordination among the relevant departments like environment, school education, etc., is necessary for the implementation of environmental education and public awareness raising activities. A mechanism to address environmental awareness should be developed among the agencies concerned to realise effective and coherent effort on environmental education. The relevant bodies may include Planning and Development, Education, Water and Sanitation, and Environment.
2. Inappropriate school curriculum on the environment	The curriculum is different for public and private schools. Inevitably, students in public schools, especially, primary schools, learn less about the environment.	It is necessary to increase the practical applications and classes regarding the environment in the school curriculum. Some environmental education packages for the kids as well as training for the teachers may also be implemented.
3. Lack of awareness among public	There is a tendency among the public that the government has the sole responsibility of taking care of the environment. Awareness programme and campaign can be developed through community groups which may be comprised of area representatives, religious persons and students.	Patient effort is necessary to edify the public on environment, especially, waste management. In this sense, collaboration with grassroots group or even religious body (mosque) needs to be considered in order to raise awareness among the public. In addition, feminist groups may pose strong influence to each household's waste management practices through a network of wives. The efforts can include waste reduction, reuse/recycle, source separation, and proper waste discharge.
4. Irregular informal education on the environment	There is no continuous informal education except once a year during such event as Earth Day. There is no strategy defined for the public information department regarding informal environmental education.	The government should initiate concrete efforts in highlighting the importance of environment through implementation of public information for the environment as well as cooperation with various groups working for environmental issues.

3. PLANNING DIRECTIONS OF ENVIRONMENTAL EDUCATION AND PUBLIC AWARENESS RAISING PLAN

3.1 Objective

The objective of the Environmental Education is to raise awareness of the general public as well as selected target groups (e.g., elected officials/representatives, religious scholars) at the Union Council, Tehsil and District levels of SWM.

3.2 Planning Policy

- The plan should be formulated to promote better understanding of the resident through public and school environmental education by establishing coordination mechanisms in GWMC.
- The plan should be continuous and formulated to promote more involvement of public and selected target groups' participation by providing opportunities to actively participate.

3.3 Planning Strategy

- Capacity of communication unit of GWMC should be strengthened to facilitate and coordinate numerous education routes, i.e., facilitating educational materials and coordinating relevant bodies.
- GWMC needs to inform the public of the measures to be taken to improve SWM in the city. A properly structured communication strategy should be developed.
- A public environmental education and awareness programme should be carried out to raise awareness and involve the public in the initiatives for better SWM in the city.
- The introduction of SWM in the primary education curriculum should be considered to make school children more aware on solid waste issues. In addition, the development of educational materials for teachers and students should be considered essential as a tool to promote environmental education and create awareness among educational community.

4. FORMULATION OF ENVIRONMENTAL EDUCATION AND PUBLIC AWARENESS RAISING PLAN

Result of the awareness survey may alter/modify the direction in the environmental education and public awareness raising plan. However, (1) framework to backup government's efforts and mechanism or strategy to coordinate among relevant bodies; (2) awareness raising activities targeting general public, school children especially primary students, and business establishment through regular programmes/campaign; and (3) in collaboration with community groups, feminist groups, and religious places (mosques) can be focused in the Plan.

Topics shall include, but not limited to, environmental awareness, waste collection/transportation/ disposal, source separation, 3R (Reduce, Reuse, Recycle), composting, and others.

4.1 Development of Alternatives for the Environmental Education and Public Awareness Raising Plan

When considering an environmental education and awareness raising plan, selecting the target population is one of the very important elements, not to mention what to teach/sensitise the population. Population can be targeted through a group or organization that the population belongs to, ranging from each household to religious group, to school or business entities, etc. How to reach the population is also a key element in developing the environmental education and awareness raising plan.

In these viewpoints, there are mainly four components to develop the plan. These are formal education, informal education, mass media, and periodical events. Each component has its own characteristics which are discussed below.

4.1.1 Formal Education

Formal education is defined as the education given in a classroom to the student on a structured system provided by trained teachers under the supervision of the Board of Education of Punjab Province. In the context of environmental education in SWM, a) primary schools and b) higher education can be highlighted. Private and public schools exist in Gujranwala, and public schools, inevitably, have less focus on environment than private schools.

(1) Primary School

Except for a small number of unfortunate children, almost all small children in Gujranwala go to either public or private primary schools. Currently, there is no formal programme dedicated to environmental education under the education board.

Solid waste can be dealt as part of an integrated environmental education when adopted in formal curriculum as it is an excellent educational material to: a) notice or show interest on the environment and its associated problem, b) acquire knowledge, c) aware of the solutions, and d) motivated to solve them.

The programme that covers the above contents requires not only very careful coordination with the authority concerned and other relevant bodies but also detailed study on the contents and how to integrate it with other subjects in the schools.

Photo E.4.1 Example of Formal Education

(2) Higher Education

Some colleges and universities already offer environmental education from environmental science to environmental laws. Those courses are helping to grow environmental specialists in the area; however, the impacts are very limited and do not necessarily stay within Gujranwala. Collaboration with scholars specialising in solid waste management can be sought.

4.1.2 Informal Education

Informal education is a type of education outside of the official school curriculum. It can be offered in a school setting, of course, but also in other parts of society, i.e., it can also be called social education where all parts of a social unit from each household to neighbourhood/community group, religious group, etc.

(1) Schools

Primary schools in Gujranwala have some school activities outside of the official curriculum. GWMC can, in close coordination with schools and relevant bodies, offer an education programme delivered to each school. In the delivery of programmes, GWMC staff can visit schools and teach pupils about SWM.

In Gujranwala, many schools have recreational or orientation field trips visiting some local landmarks like historical monuments or museums. During these field trips, school students can visit one of the waste management facilities or waste management activities on the ground.

Waste management educational facility can be established either within city, waste collection points or landfill site where visitors can learn about SWM through various displays, observation, or hands-on experience. This educational facility can be a building/house, but most likely can start with a single room or two, provided there is enough space to hold a class of students (approximately 30 students or so). On the walls inside the room, various explanations about waste management in the city can be displayed with samples. In the centre of the room, the students can sit and listen to the GWMC staff or practice how to separate recyclables using actual samples, for instance. Depending upon the size of a class, some creative activities can be also carried out in this space, like making artworks from recyclables, and let students think how to improve their environment though proper waste management.

Topic of the informal education at schools can include proper management of waste, separation of waste, 3R, compost, hygiene, and others.

(2) Social Group

Households play an important role in informal education since it is a basic unit of social structure. In general, a child learns various values and behaviours from his/her parents/siblings and other members of his family. Raising awareness of a household member can influence the entire household members and yield long-term impacts.

Other social groups, including neighbourhood/community groups, religious (mosque), labour union, teacher's union, transport union, Doctor's group or other organization, can also play important roles since they have their own influence in society. By closely coordinating with those groups, GWMC can help in their environmental activities and also work as entry point to spread the environmental message to the residents.

(3) Agency/Business Establishments

Environmental education can be targeted to the manager/owner and staff. It can also be carried out at each agency, business establishment or association for its prospective staffs. Industries that general customers/consumers visit like shopping malls and banks can raise environmental awareness of their customers/consumers.

Likewise, GWMC should raise awareness of its own staff, i.e., office staff/sanitary workers, through appropriate environmental awareness trainings.

4.1.3 Mass Media

There are mainly two ways to implement environmental education using mass media. One is to have an environmental programme focusing on SWM broadcasted by TV station or radio station. Another is to use them as a medium to spread environmental message or publicity to the public.

(1) Structured Programme

An educational programme focusing on the environment can be created or small portion of another programme can be delicate for the environmental topic in an existing programme. Either way, programme needs to be systematically developed and continuously broadcasted for optimal effect. Similar to formal education in schools, the process needs careful consideration.

Area and population covered are very large and impact is quick. Depending upon the time of day, target population can be fairly selective. However, as in any educational activity, the efforts must be conscious to raise and keep the awareness among recipient population.

(2) Advert

Another form of environmental education for using mass media is the advert type of PR activities. Using electronic media like TV, radio, SNS, and SMS, various types of environmental information can be disseminated. Billboards or advertisement space in buildings, public transportation like bus or "tuku-tuku" can also effectively disseminate environmental message to the general public at large.

The message can be spread quickly and widely. Pictorials can be utilised for visually sending out the message at ease.

Advert does not have to be continuous and can be used in the specific period, like just before the day of awareness raising champagne.

4.1.4 Periodical Environmental Events (such as Earth Day)

Environmental education also can be carried out at the time of periodical event. Earth Day which is held annually is a good example. Alternatively, GWMC can also establish and host some periodic events like SWM day/week, or utilise awareness raising activities in another event.

(1) Periodical Environmental Events

In this case, target population is not necessarily limited to school students or certain group, but also general public can raise their awareness on environment. Participants of the Earth day event are, naturally, environmentally conscious and thus it is easier to spread the message across.

During the event, GWMC can set up a booth to disseminate various information regarding solid waste management, recycling, 3R, composting, and others. Also it can provide hands on experience opportunity for the participants; for example, participants can separate wastes by types.

GWMC can also host a certain event, like SWM week whereby various stakeholders gather and raise awareness of the public.

(2) Public Gatherings not related to Environment

Educational opportunities are laid in other non-environmentally related events. For instance, religious event or festivals like Eid-ul-fitr day or Eid ul-Azha day would attract unspecified number of residents to gather in which environmental education can be carried out through the use of

printed materials like brochure/flyer distribution or let public experience actual environmental conscious activities like separation of waste.

4.2 Evaluation of Alternatives to the Environmental Education and Public Awareness Raising Plan

4.2.1 Formal Education

(1) Primary

SWM education should be a part of a larger integrated environmental education programme that requires in-depth consideration and coordination with relevant bodies including authority. Important impact can be expected but requires understanding of the society for not only about solid waste but also for other elements of environment.

(2) Higher Education

Environmental programmes have already existed in selected colleges/universities. Students have learnt the subject in-depth, but the number of residents who enrolled in the programme is, inevitably, very limited.

4.2.2 Informal Education

(1) Schools

If the awareness of small children is successfully raised in primary schools, the impact can spread to his/her households and be fruitful on the long-term since those children would lead the society in the future and thus influence the entire community.

It is also easier for GWMC to introduce environmental education on SWM to small children than going through formal education since GWMC can entirely host the programme.

(2) Social Groups

Various community groups exist in Gujranwala from town level to union council level. They are, in general, rooted on the local community and thus hold important impacts on their community members. There are a numerous number of such groups and interest in environmental issues also varies. Those social groups may be good entry point to community.

(3) Agency/Business Establishments

Governmental agency should play a leading role in proper solid waste management in Gujranwala. Consensus must be reached within all governmental bodies.

Business establishment can also influence the SWM activities in the city, but types, volume, and frequency of waste differs greatly depending upon the business type.

4.2.3 Environmental Education using Mass Media

(1) Structured Programme

Creating a structured programme for environmental education in mass media can expect immediate and huge impacts to population across the city. Nonetheless, the cost is extremely high and the impact may well be eroded away as quickly as it reaches the population. There is a need to come up continuously with such huge cost in order to sustain a realistic and proper environmental education.

(2) Advert

Advert type of mass media can be very useful in spreading message quickly and widely. It should be used for publicity purpose only and not for continuous awareness raising media.

4.2.4 Periodical Environmental Events (such as Earth Day)

(1) Periodical Environmental Events and Public Gatherings not related to Environment

Periodical environmental events can reach a wide range of population at one time. By consciously holding the same event or campaign, the message would be imbedded to the residents. エラー! 参照元が見つかりません。 gives a summary of the alternatives.

Table E.4.1 Comparison of Alternatives of Environmental Education and Public Awareness Raising Activities

Options		Target	Recipient Number	Impact	Remarks
1) Formal	a) Primary	Small kids	Limited, but covers all students	Long-term	Influence in household as well
	b) Higher education	Young adults	Limited	Long-term	Specialists
2) Informal	a) School	Small kids	Limited, but covers good portion of students	Long-term	Influence in household as well
	b) Social	All member of society	Large	Long-term	Requires understanding from all parties
	c) Agency / business	Staff/ employees	Limited to specific body	Short-long term	
3) Mass media	a) Structured	General public	Large	Quick	Expensive
	b) Advert	General public	Large	Quick	Affordable if limited duration
4) Periodical event	a) Periodical	General public	Large	Short-long term	Participants are environmentally conscious
	b) Public gatherings	General public	large	Short – long term	Can reach non-environmentally conscious people

4.2.5 Conclusion

Each option has its own unique characteristics. A summary of each option is as follows:

- Formal education is a solid way but requires extensive consideration and coordination with all parties involved.
- Informal education, on the other hand, can be carried out relatively easily since GWMC can control the content and activities on its own.
- Mass media have huge impact but requires large amount of fund to be effective in long term; therefore, it should be limited to advert type of utilisation.
- Periodical event, like Earth Day, can be an excellent opportunity to reach general population.

4.3 Identification of Project Components for Environmental Education and Public Awareness Raising Plan

In identifying the project components for environmental education and awareness raising, a) target, b) impact, and how easily the activities can be carried out by GWMC were considered. Ideally an activity can reach all population in the city with long lasting impact at minimum cost. This is important because this activity is a type of component that cannot expect immediate effect or sudden change in people's behaviour.

Therefore, there are mainly two projects to proceed; specifically, one is informal education in schools targeting primary students, and the other is periodical events targeting general population. Following is the approximate schedule for each activity.

4.3.1 Informal Education in Schools

There are approximately 161,000 students in 273 public and 437 private schools in Gujranwala. Among them, class 4 students are approximately 21,000. (Class 4 is picked since it consists of about 10 years old children who are old enough to understand the importance of environmental education and to think how to digest the knowledge and information received and put them into practice.)

In order to cover all class 4 students in the city by the end of 2030, the following targets were set.

Table E.4.2 Target of Students Covered by Informal Education in Schools by Terms

	Short-Term (~ 2018)	Mid-Term (~2024)	Long-Term (~2030)
Target	Approx. 15%	Approx. 60%	100%
Number of Students	3,000	12,000	21,300

(1) Components of Informal Education Programmes

In informal education in schools, there are two approaches GWMC can take to reach the students. One of them is to deliver the programme to the schools, and the other one is to receive students at appropriate facility to teach and let them experience in practice.

In the short term (2016–2018), informal education should be focused on delivery of lectures in each school in order to build bases for understanding the importance of proper waste management. In the delivery programme, a team of GWMC communication unit can visit each school and hold a session targeting Class 4 students of that school. Topic should include: a) general information about solid waste; b) current status of SWM in the city; c) what can be done and their effects; and d) other related topics.

In the environmental facility side which can be implemented in mid-term plan, GWMC can establish a facility to accept visitors from schools. The facility can be first set up within the city where schools can easily access but later on can be set up in landfill site where student can observe the actual condition of SWM.

In order to realise the above, the following components are necessary:

- Establishment of communication unit
- Establishment of SWM environmental education facility
- Development of materials for trainers (teachers) and for students
- Develop and implement Pilot Project for environmental education at schools

(a) Establishment of Communication Unit

Volume of work is expected to be carried out by the communication team; therefore, a number of new staff should be newly recruited in addition to the current manager and assistant manager of communication. Main responsibility of the communication unit include, a) coordination among relative bodies, b) preparation of training materials for trainers/trainees, c) lecture to the students, and d) management of environment facility.

A team of five (5) members with two (2) drivers can start the programme in the short-term period, and gradually increasing these members as target students grow. **Table E.4.3** shows a summary of number of students and communication team members in the school programme.

Table E.4.3 Relationship between Number of Visiting Schools and Communication Members (Year 2016-2030)

Term/Year	Short-Term			Mid-Term						Long-Term					
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Schools	50	70	100	100	200	200	300	300	400	400	500	500	600	600	710
Number of Students	1,500	2,100	3,000	3,000	6,000	6,000	9,000	9,000	12,000	12,000	15,000	15,000	18,000	18,000	21,300
Staff (No.)	7	7	7	7	7	8	21	21	21	21	22	22	28	28	28

(b) Establishment of Environmental Facility

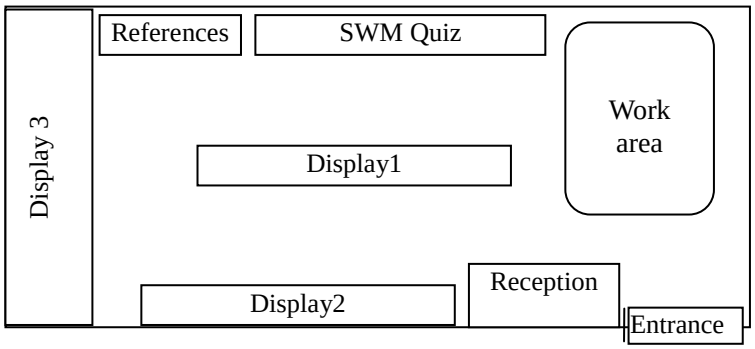
In Gujranwala, schools commonly organize field trips for either recreational or orientations purpose and visit historical monuments or museums. During this field trip, students can visit the environmental education facility to learn about solid waste management, through displays, materials, observation, or hands-on experience. Examples of these contents would include: a) a display showing waste flows in Gujranwala, b) actual waste and recyclable materials and how they are treated, and c) experience in separating recyclables through games.

The communication team needs to come up with those display or materials interesting enough for students.

Number of schools (students) that visit and GWMC staff who manage the facility can be shared with: i) the above, meaning some schools targeted for the delivery programme can actually visit the environmental facility and one of the five (5) communication team members can manage this facility.

The facility does not have to limit its usage to school students but also open to the general public. This would help PR the GWMC's work to the public.

This environmental facility can be established in mid-term, or in 2012, of the Master Plan to support the informal education program in schools as well as general public. Before opening up this facility, a) careful design, b) developing materials and guidelines similar to school program, and c) operation/coordination plan should be prepared.



Display 1 (front): Current condition & waste flow of SWM in Gujranwala, including introduction of GWMC.
Display 2: Recyclable items, recycling flow, how to segregate, information about composting, etc.
Display 3: (Touchable) display of actual items, such as recycling bins, recyclable wastes, recycled products, other waste, compost, waste collection gears/equipment, etc.
References: Reading materials, brochures, etc.
Display 1 (back): Effects on health, ecosystem, and others.
SWM quiz: quiz about SWM, what has been learnt from this room, etc.
Work area: Various activity can be done, for example, set up a table and let visitor make wind fan out of used PET bottles, or art work using waste papers.

Figure E.4.1 Sample Layout of Environmental Facility

(c) Development of Materials for Lecturer (GWMC Staff)

In order to facilitate the above components, GWMC has to develop the following materials:

- A detailed action plan to implement the activities;

- Materials to be used in the programme; and
- Guidelines (or lecture syllabus) to be used in a) coordinating with other entities and b) lecturing in school and environment facility.

These materials should be carefully developed to not only disseminate information about SWM in Gujranwala but also to help the recipient think about how waste is related to his life. For instance, the manner to separate recyclables from the waste stream in a household is good information itself, but can be much more meaningful if the method on which recycling could help conserve the environment or what would be the impact if thrown away into the environment were known.

The materials need to be developed by GWMC in the first period or within the short-term period (2016-2018), but needs to be regularly updated.

Proposed content of the manual is as follows.

	Contents
Chapter 1	Introduction
Chapter 2	Planning the program a) Setting up clear objectives (What is the objective of the program? E.g. Make students understand the relationship between their life and waste) b) Conceptualisations (For what the program will be implemented, with what kind of idea?) c) Brainstorming
Chapter 3	Designing the program a) 5W1H (Clarify why, what, where, who/whom, how/how much.) b) 3 points when designing a program (concreate goal, correct sequence of activities, and continuity of the activities) c) Opening the session (how to catch attention from students is very important) d) Formation of staff (how to arrange staff in a classroom or how to coordinate among staff is very important) e) Talking to the student (concept, concentration, and communication are key for successful discussion) f) Review (review within the session to let student absorb the program) g) Evaluation (how to evaluate the session/program)

(d) Pilot Project for Schools

In order to introduce informal education in schools and use the materials/plan developed in items (i) to (iii) above, GWMC should start targeting certain areas and implement the programme as a pilot project.

The programme should target a certain town in the action plan and then gradually widen the target area. In this way, it will be easier to manage the programme and impacts may be more visible than targeting the entire city from the beginning.

In order to realise these activities, communication team needs to come up with proper materials, syllabus or training materials for GWMC's trainers, coordination mechanisms, as well as means of transportation.

(2) Cost of Implementation of the Informal Education Programme

Approximate costs for environmental programme in schools are summarised in **Table E.4.4** for short-term, and **Table E.4.5** for mid- and long-term.

In the short-term plan, 50 schools will be targeted in the first year, and 70 schools and 100 schools in the second and third year, respectively. Some printed materials are expected to be produced and distributed (used) in the lecture. Staff in the table includes the technical staff that would go out and give lectures and 2 drivers. The two (2) drivers are necessary since there is a need to secure

transportation for GWMC staff to take all the materials to the schools. Two new vehicles in the first year are needed and expected to be used in the following 10 years.

Table E.4.4 Approximate Costs for the Short-Term Plan (Year 2016-2018)

Term/Year	Short-Term		
	2016	2017	2018
Number of Schools	70	80	100
Number of Students	2,100	2,400	3,000
PR/Educational Materials (Total)	596,830	114,755	136,281
Miscellaneous	410,000	440,000	500,000
Staff	1,752,000	1,828,800	1,905,600
Vehicle	1,250,000	0	0
Vehicle maintenance	80,000	80,000	80,000
Venue/Advert	15,200	15,200	15,200
Other	150,000	0	0
Total Expenditure	4,254,030	2,478,755	2,637,081

Printed materials and number of staff increase as the target school increases. In addition to the short-term cost is the cost for the environmental facility from the 5th year (2021) and the new and repaired vehicles in 2022, 2026 and 2028.

Table E.4.5 Approximate Cost for Mid and Long-Term Plans (Year 2019-2030)

Term/Year	Mid-Term						Long-Term					
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of expected participants	3,000	6,000	6,000	9,000	9,000	12,000	12,000	15,000	15,000	18,000	18,000	21,300
Target number of households	2,047	2,302	2,558	5,116	7,675	10,233	12,791	15,349	17,907	2,047	23,024	25,582
Number of campaigns	3	3	3	3	3	3	4	4	4	4	4	4
PR/Educational Materials (Total)	968,607	836,933	851,259	1,902,518	1,545,777	2,061,036	2,560,295	2,539,554	2,682,813	2,630,607	3,305,332	3,818,191
Venue/advert	22,800	22,800	122,800	122,800	122,800	122,800	130,400	230,400	230,400	230,400	230,400	230,400
Miscellaneous	750,000	1,200,000	1,200,000	1,650,000	1,650,000	2,100,000	2,200,000	2,650,000	2,650,000	3,100,000	3,100,000	3,595,000
Staff	1,982,400	2,059,200	2,160,480	3,601,760	3,810,240	4,018,720	4,227,200	4,476,480	4,759,930	5,283,440	6,913,770	8,645,380
Social Survey	0	1,375,000	0	0	0	0	1,375,000	0	0	0	0	1,375,000
Other	80,000	80,000	80,000	705,000	80,000	80,000	80,000	1,480,000	80,000	705,000	80,000	80,000
Total expenditure	3,803,807	5,573,933	4,414,539	7,982,078	7,208,817	8,382,556	10,572,895	11,376,434	10,403,143	11,949,447	13,629,502	17,743,971

4.3.2 Periodical Events (such as Earth Day)

There has been some awareness raising for activities in the environmental field in Gujranwala. In such events, many different activities could help sensitise the public by, for example, distributing flyers/brochures, gathering at a park, and so on.

In addition, GWMC can carry out SWM day (or week) at certain times of the day, just like the awareness raising activity carried out in May 2014. This type of activity can target a large number of the general public and by periodically and repeatedly sending out the same message again and again until they become well aware of the consequences of unattended waste.

(1) Components of the Event

In periodical events, both in environmental events such as Earth day and non-environmental day such as Eid-ul-Fitr day or SWM day, GWMC can approach the general public in various ways. Components of this plan could be the following:

- Development of coordination plan for relevant bodies.
- Development of materials.

- Development of activity plan for periodic event.

(a) Development of Coordination Plan for Relevant Bodies

Earth day events involve many people; therefore, close coordination is necessary to successfully disseminate GWMC's message to the public. This would include not only the organizer of the event per se, but also the various media since this event is one of the key to let the public know the involvement of GWMC.

(b) Development of Materials

The Communication Unit has to develop materials to be used during the periodical event. Topics should be similar to those of informal education in schools, aside from the information on how GWMC is working on solid waste management in the city. Example of educational booklet can be seen in **Figure E**.4.3.

Educational Booklet (sample)
Table of Contents

1. **What is Solid Waste?**
2. **Solid Waste and our lives**
3. **What can you do?**
4. **What is GWMC and their role?**
5. **How can you apply 3R on yourself?**
6. **Ways to contact GWMC**

Figure E.4.2 Contents of Educational Material (sample)

(c) Development of Activity Plan for Periodic Event

Activity plans include the planning stage up to actual content, evaluation, and review. The planning stage includes procedure and to whom the communication unit has to coordinate, while actual contents may include what and how to distribute the printed materials and how to attract the general public to participate in the GWMC work. The topic may be a) the current SWM condition in the city, b) GWMC's progress in SWM, and c) how to separate or practical advice for waste management.

(2) Cost of Implementation of the Event

Approximate cost for short term periodical events is shown in **Table E.4.6**. This cost includes the printing of materials for distribution to the participants. Venue/advert is the cost for the specific venues if needed and advert cost for the event. This advert is assumed to be held for some electronic media like radio, SNS (Social Networking Service), and SMS (Short Message Service), as well as posters and advertisement space in public transportation. Any additional cost, such as cost involved in setting up a tent, if needed, should be covered by "miscellaneous" cost.

Table E.4.6 Approximate Cost for Short-Term Periodical Events (2016–2018)

	Short-Term		
	2016	2017	2018
Target number of household (Rs.)	1,279	1,535	1,791
number of campaigns (Rs.)	2	2	2
Print material total (Rs.)	71,630	85,955	100,281
Venue/advert (Rs.)	15,200	15,200	15,200
Miscellaneous (Rs.)	200,000	200,000	200,000
Total expenditure (Rs.)	286,830	301,155	315,481

Approximate cost for the mid- and long-term plan is shown in **Table E.4.7**. Number of expected participants and target households were derived from the current estimated number of households in Gujranwala, which are 255,819. In this calculation, 10% of households are expected to be a part of this effort by the end of the long-term plan (the year 2030).

Table E.4.7 Approximate Cost for Periodical Events in the Mid and Long-Term Plans (2019–2030)

Term/Year	Mid-Term						Long-Term					
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Target number of household	2,047	2,302	2,558	5,116	7,675	10,233	12,791	15,349	17,907	2,047	23,024	25,582
Number of campaigns	3	3	3	3	3	3	4	4	4	4	4	4
Print material-total (Rs.)	114,607	128,933	143,259	286,518	429,777	573,036	716,295	859,554	1,002,813	114,607	1,289,332	1,432,591
Venue/advert (Rs.)	22,800	22,800	22,800	22,800	22,800	22,800	30,400	30,400	30,400	30,400	30,400	30,400
Miscellaneous (Rs.)	300,000	300,000	300,000	300,000	300,000	300,000	400,000	400,000	400,000	400,000	400,000	400,000
Staff - skilled (Rs.)	0	0	0	140,000	151,200	162,400	173,600	184,800	199,570	214,340	229,110	243,880
Total expenditure (Rs.)	437,407	451,733	466,059	749,318	903,777	1,058,236	1,320,295	1,474,754	1,632,783	759,347	1,948,842	2,106,871

4.3.3 Total Project Cost for the Implementation of Environmental Education and Public Awareness Raising Plan

Based on the above, the total project cost of Environmental Education and Public Awareness Raising Plan between 2016 and 2030 is estimated at approximately Rs. 65 million and as summarised in **Table E**.4.8.

Table E.4.8 Project Cost for the Implementation of Environmental Education and Public Awareness Raising Plan

Unit: thousand Rs.

Term/Year	Short-Term			Mid-Term						Long-Term						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Informal Education	3,967	2,178	2,322	3,366	3,747	3,948	7,233	6,305	7,324	7,878	9,902	8,770	11,190	11,681	14,262	104,073
Periodical Events	287	301	315	437	452	466	749	904	1,058	1,320	1,475	1,633	759	1,949	2,107	14,213
Social Survey	0	0	0	0	1,375	0	0	0	0	1,375	0	0	0	0	1,375	4,125
Total	**4,254**	**2,479**	**2,637**	**3,804**	**5,574**	**4,415**	**7,982**	**7,209**	**8,383**	**10,573**	**11,376**	**10,403**	**11,949**	**13,630**	**17,744**	**122,411**

Note: Totals may not always be equal to the sum of the subjected column or row due to rounding off.

4.4 Implementation Schedule of Environmental Education and Public Awareness Raising Plan

The implementation schedule of the Environmental Education and Public Awareness Raising Plan is illustrated in **Figure E.4.3**.

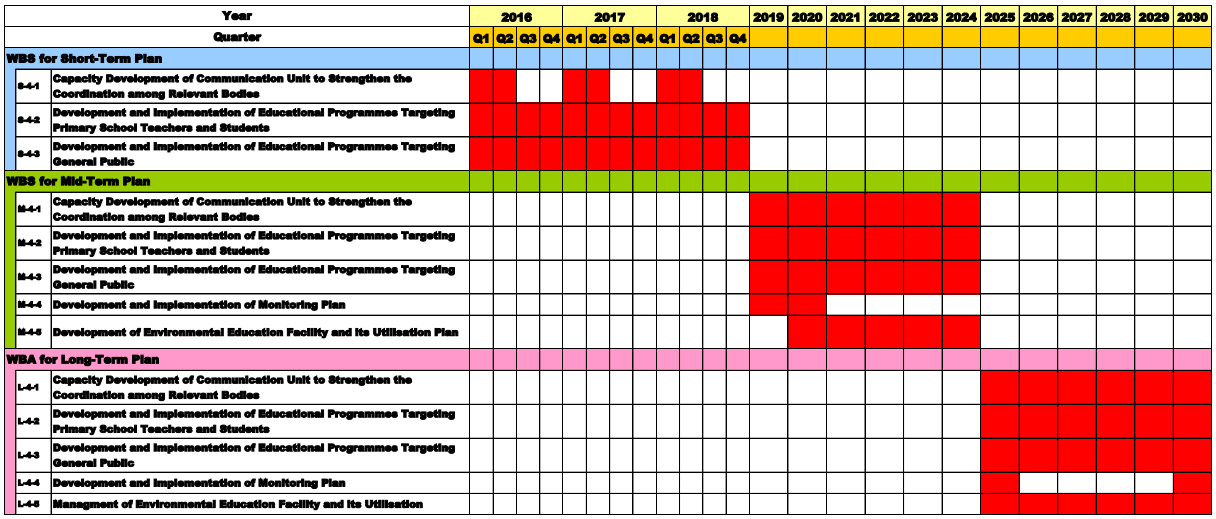


Figure E.4.3 Implementation Schedule of the Environmental Education and Public Awareness Raising Plan

4.5 Project Cost of Environmental Education and Public Awareness Raising Plan

Table E.4.10 shows the project cost for the Master Plan and **Figure E.4.4** shows the Project Cost and Responsibility under the Education and Public Awareness Raising Plan.

Table E.4.9 Implementation Cost of the Environmental Education and Public Awareness Raising Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 4: Environmental Education and Public Awarenss Raising Plan																	
Short-Term Plan																	
S-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies	6,736	3,002	1,829	1,906												
S-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students	1,730	965	349	416												
S-4-3	Development and Implementation of Educational Programmes Targeting General Public	903	287	301	315												
	Sub-Total	9,370	4,254	2,479	2,637												
Mid-Term Plan																	
M-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies	18,738				2,062	2,139	2,240	4,307	3,890	4,099						
M-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students	13,240				1,304	1,608	1,608	2,966	2,466	3,288						
M-4-3	Development and Implementation of Educational Programmes Targeting General Public	3,613				437	452	466	609	753	896						
M-4-4	Development and Implementation of Monitoring Plan	1,375				0	1,375	0	0	0	0						
M-4-5	Development of Environmental Education Facility and Its Utilisation Plan	400				0	0	100	100	100	100						
	Sub-Total	37,366				3,804	5,574	4,415	7,982	7,209	8,383						
Long-Term Plan																	
L-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies	36,661										4,307	5,806	4,840	5,988	6,994	8,725
L-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students	27,167										3,644	4,080	3,930	5,216	4,716	5,581
L-4-3	Development and Implementation of Educational Programmes Targeting General Public	7,998										1,147	1,290	1,433	545	1,720	1,863
L-4-4	Development and Implementation of Monitoring Plan	2,750										1,375	0	0	0	0	1,375
L-4-5	Managment of Environmental Education Facility and Its Utilisation	1,100										100	200	200	200	200	200
	Sub-Total	75,675										10,573	11,376	10,403	11,949	13,630	17,744
	Grand Total	122,410	4,254	2,479	2,637	3,804	5,574	4,415	7,982	7,209	8,383	10,573	11,376	10,403	11,949	13,630	17,744

Programme No.	WBS No.	WBS	Legal Action (Required=●)	Name of Act/Regulation/By-law	Budgetary Arrangment (Required=●)	Total Budget (Thousand Rs.)	Responsibility Assignment Matrix: M=Main Responsibility, S=Sub Responsibilities. B=Budgetary Arrangement, L=Legal Action, P=Participation in Discussions																
							GWMC/Operation Unit	GWMC/P&C Unit	GWMC/Financial Unit	GWMC/HR & Administration Unit	City District Government Gujranwala (CDGG)	The Urban Unit, Government of the Punjab	P&D Dept., Government of the Punjab	Local Gov't Dept., Government of the Punjab	Environment Protection Department (EPD)	Donor Organisations	Private Contractors/Consultant	Recyclers	CBOs & NGOs	Waste Pickers	PAPs around Gondlanwala Disposal Site	PAPs around Bhaktrywali Disposal Site	Gujranwala Citizens
Programme 4: Environmental Education and Public Awareness Raising Plan																							
Short-Term Plan																							
	S-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies			●	6,736	M	B															
	S-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and			●	1,730	M	B			P	S		P	P								
	S-4-3	Development and Implementation of Educational Programmes Targeting General Public			●	903	M	B			P	S		P	P								
		Sub-Total				9,370																	
Mid-Term Plan																							
	M-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies			●	18,738	M	B															
	M-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and			●	13,240	M				P	S		P	P								
	M-4-3	Development and Implementation of Educational Programmes Targeting General Public			●	3,613	M	B			P	S		P	P								
	M-4-4	Development and Implementation of Monitoring Plan			●	1,375	M	B				S					S						
	M-4-5	Development of Environmental Education Facility and its Utilization Plan			●	400	M	B			P	S											
		Sub-Total				37,366																	
Long-Term Plan																							
	L-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies			●	36,661	M	B															
	L-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and			●	27,167	M				P	S		P	P	P							
	L-4-3	Development and Implementation of Educational Programmes Targeting General Public			●	7,998	M				P	S		P	P								
	L-4-4	Development and Implementation of Monitoring Plan			●	2,750	M					S					S						
	L-4-5	Managment of Environmental Education Facility and its Utilization			●	1,100	M	B			P	S											
		Sub-Total				75,675																	
		Grand Total				122,410																	

Figure E.4.4 Project Cost and Responsibility under Environmental Education and Public Awareness Raising Plan

5. PROPOSAL FOR THE ACTION PLAN

5.1 Selection of the Priority Project

The priority projects are defined as projects for the short-term period of the Master Plan which will be developed to the action plans in this chapter. Based on the detail discussions described in previous **Chapter 4,** the following projects are thus selected as the priority projects:

1. Project for Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies
2. Project for Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students to Enhance Knowledge/Awareness on SWM and 3R Promotion
3. Project for Development and Implementation of Educational Programmes Targeting General Public to Enhance Knowledge/Awareness on SWM and 3R Promotion

5.2 Project for Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies

The Communication Unit will be the focal point of GWMC when it comes to public relations. This unit will serves as the information dissemination point and where the general public can make inquiries about solid waste management in GWMC. The Unit will work closely with the Waste Managers of GWMC.

The Communication Unit should be composed of eight (8) staff of GWMC; namely, one (1) Senior/Manager Communication; one (1) Assistant/Deputy Manager Public Relations; one (1) Assistant/Deputy Manager Environmental Education, and a team of five (5) officers for field operations with diploma as environmentalist, sociologist or public health. It should be noted, however, that the staff in this unit should not only have environmental/hygienic background but also have good people's skill. The team of field officers should be increased as activity areas expand in the future.

As mentioned above, the Communication Unit is the unit which goes out from the GWMC office and disseminates various types of information, i.e., implementing body of environmental communication. In the short-term period, the Unit will implement environmental education programmes in elementary schools targeting small children and their teachers, and environmental programmes targeting the general public in periodical events. In order to mobilise this, the Unit will need vehicles and subsequent drivers. **Table E.5.1** below shows the estimated salary cost for the Communication Unit for this period.

Table E.5.1 Estimated Salary for Newly Staff for Communication Unit in Short Team Period

Unit: Rs./yr

Position	2016	2017	2018
Filed officers (4)*	960,000	1,036,800	1,113,600
Drivers (2)	792,000	792,000	792,000
Total	1,752,000	1,828,800	1,905,600

Note) One of current waste manager will lead the team; therefore, first new recruit will be 4.

An important role of the Communication Unit is to coordinate the programme with relevant bodies. In the school programme, for example, the Unit needs to coordinate not only with target schools but also all the authorities concerned. Likewise, the coordination in implementing the environmental programmes targeting the general public requires careful coordination with community groups, labour union, NGOs for collaboration efforts, TV / radio stations or various advertising media on bus or street billboards, etc., for publicity purpose, and editors and printing companies for preparing these materials to be used in the programmes. In order to facilitate these, the Unit must develop a list of contact information and mechanisms to maintain and update the list.

5.3 Project for Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students

Following activities are proposed: i) development of manuals for environmental education programme in schools, ii) development of educational materials for the school programme, iii) selection of target schools, and iv) implementation of the environmental education programmes at schools. Explanation of each activity is presented below.

5.3.1 Development of Manuals for Environmental Education Programme in Schools

It is proposed to develop manuals for the environmental education programme in schools. This manual will be used by the field personnel who go out and give lectures to the elementary students and teachers. The contents of the manual shall include a) purpose of the manual and objective of the programme, b) planning the programme, c) carrying out the programme, and d) reference data.

The manual should be written in a way that the Communication Unit staff can learn how to develop or modify an attractive programme for elementary schools and carry out lectures attractive to the students. It should also include background information on proper SWM practices or 3R, so that the staff can easily find the right information. The manual should be prepared by the Waste Managers led by the Communication Unit.

5.3.2 Development of Educational Materials for the School Programme

It is proposed to produce a short video clip, explaining the overall SWM and 3R efforts in Gujranwala. The production of the video should be entrusted to a production company specialising in PR material production under the supervision of the Communication Unit. The video should cover the current SWM in Gujranwala and the issues to be solved.

Besides the video clip, a printed material should be developed to be used and distributed during the programme. The contents of the printed material should include proper SWM practices and promotion of 3R. Topics should be dealt from the viewpoint of everyday life of target students/teachers. For the Short-Term Period, a total of 75,000 copies will be necessary. Example of educational material is shown in **Figures E.5.1 and E.5.2**.

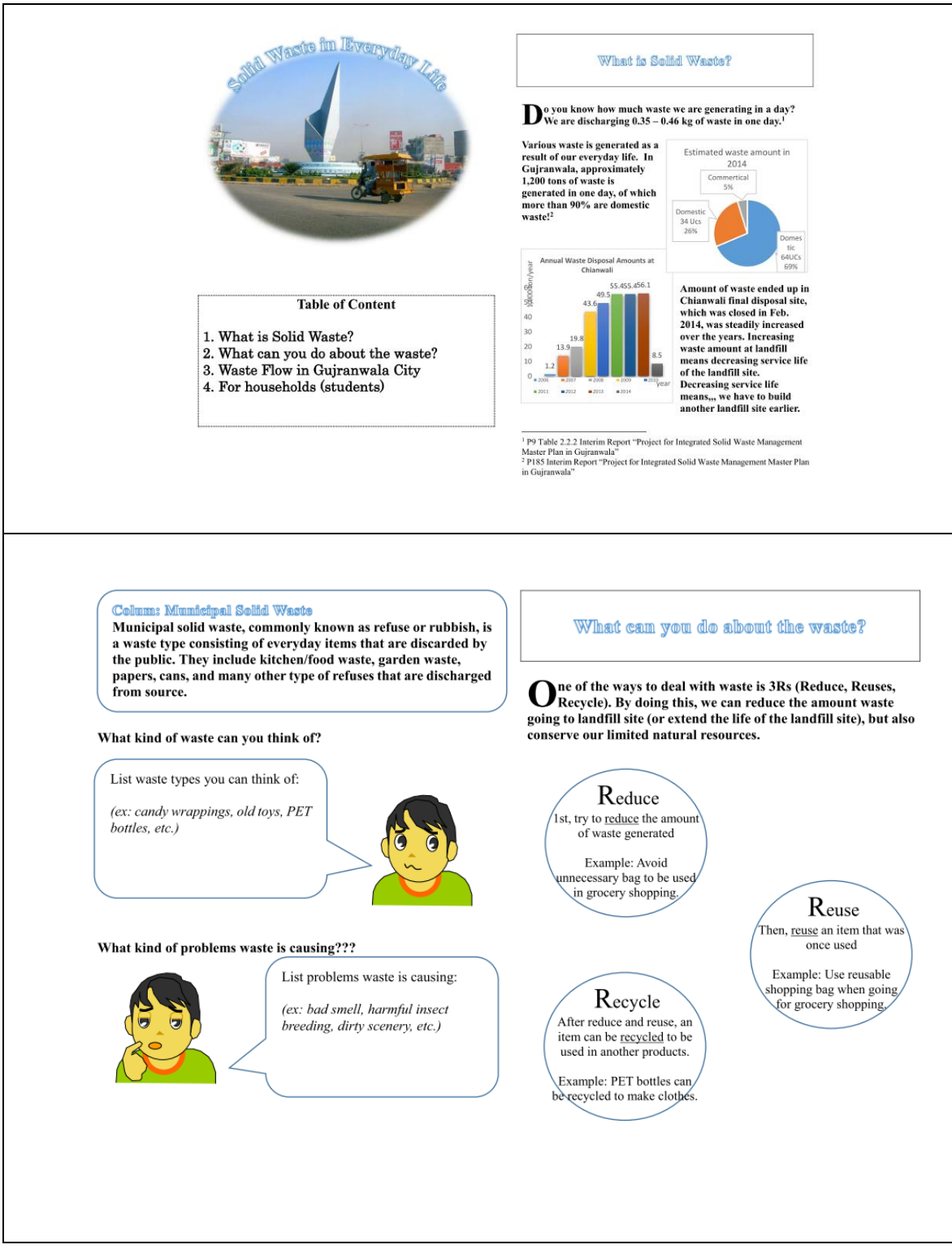


Figure E.5.1 Example of Educational Material for Schools (1/2)

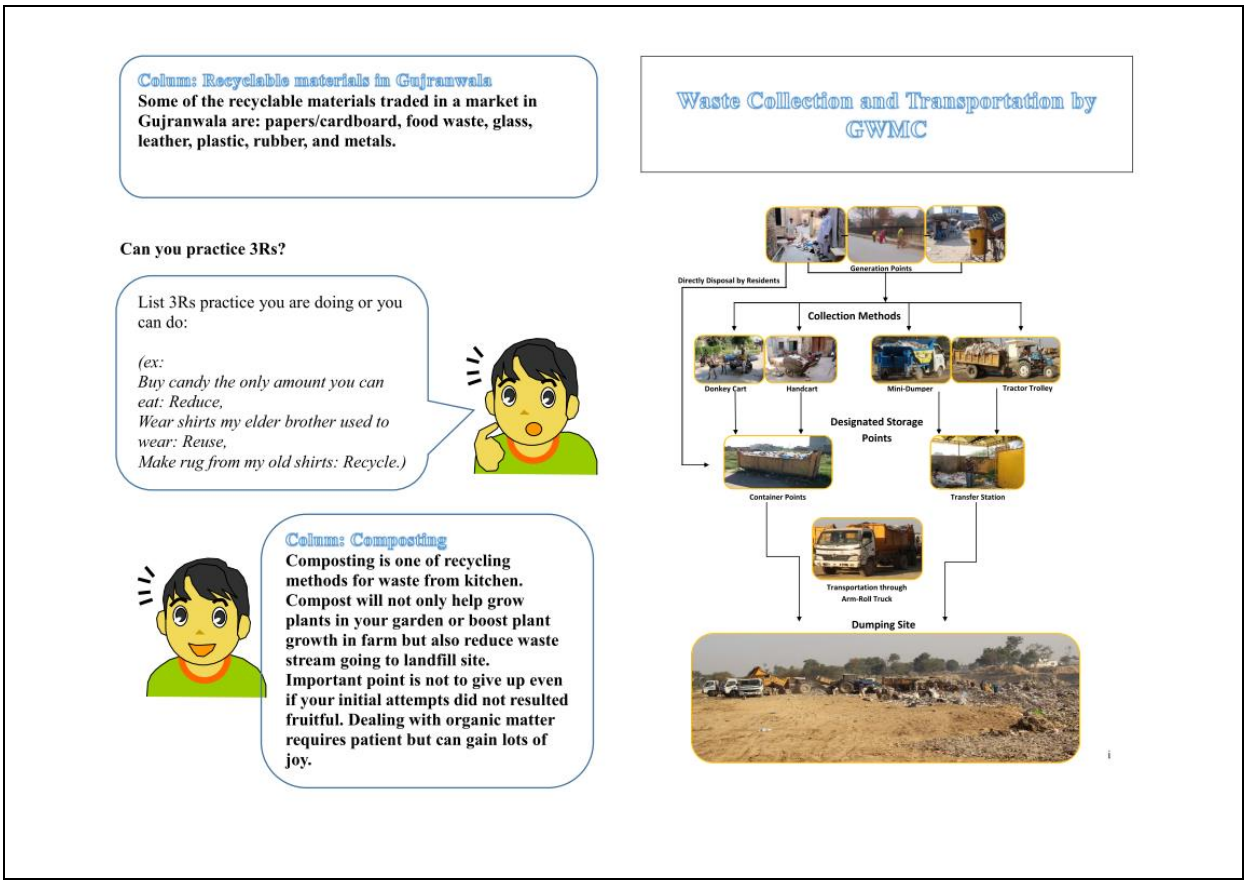


Figure E.5.2 Example of Educational Material for Schools (2/2)

5.3.3 Selection of Target Schools

The Communication Unit should select a target area or UC to implement the school environmental education programme. The area should preferably be coincided with other programmes, such as, the separate collection pilot project in Zone 6, to implement the programme effectively.

Firstly, all public and private elementary schools in the area should be listed, together with the number of students and contact information. Secondly, target schools should be selected in consideration of the number of students and the degree of cooperativeness of the schools. Then with careful coordination with school representatives, a schedule to visit is planned. The number of expected target schools and students for the Short-Term Period is as shown below. (**Table E.5.2**)

In this program, class 4 students will be targeted since class 4 students are mainly composed of 10 years old children who are, in general, old enough to understand the importance of proper SWM and can think and act on their own. These children can also give influence in their family's behaviour in their households, thus have large and long term impact.

Table E.5.2 Number of Schools and Students targeted for the Environmental Education Programme in the Short-Term Period

Year	2016	2017	2018
Number of Schools	70	80	100
Number of Students	2,100	2,400	3,000

5.3.4 Implementation of the Environmental Education Programme at Schools

Based on the list of schools and schedule of the programme developed in **Item (3)** above, coordination with the school principal or teacher in charge prior to implementation of the programme is indispensable to confirm how will be carried out, including, but not limited to, size of room, availability of power and lights, space to display materials, etc. For example, depending upon the school condition, a large number of students may be given the programme in the same room, but later divided into 5 smaller groups for more detailed discussions. In general, it is more effective to have an environmental programme in smaller groups for better control and enough attention to each student and thus bring a more meaningful programme than in a large group.

5.4 Project for Development and Implementation of Educational Programmes Targeting General Public

Following activities are proposed: i) development of guideline for environmental education programmes for the general public, ii) development of educational materials, iii) development of schedule for public environmental education , and iv) implementation of the environmental education programmes for the public. Explanation of each activity is presented below.

5.4.1 Development of Guideline for Environmental Education Programmes for the General Public

A guideline for the environmental education programme for the general public is proposed to be developed. This guideline will be used by the field staff that go out and raise awareness among the public in periodical events like the Earth Day and Eid-ul-Fitr Day. The contents of the guideline shall include a) purpose of the guideline and objective of the programme, b) planning of the programme, c) carrying out of the programme, and d) references including data and contacts information about possible collaborating partners.

The programme should be written in a way that staff of the Communication Unit can plan how to develop or modify the programme to make it attractive to the general public. It should also include background information on proper SWM practices or 3R, so that the staff can easily find the right information. The target population is different from that of the school educational programme; therefore, broader viewpoints are necessary when developing this guideline. For instance, budget allocation and how they are used in GWMC operation is good information for adults who pay for his/her SWM. The manual should be prepared by the Waste Managers led by the Communication Unit.

5.4.2 Development of Educational Materials for the General Public

Some printed materials should be developed for use and distribution during implementation of the programme. Contents of the printed materials should include proper SWM practices and promotion of 3R, as well as information necessary to gain confidence among the general public on the GWMC's operation. Such information shall include budget allocation and how they are used in GWMC operations since it is vital information to gain confidence from the adults who pay for his/her SWM. For the Short-Term Period, a total of 5,000 copies will be necessary.

Besides the printed materials, some displays which show waste flow in Gujranwala or items which can be recycled should be prepared, along with actual recyclable or recycled materials so that the general public can touch and easily understand them.

5.4.3 Implementation of Environmental Education Programmes in Periodical Events

Based on the list of schools and schedule of the program developed in **Subsection 5.3.3** above, coordinate with school principle or teachers in charge prior to carry out the programme, to confirm how the programme will be carried out, including, but not limited to, size of a room, availability of power and lights, and space to display materials, etc. For example, depending upon a school condition, a large

number of students may be given a programme in the same room, but later divided into 5 smaller groups to have detailed discussions. In general, it is more effective to have an environmental program in smaller groups for better control and gives enough attentions to each student thus give more meaningful program than in large group.

In the implementation of the programme, close coordination should be made among the other relevant bodies listed in the guideline prepared in **Subsection 5.4.1** above. Coordination may include co-hosting awareness raising programmes activities. It can be worth considering to having support from local and influential leaders, such as religious leaders, head of labour union, and neighbourhood groups and alike. This gives the residents additional reasons why their cooperation in SWM makes sense.

5.5 Plan of Operations and Cost of Action Plan

Figure E.5.3 shows the Plan of Operations of Economic and Financial Plan (Short-Term) and **Table E.5.3** shows the Estimated Cost of the Economic and Financial Plan (Short-Term).

Time Framework of the Master Plan		Short-Term Plan Period											
Year		2016				2017				2018			
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WBS for Short-Term Plan													
S-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies												
S-4-1-1	Preparation of new staff recruitement												
S-4-1-2	Listing of all relevant bodies and formulation of mechanism to maintain/update the listing												
S-4-1-3	Procurement of new vehicle												
S-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students												
S-4-2-1	Development of manuals for environmental education program in schools												
S-4-2-2	Development of the educational materials for school program												
S-4-2-3	Selection of target schools												
S-4-2-4	Implementation of the environmental education programs at schools												
S-4-3	Development and Implementation of Educational Programmes Targeting General Public												
S-4-3-1	Development of guideline for environmental education programs for general public												
S-4-3-2	Development of the educational materials for general public												
S-4-3-3	Implementation of the environmental education programs in periodical events												

Figure E.5.3 Plan of Operations of the Environmental Education and Public Awareness Raising Plan (Short-Term)

Table E.5.3 Cost of Operations for Environmental Education and Public Awareness Raising Action Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost		
			2016	2017	2018
Programme 4: Environmental Education and Public Awareness Raising Plan					
Short-Term Plan					
S-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies	6,736	3,002	1,829	1,906
S-4-1-1	Preparation of new staff recruitement	5,486	1,752	1,829	1,906
S-4-1-2	Listing of all relevant bodies and formulation of mechanism to maintain/update the listing				
S-4-1-3	Procurement of new vehicle	1,250	1,250		
S-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students	1,730	965	349	416
S-4-2-1	Development of manuals for environmental education program in schools	740	675.2	28.8	36
S-4-2-2	Development of the educational materials for school program				
S-4-2-3	Selection of target schools				
S-4-2-4	Implementation of the environmental education programs at schools	990	290	320	380
S-4-3	Development and Implementation of Educational Programmes Targeting General Public	903	287	301	315
S-4-3-1	Development of guideline for environmental education programs for general public	258	72	86	100
S-4-3-2	Development of the educational materials for general public				
S-4-3-3	Implementation of the environmental education programs in periodical events	646	215	215	215
	Total (Short-Term)	9,370	798,662	614,600	92,363

6. CONCLUSION

6.1 Public Awareness Raising through Informal Education Program

Public awareness raising urges behavioural changes in people's life, so that it needs to be considered in a long term perspective. In addition, most cost effective ways need to be employed in penetrating the residents mind on the issues GWMC wish the residents to understand. For these reasons, the informal program targeting (1) Class 4 students, who are old enough to understand the importance of proper solid waste management, can think and act by themselves, have influence in each household, and can expect long term impacts;, and (2) the general public who are also active members and thus important constituent of society, should be developed.

6.2 Developing Capacity of GWMC Responsible for Public Awareness Raising

In order to realise the program above, adequate capacity is necessary for GWMC. Capacity in this case means both physical (GWMC staff would need to deal with mass population) and individual (GWMC staff needs ability to understand and carry out the program) capacities. GWMC should acquire enough number of staff, prepare materials/resources, and develop the capacity of individual staff through such activity as development of guidelines.

6.3 Implementation of the Environmental Education Program Targeting Small Children and General Public

Development of the program and capacity development of GWMC would be meaningless if the program is not implemented in real world. It should be noted in the implementation that the effort should start from small scale in the beginning to build up experiences and expanded gradually. In other words, the environmental education should begin with a limited number of Class 4 students and the general public in 2016, and reach all of the Class 4 students and approximately 10% of the population in Gujranwala by year 2030.

7. RECOMMENDATIONS

7.1 Securing the Budget for Establishment of the Communication Unit

To ensure proper implementation of environmental education, the Communication Unit with proper manpower and resources needs to be established. Also their activities are not ad hoc and one-time event, so that continuous commitment, or budgeting, is necessary.

7.2 Updating of Educational Materials/Program

Although key elements should remain the same, materials and/or strategies for probing public minds can be fine-tuned depending upon the results of (1) feedback from each session, or (2) awareness survey which is planned to be carried out in every 5 years. For example, recycling of tin cans maybe added in the educational material in addition to PET bottles if students express desire to learn about tin can recycling.

PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

DRAFT FINAL REPORT

VOLUME 2

SUPPORTING REPORT

SECTION F

ECONOMIC AND FINANCIAL ASPECT

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SECTION F

ECONOMIC AND FINANCIAL ASPECT

1. INTRODUCTION

Section F describes the in-depth analysis of the economic and financial aspect of the Chapter 2, Chapter 3, Chapter 4 and Chapter 6 of the main report. The economic and financial aspect includes the description and evaluation of the current condition, the planning direction of the economic and financial plan, the formulation of the economic and financial plan together with the economic and financial evaluation, and the formulation of the action plans.

2. DESCRIPTION AND EVALUATION OF CURRENT CONDITION

2.1 Demographic Situation

As indicated in **Table F.2.1**, the estimated population of 64 Urban UCs of Gujranwala City is approximately 1.56 million as of 2012 and 1.65 million as of 2014. The estimation in 2014 is based on the latest population growth rate of 2.6 percent per annum applied to *"Situation Analysis of SWM Services in Gujranwala City"* conducted in 2012. Due to the rapid growth rate of population, the population density is higher as compared to the whole Punjab.

Table F.2.1 Town-Wise Population in Project-Related Town in Gujranwala

Town	No. of Urban UCs	Estimated Population for Year 2012	Estimated Population for Year 2014	Area (km^2)	Estimated Population Density for Year 2014 (1000 persons per km^2)
Nandi Pur Town	15	379,980	400,000	12.2	32.8
Khiali Shah Pur Town	13	339,930	357,840	19.8	18.1
Aroop Town	17	426,920	449,410	23.4	19.2
Qila Dedar Singh Town	19	417,680	439,680	9.6	45.8
Total	64	1,564,510	1,646,930	65.0	25.3

Note: Estimated from Socio-economic and Demographic Profile, 1998-2008 and Situation Analysis of SWM Services in Gujranwala City, 2012

2.2 Economic Situation

Gujranwala is one of the major industrial cities of Punjab, thereby contributing to the economy of Pakistan. Being an industrial city, it has a variety of manufacturers in industrial machinery, fan industry, motor pumps industry, washing machine industry, electric goods, poultry feed, soap, ballpoint, rubber tube, metal utensils, melamine utensils, cutlery, kitchenware, ceramic tiles, sanitary wares, sanitary fittings, agriculture implements, woollen textiles, steel pipe industries, etc.

The estimated and forecast of percentage of population by economic category and the industrial profiles are as indicated in **Table F.2.2** and **Table F.2.3**, respectively.

Table F.2.2 Estimated and Forecast Percentage of Population by Economic Category in Gujranwala

(Unit: %)

Category			1998	2005	2008	2010	2015
1=2+3		Economically Active	21.64	23.33	24.09	24.60	25.92
2		Employed	16.39	17.68	18.25	18.64	19.64
3		Unemployed	5.24	5.65	5.84	5.96	6.28
4=5+6+7+8		Economically Inactive	78.36	76.67	75.91	75.40	74.08
5		Children under 10 years old	27.52	26.93	26.66	26.48	26.02
6		Students	9.74	9.53	9.43	9.37	9.20
7		Domestic Workers	34.60	33.85	33.51	33.29	32.71
8		Others	6.51	6.36	6.30	6.26	6.15
7=1+4	Total		100.00	100.00	100.00	100.00	100.00

Source: Estimated from Socio-economic and Demographic Profile1998-2008

Table F.2.3 Industrial Profile of Gujranwala

Type of Industry	No. of Units
Power Looms	921
Utensils	504
Foundry Products	341
Fans/Coolers/Washing Machines	321
Sanitary Fittings	172
Motor Pumps	151
Hosiery Products	107
Textile Processing	52
Woven Textile Spinning/Weaving	48
Agricultural Implements	44
Total	2,661

Source: Estimated from Socio-economic and Demographic Profile1998-2008

2.3 Social Situation

The Government of the Punjab is committed to attain the Millennium Development Goals (MDGs) for education, health, water supply and sanitation, and poverty. Towards this end, the Government, with assistance of UNICEF, has been periodically carrying out the Multiple Indicator Cluster Surveys (hereinafter referred to as "MICS"). MICS provides provincial and district-wise social data.

MICS 2003-04 was based on 40 indicators and the usage of information generated by the survey pointed to the need of further improvements in the scope and coverage of selected indicators. The scope of MICS 2007-08 was further expanded to more than 70 indicators and coverage level. The results of the 2007-08 survey as well as the 2011-12 survey do not only provide information on progress made in key social indicators since 2003-04 but also provide an excellent baseline for the key social indicators.

Recently, the results of the latest MICS 2011-12 have been compiled. The detailed comparison of the results of the major social indicators for Punjab Province as well as Gujranwala under MICS 2007-08 and MICS 2011-12 are presented from **Table F.2.4** to **Table F.2.15**. These socio-economic indicators cover a wide range of socio-economic situation of the residents of Gujranwala, including literacy, education, water and sanitation, adult health and health care, child mortality, nutrition, child health, child protection, reproductive health, HIV knowledge and attitudes, employment, and housing and assets. The results clearly prove that the social indicators of Gujranwala are better than the average of Punjab in almost all areas.

Table F.2.4 Socio-economic Indicators (Literacy)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Literacy Rate 10+ years (%)	72.0	59.0	72.0	60.0
Adult Literacy Rate 15+ years (%)	68.0	56.0	69.0	57.0
Adult Literacy Rate 15-24 years (%)	87.0	73.0	87.0	74.0

Source: MICS 2007-08, MICS 2011-12

Table F.2.5 Socio-economic Indicators (Education)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Net intake rate in primary education (5 years) (%)	16.0	19.0	31.0	26.0
Net primary attendance rate (5-9 years) (%)	60.0	53.0	72.0	59.0
Net middle/secondary attendance rate (%)	36.0	29.0	48.0	40.0

Source: MICS 2007-08, MICS 2011-12

Table F.2.6 Socio-economic Indicators (Water and Sanitation)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Use of improved drinking water sources (%)	99.0	97.0	96.0	94.0
Use of properly treated water (%)	7.9	4.8	12.0	3.6
Use of improved sanitation (%)	95.0	68.0	97.0	72.0

Source: MICS 2007-08, MICS 2011-12

Table F.2.7 Socio-economic Indicators (Adult Health and Health Care)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Prevalence of chronic cough (%)	1.0	2.0	1.4	2.2
Reported tuberculosis (%)	0.4	0.3	0.5	0.4
Reported hepatitis (%)	0.7	0.7	1.3	1.2
Care provided by Lady Health Worker (LHW)	38.0	50.0	68.0	48.0

Source: MICS 2007-08, MICS 2011-12

Table F.2.8 Socio-economic Indicators (Child Mortality)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Under-five mortality rate (Death per 1000 births)	95	111	85	104
Infant mortality rate (Death per 1000 births)	67	77	69	82

Source: MICS 2007-08, MICS 2011-12

Table F.2.9 Socio-economic Indicators (Nutrition)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Underweight prevalence (moderate & severe) (%)	27.0	34.0	24.0	33.0
Underweight prevalence (severe) (%)	10.0	11.0	7.1	11.0
Stunting prevalence (moderate & severe) (%)	37.0	42.0	29.0	36.0
Stunting prevalence (severe) (%)	20.0	23.0	12.0	15.0
Wasting prevalence (moderate & severe) (%)	13.0	13.0	13.0	16.0
Wasting prevalence (severe) (%)	6.8	5.6	3.7	4.4
Continued breastfeeding rate at 12-15 months (%)	67.0	74.0	68.0	68.0
Continued breastfeeding rate at 20-23 months (%)	42.0	53.0	34.0	34.0

Source: MICS 2007-08, MICS 2011-12

Table F.2.10 Socio-economic Indicators (Child Health)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Use of Oral Rehydration Therapy (ORT) (%)	37.0	47.0	44.0	40.0
Received ORT or increased fluids and continued feeding (%)	35.0	30.0	39.0	30.0
Care seeking for suspected pneumonia (%)	67.0	70.0	71.0	77.0

Source: MICS 2007-08, MICS 2011-12

Table F.2.11 Socio-economic Indicators (Child Protection)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Birth registration (%)	90.0	77.0	94.0	77.0
Child labour (%)	3.2	5.1	4.6	11.0
Labourer students (%)	2.3	3.4	2.8	7.7

Source: MICS 2007-08, MICS 2011-12

Table F.2.12 Socio-economic Indicators (Reproductive Health)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Use of contraceptives (%)	40.0	32.0	47.0	35.0
Antenatal care (%)	69.0	53.0	86.0	74.0
Skilled attendant at delivery (%)	59.0	43.0	73.0	59.0
Institutional deliveries (%)	51.0	38.0	67.0	53.0

Source: MICS 2007-08, MICS 2011-12

Table F.2.13 Socio-economic Indicators (HIV Knowledge and Attitudes)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Knowledge of preventing HIV/AIDS (%)	18.0	18.0	25.0	14.0
Negative attitude towards people with HIV/AIDS (%)	53.0	43.0	54.0	61.0

Source: MICS 2007-08, MICS 2011-12

Table F.2.14 Socio-economic Indicators (Employment)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Unemployment rate (15+ years) (%)	7.6	6.8	1.6	2.9

Source: MICS 2007-08, MICS 2011-12

Table F.2.15 Socio-economic Indicators (Housing and Assets)

Indicator	MICS 2007-08		MICS 2011-12	
	Gujranwala	Punjab	Gujranwala	Punjab
Per cent of Households who own three or more possessions (%)	99.0	89.0	99.0	89.0
Percent of household members who use at least one utility (%)	99.0	94.0	96.0	94.0
Household characteristics (finished floor) (%)	77.0	57.0	84.0	58.0
Household characteristics (finished roof) (%)	97.0	84.0	68.0	76.0
Household characteristics (finished wall) (%)	95.0	76.0	97.0	74.0
Ownership of assets (house) (%)	78.0	84.0	90.0	86.0
Ownership of assets (land) (%)	19.0	34.0	18.0	34.0
Ownership of assets (livestock) (%)	31.0	51.0	22.0	48.0
Mean household size (persons per household)	7.0	6.5	6.7	6.3
Mean number of persons per room (persons per household)	3.7	3.7	3.4	3.7

Source: MICS 2007-08, MICS 2011-12

2.4 Infrastructure Situation

2.4.1 Roads and Railways

The road network in Gujranwala has 9 primary roads, 13 secondary roads and 8 local roads connecting the city with other areas. In addition, the Grand Trunk Road (G.T. Road) and a motorway also pass through it. The inter-city railway infrastructure is also available, and helps to connect the city to other areas. The major road network in Gujranwala is as shown in **Table F.2.16**.

Table F.2.16 Major Road Network in Gujranwala in 2008

Classification	Length (km)
National Highway	69.52
Motorway	45.50
Provincial Roads	422.58
Farm to Market Roads	1,454.28
Sugar Cess Roads	16.66
Ex-District Council Roads	235.70
Intra-City Roads	115.51

Source: Socio-economic and Demographic Profile 1998-2008

2.4.2 Educational Infrastructure

Educational facility is considered to be one of the most important social infrastructures. In Gujranwala, a large number of schools, colleges, and medical colleges provide educational services to the citizens. The number of educational institutions in Gujranwala and Punjab is as shown in **Table F.2.17**.

Table F.2.17 Number of Educational Institutions in Gujranwala and Punjab

Type of Institutions	Number of Institutions (As of 2012)	
	Gujranwala	Punjab
Mosque School	41	1,897
Primary School	1,470	42,048
Middle School	290	7,756
High School	193	5,589
Higher Secondary School	15	798
Arts and Science Intermediate College	17	212
Arts and Science Degree College	33	718

Source: Punjab Development Statistics 2013

2.4.3 Health Facilities

Health facility is also considered to be one of the most important social infrastructures. In Gujranwala, a wide range of health institutions such as hospitals, dispensaries, clinics and health centres are available. The number of medical institutions in Gujranwala is separately shown in **Section I, Hospital, Industrial, and Construction and Demolition Waste Management**.

2.5 Economic and Financial Situation of GWMC

2.5.1 Budget Allocation Mechanism of GWMC

The operational budget and the investment budget for GWMC are being allocated from the budget of CDGG which almost depends on the subsidies from the Government of the Punjab (GOPb) and the regular budget of GOPs itself, respectively. For the financial year 2015-16, the total budget allocated

from CDGG and GOPb is approximately Rs. 504 million and Rs. 730 million, respectively. Out of the operational budget from CDGG, 75.6 percent of the budget is allocated for salary-related expenses and the remaining 24.4 percent is earmarked for other operating costs. **Table F.2.18** gives a snapshot of the GWMC budget for SWM services. In addition to the below regular budget of GWMC, approximately, Rs. 12.2 billion of the development scheme of the sanitary landfill site is being submitted to GOPb through the PC-1 (Planning Commission 1) format under 2015-2016 financial year budget of GOPb.

Table F.2.18 Budget for SWM Services of GWMC

Expenditure Item	2014-2015 Revised Budget		2015-2016 Budget Estimates	
	Budget (Rs. 1,000)	Share (%)	Budget (Rs. 1,000)	Share (%)
Total Expenditure of GWMC	956,968	100.0	1,233,612	100.0
Budgetary Allocation from CDGG for Operating Expenditure	482,968	50.5	503,612	40.8
Salary-related Expenditure	346,208	71.7	380,532	75.6
Other Operating Expenditure	136,760	28.3	123,080	24.4
Budgetary Allocation from GOPb for Investment Expenditure	474,000	49.5	730,000	59.2

Source: Revised Budget for 2014-2015 and Budget Estimates for 2015-2016, CDGG

In conclusion, GWMC is not in a position to meet their financial needs from the internal financial sources. They fall back on subsidies from the GOPb. This dependence on the budget of CDGG is not sustainable in the long term, and GWMC needs to increase their financial resources to meet their statutory obligations instead of solely depending on the budget of CDGG which is subsidised from the Provincial Government.

Direct cost recovery through user charges does not exist in Gujranwala although LWMC is planning to charge user fees in accordance with the income level. An important reason for this situation is the lack of willingness to pay and proper billing systems. Since there is no official tariff system for SWM services in Punjab, the tariff setting for SWM services is not controlled by an authorised organization of the provincial government of Punjab.

The determination of tariff for electric power services is one of the primary responsibilities of NEPRA (National Electric Power Regulatory Authority). NEPRA determines electricity tariffs, keeping in view the principles of economic efficiency and service quality, according to the prescribed tariff standards and procedures of 1998. While the tariff setting/revision of the power sector is controlled by the federal government, the tariff setting/revision of the water and sanitation sector is controlled by the independent committee involved in each urban development authority such as LDA (Lahore Development Authority) and GDA (Gujranwala Development Authority).

Likewise, the tariff setting/revision of plans is subject to the approval of independent organizations for the price regulation of sanitation/water and electricity, thereby being finally approved by the provincial and federal governments, respectively. Both of the mechanisms do not require enactment by the assemblies.

2.5.2 Cost Structure for SWM Services

GWMC is required to accurately identify how much is spent for the various components of SWM services in Gujranwala to establish strategies to minimise the cost of the services. However, at present, GWMC is not sufficiently capable of grasping the variable costs, the fixed costs and even the break-even point for the provision of SWM services.

Public services such as SWM services require cost accounting in order to financially track activities. Cost accounting is a process of collecting, analysing, summarising and evaluating various alternative public utility services. Cost accounting provides the detailed cost information required to control current operations of SWM services.

Cost accounting is used to help grasp the costs of operating SWM services. Most of the costs incurred by SWM services are what is called "variable costs" because they varied directly with the amount of wastes.

Some costs tend to remain the same even during busy periods, unlike variable costs, which rise and fall with the volume of work. These "fixed costs" should also be identified.

In order to efficiently provide SWM services, GWMC is required to adopt a strategy for minimising these costs. For this purposes, it is essential for GWMC to grasp the cost of services accurately.

2.5.3 Pricing Mechanism

GWMC currently does not levy any SWM tax, nor does it impose user fees for SWM services. SWM tax is a tax whose specific objective is limited to the improvement of SWM services. Although the SWM tax is being adopted by some other countries, no city in Pakistan has introduced this purpose-specific tax system for the generation of funds required for SWM services. Financial sources for SWM services are covered by the budget of CDGG which almost depends on the budget of the GOPb. Inadequate cost recovery mechanisms by GWMC limit the extent of operation as well as new investments of SWM services. Therefore, the pricing mechanism such as charging user fees needs to be considered and adopted.

Thus, in order to secure the budget for financially sustainable SWM services, GWMC needs to consider its revenue raising capabilities by introducing a proper user charging system for SWM services.

2.5.4 Situation of Private Sector Involvement

GWMC should explore the possibilities of involving the private sector in SWM services to provide efficient services cost-effectively with minimum costs. The private sector has been involved in the SWM services in Punjab in formal as well as informal sectors. Waste Management contracts were given out on small-scale community areas especially in new developed housing schemes due to lack of such facilities.

Likewise, GWMC is not currently working with the private sector although it is exploring the possibilities to introduce the option of private sector participation. Due to the limited resources available, GWMC is looking towards improvement of its SWM services through outsourcing the service to the private sector. It is commonly believed that the private sector would perform significantly better than the public sector. This belief is based on assumptions that the private sector would be more efficient, cost effective and would bring in new technologies for the improvement of the SWM system. **Table F.2.19** shows the recent experiences on private sector participation in Punjab.

Table F.2.19 Recent Experiences of Private Sector Participation in Punjab

Project Name	Type of PSP	Collection	Transport	Recycling	Treatment	Final Disposal
Lahore Sanitation Programme	Franchise	×	×			×
Gujrat Sanitation Programme	Management Contract	×	×			×
Cantonment Board Lahore	Management Contract	×	×		×	×
Clifton Cantonment Board, Karachi	Management Contract	×	×			×
Awam Sanitation Programme, Faisalabad	Franchise	×	×			×
Chaklala Waste Management Programme, Rawalpindi	Service Contract	×	×	×		×
Solid Waste and Environment Enhancement Project	Management Contract	×	×		×	×
Lahore Compost Plant, Lahore	BOT/ Concession			×		×

Project Name	Type of PSP	Collection	Transport	Recycling	Treatment	Final Disposal
Multan Composting Project, Multan	BOT			×		×
Metropolitan Corporation, Lahore	Franchise	×		×		×

Source: Punjab SWM Reform

2.6 Evaluation of Economic and Financial Condition

The problems and issues in relation to economic and financial management under the current situation are summarised in **Table F.2.20**. These items will be the basic elements to develop the plans, programmes and projects to comprise the economic and financial management plan in the Integrated Solid Waste Master Plan in Gujranwala.

Table F.2.20 Identification of Problems and Issues on Economic and Financial Condition

Problem	Description of Problem	Issues for Solving the Problems
1. Insufficient financial independence in SWM services	GWMC is not in a position to meet its financial needs from the internal financial sources. It falls back on subsidies from the GOPb. This dependence on the budget of CDGG is not sustainable in the long term, and GWMC needs to increase its financial resources to meet its statutory obligations instead of solely depending on the budget of CDGG which is subsidised from the Provincial Government.	The proper revenue generation mechanism such as the introduction of tariff system by GWMC should be carefully studied. Transparency for setting the tariff level as well as a wide range of activities raising users' willingness to pay for SWM services is also required. The continuous financial monitoring mechanism for GWMC should be also established in the framework of the institutional strengthening the headquarters of GWMC.
2. Not well identified cost structure for SWM services	GWMC is required to accurately identify how much is spent for the various components of SWM services in Gujranwala to establish strategies to minimise the cost of the services. However, at present, GWMC is not sufficiently capable of grasping the variable costs, the fixed costs and even the break-even point for the provision of SWM services.	In order to set proper tariffs for users, all the costs associated in providing SWM services by GWMC should be reflected as accurately as possible and streamlined as fixed costs and variable costs.
3. Lack of pricing mechanism for SWM services	Currently, there is no substantial pricing mechanism for SWM services in Gujranwala. GWMC currently does not levy any SWM tax, nor does it impose user fees for SWM services. Inadequate cost recovery mechanisms by GWMC limits the extent of operation as well as new investments of SWM services.	To secure the budget for financially sustaining SWM services, GWMC needs to consider its revenue raising capabilities by introducing a proper user charging system for SWM services. The pricing mechanism such as charging user fees need to be considered and adopted.
4. Few involvement of the private sector	GWMC is not currently working with the private sector although it is exploring the possibilities to introduce the option of private sector participation. Due to the limited resources available, GWMC is looking towards improvement of its SWM services through outsourcing to the private sector.	GWMC should explore the possibilities of involving the private sector in SWM services to provide efficient services cost-effectively with minimum costs. The objectives of involving the private sector include 1) enhancing efficiency; and 2) mobilise the investment resources of the private sector.

3. PLANNING DIRECTIONS OF ECONOMIC AND FINANCIAL PLAN

3.1 Objective

The objective of the Economic and Financial Plan is to establish the optimum cost recovery in the SWM operations of GWMC, thereby achieving the long-term financial sustainability of providing SWM services to be planned in the Master Plan.

3.2 Planning Policy

- Cost recovery for the provision of SWM services should be achieved through the ample generation of stable revenues from users and taxation.
- Current operating costs required for SWM services should be accurately and continuously reviewed and estimated.
- Revenues required for the cost recovery should be mainly generated from the tariff charging system which reflects the cost of SWM services.
- Outsourcing of part of SWM services should be introduced for the purpose of utilising the efficient private sector.

3.3 Planning Strategy

(1) Optimum cost recovery to cover the operation and maintenance cost for SWM services should be achieved for the long-term financial sustainability based on the following strategies:

- Establishment of the long-term road map for the full recovery of the operation and maintenance cost by user charges and subsidies from the provincial government;
- Establishment of a wide range of financial monitoring indicators together with the standard procedures for monitoring the cost recovery; and
- Preparation of manual and training of GWMC's staff for the management of the cost recovery.

(2) Operation and maintenance cost for SWM services should be accurately estimated based on the following strategies:

- Establishment of an independent accounting system for the financial autonomy of GWMC;
- Establishment of organizational setting such as a focal point inside GWMC in charge of accurately managing and estimating the operation and maintenance cost for SWM services; and
- Establishment of proper monitoring of the operation and maintenance cost for SWM services together with the minimisation of operation and maintenance cost to attain the operational efficiency of SWM services.

(3) Revenue generation through the proper tariff charging system should be introduced based on the following strategies:

- Selection and introduction of proper user charge system to cover the operation and maintenance cost for SWM services;
- Selection and introduction of stable financial resources to cover the financial shortages from the provincial government through subsidies or taxation;
- Preparation of official tariff table for the selected user charge system;

- Establishment of a wide range of financial monitoring indicators together with the standard procedures for setting and revising the tariff level; and
- Improvement of users' willingness to pay through raising of public awareness for the payment of user charges.

(4) Efficient private sector involvement should be introduced by outsourcing part of SWM services to private service operators as the following strategies:

- Selection and introduction of an efficient service contract for collection and transport services; and
- Establishment of a wide range of performance monitoring indicators together with the standard procedures for monitoring the financial performance of private service operators.

4. FORMULATION OF ECONOMIC AND FINANCIAL PLAN

4.1 Development of Alternatives for Economic and Financial Plan

4.1.1 Alternative Options for Cost Recovery

(1) Basic Principles for Cost Recovery

The optimum cost recovery can be attained by promoting GWMC's rational uses of financial resources, thereby efficiently providing better SWM services. In order to achieve this objective, the following basic principles for the cost recovery should be satisfied.

- The tariffs for SWM services should cover at least the operating cost, desirably the depreciation for replacement cost of existing facilities and part of the debt service obligations for the future investment cost. The tariff should be accurately calculated by making use of the latest financial data and information available.
- For the optimum cost recovery, the tariff level should send clear signals to waste generators as well as GWMC, thereby efficiently providing SWM services. Users will adjust their waste generation amount to the tariff level. At the same time, the cost recovery level should be periodically readjusted to reflect the real cost of SWM services.
- The demand side such as users' affordability and willingness to pay for SWM services should be properly taken into account, when the cost recovery level is projected based on the proper tariff system.

(2) Alternative Options for Cost Recovery

The major components to estimate costs for SWM services by which the cost recovery will be studied are as shown below.

- Operating costs, often called operating and maintenance expenditures, are costs of regular operation of services and performing routine maintenance of the related assets. The overhead and administrative expenses are also included.
- Replacement costs are often expressed as the depreciations of the capital replacement of existing facilities.
- Capital investment costs include costs of land, building facilities and procurement of equipment required for SWM services.

Based on the scope of costs mentioned above, the alternative options for the cost recovery include 3-step scenarios as below.

- **1st Step:** Operating costs, often called operating and maintenance expenditures, will be covered by the total revenue.
- **2nd Step:** Operating costs plus replacement costs often expressed as the depreciation of the capital replacement of existing facilities will be covered by the total revenue.
- **3rd Step:** Operating costs plus the depreciations of the capital replacement of existing facilities and part of new capital investment costs will be covered by the total revenue.

4.1.2 Alternative Options for Costing Methods

In order to provide the cost recovery analysis based on the accurately estimated costs for SWM services, the following costing methods are regarded as the alternative options.

(1) Average Cost Approach

The average cost is simply calculated from the sum of the required operation and maintenance cost, replacement cost and investment cost for the entire period of the master plan. The average cost reflects the total planned investment cost and the replacement cost in addition to the total planned operation and maintenance cost of each project year in the entire period of the master plan.

(2) Marginal Cost Approach

The marginal cost is the increase in total cost as a result of providing one more unit of SWM services. Since certain overhead costs are fixed, the marginal cost is almost always less than the total per-unit cost of providing SWM services averaged over the same services provided. The marginal cost achieves two goals: the efficient use of financial resources when operating at less than the full capacity and providing the signal to invest on the additional capacity of facilities.

In SWM services, the marginal cost pricing is problematic because of the relatively high start-up investment cost in comparison with the relatively low operation and maintenance cost. Significant fluctuations of the tariff would occur based on purely marginal cost calculations. Therefore, the marginal cost can be applied only to the phase in which the investment cost is borne as the project cost.

4.1.3 Alternative Options for Tariff Charging System

(1) Basic Principles for Tariff Charging System

A tariff charging system for SWM services has several objectives: cost recovery, financial sustainability, efficient allocation of scarce resources and income distribution. It is unlikely that all these objectives can be met, so even the most carefully designed tariff will require trade-offs.

The principle underlying the imposition of direct user charges for SWM services is that the cost of the services should be recovered from users. A well-designed tariff structure is a major part of ensuring an efficient SWM services. Advantages and disadvantages of each tariff charging option should be streamlined for the selection of the optimum option.

It is absolutely necessary for GWMC to keep the financial sustainability for continuously providing SWM services. The tariff charging system must reflect the costs reasonably associated with rendering the services, including capital, operating, maintenance, administration and replacement costs. In the long run, GWMC is required to consider introducing the tariff charging system for SWM services to meet the cost of services.

The tariff charging system may be also used as an incentive to reduce waste generation and encourage recycling, so that those who pollute more pay more. Increased public awareness of solid waste issues and public involvement in the decision-making process may provide the opportunity to adjust user charges to reflect real costs required for SWM services.

Alternative tariff charging mechanisms for providing SWM services affect the efficiency, equity and sustainability. The following principles should be adopted in shaping the design of the user charging system for SWM services:

- ***Efficient allocation of resources****:* The efficient allocation of available financial resources between users should be fostered.
- ***Efficient supply of services****:* Incentives should be created to provide services at the lowest cost.
- ***Cost recovery****:* Tariffs must reflect the costs associated with providing SWM services, including operating and maintenance, capital, replacement and financing costs.
- ***Financial viability****:* Tariffs should allow for the financial sustainability of the service, taking any other subsidies into account.

- ***Horizontal equity****:* Users of services should be treated equitably and should pay the same amount for the same level of services.
- ***Vertical equity and poverty alleviation****:* Poor consumers should pay proportionally less for services. Poor households must pay tariffs that only cover operating and maintenance costs, or have special lifeline tariffs or be subsidised in such a way as to allow access to basic services.
- ***Administrative and technical feasibility****:* Any tariff should be administratively and technically feasible to implement. The implementation process should be less costly than the benefits of implementation itself.
- ***Polluter pays****:* Those responsible for waste generation and externalities from waste generation or disposal should pay for the social costs of this waste.
- ***Avoiding illegal dumping****:* The tariff should not provide incentives for tariff avoidance through illegal dumping.
- ***Proportionality****:* The amount the user pays should be in proportion to the use of the services.
- ***Transparency****:* Tariffs should be understandable and any subsidy which exists must be visible and understood by all those affected.

The process of the tariff setting includes the following 3 steps:

- The analysis on the costs and revenues will be carried out by GWMC for estimating the required tariff level;
- GWMC will officially request the tariff setting for the tariff setting/revision committee which will be set up inside CDGG; and
- The tariff setting/revision committee will review and approve the request from GWMC.

(2) Alternative Options for Tariff Charging System

There are a wide range of below tariff charging options together with advantages and disadvantages of each option.

Option 1: Financing through Provincial Property Tax

While the direct cost recovery for SWM services can be used depending on the quantity of SWM services, the indirect cost recovery for SWM may rely on the government revenues, especially, various forms of taxation including a special tax for SWM services and surcharges on other taxes. The property tax is one of the most promising candidates of this option, since this option tends to secure the vertical equity.

Advantages

- The revenue collection cost is relatively low.
- The charges through the provincial tax tend to be correlated with income and in turn with amounts of waste generated. Therefore, there might be some relationship between the costs imposed on consumers and the amount of wastes generated.
- The option provides for the vertical equity, since poorer households will tend to pay less for SWM services.
- Low value properties can be zero-rated thus providing free basic SWM services to those households.

Disadvantages

- It may not be horizontally equitable, since households with different service levels pay the same amount for different SWM services.
- The option provides no incentive to reduce wastes.
- It may be technically difficult to set aside the solid waste proportion of the property tax revenue.

- The number of the property taxpayers is limited.
- Tough negotiations with the provincial government will be required.
- The option does not provide any incentive for GWMC to provide SWM services more efficiently.

Option 2: SWM Services Funded by User Charges

Option 2-a: User Charges Based on Proxy for Amounts of Wastes Generated

In this option, a proxy variable such as stand size is used as the basis to distinguish the solid waste tariff.

Advantages

- The use of stand size is appropriate if collection costs increase with decreasing residential density and, therefore, this option promotes the proportionality principle.
- Stand size is likely to be correlated to a sizable degree with the volume of wastes generated and the income level of waste generators.
- Other proxies, such as tariffs differentiated by location, may be appropriate, if different areas have different waste generation rates on average and different costs.
- The option provides no incentive for illegal dumping because residents are charged anyway.
- The option is vertically equitable, since poorer households will tend to pay less for SWM services.

Disadvantages

- The option does not encourage waste reduction or recycling.
- There is only a limited relationship between stand size and waste volumes, and, therefore, it is not always horizontally equitable.
- It is technically complicated to establish and administer proxy variables.

Option 2-b: User Charges Based on Service Level

In this option, tariffs are based on the level of services provided to customers. Ideally, consumers would be able to choose the level of services according to demand and affordability.

Advantages

- The option has a greater degree of horizontal equity than a flat rate as customers pay for the services received.
- The option allows service level targeting of poor households. Poor households may be able to choose a lower service level for a lower charge or for no charge in the case of free basic SWM services.
- The option provides efficiency incentives for GWMC.

Disadvantages

- The option is only loosely proportional to the cost of provision as there are other cost drivers aside from service level.
- The option is not vertically equitable, since poor households pay the same as wealthy households if a single service level is provided.
- Service level is not always related to amount of waste generated and therefore does not meet the polluter pays principle.
- The option may encourage illegal dumping if service level choice is available.

Option 2-c: Charges Based on Actual Amounts Generated (Pay as You Throw)

The option requires a detailed recording of the amounts of wastes collected from a site and establishes a charge per amount of wastes generated. More crude versions of this approach are

based on customers' purchasing special bags with a surcharge which goes to service providers, which are the only bags collected. The more wastes generated, the more bags have to be bought by a household.

Advantages

- There is direct relationship between waste generation and cost to the customer.
- The option provides incentives for waste reduction.
- The option is horizontally equitable.
- The option can allow for a free basic service such as the collection up to a certain mass or volume of waste can be provided at no charge.

Disadvantages

- The option has large technical costs and constraints.
- The option has social and management constraints.
- The option is not vertically equitable since all households pay an equal amount per volume of wastes.
- Use of plastic bags is not allowed in Pakistan for environmental reasons.
- The users' willingness to buy bags is low.

Option 3: Combined Options

Option 3-a: Flat-Rate and Variable-Rate User Charge

The use of a flat-rate user charge on all households and variable user charge by income level provides a workable option. If free basic SWM services are provided, the flat rate could be waived for poor households or households in low-income areas.

The flat-rate cost recovery is easily implemented, administered, altered, and explained to customers and provides predictable cash flows. It is appropriate for SWM services with a single customer class. The main disadvantage of a flat-rate cost recovery is the lack of concern or accountability for wastes.

On the other hand, a variable user charge by income group can impose the tariff in accordance with customers' willingness to pay. Although the combination of a flat rate user charge and a variable user charge is vertically equitable with the cross-subsidies among customers, it is rather difficult to identify a border of the income-block between low-income households and high-income households.

Option 3-b: Combination of Property Tax and Flat-Rate User Charges

This option splits the financing of SWM services between the stable revenue from a property tax account for SWM services and the additional flat-rate user charge for the minimum SWM services. The advantage of this option is that it aims at raising stable finance sources for providing SWM services, and, at the same time, it can easily accommodate equity considerations with low value properties having low rates or being exempted.

This combined option is being applied by many municipalities on an ad-hoc basis, when part of the revenues from a property tax is used to subsidise any deficit accruing on the SWM account. The ad-hoc approach, where any deficit is automatically funded out of the property tax account, provides no efficiency incentives and cannot be regarded as an acceptable and official tariff structure.

Option 3-c: Combination of Property Tax and Variable-Rate User Charges

Option also splits the financing of SWM services between the stable revenue from a property tax account for SWM services and the additional variable-rate user charge for the minimum SWM services. Although the advantage of this option is basically the same as Option 3-b, the additional variable user charge is vertically equitable even if the property tax is imposed on high-income households due to the extra affordability to pay of high-income households.

Option 3-d: Combined Billing with WASA or GEPCO

One of the less common cost-recovery methods is to combine billing of SWM services with that of another utility such as water and sewerage services or power supply services. This can be either a direct fee or a surcharge on the primary utility bills. The problem is that households receiving SWM services may consume little water or electricity or none at all. In effect, large customers of water supply/sewerage or electricity pay their own share plus part of the low-income users' share for SWM services.

This option may produce adequate revenue but is difficult to justify the basis of equity, because many low-income households will receive virtually free SWM services. In addition, the WASA or GEPCO will be reluctant to accept the joint billing proposal due to the anticipated increase in their bills which might induce their customers' strong objections.

(3) Alternative Options for Tariff Revision Mechanism

In addition to the tariff setting mechanism, the alternative options for the tariff revision mechanism should be also assumed. There are mainly three (3) options for regulating the overall tariff level: rate of return regulation, yardstick regulation and price cap regulation.

(a) Rate of Return Regulation

Rate of return regulation adjusts overall tariff levels to the operator's total accounting costs and cost of capital. The regulator reviews a service provider's overall tariff level in response to a claim that the expected rate of return is less than its cost of capital.

Since the current costs of capital of all GWMCs are substantially borne by the external financial sources, the rate of return regulation could be substantially *"total costing regulation"* without the cost of capital. Although the traditional rate-of-return regulation has been criticised on the grounds that it deteriorates incentives for cost efficiency, the monitoring on the management efficiency improvement through the performance monitoring indicators will be alternative measures to strengthen incentives for cost efficiency.

(b) Yardstick Regulation

Yardstick regulation is a regulation method that a SWM service operator's (GWMC's in this case) performance is compared to other operators' performance such as SWM service operators in other cities of Punjab Province (LWMC, etc.) and other public utility operators like the water/sewerage sector and the power sector.

Penalties or awards are assessed based on a SWM service operator's relative performance. The most efficient operators would be rewarded with extra profits and the least efficient operators would be penalised in terms of the tariff level. Since operators are actually in different markets, it is important to keep those operators in similar situations so that the comparison is valid.

(c) Price Cap Regulation

Price cap regulation allows a service provider to change its tariff level according to an index that is typically comprised of an inflation rate, I-factor, and a "productivity offset," which is commonly called the X-factor. Price cap regulation can be an alternative tariff revision method to traditional rate-of-return regulation. It has been widely used as a regulatory rule for limiting abuse of market power by a dominant supplier of public utility services after a service provider's obtaining sufficient operating profits.

Eventually, the price cap regulation would give a service operator more incentives to achieve and improve productive efficiency. Unlike the rate-of-return regulation, the price cap regulation does not require frequent arbitrary measures of a rate of return on capital.

4.1.4 Alternative Options of Financial Arrangement for Private Sector Involvement

(1) Basic Principles for Private Sector Involvement

During the long-term period from 2025 to 2030, the private sector involvement will be started for the collection and transport services. The financial arrangement of each private sector involvement option is evaluated in terms of the economic efficiency and profitability under the following principles.

- The major economic reason for involving the private sector in SWM services is the enhancement of the efficiency of operations through competition. Private sector involvement through a competitive bidding can improve the efficiency of SWM services. By using the private sector's cost-saving expertise, outsourcing to the private sector will significantly reduce the financial burden on a public service provider.
- The involvement of the private sector can also enlarge the access to capital or financial resources for procurement of collection vehicles as well as human capital for expertise and skills. The degree of the accessibility to those financial and human capitals by the public sector is one of the important motivations for the private sector involvement.

(2) Alternative Options for Private Sector Involvement in terms of Financial Arrangement

- ***Licensing:*** Licensing or private subscription allows qualified private service providers licensed by an authority to compete for the delivery of SWM solid services in a specific zone. Under this arrangement, waste generators make contracts with individual private service providers.
- ***Service Contract:*** Service contract is a finite-term contract to a private service provider to render SWM services, and an authority pays the private service provider for charges in response to the services to be delivered. Part of SWM services such as collection and transportation of wastes and management of a sanitary landfill site can be contracted out to a private operator for a certain period.
- ***Management Contract:*** Management contract is a contract entrusting specific solid SWM services under private management for a certain period of time, for which a management fee is paid to the management contractor.
- ***Lease Contract:*** Lease contract grants a private operator full control over delivering specific SWM services in exchange for use of the fixed assets whose ownership and responsibilities belong to the authority.
- ***Concession:*** Concession is a long-term contractual arrangement in which a private operator is awarded an official license to provide specific SWM services over a longer period of time in exchange for a negotiated fee.

4.2 Evaluation of the Alternatives

4.2.1 Alternative Options for Cost Recovery

By applying both of the revenue increase efforts and cost reduction efforts, the alternative options for the cost recovery through the following steps are selected:

- To apply the revenue increase efforts, thereby shifting the revenue line upward.
- To apply the cost reduction efforts, thereby shifting the operating cost line downward.
- To shift the break-even point leftward, thereby shortening the overall cost recovery years.
- To identify the optimum cost recovery level under the new break-even point.

Figure F.4.1 illustrates the image of 3 phases of the cost recovery. Based on the above assumptions, out of 3 alternative options for the cost recovery, the first step which covers part of the operation and maintenance cost is the realistic and optimum option for the cost recovery for the evaluation in the master plan.

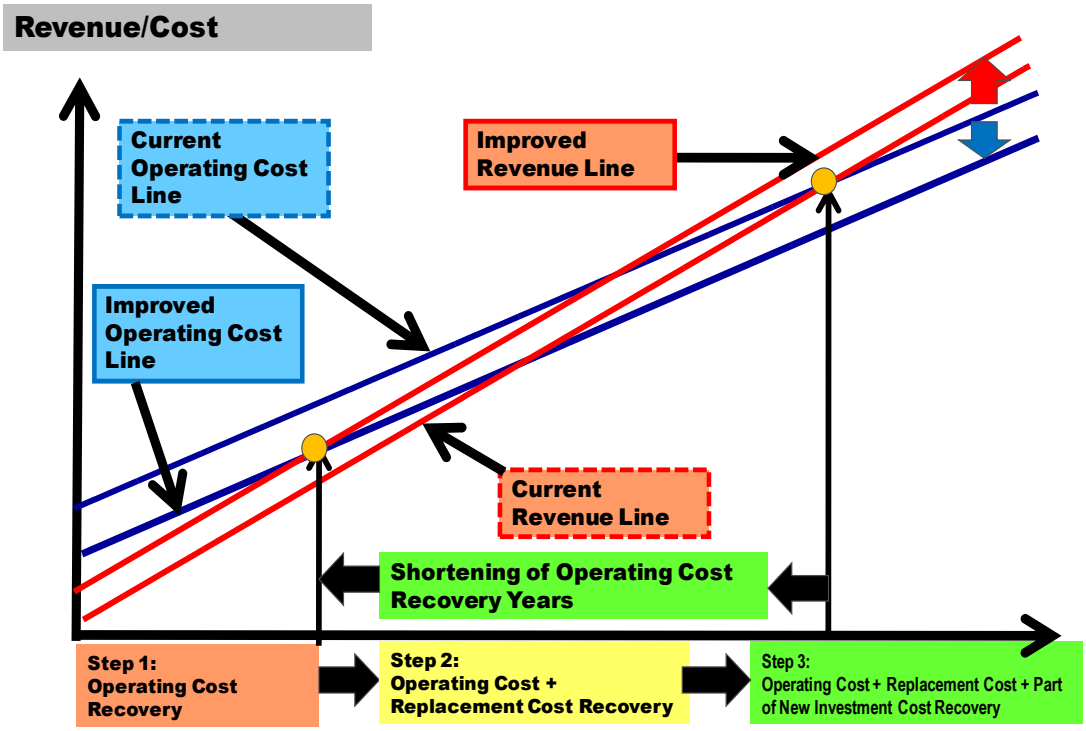

Figure F.4.1 Image of Three Phases of Cost Recovery

4.2.2 Alternative Options for Costing Methods

The costing method to be employed for the cost recovery is different in response to each phase of the cost recovery.

The costing method required for the phase where the cost recovery is only achieved to cover the operation and maintenance cost is the average cost method. On the other hand, the marginal cost includes the depreciation of assets. The cost of long-term investments in capital assets must be included in the cost-recovery applications.

Since the master plan is regarded as the first step/phase which only seeks for covering part of the operation and maintenance cost, the average costing method is employed for the appropriate option as the costing method. A key difference between the average cost and the marginal cost is that the former is concerned with the revenues needed to ensure the financial viability while the latter is concerned with relaying the appropriate price signals to consumers. The tariff level must be high enough to cover the average cost over the entire period of the master plan. **Table F.4.1** shows alternative options for costing methods.

Table F.4.1 Alternative Options for Costing Methods

Phase of Cost Recovery	1st Step	2nd Step	3rd Step
Cost Recovery	Operation and Maintenance Cost	Operation and Maintenance Cost + Capital Charge on Replacement Cost	Operation and Maintenance Cost + Capital Charge on Replacement Cost + Part of New Investment Cost
Average Costing Pricing Method	Yes	No	No
Marginal Cost Pricing Method	No	Yes	Yes

4.2.3 Alternative Options for Tariff Charging System

(1) Tariff Charging System

Table F.4.2 shows the results of evaluating alternative tariff charging options together with advantages and disadvantages of each option.

Table F.4.2 Alternative Options for Tariff Charging System

Alternative Tariff Charging System		Advantage	Disadvantage
User Charge	Flat Rate	・ It is easy to administer the tariff system. ・ SWM charges will be minimal due to the wider basis for the revenue generation.	・ There is lack of concern or accountability for wastes. ・ The cost of the door-to-door collection of SWM charges is relatively high. ・ Users' willingness to pay is low in low-income areas.
	Variable Rate	・ The vertical equity of the tariff system is secured.	・ The cost of the door-to-door collection of SWM charges is relatively high. ・ It is difficult to identify the areas by income group.
Charging through Selling Plastic Bag System (Pay-as-you-Throw System)		・ There is direct relationship between waste generation and costs to customers. ・ The proportionality of the tariff charging system is secured. ・ There are incentives for waste reduction.	・ Users' willingness to buy plastic bags is relatively low ・ Use of plastic bags is not allowed in Pakistan.
Charging through Tax System	Charging through Provincial Property Tax	・ The revenue collection cost is relatively low. ・ The tariff can be charged only on the relatively high-income users, thereby achieving the vertical equity.	・ Negotiation with the Provincial Government is necessary. ・ The number of property tax payers is limited.
Combined Approach	Flat Rate + Variable User Charge	・ There is the vertical equity of the tariff system. ・ The revenue base is relatively large.	・ It is technically rather difficult to administer the tariff system. ・ The threshold between high-income customers and low-income customers is difficult to define.
	Property Tax + Flat-Rate Use Charge	・ The property tax is the stable income in addition to the flat-rate user charge. ・ The revenue basis is relatively large.	・ Negotiation with the provincial government is necessary. ・ The vertical equity of the tariff system is not enough.
	Property Tax + Variable-Rate User Charge	・ The property tax is the stable income in addition to the variable-rate user charge. ・ The revenue basis is relatively large.	・ It is technically rather difficult to administer the tariff system. ・ Negotiation with the provincial government is necessary. ・ The vertical equity of the tariff system is secured.
Joint Billing with Other Public Utilities	Joint Billing with WASA (Water and Sanitation Bill)	・ It is relatively easy to manage the charging system. ・ The revenue collection cost is relatively low.	・ Negotiation with WASA is necessary. ・ The number of users connected to WASA water supply network is limited.
	Joint Billing with GEPCO (Electricity Bill)	・ It is relatively easy to manage the tariff system. ・ The revenue collection cost is relatively low.	・ Negotiation with GEPCO is necessary. ・ The number of users who are connected to the GEPCO grid network is limited. ・ There is little horizontal equity.

Out of the above-listed alternative options, the combination of the provincial property tax as the baseline stable revenue and the variable user charge system as the additional revenue from high-income households is recommended as the optimum alternative option due to the following reasons.

- The variable-rate user charge can secure the vertical equity, since the majority of the households in Gujranwala are low-income households, and the flat-rate user charge does not secure the vertical equity.
- The affordability to pay for the high-income areas are more than their willingness to pay, and, therefore, the revenues through the property tax can be generated from high-income households.
- The revenue collection cost is relatively low for the provincial property tax, and the baseline income can be stable.
- The negotiation with the provincial government is much easier, compared with the negotiation with WASA and GEPCO, since they are more profit-oriented, and, therefore, they are much reluctant to add the SWM bill to their own bills.

In addition to the optimum option for the tariff charging system, the following arrangements for the introduction of the system are also recommended.

- Three-year preparation period (2022-2024) in the latter half of the mid-term period of the master plan should be assumed to secure the period for raising users' willingness to pay.
- Three-year trial period (2025-2027) in the former half of the long-term period of the master plan should be assumed to smoothly introduce the tariff charging system. During this trial period, the tariff will be exempted for low-income households.
- The negotiation with the excise and taxation department of the provincial government should be commenced from 2016 to adjust the rate of the provincial property rate so as to add the surcharge for generating baseline stable revenue to fill the gap between the tariff revenue and the required revenue, thereby covering the operation and maintenance cost.
- In case of the non-payment of waste collection charges under the proposed tariff charging system, it should be explored that a sort of penalty for non-payers will be enforced so as to secure the horizontal equity among beneficiaries.
- The full-scale introduction of the recommended tariff charging system in all areas will be started from 2025.

Regarding the concrete tariff collection methods, since the variable-rate user charge system requires the identification of the income level, it is technically difficult to accurately grasp the income level of each household. Therefore, the following 2 options are recommended as possible concrete tariff collection methods under the variable-rate user charge system or flat-rate user charge system:

- To divide the entire project area into 3 zones in accordance with the results of the social survey (low-income area, middle-income area and high income area), thereby introducing the zone-wise variable-rate user charge system by dividing; and
- To estimate the weighted average tariff level in accordance with the results of the tariff review analysis under the financial evaluation, thereby introducing the flat-rate user charge system.

However, since the willingness to pay for SWM service charges is extremely low in the low-income area, the latter option to introduce the flat rate user charge system is not realistic.

(2) Tariff Revision Mechanism

In addition to the tariff charging system, the best option for the tariff revision mechanism should be also selected.

Since the current capital investment costs of GWMC are substantially borne by the external financial sources, the rate of return regulation could be "total costing regulation" without the cost of capital. Although the traditional rate-of-return regulation has been criticised on the grounds that it deteriorates incentives for cost efficiency, the monitoring on the management efficiency through the performance monitoring indicators will be alternative measures to strengthen incentives for cost efficiency.

Yardstick regulation depends on a wide range of data to provide indicative information on relative performance of similar SWM service operators and other public utilities service providers such as the power sector. In practice, information requirements in other service providers might be obstacles to the implementation of yardstick competition. Yardstick competition is the most effective when those service providers face similar conditions. Therefore, the yardstick regulation is not suitable for the tariff revision mechanism, since other service providers are operating in different management conditions.

On the other hand, the price cap regulation could be employed for the period only after achieving the cost recovery of operation and maintenance cost as well as the depreciation of the replacement cost.

In conclusion, "the rate of return" regulation is the recommended option for the tariff revision mechanism.

4.2.4 Alternative Options for Private Sector Involvement

The optimum option for the private sector involvement is selected in the economic aspects such as form of management, tariff collection, contract term, status of monopoly, and ownership of assets. The step-wise service contract in the field of collection and transport is the best option for the private sector involvement due to the following reasons. **Table F.4.3** shows the results of evaluating options for the private sector involvement.

- There are many low-income areas with extremely low customers' willingness to pay, and, therefore, "licensing" and "concession", in which the tariff collection by the private sector is required, will be excluded.
- Since GWMC is required to put the management of SWM services under control, "management contract" will be excluded.
- On the other hand, "lease contract" will be excluded due to the fact that GWMC cannot effectively utilise the current sanitation workers for the economy of scale.
- Unlike the concession, under the service contract, GWMC can finally decide the level of the tariff.

Table F.4.3 Alternative Options for Private Sector Involvement in terms of Economic Aspects

Outsourcing Options	Management	Tariff Collection	Contract Term	Monopoly	Ownership of Assets
Licensing	Public	Private	Limited	No	Public
Service Contract	Public	Public	Limited	No	Private
Management Contract	Private	Public	Limited	No	Private
Lease Contract	Public	Public	Limited	No	Public
Concession	Private	Private	Limited	Yes	Private

Furthermore, there will be positive and negative effects of introducing the service contract through the private sector involvement in the field of collection and transport of wastes. **Table F.4.4** indicates the positive and negative effects of the service contract with the private sector. In conclusion, it is estimated that the net effect of the service contract with the private sector is approximately 10 per cent compared with the current GWMC's direct service.

Table F.4.4 Positive and Negative Effects of Service Contract with Private Sector

Item	Positive Effect (Reduction of Cost by Service Contract Compared with GWMC's Own Service)	Negative Effect (Increase of Cost by Service Contract Compared with GWMC's Own Service)	Net Effect (Reduction of Cost by Service Contract Compared with GWMC's Own Service)
Utilization of Facilities and Equipment of Private Service Providers	10.0%	0.0%	10.0%
Collection Efficiency of Wastes	10.0%	0.0%	10.0%
Collection Efficiency of Waste Charges	5.0%	0.0%	5.0%
Underutilization of Staff and Workers	0.0%	15.0%	-15.0%
Total	25.0%	15.0%	10.0%

4.3 Identification of Project Components for Economic and Financial Plan

4.3.1 Short-Term Plan (2016-2018)

(1) Establishment of Sustainable Cost Recovery

During the short-term period from 2016 to 2018, the tariff system will not be introduced, and, therefore, the cost recovery for GWMC's operation of SWM services will not be actually started. However, there are a handful of preparation activities for the future cost recovery even in the short-term period. There is a wide spectrum of activities in the field of the preparatory activities for the cost recovery as below. The proper cost recovery system in SWM services will be established in the long-term period. For the time being, the gap between the revenues and the expenditures due to the absence of the cost recovery system will be replenished by the CDGG's financial assistance on the recurrent costs as well as the provincial government's subsidies for the capital investment.

(2) Implementation of Accurate Total Costing

Although, during the short-term period from 2016 to 2018, the tariff will not be charged, it is absolutely necessary to accurately grasp the total cost based on the selected methodologies for future monitoring of the cost recovery after the full-scale introduction of the tariff system from 2025. The cost centre will be established inside the financial department of GWMC, and the centre provides the management of GWMC with a convenient mechanism to determine the proper tariff level to recover the total operation and maintenance costs required for the providing SWM services.

The cost minimisation plan, being jointly prepared by the financial department and the human resources development department of GWMC, will include a series of actions to significantly reduce operating costs and bring improvements in the service delivery efficiency such as the operation of the sanitary landfill, the operation of the collection and transport, billing and collection, and fuel and repairs of collection vehicles, the overhead cost of the headquarters, etc.

In addition, the preventive maintenance programme will help identify possible inefficiency in the operation of the sanitary landfill as well as the collection and transport of wastes with minimum expenses thus saving major repairs and maintenance costs. The efficient collection route should be continuously reviewed in each service zone which will bring more efficiency in the operations thus reducing costs.

(3) Introduction of Proper Tariff Charging System

During the short-term period from 2016 to 2018, the tariff system will not be introduced, and, therefore, the cost recovery for SWM services through the introduction of the tariff system will not be actually started. The establishment of the cost recovery through the partial introduction of the optimum tariff system in high-income area and full-scale introduction in all areas will be commenced from 2022 in the mid-term period and 2025 in the long-term period, respectively. Although the proper tariff system in SWM services will be introduced in the mid-term and long-term periods, the short-term period is regarded as the preparatory phase for introducing the proper tariff charging system in the mid-term and long-term periods.

(4) Implementation of Financially Efficient Private Sector Involvement

During the short-term period from 2016 to 2018, the private sector involvement will not be started. However, there is a wide range of preparation activities for the future commencement of the efficient private sector involvement for the collection and transport services. During this preparatory phase, the outline of the service contract to be outsourced including such as area, scope and criteria to select the private service providers will be clarified.

4.3.2 Mid-Term Plan (2019-2024)

(1) Establishment of Sustainable Cost Recovery

During the mid-term period from 2019 to 2024, in response to the preparatory activities for the cost recovery conducted during the short-term period, the following activities to accelerate the cost recovery in SWM services will be carried out:

- To update the long-term cost recovery strategies for the operation and maintenance costs to provide SWM services;
- To operate the financial monitoring system through a wide range of the financial KPIs related to the cost recovery;
- To update the standard procedure for monitoring the cost recovery;
- To update the manual for the management of the cost recovery;
- To continue on-the-job training of GWMC's staff in charge of managing the cost recovery;
- To review the previous 3-year recurrent cost rolling plan and prepare the new 6-year recurrent cost rolling plan to request CDGG for the budgetary arrangement; and
- To review the previous 3-year capital investment rolling plan and prepare the new 6-year capital investment rolling plan to request the provincial government for the budgetary arrangement

The mid-term financial monitoring system will significantly contribute to the feedback mechanisms for rectifying the financial performance of GWMC. GWMC is requested to monitor whether or not SWM services are actually and properly being delivered by the efficient manner.

(2) Implementation of Accurate Total Costing

During the mid-term period from 2019 to 2024, the tariff will not be charged yet, and, therefore, the cost recovery for the operation of SWM services will not be actually started. However, there are various activities for the cost centre to support the cost recovery by estimating the total operation and maintenance cost as below. The actual establishment of the cost recovery system in SWM services will be started from the long-term period. Even during the mid-term period, the absence of the cost recovery will be replenished by the subsidies or the revenues from the provincial property tax. The activities of the cost centre will be a basis for the explanation to the provincial government and users for raising funds from the provincial property tax and the tariff system:

- To make the cost centre function well to accurately estimate the total cost for SWM services;
- To update the latest operating costs for SWM services;
- To update the latest maintenance costs for SWM services;
- To update the break-even point analysis as well as the breakdown of the operating costs by fixed costs and variable costs;
- To update the average cost and the marginal cost per unit amount of the disposed wastes;
- To fully implement the cost minimisation plan of GWMC;
- To fully make use of the operation manual for the standard procedures for the cost centre; and
- To continue the training the staff of the cost centre for estimating various costs for SWM services

(3) Introduction of Proper Tariff Charging System

During the mid-term period from 2019 to 2024, the tariff will not be charged yet, and, therefore, the cost recovery for the operation of SWM services will not be actually started. However, there is a wide spectrum of activities in the field of the preparatory activities for the full-scale introduction of the tariff system from 2025 as below:

- To prepare the official tariff table for requesting the approval by the price regulatory organization under the provincial government;
- To prepare for the partial and test introduction of the tariff system under the selected option from 2025 only in middle-income and high-income areas;
- To prepare for the full-scale introduction of the tariff system under the selected option from 2028 in all areas;
- To explore the possibility of outsourcing the tariff collection through the introduction of the cross subsidy system;
- To continuously update the survey on ATP and WTP;
- To prepare for the establishment of monitoring the users' grievance on the tariff collection practices;
- To prepare for the smooth transfer of the property tax surcharge to GWMC; and
- To start training the staff in charge of collection of user charges

During the mid-term period, more in-depth tariff level should be carefully studied based on the updated level of ATP and WTP. The degree of WTP depends upon two major factors. The most important factor is the financial status of waste generators in Gujranwala. While in an area where the financial status is relatively high, there is a tendency for paying for SWM services. The second issue is the level of service provided. The better the SWM service, the more willing households are to pay. The tariff system must be introduced with the following considerations:

- The bases for imposing charges are easy to explain and the structure and level of tariffs, equitable and easy to understand;
- The collection methods of user charges are based on long-standing or accepted practices; and
- Prior to implementation of the tariff system, GWMC is requested to fully explain the intention and reasons for imposing or revising the tariff system.

To set up a regulatory organization on imposing and revising the tariff is another critical action to be taken during the mid-term period. Since there is currently no official tariff system for SWM services in Punjab, the tariff setting and revision for SWM services is not being regulated by an independent organization of the provincial government. On the other hand, the tariff setting and revision plans are subject to be approved by the independent price regulatory organizations for the water/sewerage and electricity sectors under the provincial and federal government, respectively.

The cross-subsidy system which provides financial assistance to poor households through transferring user charges from well-off households to poor households should be introduced by setting the tariff based on the proposed income-wise variable-rate user charges with the following principles:

- The subsidy should be limited to the poor to guarantee access to SWM services;
- The level of the subsidised tariff should be decided on the basis of the affordability-to-pay survey on poor households; and
- The subsidy system, including eligibility criteria, should be separately set up in close cooperation with the provincial government.

(4) Implementation of Financially Efficient Private Sector Involvement

During the mid-term period from 2019 to 2024, there will be a wide range of preparatory activities of the outsourcing by GWMC in the form of the service contract with the selected private service provider, which will be actually carried out from 2028 with the following actions:

- To prepare for the procedures required for the tender practices for the service contract;
- To prepare for the monitoring of the financial performance of the selected private service provider by the KPIs which are separated from those of GWMC;
- To prepare for the establishment of the auditing services for the selected private service provider; and
- To plan the scope of the outsourced service zone.

The monitoring system which contributes to the feedback mechanisms for improving the performance of the selected service provider will be arranged during the mid-term period.

The following financial KPIs for the selected service provider should be established apart from the KPIs for GWMC:

- Degree of meeting contractual level of quality of SWM services;
- Degree of meeting contractual frequency of SWM services;
- Waste collection rate;
- Charge collection rate;
- Degree of cooperation for 3R activities;
- Contents of financial and activity reports;
- Number of grievances; and
- Degree of meeting other contractual requirements.

4.3.3 Long-Term Plan (2025-2030)

(1) Establishment of Sustainable Cost Recovery

During the long-term period from 2025 to 2030, the full-scale tariff system will be introduced in 2028, and, therefore, the cost recovery for the operation of SWM services will be partially attained. Accordingly, the cost recovery for the operation and maintenance costs in SWM services will be to the certain extent enhanced during the long-term period. The following actions should be taken for the sustainable cost recovery during the long-term period. In spite of the partial cost recovery, CDGG's financial support for the recurrent cost as well as the provincial government's subsidies for the investment cost will be still required:

- To update the long-term cost recovery strategies for the operation and maintenance costs to provide the SWM service;
- To continuously operate the financial monitoring system through a wide range of the financial KPIs related to the cost recovery;

- To update the standard procedure for monitoring the cost recovery;
- To update the manual for the management of the cost recovery;
- To continue on-the-job training of GWMC's staff in charge of managing the cost recovery;
- To review the previous 6-year recurrent cost rolling plan and prepare the new 6-year recurrent cost rolling plan to request CDGG for the budgetary arrangement ; and
- To review the previous 6-year capital investment rolling plan and prepare the new 6-year investment cost rolling plan to request the provincial government for the budgetary arrangement

Based on the tariff actually collected, the actual cost recovery level should be accordingly updated. The gap between the actual operation and maintenance cost and the tariff actually collected should be replenished the revenue from the subsidies or the provincial property tax revenues from the provincial government.

(2) Implementation of Accurate Total Costing

During the long-term period from 2025 to 2030, in response to the actual introduction of the tariff system, the cost centre of GWMC is requested to implement its full-scale operations with the following activities:

- To make the cost centre function well to accurately and continuously update the total cost for SWM services;
- To update the latest operating costs for SWM services;
- To update the latest maintenance costs for SWM services;
- To update the break-even point analysis as well as the breakdown of the operating costs by fixed costs and variable costs;
- To update the average cost and the marginal cost per unit amount of the disposed wastes;
- To continuously implement the cost minimisation plan of GWMC;
- To fully make use of the operation manual for the standard procedures for the cost centre; and
- To continue the training of staff of the cost centre for estimating various costs for SWM services.

It is extremely important for the cost centre to identify the costs in the long-term period in which the tariff will be actually imposed, thereby updating the planned cost recovery rate under the official tariff charging system. At the same time, the cost minimisation plan by GWMC is critical for transparency and accountability of the tariff system, since the tariff will be actually charged on users during the long-term period.

(3) Introduction of Proper Tariff Charging System

During the long-term period from 2025 to 2030, the proposed tariff system will be actually introduced to partially cover the operation and maintenance cost for SWM services. The said partial cost recovery will be started from 2025 with the following activities related to the introduction of the proper tariff system:

- The partial and test introduction of the tariff system under the selected option from 2025 only in middle-income and high-income areas;
- The full-scale introduction of the tariff system under the selected option from 2028 in all areas;
- To explore the possibility of outsourcing the tariff collection services;
- To continuously update the survey on ATP and WTP;
- To monitor the users' grievance on the tariff collection practices;
- To smoothly transfer the property tax surcharge to GWMC; and

- To continuously train the staff in charge of collection of user charges.

The trial introduction of the tariff system from 2025 will be carried out only in middle-income and high-income areas, while the full-scale introduction of the tariff system will be implemented from 2028, the latter half of the long-term period. The collection efficiency as well as the actually collected amount of user charges will be continuously monitored for verifying the optimum tariff level for the full cost recovery of the operation and maintenance cost during the long-term period. The tariff level should be also adjusted to the total cost including the outsourcing costs for the collection and transport services to the selected private service provider.

(4) Implementation of Financially Efficient Private Sector Involvement

During the long-term period from 2025 to 2030, the outsourcing by GWMC in the form of the service contract with the selected private service provider will be actually carried out from 2028 with the following actions:

- To manage the tender procedure for the service contract;
- To monitor the financial performance of the selected private service provider by the financial KPIs which are separated from those of GWMC;
- To provide the auditing services for the selected private service provider; and
- To properly manage the outsourced service zone.

The pre-contract requirements for a zone-wise service contract for waste collection and transport services are the management of the complicated tendering procedures for the private sector involvement. Especially, it is crucial to secure the following 7-step processes of preparing for the service contract:

- Step 1: Preparation for expression of interests and pre-qualification of bidders
- Step 2: Preparation of tender documents
- Step 3: Preparation of the bid
- Step 4: Clarifications and feedbacks to tender documents
- Step 5: Bid bond
- Step 6: Submission of bids
- Step 7: Selection of the private service provider

Effective performance monitoring requires that the GWMC monitors whether or not the service is actually and properly being delivered by the selected service provider in the financially sound manner. The staff of the MIS unit inside GWMC should monitor the performance of the private service provider on the regular basis.

After the long-term period, the private sector involvement through the partial outsourcing of the collection and transport services will be comprehensively reviewed to achieve the long-term sustainability of the private sector involvement in future. This review requires the continuous performance monitoring of the selected service provider for the future expansion of the outsourced zones.

4.4 Implementation Schedule of Economic and Financial Plan

The implementation schedule of the Economic and Financial Plan is illustrated in **Figure F.4.2**.

Time Framework of the Master Plan		Short-Term Plan Period											Mid-Term Plan Period						Long-Term Plan Period					
Year		2016				2017				2018			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4											
WBS for Short-Term Plan																								
S-S-1	Establishment of Sustainable Cost Recovery (Preparatory Phase)																							
S-S-2	Implementation of Accurate Total Costing (Preparatory Phase)																							
S-S-3	Introduction of Proper Tariff Charging System (Preparatory Phase)																							
S-S-4	Implementation of Financially Efficient Private Sector Involvement (Preparatory Phase)																							
WBS for Mid-Term Plan																								
M-S-1	Establishment of Sustainable Cost Recovery (Phase 1)																							
M-S-2	Implementation of Accurate Total Costing (Phase 1)																							
M-S-3	Introduction of Proper Tariff Charging System (Phase 1)																							
M-S-4	Implementation of Financially Efficient Private Sector Involvement (Phase 1)																							
WBA for Long-Term Plan																								
L-S-1	Establishment of Sustainable Cost Recovery (Phase 2)																							
L-S-2	Implementation of Accurate Total Costing (Phase 2)																							
L-S-3	Introduction of Proper Tariff Charging System (Phase 2)																							
L-S-4	Implementation of Financially Efficient Private Sector Involvement (Phase 2)																							

Figure F.4.2 Implementation Schedule of the Economic and Financial Plan

4.5 Project Cost of Economic and Financial Plan

Table F.4.5 shows the project cost for the Master Plan and **Figure F.4.3** shows the Project Cost and Responsibility under the Economic and Financial Plan.

Table F.4.5 Implementation Cost of the Economic and Financial Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost															
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 5: Economic and Financial Plan																		
Short-Term Plan																		
S-S-1	Establishment of Sustainable Cost Recovery (Preparatory Phase)	GWMC																
S-S-2	Implementation of Accurate Total Costing (Preparatory Phase)	GWMC																
S-S-3	Introduction of Proper Tariff Charging System (Preparatory Phase)	186 (Included in GWMC's Staff Training Budget: Module 6)	62	62	62													
S-S-4	Implementation of Financially Efficient Private Sector Involvement (Preparatory Phase)	186 (Included in GWMC's Staff Training Budget: Module 6)			186													
	Sub-Total	372 (Included in GWMC's Staff Training Budget: Module 5 and 6)	62	62	248	0	0	0	0	0	0	0	0	0	0	0	0	0
Mid-Term Plan																		
M-S-1	Establishment of Sustainable Cost Recovery (Phase 1)	GWMC																
M-S-1	Implementation of Accurate Total Costing (Phase 1)	GWMC																
M-S-3	Introduction of Proper Tariff Charging System (Phase 1)	624 (Included in GWMC's Staff Training Budget: Module 6)				104	104	104	104	104	104							
M-S-4	Implementation of Financially Efficient Private Sector Involvement (Phase 1)	726 (Included in GWMC's Staff Training Budget: Module 6)				121	121	121	121	121	121							
	Sub-Total	1,350 (Included in GWMC's Staff Training Budget: Module 5 and 6)	0	0	0	225	225	225	225	225	225	0	0	0	0	0	0
Long-Term Plan																		
L-S-1	Establishment of Sustainable Cost Recovery (Phase 2)	GWMC																
L-S-2	Implementation of Accurate Total Costing (Phase 2)	GWMC																
L-S-3	Introduction of Proper Tariff Charging System (Phase 2)	504 (Included in GWMC's Staff Training Budget: Module 6)										84	84	84	84	84	84
L-S-4	Implementation of Financially Efficient Private Sector Involvement (Phase 2)	GWMC																
	Sub-Total	504 (Included in GWMC's Staff Training Budget: Module 6)	0	0	0	0	0	0	0	0	0	84	84	84	84	84	84
	Grand Total	2,226 (Included in GWMC's Staff Training Budget: Module 5 and 6)	62	62	248	225	225	225	225	225	225	84	84	84	84	84	84

Programme No.	WBS No.	WBS	Budgetary Arrangment (Required=●)	Total Budget (Thousand Rs.)	Responsibility Assignment Matrix: M=Main Responsibility, S=Sub Responsibilities. B=Budgetary Arrangement, L=Legal Action, P=Participation in Discussions																
					GWMC/Operation Unit	GWMC/P&C Unit	GWMC/Financial Unit	GWMC/HR & Administration Unit	City District Government Gujranwala (CDGG)	The Urban Unit, Government of the Punjab	P&D Dept., Government of the Punjab	Local Gov't Dept., Government of the Punjab	Environment Protection Department (EPD)	Donor Organisations	Private Contractor/Consultant	Recyclers	CBOs & NGOs	Waste Pickers	PAPs around Gondianwala Disposal Site	PAPs around Shakhraywall Disposal Site	Gujranwala Citizens
Programme 5: Economic and Financial Plan																					
Short-Term Plan																					
	S-5-1	Establishment of Sustainable Cost Recovery (Preparatory Phase)		GWMC	P	P	M	S													
	S-5-2	Implementation of Accurate Total Costing (Preparatory Phase)		GWMC	P	P	M	S													
	S-5-3	Introduction of Proper Tariff Charging System (Preparatory Phase)	●	186 (Included in GWMC's Staff Training Budget: Module 6)	P	P	M	B	L	P	P	P									
	S-5-4	Implementation of Financially Efficient Private Sector Involvement (Preparatory Phase)	●	196 (Included in GWMC's Staff Training Budget: Module 5)	P	P	M	B	L	P					P						
		Sub-Total		GWMC																	
Mid-Term Plan																					
	M-5-1	Establishment of Sustainable Cost Recovery (Phase 1)		GWMC	P	P	M	S													
	M-5-2	Implementation of Accurate Total Costing (Phase 1)		GWMC	P	P	M	S													
	M-5-3	Introduction of Proper Tariff Charging System (Phase 1)	●	624 (Included in GWMC's Staff Training Budget: Module 6)	P	P	M	B	L	P	P	P									
	M-5-4	Implementation of Financially Efficient Private Sector Involvement (Phase 1)	●	726 (Included in GWMC's Staff Training Budget: Module 5)	P	P	M	B	L	P					P						
		Sub-Total		GWMC																	
Long-Term Plan																					
	L-5-1	Establishment of Sustainable Cost Recovery (Phase 2)		GWMC	P	P	M	S													
	L-5-2	Implementation of Accurate Total Costing (Phase 2)		GWMC	P	P	M	S													
	L-5-3	Introduction of Proper Tariff Charging System (Phase 2)	●	504 (Included in GWMC's Staff Training Budget: Module 6)	P	P	M	B	L	P	P	P									
	L-5-4	Implementation of Financially Efficient Private Sector Involvement (Phase 2)		GWMC	P	P	M	B	L	P					P						
		Sub-Total		GWMC																	
		Grand Total		2,236 (Included in GWMC's Staff Training Budget: Module 5 and 6)																	

Figure F.4.3 Project Cost and Responsibility under Economic and Financial Plan

4.6 Financial and Economic Evaluation

4.6.1 Financial Evaluation

(1) Objective

The purpose of the financial evaluation is to ensure the long-term financial sustainability of the implementation of the master plan, which implies the following:

- Estimation of the project revenues and costs on the market price basis and their implications in terms of cash flow;
- Definition of the project financing structure as well as its financial viability; and
- Verification of the sufficiency of the projected cash flow to ensure the adequate operation of the SWM services.

For the purpose of preparation of the application for funding, the financial evaluation is necessary in order to provide the basis for the calculation of the funding gap of the selected option of the master plan. The verification of the project financial sustainability implies a cumulative positive cash flow for each year of the selected option.

(2) Presumption

(a) Project Life

The period for the financial evaluation of the master plan is assumed to be 15 years from 2016 to 2030.

(b) Prices

The prices employed for the financial evaluation are all market prices as of August 2015.

(c) Cut-off Rate

The cut-off rate for the economic evaluation is 7.0 per cent[1], being equivalent to the reverse repo rate of the State Bank of Pakistan as of August 2015, which is also known as the policy rate or the discount rate of Pakistan.

(3) Identification of Financial Costs

(a) Investment Cost

The investment cost for the master plan on the financial price basis is estimated at Rs. 10,848 million for the period of 15 years from 2016 to 2030. The investment cost is composed of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarter of GWMC. The detailed financial investment cost for the entire period of the master plan is as shown in **Table F.4.6**.

Table F.4.6 Financial Investment Cost for the Master Plan

Year	Investment Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2016	779,993	408,382	0	1,400	0	3,500	1,193,275
2017	592,741	247,600	0	0	0	3,500	843,841
2018	60,740	1.093,648	40,000	0	0	3,000	1,197,388
2019	0	129,800	402,000	0	0	1,000	532,800
2020	0	144,020	0	0	0	500	144,520
2021	541,455	284,640	0	0	0	500	826,595
2022	552,755	263,940	0	625	0	500	817,820
2023	127,458	236,900	0	0	0	0	364,358
2024	300,000	266,420	0	0	0	0	566,420
2025	541,455	540,650	0	0	0	0	1,082,105
2026	552,755	384,460	0	0	0	1,000	938,215
2027	57,333	392,464	0	0	0	0	449,797
2028	0	706,180	4,000	625	0	0	710,805
2029	105,000	481,344	70,000	0	0	0	656,344
2030	0	523,084	0	0	0	1,000	524,084
Total	4,211,685	6,103,532	516,000	2,650	0	14,500	10,848,367

(b) Operation and Maintenance Cost

The operation and maintenance cost for the master plan on the financial price basis is estimated at Rs. 8,490 million for the period of 15 years from 2016 to 2030. The operation and maintenance cost is composed of personnel costs, operating costs and maintenance costs of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarter of GWMC. The detailed financial operation and maintenance cost for the entire period of the master plan is as shown in **Table F.4.7**.

Table F.4.7 Financial Operation and Maintenance Cost for the Master Plan

Year	Operation and Maintenance Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2016	18,669	179,543	0	2,854	435	10,789	212,290
2017	21,859	210,847	0	2,479	870	11,018	247,073
2018	31,623	335,601	0	2,637	1,290	15,745	386,896
2019	32,831	357,183	0	3,803	1,290	28,496	423,603
2020	31,547	378,915	39,239	5,574	1,290	18,499	475,063
2021	32,554	420,057	42,415	4,314	1,725	19,201	520,266
2022	33,637	408,541	43,376	7,257	2,160	35,501	530,472
2023	37,200	439,176	44,799	7,109	1,290	23,109	552,683
2024	43,786	472,558	45,866	8,283	1,290	24,604	596,388
2025	44,780	507,834	45,866	10,473	1,725	41,891	652,569
2026	45,766	543,432	45,866	9,776	2,160	29,420	676,420
2027	49,254	581,395	45,866	10,203	1,290	30,848	718,856
2028	50,431	622,646	45,866	11,124	1,725	49,592	781,385
2029	51,606	669,986	45,866	13,430	2,160	34,034	817,082
2030	58,710	720,640	63,886	17,544	1,290	37,198	899,267
Total	584,252	6,848,354	508,911	116,860	21,990	409,947	8,490,314

(c) Replacement Cost

The replacement cost for the master plan on the financial price basis is estimated at Rs. 1,158 million for the period of 15 years from 2016 to 2030. The replacement cost is composed of the replacement of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarter of GWMC. The detailed financial replacement cost for the entire period of the master plan is as shown in **Table F.4.8**.

Table F.4.8 Financial Replacement Cost for the Master Plan

Year	Replacement Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2016	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0
2020	0	980	0	0	0	0	980
2021	0	2660	0	100	0	0	2,760
2022	0	4,620	0	100	0	0	4,720
2023	17,325	24,500	0	100	0	0	41,925
2024	0	74,280	0	100	0	0	74,380
2025	0	65,380	0	100	0	0	65,480
2026	0	136,420	0	1,600	0	0	138,020
2027	0	160,336	0	200	0	0	160,536
2028	0	158,256	0	200	0	0	158,456
2029	69,300	221,056	0	200	0	0	290,556
2030	0	220,416	0	200	0	0	220,616
Total	86,625	1,068,904	0	2,900	0	0	1,158,429

(d) Total Project Cost

The total cost for the master plan on the financial price basis is estimated at Rs. 20,497 million for the period of 15 years from 2016 to 2030, summing up the investment cost, the operation and maintenance cost and the replacement cost of all project components. The contingencies for the project cost are separately added. The total financial project cost for the entire period of the master plan is as shown in **Table F.4.9**.

Table F.4.9 Total Financial Project Cost for the Master Plan

Year	Total Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2016	798,662	587,925	0	4,254	435	14,289	1,405,565
2017	614,600	458,447	0	2,479	870	14,518	1,090,914
2018	92,363	1,429,249	40,000	2,637	1,290	18,745	1,584,284
2019	32,831	486,983	402,000	3,803	1,290	29,496	956,403
2020	31,547	523,915	39,239	5,574	1,290	18,999	620,563
2021	574,008	707,357	42,415	4,414	1,725	19,701	1,349,620
2022	586,392	677,101	43,376	7,982	2,160	36,001	1,353,012
2023	181,983	700,576	44,799	7,209	1,290	23,109	958,966
2024	343,786	813,258	45,866	8,383	1,290	24,604	1,237,188

Year	Total Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2025	586,234	1,113,864	45,866	10,573	1,725	41,891	1,800,154
2026	598,521	1,064,312	45,866	11,376	2,160	30,420	1,752,655
2027	106,587	1,134,195	45,866	10,403	1,290	30,848	1,329,189
2028	50,431	1,487,082	49,866	11,949	1,725	49,592	1,650,646
2029	225,906	1,372,386	115,866	13,630	2,160	34,034	1,763,982
2030	58,710	1,464,140	63,886	17,744	1,290	38,198	1,643,967
Total	4,882,562	14,020,790	1,024,911	122,410	21,990	424,447	20,497,110

(4) Identification of Financial Benefits

The financial project benefits of the master plan are calculated based on the market prices as of August 2015. The benefit accrued from the methane gas reduction is excluded from the financial project benefits, since the benefit cannot actually be converted into real monetary values. Other unquantifiable benefits are also excluded from the financial project benefits.

The total benefit of the master plan on the financial price basis is estimated at Rs. 25,139 million for the period of 15 years from 2016 to 2030, summing up a wide range of the economic benefits, social benefits and environmental benefits. The total financial benefits for the entire period of the master plan are as shown in **Table F.4.11**.

The following factors are taken into account when the benefits are calculated.

- The monetary-based benefit on the market price accrued from the total saved cost for the final disposal is based on the unit saved waste disposal cost as well as the related cost of Rs. 625.7 per ton.
- The above unit saved waste disposal cost as well as the related cost is estimated by the calculation based on the 5-percent increase of the unit cost of Rs. 595.9 with the master plan.
- The unit waste disposal cost of Rs. 595.9 in case of the implementation of the master plan is calculated based on the following formula:

  Unit Waste Disposal Cost in case of Implementation of Master Plan = Total Disposal and Related Cost for Entire Period of Master Plan (2016-2030) / Total Disposed Amount of Waste for Entire Period of Master Plan (2016-2030)

- The 5-percent increase of the unit waste disposal cost of Rs. 595.9 with the master plan is accrued from the inefficient waste management through illegal dumping of uncollected wastes under the absence of the implementation of the master plan. This inefficient waste management is caused by the scattered collection points as well as the increase in the collection frequency in association with the ado-hoc collection of wastes due mainly to the said illegal dumping without the master plan. The said 5-percent increase is estimated by the final disposal expert of the study team based on the collection inefficiency and the collection routes under the absence of the implementation of the master plan.
- The monetary-based benefit on the market price accrued from the total saved cost for the collection and transport is based on the unit saved cost for the collection and transport of Rs. 1,354.7 per ton.
- The above unit saved waste collection and transport cost is estimated by the calculation based on the 5-percent increase of the unit cost of Rs. 1,290.2 with the master plan.
- The unit waste collection and transport cost of Rs. 1,290.2 in case of the implementation of the master plan is calculated based on the following formula:

  Unit Waste Collection and Transport Cost in case of Implementation of Master Plan =

Total Collection and Transport Cost for Entire Period of Master Plan (2016-2030) / Total Collection and Transport Amount of Wastes for Entire Period of Master Plan (2016-2030)

- The 5-percent increase of the unit waste collection and transport cost of Rs. 1,290.2 with the master plan is accrued from the inefficient waste management through illegal dumping of uncollected wastes under the absence of the implementation of the master plan. This inefficient waste management is caused by the scattered collection points as well as the increase in the collection frequency in association with the ado-hoc collection of wastes due mainly to the said illegal dumping without the master plan. The said 5-percent increase is estimated by the collection and transport expert of the study team based on the collection inefficiency and the collection routes under the absence of the implementation of the master plan.
- The monetary-based benefit accrued from the recycling is based on the condition that the unit cost per recovered material, the unit cost per compost product, and the unit cost per combustible waste is Rs. 27.38 per kg, Rs. 5.00 per kg, and Rs. 52.50 per ton, respectively.
- The unit cost of Rs. 27.38 per kg per recovered material is estimated by the latest weighted average of market prices of various recovered materials in Gujranwala, which is tabulated in **Table F.4.10**.

Table F.4.10 Estimated Weighted Average of Selling Prices of Various Recyclables

Recyclables	Average Unit Selling Prices (Rs./kg)	Percentage of Each Recyclable (%)	Weighted Average of Selling Prices of Recyclables (Rs./Kg)
Cardboard	8.0	26.0	2.08
Paper (Others)	8.0	8.0	0.64
Plastic	23.0	13.0	2.99
Plastic (Others)	12.0	15.0	1.8
Metal (Others)	62.0	29.0	17.98
Metal (Steel)	30.0	6.0	1.8
Glass	3.0	3.0	0.09
Total	-	100.0	27.38

Source: Field Survey in Gujranwala, August 2015

- The unit cost of Rs. 5.00 per kg per compost product is estimated by the latest market price in August 2015, which is based on the information collected from the compost plant in Lahore.
- The unit cost of Rs. 52.50 per ton per RDF product is estimated by the latest market price in August 2015, which is based on the information collected from the RDF plant in Lahore.
- The social benefit accrued from the willingness to pay is based on the condition that the willingness to pay for SWM services in low-income areas, middle-income areas, and high-income areas is Rs. 25 per month per household, Rs. 50 per month per household, and Rs. 100 per month per household, respectively.

Table F.4.11 Project Benefits on Financial Price Basis for the Master Plan

Year	Economic Benefit			Social Benefit	Environmental Benefit	Total Benefit (Rs. 1000)
	Total Saved Cost by Final Disposal (Rs. 1000)	Total Saved Cost by Collection and Transport (Rs. 1000)	Recycling (Rs. 1000)	Willingness to Pay (Rs. 1000)	Methane Gas Reduction (Rs. 1000)	
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	275,992	597,549	0	0	0	873,541
2019	303,560	657,235	111,352	0	0	1,072,147
2020	333,307	721,642	122,264	0	0	1,177,213
2021	365,590	791,536	134,106	0	0	1,291,232
2022	400,547	867,222	146,929	131,311	0	1,546,009
2023	438,307	948,977	160,780	136,288	0	1,684,352
2024	479,045	1,037,177	175,724	141,453	0	1,833,399
2025	518,565	1,122,741	307,156	204,849	0	2,153,312
2026	559,244	1,210,817	331,252	212,613	0	2,313,926
2027	604,722	1,309,280	358,189	220,671	0	2,492,861
2028	654,829	1,417,768	387,869	229,034	0	2,689,501
2029	706,714	1,530,102	418,601	237,714	0	2,893,132
2030	764,250	1,654,674	452,681	246,724	0	3,118,329
Total	6,404,671	13,866,721	3,106,904	1,760,657	0	25,138,953

(5) Cases of Evaluation

The timing of the introduction of the tariff system and the involvement of the private sector through outsourcing are major variations to affect the financial viability of the master plan. The following 3 cases including the base case (Case A) together with 2 variations are the cases of the financial evaluation in the master plan.

- Case A: Base Case of Master Plan
- Case B: Based on the current level of users' willingness to pay, the tariff system will be introduced from 2019 at the early stage of the master plan.
- Case C: Outsourcing to the private sector (service contract of the collection and transport) will be introduced from 2025 based on the basic organisational and institutional setting up of the master plan.

(6) Results of Financial Evaluation

(a) FIRR and NPV

The results of the calculations of financial internal rate of return (FIRR) and net present value (NPV) for 3 cases for the financial evaluation are as per **Table F.4.12**, and the major findings are as below. The detailed cost and benefit streams for the financial evaluation of the base case of the master plan are as shown in **Table F.4.13**.

Table F.4.12 Results of FIRR and NPV for Master Plan

Case	FIRR (Per cent)	NPV (Rs. 1000)
Case A	9.18	1,022,337
Case B	9.65	1,123,387
Case C	10.42	1,502,368

- For Case A, the base case of the master plan, in which the full-scale tariff system will be introduced in all areas from 2025 and the outsourcing to the private sector will not be carried out, the FIRR and the NPV are estimated at 9.18 per cent and Rs. 1,022 million, respectively.
- For Case B in which the full-scale tariff system will be introduced from 2019 at the early stage of the master plan from and the outsourcing to the private sector will not be carried out, the FIRR and the NPV are estimated at 9.65 per cent and Rs. 1,123 million, respectively.
- For Case C in which the full-scale tariff system will be introduced in all areas from 2025 and the outsourcing to the private sector will be carried out from 2025, the FIRR and the NPV are estimated at 10.42 per cent and Rs. 1,502 million, respectively.

Table F.4.13 Cost and Benefit Streams for Financial Evaluation

Year	Total Financial Cost (Rs. 1000)	Total Financial Benefit (Rs. 1000)	Net Financial Benefit (Rs. 1000)	Net Accumulated Financial Benefit (Rs. 1000)
2016	1,465,224	0	-1,465,224	-1,465,224
2017	1,145,173	0	-1,145,173	-2,610,398
2018	1,590,018	873,541	-716,478	-3,326,875
2019	956,403	1,072,147	115,744	-3,211,131
2020	620,563	1,177,213	556,650	-2,654,481
2021	1,403,766	1,291,232	-112,534	-2,767,015
2022	1,407,158	1,546,009	138,851	-2,628,163
2023	964,700	1,684,352	719,652	-1,908,511
2024	1,237,188	1,833,399	596,211	-1,312,300
2025	1,854,299	2,153,312	299,012	-1,013,287
2026	1,806,801	2,313,926	507,126	-506,162
2027	1,334,923	2,492,861	1,157,938	651,777
2028	1,650,646	2,689,501	1,038,855	1,690,631
2029	1,763,982	2,893,132	1,129,149	2,819,781
2030	11,643,967	3,118,329	1,474,361	4,294,142
Total	20,844,811	25,138,953	4,294,142	4,294,142

(b) Sensitivity Analysis

Table F.4.14 indicates the results of the financial evaluation together with the assumptions for risk factors of each option applied for the sensitivity analysis to measure the impacts caused by 10 per cent increase in costs and 10 per cent decrease in benefits.

Since the initial investment, especially the investment on the final disposal component, is large at the early stage of the master plan, the project is vulnerable to the both the increase of costs and the decrease of benefits in all cases. Especially, when the cost increase and the benefit decrease simultaneously hit the project, all the FIRRs for Case A, Case B and Case C will sharply fall down to the negative figures which are all below the cut-off rate.

Table F.4.14 Results of Financial Evaluation and Sensitivity Analysis

Case	Case No.	Scenario	FIRR (Per cent)	NPV (Rs. 1000)
Base Case	A-1	No Risk Factor	9.18	1,022,337
	A-2	Cost 10 % increase	4.72	-448,407
	A-3	Benefit 10% decrease	4.23	-550,640
	A-4	Cost 10% increase and benefit 10% decrease	-0.74	-2,021,384
Early Introduction of Full-scale Tariff System from 2019	B-1	No Risk Factor	9.65	1,123,387
	B-2	Cost 10 % increase	4.88	-347,357
	B-3	Benefit 10% decrease	4.35	-459,695
	B-4	Cost 10% increase and benefit 10% decrease	-1.06	-1,930,439
Private Sector Involvement from 2025	C-1	No Risk Factor	10.42	1,502,368
	C-2	Cost 10 % increase	6.33	79,627
	C-3	Benefit 10% decrease	5.89	-70,609
	C-4	Cost 10% increase and benefit 10% decrease	1.50	-1,493,350

(7) Conclusion

For Case A-1, although the net financial benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net financial benefit would be positive. In 2021, the net financial benefit would be temporarily negative in this single year mainly due to the additional investment of the landfill site. The total net financial benefit is estimated at Rs. 4,294 million. While the FIRR for Case A-1 is calculated at 9.18 per cent which is slightly over the cut-off rate of 7.0 per cent, the NPV for Case A-1 is estimated at Rs. 1,022 million. The result proved that the implementation of the master plan is financially viable.

For Case B-1, although the net financial benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net financial benefit would be positive. The total net financial benefit is estimated at Rs. 4,190 million. While the FIRR for Case B-1 is calculated at 9.65 per cent which is slightly over the cut-off rate of 7.0 per cent, the NPV for Case B-1 is estimated at Rs. 1,123 million. The result proved that the implementation of the master plan, if the tariff system would be introduced at the early stage of the master plan from 2019, the financial viability would be more favourable than the Case A-1.

For Case C-1, although the net financial benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net financial benefit would be positive. In 2021, the net financial benefit would be temporarily negative in this single year mainly due to the additional investment of the landfill site. The total net financial benefit is estimated at Rs. 5,188 million. While the FIRR for Case C-1 is calculated at 10.42 per cent which is slightly over the cut-off rate of 7.0 per cent, the NPV for Case C-1 is estimated at Rs. 1,502 million. The result proved that the implementation of the master plan, if the private sector involvement would be started from 2025, the financial viability would be more favourable than the Case A-1.

The sensitivity analysis proved that, in every case, the implementation of the master plan is financially vulnerable to the cost increase and the benefit decrease. Especially, the financial viability will be significantly reduced when the cost increase and the benefit decrease take place at the same time.

4.6.2 Tariff Review

(1) Objective and Scenarios

The purpose of the tariff review is to provide the additional financial evaluation for verifying an optimum level of the tariff for SWM services, thereby achieving the long-term financial sustainability of the master plan.

There are mainly three (3) scenarios for the cost recovery of SWM projects in accordance with the scope of the cost coverage including the capital investment cost, operation and maintenance cost and replacement cost.

- Scenario 1: The operation and maintenance cost will be covered by the total revenue.
- Scenario 2: The operation and maintenance cost plus the depreciations for replacement of existing facilities will be covered by the total revenue.
- Scenario 3: The operating cost and maintenance cost plus the depreciations for replacement of existing facilities and part of new investment will be covered by the total revenue.

Scenario 1 is the most realistic scenario for the tariff review, taking into account the expected cost coverage based on the current willingness to pay for SWM services.

(2) Cases of Evaluation

The cases of the tariff review analysis are the following 4 cases to be assumed based on the variations of 2 variables: i) the collection efficiency of the tariff; and ii) the timing for the full-scale introduction of the tariff system, and their combinations as tabulated in **Table F.4.15** with the following descriptions.

Table F.4.15 Cases of Evaluation for Tariff Review Analysis

Case	Willingness to Pay (Rs. per month per household)			Collection Efficiency (Per cent)			Full-scale Tariff Introduction Timing	
	Low	Medium	High	Low	Medium	High	2022	2025
Case 1	25	50	100	50.0	60.0	70.0		×
Case 2	25	50	100	60.0	70.0	80.0		×
Case 3	25	50	100	50.0	60.0	70.0	×	
Case 4	25	50	100	60.0	70.0	80.0	×	

- Case 1: The collection efficiency of the tariff is relatively lower, and the full-scale introduction of the tariff system in all areas will start from 2025 in the first year of the long-term period.
- Case 2: The collection efficiency of the tariff is relatively higher, and the full-scale introduction of the tariff system in all areas will start from 2025 in the first year of the long-term period.
- Case 3: The collection efficiency of the tariff is relatively lower, and the full-scale introduction of the tariff system in all areas will start from 2022 in the fourth year of the mid-term period.
- Case 4: The collection efficiency of the tariff is relatively higher, and the full-scale introduction of the tariff system in all areas will start from 2022 in the fourth year of the mid-term period.

(3) Results of Tariff Review

(a) Cost Recovery Rate

The results of the analysis on the cost recovery for the above 4 cases are tabulated in **Table F.4.16** to **Table F.4.19**, and the major findings are as follows:

- For Case 1, in which the collection efficiency of the tariff is relatively lower and the

full-scale introduction of the tariff system in all areas will start from 2025 in the first year of the long-term period, the cost recovery rate against the full recovery of the operation and maintenance cost is estimated at 32.4 per cent.

- For Case 2, in which the collection efficiency of the tariff is relatively higher and the full-scale introduction of the tariff system in all areas will start from 2025 in the first year of the long-term period, the cost recovery rate against the full recovery of the operation and maintenance cost is estimated at 37.9 per cent.
- For Case 3, in which the collection efficiency of the tariff is relatively lower and the full-scale introduction of the tariff system in all areas will start from 2022 in the fourth year of the mid-term period, the cost recovery rate against the full recovery of the operation and maintenance cost is estimated at 35.8 per cent.
- For Case 4, in which the collection efficiency of the tariff is relatively higher and the full-scale introduction of the tariff system in all areas will start from 2022 in the fourth year of the mid-term period, the cost recovery rate against the full recovery of the operation and maintenance cost is estimated at 42.0 per cent.

Table F.4.16 Cost Recovery Rate for Case 1

Year	Revenue from Proposed Tariff (Rs.1000)			Operation and Maintenance Cost (Rs.1000)	Net Revenue (Rs.1000)	Cost Recovery Rate (%)	Required Amount of Subsidies (Rs.1000)
	Low Income Area	Medium Income Area	High Income Area				
2016	0	0	0	212,290	-212,290	0.0	212,290
2017	0	0	0	247,073	-247,073	0.0	247,073
2018	0	0	0	386,896	-386,896	0.0	386,896
2019	0	0	0	423,603	-423,603	0.0	423,603
2020	0	0	0	475,063	-475,603	0.0	475,063
2021	0	0	0	501,866	-501,866	0.0	501,866
2022	0	98,727	32,584	511,472	-380,161	25.7	380,161
2023	0	102,469	33,819	533,083	-396,795	25.6	396,795
2024	0	106,352	35,101	576,388	-434,934	24.5	434,934
2025	58,035	110,383	36,431	632,569	-427,720	32.4	427,720
2026	60,234	114,566	37,812	656,420	-443,808	32.4	443,808
2027	62,517	118,909	39,245	698,856	-478,186	31.6	478,186
2028	64,887	123,415	40,732	761,385	-532,351	30.1	532,351
2029	67,346	128,093	42,276	797,082	-559,368	29.8	559,368
2030	69,898	132,947	43,878	876,267	-629,544	28.2	629,544
Total	382,917	1,035,861	1,760,657	8,290,314	-6,529,658	21.2	6,529,658

Table F.4.17 Cost Recovery Rate for Case 2

Year	Revenue from Proposed Tariff (Rs.1000)			Operation and Maintenance Cost (Rs.1000)	Net Revenue (Rs.1000)	Cost Recovery Rate (%)	Required Amount of Subsidies (Rs.1000)
	Low Income Area	Medium Income Area	High Income Area				
2016	0	0	0	212,290	-212,290	0.0	212,290
2017	0	0	0	247,073	-247,073	0.0	247,073
2018	0	0	0	386,896	-386,896	0.0	386,896
2019	0	0	0	423,603	-423,603	0.0	423,603
2020	0	0	0	475,063	-475,603	0.0	475,063
2021	0	0	0	501,866	-501,866	0.0	501,866
2022	0	115,181	37,239	511,472	-359,052	29.8	359,052
2023	0	119,547	38,650	533,083	-374,886	29.7	374,886
2024	0	124,078	40,115	576,388	-412,195	28.5	412,195
2025	69,642	128,780	41,636	632,569	-392,511	37.9	392,511
2026	72,281	133,661	43,214	656,420	-407,265	38.0	407,265
2027	75,021	138,727	44,851	698,856	-440,258	37.0	440,258
2028	77,864	143,984	46,551	761,385	-492,985	35.3	492,985
2029	80,815	149,441	48,316	797,082	-518,511	34.9	518,511
2030	83,878	155,105	50,147	876,267	-587,138	33.0	587,138
Total	459,500	1,208,504	390,719	8,290,314	-6,231,591	24.8	6,231,591

Table F.4.18 Cost Recovery Rate for Case 3

Year	Revenue from Proposed Tariff (Rs.1000)			Operation and Maintenance Cost (Rs.1000)	Net Revenue (Rs.1000)	Cost Recovery Rate (%)	Required Amount of Subsidies (Rs.1000)
	Low Income Area	Medium Income Area	High Income Area				
2016	0	0	0	212,290	-212,290	0.0	212,290
2017	0	0	0	247,073	-247,073	0.0	247,073
2018	0	0	0	386,896	-386,896	0.0	386,896
2019	0	0	0	423,603	-423,603	0.0	423,603
2020	0	0	0	475,063	-475,063	0.0	475,063
2021	0	0	0	501,866	-501,866	0.0	501,866
2022	51,906	98,727	32,584	511,472	-328,255	35.8	328,255
2023	53,874	102,469	33,819	533,083	-342,922	35.7	342,922
2024	55,916	106,352	35,101	576,388	-379,019	34.2	379,019
2025	58,035	110,383	36,431	632,569	-427,720	32.4	427,720
2026	60,234	114,566	37,812	656,420	-443,808	32.4	443,808
2027	62,517	118,909	39,245	698,856	-478,186	31.6	478,186
2028	64,887	123,415	40,732	761,385	-532,351	30.1	532,351
2029	67,346	128,093	42,276	797,082	-559,368	29.8	559,368
2030	69,898	132,947	43,878	876,267	-629,544	28.2	629,544
Total	459,500	849,699	274,714	8,290,314	-6,367,962	23.2	6,367,962

Table F.4.19 Cost Recovery Rate for Case 4

Year	Revenue from Proposed Tariff (Rs.1000)			Operation and Maintenance Cost (Rs.1000)	Net Revenue (Rs.1000)	Cost Recovery Rate (%)	Required Amount of Subsidies (Rs.1000)
	Low Income Area	Medium Income Area	High Income Area				
2016	0	0	0	212,290	-212,290	0.0	212,290
2017	0	0	0	247,073	-247,073	0.0	247,073
2018	0	0	0	386,896	-386,896	0.0	386,896
2019	0	0	0	423,603	-423,603	0.0	423,603
2020	0	0	0	475,063	-475,063	0.0	475,063
2021	0	0	0	501,866	-501,866	0.0	501,866
2022	62,288	115,181	37,239	511,472	-296,764	42.0	296,764
2023	64,648	119,547	38,650	533,083	-310,237	41.8	310,237
2024	67,099	124,078	40,115	576,388	-345,096	40.1	345,096
2025	69,642	128,780	41,636	632,569	-392,511	37.9	392,511
2026	72,281	133,661	43,214	656,420	-407,265	38.0	407,265
2027	75,021	138,727	44,851	698,856	-440,258	37.0	440,258
2028	77,864	143,984	46,551	761,385	-492,985	35.3	492,985
2029	80,815	149,441	48,316	797,082	-518,511	34.9	518,511
2030	83,878	155,105	50,147	876,267	-587,138	33.0	587,138
Total	653,535	1,208,504	390,719	8,290,314	-6,037,556	27.2	6,037,556

(b) Required Tariff Level for Full Cost Recovery

Since it is obvious that the cost recovery rate is 32.4 per cent out of the total operation and maintenance cost in 2025 even after the introduction of the full-scale tariff system which is in line with the current willingness to pay, the remaining balance should be replenished by other stable financial sources and/or subsidies from the provincial government. In this section, the required tariff level for the full coverage of the total operation and maintenance cost by the tariff alone will be estimated for all 4 cases. **Table F.4.20** tabulates the required tariff level for the full recovery of the operation and maintenance cost at the commencement of the introduction of the tariff system.

- For Case 1, in which the collection efficiency of the tariff is relatively lower and the full-scale introduction of the tariff system in all areas will start from 2025 in the first year of the long-term period, the required monthly tariff level for the full recovery of the operation and maintenance cost is estimated at Rs. 77.2 per month per household in low-income areas. Rs. 154.4 per month per household in middle-income areas, Rs. 308.8 per month per household in high-income areas, respectively. The said tariff level in case of low-income areas is 3.09 times as much as the assumed level of the tariff of Rs. 25.0 based on the social study.
- For Case 2, in which the collection efficiency of the tariff is relatively higher and the full-scale introduction of the tariff system in all areas will start from 2025 in the first year of the long-term period, the required monthly tariff level for the full recovery of the operation and maintenance cost is estimated at Rs. 58.9 per month per household in low-income areas. Rs. 117.8 per month per household in middle-income areas, Rs. 235.7 per month per household in high-income areas, respectively. The said tariff level in case of low-income areas is 2.36 times as much as the assumed level of the tariff of Rs. 25.0 based on the social study.

- For Case 3, in which the collection efficiency of the tariff is relatively lower and the full-scale introduction of the tariff system in all areas will start from 2022 in the fourth year of the mid-term period, the required monthly tariff level for the full recovery of the operation and maintenance cost is estimated at Rs. 62.4 per month per household in low-income areas. Rs. 124.8 per month per household in middle-income areas, Rs. 249.7 per month per household in high-income areas, respectively. The said tariff level in case of low-income areas is 2.50 times as much as the assumed level of the tariff of Rs. 25.0 based on the social study.
- For Case 4, in which the collection efficiency of the tariff is relatively higher and the full-scale introduction of the tariff system in all areas will start from 2022 in the fourth year of the mid-term period, the required monthly tariff level for the full recovery of the operation and maintenance cost is estimated at Rs. 47.6 per month per household in low-income areas. Rs. 95.3 per month per household in middle-income areas, Rs. 190.6 per month per household in high-income areas, respectively. The said tariff level in case of low-income areas is 1.90 times as much as the assumed level of the tariff of Rs. 25.0 based on the social study.

Table F.4.20 Required Tariff Level for Full Recovery of Operation and Maintenance Cost at Commencement of Full-scale Tariff System

Case	Area	Generated Revenue at Commencement of Tariff System (Rs.1000)	Required Revenue for Full Recovery of Operation and Maintenance Cost at Commencement of Tariff System (Rs.1000)	Required Tariff for Full Recovery of Operation and Maintenance Cost at Commencement of Full-scale Tariff System (Rs. per month per household)
Case 1	Low	58,035	179,211	77.2
	Middle	110,383	340,860	154.4
	High	36,431	112,499	308.8
	Total	204,849	632,569	Not Applicable (n.a.)
Case 2	Low	69,642	183,512	58.9
	Middle	128,780	339,345	117.8
	High	41,636	109,713	235.7
	Total	240,058	632,569	n.a.
Case 3	Low	51,906	144,903	62.4
	Middle	128,780	275,607	124.8
	High	41,636	90,962	249.7
	Total	240,058	511,472	n.a.
Case 4	Low	77,864	148,380	47.6
	Middle	143,984	274,382	95.3
	High	46,551	88,710	190.6
	Total	268,399	511,472	n.a.

4.6.3 Economic Evaluation

(1) Objective

The purpose of the economic evaluation is to ensure that the project has a positive net contribution to the improvement in welfare and SWM services in Gujranwala, thereby being worth to be financed. Economic efficiency is a fundamental criterion for the public investment on the SWM sector, which means that benefits must outweigh costs of using scarce resources. The benefits in the

cost-benefit analysis should be converted to monetary values. Total benefits are calculated based on three sub-groups: economic, social and environmental benefits.

(2) Presumptions

(a) Project Life

The period for the economic evaluation of the master plan is assumed to be 15 years from 2016 to 2030.

(b) Prices

Taxes, Customs duties, government subsidies, etc., are not inherent cost items incurred in the project. These transfer items should be excluded from the project cost. The project cost is estimated by the prices as of August 2015. The inflationary cost elements incurred during the construction period should be excluded, since these are external factors for the project.

(c) Cut-off Rate

The cut-off rate for the economic evaluation is 7.0 per cent, being equivalent to the reverse repo rate of the State Bank of Pakistan as of August 2015, which is also known as the policy rate or the discount rate of Pakistan.

(d) Standard Conversion Factor

The local currency portion for facilities and equipment related to the project should be converted into economic prices by applying the standard conversion factor, because this portion is usually evaluated within Pakistan and the prices are distorted due to the inefficient markets. Consequently, they do not reflect international market prices. In this master plan, the standard conversion factor employed is 0.904.

(e) Opportunity Cost of Unskilled Labour

The skilled labour cost is considered to reflect the market price. However, the unskilled labour cost is not considered to reflect the market price because of the lack of liquidity of workers which is the surplus of workers caused by the rate of unemployment or potential unemployment in Pakistan. The unskilled labour cost is necessary to be revised by the opportunity cost. Hence, the opportunity cost of the unskilled labour is assumed to be 0.750 of the financial price as the conversion factor by taking into account the unemployment rate of Pakistan.

(f) Physical Contingency

The physical contingency is calculated as 10 per cent of the relevant construction cost of the final disposal site including civil works and facilities.

(3) Identification of Economic Costs

The economic costs are estimated based on the financial costs required for extending the improved SWM services in the master plan. The economic costs consist of all resources required to put in place and maintain SWM services in the selected master plan as well as other costs that result from the implementation of the master plan. These costs include investment cost, operation and maintenance costs, and replacement costs.

(a) Investment Cost

The investment cost for the master plan on the economic price basis is estimated at Rs. 8,417 million for the period of 15 years from 2016 to 2030. The investment cost is composed of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the

environmental education, the environmental monitoring and the strengthening of the headquarters of GWMC. The detailed investment cost for the entire period of the master plan is as shown in **Table F.4.21**.

Table F.4.21 Economic Investment Cost for the Master Plan

Year	Investment Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2016	605,245	313,229	0	1,109	0	2,685	922,267
2017	463,253	189,909	0	0	0	2,685	650,477
2018	46,588	838,828	30,680	0	0	2,301	918,397
2019	0	99,557	340,954	0	0	767	441,278
2020	0	110,463	0	0	0	384	110,847
2021	415,296	218,319	0	0	0	384	633,998
2022	423,963	202,442	0	479	0	384	627,268
2023	113,139	181,702	0	0	0	0	294,841
2024	230,100	204,344	0	0	0	0	434,444
2025	415,296	414,679	0	0	0	0	829,974
2026	423,963	294,881	0	0	0	767	719,611
2027	43,975	301,020	0	0	0	0	344,995
2028	0	541,640	3,068	479	0	0	545,187
2029	103,835	369,191	63,476	0	0	0	536,502
2030	0	401,205	0	0	0	767	401,972
Total	3,284,651	4,681,409	438,178	2,068	0	11,122	8,417,427

(b) Operation and Maintenance Cost

The operation and maintenance cost for the master plan on the economic price basis is estimated at Rs. 6,588 million for the period of 15 years from 2016 to 2030. The operation and maintenance cost is composed of personnel costs, operating costs and maintenance costs of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarter of GWMC. The detailed operation and maintenance cost for the entire period of the master plan is as shown in **Table F.4.22**.

Table F.4.22 Economic Operation and Maintenance Cost for the Master Plan

Year	Operation and Maintenance Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2016	15,316	136,532	0	2,399	334	9,366	163,946
2017	17,763	160,329	0	2,130	667	10,719	191,608
2018	25,752	255,085	0	2,269	989	15,442	299,538
2019	26,679	271,284	0	3,181	989	25,582	327,715
2020	25,694	287,806	30,814	4,557	989	18,227	368,087
2021	26,466	319,124	33,434	3,614	1,323	19,111	403,073
2022	27,297	310,365	34,192	6,207	1,657	31,992	411,710
2023	20,030	333,686	35,335	6,142	989	22,837	429,019
2024	35,473	359,093	36,216	7,091	989	24,337	463,200
2025	36,235	385,939	36,216	8,820	1,323	37,950	506,483
2026	36,991	413,040	36,216	8,343	1,657	29,011	525,258
2027	39,667	441,917	36,216	8,737	989	30,573	558,099
2028	40,570	473,301	36,216	9,565	1,323	45,456	606,431
2029	41,471	509,307	36,216	11,714	1,657	34,034	634,399

Year	Operation and Maintenance Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2030	47,506	547,838	50,378	15,273	989	37,198	6699,183
Total	472,911	5,204,647	401,448	100,041	16,866	391,834	6,587,747

(c) Replacement Cost

The replacement cost for the master plan on the economic price basis is estimated at Rs. 907 million for the period of 15 years from 2016 to 2030. The replacement cost is composed of the replacement of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarter of GWMC. The detailed replacement cost plan for the entire period of the master plan is as shown in **Table F.4.23**.

Table F.4.23 Economic Replacement Cost for the Master Plan

Year	Replacement Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2016	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0
2020	0	752	0	0	0	0	752
2021	0	2,040	0	77	0	0	2,117
2022	0	3,544	0	77	0	0	3,620
2023	17,133	18,792	0	77	0	0	36,001
2024	0	56,973	0	77	0	0	57,049
2025	0	50,146	0	77	0	0	50,223
2026	0	104,634	0	1,262	0	0	105,896
2027	0	122,978	0	153	0	0	123,131
2028	0	121,382	0	153	0	0	121,536
2029	68,531	169,550	0	153	0	0	238,234
2030	0	169,059	0	153	0	0	169,212
Total	85,664	819,849	0	2,259	0	0	907,772

(d) Total Project Cost

The total cost for the master plan on the economic price basis is estimated at Rs. 15,913 million for the period of 15 years from 2016 to 2030, summing up the investment cost, the operation and maintenance cost, and the replacement cost of all project components. The contingencies for the project cost are also included. The detailed total economic project cost for the entire period of the master plan is as shown in **Table F.4.24**.

Table F.4.24 Total Economic Project Cost for the Master Plan

Year	Total Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2016	620,561	449,761	0	3,508	334	12,050	1,086,213
2017	481,017	350,238	0	2,130	667	13,403	847,455
2018	72,340	1,093,913	30,680	2,269	989	17,743	1,217,934
2019	26,679	370,841	340,954	3,181	989	26,349	768,992
2020	25,694	399,021	30,814	4,557	989	18,610	479,685
2021	441,762	539,483	33,434	3,691	1,323	19,495	1,039,188

Year	Total Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	GWMC's Headquarter	
2022	451,260	516,350	34,192	6,763	1,657	32,375	1,042,598
2023	160,301	534,180	35,335	6,219	989	22,837	759,861
2024	265,573	620,410	36,216	7,168	989	24,337	954,693
2025	451,531	850,764	36,216	8,896	1,323	37,950	1,386,680
2026	460,954	812,555	36,216	9,605	1,657	29,778	1,350,765
2027	83,641	865,915	36,216	8,890	989	30,573	1,026,225
2028	40,570	1,136,324	39,284	10,198	1,323	45,456	1,273,154
2029	213,837	1,048,048	99,692	11,867	1,657	34,034	1,409,135
2030	47,506	1,118,103	50,378	15,426	989	37,965	1,270,368
Total	3,843,226	10,705,905	839,626	104,368	16,866	402,955	15,912,947

(4) Identification of Economic Benefits

(a) Economic Benefits

The economic benefits which will be converted to the monetary values would include the following three (3) categories of benefits.

- ***Saving in Disposal Costs of Wastes:*** Waste disposal costs can be significantly reduced by introducing more efficient disposal and segregating wastes in the master plan. The unit saved cost per ton to dispose wastes is estimated at Rs. 625.7 per ton of wastes on the financial price basis. The said unit cost is applied to the waste amount to be disposed of each project year.
- ***Saving in Collection and Transport Costs of Wastes:*** Waste collection and transport costs can be significantly reduced by introducing more efficient collection and transport in the master plan. The unit saved cost per ton to collect and transport wastes is estimated at Rs. 1,354.7 per ton of wastes on the financial price basis. The said unit cost is applied to the waste amount to be disposed of each project year.
- ***Saving through Resource Cost Recovery:*** Cost savings can be also achieved through various types of resource cost recovery which enables waste generators to recover monetary values by selling them in the markets. When reusing reclaimed materials on site, purchase costs of new materials avoided can become economic benefits to the project. The resource cost recovery includes a wide range of the material recovery, the biodegradable waste recovery and the combustible waste recovery. The average values employed for the economic evaluation of the material recovery, the biodegradable waste recovery, and the combustible waste recovery are estimated at Rs. 27.38 per kg, Rs. 5.0 per kg, and Rs. 52.5 per ton, respectively.

(b) Social Benefits

The social acceptance of a SWM project is generally expressed in the form of users' ***Willingness to Pay (WTP)*** for the improvement of SWM services. This is the so-called demand side of the project benefit. In the cost-benefit analysis of the SWM sector, the WTP can be included in the financial and economic benefits only after the said WTP can be converted to real waste collection charges as monetary values under the tariff system.

Although ***Contingent Valuation Method (CVM)*** is one of the methodologies which enable to convert beneficiaries' WTP to monetary values of environmental benefits, there is uncertainty that the results of the CVM represent the accurate monetary values of a SWM project. Therefore, the WTP in the financial and economic evaluation of the master plan will not be employed as monetary values unless the official full-scale tariff system is introduced from 2025. The social study in this project revealed that the average WTP is approximately Rs. 25

per month per household in low-income areas, Rs. 50 per month per household in middle-income areas, and Rs. 100 per month per household in high-income areas.

(c) Environmental Benefits

Although it is rather difficult to convert to monetary values, the benefits in the master plan would also include the environmental benefits derived from the reduction of ***GHG (Greenhouse Gas)*** emissions. The said environmental benefits can be converted to the theoretical monetary values by using the carbon price in the international market under ***CDM (Clean Development Mechanism)***.

Carbon credits under CDM provide an opportunity for an extra source of revenue for SWM projects in developing countries. The main idea is that developed countries will pay for projects in developing countries that contribute to the reduction of GHG emissions. Given that solid waste is a significant source of pollution such as emissions of methane gas by anaerobic degradation, carbon finance represents a good opportunity for SWM projects in developing countries. Actually, methane gas is the most critical GHG emission to air from landfills.

However, carbon credits are difficult to originate due to all the stringent requirements and long scrutiny processes that the project has to go through. Therefore, it would not be realistic to assume that the project is certain to receive an income from carbon credits. For this reason, this analysis will not present scenarios including revenues from carbon credits as financial values in the financial evaluation, while the theoretical economic values based on the current carbon price can be counted in the economic evaluation.

The environmental benefits of the reduced methane gas, one of major GHG emissions should be incorporated into the calculation of environmental benefits in the economic evaluation, which can be traced from the avoidance of methane gas through the construction of the well-controlled landfill site as well as the abolishment of the current badly-managed landfill site based on the following concepts.

A sanitary landfill with a combination of liners, leak detection and leachate collection systems would significantly decrease the amount of methane gas. On the other hand, the current uncontrolled open dumping of wastes releases much methane gas into the environment. Therefore, switching from an open dumping and an ill-managed landfill site to a well-controlled landfill site will significantly reduce the methane gas emission.

The benefits accrued from the reduction of methane gas emissions can be included in the economic analysis alone by applying theoretical monetary values of carbons. The unit economic value of methane gas reduction per ton is estimated at Rs. 7,565.3 based on the recent record-low unit carbon price of € 2.75 per ton, which was traded in April 2013 in the international market.

The calculation formula for estimating the unit economic value of methane gas reduction per ton is as follows:

Unit Economic Value of Methane Gas Reduction Rs. 7,565.3 =
Applied Unit Carbon Price of €2.75 x Exchange Rate 110.04 of Euro to Pakistan Rupee in August 2015 x Global Warming Potential of 25.0

Table F.2.25 indicates the estimation of methane generation amount in anaerobic landfill waste. The sanitary landfill site planned in the master plan will significantly reduce the methane generation amount of 38.1 kg CH4 per ton-waste by 50 per cent, which leads to the sizable environmental benefit.

Table F.4.25 Estimation of Methane Generation Amount in Anaerobic Landfill Waste

Biodegradable Waste Category in Incoming Waste Composition Survey	Objective Biodegradable Waste for Calculation of CH_4	Emission Coefficient (kg-CH_4/kg-waste)	Mixed Ratio of Objective Biodegradable Waste (Dry-base) (%)	Methane Generation Amount (kg-CH_4/ton-waste)
Kitchen Waste	Food Waste	0.145	9.2	13.4
Paper (recyclable)	Waste Paper	0.136	0.4	0.6
Paper (other paper)	Waste Paper	0.136	3.1	4.2
Textile	Waste Fiber	0.150	3.2	4.8
Grass & Wood	Waste Wood	0.151	1.3	1.9
Sieve Remaining	Sludge from Night Soil Treatment Plant	0.133	5.4	7.2
Miscellaneous	Sludge from Night Soil Treatment Plant	0.133	4.6	6.1
Total		-	27.2	38.1

(d) Unquantifiable Benefits

The economic evaluation on a SWM project generally identifies and quantifies relevant benefits by using appropriate measurement and valuation methods. Although it is relatively difficult to convert them into monetary values, the project benefits accrued from the master plan would also include the following unquantifiable social and environmental benefits.

It is widely recognised that the inclusion of these unquantifiable benefits contributes to the indicators of the economic evaluation which frequently underestimates potential positive impacts of a SWM project. Although there are a handful of unquantifiable benefits which might be regarded as rather difficult to be converted into monetary values, it is extremely important to identify and describe the following unquantifiable benefits accrued from the implementation of the master plan.

Direct Benefits Related to Health Improvement

The implementation of the selected master plan, especially the improvement of the poorly-managed landfill sites, might mitigate a wide spectrum of transmissions of infectious diseases around the landfill sites through water-borne diseases, polluted air-borne diseases and vector-borne diseases. Although these direct health impacts can be measured by such indicators as the reduction in incidence rates (number of cases reduced per year) and the reduction in mortality rates (number of deaths avoided per year), it is rather difficult to convert them into monetary values.

Indirect Benefits Related to Health Improvement

Indirect benefits related to the health improvement include medical and public health costs to be avoided due to the mitigated incidence rates of infectious diseases around the landfill sites. The cost saving for the vector control activities to prevent outbreaks of vector-borne diseases around the landfill site is another indirect benefits related health improvement.

Increase in Land Value

The mitigation of visual dis-amenities and odours by the existing ill-managed landfill site and illegal dump sites would increase the prices of lands around the current landfill site and illegal dump sites. The hedonic pricing method (HPM) seeks to find a relationship between the levels of environmental services and the prices of the real estates including land and housing assets. HPM has been used to value such things as noise around airports,

amenity values of woodland and dis-amenity values of living near landfill sites. However, it is rather difficult to identify the increase in the specific land value.

(e) Total Benefits

The total benefit for the master plan on the economic price basis is estimated at Rs. 20,232 million for the period of 15 years from 2016 to 2030, summing up a wide range of the economic, social and environmental benefits. The detailed total economic benefits for the entire period of the master plan are as per **Table F.4.26**.

Table F.4.26 Project Benefits on Economic Price Basis for the Master Plan

Year	Economic Benefit			Social Benefit	Environmental Benefit	Total Benefit (Rs. 1000)
	Total Saved Cost by Final Disposal (Rs. 1000)	Total Saved Cost by Collection and Transport (Rs. 1000)	Recycling (Rs. 1000)	Willingness to Pay (Rs. 1000)	Methane Gas Reduction (Rs. 1000)	
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	211,686	458,320	0	0	40,956	710,962
2019	232,830	504,100	85,047	0	45,047	867,384
2020	255,647	553,499	93,777	0	49,462	952,385
2021	280,407	607,108	102,859	0	54,253	1,044,628
2022	307,219	665,159	112,695	100,716	59,440	1,245,229
2023	336,182	727,865	123,318	104,533	65,044	1,356,942
2024	367,427	797,515	134,780	108,495	71,089	1,477,306
2025	397,739	861,143	235,589	157,119	76,954	1,728,544
2026	428,940	928,697	254,070	163,074	82,990	1,857,772
2027	463,821	1,004,217	274,731	169,254	89,739	2,001,763
2028	502,254	1,087,428	297,496	175,669	97,175	2,160,022
2029	542,049	1,173,589	321,067	182,327	104,874	2,323,906
2030	586,180	1,269,135	347,206	189,237	113,413	2,505,171
Total	4,912,383	10,635,775	2,382,996	1,350,424	950,436	20,232,013

(5) Cases of Evaluation

The timing of the introduction of the tariff system and the involvement of the private sector through outsourcing are major variations to affect the economic viability of the master plan. The following three (3) cases including the base case (Case A) together with two (2) variations are the cases of the economic evaluation in the master plan.

- Case A: Base Case of Master Plan
- Case B: Based on the current level of users' willingness to pay, the tariff system will be introduced from 2019 at the early stage of the master plan.
- Case C: Outsourcing to the private sector (service contract of the collection and transport) will be introduced from 2025 based on the basic organisational and institutional setting up of the master plan.

(6) Results of Economic Evaluation

(a) EIRR and NPV

The results of the calculations of economic internal rate of return (EIRR) and net present value (NPV) for 3 cases for the economic evaluation are as per **Table F.4.27**, and the major findings

are as below. The detailed cost and benefit streams for the economic evaluation of the base case of the master plan are as shown in **Table F.4.28**.

Table F.4.27 Results of EIRR and NPV for the Master Plan

Case	EIRR (Per cent)	NPV (Rs. 1000)
Case A	10.88	1,256,561
Case B	11.36	1,311,721
Case C	11.79	1,560,970

- For Case A, the base case of the master plan, in which the full-scale tariff system will be introduced in all areas from 2025 and the outsourcing to the private sector will not be carried out, the EIRR and the NPV are estimated at 10.88 per cent and Rs. 1,257 million, respectively.
- For Case B in which the full-scale tariff system will be introduced in all areas at the early stage of the master plan from 2019 and the outsourcing to the private sector will not be carried out, the EIRR and the NPV are estimated at 11.36 per cent and Rs. 1,312 million, respectively.
- For Case C in which the full-scale tariff system will be introduced in all areas from 2025 and the outsourcing to the private sector will be carried out from 2025, the EIRR and the NPV are estimated at 11.79 per cent and Rs. 1,561 million, respectively.

Table F.4.28 Cost and Benefit Stream for Economic Evaluation

Year	Total Economic Cost (Rs. 1000)	Total Economic Benefit (Rs. 1000)	Net Economic Benefit (Rs. 1000)	Net Accumulated Economic Benefit (Rs. 1000)
2016	1,131,972	0	-1,131,972	-1,131,972
2017	889,072	0	-889,072	-2,021,044
2018	1,222,332	710,962	-511,370	-2,532,414
2019	768,992	867,384	98,392	-2,434,022
2020	479,685	952,385	472,699	-1,961,323
2021	1,080,718	1,044,628	-36,090	-1,997,413
2022	1,084,127	1,245,229	161,102	-1,836,311
2023	764,259	1,356,942	592,683	-1,243,628
2024	954,693	1,477,306	522,613	-721,015
2025	1,428,210	1,728,544	300,334	-420,682
2026	1,392,294	1,857,772	465,477	44,796
2027	1,030,622	2,001,763	971,141	1,015,937
2028	1,273,154	2,160,022	886,868	1,902,805
2029	1,409,135	2,323,906	914,771	2,817,576
2030	1,270,368	2,505,171	1,234,803	4,052,379
Total	16,179,634	20,232,013	4,052,379	4,052,379

(b) Sensitivity Analysis

Table F.4.29 indicates the results of the economic evaluation together with the assumptions for risk factors of each option applied for the sensitivity analysis to measure the impacts caused by 10 per cent increase in costs and 10 per cent decrease in benefits.

Since the initial investment, especially the investment on the final disposal component, is large at the early stage of the master plan, the project is vulnerable to the both the increase of costs and the decrease of benefits in all cases. Especially, when the cost increase and the benefit decrease simultaneously hit the project, all the EIRRs for Case A, Case B and Case C will sharply fall to the figures close to zero which are all below the cut-off rate.

Table F.4.29 Results of Economic Evaluation and Sensitivity Analysis

Case	Case No.	Scenario	EIRR (Per cent)	NPV (Rs. 1000)
Base Case	A-1	Base Case	10.88	1,256,561
	A-2	Cost 10 % increase	6.50	115,318
	A-3	Benefit 10% decrease	6.03	-10,338
	A-4	Cost 10% increase and benefit 10% decrease	1.24	-1,151,581
Early Introduction of Full-scale Tariff System from 2019	B-1	Base Case	11.36	1,311,721
	B-2	Cost 10 % increase	6.69	170,478
	B-3	Benefit 10% decrease	6.17	39,306
	B-4	Cost 10% increase and benefit 10% decrease	0.98	-1,102,119
Private Sector Involvement from 2025	C-1	Base Case	11.79	1,560,970
	C-2	Cost 10 % increase	7.71	450,168
	C-3	Benefit 10% decrease	7.26	294,071
	C-4	Cost 10% increase and benefit 10% decrease	2.92	-816,731

(7) Conclusion

For Case A-1, although the net economic benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net economic benefit would be positive. The total net economic benefit is estimated at Rs. 4,052 million. While the EIRR for Case A-1 is calculated at 10.88 per cent which is significantly over the cut-off rate of 7.0 per cent, the NPV for Case A-1 is estimated at Rs. 1,257 million. The result proved that the implementation of the master plan is economically feasible.

For Case B-1, although the net economic benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net economic benefit would be positive. The total net financial benefit is estimated at Rs. 3,928 million. While the FIRR for Case B-1 is calculated at 11.36 per cent which is significantly over the cut-off rate of 7.0 per cent, the NPV for Case B-1 is estimated at Rs. 1,311 million. The result proved that the implementation of the master plan, if the tariff system would be introduced at the early stage of the master plan from 2019, the economic feasibility would be more favourable than the Case A-1.

For Case C-1, although the net economic benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net economic benefit would be positive. The total net financial benefit is estimated at Rs. 4,635 million. While the FIRR for Case C-1 is calculated at 11.79 per cent which is significantly over the cut-off rate of 7.0 per cent, the NPV for Case C-1 is estimated at Rs. ,1561 million. The result proved that the implementation of the master plan, if the private sector involvement would be started from 2025, the economic feasibility would be more favourable than the Case A-1.

The sensitivity analysis proved that, in every case, the implementation of the master plan is economically vulnerable to the cost increase and the benefit decrease. Especially, the financial viability will be significantly reduced when the cost increase and the benefit decrease take place at the same time.

4.6.4 Overall Conclusion for Financial and Economic Evaluation

(1) Project Feasibility

The results of the economic evaluation show that the implementation of the selected option of the master plan might be economically feasible and financially viable on the condition that the following recommendations will be taken into account for the implementation of the master plan. The sensitivity analysis reveals that the master plan is financially and economically vulnerable to the increase of costs and the decrease of benefits. The cost recovery levels for the full coverage of the operation and maintenance costs remain approximately one-third of those costs, implying the necessity of other alternative stable financial sources. However, taking into account a spectrum of various unquantifiable benefits which cannot be converted to monetary values, the selected option of the master plan might be economically feasible and financially viable thereby the master plan is worth implementing.

(2) Recommendations

In order to implement the selected optimum option of the master plan, the following recommendations should be taken into account in terms of economic feasibility and financial viability.

- Although the selected option of the master plan proves to be economically feasible and financially viable, the capital investment should be funded by subsidies from the provincial government and/or a sort of concessional loan whose interest rate is relatively lower than those of commercial banks.
- Since the project is rather vulnerable to such risks as the increase of costs as well as the decrease of benefits, the financial statements such as cash flow statements should be continuously monitored by GWMC. ***The continuous financial monitoring on revenues, expenditures and the cost recovery rate by GWMC*** is absolutely necessary to avoid any risks to enlarge the gap between the projected cash flow and the actual cash flow. GWMC's headquarter should be institutionally strengthened so that the financial statements would be readily prepared in comparison with the original calculation tables of the FIRRs.
- ***The construction of the final disposal site should not be delayed*** to generate the project benefits at least from 2018 which is the last year of the short-term period, since the project is extremely vulnerable to the cost increase in the early stage of the master plan.
- It is revealed that the earlier the introduction of the tariff system is, the higher the EIRR and FIRR are, implying that ***the early introduction of the proposed tariff system is a key to the financial stability*** of the master plan.
- The cost recovery by the introduction of the optimum variable-rate user charge system is not sufficient to fully cover the operation and maintenance cost required for the implementation of the master plan.
- ***The cost recovery rate is 32.4 per cent out of the total operation and maintenance cost*** in 2025 even after the full-scale introduction of the tariff system in all areas which is in line with the current willingness to pay, and ***the remaining 67.6 per cent of the total operation and maintenance cost should be replenished by other stable financial sources and/or subsidies from the provincial government***.
- In order to fully cover the total operation and maintenance cost in 2025 which is the first year of the full-scale introduction of the tariff system in all areas, ***the required tariff level per month per household is estimated at approximately 3 times as much as the current level of the users' willingness to pay***.
- The introduction of the revenue generation through the provincial property tax as the stable financial sources should be urgently explored to cover the shortage of revenues. The

negotiation with the provincial government on this revenue generation through the provincial property tax should be commenced as soon as possible.

- ***The users' willingness to pay should be transformed into the actual payment of user charges under the official tariff table*** so that the stable revenue generation for SWM services can be secured. However, the user charge system in low-income areas whose willingness to pay is extremely low should be carefully introduced by the delayed timing of the implementation of the full-scale tariff system in all areas.
- The budget request to the provincial government for the capital investment cost as well as the request to CDGG for the recurrent cost should be applied in time for each financial year of GWMC, and those requests should be based on the cash flow statement of the master plan.
- ***The financial key performance indicators (KPIs) should be monitored*** by the management information system (MIS) unit to keep the financial performance well controlled by the management of GWMC.
- The recurrent cost such as operating, personnel and maintenance costs should be minimised based on the cost minimisation plan by GWMC.
- Since ***the benefits accrued from the methane gas reduction cannot be converted into the actual cash flow*** due to the current situation of the CDM as well as the international market of carbon prices, the financial IRR is relatively low. However, in addition to the environmental monitoring, the traded price level of carbon credits in the international market should be continuously monitored for the identification of the environmental impacts by monetary values.

5. FORMULATION OF THE ACTION PLAN

5.1 Selection of the Priority Project

The priority projects are defined as projects for the short-term period of the Master Plan which will be developed to the action plans in this chapter. Based on the detail discussions described in previous **Chapter 4,** the following projects are thus selected as the priority projects:

1. Establishment of Sustainable Cost Recovery
2. Implementation of Accurate Total Costing
3. Introduction of Proper Tariff System
4. Implementation of Financially Efficient Private Sector Involvement

5.2 Project for Sustainable Cost Recovery

During the short-term period from 2016 to 2018, in order to prepare for the establishment of the future sustainable cost recovery, a wide spectrum of below actions will be carried out:

- To establish the long-term cost recovery strategies for the operation and maintenance costs to provide SWM services;
- To establish the financial monitoring system through a wide range of the financial key performance indicators (KPI) related to the cost recovery;
- To establish the standard procedure for monitoring the cost recovery;
- To prepare the manual for the management of the cost recovery;
- To train GWMC's staff in charge of managing the cost recovery;
- To prepare a 3-year recurrent cost rolling plan to request CDGG for the budgetary arrangement; and
- To prepare a 3-year capital investment cost rolling plan to request the provincial government for the budgetary arrangement

The typical standard procedures for monitoring the cost recovery are as follows:

Step 1: Setting up of Assumptions

The following assumptions for the cost recovery will be set up:

- The initial year of introducing the tariff system;
- The scope and target of the cost recovery; and
- The number of households

Step 2: Estimating of Revenues

The following procedures for estimating the revenues under the cost recovery will be carried out:

- The area-wise tariff level will be decided;
- The collection efficiency of the tariff charging will be assumed; and
- The revenue of each financial year will be estimated.

Step 3: Estimating of Expenditures

Step 3-a: Operating and Maintenance Expenditures (Opex)

Opex is broken down into 2 components: fixed costs which are not significantly related to the volume of disposed wastes, and variable costs related to the volume of disposed wastes or the number of customers. Estimating the future Opex would be based on the parameters indicated in the master plan.

Step 3-b: Capital Maintenance Charge (Depreciation for Replacement Cost)

The capital maintenance charge, which is depreciations for the replacement cost of existing facilities, is also important. One controversial issue concerning capital maintenance charge is whether assets funded by third parties should be included in the capital maintenance charge. Since the third-party-funded assets such as CDGG and the provincial government also generate the revenues over the master plan period, those capital maintenance charges should be also included.

Step 3-c: Capital Expenditures (Capex)

The capital expenditures required for the new investment which are actually covered by the budget of the provincial government in accordance with the master plan will be included.

Step 4: Calculation of Financial Gap between Revenues and Expenditures

The financial gap of each year between the above-estimated revenues and expenditures will be calculated.

Step 5: Calculation of Required Subsidies to be covered by CDGG and Provincial Government

An appropriate monitoring system though a wide range of the financial KPIs is a key to the cost recovery in the long-term period. Therefore, the monitoring system through those financial KPIs should be established at the early stage of the short-term period of the master plan. The financial KPIs are subject to quantitatively measure the delivery of SWM services in a financially efficient manner.

The staff in charge of the financial KPIs of the newly created MIS unit inside GWMC will be responsible of periodically monitoring the data and information on the selected financial KPIs. The following institutional set-up should be arranged for monitoring the financial KPIs.

- Timing for collection, aggregation and feedback of the collected data
- Frequency for collection, aggregation and feedback of the collected data
- Methodologies for collection, aggregation and feedback of the collected data

GWMC should develop a number of the following financial KPIs to assess its performance with respect to the situation of the cost recovery and other benchmarks. These monitoring indicators will serve as effective tools to assess the financial status of GWMC.

- Unit Operational Cost: Total annual operating expenses divided by total amount of disposed wastes
- Salary Costs as a Proportion of Operating Costs: Total annual salary costs (including salaries, wages, pensions, other allowances, etc.) expressed as a percentage of total annual operating costs
- Collection period: Year-end accounts receivable divided by total annual operating revenues expressed in month's equivalent collected charges
- Collection Efficiency: Number of customers who actually paid the bills divided by the total number of customers
- Contract Rate: Number of customers who actually contracted divided by the total number of customers
- Cost Recovery Rate to Total Cost: Total annual expenses divided by total annual operating revenues
- Cost Recovery Rate to Operation and Maintenance Cost: Total annual operating expenses divided by total annual operating revenues

The above preparatory actions for the establishment of the sustainable cost recovery will start from the first quarter of 2016 with the detailed plan of operations indicated in **Table F.5.1**.

5.3 Implementation of Accurate Total Costing

Although, during the short-term period from 2016 to 2018, the tariff will not be charged, it is absolutely necessary to accurately grasp the total cost based on the selected methodologies for future monitoring the cost recovery after the full-scale introduction of the tariff system from 2025. There is a wide range of actions to be taken for grasping the total cost as well as the cost structure of providing SWM services as follows:

- To establish the cost centre inside the financial department of GWMC;
- To monitor and streamline the latest operating and maintenance costs for SWM services;
- To carry out the break-even point analysis as well as the breakdown of the operation and maintenance costs by fixed costs and variable costs;
- To estimate the average cost and the marginal cost per unit amount of the disposed wastes;
- To prepare and start the cost minimisation plan for SWM services;
- To prepare the operation manual for the standard procedures for the cost centre; and
- To train the staff of the cost centre for estimating various costs for SWM services.

The cost centre will be established inside the financial department of GWMC, and the centre provides the management of GWMC with a convenient mechanism to determine the proper tariff level to recover the total operation and maintenance costs required for the providing SWM services.

Another important action to be taken is to minimise the cost of providing SWM services by the financially efficient manner under the cost minimisation plan of GWMC. The organizational assessment was carried out in the master plan, and the most efficient organizational structure was proposed. The purpose of organizational assessment is to realign organization's resources in a way that GWMC will be able to achieve the best performance and SWM services thus minimising the operating costs.

The cost minimisation plan, being jointly prepared by the financial department and the human resources development department of GWMC, will include a series of actions to significantly reduce operating costs and bring improvements in the service delivery efficiency such as the operation of the sanitary landfill, the operation of the collection and transport, billing and collection, and fuel and repairs of collection vehicles, the overhead cost of the headquarters, etc.

In addition, the preventive maintenance programme will help identify possible inefficiency in the operation of the sanitary landfill as well as the collection and transport of wastes with minimum expenses thus saving major repairs and maintenance costs. The efficient collection route should be continuously reviewed in each service zone which will bring more efficiency in the operations thus reducing costs.

The above preparatory actions for the implementation of the accurate total costing will start from the first quarter of 2016 with the detailed plan of operations indicated in **Table F.5.1**.

5.4 Introduction of Proper Tariff Charging System

During the short-term period from 2016 to 2018, the tariff system will not be introduced, and, therefore, the cost recovery for SWM services through the introduction of the tariff system will not be actually started. However, there is a wide spectrum of the following activities in the field of the preparatory activities for the introduction of the tariff system as below. The partial establishment of the cost recovery through the introduction of the optimum tariff system will be commenced from 2022 in high and middle income areas during the mid-term period. For the time being, the absence of the cost recovery will be

replenished by the CDGG's financial support for the recurrent costs and the provincial government's subsidies for the investment and replacement on facilities and equipment required for SWM services.

- To forecast the cost recovery rate and the optimum tariff level as well as the required amount to be covered by the provincial property tax;
- To roughly establish the tariff table in low-income, middle-income and high-income areas;
- To establish the standard procedure for the tariff setting;
- To carry out the survey on customers' willingness to pay by income group;
- To carry out the survey on customers' affordability to pay by income group;
- To train the staff in charge of establishing and operating the financial monitoring system; and
- To start the negotiation with the provincial government for exploring the required legal actions for the introduction of the additional surcharge of the provincial property tax.

It is essential to set the SWM tariff at the level for which users can actually afford to pay. In this connection, the concept of ATP (Affordability to Pay) is frequently used. ATP is defined as the amount which beneficiaries can pay for certain public utility services, being calculated with reference to household income and composition of household expenditures in the service areas. There are various methodologies employed for estimating ATP. A typical methodology is to determine ATP as a certain share of a household's disposable income based on a household economy survey. The survey on the household economy for estimating ATP should be periodically carried out during the early stage of the short-term period.

WTP (Willingness to Pay) is another consideration factor of the demand side, which is the amount expressed by respondents on the monetary value on users' degree of payment willingness for SWM services. WTP can be measured through a questionnaire survey such as CVM (Contingent Valuation Method).

Based on the survey results of the updated level of ATP and WTP, the optimum level of the tariff as well as the required revenue to be covered by the provincial property tax will be estimated.

Although the actual tariff charging system will be introduced from 2022 which is the fourth year of the mid-term period, the above preparatory actions for the introduction of the proper tariff charging system will start from the first quarter of 2016 with the detailed plan of operations indicated in **Table F.5.1**.

5.5 Implementation of Financially Efficient Private Sector Involvement

During the short-term period from 2016 to 2018, the private sector involvement will not be started. However, there is a wide range of preparation activities for the future commencement of the efficient private sector involvement for the collection and transport as below. The outline of the service contract to be outsourced including such as area, scope and criteria to select the private service providers will be clarified:

- To study the tender procedure for the service contract;
- To study the area and scope of the service contract; and
- To review the unit cost of outsourcing.

Although the actual private sector involvement through the service contract will be introduced from 2028 which is the fourth year of the long-term period, the above preparatory actions for the implementation of the financially efficient private sector involvement will start from the first quarter of 2018 with the detailed plan of operations indicated in **Table F.5.1**.

5.6 Plan of Operations and Cost of Action Plan

Figure F.5.1 shows the Plan of Operations of Economic and Financial Plan (Short-Term) and **Table F.5.1** shows the Estimated Cost of the Economic and Financial Plan (Short-Term).

Time Framework of the Master Plan		Short-Term Plan Period											
Year		2016				2017				2018			
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WBS for Short-Term Plan													
S-5-1	Establishment of Sustainable Cost Recovery (Preparatory Phase)												
S-5-1-1	Establishment of Long-term Cost Recovery Strategies												
S-5-1-2	Establishment of Financial Monitoring System through KPIs												
S-5-1-3	Establishement of Standard Procedures for Monitoring Cost Recovery												
S-5-1-4	Preparation of Manual for Management of Cost Recovery												
S-5-1-5	Training of GWMC's Staff in Charge of Management of Cost Recovery												
S-5-1-6	Preparation of 3-Year Recurrent Cost Rolling Plan for Budgetary Arrangement by CDGG												
S-5-1-7	Preparation of 3-Year Capital Investment Cost Rolling Plan for Budgetary Arrangement by GOPb.												
S-5-2	Implementation of Accurate Total Costing (Preparatory Phase)												
S-5-2-1	Establishment of Cost Centre Inside Financial Department of GWMC												
S-5-2-2	Monitoring and Streamlining of Latest Operating and Maintenance Cost for SWM Services												
S-5-2-3	Implementation of Break-even Point Analysis												
S-5-2-4	Estimation of Average and Marginal Costs per Unit Amount of Wastes												
S-5-2-5	Preparation of Cost Minimisation Plan												
S-5-2-6	Preparation of Operation Manual for Standard Procedure for Cost Centre												
S-5-2-7	Training of Staff of Cost Centre												
S-5-3	Introduction of Proper Tariff Charging System (Preparatory Phase)												
S-5-3-1	Forecasting Cost Recovery Level, Optimum Tariff Level and Required Amount of Subsidies												
S-5-3-2	Establishment of Draft Tariff Table for SWM Services												
S-5-3-3	Establishment of Standard Procedure for Tariff Setting												
S-5-3-4	Implementation of Customers' Willingness to Pay (WTP) Survey												
S-5-3-5	Implementation of Customers' Affordability to Pay (ATP) Survey												
S-5-3-6	Training of GWMC's Staff for Tariff Management												
S-5-3-7	Negotiation with GOPb for Exploring Additional Surcharge of Provincial Property Tax												
S-5-4	Implementation of Financially Efficient Private Sector Involvement (Preparatory Phase)												
S-5-4-1	Study of Tender Procedures for Service Contract												
S-5-4-2	Study of Area and Scope of Service Contract												
S-5-4-3	Review of Unit Cost of Outsourcing												

Figure F.5.1 Plan of Operations of the Economic and Financial Plan (Short-Term)

Table F.5.1 Cost of Operations for Economic and Financial Action Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost		
			2016	2017	2018
Programme 5: Economic and Financial Plan					
Short-Term Plan					
S-5-1	Establishment of Sustainable Cost Recovery (Preparatory Phase)				
S-5-1-1	Establishment of Long-term Cost Recovery Strategies	GWMC			
S-5-1-2	Establishment of Financial Monitoring System through KPIs	GWMC			
S-5-1-3	Establishement of Standard Procedures for Monitoring Cost Recovery	GWMC			
S-5-1-4	Preparation of Manual for Management of Cost Recovery	GWMC			
S-5-1-5	Training of GWMC's Staff in Charge of Management of Cost Recovery	GWMC			
S-5-1-6	Preparation of 3-Year Recurrent Cost Rolling Plan for Budgetary Arrangement by CDGG	GWMC			
S-5-1-7	Preparation of 3-Year Capital Investment Cost Rolling Plan for Budgetary Arrangement by GOPb.	GWMC			
S-5-2	Implementation of Accurate Total Costing (Preparatory Phase)				
S-5-2-1	Establishment of Cost Centre inside Financial Department of GWMC	GWMC			
S-5-2-2	Monitoring and Streamlining of Latest Operating and Maintenance Cost for SWM Services	GWMC			
S-5-2-3	Implementation of Break-even Point Analysis	GWMC			
S-5-2-4	Estimation of Average and Marginal Costs per Unit Amount of Wastes	GWMC			
S-5-2-5	Preparation of Cost Minimisation Plan	GWMC			
S-5-2-6	Preparation of Operation Manual for Standard Procedure for Cost Centre	GWMC			
S-5-2-7	Training of Staff of Cost Centre	GWMC			
S-5-3	Introduction of Proper Tariff Introduction (Preparatory Phase)				
S-5-3-1	Forecasting Cost Recovery Level, Optimum Tariff Level and Required Amount of Subsidies	GWMC			
S-5-3-2	Establishment of Draft Tariff Table for SWM Services	GWMC			
S-5-3-3	Establishment of Standard Procedure for Tariff Setting	GWMC			
S-5-3-4	Implementation of Customers' Willingness to Pay (WTP) Survey	GWMC			
S-5-3-5	Implementation of Customers' Affordability to Pay (ATP) Survey	GWMC			
S-5-3-6	Training of GWMC's Staff for Tariff Management	186 (Included in GWMC's Staff Training Budget: Module 6)	62	62	62
S-5-3-7	Negotiation with GOPb for Exploring Additional Surcharge of Provincial Property Tax	GWMC			
S-5-4	Implementation of Financially Efficient Private Sector Involvement				
S-5-4-1	Study of Tender Procedures for Service Contract	196 (Included in GWMC's Staff Training Budget: Module 5)			196
S-5-4-2	Study of Area and Scope of Service Contract	GWMC			
S-5-4-3	Review of Unit Cost of Outsourcing	GWMC			
	Total (Short-Term)	382 (Included in GWMC's Staff Training Budget: Module 5 and 6)	62	62	258

6. CONCLUSION

6.1 Establishment of Cost Recovery Mechanism for Sustainable Operation and Maintenance of GWMC

GWMC currently does not levy any tariff for SWM services, so that its operation is subsidised by CDGG and GOPb. The absence of a cost recovery mechanism limits the extent of GWMC's operation and further investment on SWM services and hence a mechanism to cover the operation and maintenance cost of SWM services should be established for the long-term financial sustainability of GWMC.

In order to establish the sustainable cost recovery mechanism, the major priority actions listed below shall be carried out:

- Establishment of long-term cost recovery strategy to sustainably provide the SWM services;
- Establishment and implementation of a financial monitoring system through a wide range of financial key performance indicators related to the cost recovery; and
- Preparation and updating of recurrent costs as well as investment rolling plans for the request to CDGG and GOPb for budgetary arrangement.

The above priority actions shall start from the first quarter of 2016. The financial unit of GWMC shall be responsible of these actions.

6.2 Implementation of Accurate Total Costing as Basis of Cost Recovery

At present, GWMC is not sufficiently capable of grasping variable costs, fixed costs and even the break-even point for SWM services. GWMC requires the total cost accounting system which contains the detailed cost information to financially track the current operations for providing the basis of cost recovery. Therefore, all costs associated with providing SWM services should be accurately monitored and streamlined for setting an optimum tariff system.

In order to implement an accurate total costing, the major priority actions listed below shall be carried out:

- Establishment and operation of a cost centre inside GWMC;
- Monitoring and streamlining of the latest operation and maintenance cost for SWM services together with the break-even point analysis; and
- Preparation and implementation of a cost minimisation plan.

The above priority actions shall start from the first quarter of 2016. The financial unit of GWMC shall be responsible of these actions. The cost centre created inside GWMC shall take the responsibility for the implementation of accurate total costing system.

6.3 Introduction of Proper Tariff Charging System for Generating Revenue

Currently, GWMC has no substantial pricing mechanism for SWM services and it does not impose any charge on users. For the purpose of ensuring financial sustainability of SWM services, GWMC has to introduce a proper tariff charging system as soon as possible.

In order to introduce a proper tariff charging system, the major actions listed below shall be carried out:

- Selection and introduction of the optimum tariff charging system to cover the operation and maintenance cost based on users' willingness to pay and affordability;
- Preparation and introduction of an official tariff table under the selected tariff charging system; and

- Periodical monitoring of a wide range of key financial performance indicators for revising the tariff level, if and when necessary.

Although the actual tariff charging system will be introduced from 2022, the preparatory actions shall start from the first quarter of 2016. The financial unit of GWMC shall be responsible for these actions. The staff training programme for the tariff introduction and implementation is included in Module 6 of the comprehensive capacity development programme that is estimated to have the total cost of Rs. 1,314 thousand at the current prices.

6.4 Outsourcing to Private Sector for Financial Efficiency

Since GWMC is not currently working with the private sector, the outsourcing to the private sector should be introduced to cost-effectively provide efficient collection and transport services, when the conditions are met. The main objective of involving the private sector is to enhance efficiency and mobilise investment resources of the private sector.

In order to outsource the collection and transport services to the private sector, the major priority actions listed below shall be carried out:

- Preparation and management of the tender procedure for the service contract; and
- Continuous monitoring of the performance of the selected private service provider by the financial key performance indicators.

Although the actual private sector involvement will be introduced from 2025, the preparatory actions shall start from the first quarter of 2018. The procurement and contract unit as well as the financial unit of GWMC shall be responsible for these actions. The staff training programme for private sector involvement is included in Module 5 of the comprehensive capacity development programme that is estimated to have the the total cost of Rs. 922 thousand at the current prices.

6.5 Project Feasibility

The results of the project evaluation prove that implementation of the selected option of the master plan is economically feasible and financially viable on the condition that the following recommendations are simultaneously implemented.

7. RECOMMENDATIONS

7.1 Securing Stable Financial Sources in addition to Tariff Charging System

Stable revenue generation through the provincial financial sources such as the property tax should be urgently explored to cover the shortage of revenue even after the introduction of optimum tariff charging system. Negotiations with GOPb on this revenue generation should be started as soon as possible. For the time being, the budget request to the provincial government for the capital investment cost as well as the request to CDGG for the recurrent cost should be applied in time for each financial year of GWMC.

7.2 Institutional Set-up for Monitoring of Operation and Maintenance Cost through Key Performance Indicators.

To accurately implement the total costing for SWM services, the operation and maintenance cost should be regularly monitored and updated by collecting financial key performance indicators through the management information system (MIS) unit of GWMC.

7.3 Preparation for Tariff System based on Users' Willingness to Pay (WTP) and Affordability to Pay (ATP)

The users' willingness to pay should be transformed into the actual payment of user charges under the official tariff table so that the stable revenue generation for SWM services can be secured. However, the tariff charging system in low-income areas whose willingness to pay is extremely low should be carefully introduced. In order to introduce the proper level of the tariff system, continuous surveys on users' willingness to pay (WTP) and affordability to pay (ATP) should be implemented.

7.4 Use of LWMC's Experiences for Private Sector Involvement

LWMC (Lahore Waste Management Company) had already introduced the private sector involvement for its collection and transport services. It is then necessary to continuously review the experiences of LWMC's service contracts with the private sector, and the study on the situational analysis on the availability and capacities of private service providers should also be carried out.

7.5 Updating Project Feasibility based on Continuous Updating of Financial Data

Continuous financial monitoring of revenues, expenditures and the cost recovery rate by GWMC is required to avoid any risk that would enlarge the gap between the projected cash flow and the actual cash flow. GWMC's headquarters is thus required to be institutionally strengthened so that the financial statements would be readily prepared in comparison with the original calculation tables of the financial evaluation.

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PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

DRAFT FINAL REPORT

VOLUME 2

SUPPORTING REPORT

SECTION G

INSTITUTIONAL STRENGTHENING AND ORAGINAZATIONAL RESTRUCTURING

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SECTION G

INSTITUTIONAL STRENGTHENING AND ORAGINAZATIONAL RESTRUCTURING

1. INTRODUCTION

Section G describes the in-depth analysis of the Institutional Strengthening and Organizational Restructuring of the Chapter 2, Chapter 3, Chapter 4 and Chapter 6 of the Main Report. The Institutional Strengthening and Organizational Restructuring includes the description and evaluation of the current condition, the planning direction of institutional strengthening and organizational restructuring plan, the formulation of institutional strengthening and organizational plan and proposal for the action plan.

2. DESCRIPTION AND EVALUATION OF CURRENT CONDITION

2.1 Laws and Regulations Related to Solid Waste Management

This section deals with laws and regulations related to solid waste management especially focusing on the important ones in Punjab Province.

2.1.1 Overview of Environmental Laws in Pakistan

The Pakistan Environmental Protection Ordinance of 1983 was the first federal legislation aiming to improve the environment especially in the matter of waste. As a federal legislation, the Ordinance established the Pakistan Environmental Protection Council (hereinafter referred to as "PEPC") as the supreme environmental policy-making body in the country and the Pakistan Environmental Protection Agency (hereinafter referred to as "Pak-EPA") at the federal level and Environmental Protection Agencies at provincial level in all four provinces of the State, including the Province of Punjab, to administer and implement the provisions of the Ordinance. In 1997, the improved Ordinance was enacted after approval by the Parliament as the Pakistan Environmental Protection Act (hereinafter referred to as "PEPA").

The 1997 PEPA retained the institutional framework of the 1983 Ordinance and provides for the protection, conservation and improvement of environment, for prevention and control of pollution, and for the promotion of sustainable development.

The PEPA defines waste as any substance or object which has been, is being or is intended to be, discarded or disposed, and includes liquid waste, solid waste, waste gases, suspended waste, industrial waste, agricultural waste, nuclear waste, municipal waste, hospital waste, used polyethylene bags, and residues from the incineration of all types of waste (PEPA Section 2 (xiv). Other federal legislations related to solid waste management are summarised in **Table G.2.1**.

Table G.2.1 Other Federal Legislations Related to Solid Waste Management

Name of Regulation	Year	Major Issues related to Solid Waste Management
Pakistan Penal Code	1860	・ Penal Law ・ Handling and negligent conduct with respect to poisonous, toxic and hazardous waste is an offence. The code is to be monitored by the provincial government.
The Factories Act	1934	・ Regulations on labour factories ・ Disposal of waste and effluents has to be arranged.
Constitution	1973	・ Basic rights and duties of the citizens and the Government of Pakistan ・ Acquiring land for public interest
Pakistan Environment Protection Act (PEPA)	1997	・ Protection, conservation, rehabilitation and improvement of environment, prevention and control of pollution ・ Defines municipal waste, hazardous waste, hospital waste, industrial waste, agricultural waste, organic and inorganic matters and living organisms, buildings. ・ Prohibits discharge of waste in a concentration that violates the National Environmental Quality Standards (NEQS) ・ EPAs that are satisfied that the discharge of any kind of waste in violation of the provisions of the Act is likely to occur or occurring are empowered to direct the responsible person to take necessary measures. ・ Penalties for contraventions against the provisions of the Act.
Environmental Tribunal Rules	1999	・ Organization and procedures/rules (updated in 2012)
Review of IEE/EIA Regulations	2000	・ Regulation on Environmental Impact Assessment (EIA) ・ Projects requiring an Initial Environmental Examination (IEE)/EIA ・ Waste disposal projects require IEE/EIA
National Environmental	2000	Quality Standards for:

Name of Regulation	Year	Major Issues related to Solid Waste Management
Quality Standards (NEQS)		・Municipal and liquid industrial effluents ・Industrial gaseous emissions ・Motor vehicle exhaust and noise
NEQS Regulations	2000	・Certification of environmental laboratories
Pollution Charge for Industry Rules	2001	・Calculation and collection of charges
Provincial Sustainable Development Fund Board Rules	2001	・Rules on constitution and meetings of the Board
NEQS Rules	2001	・Self-monitoring and reporting by industrial units ・Categories of industrial units ・Monitoring report in addition to EIA approval
Environmental Sample Rules	2001	・Procedure of inspection and taking samples
Hazardous Substance Rules	2003	・Management of hazardous substances ・Waste management plan pertaining to hazardous waste
Hospital Waste Management Rules	2005	・Management of waste generated by healthcare institutions

2.1.2 Important Laws and Regulations Concerning Solid Waste Management in Punjab Province

Among the environmental laws related to solid waste management, the following five laws and regulations are most noteworthy in the Province of Punjab.

(1) Punjab Environmental Protection Act (2012)

Following the enactment of Pakistan Environmental Protection Act (PEPA, 1997), the Punjab Environmental Protection Act was approved in 1997 and subsequently amended in 2012. Similar to PEPA, the Punjab Environmental Protection Act defines several types of waste and stipulates powers and functions of the Council and Agency at the provincial level. The major amendment made in 2012 could be said that, in general, powers and functions of the Provincial Government were slightly weakened compared to the Federal Government. For example, the previous Act (1997) allowed both Federal and Provincial Government to delegate any of their powers or functions under the Act, the rules or the regulations to any Government Agency, local council or local authority. However, the amended Act allows only the Federal Government to do so.

(2) Hazardous Substance Rules (2003)

These Rules were formulated to deal with hazardous substances listed in Schedule I (242 chemicals and any other prescribed by Pak-EPA) of these Rules. Only the licence holder personnel can import, handle transport, treat and dispose of the hazardous waste and the proprietor has to submit and follow a safety management plan.

Issues related to solid waste management and addressed in these Rules are as follows:

- Instructions regarding return or disposal of an empty container (Section 9(2)(f));
- Safety precautions to deal with containers (Section 11(1)(b)); and
- Waste management plan (Section 19).

(3) Hospital Waste Management Rules (2005)

These Rules were formulated to deal with hospital waste in response to Section 31 of PEPA 1997. These Rules define chemical waste, genotoxic waste, infectious waste, non-risk waste, pathological waste, pharmaceutical waste, radioactive waste, risk waste and sharp objects. The rules clearly state that hospitals are responsible for the management of waste generated within their premises

and thus each hospital has a waste management team responsible for preparation of the waste management plan, its implementation and periodic review and revision. In addition, the detailed procedures are described in the Rules for waste segregation, transportation, storage, disposal, and minimisation and reuse.

(4) Punjab Municipal Solid Waste Management Guidelines (2011)

The Guidelines attempt to address all important elements of waste management systems as a general guidance to the provincial government departments, local governments, private operators and other agencies that initiate or operate any solid waste management activity in urban areas. Various components of solid waste management such as waste collection, waste transfer, recovery of useful components, waste incineration, composting, bio-gas generation and land-filling are covered in these guidelines giving a technical guidance to do these operations with minimal impacts to the environment.

(5) Punjab Municipal Solid Waste Management Act (Draft) (2013)

The objective of the Act is to provide a system for the generation, storage, transport, collection, recovery, treatment and disposal of waste which regulates and mitigates the adverse impacts associated with the uncontrolled generation and disposal of waste in a manner that promotes sustainable economic growth, social development and environmental protection.

The Act obligates persons desirous of being engaged in waste management to apply for a licence and prohibits certain activities relating to waste such as littering in any public place and burning of waste. It also provides instructions for dealing with specific types of wastes including horticultural waste, hazardous waste and bio-medical waste.

The Act had established the Punjab Waste Management Commission which is responsible for the following fields:

- Preparation of a Provincial Waste Management Plan;
- Giving general or specific directions to a Local Government or Local Governments or Authorised Officers regarding this Act;
- Proposal to the Government such as tariffs, rates, fees, charges and penalties if it is deemed necessary to carry out the purposes of this Act;
- Meeting no less than once in every calendar year to review implementation of this Act and to make such recommendations as may be necessary for the implementation of this Act;
- Ensuring that this Act and Rules and Regulations framed thereunder are enforced;
- Monitoring areas where this Act has been applied through Monitoring and Evaluation Reports and Waste Management Plans;
- Hearing appeals against decision taken by Authorised Officers;
- Preparation and presentation of the key performance indicators to the Government once in each calendar year;
- Proposal to the Government such Guidelines, Rules, Policies, Schemes, Programmes and Strategies in order to carry out the purposes of the Act;
- Delegation, with the approval of the Government, of such functions to an Authorised Officer as may be determined; and
- Performance of such other functions as may be prescribed or is incidental to the above functions or assigned by the Government from time to time.

In addition to the Provincial Waste Management Plan, the Act establishes that every local government is responsible to prepare a Waste Management Plan provided that the Waste Management Plan shall contain details on prevention, minimisation, collection, recovery and disposal of waste within the area.

Although this Act is still in the process of legislation, it can be said that it is the most comprehensive law to deal with solid waste management in the Punjab Province since it also mentions recovery of waste and landfills.

(6) Solid Waste Management By-Laws, City District Government Lahore (2005)

The By-Laws was formulated to create provision for healthy improvement of the environmental standard in Lahore contemplating many innovative ideas and proposals by the members of civic body which cannot be materialised because of lack of necessary legal and regulatory framework.

These By-Laws hold responsible for the sanitation of the area within its jurisdiction the City District Government Lahore (CDG Lahore SWM By-Laws Section 3). The City District Government shall therefore arrange for sweeping and cleaning of public streets (CDG Lahore SWM By-Laws Section 3). The City District Government may arrange for the removal and carriage of refuse and for this purpose will provide receptacles and vehicles (CDG Lahore SWM By-Laws Section 6). Furthermore, the City District Government will provide landfills and other facilities for the disposal of waste (CDG Lahore SWM By-Laws Section 7). The local by-laws also contain the prohibition against depositing refuse, building materials, etc., in any public place (CDG Lahore SWM Section 16) and sets out fines for the violation of these rules (CDG Lahore SWM By-Laws Section 34).

Although there are several laws and regulations related to solid waste management in the Punjab Province, they are very much fragmented or not well integrated. It means there is no single law on solid waste management which is precise and comprehensive. This makes it more difficult for government officials to understand their work and responsibilities.

In addition, the general public is unaware of those laws and regulations partially because of illiteracy in English. Thus, the by-law being drafted by UU and LWMC should be precise and comprehensive enough for government officials and residents to understand and comply with it. This means the by-law should be written not only in English but also in Urdu.

Another issue concerning laws and regulations is their insufficient implementation. This is due to lack of enforcement. Thus it is necessary to equip GWMC with more effective and efficient enforcement measures. Another cause is the ignorance of the public. The general public even does not know what is written in the laws and regulations and it seems that most of them do not know their existence. This should be rectified by interpretation and/or translation of important laws and regulations in Urdu and also by raising public awareness on the general issues related to solid waste management.

As overviewed above, there are many laws, regulations and policies related to solid waste management but they are fragmented and insufficiently enforced. Another challenge in terms of legislation is the lack of coordination among different government agencies. Whether national or provincial, environmental issues tend to be overlooked in the political arena, resulting in the lack of funds and personnel compared to other urgent issues of more importance. In order to ensure compliance with the related legislations, it is also important to mainstream the environmental issues, especially, solid waste management in the political agenda.

2.2 Policies Related to Solid Waste Management

2.2.1 Overview of National/Provincial Development Plan

There are three major development policies at national and provincial level. Though none of them deals with solid waste management as a separate issue from sanitation/environment, all of them briefly touch the issue. Thus, it can be said that improvement of solid waste management is in line with the national and provincial governments' policy.

(1) Vision 2030

Vision 2030 is the policy document that depicts the vision of the Pakistan Government to realise Pakistan in 2030 in the world context. Its main objectives are as below:

- To realise industrialised, prosperous, just and developed Pakistan through sustainable development in a resource constrained economy by knowledge inputs; and
- To be a middle income country with a GDP of around USD 4,000 by 2030.

Vision 2030 deals with solid waste management in the context of refuse recovery and electricity generation strategies. In addition, it aims at strengthening urban management and municipal services in universities including solid waste management.

(2) Vision 2020

Vision 2020 is the policy document that depicts the vision of Punjab Government. It aims at making Punjab Province fully literate, employed, skilled, tolerant, culturally sophisticated, with world class infrastructure and modern centres, internationally connected and a healthy society by 2020.

Its development plan encompasses the following areas:

- Agriculture sector
- Manufacturing sector
- Poverty reduction
- Improvement of public services delivery
- Public private partnership strategies
- Governance reforms
- Reforms in civil services
- Improvement of infrastructure
- Educational reforms

Solid waste management is not considered as a separate issue; however, it is discussed under the subsection of water supply and sanitation. Water supply and sanitation is discussed under public health. It mentions that in order to improve public health condition it is important to improve water and sanitation condition of the Province.

(3) Punjab Development of Cities Act 1976

This Act was provided for the development of cities in the Punjab Province. Its objectives are listed as follows:

- To establish a comprehensive system of planning and development in order to improve the quality of life in the cities of the Punjab;
- To establish an integrated development approach and a continuing process of planning and development;

- To ensure optimum utilisation of resources, economical and effective utilisation of land; and
- To evolve policies and programmes, relating to education, water supply, sewerage, drainage, solid waste disposal and matters connected therewith and incidental thereto.

The Act makes the City Development Authority responsible for preparing and implementing environmental improvement schemes including solid waste disposal in cities. Solid waste management is considered as a compulsory part of cities development of this act. The Authority has the power to remove sources of pollution such as cattle, tongas (carts pulled by horses), horses, other animals, solid waste, industrial waste, etc., from the cities after providing alternate accommodation or compensation. The Authority also has the power to impose fines or imprisonment on the person involved in the deviation from this Act.

(4) National Policy

There are five (5) national policies related to solid waste management.

(a) National Environmental Policy (2005)

The National Environmental Policy (hereinafter referred to as "NEP") was adopted in 2005 by the Federal Government driven from the National Environment Action Plan (approved in 2001 by Pakistan Environmental Protection Council). The NEP provides an overarching framework for addressing the environmental issues facing Pakistan, particularly, pollution of freshwater bodies and coastal waters, air pollution, lack of proper waste management, deforestation, loss of biodiversity, desertification, natural disasters and climate change. It also gives directions for addressing the cross-sector issues as well as the underlying causes of environmental degradation and meeting international obligations.

The NEP aims to protect, conserve and restore Pakistan's environment in order to improve the quality of life of citizens through sustainable development. The following guiding principles shall be applied to achieve the objectives of the Policy:

- Principles of sustainable development;
- Principles of equitable access to environmental resources;
- Integration of environment into planning and implementation of policies, programmes and project;
- Changing personal attitudes and behaviours;
- Precautionary principles;
- Polluter pays principle;
- Improving efficiency with which environmental resources are used;
- Cradle to grave management;
- Best available technology;
- Decentralisation and empowerment;
- Extensive participation of communities, stakeholders and the public;
- Accountability and transparency; and
- Increased coordination and cooperation among federal and provincial governments.

NEP addresses solid waste management under Section 3.3, Waste Management. The purpose is to prevent and reduce pollution caused by liquid and solid waste. Among others, subsequent principles are mentioned as follows:

- Encourage reduction, recycling and reuse of municipal and industrial solid and liquid wastes;
- Develop and enforce rules and regulations for integrated management of municipal,

industrial, hazardous and hospital wastes; and

- Develop and implement strategies for integrated management of municipal, industrial, hazardous and hospital waste at national, provincial and local levels.

(b) Guideline for Solid Waste Management (2005)

The Guideline addresses the management of municipal solid waste and hazardous waste, i.e., above all hospital wastes. The focus is on municipal waste.

According to the Guideline, the overall aim of the solid waste management strategy for Pakistan is "to provide an effective, efficient, affordable, safe and sustainable solid waste management system for all the urban and rural settlements in Pakistan." The Guideline suggests different options on different operational levels right from generation, primary collection to disposal including capacity building of concerned department.

Within the Guideline, a strategy for solid waste management in Pakistan is proposed (Part A, Chapter 7). The Guideline forms part of a package of regulations and guidelines which includes the following:

- The Pakistan Environmental Protection Act of 1997;
- Policy and procedures for filing, review and approval of environmental assessments;
- Guidelines for the preparation and review of Environmental Reports; and
- Pakistan environmental legislation and the National Environmental Quality Standards (NEQS) as amended from time to time.

(c) National Sanitation Policy (2006)

The National Sanitation Policy of Pakistan provides a broad framework and policy guidance to the Federal Government, Provincial Governments, federally administered territories and the local governments to enhance and support sanitation coverage in the country through formulation of their sanitation strategies, plans and programmes at all respective levels for improving the quality of life of the people of Pakistan and the physical environment necessary for healthy life. The Policy envisions creation of an open defecation free environment with safe disposal of liquid and solid waste and the promotion of health and hygiene practices in the county.

The National Sanitation Policy states 10 objectives. The ones relating to solid waste management are as follows:

- To ensure open defecation free environment; the safe disposal of liquids, solids, municipal, industrial and agricultural wastes; and the promotion of health and hygiene practices;
- To promote community-led total sanitation (CLTS);
- To develop and implement strategies for integrated management of municipal, industrial, hazardous, and hospital and clinical wastes of national, provincial and local levels; and
- To increase mass awareness on sanitation and community mobilisation.

According to the Policy, the guiding principles for solid waste management (scenario of sanitation options) are described as follows:

- Integrated solid waste management will be promoted and practiced by selection and application of appropriate measures, technologies and management programmes;
- Government at all levels will promote the principle of 3R's of waste management (i.e., reduce, reuse and recycle) and encourage waste separation to maximise resource use and conservation;
- Fines will be imposed on citizens, businessmen, factory owners and government

institutions for any violation of the laws relating to solid waste management;

- Appropriate solid and liquid waste treatment facilities will be made integral part of all development projects;
- Solid waste in large and intermediate cities will be disposed of into properly designed landfill sites. In case of smaller settlements, area specific solutions will be developed in line with the National Environmental Quality Standards (NEQS); and
- Bio-gas projects will be introduced to generate energy from wastes.

(d) National Drinking Water Policy (2009)

The National Drinking Water Policy was approved in order to improve the quality of life of people of Pakistan by reducing incidence of death and illness caused by waterborne diseases through ensuring provision of adequate quantity of safe drinking water to the entire population at an affordable cost and in an equitable, efficient and sustainable manner.

While the Policy does not address issues related to waste management, its policy guidelines can be applicable for provision of waste management services. The policy guidelines which can be applied include the following:

- Increasing access;
- Appropriate technologies and standardisation;
- Community participation and empowerment;
- Public awareness;
- Capacity development;
- Public private partnership;
- Research and development;
- Coordinated planning and implementation; and
- Legislation.

(e) National Climate Change Policy (2012)

The National Climate Change Policy was established in 2012 to ensure that climate change is mainstreamed in the economically and socially vulnerable sectors of the economy and to steer Pakistan towards climate resilient development.

The Policy addresses issues related to waste management in the context of climate change mitigation in the energy field. The policy measures raised by the Policy are as follows:

- Promote the development of renewable energy resources and technologies such as solar, wind, geothermal and bio-energy;
- Install plants to generate power from municipal waste; and
- Promote and provide incentives for activities required for increasing the energy-mix and switching to low-carbon fossil fuels, and develop indigenous technology for CO_2 Capture and Storage (CCS); Waste Heat Recovery, Co-generation; Coal Bed Methane Capture; and Combined Cycle Power Generation.

(5) Provincial Level

There are two provincial policies related to solid waste management.

(a) Punjab Urban Water Sanitation Policy (2007)

The Punjab Urban Water Sanitation Policy was approved in 2007 with the vision of "sustainable water and sanitation for all" to provide optimum quantity of water and sanitation services on a sustainable bases. The objectives of the Policy are mentioned below:

- Provide a legal, regulatory framework and efficient institutional arrangements for sustainable water supply, sanitation and wastewater treatment services; and
- Sustainable financing arrangements including community participation and public private partnership.

In the same manner as the National Drinking Water Strategies, the Punjab Urban Water Sanitation Policy does not directly deal with waste management issues. However, its policy principles are applicable to solid waste management. The applicable principles are as follows:

- Community participation;
- Social and environmental considerations;
- Capacity building;
- Public Private Partnership (hereinafter referred to as "PPP"); and
- Environmental education.

In addition, the following socio-economic instruments could serve as useful reference in light of private sector involvement in solid waste management:

- Performance-Based Financing: The Government of the Punjab and the cities will fund water utilities based on performance-based incentive financing from its own resources and from private sectors, which are sustainable and invested in sustainable systems;
- Component Sharing: Water and sanitation projects will use internal and external component sharing model for financing of community based interventions;
- Need-Based Financing: The Government of the Punjab will fund water and sanitation projects based on the accessibility to services and the condition of infrastructure in the city;
- PPP Contract: PPP mode of financing and management shall be used as an instrument to facilitate capital investment, enhance efficiencies, expand the service areas and improve accountability & quality of service delivery;
- User charges: The tariff for provision should be linked to the actual cost of service provision to ensure financial sustainability; and
- Subsidies: Subsidies will be provided through lifeline tariff in the low income areas. To enhance provision of water and sanitation services in low income areas, the differential cost will be met through targeted subsidies.

(b) Punjab Landfill Sites Policy (Draft) (2008)

The Punjab Landfill Sites Policy was adopted in order to facilitate, guide and support local governments in establishing proper landfill sites in the province based on the concept of waste hierarchy that is waste reuse, reduction, recycling and recovery in the province. The Policy provides an overarching framework that would address the legal, regulatory, institutional, administrative, environmental issues and challenges faced by stakeholders.

The goal of the Policy is to protect environment, improve public health and to make cities clean with the following objectives:

- To minimise negative externalities associated with unregulated waste dumping;
- To establish and strengthen the institutional arrangements for landfill site selection, development, operation, maintenance and post closure; and

- To improve the overall solid waste management system in the cities by providing well managed sanitary landfill sites.

In line with other policies, the Punjab Landfill Site Policy of 2011 sets its policy principles such as sustainable development, private sector participation and polluter pays principle. In addition, attention is paid to economies of scale so that the Policy suggests various policy measures to share the responsibility among the government of Punjab and local governments.

2.3 Organizations Related to Solid Waste Management

There are several organizations related to solid waste management at national, provincial, and local government levels.

2.3.1 Federal Government

The Planning and Devolution Division at federal level and Planning and Development Departments at provincial level are responsible for the preparation of development plans and allocation of financial resources. At the federal level the Ministry of Environment is responsible for the development of policies and programmes under the environmental scheme (Rules of Business 1973 Schedule II).

The Federal Government may, by notification in the official Gazette, make rules for carrying out the purposes of the PEPA including rules for implementing the provisions of the international environmental agreements, specified in the Schedule to the Act (PEPA Section 31). Making use of this power, the Federal Government of Pakistan has enacted several rules in connection with waste management and enforcement. The federal government has been empowered to levy pollution charge on persons not complying with the NEQS.

The Pakistan Environmental Protection Agency (Pak-EPA) was established in 1984 under the Environmental Protection Ordinance. Pak-EPA and the provincial EPAs are the main regulatory bodies for the implementation of PEPA. In 1997 the Parliament passed the Environmental Protection Act that repealed the Ordinance. The additional waste management related functions and responsibilities of Pak-ETA are summarised as follows:

- Preparation of national environmental policies for approval by the Council [PEPA Section 6(1)(b)];
- Implementation of national environmental policies [PEPA Section 6(1)(c)];
- Formulation of ambient air and water standards [PEPA Section 6(1)(g)];
- Render Advice and assistance in environmental protection matters [PEPA Section 6(1)(m)];
- Assistance to local authorities to implement schemes for the proper disposal of wastes [PEPA Section 6(1)(n)];
- Promote public education and awareness policies [PEPA Section 6(1)(q)]; and
- Undertake inquiries and investigations into environmental issues [PEPA Section 6(1)(i)].

For carrying out the purposes of the PEPA, the EPA may, with the approval of the Federal Government, make regulations according to the enumeration in Section 33 of PEPA. Regulation of hazardous substances/wastes and introduction of public participation in EIA reviews are the topics relevant to waste management.

2.3.2 Provincial Government

(1) Provincial EPA

Every provincial government established a Provincial Environmental Protection Agency and delegates powers and functions to them. Punjab EPA was established by Notification No. S.R.O.

2151 (1) 98 to the Punjab EPA. The following is their responsibility concerning waste management:

- The powers and functions of review and approval of IEE/EIA and those on handling of hazardous substances.

Provincial EPAs have been given statutory cover. Provincial EPAs can exercise powers delegated to them by the respective provincial governments or the Pak-EPA. According to PEPA Section 26, the Federal Government may delegate any of its or of the Federal Agency's powers and functions to any government agency of such Provincial Government or any local council or local authority in the Province.

Under Section 16 of the 1997 PEPA, the Federal Agency or any Provincial Agency that is satisfied that the discharge of any waste in violation of the provisions of the Act is likely to occur or occurring are empowered to direct the responsible person to take necessary measures. Pak-EPA and the provincial EPAs have been empowered to issue Environmental Protection Orders to deal with an actual or potential adverse environmental effect following a violation of the provisions of the Act. This may include immediate stoppage of pollution, installation of pollution control devices and action for disposal of waste and restoration of environment.

(2) Urban Unit

The Urban Unit was established in 2006 as a Project Management Unit of the Planning and Development Department, Government of the Punjab. In 2012, it was transformed into a wholly government-owned company registered with the Securities and Exchange Commission of Pakistan (SECP). The fields of operations mainly include urban planning, urban transport, solid waste management, urban water and sanitation, geographic information systems (GIS), urban property tax and land records as well as municipal finance.

The Solid Waste Management (SWM) Sector of the Urban Unit envisions developing and formulating provincial policies, and legal and regulatory framework for solid waste management in the cities of Punjab. It aims at providing technical assistance to various local governments and building their institutional capacity by imparting trainings and recruiting professionals in the field of SWM. The sector on the whole, is committed to improving the solid waste management practices in Punjab to make its cities the engines of growth and sustainable development according to the Chief Minister's vision.

Its scope of work includes the following:

- Formulation of provincial policies, legal and regulatory framework for SWM;
- Strategy planning for proper waste management for towns, cities and regions;
- Capacity building of the relevant stakeholders;
- Technical assistance to various local governments in development of SWM action plans, landfill sites, improvement in existing SWM system and overall capacity building of departments;
- Facilitate foreign agencies working in Pakistan in the SWM Sector; and
- Training to government officers, professionals, researchers and students to enhance their technical skills of managing solid waste.

2.3.3 City District Government Gujranwala (CDGG)

The Gujranwala District Government was established under the devolution process that took place in 2001 as the City District Government in 2005. The district comprises the following five areas and Tehsils, and the city area and 34 union councils in Sadar area is the Project area:

- City area (64 union councils)
- Sadar area (39 union councils)

- Noshehra Virkan Tehsil
- Wazaribad Tehsil
- Kamoke Tehsil

Besides, the City and Sadar area is administratively divided into the following four towns:

- Aroop Town
- Khiali Shahpur Town
- Nandipur Town
- Qila Didar Singh Town

City District Government Gujranwala (CDGG) is responsible for providing solid waste management in the four Towns (City area and Sadar area). However, due to the budget constraint, it is capable to provide the service in only 64 Union Councils (UCs) of the City. In the three Tehsils, each Tehsil Municipal Administration is in charge of solid waste management.

The City District of Nazim, assisted by the District Coordination Officer and the District Police Officer, heads the CDGG. The District Coordination Officer (DCO), the highest ranking civil servant in the City District Government, heads the executive branch of the district government. The executive branch is divided into 7 departments and an Executive District Officer (EDO) heads each department to carry out its function (see **Figure G.2.1**). Before the declaration of the District as City District, all functions under the Municipal Services category including solid waste management were performed by the Teshil Municipal Administrations (TMAs). In 2005 when the District Government Gujranwala declared a City District Government, solid waste management function together with the staff became the responsibility of the CDGG.

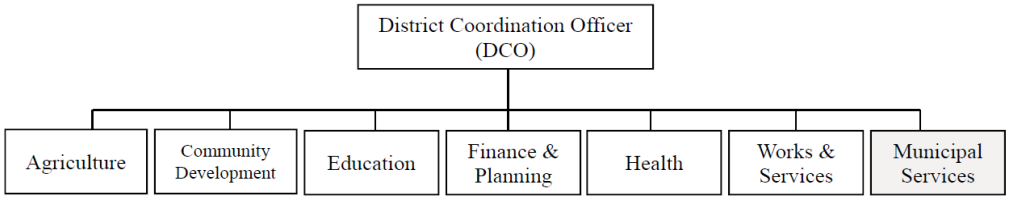

Figure G.2.1 Organizational Chart of CDGG as of March 2015

The solid waste management comes under the Municipal Services (MS) function in the City District Government Gujranwala. The other functions of the MS department include Environment, Spatial Planning and Commercialisation, and Transport. The MS department is headed by the Executive District Officer (EDO) and the District Officer (DO) heads the sub-departments. The Solid Waste Management sub-department is responsible for solid waste collection, transportation and disposal of the municipal waste to the final disposal site in four towns of Gujranwala (Aroop, Khiali Shahpur, Nandipur and Qila Didar Singh). In other three outer teshils, solid waste is managed by the respective TMAs.

Figure G.2.2 below illustrates the organizational structure of the MS department. The shaded parts show the Solid Waste Management Department. The District Officer is supported by the chief sanitary inspectors and assistant sanitary inspectors for primary and secondary collection of solid waste. Sanitary supervisors supervise sanitary workers in the field.

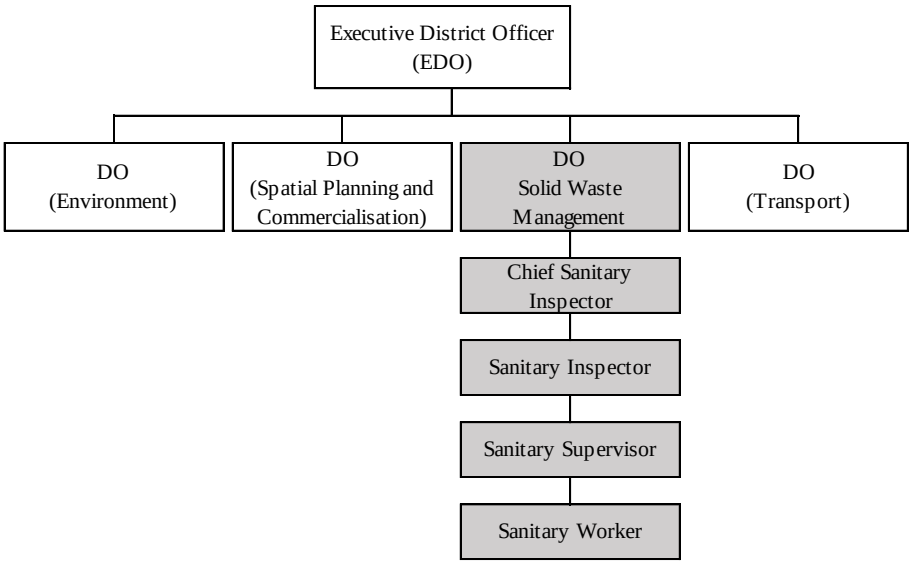

Figure G.2.2 Organizational Structure of the Municipal Services of CDGG as of March 2015

As for capacity development of staff of CDGG, only 6 waste managers received training programme by the Urban Unit specific to solid waste management while Even EDO (MS) and DO (SWM) have never attended such programme. This shows the lack of technical expertise of CDGG.

2.3.4 Gujranwala Waste Management Company (GWMC)

Due to rapid urbanisation, waste management has become a major challenge and the Government including CDGG realised that they could not manage increasing waste by themselves. In case of Lahore, the City District Government Lahore outsourced sweeping, collection and transportation three years ago in order to make it more efficient. Following the success of Lahore Waste Management Company (LWMC), the Chief Minister of the Province of Punjab decided that this model is to be replicated in the other major six cities of the Punjab Province; namely, Sialkot, Faisalabad, Rawalpindi, Multan, Bahawalpur and Gujranwala. In this way, the Gujranwala Waste Management Company (GWMC) was formed under the Company's Ordinance Section 42 and registered in July 2013. Actual Operation started in January 2014 as the Managing Director (MD) was selected.

Figure G.2.3 below illustrates the organizational structure of GWMC. Operational staff still belongs to CDGG but under the supervision of MD of GWMC. Management staff of 45 personnel is going to be hired to supervise 1,604 sanitary workers who are transferred from CDGG.

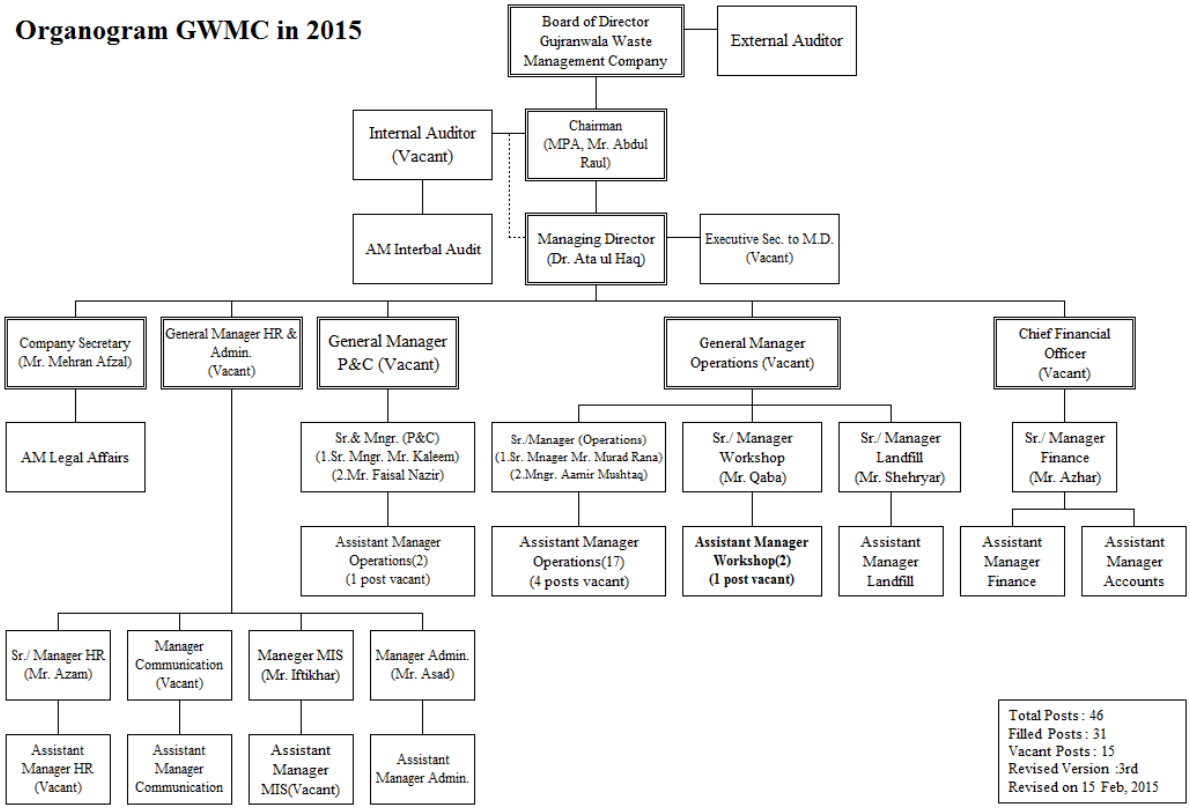

Figure G.2.3 Organogram of Gujranwala Waste Management Company as of February 2015

According to the Service and Asset Management Agreement (SAAMA), GWMC is responsible for field work (actual provision of solid waste management service) in 64 UCs while CDGG is responsible for monitoring of GWMC's work as well as enforcement and enactment of rules and regulations. In addition, CDGG aims at provision of solid waste management service in the remaining 34 UCs in 4 towns if its budget allows.

The Contract between CDGG and GWMC is a service contract where:

- Equipment is transferred from CDGG to GWMC and owned by GWMC.
- Staff belonging to CDGG is placed at the disposal of GWMC.
- Additional staff is hired directly by GWMC.
- GWMC budget (including staff salary) is covered by CDGG.

Since GWMC is a new organization, it has several challenges to address. The first challenge is lack of human resources. Since the establishment of GWMC, the hiring of management staff has been ongoing. However, the first level of hierarchy has not been filled up yet; for example, general managers and chief financial officer. This is because of: (a) lack of experts in SWM; and (b) strict criteria of selection. These make it quite difficult to find qualified and/or capable staff in the market at affordable compensation. Currently, MD is considering filling the positions by developing the capacity of existing staff and promoting them to the higher positions. For this purpose, an appropriate training system should be established.

Another challenge is lack of training system. The Management and Profession Development Department of the Punjab Province is in charge of the provision of training. However, the training course is only about general administrative issues and not specifically about solid waste management. As a result, even the management staffs of GWMC and CDGG have not received any training on solid waste management (only 6 waste managers have received training by UU). To develop their

human/institutional capacity, it is essential to provide such training especially for management level staff. At the moment, GWMC is planning to have its own training programme and has started needs assessment of each department.

The third challenge is lack of performance monitoring system. Although it is supposed to be defined according to the SAAMA agreement, there is no performance indicator (KPI) to monitor the performance of individual staff. CDGG as well as GWMC should start to work on setting KPI as soon as possible. Together with performance monitoring system, it is also essential to introduce incentive measures for staff based on their performance.

The final challenge is lack of financial independence from CDGG. For now, GWMC does not collect any fee for collection of wastes, meaning there is no waste management related revenue. Thus, CDGG transfers its budget from the Provincial government to GWMC. In order to establish financial independence of GWMC from CDGG, it is required to secure its own budget by imposing waste collection fees and tipping fees as currently discussed by UU and LWMC. Otherwise, one of the advantages of private sector involvement, which is relative freedom from political interference cannot be assured.

Table G.2.2 summarises the capacity of CDGG and GWMC under the status quo.

Table G.2.2 Capacity of CDGG and GWMC

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Aug, 2015
Generation	Solid Waste Generation	• 860 tons/day generation in 2012 (based on situational analysis report of Gujranwala City by UU)	• Lack of reliable data.	• 910 tons/day in 2014 at the rate of 0.55kg/ capita/day (based on observations and work done by Mr. Sami Ullah). • Office and weighbridge are under construction at Gondlanwala dump site.	• 0.40 kg/capita/day generation rate (Based on First and Second WACS survey result • Second WACS Survey was conducted in February 2015. • Third WACS Survey was conducted in May 2015 (Results are awaited.).
Transportation & Collection	Service Provision	• Service is not provided in the whole city.	• Lack of resources proper planning and skilled personnel. • Some of the areas are impartially served.	• Planning to start pilot project of new SWM system in two UCs.	• GWMC is currently providing services in 64 union councils further divided into zones. (8 zones for UC's, main roads are divided into 2 parts). • Plan to start pilot project in union councils after procurement of 10 compactors. • 8 Zonal offices are operational.
	Primary Collection	• Handcarts: 378/385 • Donkey carts: 102	• Lack of primary collection equipment and devices.	• 500 new handcarts are introduced into the system of which 400 are in the field and 100 stored in the workshop • 20 wheelie bins are introduced in the system for trial run.	• Almost 980 Handcarts are in the field. • 37 wheelie bins are in field and 20 wheelie bins on trial bases were used on Eid-ul-Fitar.

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Aug, 2015
Transportation & Collection	Primary Transportation	• Through tractor trolleys	• Lack of up-to-date vehicles and equipment	• 37 tractor trolleys are engaged in primary collection. • Plan to introduce 35 mini-dumpers in the system to increase efficiency of work and up-date the system.	• 43 mini-dumpers and 36 tractor trolleys are operational in the field for primary collection and transportation.
	Secondary Collection	• Secondary collection is done by $5m^3$ and $10m^3$ capacity containers. • 191 containers of $5m^3$ capacity are in the field, transfer stations, masonry and iron enclosures, 22 on arm-roll trucks, 7 in workshop and 5 at contractor's end. • 5 containers of $10m^3$ capacity are in the field, 6 in workshop, 2 on arm-roll trucks.	• Lack of proper planning for use of operational vehicles	• Plan to purchase and introduce $0.8m^3$ skips in the system to increase primary as well as secondary collection. • Identification of almost 800 illegal dump sites within the city and process to clear those sites is ongoing. • Plan to construct transfer stations in the city to improve collection services.	• Plan to purchase 400 containers ($0.8m^3$) for the compactors to be introduced in the system. • 4 Transfer stations are operational currently at: 1) Jinnah Road 2) Petrol Pump 3) Kohlowala Gala UC #47 4) Ayesha Bibi park
	Secondary Transportation	• Arm-roll trucks of $5m^3$ and $10m^3$ capacity are used for secondary transportation.	• Almost 40% of SWM vehicles and equipment are out of order most of the time.	• Same vehicles, i.e., arm roll trucks of $5m^3$ and $10m^3$ capacity are used for secondary transportation. Only 7% of the vehicles are out of order at present. • 22 out of 24 arm roll trucks of $5m^3$ capacity and 2 out of 4 arm roll trucks of $10m^3$ capacity are in operation at present.	• All of the vehicles are in working condition. • Second shift by 8 arm rolls is operational. • Second shift with 29 Sanitary Workers, 2 Sanitary Supervisors & 5 Mini Tippers are operational. • Plan to procure 10 compactors of $7m^3$.

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Aug, 2015
Transportation & Collection				• Second shift by 6 arm roll trucks was started on trial basis to increase the collection efficiency and maximum utilisation of available resources. • Plan to introduce compactors of $7m^3$ and $13m^3$ capacity and $7m^3$ dump trucks.	
	Waste Quantity (Collection Efficiency)	• 500 tons/day collection in 2012 i.e. 55% collection efficiency (based on situational analysis report of Gujranwala City by UU)	• Lack of reliable data	• 400-450 tons per day collection, i.e., 44-49% collection efficiency (based on observations and work done by Mr. Sami Ullah)	• 626 tons on average per day i.e., 72 % collection efficiency with reference to Manager Landfill.
	Workshop	• Workshop is situated at Sheikhupura Morr near mini stadium.	• Improper planning at workshop • Lack of security system • Lack of repair and maintenance works • Lack of technical expert was the reason of improper maintenance of machinery, equipment and vehicles. • Lack Of Inventory • Practice of corrective maintenance rather than preventive maintenance • Improper and poor parking • Complete outsourcing and no in-house repair and maintenance facility.	• Cost saving through engine oil change, local repair and maintenance, battery repair cost. • Sorting and storage of scrap. • 3' steel fencing of workshop. • Renovation of waste enclosures • Capacity enhancement of $3.5m^3$ tractor trolley to $6m^3$ for transportation of waste on trial basis. • Improvement in service station of workshop in progress and operational soon. • Use of scrap engine of tractor trolley as generator. • Proper records-keeping of newly purchased and replaced parts of vehicles.	• Cost saving through engine oil change, in this sense that now only branded engine oil is used which lasts for longer time. • Recycling of waste batteries. • Durable Renovation of existing 7 waste enclosures and 2 new masonry enclosures are installed and one special waste enclosure is installed. • 84 out of 84 vehicles are operational at present. • Implementation of Japanese TPM 5S standard at workshop. • Prevention of Dengue hazard in workshop by regular anti dengue spray and weather proof clothe at workshop • Functionalisation of mobile workshop. • Complete electrical wiring and lighting at workshop premises /Activation of WAPDA connection. • 20 containers are added • Mobile welding workshop is in pipeline. • Different sections in workshop are introduced i.e. Paint, Washing, welding etc. • Street washer is designed on pickup.

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Aug, 2015
Transportation & Collection			•	• Only 7% of SWM vehicles are out of order; the rest are functional. • 78 out of 84 vehicles are operational at present.	• Security guards are recruited. • 31 cameras are installed • Water hydrant is on trial basis • More than 100 handcarts and drums are manufactured in-house. • Generator is installed • Transformer is installed • Tender of engineering rack is in pipeline.
Disposal	Disposal	• At Chianwali dump site at approximately 14.4km from the city centre.	• Poor management of the Chianwali dump site resulted in closure of the site before expected lifetime; according to UU studies, it should be utilised until 2016. • Lack of expert staff at dumpsite. • Lack of planning.	• Shifting of the dump site to Gondlanwala at approximately 7km from the city centre. • Chianwali dump site closure and heap management from the roadside. Rehabilitation of the site will be according to the plan devised by JICA. • 360-415 tons of waste are transported to the disposal site, i.e., 39.5% to 46% is disposed. • Fuel consumption is cut down to 10-12 lacs/month for transportation of waste.	• Weighbridge installed at Gondlanwala. • Maintaining record of tonnage • Proper soil cover over waste along with compaction. • Dewatering stagnant water through peter pump. • Office construction at Gondlanwala disposal site. • Fumigation and daily cover on daily basis. • Plan to cap Chianwali and to complete boundary wall construction. • Land Acquisition of Bhakraywali PC-1 is submitted. • Public hearing of landfill has been organized. • Average 626 tons/day Routine collection. • 3 Buckets are procured.
Special Waste	Industrial Waste	• Industrial waste though not in jurisdiction of SWM department but is carried and disposed of by it. • Some industries reuse and recycle their waste.	• Industrial waste management is not the responsibility of the SWM Department but no other system of industrial waste management exists.	• Only municipal waste management is under the responsibility of GWMC.	• One road washer is procured and operational on trial. • Street washer is also installed.
	Construction and Demolition Waste (C & D Waste)	• SWM Department takes C & D waste to the Chianwali dump site without charging fee from the generator.	• C & D waste management is out of the scope of municipal waste.	• GWMC yet has not devised any strategy of C & D waste.	• 15 Sanitary workers are working in the industrial estates for municipal solid waste management

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Aug, 2015
	Hospital Waste	• 36 hospitals and clinics were registered with Shalimar hospital for incineration of waste.	• Hospital waste is being mixed with municipal waste.	• Hospital waste is the responsibility of concerned healthcare unit to onsite segregate, collect, treatment and dispose off as per hospital waste management rules 2005.	• Currently GWMC is lifting the C & D waste but has not devised any strategy yet as C & D is not the responsibility of GWMC.
	Drainage Waste	• Drainage de-silting and removing up to 2' width drains and the removal of silt from the drains of WASA are the responsibility of CDGG. • No record is maintained.	• Lack of proper machinery and vehicles for transport of de-silted material.	• GWMC has not devised any strategy about handling and transportation of de-silted material. • Till now same procedures are adopted by CDGG.	• Same
3R	Recovery	• Informal scavenging activity of about 600 waste pickers involved in the activity (based on situational analysis report of Gujranwala City by UU).	• Lack of reliable data.	• About 700 waste pickers are involved in informal scavenging activity at disposal points and dumping site (based on field observation and interview with waste pickers/scavengers by Waste Manager Hina Aslam).	• For handling of de-silted material one gang with 10 Sanitary Workers is working in each zone. • Mini tippers, Tractor Trolleys and handcarts are used for transportation of de-silted waste. • Desilted waste of WASA is also lifted by GWMC
	Composting	• Yard trimmings and waste from fruits and vegetable markets is disposed into the dump site. • Composting is not practiced.	• Lack of market for composting. • There should be separate collection vehicles for organic waste in order to make compost.	• GWMC has not devised any strategy about composting yet.	• About 800 waste pickers are involved in informal scavenging activity in the city and dumping site (based on field observation and interview with waste pickers/scavengers by Waste Manager Hina Aslam).

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Aug, 2015
Institution	Legislative Framework	• No by-law of SWM for CDGG.	• Lack of a single comprehensive law about MSWM. • Laws are fragmented and hence their implementation is questionable since implementing bodies are more than one. • Lack of clear policy on municipal waste. • Weak enforcement of existing laws and regulations. • Lack of policy to promote 3R. • Inadequate planning. • Ineffective regulations • Lack of good governance.	• UU and LWMC are drafting a by-law.	• Same
	Human Resource	• DO (SWM), CSI, SI, SS, SW and office staff • Unskilled work force: 1,604	• Lack of technical experts • Shortage of sanitary workers • 1,604 sanitary workers were hired upon establishment of the SWM Department. Updated data is not available about dead, retired and left-over personnel out of the 1,604 workers.	• Recruitment of experts of each field like company secretary, HR, Administration, Finance, Operations, Procurement, Workshop, Landfill site, Communication. • Hiring of 345 unskilled labourers • Hiring of one more CSI on trial basis for supervision of cleaning activity on roads. • Deputation of staff (est. 60 sanitary workers) on roads. • Group insurance policies are in hand. • 1,420 (1,003 regular, 417 contract) workers of CDGG were transferred to GWMC 325 daily waged employees; 345 new contract workers hired by GWMC.	• Same

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Aug, 2015
	Training	• Local training and workshop of waste managers by urban unit (Sept. to Oct. 2013)	• Lack of training of employees	• Foreign training of the waste managers and MD in June 2014. • Training of all the managers of GWMC by LWMC is proposed in consultancy service document.	• Recruitment of CFO & Manager MIS. • Finalisation of Organogram of GWMC with the coordination of LWMC as per consultancy agreement. • Obtained the ISO 9001:2008 certification for GWMC, aiming to continue on yearly basis on September 2014. • Plan to complete with strong coordination and obtain the necessary HR related software, trainings, census, PMS, etc., from LWMC as per the consultancy agreement & executions with true letter & spirit. • To identify the weak areas of employees through using/implementing effective system of TNA & provide necessary trainings for improvements/ to overcome the shortfalls. Accordingly, we need the assistance by the experts in this regard. • Preparation of HR Manual for GWMC • Hiring of sanitary workers is complete & 25 drivers are still to be hired for state of art vehicles on third party labour for more improvement / collection / cleanliness efforts are in hand. • Plan to liaison with DHQ & Social Security Hospital regarding the screening test of Hepatitis/Tuberculosis, etc., for field staff as a part of health & safety along with the procurement of required / necessary gadgets (i.e., Musk, Gloves, Gumshoe, etc.) • Procurement of android system of attendance for field staff along with monitoring (tender in process). • Procurement & execution of HRIS & Payroll system for making & maintaining transparency & accuracy • To provide medical coverage of all the GWMC staff (direct) along with Group Life Insurance (efforts are in hand) as the Group Life Insurance coverage of Permanent workers of Solid Waste with State Life has been continued/resumed is effective from February 2015.

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Aug, 2015
	Finance	• For the fiscal year 2012-2013 budget of SWM was 4% of the total CDGG budget. • Out of SWM budget, 88% budget is utilised for salaries of SWM staff while remaining 12% is non-salary expenses.	• Improper file management and data handling system. • Lack of revenue collection system from SWM services. • Lack of financial expert in the department. • Limited budget	• Capital investment for purchase of up-to-date vehicles, skips and landfill site is proposed in current budget. • Conversion of documents and old record of CDGG data in soft form. • No revenue generation plan.	• Developed a mechanise system for employee database/getting the complete information of employee (i.e., Permanent , Contractual, Daily Wager & third party labour employees) • Regularization of contractual employees • Leave encashment of regular employees • Financial Assistance of employees • Four month salary cases in progress • Upgradation of regular employee cases • LWMC plan to train the concerned employees accordingly as per of agreement. • A few trainings are already conducted.
Public Communication	Education and Awareness	• Awareness of SWM effects on wetlands to the school children and teachers on world wetland day (collaboration of GWMC and CDGG)	• Lack of awareness programmes • Lack of participation and coordination among stakeholders, e.g., inter-agency collaboration at national/local level.	• One week awareness campaign of cleanliness celebrated with joint venture of WWF Pakistan and GCCI involving schools, colleges, communities, influential personalities. • Plan to raise awareness among citizens on Independence Day, 14th day of August. • Process of awareness will boost up after recruitment of communication manager.	• Proposed budget is approved and items to be procured are in process. Requisition is sent to the procurement department.
	Management Information System (MIS)	• Facebook page of SWM has been created but not updated daily due to non-availability of the internet facility and MIS manager.	• Lack of technical expert and MIS system	• GWMC domain name registered as gwmc.com.pk. • Official email accounts of GWMC employees are active. • Toll free telephone service activated to facilitate complaint registration by citizens/residents. • GPS based tracker	• Assistant Communication Manager is recruited by GWMC. • Awareness Campaign on Eid ul-Azha along with provision of shopping bags. • 14 August celebration with a programme on FM Radio and shopping bags distribution in 2014 • Awareness campaign in Sanitation Week (16 March to 21 March 2015). • School awareness in 16 schools • Awareness in hospitals

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Aug, 2015
				system installed in two vehicles as a pilot activity. • GWMC Facebook page created and updated. • Tender floated for security & surveillance system for mechanical workshop & office premises.	• Awareness camps in different locations for general public awareness • FM Radio program on 14th August 2015. • Wall Chalking • Door to door awareness campaign • Ramadan camps • Road show on 13th august for awareness. • Server machine and its allied equipment are installed. • Dedicated ether network cable spreader in head office. • Laptops and mobile sets procured. • Tender for Desktop computers, multimedia completed. • Network photocopier cum printer and digital telephone exchange installed. • Vehicle tracking and management system for 100 vehicles installed. • Work order for vehicle trip counting system in pipeline. • Tender floated for digital android based monitoring. • CCTV equipment installed in head office and mechanical workshop. • GWMC website in process. • GWMC activities are being updated on Facebook page.

2.4 Review of Past and Present Plans and Projects Related to Solid Waste Management

2.4.1 Review of Past Foreign Aided Projects Related to Solid Waste Management

Past and present plans and projects related to solid waste management in Punjab Province are summarised according to donor, namely; the Government of Japan, the Asian Development Bank and the World Bank.

(1) Government of Japan

(a) Improvement of Garbage Collection and Disposal in Rawalpindi City (1996)

Under the scheme of Grant Aid, container trucks for waste collection, containers and heavy machinery have been provided to improve waste collection efficiency.

(b) Dispatch of Short-Term Expert on Solid Waste Management (2002)

A short-term expert has dispatched aiming at evaluation of the above-mentioned project, including similar projects in Karachi and Quetta, as well as at identification of challenges. As the result, the necessity of development of laws and guidelines was noted.

(c) Dispatch of Long-Term Expert on Municipal Waste Management (2003-2005)

No report was available. Thus it is unclear whether or not an expert was dispatched to Punjab Province.

(d) Project for Solid Waste Management in Pakistan (2005-2006)

District officers in charge of solid waste management in major cities were trained on solid waste management in Japan. As a result of the training, the Punjab Municipal Solid Waste Management Guidelines was developed in collaboration with United Nations Development Programme in 2007.

(e) Capacity Building for Solid Waste Management (2006-2009)

The technical cooperation project was implemented to enhance the output of the above-mentioned project and to further improve the solid waste management system. Main activities were the training in the eight major cities for the purpose of capacity development in solid waste management.

(f) Data Collection Survey on Solid Waste Management in Punjab Province (2009-2010)

Data on budget allocation, staffing, assistance from other donors in the field of solid waste management in seven major cities in the Punjab Province, namely Lahore, Faisalabad, Rawalpindi, Multan, Gujranwala, Sargodha and Sialkot was collected and surveyed. Consequently, it was confirmed that there was high need for assistance in solid waste management in those cities.

(2) Asian Development Bank (ADB)

(a) Southern Punjab Basic Services Project (2005-2009)

This project aimed at basic infrastructure development, including not only waste management but also water supply, sewerage, drainage and roads in 26 cities having the population of more than 50,000 people in Punjab Province. Approximate project cost was 55-60 million US dollars. The implementing agencies were the Water and Sanitation Agency (WASA) and the Development Authority (DA). The project covered hard components such as construction, as well as soft components; i.e., financial capacity development and institutional improvement of the implementing agencies. Although this project had overarching coverage, activities for each city were chosen according to prioritisation based on its needs. Out of the 26 landfills constructed, 13 were for cities including Multan.

(b) Rawalpindi Environment Improvement Project (2006-2011)

Aiming at improvement of living environment in Rawalpindi, this Project intended to develop water supply, sewerage and waste management. Total project cost was 5,142.6 million rupees, out of which ADB bore 3600 million rupees and the Government of the Punjab, 1,542.6 million rupees. The project included the construction of wells and water drainage, development of sewerage and drainage system, procurement of waste collection vehicles and construction of a final disposal site. In addition, the project provided the capacity development programme of implementing agencies and the public awareness raising programme.

(3) The World Bank (WB)

(a) Punjab Municipal Services Improvement Project (2006-2010)

The purpose of this project was to develop capacity in terms of planning and finance for municipal services of Tehsil Municipal Administration (TMA) in the Punjab Province. Total project cost was 58.9 million US dollars, out of which WB incurred 50 million US dollars and the Government of the Punjab 8.9 million US dollars. Target area of municipal services included water supply and sewerage system, drainage system, waste management, road/transportation and fire-fighting measures.

(b) KOICA-World Bank Joint Study on Solid Waste Management in Punjab (2006-2007)

The Korean International Cooperation Agency (KOICA) in collaboration with WB conducted a study on current status of waste management in nine major cities of the Punjab Province. Out of the nine cities, the Study developed master plans of waste management for the cities of Lahore and Sialkot targeting the year 2021. The WB consultants conducted a study and made recommendations on the legal framework, private sector involvement, technology and planning, while the KOICA consultants conducted the study on finance, institution and stakeholders.

2.4.2 Institutions for Private Sector Involvement in Solid Waste Management

Although currently there is no private service provider of solid waste management in Gujranwala, the provincial government has taken initiative of private sector involvement. This is mainly because of the lack of capacity of local governments to catch up with the dramatic urbanisation and drastic increase of waste volume of cities. This section first briefly overviews laws and regulations related to private sector involvement, then analysis examples of private sector involvement in the Punjab Province.

(1) Laws and Regulations Related to Private Sector Involvement

Table G.2.3 below summarises major laws and regulations related to private sector involvement in Pakistan.

Table G.2.3 Summary of Laws and Regulations Related to Private Sector Involvement

Laws and Regulations	Related Issues	Remarks
Pakistan Policy on Public-Private Partnership (2010)	・ In the early 1990's, Pakistan established a policy and regulatory framework for Public-Private Partnership (PPP) in the telecom and power sectors. Unregulated sectors like transport and logistics, water supply, sanitation, solid waste management, real estate and social sectors including education, healthcare and housing have yet to benefit from such a framework. ・ A PPP may include an equity joint venture between GOP and the private sector. ・ **Benefits:** - Development of more infrastructure on time and within budget. - Encouraging the private sector in innovative design, technology and financing structures and including increased international and domestic investment. - Risk sharing by GOP with private sector partners. - Ensuring good quality public services and their wider availability. - Real financial benefits, and a better utilisation and allocation of public funds.	・ These policies are specifically related to Partnership between public and private sectors. ・ These policies are developed to establish a clear financial, legal and administrative framework and also eliminate undesirable obstacles confronting private investments in infrastructure facilities and in order to facilitate public-private partnerships. ・ These policies are most suitable for understanding the PPP project approval and process, PPP structure and legal framework.

Laws and Regulations	Related Issues	Remarks
	- Economic growth and increased and wider employment opportunities. · **Objectives:** - Promote inclusive social and economic development through the provision of infrastructure. - Leverage public funds with private financing from local and international markets. - Encourage and facilitate investment by the private sector by creating an enabling environment in PPP in infrastructure. - Protect the interests of all stakeholders including end users, affected people, government and the private sector. - Set up efficient and transparent institutional arrangements for identification, structuring and competitive tendering of projects. - Develop efficient risk sharing mechanisms in such that the party best equipped bears the appropriate level of risk. - Provide viability gap funding where the projects' viability is insufficient to attract private sector funding.	
Protection of Economic Reforms Ordinance (1999)	· Related to privatisation of public sector enterprises. · Fiscal incentives for setting-up of industries. · Transfer of ownership to private sector. · Foreign and Pakistani Investment. · Financial obligation.	This Ordinance is about banking, finance, exchange and payments systems, holding and transfer of currencies between public and private or 2 different countries and about "Foreign Currency Accounts".
Companies Ordinance (1984)		Specifically related to formulation of companies and about how to windup, Liquidation and so on (memorandum of association, Association Not for Profit, Companies Limited by Guarantee, Services and Authentication of Documents, Certificate of Share and Debentures, Regulation of deposits, Classes and kinds of shares, etc.).
Labour Policy (2010)	· Workers' right to form unions. · Equitable adjustment of rights between workers and employers. · Consultations between workers and employers. · Adequate security of jobs. · Conditions should be created that workers and employers are committed in enhancing the labour productivity. · Promotion to higher jobs on suitability and merit. · Social insurance schemes. · Humane conditions of work should be guaranteed to all workers. · Forced labour in all its forms to be eliminated. · The minimum wage was raised from Rs. 4600/- to Rs. 6000/- in the year 2008, which will be further enhanced to Rs.7000/- there is increase of about 17%.	This policy stipulate rules related to wages and women workers; Eradication of Bonded Labour, Construction Labour, Contractual Employees, Child Labour, Informal Economy Workers, etc. It has nothing related to PPP.

Laws and Regulations	Related Issues	Remarks
	(Now According to the Budget of 2014-15, minimum wage is 12,000/-) ・ All industrial, commercial and other establishments registered under any law shall pay wages to the employees through cheque/bank transfer. ・ Points related to women, young, mine and child labours. ・ Health safety and so on. ・ Expansion in scope of workers' welfare fund. ・ Social security. ・ Employees' Old-Age benefits scheme. ・ Different strategies of skill development and employment.	
Punjab Procurement Rules (2014)		These rules are related to procurement (like bid and bidding documents)

(2) Examples of Private Sector Involvement in Solid Waste Management in Punjab Province

Table G.2.4 gives an overview of private sector involvement projects/programmes in the Punjab Province.

Table G.2.4 Overview of Private Sector Involvement Project/Programme in the Punjab Province

Project	Mechanisms	Project Overview		Comments
Tehsil Municipal Administration Gujrat	Management Contract	Contract Parties	Tehsil Municipal Administration (TMA) Gujrat and Waste Management Pakistan (Pvt.) Ltd.	> one year contract with automatic renewal up to 2 years. > due to lack of experience and several management lapses the project failed as a Private Sector Participation (PSP) model. Comments are given below*1.
		Description of Services	Integrated Solid Waste Management Services for the entire urban area of Gujrat City. Primary and secondary collection, transportation and final disposal of solid waste. Municipal solid waste, construction waste, healthcare waste, industrial waste, and sewage sludge.	
		Description of Area Served	Urban population mix of low-middle income groups.	
		Size of Collection Zone	15 Union Councils comprising of 30,000 households.	
		Description of Staff Involved	1 Project Director, 2 Project Managers, 3 Administrative Managers, 18 Supervisors, 36 Drivers, 64 Loaders, 480 Sanitary Workers and 30 Social Motivators.	
		Description of Equipment	2 Mazda Trucks, 14 Tractor Trolleys, 3 Front End Loaders, 2 Mechanical Sweepers, 2 Blades, 1 Excavator, 1 Gully Sucker and 1 Jetting Machine.	
		Put into Operation	February 2004	
		Present Status	Contract Dissolved.	
Lahore Sanitation Programme	Franchise Contract	Contract Parties	Cantonment Board Lahore, Waste Busters, Residents	Comments are given below*2.
		Description of Services	Door to door collection of household waste daily	

Project	Mechanisms	Project Overview		Comments
			Delivery of 30 garbage bags per month Transportation of waste to disposal site.	
		Description of Area Served	High Middle income urban areas of Lahore Cantonment.	
		Size of Collection Zone	10,000 households	
		Description of Staff Involved	Social Motivators, Supervisors, Drivers and Labour Mostly new staff was hired from within the community.	
		Description of Equipment	Suzuki Pick up vans, Hand carts, Uniforms.	
		Put into Operation	December 1996	
		Present Status	In Operation.	
Cantonment Board Lahore	Management Contract	Contract Parties	Cantonment Board Walton & M/s. Babar & Umer (Pvt.) Ltd. , GHS (Pvt.) Ltd., Waste Management Pakistan (Pvt.) Ltd.	Comments are given below*3.
		Description of Services	Solid Waste Conservancy including waste collection, street sweeping, drain cleaning, garden waste collection and commercial areas cleaning.	
		Description of Area Served	Urban areas falling under Lahore Cantonment within the administrative control of the Cantonment Board Walton, Lahore	
		Size of Collection Zone	50,000 households	
		Description of Staff Involved	Project Manager, Chief Sanitary Inspector, Supervisors, Administrative Staff, Sanitary Workers.	
		Description of Equipment	Mazda Dump Trucks (3 MT), Tractor Trolleys, Front End Loader, Mechanical Sweeper, Refuse Collection Vehicles (RCV), Suzuki Pickups.	
		Put into Operation	April 1999	
		Present Status	In operation	
Chaklala Waste Management, Rawalpindi	Service Contract	Contract Parties	Union Council 97, Shell Pakistan Ltd. and Green Management (Pvt.) Ltd.	Comments are given below*4.
		Description of Services	Clean-up of waste dumps, Community Awareness Programme Capacity building of Union Council Introduction of door to door waste collection.	
		Description of Area Served	Low Income Urban population. Living in Dhok Munshi, Chaklala, and Rawalpindi.	
		Size of Collection Zone	1 Union Council, 4500 Households.	
		Description of Staff Involved	Social Organizers, Project Manager, Sanitary Workers, Drivers.	
		Description of Equipment	Handcarts, Tractor Trolley, Pick-up Truck, Suzuki Pick-ups, Garbage Bags	
		Put into	April 2005	

Project	Mechanisms	Project Overview		Comments
		Operation		
		Present Status	Project period ended October 2005	
Lahore Compost Plant	BOT Contract	Contract Parties	City District Government Lahore and Lahore Compost (Pvt.) Ltd.	Comments are given below*5.
		Description of Services	Establishment of a compost plant	
		Description of Area Served	Municipal solid waste collected in Lahore	
		Size of Collection Zone	1000 MT/day	
		Description of Staff Involved	Project Manager, Supervisor, Labour, Mechanics, Engineers, Biochemist, Marketing Representatives.	
		Description of Equipment	Compost plant comprising of sorting conveyor, sieving screens, trammel screen, shredder, turner and bagging unit.	
		Put into Operation	March 2005	
		Present Status	In operation	
Metropolitan Corporation Lahore (MCL)	Franchise	Contract Parties	Metropolitan Corporation Lahore (MCL) and Waste Collection & Sweeping (Pvt.) Ltd.	Comments are given below*6.
		Description of Services	Solid Waste Management of Ward No. 79, MCL, Lahore.	
		Description of Area Served	Urban area comprising of one ward in Metropolitan City	
		Size of Collection Zone	1000 households	
		Description of Staff Involved	Supervisor, 10 labour	
		Description of Equipment	Hand Carts, Transfer station, Suzuki Pickup	
		Put into Operation	April 2001	
		Present Status	Aborted	

(a) Tehsil Municipal Administration Gujrat[*1]

There are different steps of private sector participation (hereinafter referred to as "PSP") in the Gujrat Project which has some positive and negative impacts.

Steps which makes negative impact:

- Too big area for primary and secondary collection;
- It is very difficult to perform many tasks at one time;
- Too many waste categories to be managed by private party;
- Initial time period for contract is too short to purchase equipment and investments (for private party);
- Variable costs not covered (Fuel & Salaries);
- Inexperienced private company;
- Bad monitoring of drivers during transportation of waste;
- Private company did not focus on unforeseen breakdown and repair costs;
- Only one time awareness campaign and less communication with local public;

- Key stakeholders were not involved;
- The first opposition came from the labour union that was sceptical about the new private contractor. There were genuine concerns since the labour union was not involved in deciding privatisation and thus lack of trust had developed naturally;
- The local media also sought opportunity to comment on the private contractor. There were 26 reporters on the sanitation beat and all had demands which needed to be addressed; otherwise, the press would release negative news everyday against the sanitation project. This was also an unforeseen expense which needed to be dealt with;
- No political backing of private company;
- Less monitoring and control of sanitary workers; and
- Political influence.

Steps which make positive impact:

- Cristal clear process of selection of a private company;
- Counting the number of trips to dumping site;
- Procurement of new equipment and handcarts.
- Awareness campaign before launching the project;
- Bit sport of newly elected Nazim (Mayor); and
- Social motivation.

(b) Lahore Sanitation Programme[*2]

There are different steps of PSP Lahore Sanitation Programme with some positive and negative impacts.

Steps which make negative impact:

- No formal agreement and tendering process;
- No competition among service providers;
- No tariff system on the bases of no profit no loss; and
- No handling system of waste pickers.

Steps which make positive impact:

- Limited and manageable area;
- Fully designed and planned project area;
- Monitoring through the local committee;
- Door to door collection system;
- Awareness campaigns;
- Social motivators;
- Time decided for door to door collection;
- Uniform for sanitary workers;
- Baskets installed outside each house;
- 30 garbage bags for each house/month.
- Suzuki pickups for waste collection;
- Support from local media; and
- Cooperation of Cantonment Board and local public.

(c) Cantonment Board Lahore[*3]

There are different steps of PSP Cantonment Board Lahore with some positive and negative impacts.

Steps which make negative impact:

- No proper disposal of waste;
- No sharing of Extra Costs among Contractors; and
- Heavy machinery required for dumpsite.

Steps which make positive impact:

- Detail design of the project;
- More than one contractor for the project;
- Open tender;
- Prequalification of contractors;
- Long-term contract (3 years);
- No political interference;
- Strict penalty clauses;
- Manpower and machinery are provided according to requirement;
- Sweeping and lifting of waste on daily bases;
- Door-to-door collection;
- Decided key performance indicators;
- Chief sanitary inspector and sanitary inspectors to monitor the programme;
- Machinery (waste trucks, Suzuki pickups, frontend roller and tractor trolleys);
- Awareness campaigns; and
- Support of stakeholders.

(d) Chaklala Waste Management, Rawalpindi[*4]

There are different steps of PSP Chaklala Waste Management, Rawalpindi with some positive and negative impacts.

Steps which make negative impact:

- Large population and project area;
- The area legally falls under the Municipal Administration of the City District Government Rawalpindi. However, physically, the Union Council lies in the Cantonment Board area;
- No tendering process;
- Short-term service contract (6 months);
- No clause on the extension in the contract period;
- As soon as the project was handed over to the Union Council, politics took over and a debate over the ownership of the project came up. (Political differences among local leaders);
- Overhead costs of transportation of the waste from the collection point to the waste disposal site; and
- No sustainability of project without corporate support.

Steps which make positive impact:

- Shell Pakistan Ltd. undertook this venture as part of its Corporate Social Responsibility;

- Procured services from private contractor;
- Tasks for cleaning garbage dumps;
- The private contractor (Green Management) hired 20 female social organizers and trained them on aspects of community mobilisation;
- Well-designed plan;
- Planned cleaning of plots and dump sites;
- Handcarts and safety gears distributed among workers;
- Excavators, Bulldozers, Tractor Trolleys, Pickup Trucks, Handcarts, Garbage Bags.
- Support from local government; and
- Motivated workers with good salaries.

(e) Lahore Compost Plant[*5]

There are different steps of PSP Lahore Compost Plant with some positive and negative impacts.

Steps which make negative impact:

- Negotiations took more than one year;
- Stay order taken by local residents against the agreement;
- No experience in composting or solid waste management;
- Hired local consultants for advising the company;
- Slow sales of compost material due to inexperience; and
- Few companies participated due to inexperience.

Steps which make positive impact:

- First Build-Operate-Transfer (BOT) Project in solid waste management sector;
- Land and waste given free of cost to private contractor;
- Private contractor to invest in capital cost and operational cost;
- Recycling of organic waste;
- 30 years concession given to private contractor;
- 25 Acres land & 1000 ton/day or organic waste;
- Sharing of 10% profit with city government;
- Well reputed and established business house;
- Strong financial support from banks;
- Modern compost plant imported from Belgium; and
- Organic waste being delivered by City District Government Lahore.

(f) Metropolitan Corporation Lahore (MCL) [*6]

There are different steps of PSP Lahore Compost Plant with some positive and negative impacts.

Steps which make negative impact:

- Lack of competition;
- Tariffs not negotiated;
- No administration support;
- Low skill level;
- Lack of training of franchise;

- Lack of monitoring skills of MCL;
- Lack of cooperation from community;
- Waste pickers, gypsy families involved; and
- Lack of support by MCL.

Steps which make positive impact:

- Well planned design;
- Economic solution;
- Door-to-door collection;
- Segregation of waste;
- Income generation (Rs. 50/month);
- Proper tender solicitation;
- Pre-tender conference;
- Transfer stations provided;
- Handcarts; and
- Containers.

(g) Lahore Waste Management Company (LWMC)

Another example of private sector involvement can be seen in the City District Government Lahore (CDGL). CDGL established LWMC under Section 42 of the Companies Ordinance of 1984 on 19 March 2010. The company is limited by guarantee having no share capital and is formed not for profit within the context of Section 42 of the Companies Ordinance. The LMWC is governed by a Board of Directors, headed by a Chairman. The organogram of LWMC is given in **Figure G.2.4.** (The budgetary status is not yet provided by LWMC.). The company was formed in order to meet the demand of institutional innovation such as:

- To have financial and administrative autonomy for quick decision-making;
- To exercise corporate governance and professional approach;
- To improve human resource and financial management; and
- To ensure transparency, accountability and public disclosure.

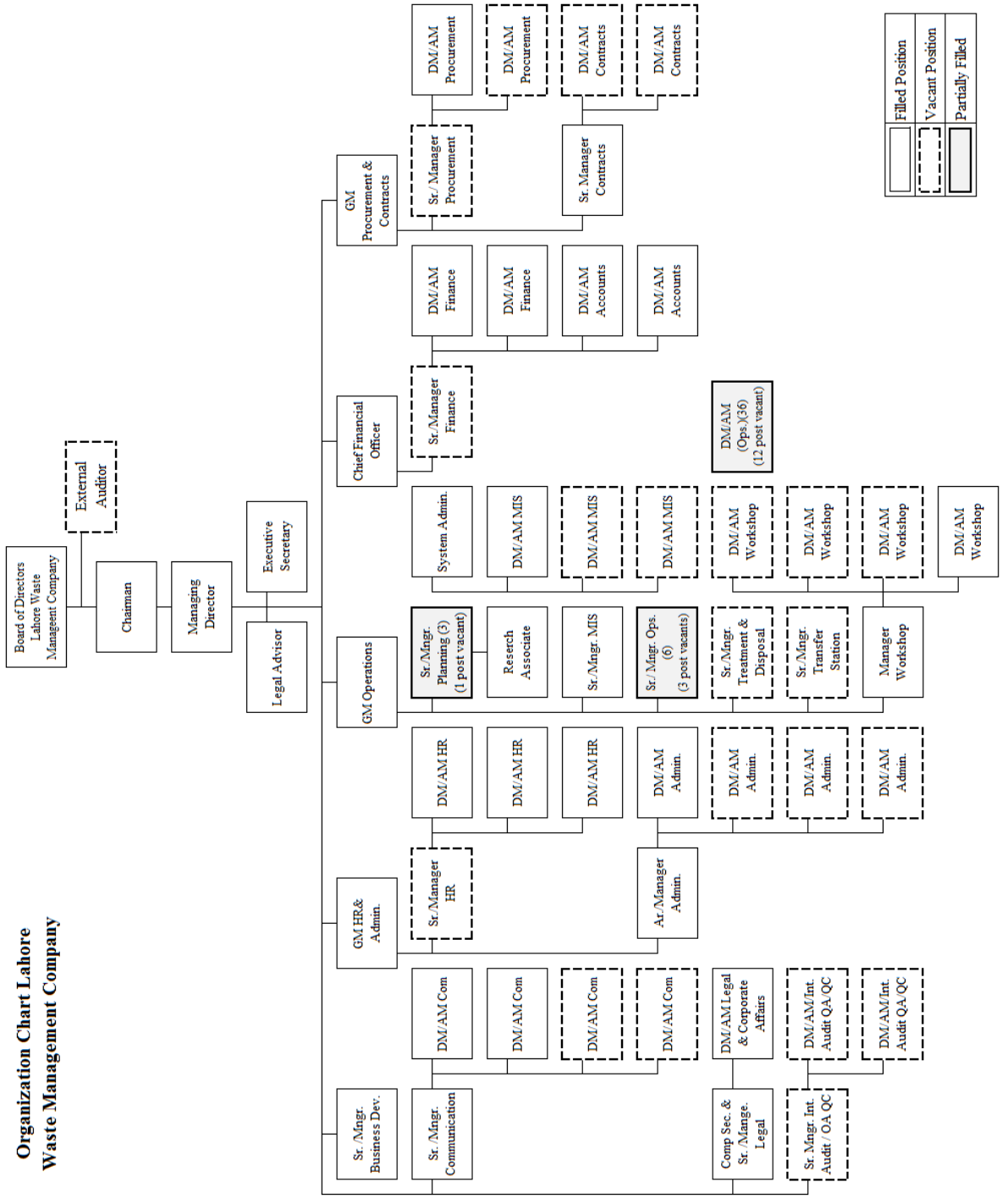

Figure G2.4 Organogram of Lahore Waste Management Company as of March 2015

According to the Services and Asset Management Agreement (SAAMA) between CDGL and LWMC, all the functions and assets of the SWM department of CDGL and the TMAs have been entrusted to LWMC. LWMC aims to develop an integrated system of solid waste management to ensure efficient collection, transportation, recovery, treatment and disposal of wastes generated in Lahore.

LWMC's vision was the transformation of Lahore as one of the cleanest cities in the world by providing customised solutions in the consultation with citizens and private partners to ensure sustainable, safe, clean and green environment. Following the vision, LWMC had the mission to provide a waste management programme that contributes to the maintenance of health of the residents by ensuring that waste is removed from the city and disposed in an environmentally acceptable manner.

Since the inception of LWMC, M/s ISTAC, a company in the Municipality of Istanbul, had provided technical support to LWMC through a consultancy agreement for the period from December 2010 to December 2013. ISTAC has assisted LWMC in improving its institutional structure. It conducted waste characterisation studies, prepared waste management plans, design of outsourcing of SWM system for Lahore, design of sanitary landfill and conducted training of LWMC's professional staff. ISTAC is currently engaged in the preparation of the integrated SWM plan of hospital, industrial and packaging waste management plans.

LWMC designed a new SWM System with the assistance of M/s ISTAC, which will outsource the SWM services in the city of Lahore to international companies. This outsourcing has been done through transparent international bidding and various internal firms were considered before awarding the contract to the two (2) Turkish companies, i.e., Albayrak and Ozpak against an amount of USD320 million for 7 years. The new Solid Waste Management Operations by Turkish companies were inaugurated jointly by His Excellency Kadir Tapas, the Mayor of Istanbul and Chief Minister Punjab Mian Muhammad Shahbaz Sharif on 11 March 2012.

The contracts include the following:

- Door-to-door collection of waste;
- Collection and removal of waste to the approved disposal sites;
- Mechanical/Manual sweeping of main and arterial roads, streets and squares with vacuum vehicles;
- Mechanical washing; and
- Health insurance and safety measures and standards.

The Turkish contracts have brought international expertise along with modern equipment and vehicles for carrying out SWM operations.

The workshops have been upgraded and M/s Ozpak has also started manufacture of 0.8 m^3 containers. The contractors have brought in additional vehicles like hauler dumper, mini-dumpers and chain arm rolls to address the SWM issue on the ground. Presently, about 1,500 km of roads are mechanically swept along with washing of about 100 km of area daily. More than 80% waste collection efficiency has been achieved by the contractors in their respective zones which was only 60% at the onset of the project.

From the above-mentioned examples, factors for success and failure of private sector involvement can be summarised as shown in **Table G.2.5**.

Table G.2.5 Factors for Success and Failure of Private Sector Involvement

Success	Failure
• Capacity of the private sector partner must be compatible to undertake the proposed project. • Proper planning and design of the project is the key to success of any PSP model. • Appropriate machinery and manpower. • Strict and vigilant monitoring. • Time Management. • A motivated team of workers. • Involvement of key stakeholders. • Community support. • Support of the local government. • A good customer service system with a complaint cell. • Public Awareness Campaigns.	• Lack of capacity. • Lack of Standard Operation Procedures (SOPs). • Contracts are drawn out without any legal or regulatory bindings. • There is no penalty clause in PSP Model. • Weak political support. • Resistance and non-cooperation from the community. • No implementation of Local Government ordinances/laws. • Appropriate and efficient technologies are required to bring about positive changes. Whereas expensive machinery causes financial burden in terms of costs and maintenance of such machines. • Corrupt practices in all local governments. • Lack of transparency.

From the above analysis, the following recommendation could be drawn:

Collection

- Door-to- door collection is the most efficient and effective method for the collection of waste. For this purpose, handcarts, mini-dumpers and even donkey carts can be used to bring the waste to transfer points.
- Garbage bags can be distributed if the community is willing to pay for them, or they can use any shopping bag for the disposal of daily waste.
- The door-to-door collection can be privatised to a private sector partner under the management. Waste collection areas where a private sector could operate may be contracted or franchised and be allowed to collect fees negotiated with the community.
- The door-to-door collection should be limited to not more than 200 households per vehicle.

Transportation

- Once the waste reaches the designated transfer point, the private sector may again be contracted for the transportation of waste from the transfer station to the disposal point.
- The private sector could enhance its capacity by using larger vehicles.

Disposal

- Alternate solutions are now in vogue such as Material Recovery Facility (MRF) where recyclable materials are sorted out before the waste is transported to the landfills.
- Composting plants can cater for the organic component of the waste by recycling into compost.
- Some studies are being conducted into biomass energy, Refuse Derived Fuel (RDF) and bio mechanisations on the same principles as that being conducted in India.
- Use 3R approach to minimise the amount of waste being transported to the landfill sites.

2.4.3 Institutions for Community Participation in Solid Waste Management

(1) Types of Organization

In Gujranwala, there are two types of civil organizations; namely, Community-Based Organization (hereinafter referred to as "CBO") and Non-Governmental Organization (hereinafter referred to as

"NGO". CBO is a group of volunteers for specific purposes while NGO is a group with common interest registered under the Social Welfare Act. Both are also called generally as Civil Society Organization. There used to be another type of group called Citizen Community Board (hereinafter referred to as "CCB"). CCB is defined under the Punjab Local Government Ordinances of 2011 and is a coordination group between government and residents. Eighty percent (80%) of its budget is from government and 20% is from the residents. There used to be 827 CCBs but 750 CCBs were abolished due to budgetary constraints of the government. As of January 2015, only 77 CCBs were operating although no official records exist in terms of their current activities.

(2) Door-to-Door Collection of Solid Waste Management Project, Union Council No. 8, Shahinabad, Gujranwala

Currently there is no CBO or NGO working in the area of solid waste management. However, there used to be the pilot project implemented by a CCB called the OPE Development Citizen Community Board, which was registered under the Social Welfare Department with the aim to improve solid waste collection in UC No. 8. Its project area was UC No.8 with the population of 22,000 people. The UC includes the following areas:

- Samnabad
- Gaoshala
- Block B, C, D, Shaheen Abad
- Muhalla Insariyan
- Javed Town
- Mirza Colony, etc.

CDGG aimed at providing people with basic health and sanitation facilities. Thus CDGG in collaboration with OPE started the door-to-door collection project with the main purpose of making UC No.8 a model of clean UC where waste is collected on daily basis from the households.

The responsibilities of each party, CDGG and OPE, are as follows:

CDGG

- To provide containers for waste collection in UC No.8;
- To provide secondary collection on daily basis to disposal site;
- To provide door-to-door collection and to ensure cleanliness of drains and streets; and
- To provide technical assistance to OPE during the project.

OPE

- To inspect the project on daily, weekly and monthly basis;
- To provide 12 private sanitary workers for UC No.8.
- To ensure attendance of sanitary workers;
- To supervise the work performed by the sanitary workers to ensure door-to-door collection;
- To procure 6 motorbike carts for the collection of waste;
- To prepare and submit monthly inspection reports of cleanliness to EDO (MS) and DO (SWM);
- To make arrangements with the involvement of residents of UC No. 8 on the mobilisation of UC NO. 8 seminars and group discussions (community, schools, mosques);
- To be responsible for the printing of all materials necessary for the project;
- To address any and all complaints regarding the project in UC No.8.
- To bear the maintenance and petrol charges of motorbike carts
- To be able to charge Rs.50 per household only after 6 months of free service period;

Although this was the first and the last project which involved public participation in solid waste management, the project was considered as a failure since only 25% of the population paid the collection fee. In addition, the DCO at that time forced OPE to collect waste from households whether or not the households pay the collection fee. This action was unfair to the 25% of households that paid the collection fee. The reason of the failure can be summarised as follows:

- People were unwilling to pay for the SWM services;
- CCB did not have enforcement power;
- Mechanism of collection might not have been effective; and
- Policy was not consistent enough to support CCB activities.

2.5 Evaluation of Institutional Strengthening and Organizational Condition

The problems and issues in relation to institutional strengthening and organizational study under the current situation are summarised in **Table G.2.6**. These items will be the basic elements to develop the plans, programmes and projects to comprise the institutional strengthening and organizational plan in the Integrated Solid Waste Master Plan in Gujranwala.

Table G.2.6 Identification of Problems and Issues on Institutional Strengthening and Organizational Condition

Problem	Description of Problem	Issues for Solving the Problems
1. Difficulty to understand and comply with laws and regulations	There is no comprehensive law on Solid Waste Management in Gujranwala that is understandable to officials and residents. In addition, regulations are written only in English so that most of the residents cannot read them. CDGG/GWCM has not implemented any awareness raising activity on SWM rules that residents should follow.	Currently, the committee concerned in the Punjab Province is drafting a by-law, referring to the Indian Municipal Solid Waste Management Rules (Draft) (2013). This by-law should integrate the latest version of laws and regulations related to SWM in the Punjab Province, so that it becomes one single comprehensive by-law to comply with. In order to make residents understand and comply with the by-law, it is advisable to translate and interpret it in Urdu and implement awareness raising activity on SWM rules.
2. Lack of management staff (especially managers)	There is a high vacancy rate in managerial level. 4 manager positions out of 4 are still vacant due to difficulty to recruit suitable persons. As a result, there is too much burden on MD and the Company Secretary.	In order to attract human resources with adequate expertise on solid waste management, the working environment must be attractive enough. Therefore, it is advisable to introduce the following systems: • Performance Based Salary; • Provision of Incentives such as monthly award for outstanding performance; • Gifts and incentives on Eid and Christmas holidays; • Rationalisation of working hours: work in three shifts without extra burden; • Provision of social welfare and old age benefits to secure the minimum quality of life of workers; and • Health screening and other facilities. In addition, in order to develop the capacity of CDGG/GWMC staff continuously, it is essential to provide training regularly. Training modules are further discussed in Chapter 5.
3. Lack of expertise of technical staff	Technical staff does not have enough expertise and are not required to have any qualification. As a result, there is a lack of reliable data and improper management and maintenance of vehicles and equipment. Therefore, GWMC cannot provide efficient waste management services. In addition, there is no institutional arrangement among technical staff, resulting in ambiguous reporting line.	
4. Lack of financial independence of GWMC from the government	Since the GWMC budget (including staff salary) is covered by CDGG, it is difficult to get funds at the right time. In addition, technical staff such as sanitary workers still belong to CDGG and impossible to lay-off as GWMC needs. This means that GWMC cannot allocate staff flexibly	In order to achieve financial independence from CDGG, it is necessary to introduce user charge. For this purpose, it is quite important to raise awareness of residents and to increase the willingness to pay. As for the technical staff transfer, it is usually difficult to simply transfer them from the public sector (CDGG) to the private sector (GWMC) due to several reasons such as social welfare. Thus, it is recommended to decrease CDGG technical staff

Problem	Description of Problem	Issues for Solving the Problems
		gradually as they retire and outsource the service to the contractor.
5. Too high cost of outsourcing compared to direct service	It is difficult to involve the private sector due to the small market size and immature local private sector. In Gujranwala, direct service (GWMC service) cost is much cheaper than outsourcing cost (800PKR/3500PKR). This is because the market is too small for economy of scale to function. It is also because the local private sector in SWM is still immature and results in outsourcing to Lahore/international contractor.	In order to improve efficiency, it is also advisable to introduce outsourcing of collection and transportation service. In 2025, the population of Gujranwala is estimated to be big enough for economy of scale to work and for the private sector to make profit. By this time, outsourcing cost will decrease as the technologies are localised such as production of machinery and equipment.
6. Extremely low acceptance of new SWM system	There is a quite serious lack of understanding of residents on SWM. Most of them take SWM service as free of charge. This leads to quite low willingness to pay and possible strong resistance to introduce user charge.	It is necessary to raise awareness of residents on a long-term basis. The emphasis should be given to the financial aspect in order to raise understanding on SWM cost and responsibility of each stakeholder. In order to facilitate the process, GWM should provide good service enough for residents to appreciate the service.

3. PLANNING DIRECTIONS OF INSTITUTIONAL STRENGTHENING AND ORAGINAZATIONAL RESTRUCTURING PLAN

3.1 Objective

The Institutional Strengthening and Organizational Restructuring Plan have three objectives as follows:

- To comprehensively reorganize the functions of the GWMC so that the responsibilities and services on solid waste management could be effectively and efficiently managed;
- To comprehensively strengthen human resources capacities of the managerial and technical staff of the GWMC to support its functions; and
- To establish a comprehensive Solid Waste By-Law for Gujranwala.

3.2 Planning Policy

For the establishment of the new organization in charge of solid waste management services, the function of the GWMC should be comprehensively reviewed in terms of organizational and individual capacity assessment, as follows:

- Responsibilities and obligations of the new organization should not be fragmented or overlapping among the staff and workers;
- Linkages and coordination arrangements between different departments in the new organization should be efficient and effective;
- The organizational structure should be optimised in line with the selected structure for Public-Private Partnership;
- Human resources development for providing solid waste management services shall be comprehensively designed and implemented based on the results of the capacity assessment;
- All rules and regulations related to SWM should be integrated;
- Integrated By-Law should be translated in Urdu; and
- Public awareness raising should be carried out in order to heighten the residents' understanding of the importance of SWM.

3.3 Planning Strategy

The organization of GWMC shall be restructured comprehensively for effective and efficient service provision based on the following concepts:

- An efficient and rationalised organizational structure with clear reporting lines, reasonable spans of control and number of levels of managerial and technical staff, and the appropriate vertical structure to attain the operational efficiency of the solid waste management;
- A clear assignment and delegation of responsibilities and adequate authority to managers and supervisors with accountability for individual performance as well as a simple workflow for a quick decision process;
- A streamlined workflow based on the practical basis to avoid the overlapping of organizational structure;
- Clear-cut directing functions from the strategic level down to middle management and supervisors;
- Effective and appropriate management information systems and other procedures;

- Periodic assessment and feedback of management systems and other procedures based on agreed performance targets and criteria;
- A department or unit in charge of managing and regulating the proper Public-Private Partnership scheme;
- More practical human resources development including on-the-job training programme based on the capacity assessment and feedback system to share job skills among staff and workers should be implemented; and
- Raising public awareness on best practices in solid waste management such as rules and regulations, recycling, segregation, re-use, and recovery as well as inculcating the culture of waste reduction and proper storage among producers and consumers.

4. FORMULATION OF INSTITUTIONAL STRENGTHENING AND ORAGINAZATIONAL PLAN

4.1 Development of Alternative for Institutional Strengthening and Organizational Plan

4.1.1 Options for Private Sector Involvement

There is a wide variety of Public-Private-Partnership (PPP) options which can be implemented to make maximum use of the private sector involvement scheme. Out of the following options, the optimum private sector involvement plan will be selected.

Licensing (Private Subscription): Licensing or private subscription allows qualified private service providers licensed by an authority to compete for the delivery of solid waste management collection services in a specific zone. Under this arrangement, waste generators make contracts with individual private service providers. No firm has the monopoly in a specific zone, and each firm collects service charges from its customers or subscribers. The license is utilised to guarantee that a licensed service provider operates in accordance with the operational standards, and might be withdrawn if the service provider's performance is poor.

Service Contract: Service contract is a finite-term contract for a private firm to provide solid waste services, and an authority pays the firm for charges in response to the services to be delivered. Part of solid waste management services such as collection and transportation of wastes and management of a sanitary landfill site can be contracted out to a private operator for a certain period. In case of a service contract, collection vehicles are basically owned by an outsourced private firm, and a guaranteed payment from the authority to the service provider is clearly defined in the contract document. While the authority is responsible for charge collections, the service provider has to bear the operational risks.

Franchise: Franchise is a contract through competition in a finite-term to grant a private firm an exclusive monopoly to deliver a specific type of solid waste services within a specific zone. The awarded private franchisee directly collects its own revenue from waste generators within the designated zone. The franchisee pays a franchise fee to cover the authorities' costs of managing and monitoring the performance of the solid waste management services.

Management Contract: Management contract is a contract entrusting a specific solid waste management service under private management for a certain period of time, for which a management fee is paid to the management contractor. The management fee could be paid in accordance with the performance of the management contractor. Although a management contract could be an attractive first step to the full-scale private sector involvement, it does not directly lead to the investment on the improvement of solid waste management services due to the relatively shorter contract term. A management contractor is required to mainly focus on improving its services to existing customers rather than on enlarging the service coverage such as delivering the services to the lower-income area.

Lease Contract: Lease contract grants a private operator full control over delivering specific solid waste management services in exchange for use of the fixed assets whose ownership and responsibilities belong to the authority.

Concession: Concession is a long-term contractual arrangement in which a private operator is awarded an official license to provide specific solid waste management services over a longer period of time in exchange for a negotiated fee. A concession agreement stipulates the rights and obligations of the awarded concessionaire who retains ownership of the principal assets. Normally, during an average period of 25 years, the concession contract transfers all responsibilities for capital investment and operation and maintenance to a private concessionaire. While the fixed assets legally remain the property of the authority, the concessionaire might pay a fee to use them.

Build-Operate-Transfer (BOT) Contract and Its Variations: Build-Operate-Transfer (BOT) contract and its variations are options which are similar to concession and are primarily suitable for large-scale investments on facilities such as sanitary landfill sites. During a relatively longer period of up to 30 years, depending upon the size of the investment which has to be amortised, a BOT operator provides a wide range of solid waste management services in exchange for guaranteed service fees in the contract, although the operator accepts the risk to design, build and operate the facilities at the agreed standards of services in exchange for a guaranteed cash flow.

Full Privatisation: Full privatisation is the most radical form of private sector involvement in which existing operations and assets for the solid waste management services are sold to the private sector, in some cases, with a limited term license.

Table G.4.1 shows a variety of possible PPP options with the comparison of asset ownership, operations and maintenance, capital investment, commercial risks and duration of contract.

Table G.4.1 Comparison of Possible PPP Options

Option	Asset Ownership	Operations and Maintenance	Capital Investment	Commercial Risks	Duration of Contract
Service Contract	Public	Public and Private	Public	Public	1-2 Years
Franchise	Public	Public and Private	Public	Public	1-5 Years
Management Contract	Public	Private	Public	Public	3-5 Years
Lease Contract	Public	Private	Public	Public and Private	8-15 Years
Concession	Public	Private	Private	Private	25-30 Years
BOT and Its Variations	Public and Private	Private	Private	Private	20-30 Years
Full Privatisation	Private or Private and Public	Private	Private	Private	Indefinite

Source: Public-Private Partnership Handbook, Ministry of Finance, Singapore, 2004

Out of the above possible options, the BOT-related PPP options have a wide range of varieties and can be applied in different forms to different phases and facilities of solid waste management services. **Table G.4.2** shows possible BOT-related PPP options with the comparison of asset ownership, operations and maintenance, capital investment, commercial risks and duration of contract.

Table G.4.2 Comparison of Options for BOT and Its Variations

Acronym	Name of Option	Brief contents of the option
DB	Design-Build	One entity enters a contract with the owner to provide both architectural/engineering design services and construction services.
BOT	Build-Operate-Transfer	A concession is granted to a constructor to design, finance, maintain, and operate a facility for a period of time. The constructor recoups the cost of the project by collecting tolls during the life of the concession period.
BTO	Build-Transfer-Operate	A private developer finances and builds a facility and, upon completion, transfers legal ownership to the sponsoring government agency. The agency then leases the facility back to the developer under a long-term lease. During the lease, the developer operates the facility and earns a reasonable return from user charges.

Acronym	Name of Option	Brief contents of the option
BOOT	Build-Own-Operate-Transfer	Ownership of the facility rests with the constructor until the end of the concession period, at which point ownership and operating rights are transferred to the host government.
BOO	Build-Own-Operate	Resembles outright privatisation. Projects of this type are often let with no provision for the return of ownership to government.
DBO	Design-Build-Operate	The contractor is responsible for the design and construction of a facility. Upon completion transfer of legal ownership to the sponsoring government agency. The contractor is also responsible for Operating and Maintaining the facility for the stipulated period.
DBFO	Design-Build-Finance-Operate	A constructor is responsible for the design, construction, maintenance, and financing. The constructor is compensated by specific service payments from government during the life of the project.
BLTM	Build-Lease-Transfer-Maintain	In this type of arrangement, a facility is typically designed, financed, and constructed by the private sector and is then leased back to government for some predetermined period of time at a pre-agreed rental.
LROT	Lease-Renovate-Operate-Transfer	This model is for facilities that need to be modernised. The private sector constructor pays a rental to government and agrees to renovate the facility. In exchange, the constructor is granted a concession to operate the facility for a fixed period of time and to charge a fee for the service.

Source: NETAP Regional Solid Waste Management Project: Regional Guideline

4.2 Evaluation of Alternatives

4.2.1 Criteria for Selecting Optimum PPP Scheme

The following criteria are employed in an attempt to select the best and optimum option for the private sector involvement scheme in providing the solid waste management services. However, when applying these criteria, the current site-specific conditions of Gujranwala City should be carefully taken into account. Choosing the optimum private sector involvement option is one of the most crucial decisions before formulating the organizational and legal contents of the Master Plan as it indicatively defines the major conditions between the public sector and private sector. However, as the decision-making process depends on various factors, no substantial solution can be applied. A broad range of the past experiences indicate that a mere copying of approaches that have been successful in other countries will tend to fail when they are not properly adapted to the local and site-specific situation.

Effectiveness: Effectiveness is the quantitative degree of increasing the service coverage and qualitative significance of improving the quality of services through involving the private sector.

Competition and Efficiency: By using the private sector expertise and experiences on cost saving, the private sector involvement will significantly improve the efficiency of SM services through a competitive business environment.

Accessibility to Capital Investment: The private sector involvement can enlarge the access to capital and financial resources for procurement of collection vehicles as well as human capital for expertise and skills.

Accountability and Transparency: Accountability and transparency under the private sector involvement depends on the degree to which the procurement process is open to competitive market forces.

Sustainability: By properly sharing the risk factors between the public sector and the private sector, the private sector involvement will sustainably function in the long run.

Equity: The level of equity in universally providing SWM services to all uses under the private sector involvement is also one of the important evaluation criteria.

However, when applying the above criteria for selecting the optimum private sector involvement option, the current site-specific conditions of Gujranwala City and beneficiaries should be carefully taken into account. For example, it has been already found that the willingness to pay for SWM services in Gujranwala is relatively lower than in Lahore. Therefore, it is easily envisaged that the full-scale private sector involvement option which requires the introduction of the relatively higher level of the user charging system will be rather difficult in Gujranwala where beneficiaries' willingness to pay is low.

Since the selection of the optimum private sector involvement option is closely related to the formulation of the appropriate organizational and legal mechanisms for providing the sustainable SWM services, the success of the private sector involvement by LWMC should not be simply replicated by GWMC. In this sense, the progress of the consultancy works rendered by LWMC in the field of the private sector involvement should be carefully monitored in the course of the subsequent study.

4.2.2 Factors to Consider for Designing Optimum PPP Scheme

The following factors should be carefully taken into account in designing a full-scale private sector involvement plan.

Duration of Contract: The contract period should be in such a term which allows the depreciation of vehicles and equipment used to achieve the service level in the contract. A limited contract period would be a disincentive for the service provider to make investment on new and replaced vehicles as it feels the risk of termination of the contract before depreciating vehicles and repayment of its loans.

Mitigation of Long-Term Risk: Although the duration of a contract should be reasonably long, another risk on the contract term to be considered would be the long-term contract risk. If a private service provider is awarded a long-term contract, it might put the private company into a monopoly position so that there will be no alternative service providers where it is rather difficult for the authority to keep the service level satisfactory.

Step-wise Approach: It is better to start the private sector involvement with a step-wise approach, and expand the degree of the involvement of private companies in a gradual manner, so that the financial and service-quality risks by the private sector involvement can be minimised and subsequent contractual arrangements can be modified to improve the performance of the private operator.

Continuous Competition: Competition is widely regarded as a key to successful private sector involvement. Continuous competition in the tendering process ensures competitively-priced services by the private service provider. It is beneficial to divide a large-scale city-wide service into several zone-based contracts so that there will be competition among the private service providers. If private service providers compete with each other in different zones, the performance and level of services can be compared, and if one service provider fails, others can take over the service.

Size of Zone: It is also important to take into account the size of the service zone to be outsourced to a private service operator.

4.2.3 Selection of General Framework for PPP

(1) Service Contract for Collection and Transport

GWMC once tried to introduce the service contract following the LWMC model. However, due to the following reasons, GWMC gave up outsourcing and continues to provide collection and transportation service directly.

One reason is too little population for scale of economy to work. As a result, for a contractor to make a profit the contracting amount has to be relatively higher than that of LWMC. Thus, it is necessary to wait for the population of Gujranwala to reach a certain level where economy of scale works. Taking into account of the Lahore case where one collection and transportation zone has approximately 4.5 million of population, it is advisable to start outsourcing in 2025 when the population of Gujranwala reaches approximately 4.5 million according to population projection.

Another reason is very cheap local cost compared to outsourcing cost to a foreign company, not only because the market of Gujranwala is too small for economy of scale to work, but the local cost of labour is fundamentally cheap in Gujranwala. Currently, there is no private provider for collection and transport. This means that if GWMC outsources the service, it is necessary to contract out the service to a Lahore or international company whose service is far more expensive than that of direct service. Thus, for now it is cheaper for GWMC to provide the service directly. However, as the production of machinery and equipment is localised and gets cheaper, it is possible for Lahore or international companies to provide service at cheaper rate in the future.

The last reason is too low willingness to pay. According to the survey, it is less than 50 rupees per month which is too little for the private sector to run its business. In order to introduce outsourcing, public awareness raising is essential. Thus, targeting at the year of 2025, it is quite important to carry out awareness raising programme intensively so that WTP will at least reach the level where outsourcing is possible.

Considering the reasons mentioned above, these current constraints should be eliminated to introduce PPP scheme into the ISWM projects in Gujranwala. Firstly, the population of Gujranwala is predicted to reach 4.5 million in 2025, which is almost equivalent to that of one waste collection zone in Lahore. Thus, it can be said that it will be feasible to introduce the service contract system for waste collection and transportation since the economy of scale starts to function at this population level, i.e., year of 2025. If some sort of the economy of scale is secured, private collectors who are interested in the SWM business will come to Gujranwala. Lastly, public awareness raising programmes that are proposed to start from 2016 will enhance the residents' as well as commercial entities' moral consciousness and intention towards improvement of the environment, and it will result in increase of their WTP to a certain level.

Therefore, it is recommended to introduce ***service contract for collection and transportation service*** from year of 2025. The service contract may be the key instrument used in municipal SWM after the operations are unbundled, enabling the municipality to let areas or parts of the service to small- and medium-sized enterprises. In relation to SWM, a service contract is often a preferred method of contracting an operator for collection services in middle-income areas.

The service contract is not ambitious: It is often short in duration (1-3 years), and control is still firmly lodged with the municipality. Duration must be sufficient to allow contractors to fully write-off the cost of any equipment purchased (such as collection vehicles). Conversely, the duration will determine the level of investment and therefore the standard of service provided.

The municipality retains ownership and control of all capital assets and property, and must finance fixed assets and working capital. The municipality establishes the performance criteria, evaluates the bids, selects and supervises the contractor and monitors the work to be carried out to ensure the contractor meets the performance specification. For the contracting of solid waste collection services (that do not always raise revenue), the municipality must ensure that it has sufficient revenue to pay the contractor, This must be calculated to include depreciation, interest on borrowing, salaries, consumables, insurance and profit.

Under the service contract, the contractor is normally responsible for managing personnel and services. To ensure the service contract results in greater efficiency, it should be awarded through competitive bidding, and this can be compared against the public sector costs through a benchmarking process. The selected contractor is obliged to carry out the service to the specification established in the agreement, and agrees to a fee for the service on a lump sum, unit cost or other basis. Unlike more complex form of private sector participation, to the contractor, the municipality is still the client and the source of payments. The commercial risk for the private operator is that the municipality may default on payment.

The service contract is relatively simple to arrange, resembling the traditional construction contracts with which municipal engineering departments are familiar. The service contract does not bring with it the risk, and therefore does not need the complex regulatory environment critical to the concession. Municipalities are therefore able to embark on improvements much more quickly and

not be concerned with the impact of the operating environment outside their control. The short duration means they can review the work done and make decisions easily, and the timeframe can adapt to electoral cycles.

(2) Direct Management by GWMC of Final Disposal

For final disposal, management of new landfill site, it is recommended to keep ***the direct management by GWMC***. It is because the private sector tends to prioritise the economic benefits to environmental protection. Naturally, the private sector pursues to maximise its profit by minimising the cost which, in this case, the management cost of landfill site. As a result, poorly managed landfills have the potential of causing a number of issues. One is pollution of the local environment such as contamination of groundwater or aquifers or soil contamination by leachate. The local roads and water courses can also be contaminated by wheels of collection vehicles when they leave poorly managed landfills. Another is de-facto open dumping. This may occur if the private sector accepts waste without limit and keep it for a long time.

(3) BOT for Intermediate Treatment

Currently, composting is not a common practice in Gujranwala. Due to the lack of awareness and understanding on compost, the market price of compost is low compared to its production cost. As a result, farmers are not willing to produce compost. However, composting is globally well recognised environmentally friendly practice with no side effect. This means once residents realise its benefit and usefulness, it is possible for the private sector to make profit. Therefore, in order to promote composting, public involvement is essential. The simulation results of economic internal rate of return (EIRR) as presented in **Subsection 4.6.2** show that the establishment of a central compost plan will be feasible if the production capacity is satisfactory although the quality of the products should be assured. Thus, for composting, ***BOT between GWMC and the private sector*** is recommended. Following the case of Lahore, GWMC should provide a land and certain amount of organic waste in return for a certain percentage of the annual profit. The same can be applied to the RDF plant.

4.3 Identification of Project Components for Institutional Strengthening and Organizational Plan

4.3.1 Organizational Restructuring

(1) Basic Direction of Organizational Restructuring

In order to implement the Master Plan, it is necessary to restructure and strengthen the organization of GWMC. Basic direction is summarised as follows.

Strengthening of Operation (Field) Unit

As the zone coverage of waste collection and transportation expands from 8 to 16 zones, it is necessary to increase senior (Sr.) managerial positions from two (2) to four (4) and assistant (Asst.) managers from 11 to 28, as shown in **Table G.4.3** below.

Table G.4.3 Proposed Number of Staff in the Operation Unit

Number of Personnel	Position	Responsibility
4	Sr. Manager	4 zones for each Sr. Manager
20	Asst. Manager	1 zone for each Asst. Manager plus 4 additional zones
6	Asst. Manager	Road: 4 Asst. Managers in urban and 2 in rural area
2	Asst. Manager	Maintenance

Establishment of Manager Complaint Management under GM Operations

Currently, the Manager Communication Unit is in charge of complaint management. It is recommended to establish a Manager Complaint Management Unit to be in charge of the call centre which is directly under GM Operations. In this way, GM Operations can handle complaints directly and thus promptly. In addition, this call centre function should be outsourced and the Manager Complaint Management Unit concentrates on management and supervision.

Establishment of Intermediate Treatment Unit under Operations Department

Though full privatisation is proposed by the MP, it is still necessary for GWMC to supervise intermediate treatment facilities such as compost and RDF plants. Accordingly, it is recommended to rename the Sr. Manager for Landfill position into Sr. Manager for Disposal position and establish the Asst. Manager for Landfill and Asst. Manager for Intermediate Treatment positions under him/her.

Establishment of Communication Unit under GM Operations (Shift from Human Resources & Administration Department)

The Master Plan emphasises the necessity of public awareness raising especially at schools. It is advisable to establish the Environmental Education Unit led by the Assistant Manager for Environmental Education specifically in charge of public awareness raising. Another Assistant Manager (for Public Relations) shall concentrate more on general public communications such as media relations.

Strengthening of P&C Department for PPP Introduction of Collection and Transport

To commence the service contract from 2025, strengthening of the procurement and contract division is required for establishment of management system for tender preparation, selection of service providers, contracting with the selected tenderer and so on. Thus, it is necessary to assign one Sr. Manager for PPP and three (3) Asst. Managers for PPP to handle this system.

Establishment of Monitoring & Evaluation Department under GM

The Monitoring & Evaluation Department should be totally independent from other departments to carry out its function as a focal point to check performance of GWMC. It is advisable to assign three (3) Managers in charge of 1) KPI, 2) Finance and 3) Environmental monitoring. In order to establish a mechanism of feedback, it is also recommended to have regular meetings of Directors to review the monitoring results and to take countermeasures.

The organograms of years 2018 (start of the Master Plan), 2022 (start of preparation of service contract and tariff charging system) and 2030 (completion of the Master Plan) are shown in **Figure G.4.1** to **Figure G.4.3**. GWMC is basically in charge of management part of the SWM services only whereas the operation part is done by CDGG staff. Even though the work load of GWMC might decrease slightly if the collection and transportation work is contracted out to private sector, it is difficult to predict how many staff members can be reduced from this action. Therefore, keeping the status quo, the required number of GWMC staff and total number of GWMC staff by implementation of the master plan is estimated as presented in **Table G.4.4**. Apart from road sweepers whose salary paid by CDGG, this table shows that the number of GWMC staff in 2030 will increase 5 times as many as that of the current numbers.

Table G.4.4 Required Number of Managers and Total Number of GWMC Staff for Implementation of the Master Plan

Year	2015 (present)	2018	2020	2022	2030
Management Staff	46	66	70	72	75
Managing Director	1	1	1	1	1
General Managers	5	7	7	7	7
Managers	12	21	21	22	22
Assistant Managers	28	37	41	42	45
Operation and Maintenance Staff for Sanitary Landfill Management	15	24	24	24	34
Workers for Waste Collection	307	830	951	1,060	1,875
Total	368	920	1,045	1,156	1,984

Note: The number of "Workers for Waste Collection" indicates the number on the assumption that GWMC would carry out the waste collection and transportation services continuously and varies depending on the number of waste collection workers on private contractors.

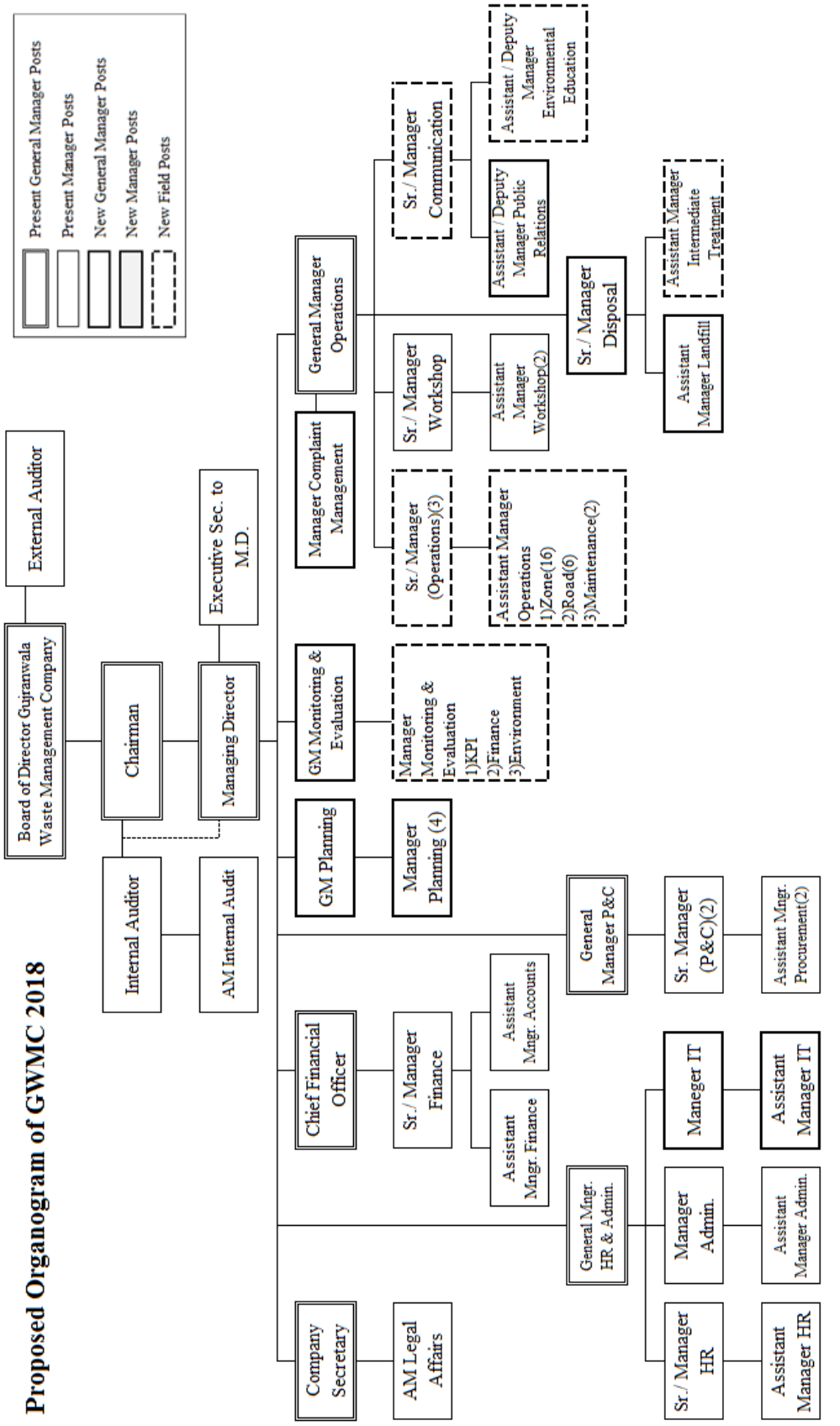

Figure G.4.1 Project Organization of GWMC 2018

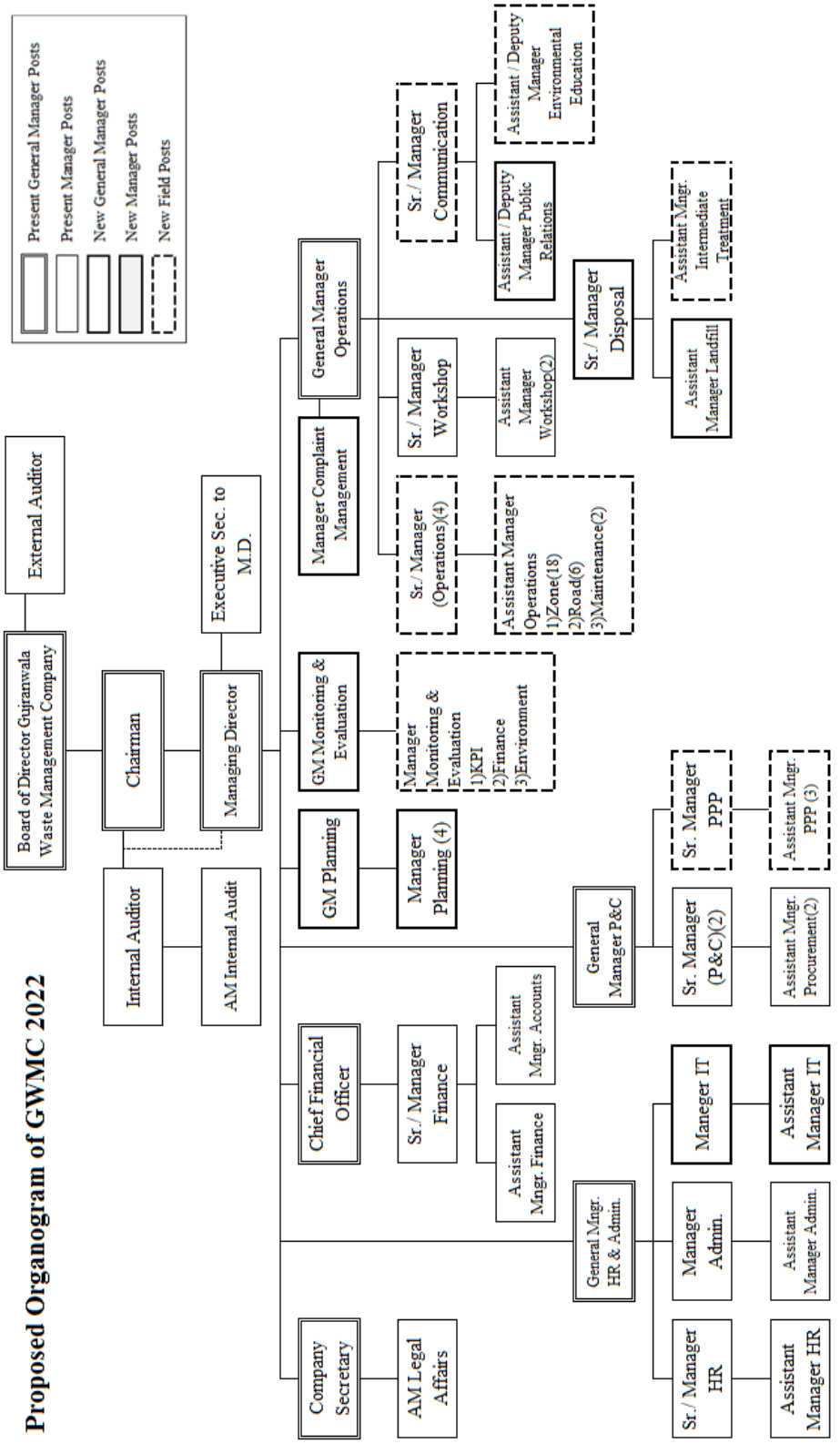

Figure G.4.2 Project Organization of GWMC 2022

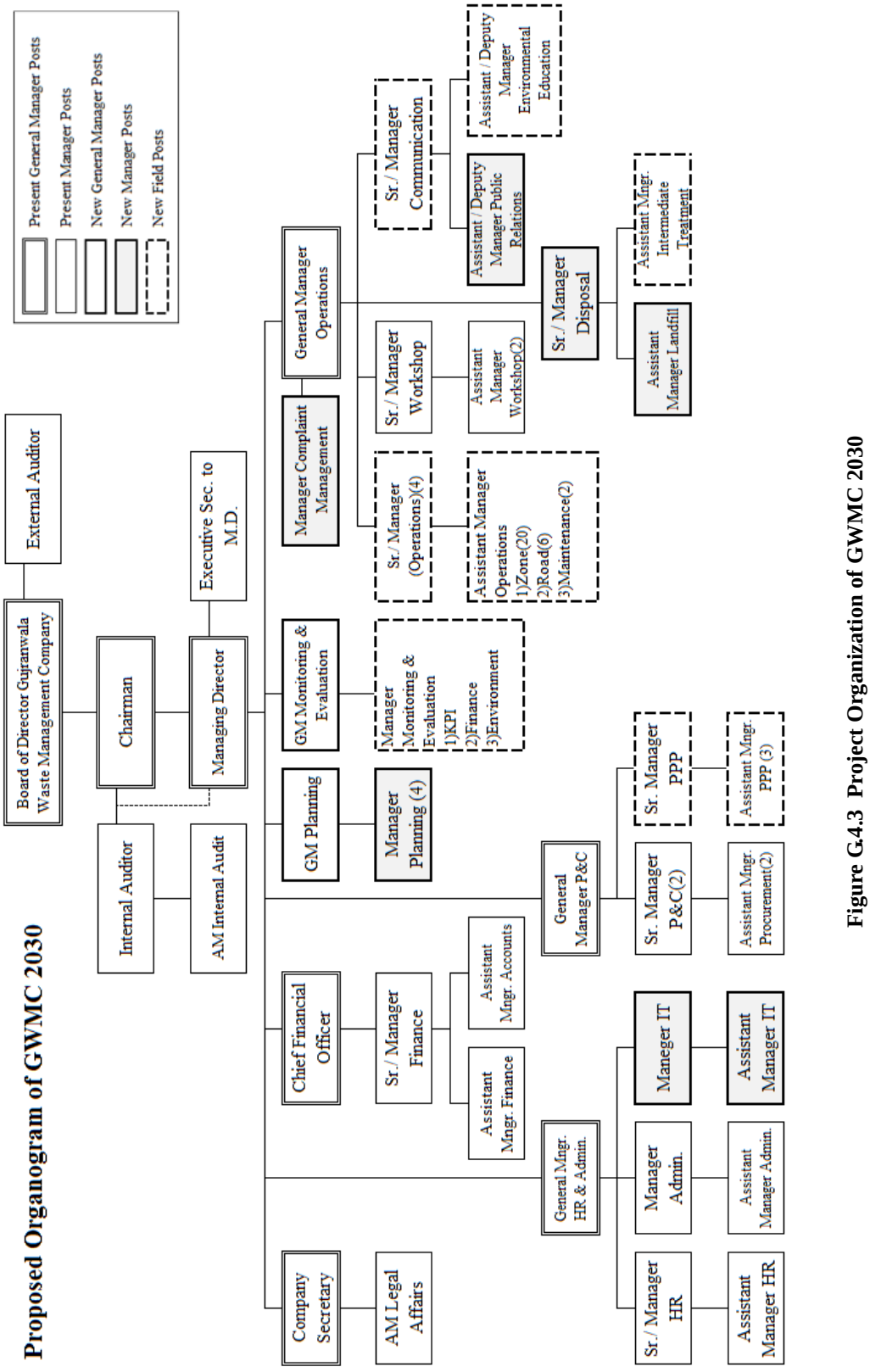

Figure G.4.3 Project Organization of GWMC 2030

Before allocating new staff, it is necessary to clear their division of duties. Therefore the process of recruitment of new staff needs preliminary arrangements in the entire GWMC. **Figure G.4.4** below indicates each process of recruiting with the preliminary arrangements.

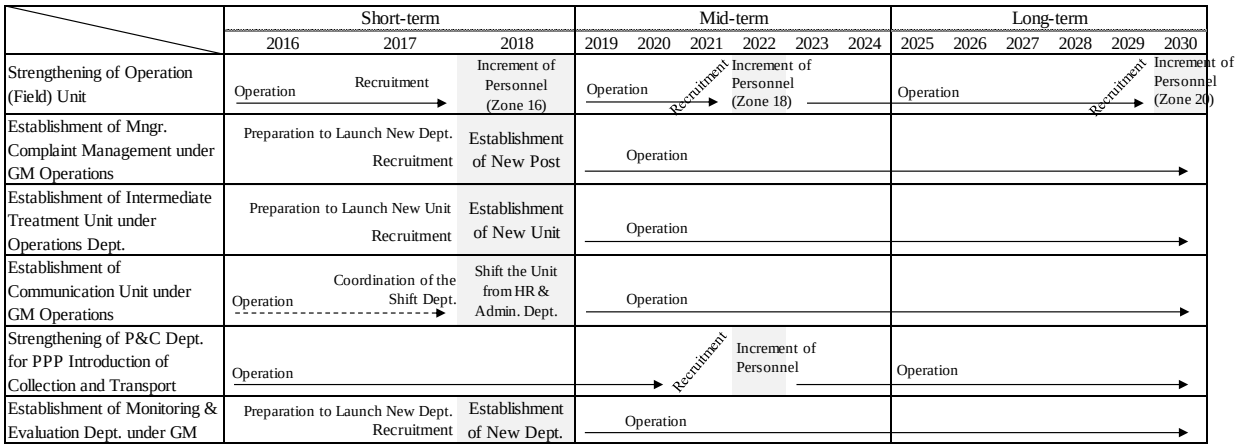

Figure G.4.4 Process of Recruiting for the Strengthen of Organization

(2) Improvement of Working Environment for Managerial Staff

Currently, GWMC is suffering from the lack of human resources as well as the capacity of existing human resources. Most of competent persons prefer to work in Lahore than in Gujranwala. Thus GWMC must overcome this challenge. In order to attract human resources with adequate expertise on solid waste management in this competitive market, the working environment must be attractive enough. Therefore, it is advisable to introduce the following systems.

(a) Performance Based Salary

Currently, GWMC just adapted the LWMC salary scale and there is an annual salary increase automatically. This situation can be described as socialistic. Therefore, in order to motivate staff by bringing in competition and eventually providing better service, GWMC should come up with its own salary scale and performance measurement system. As a result, staff working harder can receive higher salary and feel more appreciated. In this way, GWMC should grow out from seniority to merit oriented system.

(b) Provision of Social Welfare and Old Age Benefits to Secure the Minimum Quality of Life of Workers

In addition to awarding outstanding performance, it is also important to provide enough social welfare in order to secure the minimum quality of life of staff. In this way, workers can concentrate on working and not worrying about immediate needs.

(3) Improvement of Working Environment for Technical Staff

(a) Performance Based Salary

Similar to the case of managerial staff, it is advisable to introduce performance based salary in technical staff. For now, however, as technical personnel still belong to CDGG, it is difficult to change their salary scale. Thus, first of all it is necessary to wait for CDGG staff to retire and to outsource the service to contractors gradually. In this way, GWMC can measure their performance directly and change a contractor if the contractor fails to fulfil its mandate.

(b) Organization of Sanitary Staff

Currently, there are more than 1,600 sanitary workers but there is no organizational structure. This situation is not preferable as there is no reporting line. In order to organize the sanitary workers and supervise and measure their performance, it is recommended to group sanitary workers into about 20 and one of them becomes the leader. It is also preferable if the groups are allocated according to each Urban Unit. Accordingly, in order to streamline their workflow, it is necessary to review collection routes.

In addition, it is also necessary to make a guideline for technical staff to provide uniform service to all residents. This guideline should include the following items:

- Filling out daily driving report;
- Safe driving;
- Safe operation; and
- Response to vehicle accidents, breakdowns and fires.

(c) Provision of Incentives Such as Monthly Award for Outstanding Performance

In addition to performance based salary system, it is also effective to provide special incentives such as monthly award for outstanding sanitary workers. Currently there are more than 1,600 sanitary workers and they are not evaluated personally. As a result, they do not pay much attention to their work. In order to prevent this situation, it is advisable to group them as mentioned above and give the best sanitary workers' award monthly or annually based on their performance. In addition to appreciate sanitary worker leaders, it is also advisable to give him/her small gifts as a leader such as photo display in the entrance of GWMC.

(d) Gifts and Incentives on Eid and Christmas

In general, festive seasons are difficult to afford with technical workers who are low-incomers. Thus even if small, gifts on Eid and Christmas are very much appreciated and foster affection to GWMC.

(e) Provision of Social Welfare and Old Age Benefits to Secure the Minimum Quality of Life of Workers

One of the main reasons why sanitary workers of CDGG are not willing to be transfer to GWMC is because of generous social welfare and pension promised by CDGG. In order to facilitate the smooth transfer of CDGG sanitary workers to GWMC, it is recommended that equivalent social welfare and pension system be provided.

(f) Health Screening and Other Facilities

Waste collection is a heavy manual labour and involves risks of injuries and infections. Therefore, it is also important to protect and promote workers health condition by providing regular health check-ups and health facilities such as rest rooms.

4.3.2 Human Resources Development through Implementation of Comprehensive Capacity Development Programme (CCDP)

A major challenge to the human resources development plan in the Master Plan is how to incorporate the improvement of individual capacities into the organizational capacities of GWMC required for providing the service contract system. Another challenge is how to upgrade the capacities and motivation of the staff of GWMC in response to the massive human resources development demand of the new organization. Based on the wide range of capacity gap assessment on human resources for the improvement of the current solid waste management system, the human resources development plan has

been identified as a comprehensive capacity development programme required for the restructuring of GWMC, thereby identifying the following eight (8) modular human resources development projects.

However, it is acknowledged that "human resources development project approach" based on a single human resource development project alone does not comprehensively solve the constraints of the solid waste management services. Since "human resources development programme approach" is the process of managing a portfolio of multiple inter-dependent projects, the programme approach can be used for the management of the identified multiple modular projects. The programme approach provides the human resources development plan with a common platform to implement these modular projects under the Comprehensive Capacity Development Programme (CCDP). The CCDP acts as a key pre-condition to maximise the sustainability of the city-wide solid waste management services.

The proposed CCDP should be implemented with full-scale technical assistance by an external donor organization. The overall goals of the proposed CCDP are to create the new organizational structure of the GWMC as well as to upgrade the technical and managerial capacities for the staff of the GWMC, thereby upgrading the comprehensive capacity to implement the Master Plan.

The outline of the proposed Comprehensive Capacity Development Programme (CCDP) is given in **Table G.4.5** The concept of the detailed modular training projects under the CCDP are shown in **Table G.4.6** to **Table G.4.13**, and the time schedule of eight (8) Programmes is illustrated in **Table G.4.14**. The cost of implementation of the CCDP is estimated at approximately at Rs. 78 million.

Table G.4.5 Outline of Comprehensive Capacity Development Programme

Item No.	Modular HRD Project	Training No.	Specific Subjects for Human Resources Development	Target			
				GWMC Managerial Staff	Sanitary Worker Leader	Private Sector	CBO NGO
1	Overall Management	1-a	Overall capacity for SWM	●			
		1-b	Capacity for SWM information system	●	●		
2	Collection and Transport	2-a	Capacity to efficiently operate collection and transport services	●	●		
		2-b	Capacity to maintain collection vehicles and equipment	●	●		
3	Intermediate Treatment and 3R Promotion	3-a	Capacity to implement 3R	●		●	●
		3-b	Capacity to operate intermediate treatment facilities	●			
		3-c	Capacity to maintain intermediate treatment facilities	●			
4	Sanitary Landfill Site Management	4-a	Capacity to select candidate sanitary landfill sites	●			
		4-b	Capacity to operate sanitary landfill sites	●			
		4-c	Capacity to implement EIA and monitor environment for sanitary landfill sites	●			
		4-d	Capacity to design sanitary landfill sites	●			
5	Public –Private Partnership	5-a	Capacity to manage PPP tender and procurement procedures	●		●	
		5-b	Capacity to provide franchised collection services	●		●	
		5-c	Capacity to provide service contracts for sanitary landfill management	●			
6	Financial Management	6-a	Capacity to implement proper financial management	●			
		6-b	Capacity to finance SWM projects	●			
		6-c	Capacity to collect and manage service fees	●			
		6-d	Capacity to manage SWM special account and revolving funds	●			
7	Organizational and Legal Improvement	7-a	Capacity to improve organization for SWM	●			
		7-b	Capacity to improve legal system for SWM	●			
		7-c	Capacity to monitor and enforce SWM regulations	●			
8	Community Participation	8-a	Capacity to primary collection at community and raise public awareness	●		●	●

Table G.4.6 Concept of Module Training Programme for CCDP (Module 1)

Module:	**Module 1**	**Training No.:**	**1-a, 1-b**
Title of Training Programme:	**Overall Management Capacity for SWM**		
Target:	**GWMC Staff**		
Lecturers:	**Urban Unit**	**Cost:**	**Rs. 4,219,600**
Funding Sources:	**Urban Unit / GWMC**	**Duration**	**1 Years**
Implementation Year:	**2016, 2019, 2022, 2025, 2028**		

Objectives and Outlines:

The provider of SWM services in local governments needs to develop effective management capabilities. These management capabilities should include:

- An efficient organizational structure with clear reporting lines, rational departmentalisation, reasonable spans of control and number of levels of managers and supervisors, and appropriate senior management structure;
- A clear assignment and delegation of responsibilities, and adequate authority to managers and supervisors with accountability for individual performance;
- Procedures to clearly set and monitor objectives from the strategic level down to middle management and supervisors;
- Effective planning and policy formulation; and
- Effective integration of financial planning into the planning process, implementing budgetary planning and control, and appropriate accounting systems.

Description of Training Programme:

The following capacities in the field of overall management for solid waste management services will be upgraded through the training programme:

- Basic understanding on management (organizing, staffing, directing, controlling)
- Type of organization (functional type, project type, matrix type)
- Major constraints for efficient organization:
  - ► Over-staffing and overlapping of responsibilities
  - ► Broad span of controls
  - ► Decision-making mechanism
  - ► Allocation of duties
  - ► Number of staff
  - ► Training programmes
  - ► Motivation and incentives
  - ► Coordination and communication
  - ► Unclear mandates and job description
  - ► Monitoring and assessment
  - ► Standardisation of working procedures and manuals
- Understanding basic information on the service area (population, socio-economic profile, natural condition, map and GIS)
- Coordination with national and municipal policies (national SWM policies, SWM legal framework, subsidies from the central government, environmental impact assessment, land acquisition and compensation, licensing for private waste service providers)

Table G.4.7 Concept of Module Training Programme for CCDP (Module 2)

Module:	**Module 2**	**Training No.:**	**2-a, 2-b**
Title of Training Programme:	**Capacities for Collection and Transport**		
Target:	**GWMC Staff, Sanitary Worker, Private Sector Staff**		
Lecturers:	**Urban Unit**	**Cost:**	**Rs. 61,929,000**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**3 Years** **1 Year**
Implementation Year:	**2017-2019, 2021-2023, 2025-2026** **2016, 2019, 2022, 2025, 2028**		

Objectives and Outlines:

- The primary objective of the collection and transportation of wastes is to increase the collection service coverage in order to maintain public health and cleanliness, and to protect the people's environment.
- The GWMC is required to provide a minimum level of service throughout the city, and the minimum level of service is defined as collection service to be conducted once a week from communal collection points.
- A collection and transportation system which is the most economical and efficient as well as the least socially and environmentally harmful, should be adopted, in comparison with possible technical options such as station type and door-to-door type collection as well as direct and indirect transport methods.
- GWMC should promote and make the maximum use of private sector involvement in terms of collection services with full control by the private sector.
- In this connection, the staff of the private sector will also be invited for this programme.

Description of Training Programme:

The following capacities in the field of collection and transport will be upgraded through the training programme:

- Establishing a collection system
  - ► Clarifying the responsibility for collection
  - ► Establishing organizations responsible for collection
- Formulating collection plans
  - ► Assessing the current situation
  - ► Appropriate planning an implementation
- Expanding the coverage of collection services
  - ► Upgrading collection equipment
  - ► Promoting the involvement of CBOs/NGOs in primary collection
  - ► Outsourcing collection services to the private sector
- Improving collection efficiency
  - ► Improving collection methods
  - ► Reviewing collection routes
  - ► Improving personnel management methods
  - ► Replacement and improvement of equipment
  - ► Improving the maintenance system
  - ► Ensuring compliance with discharge rules
  - ► Collection cost analysis
  - ► Improving the quality of collection service
  - ► Improving public area sanitation

Table G.4.8 Concept of Module Training Programme for CCDP (Module 3)

Module:	**Module 3**	**Training No.:**	**3-a, 3-b, 3-c**
Title of Training Programme:	**Capacity on Intermediate Treatment and 3R Promotion**		
Target:	**GWMC Staff, Private Sector Staff, Representatives of CBOs/NGOs**		
Lecturers:	**Urban Unit**	**Cost:**	**Rs. 1,772,800**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**3 Years**
Implementation Year:	**2018-2020, 2022-2024**		

Objectives and Outlines:

- The objective of the Waste Reduction Plan is to lighten the cost burden to GWMC through reduction of solid waste amount for collection and disposal.
- The objective of the Recycling Plan is to save finite resources and minimise landfill space as a result.
- The objective of the Intermediate Treatment Plan is stabilisation and reduction of residuals in addition to resource recovery through waste conversion.
- Waste reduction shall be carried out for domestic, commercial and other business wastes, and formulation of the Waste Reduction Plan shall take public participation into consideration.
- GWMC shall have the primary responsibility for promotion, guidance and assistance to the community groups, enterprises, recycling companies, etc., for organizing the recycling groups and operations.
- The staff of the private sector and the representatives of CBOs/NGOs will be also invited to this programme.

Description of Training Programme:

The following capacities in the field of Intermediate Treatment and 3R Promotion will be upgraded through the training programme:

- Introducing and Improving Proper Intermediate Treatment
  - ► Volume reduction (Introducing and improving size-reduction facilities, Introducing and improving the compaction process)
  - ► Waste reduction (Introducing and improving incineration facilities, Collection of recyclables, Introducing and improving compost facilities)
  - ► Stabilisation and detoxification
  - ► Energy recovery
  - ► Introducing facilities to select recyclables
  - ► Promoting the purchase of recycled products

- Promoting Recycle
  - ► Promoting source separation of recyclables
  - ► Promoting community-based collection of recyclables
  - ► Institutionalising informal collection activities
  - ► Introducing separate collection of waste
  - ► Introducing facilities to select recyclables
  - ► Promoting the purchase of recycled products

- Promoting waste reduction
  - ► Promoting waste reduction at home
  - ► Promoting waste reduction at establishments
  - ► Introducing separate collection of waste
  - ► Introducing facilities to select recyclables

Table G.4.9 Concept of Module Training Programme for CCDP (Module 4)

Module:	**Module 4**	**Training No.:**	**4-a, 4-b, 4-c, 4-d**
Title of Training Programme:	**Sanitary Landfill Site Management**		
Target:	**GWMC Staff, Sanitary Worker**		
Lecturers:	**Urban Unit**	**Cost:**	**Rs. 2,110,000**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**3 Years**
Implementation Year:	**2016-2018, 2022-2024**		

Objectives and Outlines:

- Disposal of waste is problematic due to lack of space remaining at disposal sites and improper controls on dumping procedures. The latter causes odour, litter and smoke nuisance as well as posing health risks to nearby communities.
- Disposal of waste is a component of all waste management systems. Properly sited and managed waste disposal sites are protective of public health and the environment. Waste disposal sites are operations that can be designed to accommodate recovery of recyclable materials by the informal sector. Final disposal involves getting rid of all wastes that are not reused, recycled, processed or treated.
- The sanitary landfill is evaluated to be the most appropriate disposal method from both economic and environmental viewpoints. Therefore, the final disposal plan shall be formulated for the construction and operation of a sanitary landfill.
- The scale of sanitary landfill facilities and their operation shall take financial availability into consideration. At the same time, the design should be examined also from the environmental and social points of view. Due to financial constraints concerning SWM financing, a phased construction of the disposal site also shall be considered.
- The programme shall contribute to the upgrading in the field of the enhancement of the management of the sanitary landfill site.

Description of Training Programme:

The following capacities in the field of Landfill Site Management will be upgraded through the training programme:

- Landfill Design
- Environmental Impact Assessment (EIA) for Sanitary Landfill
- Proper Operation of Final Disposal Sites
  - ► Control and management of incoming vehicles
  - ► Securing cover soil
  - ► Securing and maintaining heavy machinery
  - ► Training and allocating engineers
  - ► Operating and maintaining environmental pollution control facilities
  - ► Securing of operating capital
  - ► Establishing the monitoring framework
  - ► Outsourcing to the private sector
  - ► Waste picker control
  - ► Landfill leachate and gas
- Access Road
- Environmental Monitoring
  - ► Groundwater Monitoring
  - ► Quality and Treatment of Leachate
- Handling of Industrial Wastes

Table G.4.10 Concept of Module Training Programme for CCDP (Module 5)

Module:	**Module 5**	**Training No.:**	**5-a, 5-b, 5-c**
Title of Training Programme:	**Public-Private Partnership**		
Target:	**GWMC Staff, Private Sector Staff**		
Lecturers:	**Urban Unit**	**Cost:**	**Rs. 922,200**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**3 Years**
Implementation Year:	**2017-2019, 2022-2024**		

Objectives and Outlines:

- There are wide modes and types for of the private sector involvement based on the particular situation of the service area for the solid waste management. It is essential to opt for the most acceptable and carefully-designed private sector involvement promotion plan taking into account the basic advantages of the private sector involvement over the service provision by the public sector alone.
- The private sector is regarded as a more efficient service provider than the public sector. It is generally believed that the private sector can provide an equivalent level of the service at a relatively lower cost.
- The involvement of the private sector can enlarge the access to capital such as procurement of collection vehicles required for the improvement of solid waste management services

This programme will contribute to the upgrading of the capacities to select and design the most suitable PPP options as well as to acquire the knowledge on contracting procedures on PPP projects.

Description of Training Programme:

The following capacities in the field of PPP will be upgraded through the training programme:

- Possible PPP Options
  - ► Short-term and Mid-term PPP Projects: Service Contract, Management Contract, etc.
  - ► Long-term PPP Projects: Lease, Concession, BOT and its Varieties, etc.
- Advantages and Risks of PPP Projects
  - ► Advantages of PPP Projects
  - ► Risks of PPP Projects
- Selection Criteria of PPP Projects
- Mitigation Measures of PPP Risks
- International Experiences and Lessons Learned
- Methodology of Service Contract
- Contractual Issues for PPP Projects
  - ► Preparation of Expression of Interests and Pre-qualification
  - ► Preparation of Tender Documents
  - ► Preparation of Bids
  - ► Clarifications and Feedback to Tender Documents
  - ► Bid Bond
  - ► Submission of Bids
  - ► Tender Evaluation and Selection of Private Service Provider

Table G.4.11 Concept of Module Training Programme for CCDP (Module 6)

Module:	**Module 6**	**Training No.:**	**6-a, 6-b, 6-c, 6-d**
Title of Training Programme:	**Financial Management**		
Target:	**GWMC Staff**		
Lecturers:	**Urban Unit**	**Cost:**	**Rs. 922,200**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**3 Years**
Implementation Year:	**2017-2019, 2020-2022, 2024-2026**		

Objectives and Outlines:

- Achieving the sustainable solid waste management requires the allocation and management of adequate financial resources.
- The long-term sustainability of waste management facilities requires that cost recovery frameworks are secured in place to ensure the proper operation and maintenance of those facilities.
- Legal and institutional structures for financing and recovering costs for waste management are in place at national and local levels.
- Accounting, budgetary and management systems for the solid waste management are in place at the local level.
- The proper level of the tariff as well as the efficient tariff charging system is also critical for the sustainable provision of solid waste management services.

This programme will significantly contribute to the upgrading of the financial management capacity in these fields.

Description of Training Programme:

The following capacities in the field of financial management will be upgraded through the training programme:

- Ensuring proper financial management
  - ► Clarification of SWM costs and expenses
  - ► Clarification of budget and income
  - ► Understanding on the financial management for balancing revenue and expenditure
  - ► Understanding on the special account for SWM
- Ensuring the financial arrangement for the cost recovery
  - ► Proper assessment of understanding of the fixed cost, variable cost, total cost and the break-even point
  - ► Proper planning of the tariff level
  - ► Proper planning of the charging system
  - ► Understanding of the cross-subsidy system by the tariff differentiation
- Methodology for introducing tariff charging system
  - ► Alternative options for tariff charging system
  - ► Alternative options for tariff revision mechanism
- Increasing access to investment financing from various funding option
  - ► Public financing options
  - ► Private financing options
  - ► PPP financing options
- Other Analytical Tools
  - ► Value for Money Analysis
  - ► Willingness to Pay Survey
  - ► Affordability to Pay Survey

Table G.4.12 Concept of Module Training Programme for CCDP (Module 7)

Module:	**Module 7**	**Training No.:**	**7-a, 7-b, 7-c**
Title of Training Programme:	**Organizational and Legal Improvement**		
Target:	**GWMC Staff**		
Lecturers:	**Urban Unit**	**Cost:**	**Rs. 866,400**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**1 Years**
Implementation Year:	**2017, 2022, 2026**		

Objectives and Outlines:

- Organizational and institutional strengthening is essential for sustainable improvements in providing solid waste management services
- However, due to the low priority and lack of funds to the solid waste management sector, the organizational capacity for providing the solid waste management services is rather weak in developing countries. The public sector is normally not provided with sufficient resources to keep fulfilling its mandates, while the private sector is not successfully filling the gap between the current insufficient coverage by the public sector and the required level of services. It is critical to build the sustainable organizational structure as well as establishment the related organizational reform.
- The lack of effective legal framework as well as the institutional capacity to enforce the acts, regulations and by-laws in the field of solid waste management is also one of the major constraints.

Description of Training Programme:

The following capacities in the field of organizational and institutional reforms will be upgraded through the training programme:

- Improvement in the organizational aspect
  - ► Assessment of organizational capacities
    - Organizational structure
    - Decision-making mechanism
    - Coordinating ability
    - Job classification
    - Number of staff
    - Human resources development and training opportunities
  - ► Defining job descriptions within organizations
  - ► Ensuring appropriate personnel distribution in both quality and quantity
  - ► Development of organizational management capacity

- Improvement in the institutional aspect
  - ► National SWM policies
  - ► Laws, regulations, by-laws, ordinances related to SWM
  - ► Environmental impact assessment system
  - ► SWM planning
  - ► Category, classification and coding system of wastes
  - ► Construction standards for treatment and disposal facilities
  - ► Monitoring and law enforcement mechanism
  - ► Partnership with the private sector and communities

Table G.4.13 Concept of Module Training Programme for CCDP (Module 8)

Module:	**Module 8**	**Training No.:**	**8-a**
Title of Training Programme:	**Community Participation**		
Target:	**GWMC Staff, Private Sector Staff, Representatives of CBOs/NGOs**		
Lecturers:	**Urban Unit**	**Cost:**	**Rs. 3,760,000**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**3 Years**
Implementation Year:	**2016-2018, 2025-2027**		

Objectives and Outlines:

- The objective of the community participation promotion is to raise awareness of the residents for their cooperation in the solid waste management. The community participation should be designed to promote a better understanding of citizens through public and school environmental education by establishing a workable implementation system.
- The GWMC's own awareness of the requirements of a new solid waste management strategy is to be raised through a programme of seminars and workshops directed at GWMC managerial staff. This should be made prior to a public announcement by GWMC on the implementation of the Master Plan.
- Following its decision to implement the Master Plan, the GWMC has to inform the public of the measures it proposes taking to improve SWM services in the city and of its proposals to increase the existing charge levels to pay for the services. A properly structured communications strategy is to be proposed.
- A public education and awareness programme should accompany the GWMC's announcement of the Master Plan. Any attempt to introduce such a programme before the GWMC has spelt out the steps it is to take to improve solid waste management conditions in the city would be futile.

The programme will significantly contribute to upgrading the methodologies to promote community participation and to raise public awareness in the solid waste management services.

Description of Training Programme:

The following capacities in the field of community participation will be upgraded through the training programme:

- Raising Public Awareness
  - ► Improving solid waste education
  - ► Disseminating information on the proper store and discharge of waste
  - ► Improving methods for guiding the residents
- Proper Discharge Methods
  - ► Selecting proper discharge methods
  - ► Developing discharge rules and ensuring compliance with them
- Environmental Education
  - ► School education
  - ► Community education
- Partnership
  - ► Partnership with CBOs
  - ► Reflection of input from communities in policies, systems and services
  - ► Establishment of effective communication channels
  - ► Information networks (information and communication technologies)
- Assistance to Communities
  - ► Selection of suitable primary collection equipment
  - ► Financial assistance to procurement of collection equipment

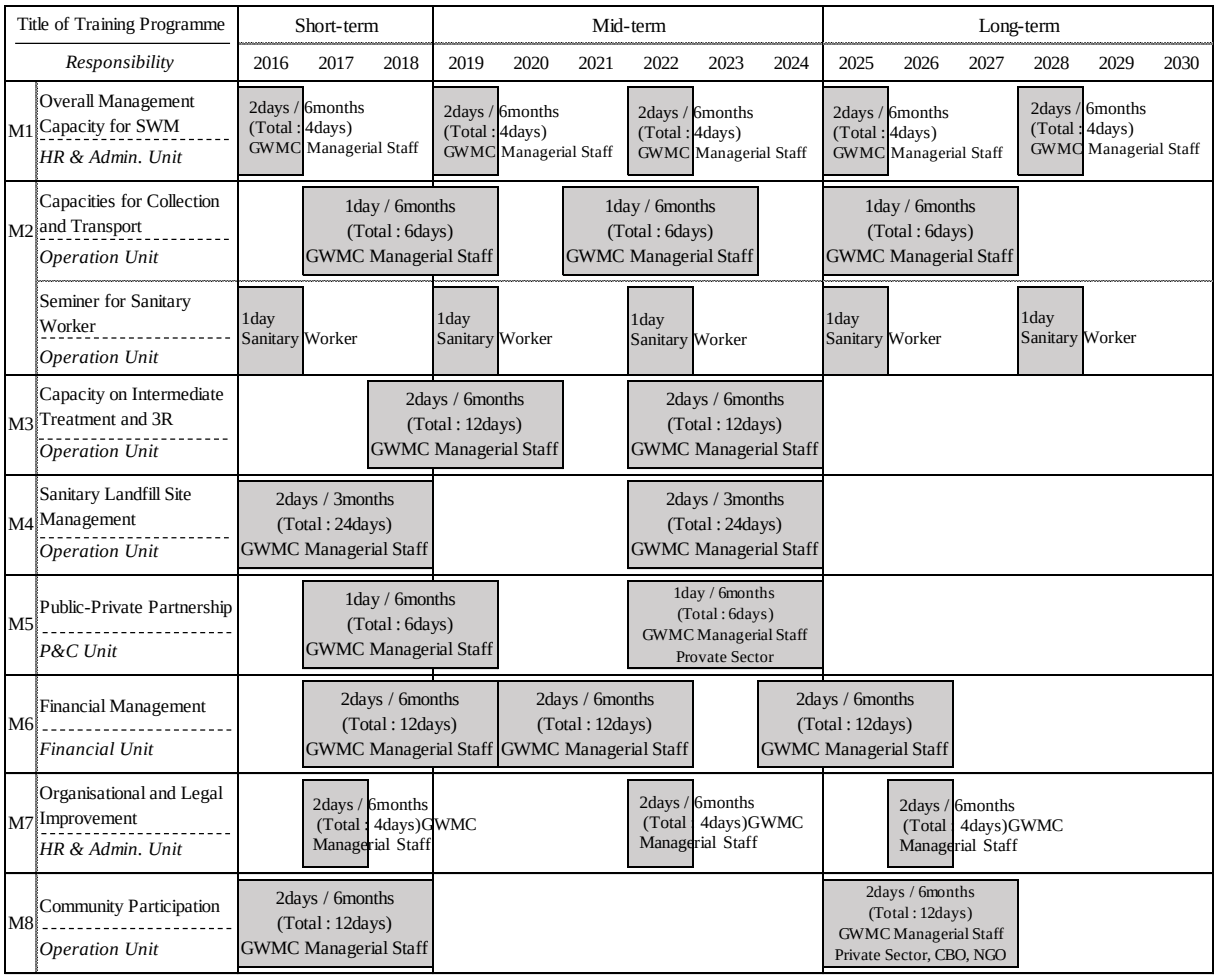

Figure G.4.5 Time Schedule of Comprehensive Capacity Development Programme (CCDP)

4.3.3 Legal and Institutional Reform

Currently there is no single comprehensive by-law in Gujranwala and the Committee of the Punjab Province is drafting a solid waste management by-law based on Municipal Solid Waste Rules 2014 (Draft) of India. This law should integrate the latest version of laws and regulations related to solid waste management in Punjab Province as well as adapt applicable clauses from Indian MSW rules so that it becomes single comprehensive by-law to comply with SWM.

In order to enforce the laws and regulations, first of all, CDGG/GWMC officials should have enough understanding of the legal matters involved. Therefore, it is necessary to provide CDGG and GWMC staff training on legal matters.

From the perspective of residents, it seems that most of residents are not aware of even the existence of laws and regulations. Therefore, in order to make them understand and comply with the by-law, it is advisable to interpret the law in Urdu.

In addition to awareness raising, it is necessary to exercise enforcement power for punishment of offences against the laws and regulations in order to prevent free riders of solid waste management services. For this purpose, CDGG/GWMC should procure some enforcement officers.

4.4 Implementation Schedule of Institutional Strengthening and Organizational Plan

The implementation schedule of the Institutional Strengthening and Organizational Plan is illustrated in **Figure G.4.6**.

Time Framework of the Master Plan		Short-Term Plan Period											Mid-Term Plan Period						Long-Term Plan Period					
Year		2016				2017				2018			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4											
WBS for Short-Term Plan																								
S-7-1	Improvement of Organisational Restructuring of GWMC																							
S-7-2	Capacity Development of GWMC Staff																							
S-7-3	Establishment of Gujuranwala Solid Waste Management By-Law																							
WBS for Mid-Term Plan																								
M-7-1	Improvement of Organisational Restructuring of GWMC																							
M-7-2	Capacity Development of GWMC Staff																							
M-7-3	Establishment of Gujuranwala Solid Waste Management By-Law																							
WBA for Long-Term Plan																								
L-7-1	Improvement of Organisational Restructuring of GWMC																							
L-7-2	Project for Capacity Development of GWMC Staff																							

Figure G.4.6 Implementation Schedule of the Institutional Strengthening and Organizational Plan

4.5 Project Cost of Institutional Strengthening and Organizational Plan

Table G.4.14 shows the project cost for the Master Plan and **Figure G.4.7** shows the Project Cost and Responsibility under the Institutional Strengthening and Organizational Plan.

Table G.4.14 Implementation Cost of the Institutional Strengthening and Organizational Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost															
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 7: Institutional Strengthening and Organizational Plan																	
Short-Term Plan																	
S-7-1	Improvement of Organisational Restructuring of GWMC	36,886	6,186	13,234	17,443												
S-7-2	Capacity Development of GWMC Staff	6,666	6,100	1,264	1,302												
S-7-3	Establishment of Gujuranwala Solid Waste Management By-Law	0															
	Sub-Total	47,552	14,289	14,518	18,745												
Mid-Term Plan																	
M-7-1	Improvement of Organisational Restructuring of GWMC	120,472				16,969	17,533	19,316	20,938	21,941	23,486						
M-7-2	Capacity Development of GWMC Staff	30,994				12,447	382	385	15,063	1,166	1,148						
M-7-3	Establishment of Gujuranwala Solid Waste Management By-Law	844				60	784										
	Sub-Total	151,910				29,496	18,699	19,701	36,001	23,106	24,634						
Long-Term Plan																	
L-7-1	Improvement of Organisational Restructuring of GWMC	187,379										24,077	28,662	29,066	31,841	34,034	38,198
L-7-2	Capacity Development of GWMC Staff	37,666										16,814	1,759	1,181	17,752		
	Sub-Total	224,994										41,891	30,420	30,248	49,592	34,034	38,198
	Grand Total	424,447	14,289	14,518	18,745	29,496	18,699	19,701	36,001	23,106	24,634	41,891	30,420	30,248	49,592	34,034	38,198

Programme No.	WBS No.	WBS	Budgetary Arrangment (Required=●)	Total Budget (Thousand Rs.)	Responsibility Assignment Matrix: M=Main Responsibility, S=Sub Responsibilities, B=Budgetary Arrangement, L=Legal Action, P=Participation in Discussions																
					GWMC/Operation Unit	GWMC/P&C Unit	GWMC/Financial Unit	GWMC/HR & Administration Unit	City District Government Gujranwala (CDGG)	The Urban Unit, Government of the Punjab	P&D Dept., Government of the Punjab	Local Gov't Dept., Government of the Punjab	Environment Protection Department (EPD)	Donor Organisations	Private Contractor/Consultant	Recyclers	CBOs & NGOs	Waste Pickers	PAPs around Gondianwala Disposal Site	PAPs around Bhakhrayewali Disposal Site	Gujranwala Citizens
Programme 7: Institutional Strengthening and Organizational Plan																					
Short-Term Plan																					
	S-7-1	Improvement of Organisational Restructuring of GWMC	●	38,858	P	P	B	M	P												
	S-7-2	Capacity Development of GWMC Staff	●	8,694	P	P	B	M													
	S-7-3	Establishment of Gujuranwala Solid Waste Management By-Law		0	M	P	B	L													
		Sub-Total		47,552																	
Mid-Term Plan																					
	M-7-1	Improvement of Organisational Restructuring of GWMC	●	120,472	P	P	B	M	P												
	M-7-2	Capacity Development of GWMC Staff	●	31,970	P	P	B	M	P	P	P	P	P	P	P	P	P	P	P	P	P
	M-7-3	Establishment of Gujuranwala Solid Waste Management By-Law	●	844	P	P	P	S	M	P	P	P	P								
		Sub-Total		153,286																	
Long-Term Plan																					
	L-7-1	Improvement of Organisational Restructuring of GWMC	●	187,379	P	P	B	M	P												
	L-7-2	Capacity Development of GWMC Staff	●	37,606	P	P	B	M							P	P	P	P			P
		Sub-Total		224,985																	
		Grand Total		425,823																	

Figure G.4.7 Project Cost and Responsibility under Institutional Strengthening and Organizational Plan

5. PROPOSAL FOR THE ACTION PLAN

5.1 Selection of the Priority Project

The priority projects are defined as projects for the short-term period of the master plan which will be developed to the action plans in this chapter. Based on the detail discussions described in previous **Chapter 4,** the following projects are thus selected as the priority projects:

1. Organizational Restructuring of GWMC
2. Capacity Development of GWMC Staff
3. Establishment of Gujranwala Solid Waste Management By-Law

5.2 Project for Organizational Restructuring of GWMC

As shown in **Subsection 4.10.3**, the organizational restructuring realises the creation of new departments and the reinforcement of personnel. The required actions are presented as follows:

- To strengthen the Operation (Field) Unit by allocating 7 additional Assistant Managers Operations until 2018;
- To establish the Manager Complaint Management post under GM Operations and allocate the manager until 2018;
- To establish the Intermediate Treatment Unit under the Operations Department and allocate an Assistant Manager Intermediate Treatment until 2018;
- To establish the Communication Unit under the GM Operations by shifting the Manager Communication and the Assistant Manager Communication from the Human Resources and Administration Department;
- To strengthen the Procurement and Contract Department for PPP Introduction of Collection and Transport; and
- To establish the Monitoring and Evaluation Department under the GM Operations and allocate the General Manager Monitoring and Evaluation and 3 Managers Monitoring and Evaluation (KPI, Finance and Environment) until 2018.

As shown in **Table G.4.4 of Subsection 4.3.1**, the required number of GWMC staff in the first three years of the short-term period is estimated at 66 or an increase of 20 personnel from the current number, 46.

GWMC should ensure the budget to cover the whole activities of recruitment, such as publicity, selection and employment, and shall carry out a series of adoption continuously. At the same time, it is necessary that GWMC shall plan the layout of office spaces and equipment with the increase in the number of staff. In addition, the compensation structure which depends on individual title, capacity and job tenure, and welfare should be reviewed from time to time.

5.3 Project for Capacity Development of GWMC Staff

Detail of eight (8) modules for capacity development programmes as the human resources development is discussed in **Subsection 4.3.2**. In this project, it is recommended that all the modules should start from the beginning of the short-term period as the following activities for three years:

- Two (2) 2-day sessions of *Overall Management Capacity for SWM* programme (Module 1) for GWMC managerial staff in 2016;

- Four (4) 1-day sessions of *Capacities for Collection and Transport* programme (Module 2) for GWMC managerial staff from 2016 to 2017;
- One (1) 1-day session of *Seminar for Sanitary Worker* programme (Module 1&2) for sanitary workers in 2016;
- Two (2) 2-day sessions of *Capacity on Intermediate Treatment and 3R Promotion* programme (Module 3) for GWMC managerial staff in 2018;
- Twelve (12) 2-day sessions of *Sanitary Landfill Site Management* programme (Module 4) for GWMC managerial staff from 2016 to 2018;
- Four (4) 1-day sessions of *Public-Private Partnership* programme (Module 5) for GWMC managerial staff and personnel of private sector from 2017 to 2018;
- Four (4) 2-day sessions of *Financial Management* programme (Module 6) for GWMC managerial staff from 2017 to 2018;
- Two (2) 2-day sessions of *Organizational and Legal Improvement* programme (Module 7) for GWMC managerial staff in 2017; and
- Six (6) 2-day sessions of *Community Participation* programme (Module 8) for GWMC managerial staff, personnel of the private sector, personnel of CBO and personnel of NGO from 2016 to 2018.

GWMC is going to entrust a part of the business to the private sector; therefore, its participation in some training programmes is necessary. Additionally, some training programmes which will invite many participants and the training programme for managers should be scheduled not to disturb the daily operations.

5.4 Project for Establishment of Gujranwala Solid Waste Management By-Law

CDGG/GWMC had already embarked on drafting the by-law and shall continue the task towards its enactment. In the process of finalising of the by-law, a series of public hearings will be held in the 8 districts of Gujranwala City to exchange opinions about the contents to be included in the by-law. Since the current by-law is in English, it should be translated into Urdu language for easier understanding of Gujranwala citizens.

The approved by-law can be an important official document to support the implementation of the Master Plan. In the meantime and since it might take a long time to establish the by-law, GWMC has to manage all the related organizations, especially the CDGG side schedule towards the establishment. However approval of the by-law is not expected during the short-term. Therefore, the first three years of this project does not need a budget.

5.5 Plan of Operations and Cost of Action Plan

Figure G.5.1 shows the Plan of Operations of Institutional Strengthening and Organizational Plan (Short-Term) and **Table G.5.1** shows the Estimated Cost of the Institutional Strengthening and Organizational Plan (Short-Term).

Year			2016				2017				2018			
Quarter			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WBS for Short-Term Plan														
	S-7-1	Improvement of Organisational Restructuring of GWMC												
	S-7-1-1	Establishment of New Posts (Mgr. Complaint Management, Intermediate Treatment Unit, Communication Unit and Monitoring & Evaluation Dept.)												
	S-7-1-2	Public Offering the Posts												
	S-7-1-3	Selection and Adoption												
	S-7-1-4	Orientation and OJT												
	S-7-2	Capacity Development of GWMC Staff												
	S-7-2-1	Training Programme of Overall Management Capacity for SWM												
	S-7-2-2	Training Programme of Capacities for Collection and Transport												
	S-7-2-3	Training Programme of Capacity on Intermediate Treatment and 3R Promotion												
	S-7-2-4	Training Programme of Sanitary landfill Site Management												
	S-7-2-5	Training Programme of Public-Private Partnership												
	S-7-2-6	Training Programme of Financial Management												
	S-7-2-7	Training Programme of Organisational and Legal Improvement												
	S-7-2-8	Training Programme of Community Participation												
	S-7-3	Establishment of Gujuranwala Solid Waste Management By-Law												
	S-7-3-1	Finalisation of Draft By-Law												
	S-7-3-2	Establishment of Related Regulation												

Figure G.5.1 Plan of Operations of the Institutional Strengthening and Organizational Plan (Short-Term)

Table G.5.1 Cost of Operations for Institutional Strengthening and Organizational Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost		
			2016	2017	2018
Programme 7: Institutional Strengthening and Organizational Plan					
Short-Term Plan					
S-7-1	Improvement of Organisational Restructuring of GWMC	38,858	8,180	13,234	17,443
S-7-1-1	Establishment of New Posts (Mgr. Complaint Management, Intermediate Treatment Unit, Communication Unit and Monitoring & Evaluation Dept.)	GWMC			
S-7-1-2	Public Offering the Posts	GWMC			
S-7-1-3	Selection and Adoption	GWMC			
S-7-1-4	Orientation and OJT	38,858	8,180	13,234	17,443
S-7-2	Capacity Development of GWMC Staff	8,695	6,109	1,284	1,302
S-7-2-1	Training Programme of Overall Management Capacity for SWM	679	679	0	0
S-7-2-2	Training Programme of Capacities for Collection and Transport	5,065	4,740	173	153
S-7-2-3	Training Programme of Capacity on Intermediate Treatment and 3R Promotion	309	0	0	309
S-7-2-4	Training Programme of Sanitary landfill Site Management	896	312	292	292
S-7-2-5	Training Programme of Public-Private Partnership	196	0	98	98
S-7-2-6	Training Programme of Financial Management	186	0	93	93
S-7-2-7	Training Programme of Organisational and Legal Improvement	270	0	270	0
S-7-2-8	Training Programme of Community Participation	1,094	378	358	358
S-7-3	Establishment of Gujuranwala Solid Waste Management By-Law	0	0	0	0
S-7-3-1	Finalisation of Draft By-Law	GWMC			
S-7-3-2	Establishment of Related Regulation	Gov. of the Punjab			
	Total (Short-Term)	47,552	14,289	14,518	18,745

6. CONCLUSION

6.1 Improvement of Organizational Restructuring of GWMC

The hiring of GWMC management staff is ongoing; however, because of the lack of experts on SWM and the strict criteria for selection, lack of human resources is still a problem. To correspond with the expansion of its business, the total number of managers has to increase from 45 to 75 personnel by 2030, because GWMC will manage the project from 2016 to 2030. The total cost is calculated at approximately Rs. 38 million at current prices.

6.2 Capacity Development of GWMC Staff

Punjab Province does not offer any training course pertaining to solid waste management (SWM) and since GWMC is tasked with project management it should maintain its own training programme to develop its human resources and/or institutional capacity. Incorporating the improvement of individual capacities into the organizational capacity of GWMC and the means of upgrading the capacity of GWMC staff in response to the massive human resources development will, therefore, demand the restructuring of GWMC's organizational setup.

Eight modules of a human resources development project have been devised for the organizational restructuring of GWMC. The training programme on the 8 modules shall be conducted from 2016 to 2028, and the total cost is calculated at approximately Rs. 77 million at current prices.

6.3 Establishment of Gujranwala Solid Waste Management By-Law

There is no comprehensive law on SWM in Gujranwala. The approval process of the By-Law is the responsibility of CDGG, and early enactment of the By-Law is expected as much as possible. The total cost is calculated at approximately Rs. 844 thousand at current prices.

7. RECOMENDATIONS

7.1 Security of Budget for New Staff

To ensure the availability of enough number of staff, GWMC needs to ensure also the salary of new staff including annual salary increases for all staff. There may also be a need to realign duties to ensure the division of responsibilities, to re-arrange the layout of job spaces, and to procure additional equipment for new staff before they join GWMC. The recruitment of new staff further needs a preparation period for coordination with the activities of relevant departments.

7.2 Consideration of Schedule Adjustment of Training Programme

The Training Programme which needs all managers and/or sanitary worker's participation should be held for several days in order not to disturb daily work. In addition, plural modules shall be carried out at the same time and hence coordination among the modules is also necessary.

7.3 Establishment of Suitable By-Law

GWMC will be designated as the implementing agency in the By-Law. Therefore, it should participate in drafting the By-Law, examining its contents, and discussing it with all stakeholders concerned. GWMC has to manage the process of approval of the By-Law to avoid any delay in its enactment.

PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

DRAFT FINAL REPORT

VOLUME 2

SUPPORTING REPORT

SECTION H

ENVAIRONMENTAL AND SOCIAL CONSIDERATIONS

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SECTION H

ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

1. INTRODUCTION

This **Section H** describes the environmental and social considerations taken for the Master Plan. These considerations are vital for making a decision on how the negative impact of the Master Plan of Solid Waste Management (SWM) to the environment in Gujranwala can be reduced or avoided.

Monitoring of the environmental and social aspects for the control of impacts is proposed. Firstly, the procedure is explained in terms of SEA (Strategic Environmental Assessment). Secondly, the socio-environmental condition of Gujranwala is explained. Public opinion is summarised as well. This section also includes a summary of the EIA for the Bhakhraywali final landfill site, and the regulatory framework of SWM in Pakistan is overviewed.

Based on this background information, impact forecast is summarised. Thus information reveals the planning of monitoring, and the Environmental Monitoring Plan in 2016 to 2030 is shown. The short-term monitoring plan (2016-2018) is provided as the "Action Plan".

2. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS FOR INTEGRATED SOLID WASTE MANAGEMENT MASTER PLAN

2.1 Introduction

The master plan of integrated solid waste management (ISWM) has been formulated by using the Strategic Environmental Assessment (SEA) technique. Environmental and social issues were taken into consideration to select the preferable options for each technical sector (collection and transportation, 3R and intermediate treatment, and final disposal) in the ISWM for mitigating the probable impacts to the neighbouring areas in the course of project implementation. Furthermore, in the formulation of the Master Plan which is a combination of the selected technical options, the environmental and social perspectives were taken into account in addition to the technological, economic and financial, institutional and organizational aspects for selecting the best combination for Option B.

In this **Chapter 2**, the qualitative impacts to environment and society are discussed in practicing the construction project of the selected Master Plan Option B, and the scoping for the implementation of Environmental Impact Assessment (EIA) or the Initial Environmental Examination (IEE) for the project(s) is prepared.

2.2 Planning Procedures and Selection of the Optimum Master Plan

2.2.1 Planning Procedures for Development of the Master Plan

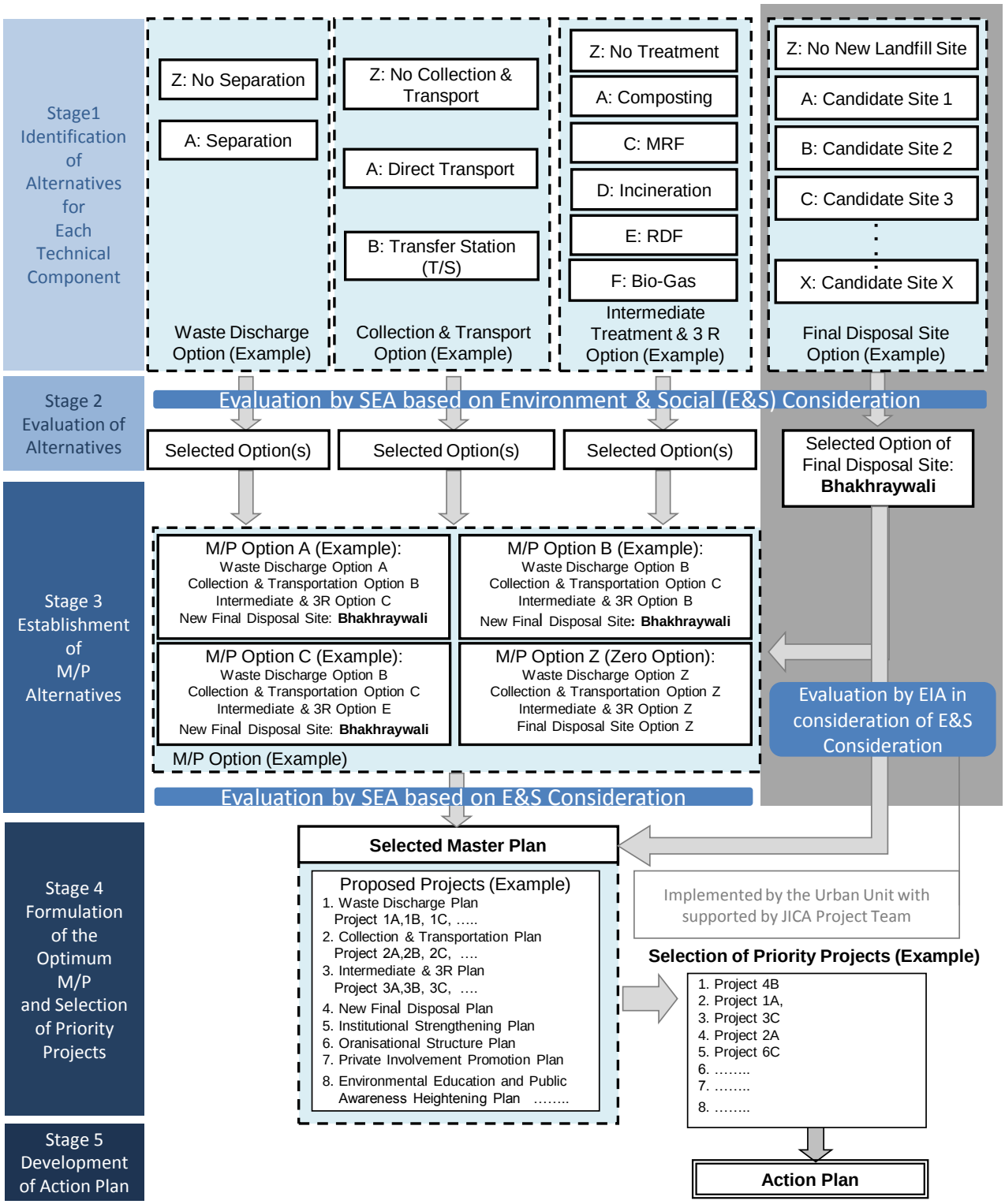
The SEA principle was conducted on the IEE level (Category B of the JICA Guidelines) to apply for decision-making of planning in the formulation of the Master Plan. Though both EIA and SEA are tools for the assessment of environmental and social impacts, in most cases, EIA deals with impacts from a single project. On the other hand, SEA deals with the comprehensive impacts of projects which cover a wide area (such as the master plan), and complicated impacts from a combination of plural projects, so that public consultation is significant.

One of the important principles in SEA is the "Zero Option". SEA provides an alternative option for the project, and it always has to take into account the case of "no project" implemented in the process of preparing the alternatives.

Figure H.2.1 shows the planning procedures of the Master Plan of this project. In the whole process, selection and decision-making, environmental and social considerations are carried out using the JICA Environmental Checklist for Waste Management.

Firstly, possible options are listed for each technical sector; i.e., Collection and Transportation, Intermediate Treatment and 3R, and Final Disposal. According to the SEA strategy, each approach must have a "Zero Option" which means no action will be made. For example, "Collection and Transportation" has the options of "Present Level Collection and Transport", "Direct Transport", "No Transfer Station for Mini-Dumpers," and "No Intermediate Treatment Facilities and No 3R Activities by GWMC", and so on.

Secondly, the best options are selected from each sector in terms of SEA. All of the selected options shall satisfy the check items in the Environmental and Social Considerations. Thirdly, some drafts of the Master Plan are formulated in combination with the options selected by the previous process. Needless to say, one of the drafts of the Master Plan is "Zero Option". Fourthly, the best Master Plan is formulated. Finally, the "Action Plan", which is defined as the priority project(s) to be implemented in the short-term period, is prepared, i.e., from year 2016 to year 2018 in this Project. The Master Plan includes many main- and sub-projects which break the components of the Master Plan down to the feasible action level. Therefore, a schedule of timing, cost and executing agencies is necessary for the implementation of these main- and sub-projects, and the projects showing these details are called "Action Plan".



Remarks
SEA: Strategic Environmental Assessment
EIA: Environmental Impact Assessment
E&S Consideration: Environmental and Social Consideration based on JICA guidelines

Figure H.2.1 Planning Procedure of the Master Plan with Environmental and Social Considerations

2.2.2 Selection of Optimum Master Plan

The master plan study options are discussed in **Chapter 4 of Volume 2, Main Report.** Option B is selected as the most optimum combination from the technical, environmental, social, financial, institutional and organizational viewpoints. This Option B is comprised of the development plans, programmes and projects listed in the following subsections.

(1) Proposed Development Plans and Programs

The environmental and social considerations should be carried out in the course of formulation of the Gujranwala Integrated Solid Waste Management Master Plan. The Master Plan is composed of the following seven programmes, the details of which are described in **Chapter 4 of Volume 2, Main Report**.

Programme 1: Waste Collection and Transportation Plan

Programme 2: Final Disposal Plan

Programme 3: Intermediate Treatment and 3R Promotion Plan

Programme 4: Environmental Education and Public Awareness Raising Plan

Programme 5: Economic and Financial Plan

Programme 6: Environmental Monitoring Plan

Programme 7: Institutional Strengthening and Organizational Plan

(2) Proposed Technical Options for Achieving Targets of the Master Plan

The technical options that will be implemented to achieve the targets set in the Master Plan are as follows:

- Separate collection;
- Construction and operation of a new final disposal site at Bhakhraywali;
- Improvement work and closure of the existing landfill site in Gondlanwala;
- Closure of the former landfill site in Chianwali;
- Construction and operation of a central compost plant; and
- Construction and operation of RDF plant.

2.3 Baseline of Environmental and Social Conditions

It is essentially required to consider the utmost mitigation of probable impacts to environmental and social aspects in practicing the projects of the selected technical option mentioned in **Section 2.2**. Under this **Section 2.3**, the natural and social conditions of the project site and the vicinities are collected and outlined for the baseline information taken into consideration for carrying out the EIA or IEE for the project(s).

The baseline of environmental and social considerations in this project is summarised based on the EIA report on the construction of a new final disposal site at Bhakhraywali and the result of the Environmental and Social Consideration Survey (E&S Survey).

The EIA report was drafted in February 2015 by the Urban Unit and submitted to the Federal Agency in March 2015. After submission, Public Hearing and Review was to be carried out between March and April 2015, and Decision was to be made by the Federal Agency in May 2015 at the latest. The Urban Unit and GWMC conducted the EIA, and the detail of the EIA of the project is described in the

following **Section 2.4**. On the other hand, the E&S survey was carried out in this project in November 2014 (**Photo H.2.1**).


Photo H.2.1 Interviews in E&S Survey

2.3.1 Natural Condition

(1) Climate

Gujranwala has a tropical hot dry climate with long summers when temperature rises to maximum up to 48 degrees Celsius in the months of June and July. The summer season starts from April and continues until the end of September; June is the hottest month with maximum and minimum temperature of 40 degrees Celsius and 27 degrees Celsius, respectively.

The winter season starts from November and continues until March. January is the coldest month with maximum and minimum temperature of 19 degrees Celsius and 4 degrees Celsius, respectively.

The mean annual average temperature for the City of Gujranwala is 22 degrees Celsius.

The monsoon starts from the later part of June and lasts over the period of two and a half months. The eastern part of the district receives more rain. The mean annual rainfall of the region is 81.9 mm.

Maximum values of relative humidifies are observed during the month of January and December. The values range between 76% and 36% during morning and evening times respectively. Whereas minimum values are obtained during the month of May between the morning and evening times i.e., 45% and 22%.

The highest wind speed recorded during February to March. As far as wind direction is concerned for Gujranwala City, the predominant wind direction during the months of January to March, May, June and October to December is North-West, while in the month of April is North-East and in the months of July, August and September is South-East.

(2) Water

Surface Water: Surface water is used mostly for irrigation through irrigation canals. There are six irrigation tributaries in Gujranwala district that serve as main conduit, as follows:

- Gajar Gola Distributary (7.2 km)
- Kot Sujana Minor (7.7 km)
- Shori Branch (7.8 km)
- Muradian Distributary (8.5 km)
- Rakh Chichra Minor (9 km)
- Chandhar Minor (10 km)

Chenab River is the only river in the district. The *Chenab* River forming the northern boundary has been described as a broad shallow stream. There are several *nallahs* (canals) in the district which form channels for floodwater in the rainy season. The most important of them are *Palkhu, Aik, Khot, Beghwala* and *Dekh*.

Groundwater: Groundwater is used mainly for drinking and irrigation in Gujranwala. For drinking, the local population is generally reliant on supply from the hand pumps in rural areas while in urban areas the population use drinking water from the piped water supply scheme.

About 60% of the total housing units in the city had access to potable drinking water in 1998. Some 10.3% of the people use tap water for household use and 80.9% of the housing units in 2007-08 obtain water from hand pumps as compared to the 36.80% in 1998. On the other hand, 0.4% use private wells to meet their need of drinking water, and 0.6% people use water from public standpipes.

(3) Fauna and Flora

Fauna: Due to the extensive cultivation, high population and human activities, there is little wildlife in the project area. However, the Wildlife Department has reported some fauna.

Common mammals reported from the project area are given in **Table H.2.1.** Until a few years ago the wolf (Canis Palfies) was also found in riverine forests, but the species has almost become extinct due to loss of forests. Wild bores are reported to be inflicting serious crop damage, mainly to sugarcane and potato crops. Some degree of illegal hunting, poaching and trapping has been reported from the project area.

Table H.2.1 Common Mammals in the Project Area

Sr. No.	Scientific Name	Common Name
1.	Sus scrofa	Wild-bore
2.	Hyaena straitaa	Hyaen
3.	Vulpes bengalensis	Red Indian Fox
4.	Paleornis torquata	Percupine
5.	Canis Aureus	Jackal

The names of commonly found birds in the area are given in **Table H.2.2**. A large variety of waterfowls and migratory birds also visit the region because of the wetlands associated with barrages along the river systems of the area.

Table H.2.2 Birds in the Project Area

Sr. No.	Scientific Name	Common Name
1.	Accipiter Badius Cenchroides	Hawk
2.	Milvus Migrans Govinda	Kite
3.	Paleornis Torquata	Parrot
4.	Fvancolinus Pondoceraianus Mecrranesis	Partridge
5.	Corvidae Splendens	Common Crow

Due to the hot and humid climate of the region, some population of reptiles has also been reported in the project area. Reptilian and amphibian fauna is not well documented. However, local people have reported that snakes and lizards are common in the region.

Flora: The entire Gujranwala District has no natural forests, mainly due to vast agricultural activities. However, according to an old provincial notification, the trees along canals, provincial highways and rural roads are the responsibility of the Forest Department, which fall in the category of reserved forests.

The project area, which is an agricultural land, is the habitat of several floral species. Common floral species with rooted vegetation are also present near most of the water bodies of the area. The list of flora in the project area is presented in **Table H.2.3**.

Table H.2.3 List of Floral Species in the Project Area

Sr. No.	Scientific Name	Common Name
1.	Dilbergia sisoo	Sheesham
2.	Acacia Arabica	Keekar
3.	Salvadora persica	Peeloo
4.	Ficus Religiosa	Bohar
5.	Tamarix Indica	Gaz
6.	Azadrichta Indica	Nim
7.	Prospis Julifora	Mesquite
8.	Eucalypts Camaldulensis	Sufaida
9.	Zizyphus Numularia	Jharber
10.	Populus Alba	Poplar
11.	Morus Alba	Mulberry
12.	Syzygium Cumini	Jamun

Local farmers practice a small degree of farm-forestry in the project area to meet their fuel-wood and other day-to-day needs. The common species in such plantations are Poplar, Eucalyptus, Keekar, Mulberry and Jamun.

Due to the hot and humid weather, Gujranwala District is also famous for its fruit production, which includes mango, guava, banana, oranges and water melons.

(4) Rainfall

The average rainfall of Gujranwala from 1994-2013 is shown in **Figure H.2.2**. The highest rainfall of more than 300 mm was recorded in the months of July and August, while the lowest was observed during the months of November and December in the range of 8-13 mm.

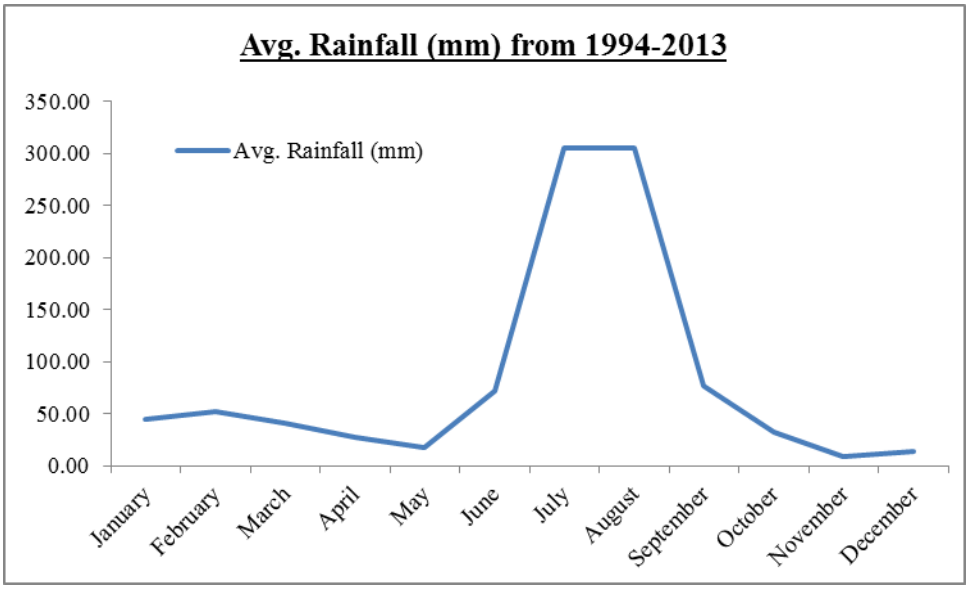


Figure H.2.2 Average Rainfall in Gujranwala

(5) Temperature

Figure H.2.3 presents the average maximum and minimum temperature in Gujranwala over the period of 20 years. The average maximum temperature reaches 39°C in summer (May and June)

and 17°C in winter (January). The average minimum temperature remains almost 5-8°C during winter season (December to February) and for summer it is almost 23°C.

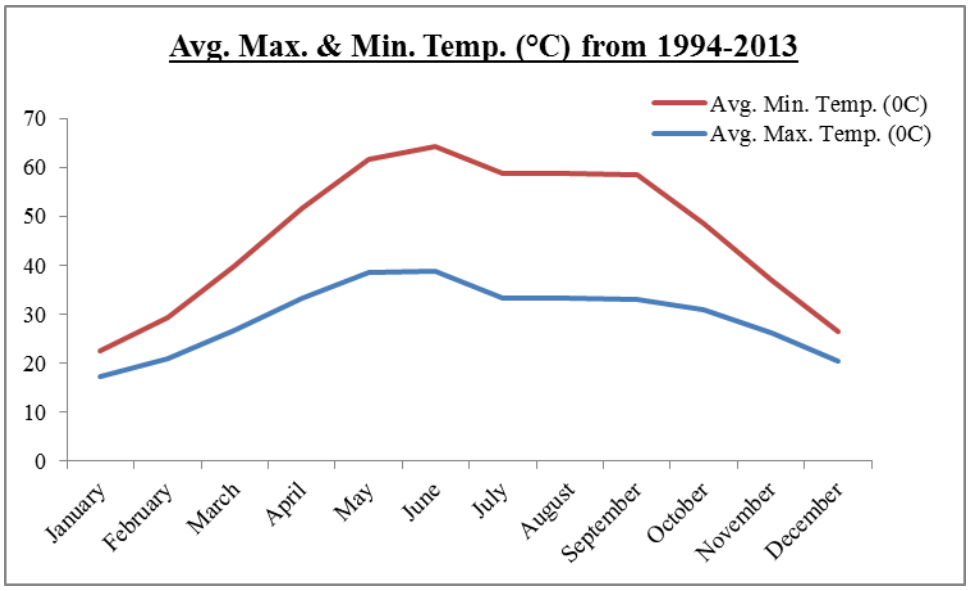


Figure H.2.3 Average Temperature in Gujranwala

(6) Humidity

Humidity is recorded twice a day (morning and evening). The humidity data of Gujranwala is portrayed in **Figure H.2.4.** In winter and monsoon season, the average maximum humidity for mornings is about 80-90% and for evenings, 50-70%.

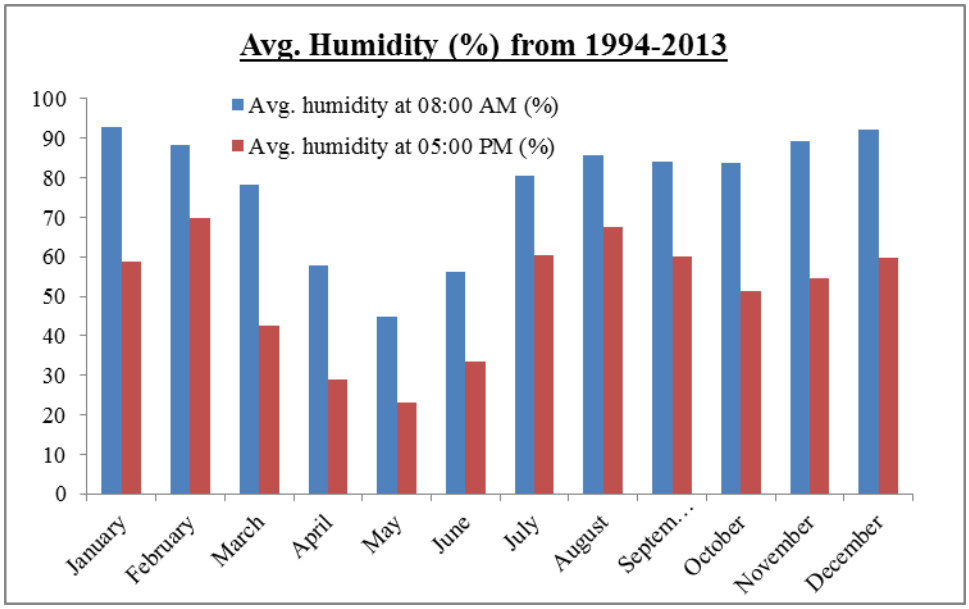


Figure H.2.4 Average Humidity in Gujranwala

(7) Land Use

Lying in the heart of the canal irrigated fertile region of Punjab, Gujranwala is a part of Rachna Doab, slopping from north-east to south-west and crossed by Upper Chenab Canal from north to south in the eastern part. The project area is plain with the ground surface sloping gently from NE to SW.

The project site of the proposed landfill is an agricultural land with 10-15% uneven land left after the exaction activities. It is also a plain of Alluvial material and scattered rocks at deeper depth. The area is underlain by Pleistocene deposits to a depth of several thousand meters. The first 200 meters of these deposits consist of approximately 70% silty sand interspersed with limited clay layers. The strata are generally heterogeneous with little vertical or lateral continuity.

Risk of earthquake devastations for Pakistan's cities should be realised since it is situated at the junction of three tectonic plates; namely, Indian, Eurasian and Arabian. The seismic hazard map of Pakistan (Figure 4-22, Page-97, EIA Report) shows that the project site lies in an area that can expect an earthquake of low magnitude. The project site is located in Seismic Zone 2A which lies between 3 and 4.5 on the MMI scale. The site is far from the region of High Seismic Hazard Zone.

(8) Air and Noise

Air quality can be considered good due to the absence of significant pollution sources. In view of this, the criteria of Ambient Air Quality Pollutants (NOx, SOx, PM, CO, etc.) in the area are within the acceptable limits. No major anthropogenic sources of air pollution were noted since the proposed site is away from the main city and no industry is situated within 5km range.

Proper Plantation on green belts, avenues and green area will help maintain the air quality of the area in future.

Similarly, noise is a significant environmental problem and originates from many sources such as vehicular traffic (termed as roadway noise), airplanes, heavy machinery employed in construction work, etc. Elevated noise levels significantly affect the physiological and psychological health which includes hearing loss, annoyance, hypertension, aggression, and high stress levels depending upon the magnitude of noise and duration of exposure.

During the site survey, there were no key sources of noise pollution noted.

2.3.2 Opinion of Residents/Landowners

Table H.2.4 shows a summary of public opinion obtained through the interviews in the E&S survey. Sixty persons were interviewed in six locations (10 respondents each). Most of them recognised that a disposal site and waste management are necessary for Gujranwala. Some of them are apprehensive that new environmental problems may occur because of the disposal site. Bad smell, vectors, and dirty environment by the facilities is commonly pointed out.

Table H.2.4 Summary of Public Opinions in the E&S Survey

Site	Interview		Major Opinions on the Facility
	No. of Interviewees	Age of Interviewees	
Chianwali	10	From 18 to 50 years	1. Community living in the vicinity have the problem on "bad smell" and "flies". 2. During the survey, respondents also highlighted health problem and disease, and few also highlighted the problem on vectors. 3. Majority of respondents consider that this facility is degrading the water quality.
Gondlanwala	10	From 25 to 55 years old	1. Bad smell, flies and vectors were the major problems of the people living near the Gondlanwala at the time of E&S survey. 2. Ground and surface water quality degradation were also claimed by the respondents. 3. Few of the respondents also claimed damage to their animals due to the dumping of waste at Gondlanwala dumping site. 4. Respondents consider that the waste management company does not properly do clay cover and spray for the vectors which are the leading problems.
Compost 1: Main Fruit and Vegetable Market	10	From 24 to 56 years old	1. Majority of the respondents do not have ideas about the compost facility. 2. 50% of the respondents agree with the compost facility at Fazal fruit market. 3. Few respondents show reservation about traffic congestion during the operations at compost facility due to narrow roads.
Compost 2: Fazal Fruit Market	10	From 18 to 51 years old	1. The community living nearby the main fruit market consider it a good option since it will reduce the waste and it will be easy also for the contractor to dispose fewer amounts from the main fruit and vegetable market. 2. Some people do not want any type of waste related activity in their neighbourhood. 3. Their views are like; they do not want odour and flies in their neighbourhood.
Transfer Station 1: Sialkot Road	10	From 18 to 46 years old	1. Majority of the respondents agree on the transfer station in their vicinity. 2. Furthermore, people are aware that this type of administrative step helps to deal with the waste in a better way. 3. One view is against the transfer station because of the bad smell and the unhygienic conditions. 4. According to the community, it is acceptable to them provided the transfer station is timely cleaned.
Transfer Station 2: Alam Chowk	10	Information on age was not recorded.	1. At the Alam Chowk transfer station, one of the landowners complained about the bad smell. 2. The Alam Chowk transfer station is fenced by the wall, so that most people do not have any problem with the transfer station in their vicinity. 3. However, few people suggested that the bad smell could be removed by timely transportation of wastes to the dumping site and the transfer station should be cleared and cleaned regularly.

2.3.3 Impacts on Environment and Society of Chianwali and Gondlanwala Disposal Sites and the Proposed Sites for Compost Facility and Transfer Station

(1) Impacts on Environment and Society

Impacts on environment and society in six locations are summarised in **Table H.2.5** to **Table H.2.10**. Proposed locations of compost facility and transfer station are shown in **Figure H**.5.1.

- Gondlanwala: Current disposal site

- Chianwali: Closed disposal site
- Main fruit market: Proposed location for compost facility
- Fazal fruit market: Proposed location for compost facility
- Alam Chowk: Proposed location for transfer station
- Sialkot Road: Proposed location for transfer station

According to the result of the impact analysis, negative impacts are recorded at the disposal sites in terms of Air, Water, and Soil. On the other hand, at the proposed sites of transfer station and compost facility, there is degradation of the local environment, especially by odour and infectious diseases, but positive impact is assumed because of new employment opportunities in the new facilities.

(2) Alternatives

In case that Compost Facility and Transfer Station are constructed in the city, odour (from Compost Facility) and scattering of waste in and around garages will be a problem for the neighbouring community. Therefore, the Compost Facility is to be constructed at the Bhakhraywali site, and the site of the Transfer Station has to be decided in consideration of not only the impact to the neighbouring community but also the effectiveness of waste collection.

Table H.2.5 Impacts of Compost Facility and Transfer Station on Environment and Society in Gondlanwala

No.	Factors which probably make impact to local environment	Current Situation	Probable Impact
Environmental Assessment			
Impacts on Environment			
1	Air	About 60 to 70% pollution is from vehicular emission. Since open dumping is being practiced without any proper plan and lining system, methane gas will emit from the site.	Open dumping will cause a minor negative impact, i.e., air pollution, since toxic gases are emitted.
2	Water	According to the water quality survey in which 14 water quality parameters were tested, the value of turbidity is high in all surface water samples while the values of BOD_5 and COD are also high in one of the samples. Regarding groundwater quality, 7 samples were taken for analysis. Most of the results seem to be satisfactory; however, values of turbidity are higher in 2 samples which may be due to poor quality of casing used in the hand pumps and overall shallow depth of installation.	Open dumping will cause a minor negative impact, i.e., water pollution since there is no leachate control and collection system.
3	Soil	Soil is contaminated since there is no liner system to isolate waste from the soil.	Open dumping will cause a moderate negative impact, i.e., soil contamination, since there is no liner system to isolate waste from soil.
4	Waste	Waste is not covered with soil layer.	Open dumping will cause a minor negative impact since waste is being disposed

No.	Factors which probably make impact to local environment	Current Situation	Probable Impact
			without any liner system and procedure.
5	Accidents	Expansion of waste collection services will lead to the increase in collection and transportation vehicles and hence more traffic congestion and accidents at the site.	There is no direct impact in the form of accidents due to open dumping of waste.
6	Water Usage	According to the Water Quality Survey, the quality of groundwater is satisfactory; only the value of turbidity is high.	Since there is no leachate control and collection system which will cause water contamination by leachate percolation, water will become unfit for use. Open dumping may cause a minor negative impact with regard to water use.
7	Climate Change	Since there is no proper soil cover on the waste, toxic gases maybe emitted from the site.	Since there is no liner system, open dumping will emit toxic gases which may result in deterioration of climate and cause a minor negative impact.
8	Ecosystems	Currently, no impact is observed.	Open dumping without any liner will deteriorate the ecosystem and cause moderate negative impacts.
9	Fauna	Since there is no fauna closed to this site, there is no impact on fauna.	No Impact
10	Flora	Flora is also not present near this site, so that there is no negative impact on flora.	No Impact
Social Assessment			
Impacts on Society			
11	Migration of Population	No migration is observed from the site activity.	No Impact
12	Involuntary Settlement	Currently, such kind of settlement is not observed.	Open dumping will attract waste pickers to involuntary settle in the surrounding area which may cause a minor impact.
13	Employment & Livelihood	Currently, 1 Manager, 2 Assistant Managers and 1 Data Entry Operator are deployed at this dumping site to manage the waste.	Moderate positive impact since employment is generated.
14	Utilisation of Land & Local Resources	Since waste is dumped, this land cannot be used for other purposes unless it is properly closed.	Unplanned dumping will result in quick filling of dumping site and requires more land which will cause moderate negative impact.
15	Social Institutions	There is no social institution near the site.	There is no direct impact on institutions.

No.	Factors which probably make impact to local environment	Current Situation	Probable Impact
16	Social Infrastructures and Services	Currently, infrastructure is poor near the site connecting to villages.	There is no direct impact on infrastructures and services.
17	Vulnerable Social Groups	No such group is observed.	People living around the dumping site will be vulnerable since there is no controlling mechanism at the site.
18	Equality of Benefits and Losses	No Impact	No Impact
19	Equality in the Development Process	No Impact	No Impact
20	Gender	No Impact	No Impact
21	Children's Right	No Impact	No Impact
22	Cultural Heritage	No Impact	No Impact
23	Local Conflicts of Interest	No conflicts	No Impact
24	Infectious Diseases	Since waste pickers separate the valuable materials at the site and all kinds of waste are being dumped, diseases may be caused.	All kinds of infectious waste that will pollute the surroundings and ecosystems are dumped, which may cause minor negative impact.
25	Working Conditions	Currently, access road is unpaved and single which causes traffic congestion. Also rainy season affects the site. When One time cleaning activity starts, number of vehicles at site increase which will cause delay in weighing and dumping at specific point.	Without any intervention the working condition will not be improved which will cause a minor negative impact.

Table H.2.6 Impacts on Environment and Society in Chianwali

	Factor which probably make impact to local environment	Current Situation	Probable Impact
Environmental Assessment			
Impacts on Environment			
1	Air	About 60 to 70% of pollution is from vehicular emission. Since the site is closed, no further waste is being dumped and soil cover is not properly made, methane gas will emit from the site.	Open dumping could cause a minor negative impact, i.e., air pollution, since toxic gases will be emitted.
2	Water	According to the water quality survey in which 14 water quality parameters were tested, the values of BOD5 and COD are high in all surface water samples while the value of suspended solids (SS) is also beyond the limits in one sample. To check the groundwater quality,	Open dumping could cause a minor negative impact, i.e., water pollution, since there is no leachate control and collection system.

	Factor which probably make impact to local environment	Current Situation	Probable Impact
		samples were collected from wells and hand pumps located in that area. The results of all samples are satisfactory except one sample which was taken from hand pump. Arsenic level is high in one sample.	
3	Soil	Soil is contaminated and there is no liner system to isolate waste from the soil.	Open dumping could cause a moderate negative impact of soil contamination since there is no liner system to isolate waste from soil.
4	Waste	The site is closed and no more waste is being dumped at this site.	Open dumping could cause a minor negative impact since waste is being disposed without any plan and procedure.
5	Accidents	No accident since the site is closed	There is no direct impact in the form of accidents.
6	Water Usage	The quality of groundwater is satisfactory. Only one sample shows high limits of arsenic and the reason for this high value is that the sample was taken near the juice factory.	Since there is no leachate control and collection system which will cause water contamination by leachate percolation and water will become unfit for use, open dumping may cause a minor negative impact in case of water use.
7	Climate Change	Since there is no proper soil cover on the waste, toxic gases may emit from this site.	There is no liner system and open dumping will emit toxic gases which may result in deterioration of climate and cause a minor negative impact.
8	Ecosystems	Currently, no impact is observed.	Open dumping without any liner could deteriorate the ecosystem and cause moderate negative impacts.
9	Fauna	Since there is no fauna closed to this site. So no impact on fauna.	No Impact
10	Flora	Flora is also not present near this site, so that there is no negative impact.	No Impact
Social Assessment			
Impacts on Society			
11	Migration of Population	No Impact	No Impact
12	Involuntary Settlement	No Impact	Open dumping will attract waste pickers to involuntary settle in the surrounding area which may cause a minor impact.
13	Employment & Livelihood	Currently, no impact is observed.	Open dumping does not require the management of waste, so that there is no opportunity for employment which will cause

	Factor which probably make impact to local environment	Current Situation	Probable Impact
			minor negative impact.
14	Utilisation of Land & Local Resources	Since waste is dumped at Chianwali, the land cannot be used for other purposes unless it is properly closed.	Unplanned dumping will result in quick filling of dumping site and requires more land which will cause moderate negative impact.
15	Social Institutions	No Impact	There is no direct impact on institutions.
16	Social Infrastructures and Services	No Impact	There is no direct impact on infrastructures and services.
16	Vulnerable Social Groups	No Impact	People living around the dumping site will be vulnerable since there is no controlling mechanism at the site.
18	Equality of Benefits and Losses	No Impact	No Impact
19	Equality in the Development Process	No Impact	No Impact
20	Gender	No Impact	No Impact
21	Children's Right	No Impact	No Impact
22	Cultural Heritage	No Impact	No Impact
23	Local Conflicts of Interest	No Impact	No Impact
24	Infectious Diseases	Stagnant water at the dumping site may lead to vector borne diseases.	All the infectious wastes are dumped that will pollute the surrounding and ecosystem which causes the minor negative impact.
25	Working Conditions	No Impact	Without any intervention the working conditions will not be improved which will cause a minor negative impact.

Table H.2.7 Impacts on Environment and Society in Main Fruit Market

	Factor which probably make impact to local environment	Current Situation	Probable Impact
Environmental Assessment			
Impacts on Environment			
1	Air	By the construction of compost facility at main fruit market, organic waste will be reduced that leads to low emission and odour.	Minor positive impact
2	Water	No impact	No direct impact
3	Soil	Currently, there are some low lying lands and agricultural lands.	Minor positive impact since compost will reduce the use of chemical fertilizers resulting in reducing soil

	Factor which probably make impact to local environment	Current Situation	Probable Impact
			pollution.
4	Waste	Currently, wastes from main fruit market are thrown into the GWMC container.	Minor positive impact since organic waste is used for composting so that less waste is to be handled.
5	Accidents	Currently, no traffic problems	There is no direct impact in the form of accidents.
6	Water Usage	-	No direct impact
7	Climate Change	-	Minor positive impact since compost will reduce the use of fertilizers resulting in protecting the climate.
8	Ecosystems	-	Minor positive impact
9	Fauna	No fauna is found	No direct Impact
10	Flora	No flora is found	No direct Impact
Social Assessment			
Impacts on Society			
11	Migration of Population	No impact	No direct impact
12	Involuntary Settlement	Currently, there are some low-lying lands and agricultural lands.	Minor positive impact since compost will reduce the use of chemical fertilizers resulting in the reduction of soil pollution.
13	Employment & Livelihood	Currently, waste from main fruit market is disposed into the GWMC container.	Minor positive impact as organic waste is used for composting so less waste is to be handled.
14	Utilisation of Land & Local Resources	Currently, no traffic problem	There is no direct impact in the form of accidents.
15	Social Institutions	-	No direct impact
16	Social Infrastructures and Services	-	Minor positive impact since compost will reduce the use of fertilizers result in protecting the climate.
16	Vulnerable Social Groups	-	Minor positive impact
18	Equality of Benefits and Losses	No fauna is found	No direct Impact
19	Equality in the Development Process	No flora is found	No direct Impact
20	Gender	No impact	No direct impact
21	Children's Right	Currently, there are some low-lying lands and agricultural lands.	Minor positive impact since compost will reduce the use of chemical fertilizers resulting in the reduction of soil pollution.
22	Cultural Heritage	Currently, waste from main fruit market is disposed into the GWMC container.	Minor positive impact since organic waste is used for

	Factor which probably make impact to local environment	Current Situation	Probable Impact
			composting so that less waste is handled.
23	Local Conflicts of Interest	Currently, no traffic problem	There is no direct impact in the form of accidents.
24	Infectious Diseases	-	No direct impact
25	Working Conditions	-	Minor positive impact since compost will reduce the use of fertilizers result in protecting the climate.

Table H.2.8 Impacts on Environment and Society in Fazal Fruit Market

	Factor which probably make impact to local environment	Current Situation	Probable Impact
Environmental Assessment			
Impacts on Environment			
1	Air	Currently, there are a considerable number of flies in the market area due to organic waste. Organic wastes cause odour problem in the vicinity of fruit market.	Minor positive impact to the construction of compost facility at Fazal Fruit Market; volume of organic waste will be reduced that leads to low emission and odour.
2	Water	No impact	No direct impact
3	Soil	Currently, this is built-up area.	Minor negative impact since the compost facility is built in a congested area which will cause traffic problems in future.
4	Waste	Currently, waste from main fruit market is thrown into the GWMC container.	Minor positive impact since organic waste is used for composting and hence less waste is to be handled.
5	Accidents	Currently, no accidents	Minor negative impact since compost facility will lead to heavy traffic due to compactors and dumpers
6	Water Usage	No direct impact	No direct impact
7	Climate Change	Currently, there are flies and odour due to organic waste.	Minor positive impact since compost will reduce the use of fertilizers result in protecting the climate.
8	Ecosystems	-	Minor positive impact
9	Fauna	No fauna is found since 90% the area is built-up area.	No direct impact
10	Flora	No flora is found since 90% of the area is built-up area.	No direct impact

	Factor which probably make impact to local environment	Current Situation	Probable Impact
Social Assessment			
Impacts on Society			
11	Migration of Population	Currently, no direct impact	Moderate negative impact since this is a congested area and acquisition of land for compost facility may result in migration of population.
12	Involuntary Settlement	Currently, no direct impact	No direct Impact
13	Employment & Livelihood	Currently, no direct impact	Moderate positive impact since employment will be generated as the compost facility will need more workers.
14	Utilisation of Land & Local Resources	Currently, no direct impact	Minor positive impact since compost will lead to reduction of waste.
15	Social Institutions	No impact	No impact
16	Social Infrastructures and Services	Currently, there are narrow roads in this area.	Minor positive impact; roads will be widened for heavy traffic.
16	Vulnerable Social Groups	Currently, No direct impact	No direct impacts
18	Equality of Benefits and Losses	No impact	No direct impacts
19	Equality in the Development Process	No impact	No direct impacts
20	Gender	No impact	No direct impacts
21	Children's Right	No impact	No direct impacts
22	Cultural Heritage	No impact	No direct impacts
23	Local Conflicts of Interest	No impact	No direct Impacts
24	Infectious Diseases	Currently, there is considerable number of flies due to organic waste that might cause infectious diseases.	Minor positive impact since compost plant will reduce the waste stream.
25	Working Conditions	Currently, poor working conditions.	Minor positive impact

Table H.2.9 Impacts on Environment and Society in Sialkot Road

	Factor which probably make impact to local environment	Current Situation	Probable Impact
Environmental Assessment			
Impacts on Environment			
1	Air	Currently, a bucket and blade work all day to collect waste and fill the container due to which engine emits smoke. There is considerable number of flies due to organic waste. Organic waste cause odour	Transfer station will restrict the movement of heavy vehicles resulting in less air pollution which may cause minor positive impact.

	Factor which probably make impact to local environment	Current Situation	Probable Impact
		problem in the vicinity.	
2	Water	There is no direct contact of waste with water.	No direct impact
3	Soil	Currently, this is built-up area so that there is no deterioration of soil.	Interaction of waste with soil or leachate might result in soil damage. Minor Negative Impact
4	Waste	Waste spreads around due to scavenging activity; no segregation activity by GWMC.	Minor Positive Impact in case transfer station will encourage segregation which will result in volume reduction.
5	Accidents	Currently, no accident	Minor Positive Impact since transfer station will restrict the movement of heavy vehicles which may result in fewer accidents.
6	Water Usage	No direct impact	No Direct Impact
7	Climate Change	Currently, a bucket and blade work all the day to collect the waste and fill the container due to which engine emits smoke. There are flies and odour due to organic waste.	Minor Positive Impact since transfer station restricts the movement of heavy vehicles which may result in less climate change.
8	Ecosystems	-	Minor Positive Impact since transfer station will isolate the waste from surrounding area resulting in the protection of ecosystem.
9	Fauna	No fauna is found since 90% of the area is built-up area.	No Direct Impact
10	Flora	No flora is found since 90% of the area is built-up area.	No Direct Impact
Social Assessment			
Impacts on Society			
11	Migration of Population	No such activity is observed, but residents have a problem due to smell, flies and vehicles loading at the site.	No Direct Impact
12	Involuntary Settlement	Currently, such settlements are not observed but a number of waste pickers come there to separate valuable materials.	Moderate Negative Impact since mixed waste attracts waste pickers to settle near the transfer station.
13	Employment & Livelihood	Currently, one supervisor is deployed at the transfer station to supervise the activity and record the trips of vehicles.	Moderate Positive Impact since employment will be generated to manage the waste at transfer station.
14	Utilisation of Land & Local Resources	Due to the waste handling activity, people avoid passing by this route.	Minor Negative Impact since transfer station requires land and resources.
15	Social Institutions	No impact	No Direct Impact

	Factor which probably make impact to local environment	Current Situation	Probable Impact
16	Social Infrastructures and Services	Currently, there are wide roads in this area.	No Direct Impact
16	Vulnerable Social Groups	Currently, no direct impact	No Direct Impact
18	Equality of Benefits and Losses	No Impact	No Direct Impact
19	Equality in the Development Process	No Impact	No Direct Impact
20	Gender	No Impact	No Direct Impact
21	Children's Right	No Impact	No Direct Impact
22	Cultural Heritage	No Impact	No Direct Impact
23	Local Conflicts of Interest	No Impact	No Direct Impact
24	Infectious Diseases	There is no segregation activity by GWMC and waste pickers separate the valuable materials for their livelihood. Waste stream at transfer station is mix waste having all types of waste including infectious wastes. No safety gadgets are used by waste pickers and GWMC staff members are present, so that infectious diseases may be caused. There is considerable number of flies due to organic waste that might cause infectious diseases.	Moderate Negative Impact since waste without separation will be infectious.
25	Working Conditions	Currently transfer station is an open storage area without any boundary and waste of the trips after 3 PM remained there so looks non-aesthetic.	Minor Positive Impact as proper transfer station will provide better working than open storage areas.

Table H.2.10 Impacts on Environment and Society in Alam Chowk

	Factor which probably make impact to local environment	Current Situation	Probable Impact
Environmental Assessment			
Impacts on Environment			
1	Air	Currently, a bucket and blade work all day to collect waste and fill the container due to which engine emits smoke. There are a considerable number of flies due to organic waste. Organic waste cause odour problem in the vicinity.	Transfer station will restrict the movement of heavy vehicles resulting in less air pollution which may cause Minor Positive Impact.
2	Water	There is no direct contact of waste with water.	No Direct Impact
3	Soil	Currently, this is no built-up area so that soil is mixed with waste.	Interaction of waste with soil or leachate might result in soil damage. Minor Negative Impact
4	Waste	No segregation activity by GWMC.	Minor Positive Impact in case transfer station will

	Factor which probably make impact to local environment	Current Situation	Probable Impact
			encourage segregation which will result in volume reduction.
5	Accidents	Currently, no accidents	Minor Positive Impact since transfer station will restrict the movement of heavy vehicles which may result in less accidents
6	Water Usage	No direct impact	No Direct Impact
7	Climate Change	Currently, there are flies and odour due to organic waste.	Minor Positive Impact since transfer station will restrict the movement of heavy vehicles which may result in less climate change.
8	Ecosystems	-	Minor Positive Impact since transfer station will isolate the waste from surrounding area resulting in the protection of ecosystem.
9	Fauna	No fauna is found since 90% of the area is built-up area.	No Direct Impact
10	Flora	No flora is found since 90%of the area is built-up area.	No Direct Impact
Social Assessment			
Impacts on Society			
11	Migration of Population	No such activity is observed.	No Direct Impact
12	Involuntary Settlement	Currently, such settlements are not observed but one or two waste pickers go there to separate the valuable materials.	Moderate Negative Impact since mix waste attracts waste pickers to settle near the transfer station.
13	Employment & Livelihood	Currently, one supervisor is deployed at the transfer station to supervise the activity and record the trips of vehicles.	Moderate Positive Impact since employment will be generated to manage the waste at transfer station.
14	Utilisation of Land & Local Resources	-	Minor Negative Impact since transfer station requires land and resources.
15	Social Institutions	No impact	No Direct Impact
16	Social Infrastructures and Services	Currently, there are wide roads in this area.	No Direct Impact
16	Vulnerable Social Groups	Currently, no direct impact	No Direct Impact
18	Equality of Benefits and Losses	No Impact	No Direct Impact
19	Equality in the Development Process	No Impact	No Direct Impact
20	Gender	No Impact	No Direct Impact
21	Children's Right	No Impact	No Direct Impact

	Factor which probably make impact to local environment	Current Situation	Probable Impact
22	Cultural Heritage	No Impact	No Direct Impact
23	Local Conflicts of Interest	No Impact	No Direct Impact
24	Infectious Diseases	There is no segregation activity by GWMC and waste pickers separate the valuable materials for their livelihood. Waste stream at transfer station is mixed waste having all types of waste including infectious waste. No safety gadgets are being used by waste pickers and GWMC staff members are present, so that infectious diseases may be caused. There are a considerable number of flies due to organic waste that might cause infectious diseases.	Moderate Negative Impact since waste without separation will be infectious.
25	Working Conditions	Transfer station is an open storage area without any wall and waste of trips after 3 PM remain in the station so that it looks unclean.	Minor Positive Impact since proper transfer station will provide better working condition than open storage areas.

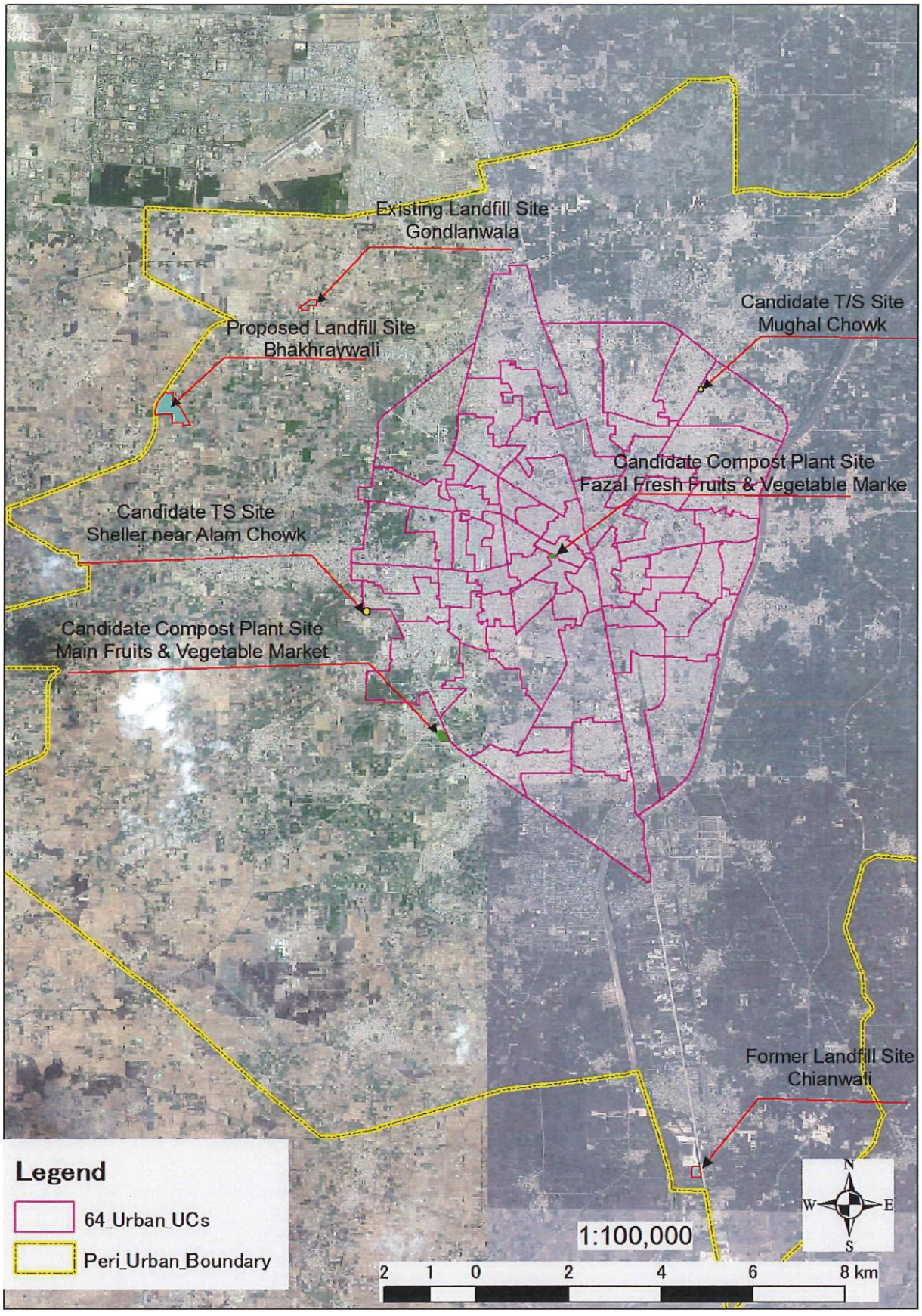


Figure H.2.5 Map of Candidate Locations for Transfer Station and Compost Facility

2.3.4 Public Consultation

As a component of public consultation, 74 stakeholders were interviewed. Fourteen stakeholders selected from public institutions such as Irrigation Department, Agriculture Department, Environment Protection Department, City District Government Gujranwala, Gujranwala Environmental Organization, and Chaon Foundation were interviewed in the EIA Public Consultation. On the other hand, 60 residents/landowners were interviewed in the E&S survey.

Positive Perceptions: Stakeholders showed affirmative standpoint on the sanitary landfill in Bhakhraywali in terms of benefit to public health and environment.

Negative Perceptions: The common viewpoint is GMWC's negligence of required procedures and the guidelines create new environmental constraint and hazards. Lack of community inclusion and public disclosure is pointed out as well.

2.4 Confirmation of Environmental and Social Considerations Systems and Organizations in Pakistan

2.4.1 Laws and Regulations Related to Environmental and Social Considerations

Pakistan laws related to comprehensive environmental issues are shown in **Table H.2.11** and **Table H.2.12** shows the policy, guidelines, and rules of solid waste management nationwide/provincial-wise.

Table H.2.11 Environmental Laws in Pakistan

Title of the Law	Contents
Pakistan Environmental Protection Act	This act provides for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. EIA is mentioned in Section 12.
National Environmental Quality Standards (NEQS)	NEQS consists of two parts: • List of laws and regulations in 14 sectors such as Environmental Protection, Land Use, Water Quality and Resource, Solid Waste Management, and so on. • Description of national standards
Pakistan Environmental Protection Agency (Review of IEE & EIA) Regulations 2000	Process of IEE and EIA is described.
National Environmental Policy	The Policy provides an overarching framework for addressing the environmental issues facing Pakistan, particular pollution of freshwater bodies and coastal waters, air pollution, lack of proper waste management, deforestation, loss of biodiversity, desertification, natural disasters and climate change. Guidelines are shown in each sector, and one of such sector is "Waste Management".

Table H.2.12 Policy, Guideline, and Rules of Solid Waste Management National/Provincial-Wise

Name	Contents
National Sanitation Policy 2006	The policy stipulates that one of its objectives is to develop and implement strategies for integrated management of municipal, industrial, hazardous and hospital and clinical wastes of national, provincial and local level.
Punjab Municipal Solid Waste Management Guidelines 2011	Various issues in waste management are covered.
Hospital Waste Management Rules 2005	Rules for the management of medical waste generated in hospital are described.

2.4.2 Organizations and Functions Related to Environmental and Social Considerations

The Ministry of Environment is the main government organization responsible for the protection of environment and conservation of resources. There are many governmental institutions organised and enforcing the laws and regulations together with the Ministry of Environment as shown in the following **Table H.2.13**.

Table H.2.13 Framework of Environmental Institutions in Pakistan

Functions, policy, plans, strategies and programmes	Status (as of February 2015)
Environmental pollution, ecology, forestry, wildlife, biodiversity, climate change and desertification	Assigned to Planning and Development (P&D) Department, but later transferred to the new Ministry with the establishment of the Ministry of National Disaster Management (NDM). At present, NDM is named as the Ministry of Climate Change with the same portfolio.
Improvement in environmental conditions of air, water and land	Devolved
Incorporation of environmental concerns in development schemes and energy conservation	Devolved
Coordination, monitoring and implementation of environmental agreements with other countries, international agencies and forums	Assigned to the Planning and Development (P&D) Department, but later transferred to the new Ministry with the establishment of the Ministry of National Disaster Management (NDM). At present, NDM is named as the Ministry of Climate Change with the same portfolio.
Pakistan Environmental Protection Agency (Federal EPA)	Assigned to the Capital P&D Department. But later, transferred to the new Ministry with the establishment of the Ministry of National Disaster Management (NDM). At present, NDM is named as the Ministry of Climate Change with the same portfolio. The domain of Federal EPA has been limited to the Federal Area.
Secretariat of Pakistan Environmental Protection Council established under the PEPA97 (XXXIV of 1997)	Assigned to Inter-Provincial Coordination (IPC) Department, but later transferred to the new Ministry. At present, NDM is named as the Ministry of Climate Change with the establishment of the Ministry of National Disaster Management (NDM).
National Council for Conservation of Wildlife (NCCW)	Devolved. The council members were transferred to the P&D Department and later to the Ministry of National Disaster Management. The NDM has been renamed as the Ministry of Climate Change and staff members of the defunct NCCW work in its Forestry Wing.
National Energy Conservation Centre (ENERCON)	Assigned to the Ministry of Water and Power.
Zoological Survey Department (ZSD)	Assigned to Ministry of Science and Technology. But later, with the enactment of Ministry of National Disaster Management (NDM), transferred to new Ministry. At present NDM has been renamed as Ministry of Climate Change with same portfolio.
Forestry Wing of MoE	Staff transferred to P&D Department and later to Ministry of National Disaster Management (NDM). At present NDM has been renamed as Ministry of Climate Change with same portfolio.

2.4.3 Projects Requiring EIA in Pakistan

The Environmental Protection Act of 1997 and the Pakistan Environmental Assessment Procedures of 1997 stipulate the conditions that would require EIA for the project site. The process of EIA is described in "Pakistan Environmental Protection Agency (Review of IEE & EIA) Regulations 2000." The case is filed in the Federal Agency, and the Agency decides whether the case is IEE (Initial Environmental Evaluation) or EIA. According to the Regulations, EIA is required in view of waste management as follows:

- Waste disposal and/or storage of hazardous or toxic wastes (including landfill state, incineration of hospital toxic waste) (for EIA)
- Waste disposal facilities for domestic or industrial wastes, with annual capacity of more than 10,000 cubic metres (for EIA)
- Waste disposal facilities for domestic or industrial wastes, with annual capacity of less than 10,000 cubic metres (for IEE)
- Waste-to-energy generation projects (for IEE)

2.4.4 EIA Process in Pakistan

Figure H.2.6 shows the process of EIA in Pakistan. Once the report is submitted, within 10 working days of application for EIA, the Federal Agency proceeds to the "Preliminary Scrutiny." After "Public Participation" is done, the Federal Agency will carry out its "Review" within 90 days of application for EIA. Upon completion of the Review, the "Decision" of the Federal Agency shall be communicated to the proponent.

2.4.5 EIA of this Project

The Urban Sector Planning and Management Services Unit Ltd. (The Urban Unit), in partnership with the Gujranwala Waste Management Company (GWMC), conducted Environmental Impact Assessment (EIA) for the proposed Bhakhraywali landfill site. The actual survey was carried out by local consultants from 15 August 2014. The contents of the EIA report are shown in **Figure H.2.7**.

The final EIA public hearing was carried out on August 18, 2015. Few processes remain, and it may take one month to acquire EIA approval at the latest.

Major conclusions are as follows:

- According to the future estimate of waste generation in Gujranwala, the building of systematic waste management is very important. The proposed sanitary landfill in Bhakhraywali will play an important role.
- Leachate generation and air pollution will have impact on the physical environment. Therefore, proper management of leachate and landfill gases is necessity.
- Movement of solid waste collection vehicles and workers health will be social problems.
- No significant irreversible impacts to environment and society since there is no biological sensitive area and no heritages.

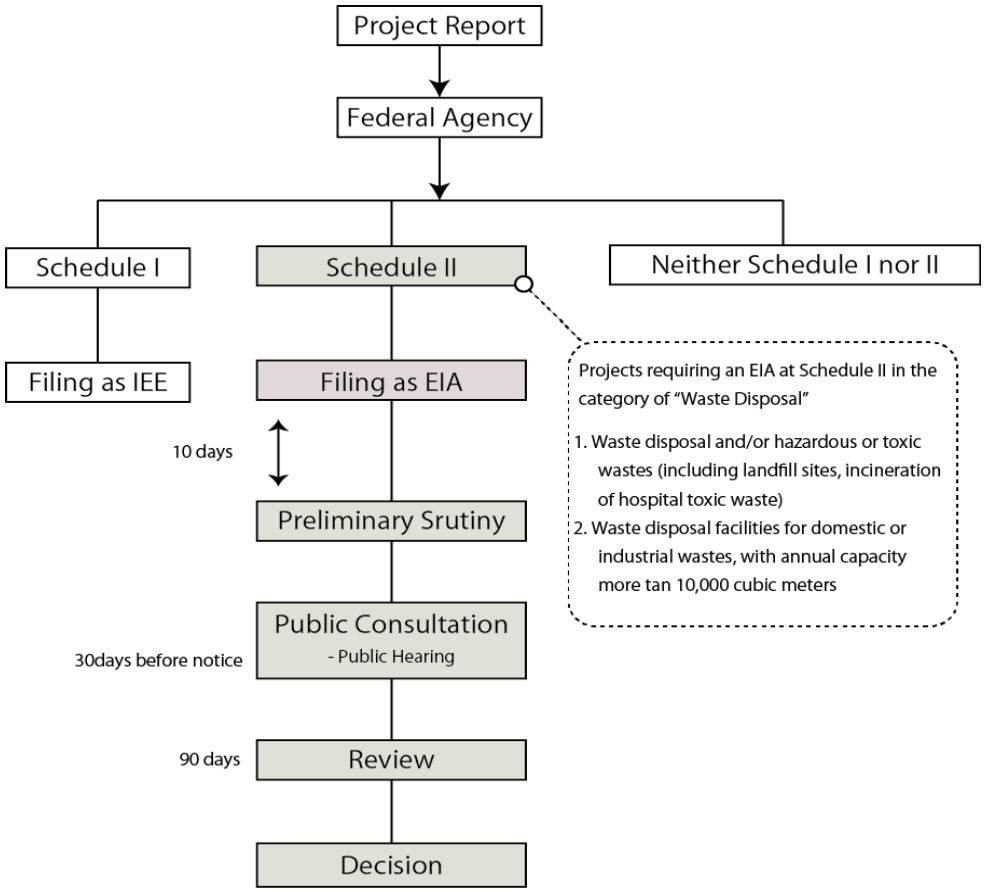


Figure H.2.6 Process of EIA in Pakistan by the "Pakistan Environmental Protection Agency (Review of IEE & EIA) Regulations 2000"

Chapter 1: Introduction
Chapter 2: National and International Policy, Legal and Institutional Framework
Chapter 3: Project Description
Chapter 4: Analysis of the Alternatives
Chapter 5: Baseline Environment and Social Conditions
Chapter 6: Stakeholder Consultation
Chapter 7: Impact Assessment and Mitigation Measures
Chapter 8: Environmental Management Monitoring Plan
Chapter 9: Conclusion

Figure H.2.7 Major Contents of EIA Report (Planned)

2.4.6 JICA Environmental Checklist for Waste Management

This project follows the JICA Guidelines for Environmental and Social Considerations as well as the Pakistani laws and regulations. This project is categorised as "Category B" based on the JICA Guidelines. Categorisation is made based on sector, scale, characteristics and location of the project, and "Category B" is defined as "Less adverse impact than "Category A" (significant adverse impact)".

The JICA Environmental Checklist is issued under the JICA Guidelines, and the Checklist mentions detailed issues and items for avoiding negative impacts to community from the project. The JICA Checklist is a list of conditions which a JICA-funded project needs to follow so as to satisfy the desired

quality of the project. For this project, the JICA Environmental Checklist for Waste Management is applied. The Checklist consists of six categories: Permits and Explanation, Pollution Control, Natural Environment, Social Environment, Others, and Note.

According to the comparison between the Pakistani laws and the JICA Environmental Checklist for Waste Management (see **Table H.2.14**), some issues show that there is no conflict between the JICA Checklist and Pakistani laws; for example, both require EIA for project implementation. On the other hand, some differences are identified in the category; for example, "Social Condition" of the JICA Checklist. "Social Conditions" in the JICA Checklist requires consideration of living and livelihood of stakeholders and working condition at the project site. These issues are not clearly mentioned in Pakistani laws.

Application of the JICA Checklist to the project will make a better situation for the future waste management in Gujranwala. The Checklist will contribute especially in the field of social consideration.

2.5 Scoping for Consideration of EIA or IEE Study

The environmental and social impact elements and the degree for the projects are clarified in advance under this **Section 2.5**. The results are summarised as a scoping for consideration to carry out the projects requiring EIA or IEE.

The target project for scoping and its contents are set up based on the information of **Section 2.3** and **Section 2.4**. Accordingly, the scoping is carried out for the intermediate treatment facilities (Compost Plant and RDF Plant) and the final disposal site (new sanitary landfill facilities, improvement of the existing landfill site and safe closure of the former landfill site) that are integral components of the Option B Master Plan.

The results of these scoping tables shall be used as reference while the EIA/IEE of the respective projects is carried out to ensure the appropriateness of Option B projects in the environmental and social aspects.

2.5.1 Scoping of EIA or IEE for Composting and RDF Projects

Table H.2.14 indicates the results of preliminary evaluation of probable environmental and social impacts of composting and RDF projects, which shall be used as the basic scoping to carry out the EIA or IEE for the project concerned.

Table H.2.14 Comparison of Pakistani Laws and Regulations Related to Environmental Protection and Waste Management and JICA Environmental Checklist for Waste Management

Category Environmental Item in JICA Environmental Checklist for Waste Management	Comparison with Pakistani Laws and Regulations
1. Permits and Explanation 1) EIA and Environmental Permits 2) Explanation to the Local Stakeholders 3) Examination of Alternatives	**[Result of Comparison]** ・ No major conflict between the JICA Checklist and the Pakistani laws and regulations **[Related Laws/Regulations]** ・ Guidelines for the Preparation and Review of Environmental Reports (1997) ・ Pakistan Environmental Protection Agency (Review of IEE & EIA) regulations 2000 ・ National Environmental Quality Standards (NEQS) ・ Building Regulation (2007) ・ Punjab Municipal Solid Waste Management Guidelines 2011 ・ Guidelines for Public Consultation (1997)
2. Pollution Control 1) Air Quality 2) Water Quality 3) Wastes 4) Soil Contamination	**[Result of Comparison]** ・ Treatment and disposal process of other hazardous and dangerous waste may not be defined. ・ Noise generated by vehicles shall comply with the National Environmental Quality Standard. Noise generated by Facility operation may not be defined. Vibration level by vehicles or facility operation may not be defined.

Category Environmental Item in JICA Environmental Checklist for Waste Management	Comparison with Pakistani Laws and Regulations
5) Noise and Vibration 6) Odour	**[Related Laws/Regulation]** ・ National Environmental Quality Standards (NEQS) ・ Punjab Municipal Solid Waste Management Guidelines 2011 ・ Hospital Waste Management Rules (2005)
3. Natural Environment 1) Protected Areas 2) Ecosystem 3) Management of Abandoned Site	**[Result of Comparison]** ・ No major conflict between the JICA Checklist and the Pakistani laws and regulations **[Related Laws/Regulation]** ・ Guidelines for Sensitive and Critical Area (1997) ・ Punjab Municipal Solid Waste Management Guidelines 2011
4. Social Environment 1) Resettlement 2) Living and Livelihood 3) Heritage 4) Landscape 5) Ethnic Minorities and Indigenous People 6) Working Conditions	**[Result of Comparison]** ・ No conflict, basically, but social and environmental considerations shall be accorded to waste pickers in the existing system in accordance with the JICA guidelines. ・ Measures for local landscape protection are not defined in Pakistani laws and regulation. ・ Working condition and environment is not clearly defined in Pakistani laws and regulations although the Labour Policy (2010) mentions labourers' human rights, health and social welfare. **[Related Laws/Regulation]** ・ Guidelines for the Preparation and Review of Environmental Reports (1997) ・ Labour Policy (2010) ・ Antique Act (1975) ・ Punjab Special Premises (Preservation) Ordinance (1985) ・ Guidelines for Sensitive and Critical Area (1997) ・ Punjab Municipal Solid Waste Management Guidelines 2011 ・ National Environmental Policy ・ The World Bank Environmental Assessment Sourcebook Volume I
5. Others 1) Impacts during Construction 2) Monitoring	**[Result of Comparison]** ・ No major conflict between the JICA Checklist and the Pakistani laws and regulations **[Related Laws/Regulations]** ・ Guidelines for the Preparation and Review of Environmental Reports (1997) ・ Punjab Municipal Solid Waste Management Guidelines 2011
6. Note 1) Reference to Checklist of Other Sectors 2) Note on Using Environmental Checklist	**[Situation]** ・ This issue is not mentioned in the Pakistani laws; therefore, The World Bank Environmental Assessment Sourcebook, Volume I, shall be applied, if necessary. **[Related Laws/Regulations]** ・ Guidelines for the preparation and review of Environmental Reports (1997) ・ The World Bank Environmental Assessment Sourcebook, Volume I

Table H.2.15 Scoping for Composting and RDF Projects

Category	Environmental Item	Compost Plant		RDF Plant		Check Item
		CON	OPE	CON	OPE	
1. Pollution Control	(1) Air Quality	B	C	B	C	Construction Phase: Generation of dust in construction work Operation Phase: Dust in workplace
	(2) Water Quality	B	B	B	B	Construction Phase: Wastewater from construction staff quarter Operation Phase: Wastewater from plant office
	(3) Wastes	C	C	C	C	Construction Phase: Construction waste and garbage Operation Phase: Garbage from plant office
	(4) Soil Contamination	C	C	C	C	Not applicable
	(5) Noise and Vibration	C	B	C	B	Construction Phase: Construction work by heavy machine Operation Phase: Noise of plant machinery and incoming vehicles
	(6) Odour	C	A	C	B	Construction Phase: Not applicable Operation Phase: Odour from incoming raw material
2. Natural Environment	(1) Protected Areas	C	C	C	C	No protected area in the neighbouring area
	(2) Ecosystem	C	C	C	C	Construction Phase: Conversion of agricultural land Operation Phase: Not applicable
	(3) Management of Abandoned Sites	C	C	C	C	Not applicable
3. Social Environment	(1) Resettlement	C	C	C	C	No resident in the site
	(2) Living and Livelihood	C	C	C	C	No resident in the neighbouring area
	(3) Heritage	C	C	C	C	No heritage in the neighbouring area
	(4) Landscape	C	C	C	C	Appearance of plant building
	(5) Ethnic Minorities and Indigenous Peoples	C	C	C	C	Not applicable
	(6) Working Conditions	B	B	B	B	Construction Phase: Accidents in construction work Operation Phase: Accidents and insanitation to plant staff in operation

Notes:
1) Phase of Project Activity: CON: During Construction; OPE: During Operation
2) Impact Level: Negative Impact: A: Serious, B: Some, C: Negligible, Positive Impact: P, - : Not applicable

2.5.2 Scoping for EIA or IEE of Waste Disposal Projects

Table H.2.16 indicates the results of preliminary evaluation of probable environmental and social impacts of the final disposal projects at Bhakhraywali, Gondlanwala and Chianwali, which shall be used as the basic scoping to carry out the EIA or IEE for the project concerned.

Table H.2.16 Scoping for Bhakhraywali, Gondlanwala and Chianwali Landfill Projects

Category	Environmental Item	Bhakhraywali Sanitary Landfill		Gondlanwala Improvement of Existing Landfill		Chianwali Closure of Former Landfill		Check Item
		CON	OPE	CON	OPE	CON	OPE	
1. Pollution Control	(1) Air Quality	B	B	B	B	B	B	Construction Phase: Generation of dust in construction work Operation Phase: Generation of dust in landfill work. Generation of landfill gases
	(2) Water Quality	B	A	B	A	B	B	Construction Phase: Wastewater from construction staff quarters Operation Phase: Wastewater from plant office. Leachate from the landfill area
	(3) Wastes	C	C	C	C	C	C	Construction Phase: Construction waste and garbage Operation Phase: Garbage from plant office
	(4) Soil Contamination	C	C	C	B	C	B	Operation Phase: Contamination by heavy metals in waste
	(5) Noise and Vibration	B	B	B	B	B	C	Construction Phase: Construction work by heavy machine Operation Phase: Noise of landfill machine and incoming vehicles
	(6) Odour	C	A	B	A	B	B	Construction Phase: Odour from the existing landfill site Operation Phase: Odour from incoming waste
2. Natural Environment	(1) Protected Areas	C	C	C	C	C	C	No protected area in the neighbouring area
	(2) Ecosystem	C	C	C	C	C	C	Construction Phase: Conversion of agricultural land Operation Phase: Not applicable
	(3) Management of Abandoned Sites	-	B	-	B	-	B	Operation Phase: Safe closure and post-closure management and monitoring of the landfill site.
3. Social Environment	(1) Resettlement	C	C	C	C	C	C	No resident in the site
	(2) Living and Livelihood	C	C	A	A	C	C	Measures for two residential houses at Gondlanwala landfill site.
	(3) Heritage	C	C	C	C	C	C	No heritage in the neighbouring area
	(4) Landscape	C	B	B	B	B	P	Appearance of the landfill site to the passers-by.
	(5) Ethnic Minorities and Indigenous Peoples	C	C	C	C	C	C	Not applicable
	(6) Working Conditions	B	A	B	A	B	C	Construction Phase: Accidents in construction work Operation Phase: Accidents and insanitation to landfill operation staff
	(7) Waste Pickers in Landfill Site	-	A	B	A	-	-	Construction Phase: Accidents in construction work Operation Phase: Accidents and insanitation to landfill operation staff

Notes:
1) Phase of Project Activity: CON: During Construction; OPE: During Operation,
2) Impact Level: Negative Impact: A: Serious, B: Some, C: Negligible, Positive Impact: P, - : Not applicable

2.6 Impact Forecast

Prior to forecasting the potential environmental impacts of the projects, field surveys were conducted in addition to collecting the baseline data described in **Section 2.3** for clarifying the background condition of candidate sites and surrounding areas. Those surveys include the impacts to be caused in the construction and operation phases of the facilities by the factors influencing daily life (e.g., bad odour, flies and vectors, traffic jam caused by garbage collection vehicles, garbage falling down from collection vehicles without cover on the way to the landfill site) and environmental issues (e.g., water quality, air quality, hydrogeological situation, soil contamination, noise and vibration). In addition to the environmental factors, the opinion of neighbouring residents and waste pickers who are the "key

stakeholders" in the waste management system were collected for analysing the impacts to the communities.

Based on the data and information gathered through the surveys, this section examines the impacts of major influencing factors among the impacts to the environment and social aspects, which were clarified in the scoping of each facility in the preceding **Section 2.5**.

2.6.1 Construction and Operation of Central Compost Plant

(1) Outline of Compost Plant Project

Location of Construction Site	: East side of Bhakhraywali Landfill Site
Site Area	: 5ha
Plant Capacity	: 250t/day
Plant System	: Pre-treatment and windrow type composting process
Input Material	: Separated organic waste

(2) Environmental and Social Impact Elements of Compost Plant Project

Air Quality

Similar to other construction projects, dust is generated during the construction work. The construction work, especially earth works for foundation will cause the dust problem. The surface soil in the project site consists of sandy silt to silty sand, and the small particles of the surface soil is easily blown by the wind and suspended in the air.

The plant does not have a process to exhaust air pollutants. However, during operation of the plant, dust could be generated in the process of segregation of raw materials and turning of compost. The dust problem in operation will result in unsanitary conditions to the operation staff of the plant.

Water Quality

Generally, a camp or quarters for the construction workers will be built in or nearby the construction site. During the construction phase, wastewater discharge from kitchen, toilet and bath will become a potential source for water pollution in the neighbouring area. In the operation phase, similar condition as the construction phase can be seen, so that wastewater discharge from toilet and bath by plant operation staff will have a potential source of water contamination.

Odour

The construction work will not be a source of odour. Raw material for composting is derived from organic waste of municipal waste mostly consisting of fresh market waste, kitchen waste, garden waste, etc., which will generate odour especially under the anaerobic decomposition process.

Working Condition

Risks of accident such as those caused by falling objects, collapse of temporary work and miss-operation of construction machinery always exist among the construction workers and passers. In the operation of the plant, the risks exist in the operation of machinery and, to the plant staff, sanitation or health risk in handling the raw materials.

2.6.2 Construction and Operation of Compost/RDF Plant

(1) Outline of Compost/RDF Plant Project

Location of Construction Site	: East side of Bhakhraywali Landfill Site
Site Area	: 7ha
Plant Capacity (Compost Plant)	: 250t/day

Plant Capacity (RDF Plant)	: 250t/day
Plant System (Compost Plant)	: Pre-treatment and windrow type composting process
Plant System (RDF Plant)	: Pre-treatment and bailing process
Input Material (Compost Plant)	: Separated organic waste
Input Material (RDF Plant)	: Separated combustible waste (plastics &Paper)

(2) Environmental and Social Impact Elements of Compost/RDF Plant

Air Quality

Similar conditions as the construction of compost plant.

Water Quality

Similar conditions as the construction of compost plant.

Odour

Similar conditions as the construction of compost plant. Input raw materials to the RDF plant and segregated combustible materials have less odour impact compared with the raw materials for the compost plant.

Working Conditions

Similar conditions as the construction of compost plant. Segregated combustible materials have less odour impact compared with the raw materials for the compost plant.

2.6.3 Construction and Operation of New Final Disposal Facility at Bhakhraywali

(1) Outline of New Final Disposal Facility at Bhakhraywali

Location of Construction Site	: Bhakhraywali, northwest of the city, approximately 11km from the city centre
Site Area	: 26ha (First phase)
Incoming Waste Amount	: 1,000t/d in 2018, 1,500t/d in 2024 and 2,000t/d in 2030
Type of Incoming Waste	: Municipal solid waste (Residual waste)
Type of Landfill	: Semi-aerobic type sanitary landfill

(2) Environmental and Social Impact Elements of New Final Disposal Facility at Bhakhraywali

Air Quality

Similar to other construction projects, dust is generated during the construction work. The construction works, especially earth works for the construction of waste containment and roads will cause the dust problem. The surface soil in the project site consists of sandy silt to silty sand, and the small particles of the surface soil is easily blown by the wind and suspended in the air.

The landfill facility does not have a process of exhausting air pollutants. However, the biodegradable waste in filled waste turn to landfill gasses in the course of degradation. Landfill gasses include carbon dioxide and/or methane gas, which is a cause of global warming.

Water Quality

During the construction phase, wastewater discharge from kitchen, toilet and bath will become a potential source of water contamination in the neighbouring area. In the operation phase, similar conditions as the construction phase can be seen, so that wastewater discharge from toilets and bath by plant operation staff will be the potential source of water contamination. In addition, wastewater or leachate is generated from the waste layer which may bring water pollution.

Soil Contamination

In the operation phase, domestic hazardous waste mixed with municipal solid waste will have a potential to cause underground soil contamination.

Noise and Vibration

A large number of construction machinery and vehicles are deployed during the construction period. These construction machinery and vehicles will be the sources of noise and vibration in daytime. In the operation phase, collection vehicles in/out from the disposal site and landfill machinery will be the potential sources of noise and vibration.

Odour

The construction work will not be the source of odour. In the operation phase, the decomposition of organic waste in incoming disposal waste will be a potential source of odour.

Management of Abandoned Site

Even after completion of landfill operation, the environmental impact represented by leachate and landfill gases remain for years.

Landscape

Configuration of the land will change from cultivated land to landfill site. At the completion of landfill operation, the landfill area will be higher than the surrounding area.

Working Conditions

Accidents involving the construction workers and the passers by such events as falling objects, collapse of temporary work, and miss-operation of construction machinery always exist during the construction work. In landfill operation, there exist the risks of accidents by landfill machinery and health and sanitation risks to the operation staff handling the wastes.

Waste Pickers in Landfill Site

If the waste pickers are allowed access to the landfill area, work accidents and health risks are assumed to be caused by poor work environment in the working area.

2.6.4 Improvement Works for the Existing Landfill Facility in Gondlanwala

(1) Outline of Existing Landfill Facility in Gondlanwala

Location of Construction Site	: Gondlanwala, north of the city, approximately 10km from the city centre
Site Area	: 5ha
Incoming Waste Amount	: 660t/d in 2016, 830t/d in 2017
Type of Incoming Waste	: Municipal Solid Waste
Type of Landfill	: Controlled open dumping

(2) Environmental and Social Impacts of the Existing Disposal Facility in Gondlanwala

Air Quality

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Water Quality

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Soil Contamination

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Noise and Vibration

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Odour

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Management of Abandoned Site

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Living and Livelihood

There are two residential houses located in the area adjacent to the landfill site. Families who reside in these houses will suffer to some extent from the construction work and landfill operation.

Landscape

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Working Condition

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Waste Pickers in Landfill Area

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

2.6.5 Closure of the Former Landfill Site in Chianwali

(1) Outline of Former Landfill Site in Chianwali

Location of Construction Site	: Chianwali, south of the city, approximately 14km from the city centre
Site Area	: 5ha
Incoming Waste Amount	: Landfill operation finished
Type of Filled Waste	: Municipal Solid Waste
Type of Landfill	: Open dumping

(2) Environmental and Social Impacts of Former Landfill Site in Chianwali

Air Quality

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Water Quality

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Soil Contamination

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Noise and Vibration

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Odour

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Management of Abandoned Site

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

Landscape

Positive effect is envisaged due to final earth cover and safe closure work.

Working Condition

Similar conditions as the construction work of new landfill facility in Bhakhraywali.

2.7 Impact Assessment and Review of the Proposed Project

In this **Section 2.7**, the preliminary impact assessment is carried out for the environmental impact elements discussed in **Section 2.6** and the appropriateness of the selected Master Plan Option B is described in terms of environmental and social considerations.

2.7.1 Impact Assessment of Each Project

Impacts from the project in the construction and operation phases have been evaluated. Impacts in the current situation as well as in the situation that possible measures are implemented were also considered. Major lingering impacts, both negative and positive, are summarised below.

(1) Construction and Operation of Central Compost Plant

Construction Phase: Similar to the construction work of compost plant, the most negative impact will be the dust problem. Surface water contamination by staff quarters and working condition of the construction workers will also cause impacts to the project. On the other hand, the increase of employment opportunity and community development will be the positive impacts.

Operational Phase: Odour, as well as noise and vibration by incoming vehicles will cause environmental impacts to the plant operation. On the other hand, employment opportunity will be the positive impact.

(2) Construction and Operation of Central Compost/RDF Plant

Construction Phase: The most negative impact will be the dust problem. In addition, surface water contamination and working condition of construction workers will also be the cause of impact to the project. On the other hand, the increase of employment opportunity and community development will be the positive impacts.

Operational Phase: Odour due to the handling of organic waste will be the most negative impact. In addition, noise and vibration by incoming vehicles will also be the cause of environmental impact to the plant operation. On the other hand, employment opportunity will be the positive impact.

(3) Construction and Operation of New Final Disposal Facility at Bhakhraywali

Construction Phase: The most negative impact will be the dust problem. In addition, surface water contamination by staff quarters, noise and vibration by construction machinery, and working condition of workers will be the causes of environmental and social problems. On the other hand, the increase of employment opportunity and community development will be counted as positive impacts.

Operational Phase: Leachate and odour will be the environmental impacts most in need of appropriate measures. Working at the disposal site will increase the risk of accidents and health problems to the landfill operation workers and the waste pickers. On the other hand, employment opportunity will be the positive impact.

(4) Improvement Works of Existing Landfill Facility in Gondlanwala

Construction Phase: Similar to the construction work of new landfill facility in Bhakhraywali, the negative impact will be the dust problem, surface water contamination, noise and vibration, and the working condition of construction workers. On the other hand, the increase of employment opportunity and community development will be the positive impacts.

Operational Phase: Similar to the landfill operation at the new landfill facility in Bhakhraywali, the major environmental and social impacts will be generated from leachate, odour, risks of accidents, and health of the landfill operation staff and waste pickers. On the other hand, employment opportunity will be the positive impact.

(5) Closure of Former Landfill Site in Chianwali

Construction Phase: The most negative impact will be the dust problem. In addition, surface water contamination, noise and vibration, and working condition of the construction workers will also give impacts to the environment and the people. On the other hand, the increase of employment opportunity will be the positive impact.

Post-Closure Phase: Groundwater contamination by leachate will be the most negative impact. In addition, the generation of landfill gasses and soil contamination by domestic hazardous waste will be considered as the environmental and social impact. On the other hand, the safe closure with final earth cover and fencing will give positive impacts.

2.7.2 Review of Impact Assessment in Environmental and Social Aspects

This subsection describes the environmental and social considerations carried out for the Master Plan Option B that has been selected as the optimum option through the technical, economic and financial evaluation. Firstly, the components of Option B, specifically, Composting, RDF and Final Disposal, are evaluated in environmental and social aspects. Secondly, the evaluation of Option B in terms of environmental and social considerations is summarised.

(1) Construction and Operation of Central Compost Plant

Composting has a good impact to the natural and social environment. Since organic waste is biodegraded by the composting procedure, the amount of waste will be reduced. Reduction of the amount of organic waste contributes to the reduction of negative environmental impact and environmental load in the landfill site. Less amount of organic waste means less generation of odour, vectors and methane gas in the landfill site. These make the lifetime of landfill site longer.

Another feature of composting is the utilisation of local resources. Currently, it is planned that 125 tons of compost will be produced by 250 tons of organic waste in the proposed compost facility. Using natural compost is environmentally friendly, and soil contamination by agricultural activities may be avoided compared to the use of chemical fertilizers. However, the use of natural compost in agriculture is not currently popular in Gujranwala, so that awareness campaign and the development of end-market are necessary.

Basically, compost facilities are environmentally safe and have no specific risk in the working process, but odour, especially the odour of ammonia, would be a problem. This problem must be carefully considered in case a compost facility is constructed in a residential area. However, in the proposed Option B, the composting facility is constructed in the compound of the landfill site, and the site is distant from the neighbouring community. Therefore, odour from the compost facility would not be a problem to the residents in the situation of Option B.

For the application of compositing in ISWM, separate collection at the waste generation point is preferably applied in advance. Organic wastes collected separately could be applied to the composting process directly. On the other hand, collecting organic waste in mixed waste takes time and requires additional working process and labour force. Mixed wastes waiting to be separated have to be carefully handled; otherwise, they will cause the problem of odour and dirty environment.

(2) Construction and Operation of RDF Plant

RDF has a good feature for waste management. It has a positive impact to waste management and contributes to the utilisation of local resources because the RDF process transforms useless material into solid fuel. In addition, introducing the new system like RDF may stimulate residents' interest on solid waste management. RDF also requires separate collection in advance because the production of RDF utilises the waste that remains after organic materials are separated.

There are some difficulties in the operation of RDF facilities. The famous negative impact of RDF is the generation of dioxin in the production process. Since RDF is a relatively new technology, producing RDF is high-cost and the quality of RDF is relatively low compared to other solid fuels. End market for the sale of RDF and the customers must be carefully considered because RDF is not competitive in the market with regard to quality as solid fuel.

The storage of RDF must be carefully controlled because it has the possibility of causing fire accidents. Once a fire happens in the storage, its extinction will take a long time and dangerous since RDF is a type of fuel.

It is strongly recommended that difficulties are discussed with the Lahore Compost, the compost company that is operating the RDF plant in Lahore, before implementation of the RDF facility in Gujranwala.

(3) Construction and Operation of New Final Disposal Site at Bhakhraywali

Although the proposed construction site is surrounded by farmland, the final disposal site at Bhakhraywali is located in a remote area away from the residential area, which is the most important factor for siting a construction site. The landfill facility is designed as what is called as sanitary landfill.

A sanitary landfill is superior to the conventional landfill types practiced in Pakistan. The introduction of sanitary landfill is required to minimise the environmental and social impacts, and it becomes possible to realise the functions of the facilities and to practice suitable landfill management.

The basic requirements for designing the proposed sanitary landfill facility in order to mitigate the impacts caused by the project are as follows:

- Waste containment, approach road and unloading platform for waste vehicles;
- Perimeter road for monitoring, inspection and maintenance of the facilities;
- Perimeter drainage to prevent surface runoff from entering the landfill containment;
- Liner system to prevent leachate infiltration into the groundwater aquifer;
- Leachate collection and circulation system for evaporation within the landfill area;
- Buffer zone and peripheral wall to separate the landfill area from the public road; and
- Buildings for site office, weighbridge equipment, parking, etc.

The landfill operation is to be carried out in accordance with the requirements in the Operation Manual to be prepared by GWMC, and regulated on a daily, weekly and monthly basis. The contents of the Operation Manual shall include, at least, the following:

- Incoming waste control for measuring, recording and analysis of waste disposal;
- Designation of landfill area for the day, week and month;
- Regular earth covering work;
- Control of leachate circulation system;
- Control of odour;

- Control of landfill gases;
- Regular health check of the landfill operation staff;
- Regular monitoring and maintenance of the facilities; and
- Environmental monitoring in the site and the surrounding area.

These functions and operation works shall be assured by at least one supervisor and inspector(s) deployed for the monitoring, inspection and restoration of defective works and operation to meet the requirements for the sanitary landfill.

By fulfilling the proposed means, the sanitary landfill in Bhakhraywali could be a successful model for introduction to other municipalities in Punjab and in the whole country of Pakistan.

(4) Improvement Works and Closure of Existing Landfill Site in Gondlanwala

According to the result of the interview survey conducted in the E&S Survey, opinions of the stakeholders in the vicinity of the Gondlanwala and the Chianwali disposal sites are similar. The opinions of stakeholders represented by neighbouring residents, GWMC staff and waste pickers are summarised in the following paragraphs.

All stakeholders in both sites answered that they have experienced problems related to the disposal site. Dirty access roads, odour and flies, and environmental pollution especially groundwater degradation are the common responses. In terms of benefit derived from the waste collection system, a majority recognise that the disposal site is beneficial for Gujranwala, and the benefit is "Collection system keeps avoiding the waste from spreading around" and "Waste does not have to be treated or carried to any disposal point by each household separately." On the other hand, some negative opinions were also recorded such as "It (disposal site) creates environmental problems."

With regard to the management staff of GWMC, the major opinion is addressed to the current situation that no soil cover to the site deteriorates the landscape and the bad quality of the sprayed insecticide.

The issue on waste pickers is common to solid waste management in developing countries. It is estimated that 35 to 40 waste pickers work regularly in the current disposal site at Gondlanwala. Their working environment is dangerous: They do not have protective gear, such as gloves and proper shoes, and the dirty environment increases their health risk (The World Bank, 1999).

Since waste pickers do not have an alternative way to earn, they go back to work in the disposal site although the authorities prohibit their activity. Many efforts trying to drive them away without giving alternative income sources had resulted in failure in other developing countries. Therefore, in order to consider the long-term solution, supporting efforts will be required to cope with the waste pickers issue instead of just trying to drive them away from the project site.

In fact, there are many difficulties to improve the existing landfill to a satisfactory condition due to the current situation under the widely spread landfill area. However, the proposed improvement plan will be effective to mitigate the environmental and social impacts to the minimum level. The improvement plan is to be carried out similarly with the development plan for the Bhakhraywali sanitary landfill system.

The basic measures for the improvement or construction of the landfill facilities are as follows:

- Prevention of surface runoff from entering the landfill containment;
- Collection of leachate and its circulation/evaporation within the landfill area; and
- Installation of landfill gas vent.

Similar to the landfill operation proposed for Bhakhraywali, the landfill operation at Gondlanwala shall be improved through the regulation of daily, weekly and monthly operation, monitoring and

maintenance. By technical and operational measures, the environment of Gondlanwala landfill site will be revived and the complaints of stakeholders described above resolved.

The improvement works for the existing landfill at Gondlanwala could be a successful model of mitigating the environmental and social problems for dissemination to other municipalities in Punjab and in the whole of Pakistan.

(5) Closure of Former Landfill Site in Chianwali

The former landfill in Chianwali is situated along the G.T. Road which goes into the city of Gujranwala, and discarded waste heaps are easily visible from the passing vehicles. Although the foul odour from the abandoned disposal site has decreased with the passage of time, organic matter in the filled waste layer has not decomposed completely and it still has the nature to cause odour and leachate problems.

In order to mitigate these problems, the site should be closed properly by implementing/installing the following major works/facilities to prevent it from generating the pollution source:

- Grading of the site and execution of final earth cover;
- Installation of landfill gas vents;
- Construction of premise road for maintenance and monitoring;
- Installation of leachate collection pipes, leachate pump well and leachate circulation piping; and
- Improvement of peripheral wall.

Regular environmental monitoring has to be carried out to check the degree of environmental impact for the consideration of necessary countermeasures for repair and restoration of the installation.

Appearance of the site will be improved drastically through the safe closure of the abandoned landfill site, and maintained through the monitoring plan.

2.7.3 Overall Evaluation of Selected Master Plan Option B

Option B has a great combination of the processes involved in waste management: separate collection, composting, and RDF. In this combination, the following good features are expected, and some issues need to be considered for reducing any negative impact in future.

(1) Expected Positive Impacts

- The technical process mutually contributes to each other in such that separate collection contributes to the easiest application of waste to composting/RDF, and composting/RDF utilises separated waste to make useful materials such as natural compost and one type of fuel;
- This combination effectively contributes to reduction of amount of waste;
- It reduces negative environmental impact such as odour, vectors and methane gas;
- It makes life longer for the final disposal site;
- Separate collection and composting are not environmentally harmful and have no serious negative impact;
- Composting/RDF contributes to utilisation of local materials;
- Using natural compost in agriculture will contribute to reduction of environmental load compared to chemical fertilizer;
- Separated waste is easy to control compared to mixed waste; and

- Separated organic waste reduces generation of odour and vectors.

(2) Issues for Consideration

- The effectiveness of the combination depends on the residents' cooperation regarding waste separation at household level. Awareness and environmental education become very important;
- Development of end-market of natural compost produced by the compost facility and RDF is necessary; and
- Generation of dioxin and other difficulties in the production of RDF is to be controlled before the implementation of RDF in Gujranwala.

2.8 Stakeholder Meeting

2.8.1 First Stakeholder Meeting

The first stakeholder meeting was held on 23 September 2014 at Mugal Mahal Hotel in Gujranwala (**Photo H.2.2**).

A summary of the meeting is shown in **Table H.2.17**. In addition to the major stakeholders who are landowners and residents in the project site, related organizations participated in the meeting. Contents of the Project, current situation of waste management in Gujranwala, and point of environmental and social considerations in the Project were discussed at the meeting. According to the discussions, stakeholders are interested in the direction of waste management in Gujranwala.

Photo H.2.2 First Stakeholder Meeting,

Table H.2.17 Summary of the First Stakeholders Meeting, Mugal Mahal Hotel, 23 September 2014

Date and Venue	23 September 2014 Mugal Mahal Hotel, Gujranwala
Type of Participants (Participating Organizations)	Residents/Landowners in the project site, Gujranwala Waste Management Company (GWMC), JICA Pakistan Office, City District Government Gujranwala (CDGG), Local NGOs
Number of Participants	32 people
Presentation Title	- Project Introduction [Dr. Haq, Managing Director of Gujranwala Waste Management Company (GWMC)] - Brief Overview of the JICA Project for Integrated Solid Waste Management in Gujranwala (Mr. Takasugi, JICA Expert for Final Disposal Plan) - Applying JICA Environmental Checklist for Waste Management (Ms. Tsutsui, JICA Expert for Environmental and Social Considerations)
Discussion/List of questions from the participants (selected)	- Will GWMC implement the JICA Master Plan and what can be the constraints for its implementation? - What is the status of dumpsites? - How will GWMC utilise waste in future? - What is the plan of GWMC for at-source separation? - Which step has GWMC taken for better unloading of waste by handcarts into the waste containers? - What is GWMC's strategy to avoid waste littering during transportation and to guide the sanitary workers at their assigned duty place? - What are the plans to monitor sanitary workers by operational staff?

2.8.2 Second Stakeholder Meeting

The second stakeholder meeting was held at Rachna Hotel in Gujranwala on the 9th of June 2015 to explain the contents of the master plan (**Photo H.2.3**).

A summary of the meeting is shown in **Table H.2.18**. From the project side, contents of the Project, collection and transportation plan, and disposal plan in the Project were discussed at the meeting. Sustainability and management policy of GWMC were mainly asked from the attendees. At the end of the meeting, the Urban Unit appreciated GWMC's great effort for capacity building in the last one year.

Photo H.2.3 Second Stakeholder Meeting, Rachna Hotel, 09 June 2015

Table H.2.18 Summary of the Second Stakeholders Meeting, Rachna Hotel, 9 June 2015

Date and Venue	09 June 2015 Rachna Hotel, Gujranwala
Type of Participants (Participating Organizations)	- Gujranwala Waste Management Company (GWMC) - Landowners - Representative/residents of UC (Gondlanwala) - JICA Pakistan Office - Lahore Waste Management Company (LWMC) - Urban Unit - City District Government Gujranwala (CDGG) - Local NGOs, Consulting companies, etc.
Number of Participants	79 people
Presentation Title	- Outline of the project (Mr. Maeda) - Collection and transportation plan presentation (Mr. Nakamura) - Disposal Plan Presentation (Mr. Takasugi)
Discussion/List of questions from the participants (selected)	- Would the JICA Project be sustainable with political influence? - How will the involvement of sanitary workers as the basic unit of SWM system be ensured? - What procedure is being followed by GWMC?

3. PLANNING DIRECTIONS OF ENVIRONMENTAL MONITORING PLAN

3.1 Objective

The objective of the Environmental Monitoring Plan is to monitor the environmental quality to avoid new negative impacts which might be caused by the disposal sites, and mitigate current negative impacts of the disposal sites to the social and natural environment in Gujranwala.

3.2 Planning Policy

- Environmental monitoring shall be practiced for not only the proposed landfill site at Bhakhraywali, but also the current disposal site at Gondlanwala and the abandoned disposal site at Chianwali.
- Environmental monitoring shall be carried out in long-term perspective.

3.3 Planning Strategy

- A system of environmental monitoring should be established and implemented.
- Practical and initial solid waste recycling activities should be carried out with the inclusion of waste pickers' activities.

4. FORMULATION OF ENVIRONMENTAL MONITORING PLAN

4.1 Necessity of Environmental Monitoring

Environmental management is essential to specify the monitoring work for finding problems and improvement points predictable at the disposal sites of Bhakhraywali, Gondlanwala and Chianwali, collection and transport, and composting. Contents of monitoring and implementation schedule are given at the end of this section.

Regarding the new landfill site at Bhakhraywali, GWMC, the agency responsible for landfill management, shall prepare the quarterly environmental compliance and project performance reports in order to foresee the environmental and social impacts of the new landfill site. Major issues of the internal reports shall be health, safety, and environmental performance of the landfill site. The reports must be filed as a part of project archives and the environmental database as an EIA Report. EIA is required for the construction of the final disposal site, and construction of the proposed compost/RDF plant may require an EIA/IEE, although the Environment Protection Department (EPD) of Punjab will be the final judge.

In the EIA, specific environmental monitoring items (**Table H.4.1**) are recommended to be measured by professional environmental consultancy. Proposed items are air quality, water quality, noise level, smelly gas (landfill gasses), treated wastewater effluent, leachate, vegetation/plantation, and safety and traffic. Most of these items should be monitored quarterly except vegetation and plantation, as well as safety and traffic that are measured annually as shown in **Table H.4.1**. Reference of standards is "National Environmental Quality Standard, Pakistan (NEQS)" and "National Standards for Drinking Water Quality (NSDWQ)" (**Figure H.4.1**, **Table H.4.2**). This proposed plan seems to be an operation phase of the proposed landfill site.

However, details of the Environmental Monitoring Plan are not shown in the EIA report. One of the proposed Environmental Monitoring in the landfill site is described in the following **Section 4.2**.

Table H.4.1 Environmental Monitoring Plan Proposed in EIA Report for Bhakhraywali

Environmental Component	Parameters	Standard	Frequency
Ambient Air Quality	SPM, PM_{10}, SO_2, NO_2, CO, CO_2, Vapours	NEQS NSDWQ	Quarterly
Groundwater Quality	pH, Temperature, TDS, Conductivity, Fluoride, Nitrate, DO, Hardness, Turbidity, Colour, Chloride, Arsenic, etc.	NEQS NSDWQ	Quarterly
Noise Level	dB(A)	N/A	Quarterly
Smelly Gases (Landfill Gases)	SO_2, H_2S, CH_4	NEQS	Quarterly
Treated Wastewater Effluent	BOD, COD, TOC, TSS, DO, Chloride, Sulphate, Turbidity, Conductivity, Oil and Grease, Colour, TKN, Heavy metals	NEQS	Quarterly
Leachate	BOD, COD, TOC, TSS, DO, Chloride, Sulphate, Turbidity, Conductivity, Oil and Grease, Colour, TKN, Heavy metals	NEQS	Quarterly
Vegetation and Plantation	Visual inspection of plant species survival rate and status of maintenance	N/A	Annual Report
Safety and Traffic	1) Inspection of Signage 2) Faulty, overloaded and speeding of vehicles	N/A	Annual Report

NEQS: National Environmental Quality Standard, Pakistan
NSDWQ: National Standards for Drinking Water Quality
N/A: Not applicable
Source: EIA Report

National Environmental Quality Standards for municipal and liquid industrial effluenets (mg/l, unless otherwise defined)

Serial No.	Parameter	Existing Standards	Revised Standards		
			Into Inland Waters	Into Sewage Treatment	Into Sea
1	Temperature / Temperature increase*	40°C	≤3°C	≤ 3°C	≤ 3°C
2	pH value	6-10	6-9	6-9	6-9
3	5-days Biochemical Oxygen Demand (BOD) at 20°C. (1)	80	80	250	80**
4	Chemical Oxygen Demand (COD) (1)	150	150	400	150
5	Total suspended solids	150	200	400	200
6	Total dissolved solids	3500	3500	3500	3500
7	Grease and oil	10	10	10	10
8	Phenolic compounds (as phenol)	0.1	0.1	0.3	0.3
9	Chloride (as Cl)	1000	1000	1000	SC
10	Fluoride (as F)	20	10	10	10
11	Cyanide (as CN) total.	2	1	1	1
12	An-ionic detergents (as MBAS) (2)	20	20	20	20
13	Sulphate (SO_4)	600	600	1000	SC
14	Sulphide (S)	1.0	1	1	1
15	Ammonia (NH_3)	40	40	40	40
16	Pesticides, herbicides, fungicides and insecticides (3)	0.15	0.15	0.15	0.15
17	Cadmium (4)	0.1	0.1	0.1	0.1
18	Chromium (trivalent & hexavalent) (4)	1.0	1	1	1
19	Copper (4)	1.0	1	1	1
20	Lead (4)	0.5	0.5	0.5	0.5
21	Mercury (4)	0.01	0.01	0.01	0.01
22	Selenium (4)	0.5	0.5	0.5	0.5
23	Nickel (4)	1.0	1	1	1
24	Silver (4)	1.0	1	1	1
25	Total toxic metals	2.0	2	2	2
26	Zinc	5.0	5	5	5
27	Arsenic (4)	1.0	1	1	1
28	Barium (4)	1.5	1.5	1.5	1.5
29	Iron	2.0	8	8	8
30	Manganese	1.5	1.5	1.5	1.5
31	Boron (4)	6.0	6	6	6
32	Chlorine	1.0	1	1	1

1. Summing minimum dilution 1:10 on discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. By 1:10 dilution means for example, that for each one cubic meter of treated effluent the recipient water body should have 10 cubic meter of water for dilution of this effluent.
2. Modified Benzene Alkyl Sulphate; assuming surfactant as bio-degradable.
3. Pesticides. herbicides, fungicides, and insecticides.
4. Subject to total toxic metals discharge.
5. Applicable only when and where sewage treatment is operational and BOD5=80 mg/l is achieved by the sewer treatment system.
6. Provided discharge is not at shore and not within 10 miles of mangrove or other important estuaries.

SC Discharge concentration at or below Sea concentration.

* The effluent should not result in temperature increase of more than 3C at the edge of the zone where initial mixing and dilution take place. In case zone is not defined, use 100 meters from the point of discharge.

Note: Dilution of gaseous emissions and liquid effluents to bring them to the NEQS limiting value is not permissible through excess air mixing/blowing in to the gaseous emissions or through fresh water mixing with the effluent before discharge into environment.

** The value of BOD and COD is 200 and 400 respectively

National Environmental Quality Standards for industrial gaseous emission (mg/nm3 unless otherwise defined)

Serial No.	Parameter	Source of Emission	Existing Standards.	Revised Standards
1	Smoke (1)	Smoke opacity not to exceed	40% or 2 (Ringlemann scale)	40 %
2	Particulate matter (2)	Boilers and furnaces:		
		(i) Oil fired.	300	300
		(ii) Coal fired.	500	500
		(iii) Cement Kilns.	200	200
		Grinding, crushing, clinker coolers and related processes, metallurgical processes, converter, blast furnaces and cupolas	500	500
3	Hydrogen Chloride (3)	Any.	400	400
4	Chlorine (3)	Any.	150	150
5	Hydrogen fluoride (3)	Any.	150	150
6	Hydrogen sulphide (3)	Any.	10	10
7	Sulphur Oxides	Sulphuric acid plant	400	5000
		Others.		1700
8	Carbon monoxide (3)	Any.	800	800
9	Lead (3)	Any.	50	50
10	Mercury (3)	Any.	10	10
11	Cadmium (3)	Any.	20	20
12	Arsenic (3)	Any.	20	20
13	Copper (3)	Any.	50	50
14	Antimony (3)	Any.	20	20
15	Zinc (3)	Any.	200	200
16	Oxides of Nitrogens	Nitric acid manufacturing unit.	400	3000
		Gas fired.	400	400
		Oil fired		600
		Coal fired		1200

1. Or 2 on the Ringlemann scale
2. Based on the assumption that the size of the particulates is 10 micron or more.
3. Any source
4. In respect of emissions of sulphur dioxide and nitrogen oxides, the power plants operating on oil or coal as fuel shall, in addition to national Environmental Quality Standards (NEQS) specified above, comply with the following standard.

Sulphur dioxide and nitrogen oxide ambient air requirements

A. SULPHUR DIOXIDE

Sulphur Dioxide Background Levels (ug/m3)

Background Air Quality (SO_2 Basis)	Annual Average (ug/m3)	Max. In 24 Hour Interval (ug/m3)	Standards: Criterion I — Max. SO_2 Emission (Tons/day/ Plant)	Standards: Criterion II — Max. Allowable Ground Level Increment To Ambient (One year average, ug/m^3)
Unpolluted	<50	<200	500	50
Moderately Polluted*				
Low	50	200	500	50
High	100	400	100	10
Very Polluted**	>100	>400	100	10

* For intermediate values between 50 and 100 µg/m^3 linear interpolations should be used

** No project with sulphur dioxide emissions will be recommended

B. NITROGEN OXIDES

Ambient air concentrations of nitrogen oides, expressed as NO2, should not exceed the following:-

Annual Arithmetic Mean	100 ug/m3 (0.05 ppm)

Emission levels for stationary sources discharges, before mixing with the atmosphere, should be maintained as follows:

For fuel fired stream generators, as nanogram (10E-9 gram) per joule of heat input:

Liquid fossil fuel	130
Solid fossil fuel	300
Lignite fossil fuel	260

Figure H.4.1 National Environmental Quality Standard, Pakistan (NEQS)

Table H.4.2 National Standards for Drinking Water Quality (NSDWQ)

Bacterial			
PROPERTIES /PARAMETERS		**STANDARD VALUES FOR PAKISTAN**	
All water intended for drinking (e.Coli Or Thermotolerant Coliform Bacteria)		Must not be detectable in any 100 ml sample	
Treated water entering the distribution system (E.Coli or thermos tolerant coliform and total coliform bacteria)		Must not be detectable in any 100 ml sample	
Treated water in the distribution system (E.coli or thermos tolerant coliform and total coliform bacteria)		Must not be detectable in any 100 ml sample In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12- month period.	
Physical			
PROPERTIES /PARAMETERS	**STANDARD VALUES FOR PAKISTAN**	**PROPERTIES /PARAMETERS**	**STANDARD VALUES FOR PAKISTAN**
Colour	≤15 TCU	Total hardness as CaCO3	< 500 mg/l
Taste	Non objectionable/Acceptable	TDS	< 1000
Odour	Non objectionable/Acceptable	pH	6.5 – 8.5
Turbidity	< 5 NTU		
Chemical			
Essential Inorganic	***mg/Litre***	***Toxic Inorganic***	***mg/Litre***
Aluminum (Al) mg/1	<0.2	Cyanide (CN)	<0.05
Antimony (Sb)	<0.005 (P)	Fluoride (F)*	<1.5
Arsenic (As)	< 0.05 (P)	Lead (Pb)	<0.05
Barium (Ba)	0.7	Manganese (Mn)	< 0.5
Boron (B)	0.3	Mercury (Hg)	<0.001
Cadmium (Cd)	0.01	Nickel (Ni)	<0.02
Chloride (Cl)	<250	Nitrate (NO3)*	<3 (P)
Chromium (Cr)	<0.05	Selenium (Se)	0.01(P)
Copper (Cu)	2	Residual chlorine	0.2-0.5 at consumer end 0.5-1.5 at source
		Zinc (Zn)	5.0
Radioactive			
Alpha Emitters bq/L or pCi	0.1	Beta emitters	1

4.2 Environmental Monitoring for Final Disposal Site

4.2.1 Monitoring of Leachate and Surface Water

Water quality of leachate and surface water is one of the most important factors in environmental monitoring for the final disposal site and shall be monitored and analysed periodically in order to determine the conditions of the landfill and the potential impact to the environment. The water quality data of leachate can also be used to determine the state of stabilisation of the landfill.

(1) Monitoring Points of Leachate and Receiving Water Body

Monitoring point(s) of leachate shall be the outlet point(s) of leachate from the landfill site and outlet point(s) of leachate treatment facilities and/or recirculation facilities. In addition, several monitoring points shall be determined at the water receiving body to check the influence of

discharge of leachate. The recommended leachate monitoring points are indicated, but not limited to the following sites:

Raw Leachate Quality

- Outflow/Outlet points from the landfill site or influent water of the leachate treatment/recirculation facilities
- Leachate of instantaneous and total flows must be recorded according to the Punjab Solid Waste Management Guidelines (2011).

Treatment/Recirculation of Leachate

- Outlet points of leachate treatment/recirculation facilities or effluent water

Leachate Influence to the Water Receiving Body

- Upstream and downstream side of outfall of leachate to the water receiving body

(2) Sampling/Monitoring Conditions

Leachate quality shall be monitored periodically at the regular sampling points. In addition, the leachate quality under the maximum/minimum flows shall be monitored. Sampling day of leachate for periodical/regular monitoring may be determined as a day after consecutive fine/cloudy days or more than 24 hours after stop of falling rain to minimise the influence of rain.

The conditions of monitoring/sampling shall be recorded to include, at least, the following conditions:

- Name of person in charge
- Name of sampling points
- Date and time
- Weather conditions
- Water temperature and ambient temperature
- Flow rate as required
- Photos of sampling work

Table H.4.3 shows the required parameters described in the EIA report and the recommended parameters as well. The water quality parameters shall be analysed by the accredited laboratory.

Table H.4.3 Parameters for Leachate Monitoring

	Parameters Specified in EIA Report	Recommended Parameters
General Items	COD, BOD_5, Total Suspended Solids, Electric Conductivity, Oil/Grease, Sulphate, Turbidity, Colour, TIN	Water Temperature, pH, Settleable Solids, Total Dissolved Solids, Surfactants (MBAS), Phenolic Substances as Phenols, Total Coliform Count
Heavy Metals	Name of parameters are not specified	Arsenic, Cadmium, Chromium (hexavalent), Cyanide, Lead, Mercury (Tot.), PCB, Formaldehyde

Source: EIA report

(3) Frequency of Monitoring

The minimum frequency of monitoring of leachate is four (4) times in a year or quarterly basis.

4.2.2 Monitoring of Groundwater Quality

Poor lining system and inappropriate leachate control will cause a potential contamination source of groundwater quality. A sign of groundwater contamination appears with the change of water quality parameters. Accordingly, the groundwater quality shall be monitored periodically for the representative water quality parameters, and a series of recorded data analysed to grasp any significant change in groundwater quality.

(1) Monitoring Points of Groundwater

Monitoring of groundwater should consist of the following items according to the Punjab Solid Waste Management Guidelines (2011):

- At least one groundwater monitoring well should be installed hydraulically above the gradient of the landfill and at least three monitoring wells should be installed hydraulically below the gradient direction;
- The monitoring well system should include a sufficient number of multi-level well nests for measurement of vertical gradients;
- Locations of the monitoring wells should be sufficiently close to the active disposal area to allow early detection of contamination and implementation of remedial measures; and
- The monitoring wells are to be retained throughout the lifespan of the facility.

(2) Sampling/Monitoring Conditions

Groundwater quality shall be monitored periodically under the maximum/minimum groundwater table. Special sampling tools shall be used to take the groundwater to meet the types of well and spring. Specified parameters in EIA are pH, Temperature, TDS, Conductivity, Fluoride, Nitrate, DO, Hardness, Turbidity, Colour, Chloride, and Arsenic (see **Table H.4.2**).

(3) Frequency of Monitoring

Frequency of monitoring of groundwater shall be at least on quarterly basis. Water quality parameters shall be determined with reference to the drinking water quality.

4.2.3 Monitoring of Landfill Gasses

Landfill gasses include harmful substances such as hydrogen sulphide, methane gas, etc. Monitoring of landfill gasses is essentially required to protect the health and safety of operation staff and the neighbouring residents. The concentration and odour from the gasses shall be monitored and analysed periodically in order to grasp the condition of the landfill and the potential impact to the environment. The data can also be used to determine the state of stabilisation of the landfill.

(1) Monitoring Points

Monitoring of landfill gasses shall be made at the final disposal site, and the detailed measuring points will be decided in the action plan.

(2) Sampling/Monitoring Conditions

Monitoring of landfill gasses shall be carried out by portable gas detector, sampling at site and laboratory analysis. Special monitoring on a calm day after the rain may be required. The monitoring/sampling conditions shall be recorded in conformity with the requirements stipulated. Parameters specified in the EIA are hydrogen sulphide (H_2S), methane gas (CH_4) and ammonia (NH_3).

(3) Frequency of Monitoring

Frequency of monitoring of landfill gasses shall be, at least, on a quarterly basis. In addition, the daily observation of odour and gas by smelling is important for the operators during implementation of the landfill work.

4.2.4 Monitoring of Odour

The landfill activities should be carried out properly and managed effectively to reduce the emission of the unpleasant odour and minimise the impact to the surrounding residents.

(1) Monitoring Points

The state or degree of unpleasantness can only be determined by smelling the air depending on the prevailing atmospheric conditions. The measurement of odour can only be expressed in distance from the source where the odour can be detected.

(2) Sampling/Monitoring Conditions

The smell or unpleasantness will have to be determined by odour concentration and substance, i.e., how bad it smells and what does it smell like.

(3) Frequency of Monitoring

Offensive odour shall be monitored daily by smelling or as-and-when necessary for some specific offensive odour substances as long as it is not having a major impact or nuisance to the communities.

4.2.5 Monitoring of Noise and Vibration

The landfill activities should be carried out properly and managed effectively to reduce the excessive noise and vibration caused by the vehicles and operation of machinery and landfill equipment. The noise and vibration levels should be minimal and comply with the relevant regulation as set out for the protection of occupational safety and health. The measurement method must be in accordance with internationally accepted protocols and procedures.

(1) Monitoring Points

The noise and vibration monitoring measurement should be carried out at or near the generation source. Other monitoring locations could be along the perimeters of the landfill or at nearby residential areas.

(2) Sampling/Monitoring Conditions

Sampling and monitoring conditions for noise and vibration shall be decided in the action plan.

(3) Frequency of Monitoring

The recommended frequency of monitoring should not be less than once a year. Quarterly monitoring is recommended in the EIA.

4.3 Environmental Monitoring for Post-Closure of Final Disposal Site in Gondlanwala and Chianwali

Post-closure monitoring shall be applied for Gondlanwala and Chianwali sites after the completion of safe closure process. According to the Punjab Solid Waste Management Guideline of 2011, the duration of post-closure monitoring is 25 years, and the specified monitoring items are groundwater, surface

water, landfill gas, and erosion and settlement. Frequency of monitoring is not mentioned in the Guideline, so that it can be suggested as once in a year. Monitoring method and sampling points are the same as those in the operational phase.

4.4 Environmental Monitoring for Collection and Transport Work

For the collection and transport work, a clean environment around garbage containers is important. Dirty environment with garbage scattered around the containers takes more time for collection and transport compared to the container and its neighbouring area kept clean. Another problem is that dirty containers and unsanitary environment around the container can be the origin of foul odour and vectors.

Waste separation at household level is essential for separate collection and intermediate treatment. Practice of waste separation at household level will be gradually increased during implementation of the Master Plan. Therefore, ratio of waste separation at household level has to be recorded periodically, and the monitoring result shall be utilised for the planning of awareness programme.

4.4.1 Monitoring of Cleanness of Garbage Containers

(1) Monitoring Points

All or selected garbage containers in Gujranwala shall be monitored.

(2) Sampling/Monitoring Conditions

Sanitary workers and UC members in each area can be in charge of this monitoring. Problems and feedback shall be given to the residents by the UC members.

(3) Frequency of Monitoring

The recommended frequency of monitoring is daily.

4.4.2 Monitoring of Waste Separation at Household Level

(1) Monitoring Points

Monitoring points shall be selected in urban and peri-urban areas. Different types of areas should be monitored, such as high/low density area.

(2) Sampling/Monitoring Conditions

Samples shall be selected by gender, age, income level, and area.

(3) Frequency of Monitoring

The recommended frequency of monitoring should be annually. Residents practicing waste separation in their household will be interviewed. Whether or not the respondent agrees or disagrees with waste separation, his reason or opinion shall be utilised for the awareness programme.

4.5 Environmental Monitoring for Intermediate Treatment (Compost Facility)

In this section, the environmental monitoring of intermediate processes, especially, about the compost facility is discussed. Basically, the compost facility is harmless to the environment and not dangerous in the labourers working process. However, odour (ammonia, etc.) from the facility shall be monitored.

4.5.1 Monitoring of Odour (Ammonia Odour)

(1) Monitoring Points

The odour of ammonia around the compost facility shall be measured.

(2) Sampling/Monitoring Conditions

The measurement method must be in accordance with the internationally accepted protocols and procedures. Sampling and monitoring conditions for odour will be decided in the action plan.

(3) Frequency of Monitoring

The recommended frequency of monitoring is quarterly, probably the same with the quarterly monitoring in the landfill site.

4.6 Implementation Schedule of Environmental Monitoring Plan

Monitoring is to be implemented in accordance with the schedule shown in **Figure H.4.2**. Timing of monitoring implementation is the same as the timing of service or start of operation.

Time Framework of the Master Plan		Short-Term Plan Period											Mid-Term Plan Period						Long-Term Plan Period					
Year		2016				2017				2018			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4											
WBS for Short-Term Plan																								
S-0-1	Monitoring of Collection and Transport Work																							
S-0-2	Monitoring of Final Disposal Site in Bhakhraywall																							
S-0-3	Monitoring of Post-Closure Final Disposal Sites in Gondlanwala and Chianwall																							
WBS for Mid-Term Plan																								
M-0-1	Monitoring of Collection and Transport Work																							
M-0-2	Monitoring of Final Disposal Site in Bhakhraywall																							
M-0-3	Post-Closure Monitoring of Gondlanwala and Chianwall Landfill Sites																							
M-0-4	Monitoring of Intermidiate Process (Compost Facility)																							
WBA for Long-Term Plan																								
L-0-1	Monitoring of Collection and Transport Work																							
L-0-2	Monitoring of Final Disposal Site in Bhakhraywall																							
L-0-3	Post-Closure Monitoring of Gondlanwala and Chianwall Landfill Sites																							
L-0-4	Monitoring of Intermidiate Process (Compost Facility)																							

Figure H.4.2 Implementation Schedule of the Environmental Monitoring Plan

4.7 Project Cost of the Environmental Monitoring Plan

Table H.4.4 shows the project cost for the Master Plan and **Figure F.4.3** shows the Project Cost and Responsibilities under the Environmental Monitoring Plan.

Table H.4.4 Implementation Cost of the Environmental Monitoring Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 6: Environmental Monitoring Plan																	
Short-Term Plan																	
S-6-1	Monitoring of Collection and Transport Work	GWMC	0	0	0												
S-6-2	Monitoring of Final Disposal Site in Shaikhupurwali	2,455	435	570	1,150												
S-6-3	Environmental Monitoring for Post-Closure Final Disposal Sitein Gondianwala and Chianwali	140	0	0	140												
	Sub-Total	2,595	435	570	1,290	0	0	0	0	0	0	0	0	0	0	0	0
Mid-Term Plan																	
M-6-1	Monitoring of Collection and Transport Work	GWMC				0	0	0	0	0	0						
M-6-2	Monitoring of Final Disposal Site in Shaikhupurwali	8,295				1150	1150	1585	2020	1150	1150						
M-6-3	Environmental Monitoring for Post-Closure Final Disposal Sitein Gondianwala and Chianwali	840				140	140	140	140	140	140						
M-6-4	Monitoring of Intermidiate Process (Compost Facility)	GWMC				0	0	0	0	0	0						
	Sub-Total	9,045				1,290	1,290	1,725	2,160	1,290	1,290						
Long-Term Plan																	
L-6-1	Monitoring of Collection and Transport Work	GWMC										0	0	0	0	0	0
L-6-2	Monitoring of Final Disposal Site in Shaikhupurwali	9,510										1585	2020	1150	1585	2020	1150
L-6-3	Environmental Monitoring for Post-Closure Final Disposal Sitein Gondianwala and Chianwali	840										140	140	140	140	140	140
L-6-4	Monitoring of Intermidiate Process (Compost Facility)	GWMC										0	0	0	0	0	0
	Sub-Total	10,350										1,725	2,160	1,290	1,725	2,160	1,290
	Grand Total	21,990	435	570	1,290	1,290	1,290	1,725	2,160	1,290	1,290	1,725	2,160	1,290	1,725	2,160	1,290

Programme No.	WBS No.	WBS	Legal Action (Required=●)	Name of Act/Regulation/By-law	Budgetary Arrangment (Required=●)	Total Budget (Thousand Rs.)	Responsibility Assignment Matrix: M=Main Responsibility, S=Sub Responsibilities. B=Budgetary Arrangement, L=Legal Action, P=Participation in Discussions																
							GWMC/Operation Unit	GWMC/P&C Unit	GWMC/Financial Unit	GWMC/HR & Administration Unit	City District Government Gujranwala (CDGG)	The Urban Unit, Government of the Punjab	P&D Dept., Government of the Punjab	Local Gov't Dept., Government of the Punjab	Environment Protection Department (EPD)	Donor Organisations	Private Contractors/Consultants	Recyclers	CBOs & NGOs	Waste Pickers	PAPs around Gondianwala Disposal Site	PAPs around Bhakhraywall Disposal Site	Gujranwala Citizens
Programme 6: Environmental Monitoring Plan																							
Short-Term Plan																							
	S-6-1	Monitoring of Collection and Transport Work			●	GWMC	M		B			S						P		P			P
	S-6-2	Monitoring of Final Disposal Site in Bhakhraywall			●	2455	M		B			S					P						
	S-6-3	Monitoring of Post-Closure Final Disposal Site in Gondianwala and Chianwall			●	140	M		B			S					P						
		Sub-Total				2,595																	
Mid-Term Plan																							
	M-6-1	Monitoring of Final Disposal Site in Bhakhraywall				8205	M		B			S					P						
	M-6-2	Post-closure Monitoring of Gondianwala and Chianwall				840	M		B			S					P						
	M-6-3	Monitoring of Collection and Transport Work				GWMC	M		B			S						P		P			P
	M-6-4	Monitoring of Intermidiate Process (Compost Facility)				GWMC	M		B			S					P						
		Sub-Total				9,045																	
Long-Term Plan																							
	L-6-1	Monitoring of Final Disposal Site in Bhakhraywall				9510	M		B			S					P						
	L-6-2	Post-closure Monitoring of Gondianwala and Chianwall				840	M		B			S					P						
	L-6-3	Monitoring of Collection and Transport Work				GWMC	M		B			S						P		P			P
	L-6-4	Monitoring of Intermidiate Process (Compost Facility)				GWMC	M		B			S					P						
		Sub-Total				10,350																	
		Grand Total				21,990																	

Figure H.4.3 Project Cost and Responsibilities under the Environmental Monitoring Plan

5. PROPOSAL FOR ACTION PLANS

5.1 Selection of the Priority Project

Priority projects are defined as the projects for the short-term period of the Master Plan which will be developed into the action plans in this chapter. Based on the detail discussions in **Chapter 4,** the following are selected as the priority projects:

1. Project for Environmental Monitoring of Collection and Transportation Work
2. Project for Environmental Monitoring of Final Disposal Site in Bhakhraywali
3. Project for Environmental Monitoring of Safe Post-Closure of the Final Disposal Sites in Gondlanwala and Chianwali

5.2 Project for Environmental Monitoring of Collection and Transportation Work

5.2.1 Monitoring of Cleanness of Garbage Containers

(1) Objectives of Monitoring

The monitoring process shall be carried out for making well-organized waste collection spaces and keeping clean environment for the following purposes:

- To avoid vector and odour;
- To keep the clean and aesthetic view of the vicinity; and
- To avoid dirty environment with garbage scattered around the containers.

(2) Methodology of Monitoring

(a) Location of Monitoring

The monitoring shall be carried out all over Gujranwala City, but it is actually made at the location of containers. For example, nearly 100 container locations have been identified in Zone 6 and they should be targets for monitoring. The container locations in Zone 6 are as indicated in **Figure H.5.1.**

(b) Monitoring Items

Following items shall be monitored:

- Cleanness of container;
- Whether or not any waste is scattered around the container; and
- Whether waste is separately collected or mixed.

(c) Monitoring Data Collection System

Data shall be collected through everyday inspection of containers by sanitary workers who shall record the situation in the monitoring format prepared by the Operation Unit of GWMC. This activity is to start by the beginning of 2016.

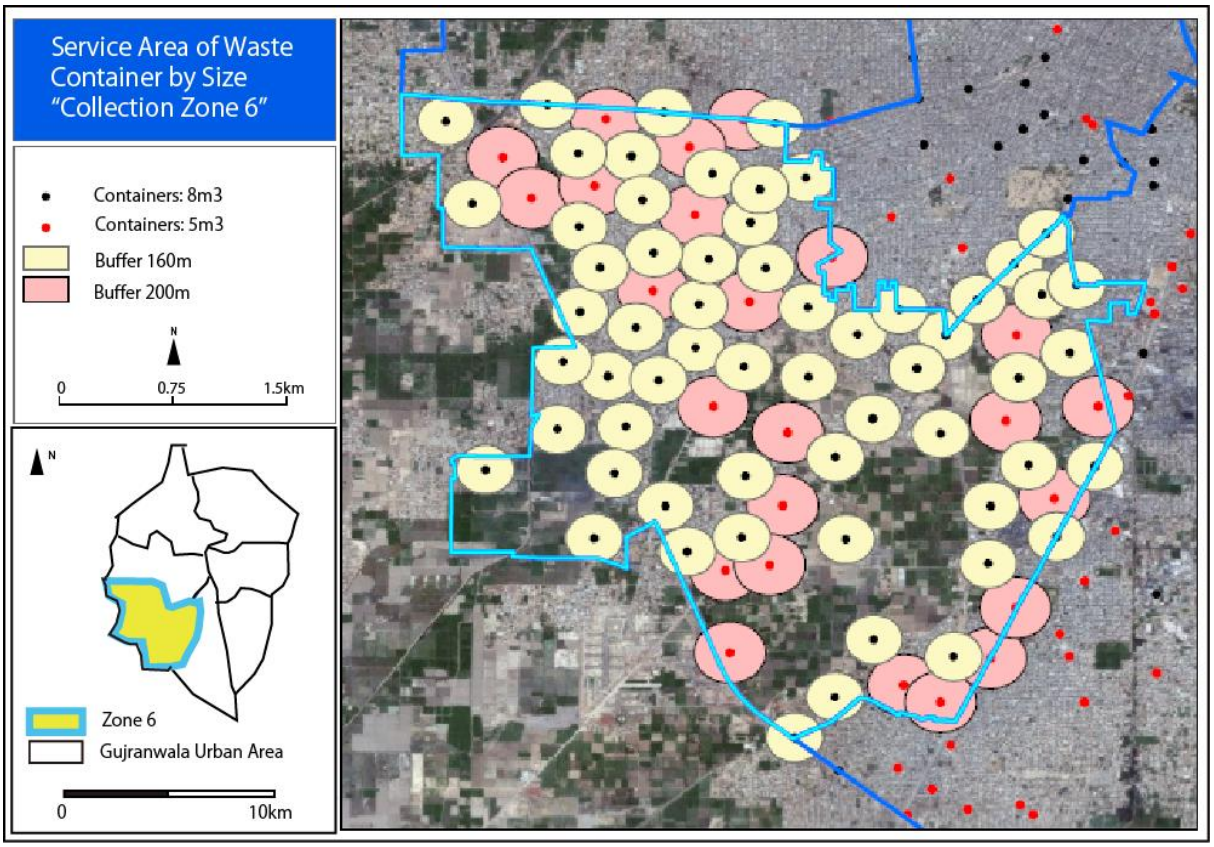


Figure H.5.1 Location Map of Containers in Zone 6 (Base Map: Figure B.5.1)

(d) Monitoring Feedback System

Sanitary workers shall monitor their working areas every day. They shall check the garbage containers in their individual working areas and record the situation in the monitoring format. Inspectors shall check the record, and the record shall be submitted to the Assistant Manager for Operations who should file and control the data. In case the dirty situation of garbage container and its environment is serious, the case shall be reported to the Senior Manager for Operations, and immediate measures should be implemented in a timely manner.

(e) Cost of Monitoring

The monitoring work shall be carried out as part of the daily work of sanitary workers, so that no extra cost is required for its implementation.

5.2.2 Monitoring of Waste Separation at Household Level

(1) Objectives of Monitoring

Waste separation at the household level is an essential issue for building the 3R system that will result in the efficient and effective waste collection and transportation work. However, currently, residents do not have the custom of waste separation, and implementation may have some difficulties and confusion. Therefore, this monitoring shall be conducted with the following objectives:

- To keep records on how households separate wastes in daily life;
- To evaluate the degree of diffusion of waste separation at household level; and

- To utilise the result of the evaluation for the awareness programme formulation.

(2) Methodology of Monitoring

(a) Location of Monitoring

Targets of household monitoring shall be selected all over Gujranwala. As the first stage of monitoring, 100 households shall be selected as monitoring samples from the 64 Urban Union Councils (UCs) that belong to the four major towns, Qila Didar Signh, Khiali Shah Pur, Aroop and Nandi Pur, and 25 households in each town shall be selected.

(b) Monitoring Items

The situation of the residents' waste separation at household shall be monitored. In the Short-Term Period, the monitoring shall focus on three items: (i) Kitchen waste; (ii) Paper and plastic bags; and (iii) Recyclable waste (e.g. valuable metals). Regarding the three items, the following interview questions shall be made:

Q1. How do you keep the three wastes in the house until you throw them away? Are they separately stored or mixed?

Q2. Where do you throw away the three wastes?

Q3. Do you know that (1) Kitchen waste and (2) Paper and plastic bags should be thrown away separately in different containers?

Monitoring items, questions, and expected answers from the residents are shown in **Table H.5.1**.

Table H.5.1 Monitoring Items, Questions, and Expected Answers

Monitoring Item	[Q1] How do you keep the three wastes in the house until you throw them away? Are they separately stored or mixed?	[Q2] Where do you throw away the three wastes?	[Q3] Do you know that (1) Kitchen waste and (2) Paper and plastic bags should be thrown away separately in different containers?
(1) Kitchen waste	(1) and (2) are mixed in waste container in the house	Any container in neighbourhood (do not know the difference of colour or type of container)	No
(2) Paper and plastic bags			
(3) Recyclable waste	Separately stored in the house	Sell to someone who will pay for it	

Note: Expected answers are shown in Italic letter.

(c) Monitoring Data Collection System

This monitoring shall be carried out once a year. The Assistant Manager for Environmental Education shall select the respondents and prepare the questionnaire, and field operation staff members shall conduct the interviews. Data shall be compiled and summarised by the Assistant Manage for Environmental Education and the results shall be submitted to the Senior Manager for Communication. The results of monitoring shall be utilised for the public awareness activities to improve the achievement of separate waste collection.

Since one of the major public awareness programmes is planned in every April, the preparation for monitoring shall be started in January 2016 and the interviews shall be carried

out in January. Preparation for the monitoring shall start in January 2016 and a summary of the results shall be prepared by the middle of March.

(d) Monitoring Feedback System

Monitoring results shall be filed in the Environmental Education Section of the Communication Unit for utilisation in the awareness programmes. After the results are summarised by the Assistant Manager of the Environmental Education Section, the Manager for Communication, together with the Assistant Manager for Communication in GWMC, shall review the results and feedback some of the results to the contents of the public awareness programme.

(e) Cost of Monitoring

This monitoring is to be carried out by GWMC employees, so that no extra cost is required for its implementation.

5.3 Project for Environmental Monitoring of Final Disposal Site in Bhakhraywali

Seven monitoring activities are planned in the project as follows:

- Monitoring of Ambient Air Quality
- Monitoring of Groundwater Quality
- Monitoring of Noise Level
- Monitoring of Landfill Gases
- Monitoring of Treated Wastewater Effluent (Leachate Pond Effluent)
- Monitoring of Leachate (Leachate Pond Influent)
- Monitoring of Vegetation and Plantation
- Monitoring of Safety and Traffic

(1) Objectives of Monitoring

The objectives of the monitoring are as follows:

- To monitor and record the environmental situation in the Bhakhraywali site; and
- To take countermeasures in case any negative impact is recorded, to reduce environmental damage.

(2) Methodology of the Monitoring

Since GWMC does not have a facility for the measurement and analysis of environmental quality, the actual monitoring shall be outsourced to an environmental monitoring laboratory (a private company). GWMC shall manage the contract for the monitoring work, the feedback of monitoring results and documentation. Quarterly monitoring is to be carried out in January, April, July, and October, and annual monitoring in April, which is between the dry season and the rainy season.

(a) Location of Monitoring

Location of monitoring is shown in **Figure H.5.2**. Leachate in leachate pond shall be monitored. Two kinds of groundwater shall be monitored: groundwater from shallow aquifer of about 20m in depth and groundwater from aquifer of about 60m in depth. Considering the water flow of a canal at the north side of the Bhakhraywali site, groundwater may flow from

north to south. Therefore, one pair of sampler shall be set at the north side of the disposal site, one pair around the office and storage, and another pair at the south side of the site. In the north side, the sampling location shall be set 50m away from the office and storage because human drainage water from the office will be mixed in shallow aquifer. Monitoring for vegetation and plantation shall be carried out in the Bhakhraywali site and its vicinity, and monitoring for safety and traffic shall target the access roads to the Bhakhraywali site.

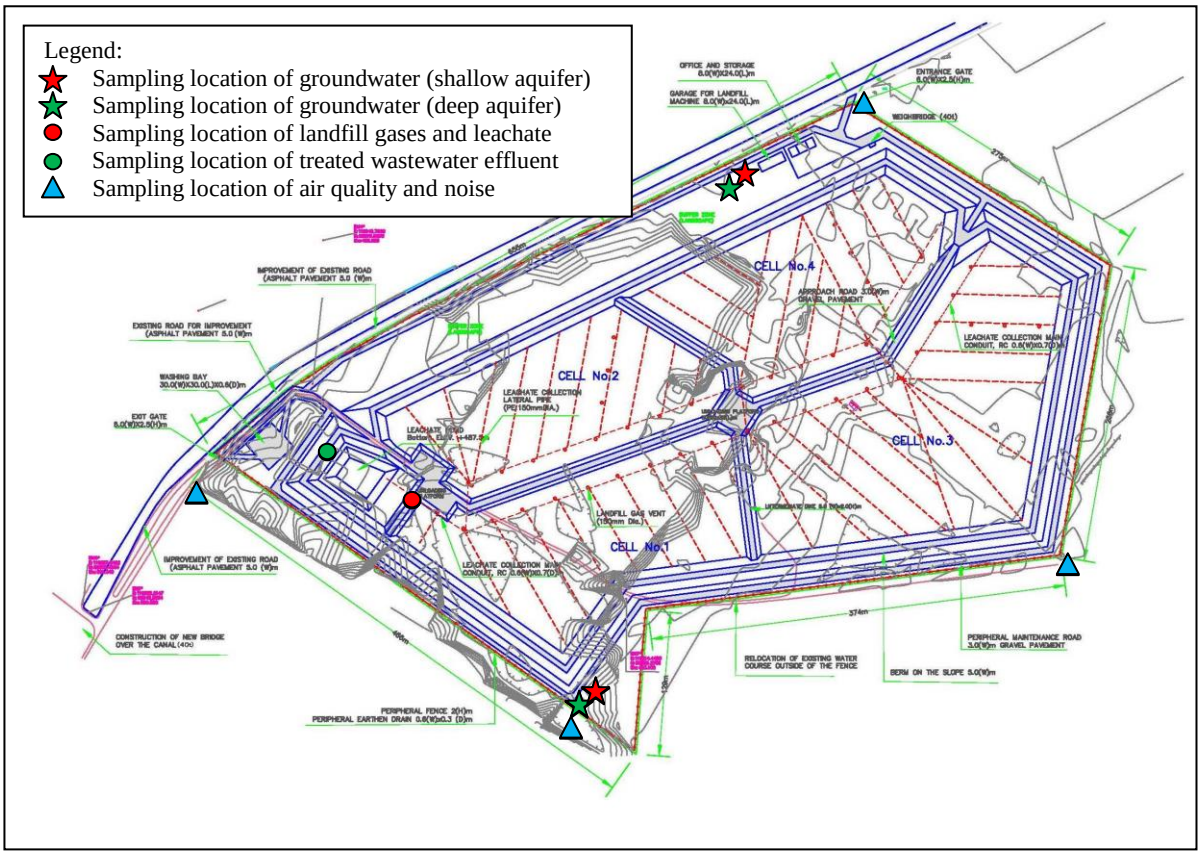


Figure H.5.2 Sampling Locations in Bhakhraywali (Base Map: Figure C.5.2)

(b) Monitoring Items

Table H.5.2 shows the monitoring items in the project.

(c) Monitoring Data Collection System

Data shall be collected by a private environmental laboratory, and the report is to be submitted to the Senior Manager for Operations in GWMC. Frequency of monitoring of the data collection system is 4 times in a year (quarterly) except the "Situation of Vegetation and Plantation" and the "Situation of Safety and Traffic". These two items shall be carried out only once a year since they may not change drastically and, therefore, annual measurements will be enough. All monitoring in the year 2016 will be half since the construction work will start in Bhakhraywali from the second half of 2016.

(d) Monitoring Feedback System

After the result of monitoring is sent to GWMC, the Assistant Manager for Operations shall check the results. If any serious environmental problem is found in the results, the Assistant Manager for Operations shall inform the Senior Manager for Operations and provide a solution in consultation with the Senior Manager for Operations and the other related

managers. In case no major problem is reported, the results shall be reviewed by the Managing Director and filed in the Operation Section.

(e) Cost of Monitoring

The total cost of the project is Rs. 2,455,000. Cost estimate for the project is shown in **Table H.5.3** while the unit price of each monitoring item is referred to the Environmental Monitoring Plan in the EIA report (Source: Urban Unit: *"Environmental Impact Assessment (EIA) of Proposed Landfill Site at Gujranwala"*, 2015, Table 8-2: Environmental Monitoring Plan, pp. 223-225). The monitoring items in the construction stage are different from those of the operation stage. The monitoring items in the construction stage are "Ambient Air Quality", "Groundwater Quality", "Noise Level", "Situation of Vegetation and Plantation", and "Situation of Safety and Traffic". On the other hand, "Smelly Gas Quality", "Treated Wastewater Effluent Quality", and "Leachate Quality" will be additionally measured in the operation stage.

Frequency of monitoring is 4 times in a year (quarterly) in most of the items. However, the monitoring for "Vegetation and Plantation" and "Safety and Traffic" shall be carried out once a year since the situations may not change drastically and annual monitoring will be enough. All monitoring in the year 2016 will be half since construction will start in Bhakhraywali at the second half of 2016. The unit price of each monitoring item is referred to the Environmental Monitoring Plan in the EIA report.

Table H.5.2 Monitoring Items in the Project for Environmental Monitoring of the Final Disposal Site in Bhakhraywali

Type of Monitoring	Frequency of Monitoring	Location of Monitoring	Parameters (Monitoring Items)
Ambient Air Quality	Quarterly*	Four corners of the site	SPM, PM_{10}, SO_2, NO_2, CO, CO_2, Vapour
Groundwater Quality	Quarterly*	North side of the disposal site around the office and storage; and South side of the site	pH, Temperature, TDS, Conductivity, Fluoride, Nitrate, DO, Hardness, Turbidity, Colour, Chloride, Arsenic, etc.
Noise Level	Quarterly*	Four corners of the site	dB(A)
Smelly Gases (Landfill Gasses)	Quarterly*	At the pit in the pump station	SO_2, H_2S, CH_4
Treated Wastewater Effluent (Leachate Pond Effluent)	Quarterly*	At the exit of leachate pond	BOD, COD, TOC, TSS, DO, Chloride, Sulphate, Turbidity, Conductivity, Oil and Grease, Colour, TKN, Heavy metals
Leachate (Leachate Pond Influent)	Quarterly*	At the pit in the pump station	BOD, COD, TOC, TSS, DO, Chloride, Sulphate, Turbidity, Conductivity, Oil and Grease, Colour, TKN, Heavy metals
Vegetation and Plantation	Once a year**	Vicinity of the site	Visual inspection of plant species survival rate and status of maintenance
Safety and Traffic	Once a year**	Vicinity of the site	1) Inspection of Signage 2) Faulty, overloaded and speeding of vehicles

Note: *Quarterly: January, April, July and October
**Once a year: April

Table H.5.3 Estimated Cost of the Project for Environmental Monitoring of the Final Disposal Site in Bhakhraywali

Check Item	Year	2016		2017		2018		Total
	Stage	Construction		Construction		Operation		
	Unit Price*	Frequency	Price	Frequency	Price	Frequency	Price	
Ambient Air Quality	40	2	80	4	160	4	160	400
Groundwater Quality	30	2	60	4	120	4	120	300
Noise Level	10	2	20	4	40	4	40	100
Smelly gases	10	N/A	0	N/A	0	4	40	40
Treated Wastewater effluent	30	N/A	0	N/A	0	4	120	120
Leachate	30	N/A	0	N/A	0	4	120	120
Vegetation Plantation	500	0.5	250	1	500	1	500	1,250
Safety and Traffic	50	0.5	25	1	50	1	50	125
Total	-		435		870		1,150	2,455

Price Unit: Rs. 1,000
Note: *EIA Report, Table 8-2: Environmental Monitoring Plan (pp.223-5). The preparation of environmental compliance and project performance report are included in the price.

5.4 Project for Environmental Monitoring of Safe Post-Closure of Final Disposal Sites in Gondlanwala and Chianwali

For the safe post-closure monitoring, Groundwater Quality, Smelly Gasses, and Leachate are selected since the impact to environment will be low compared to the operational stage of disposal site. Therefore, three monitoring processes are set for the safe post-closure monitoring of Gondlanwala and Chianwali.

- Monitoring of Groundwater Quality
- Monitoring of Landfill Gases (Smelly Gases)
- Monitoring of Leachate

(1) Objectives of Monitoring

There are three objectives of the monitoring:

- To record the environmental situation for the safe post-closure of disposal sites;
- To monitor safety of the closure process; and
- To take countermeasures in case any negative impact is recorded, to reduce environmental damage.

(2) Methodology of Monitoring

As in the preceding project, the monitoring shall be outsourced to an environmental monitoring laboratory (private company) due to the lack of measurement equipment in GWMC. GWMC shall supervise the monitoring, feedback and documentation. Monitoring shall be carried out in April since this month is between the dry season and the rainy season.

(a) Location of Monitoring

Two kinds of groundwater shall be monitored: groundwater from shallow aquifer of about 20m in depth and groundwater from aquifer of about 60m in depth. Regarding landfill gas and leachate, construction of a pumping station with manhole is to be planned for the clearing purpose, and landfill gasses and leachate are collected from the manhole. Therefore, the sampling point of landfill gasses and leachate is the same as the location of pump station. All the sampling locations in Gondlanwala and Chianwali are shown in **Figure H.5.3** and in **Figure H.5.4**, respectively.

(b) Monitoring Items

For the safe post-closure monitoring, "Groundwater Quality", "Smelly Gas Quality" and "Leachate Quality" are selected since the impact to environment will be low compared to the operation stage of disposal site. **Table H.5.4** shows the monitoring items of the project.

(c) Monitoring of Data Collection System

Data is to be collected by a private environmental laboratory, and the report is submitted to the Senior Manager for Operations in GWMC.

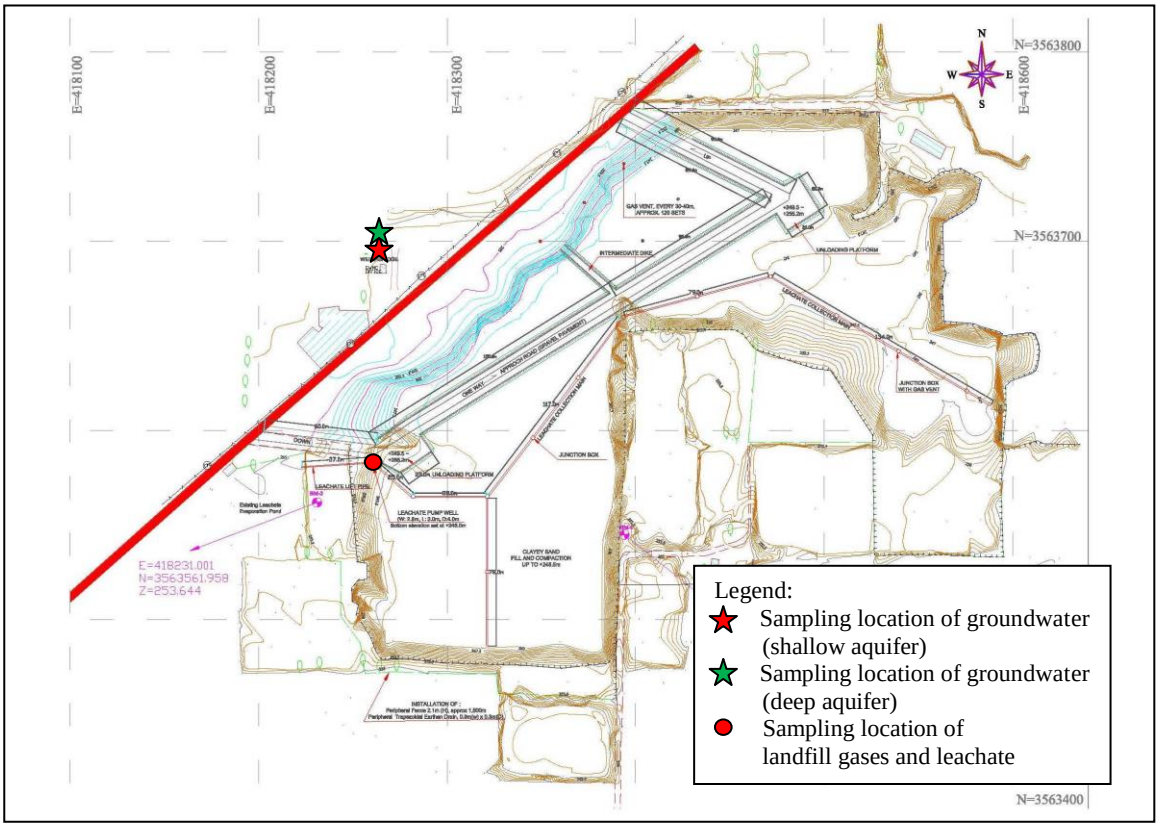


Figure H.5.3 Sampling Locations in Gondlanwala (Base Map: Figure C.5.7)

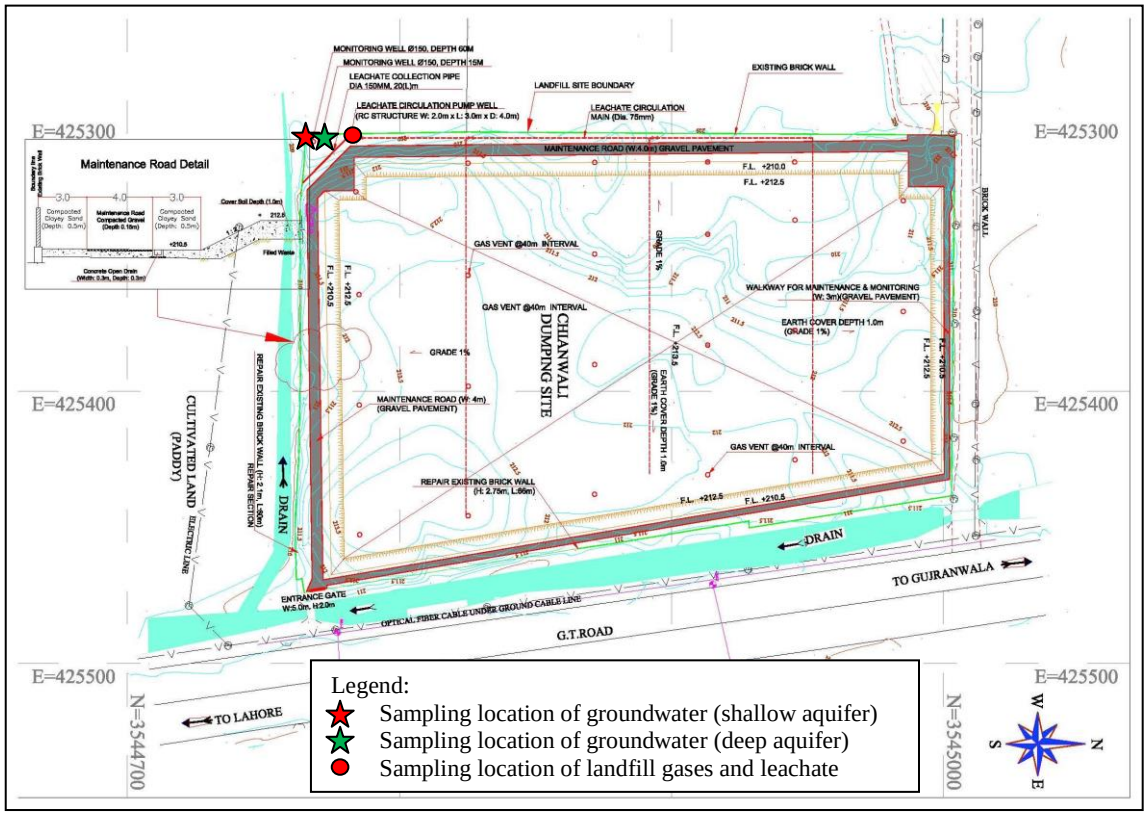


Figure H.5.4 Groundwater Monitoring Points in Chianwali (Base Map: Figure C.5.10)

Table H.5.4 Monitoring Items in the Project for Environmental Monitoring of Safe Post-Closure of Final Disposal Sites in Gondlanwala and Chianwali

Type of Monitoring	Frequency of Monitoring	Location of Monitoring		Parameters (Monitoring Items)
		Gondlanwala	Chianwali	
Groundwater Quality	Once a year (April)	Around the office/ weighbridge	At the northwest corner of the site	pH, Temperature, TDS, Conductivity, Fluoride, Nitrate, DO, Hardness, Turbidity, Colour, Chloride, Arsenic, etc.
Smelly Gases (Landfill Gasses)	Once a year (April)	At the leachate pump station	At the leachate pump station	SO_2, H_2S, CH_4
Leachate	Once a year (April)	At the leachate pump station	At the leachate pump station	BOD, COD, TOC, TSS, DO, Chloride, Sulphate, Turbidity, Conductivity, Oil and Grease, Colour, TKN, Heavy metals

(d) Monitoring Feedback System

The monitoring is to start in April 2016. The Assistant Manager for Operations in GWMC shall check the results. In case any important environmental problem is found, the Assistant Manager Operations shall inform the Senior Manager for Operations, and solutions shall be provided. In case no major problem is reported, the result shall be reviewed by the Managing Director and filed in the Operation Section.

(e) Cost of Monitoring

The total cost of the project is Rs. 210,000. The breakdown of cost estimate for the project is shown in **Table H.5.5**. The unit price of each monitoring item is referred to the Environmental Monitoring Plan in the EIA report.

Table H.5.5 Cost Estimate of the Project for Environmental Monitoring of Safe Post-Closure of the Final Disposal Sites in Gondlanwala and Chianwali

Check Item	Year	2016		2017		2018		Total
	Stage	Construction		Construction		Operation		
	Unit Price*	Frequency	Price	Frequency	Price	Frequency	Price	
Groundwater Quality	30	0	0	0	0	1	30	30
Smelly gases	10	0	0	0	0	1	10	10
Leachate	30	0	0	0	0	1	30	30
Total for 1 location								70
Total for 2 locations								140

Price Unit: Rs. 1,000

Note: * EIA Report, Table 8-2: Environmental Monitoring Plan (pp.223-5). The preparation of environmental compliance and project performance report are included in the price.

5.5 Plan of Operation and Cost of Action Plan

Figure F.5.5 shows the Plan of Operation of the Environmental Monitoring Plan (Short-Term) and **Table H.5.6** shows the Estimated Cost of the Environmental Monitoring Plan (Short-Term).

Time Framework of the Master Plan		Short-Term Plan Period											
Year		2016				2017				2018			
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WBS for Short-Term Plan													
S-6-1	Environmental Monitoring for Collection and Transport Work												
S-6-1-1	Monitoring of Cleanness of Garbage Container												
S-6-1-2	Monitoring of Waste Separation at Household Level												
S-6-2	Environmental Monitoring for Final Disposal Site in Bhakhraywall												
S-6-2-1	Monitoring of Ambient Air Quality												
S-6-2-2	Monitoring of Groundwater Quality												
S-6-2-3	Monitoring of Noise and Vibrations												
S-6-2-4	Monitoring of Smelly gases												
S-6-2-5	Monitoring of Treated Waste Water Effluent												
S-6-2-6	Monitoring of Leachate												
S-6-2-7	Monitoring of Vegetation Plantation												
S-2-6-8	Monitoring of Safety and Traffic												
S-6-3	Environmental Monitoring for Safe Post-Closure Final Disposal Sites in Gondlanwala and Chianwali												
S-6-3-1	Monitoring of Leachate and Surface Water												
S-6-3-2	Monitoring of Groundwater Quality												
S-6-3-3	Monitoring of Landfill Gases												

Figure H.5.5 Plan of Operation of the Environmental Monitoring Plan (Short-Term)

Table H.5.6 Cost of the Environmental Monitoring Action Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost		
			2016	2017	2018
Programme 6: Environmental Monitoring Plan					
Short-Term Plan					
S-6-1	Environmental Monitoring for Collection and Transport Work	0	0	0	0
S-6-1-1	Monitoring of Cleanness of Garbage Container	0	0	0	0
S-6-1-2	Monitoring of Waste Separation at Household Level	0	0	0	0
S-6-2	Environmental Monitoring for Final Disposal Site in Bhakhraywali	2,455	435	870	1,150
S-6-2-1	Monitoring of Ambient Air Quality	400	80	160	160
S-6-2-2	Monitoring of Groundwater Quality	300	60	120	120
S-6-2-3	Monitoring of Noise and Vibrations	100	20	40	40
S-6-2-4	Monitoring of Smelly gases	40	0	0	40
S-6-2-5	Monitoring of Treated Waste Water Effluent	120	0	0	120
S-6-2-6	Monitoring of Leachate	120	0	0	120
S-2-6-7	Monitoring of Vegetation Plantation	1,250	250	500	500
S-2-6-8	Monitoring of Safety and Traffic	125	25	50	50
S-6-3	Environmental Monitoring for Post-Closure Final Disposal Sites in Gondianwala and Chianwali	140	0	0	140
S-6-3-1	Monitoring of Leachate and Surface Water	60	0	0	60
S-6-3-2	Monitoring of Groundwater Quality	20	0	0	20
S-6-3-3	Monitoring of Landfill Gases	60	0	0	60
	Total (Short-Term)	2,595	435	870	1,290

6. CONCLUSION

6.1 Environmental Monitoring for the Final Disposal Site in Bhakhraywali

The EIA for the Bhakhraywali site is one of the important events in this section. The EIA was completed during the Master Plan preparation. Regarding the public hearing and opinion survey for the residents, all of the stakeholders have a relatively positive impression on the new disposal site and they believe the new disposal site is necessary for Gujranwala. On the other hand, some of them are anxious about future environmental pollution and negative impacts to society. To minimise the negative impact to environment, some monitoring in Bhakhraywali has been planned in **Chapter 4**, and the monitoring will be carried out both in the construction stage and the operational stage for the measurement of future impact to the Bhakhraywali site.

6.2 Environmental Monitoring for the Post-Closure of Final Disposal Sites in Gondlanwala and Chianwali

The environmental situation in former disposal sites, such as Chianwali and Gondlanwala, shall be taken into account in the future plan. Since no environmental monitoring has been carried out in the two disposal sites before the Master Plan preparation, negative impacts to environment in the long-term perspective is somewhat difficult to estimate. Post-closure monitoring is thus planned as in **Chapter 4**, and it may continue for 25 years as recommended in the Punjab Waste Management Guidelines of 2011.

6.3 Other Future Aspects

In terms of safety of the working environment, waste pickers in Gondlanwala site are working around in a dangerous and hazardous situation posing risks to their health. Though the waste pickers are not official employees, GWMC has to take the responsibility for anyone who actually work in the Gondlanwala site. Therefore, there is a plan to hire waste pickers as employees in the Compost Facility. The official inclusion of waste pickers not only in the Compost Facility but also in the other GWMC activities is highly recommended.

As a long-term perspective, the regulatory framework for environmental and social protection in waste management must be improved. The Strategic Environmental Assessment (SEA) has been applied for planning the Master Plan, but it is not a requirement of Pakistan under the present situation. In comparison with the JICA Guidelines, social issues such as worker's rights and safety in the work environment tend not to be mentioned in Pakistani laws on waste management. It is recommended that social aspects as well as environmental issues are added to the regulatory framework for the future waste management in Pakistan.

7. RECOMMENDATIONS

Budget, schedule, and feedback are important for implementation of the monitoring work proposed in the Master Plan. They are essential issues in terms of carrying out monitoring in every year in the same timing for the entire duration of the Master Plan. Therefore, it is recommended that the three issues should be taken into consideration.

7.1 Securing the Budget for Implementation of the Monitoring

Since there is no environmental laboratory in GWMC, most of the environmental monitoring will be carried out by a private laboratory. Therefore, the budget for outsourcing these works is essential.

7.2 Being Strict to the Schedule

Timing of the monitoring is important. Environmental monitoring should be carried out at the same time of the year. The system provides a series of environmental data in every year, and it makes comparable data of environmental impact. Some monitoring is related to the other activities such as public awareness, so that delay of monitoring will affect these related activities.

7.3 Establishment of Effective and Efficient System of Feedback

Monitoring is meaningful only if the results are utilised for environmental conservation and in avoiding future problems. All monitoring results should be reviewed by GWMC, and decisions must be made on whether or not further action is necessary.

REFERENCES

1. Urban Unit, "Environmental Impact Assessment (EIA) of Proposed Landfill Site at Gujranwala", 2015
2. World Bank, “What a Waste: Solid Waste Management in Asia”. http://web.mit.edu/urbanupgrading/urbanenvironment/resources/references/pdfs/WhatAWasteAsia.pdf [Last visit: August 20, 2015]、1999.

PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

DRAFT FINAL REPORT

VOLUME 2

SUPPORTING REPORT

SECTION I

HOSPITAL, INDUSTRIAL, AND CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

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SECTION I

HOSPITAL, INDUSTRIAL, AND CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

1. INTRODUCTION

In response to the request of the Government of Pakistan (GOP), the Government of Japan (GOJ), through the Japan International Cooperation Agency (JICA), decided to conduct "Project for Integrated Solid Waste Management Master Plan in Gujranwala." The survey consists of the Waste Amount and Composition Survey (WACS) and the analysis of incoming waste records of the existing truck scale in order to quantify the volume and type of waste being generated in the city.

2. DESCRIPTION AND EVALUATION OF CURRENT CONDITION

2.1 Current Situation of Hospital Waste

2.1.1 Category of Hospital Waste

According to the Punjab Environmental Protection Act (PEPA) of 2012 Clause 2. Definitions, (xxi), "hospital waste", includes waste medical supplies and materials of all kinds, and waste blood, tissue, organs and other parts of human and animal bodies from hospitals, clinics and laboratories. The difference between "hospitals" and "clinics" in Pakistan is generally thought to be as follows:

A **clinic** is a health care facility that is primarily devoted to the care of outpatients. Clinics can be privately operated or publicly managed and funded, and typically cover the primary health care needs of populations in local communities. Clinics usually do not have the facility to admit the patients for overnight stays in contrast to **hospitals** which offer specialised treatments and admit inpatients for overnight stays.

"Hospital waste" used in this report, however, means waste generated from both "hospitals" and "clinics", and other medical facilities as clearly described in the preceding PEPA, and this term is generally used in the rules and regulations in Pakistan. On the other hand, "municipal waste" includes sewage, refuse, garbage, waste from abattoirs, sludge and human excreta and the like (Clause 2. Definitions, (xxviii), PEPA, 2012).

According to the Hospital Waste Management Rules of 2005, "infectious waste" means waste contaminated by any type of pathogens such as bacteria, viruses, parasite or fungi and includes cultures from laboratory works, waste from surgeries, autopsies, and waste from infected patients, discarded or disposable materials and equipment which have been in contact with such patients and infected animals from laboratories. Also, according to Hospital Waste Management Rules 2005, Section 3; every hospital shall be responsible for the proper management of waste generated by it till its final disposal in accordance with the provisions of the Act and Rules 16 to 22.

Hospital waste includes both risk and non-risk waste. Risk waste means infectious waste, pathological waste, sharps, pharmaceutical waste, genotoxic waste, chemical waste and radioactive waste. Sharps include whether infected or not, needles, syringes, scalpels, infusion sets, saws, knives, blades, broken glass and any other item that could cut or puncture. Non-risk waste includes paper and cardboard, packaging, food waste and aerosols and like. **Figure I.2.1** shows the flow diagram of hospital waste.

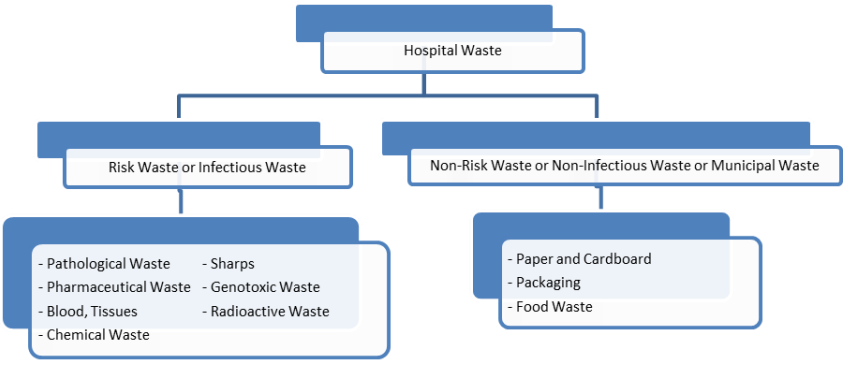

Figure I.2.1 Flow Diagram of Hospital Waste

(1) Current Situation

There is the District Headquarters (hereinafter referred to as "DHQ") in Gujranwala and it is the main medical centre of the Government. Instead of DHQ, government dispensaries, basic health

units (hereinafter referred to as "BHUs"), rural health centres (hereinafter referred to as "RHCs") and mother care health (hereinafter referred to as "MCH") are present in urban and peri-urban union councils of Gujranwala (government side). In peri-urban areas, private hospitals are few as compared to clinics. Unfortunately DHQ does not even have up to date data regarding the number of clinics and hospitals at present in Gujranwala City and in the peri-urban area especially for the private medical facilities. The JICA Project Team visited every UC of the urban and peri-urban areas and updated the database regarding the number of medical facilities. **Table I.2.1** and **Figure I.2.2** show the number of medical facilities in Gujranwala based on the field survey.

Table I.2.1 Number of Medical Facilities

Area	Town	Clinic	Hospital	Dispensary	BHU	RHC	MCH	Total
Urban		**719**	**101**	**24**	**0**	**0**	**0**	**844**
	Aroop	188	40	7	0	0	0	235
	Khiali Shah Pur	156	16	8	0	0	0	180
	Nandipur	173	29	2	0	0	0	204
	Qila Didar Singh	202	16	7	0	0	0	225
Peri-Urban		**450**	**29**	**17**	**28**	**3**	**1**	**528**
	Aroop	127	9	5	7	0	0	148
	Khiali Shah Pur	131	10	5	10	1	0	157
	Nandipur	116	8	4	7	1	1	137
	Qila Didar Singh	76	2	3	4	1	0	86
Total		**1,169**	**130**	**41**	**28**	**3**	**1**	**1,372**

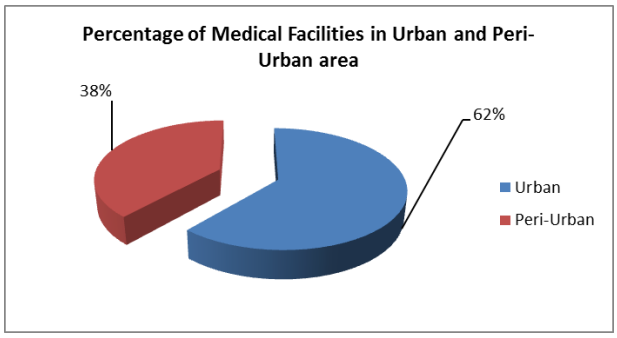

Figure I.2.2 Percentage of Medical Facilities in Urban and Peri-Urban Area of Gujranwala

Since hospital waste (risk and non-risk) is not the responsibility of GWMC, the medical facilities adopted the self-collection and disposal systems. Currently the DHQ gives their waste to A.T. Waste Management, a Lahore based private company, which had installed an incinerator at Kasur City located 120km south of Gujranwala City. A.T. Waste Management has signed a contract with hospitals and clinics, and charges them in accordance with the waste produced. Only the large scaled private hospitals have signed a contract with A.T. Waste Management. The hospitals that have signed a contract with A.T. Waste Management have dust bins with different colour-coded bags and separate boxes (for sharps) in each room (See **Photo I.2.1**). A.T. Waste Management's struck visits with the Gujranwala twice a week. Therefore, in all the hospitals a store room is present where they store the medical waste for 3 days as the collection truck visits Gujranwala only two times a week, i.e., Tuesday and Friday (See **Photo I.2.2**).

Photo I.2.1 Colour-coded Bags and a Separate Box for Waste at a Hospital

Photo I.2.2 Storeroom for Waste at a Hospital (Left: outside view, Right: inside view)

The unit fee under the contract with A.T. Waste Management is different among the hospitals and it ranges between 7 and 100 Rs./kg of medical waste. It neither depends on the number of beds nor kilogram of waste produced but perhaps on the hospital size and popularity. If the hospital is large in scale, it pays higher than the small scale hospitals.

There is no planning or set mechanism for the management of risk waste at the city or district level; for example, even in the District Head Quarter Hospital with 455 beds, which leads to huge quantity of risk waste per month. This hospital is one of the major hospitals in the whole district but still does not have any incineration or sterilisation unit.

All other government medical facilities like RHCs and BHUs, government dispensaries and MCH dig a pit, dispose all the risk wastes into the pit and burn them (See **Photo I.2.3**). This practice is modified every 3 or 4 days. They give the non-risk waste to the municipal corporation workers since GWMC does not provide services in peri-urban areas.

Representatives of BHU informed the JICA Project Team during the survey that the District Health Office does not provide any budget for the collection of waste (e.g., separate collection in different coloured bags) and disposal of risk waste. Although a few clinics signed an agreement with the A.T. Waste Company, all wastes generated from small and large clinics and also some of the hospitals, are mixed with municipal waste which is a major risk to sanitary workers. This mixture of waste is further mixed with the contents of GWMC containers and in peri-urban areas and thrown into low-lying areas or open plots where they are picked up by the waste pickers and treated as recyclable material. It was also observed that in some hospitals and clinics, sanitation staff is involved in the selling of risk waste to the recyclable dealers. Sanitary staff of medical facilities does not have enough training about the hazardous nature of risk waste and they do not bother to use any personal protective equipment while sweeping wastes.

The JICA Project Team has visited all the urban and peri-urban UCs to make a comprehensive and updated database regarding the number of medical facilities in each UC and then further visited 32 medical facilities, DHQ, 13 private hospitals, 10 clinics, 4 BHUs (1 in each town), 2 dispensaries, 1 RHC and 1 MCH in all towns of Gujranwala to know about the current waste generation, collection and disposal practices. The results of interviews are summarised in **Table I.2.2**.

Photo I.2.3 Pit for Risk Waste at BHU

From BHUs, the risk waste (also called infectious waste) generated is approximately 30-60 kg/month, from RHC 75 kg/month and from MCH 30 kg/month. On the other hand, infectious waste from clinics is 15-225 kg/month. The DHQ produces infectious waste of approximately 1,000 kg/month. The other private hospitals produce infectious waste in the range of 15 to 1,230 kg/month. The hospitals located in peri-urban areas produce less infectious waste since the number of patients visiting peri-urban hospitals are less.

Roughly, the overall risk waste produced by all 32 medical facilities is estimated at more than 6,000 kg/month and non-risk waste is more than 7,000 kg/month. Based on the survey, the total generated amount of hospital waste in Gujranwala could be roughly estimated at 200 tons/month. The breakdown is that 120 tons/month is for risk waste and 80 tons/month is for non-risk waste.

Table I.2.2 Interview Results about Hospital Waste

General Information							Infectious								Non-infectious	
Name	Category	Speciality	Bed	Employee	Infectious Waste [kg/Month]	Non-infectious Waste[kg/Month]	Outsourcing	Sharps	Bandages	Drips	Bloods	Tissues	Radioactive	Pharmaceuticals	MSW	Yard Trimmings
BHU Attawa	Basic Health Unit	General	2	17	60	90		x	x	x	x				x	
BHU Pupnakha	Basic Health Unit	General	2	16	30	60		x	x	x	x	x			x	x
BHU Gondlanwala	Basic Health Unit	General	2	7	30	45		x	x	x	x				x	x
BHU Mokalsandhwan	Basic Health Unit	General	0	16	60	105		x	x	x	x	x			x	x
Al Asad Clinic	Clinic	Physiotherapy	4	2	30	30				x		x			x	
Afshan Clinic	Clinic	Gyeanacology	7	12	21	30	x	x	x	x	x	x			x	
Farah Clinic	Clinic	Gyenacology	7	4	225	60	x	x	x	x	x	x			x	
Firdous Clinic	Clinic	General	4	7	60	45		x	x	x	x	x			x	
Ghuman Clinic	Clinic	General	0	4	15	30		x	x	x					x	
Imran clinic	Clinic	General	0	2	15	15		x	x						x	
Iqbal Clinic	Clinic	General	0	2	30	30		x	x						x	
Kamal clinic	Clinic	Surgical	6	4	45	60		x	x	x					x	
Nida Clinic	Clinic	Medicine	0	2	15	30		x	x	x	x				x	
Rehman Clinic	Clinic	Gyenacology	1	3	120	30		x	x	x	x	x			x	
Municipal Dipensary Garjakh	Dispensary	General	0	3	45	60		x	x	x					x	
Dispensary Satellite Town	Dispensary	General	0	3	75	75		x	x	x					x	x
Al-Fareed Hospital	Hospital	General	3	5	30	60		x	x	x					x	
Cheema Heart Complex	Hospital	Heart	25	15	105	375	x	x	x	x	x				x	
Gondal Medical Complex Hospital	Hospital	General	40	30	600	750	x	x	x	x	x	x			x	
Jinnah Memeorial Hospital	Hospital	General	120	105	480	600	x	x	x	x	x	x			x	
Medcare Hospital	Hospital	General	55	50	99	135	x	x	x	x	x				x	
Siddique Sadiq Hospital	Hospital	Cardiac	200	145	630	570	x	x		x	x	x			x	
Allama Iqbal memorial Trust Hospital	Hospital	General	150	150	450	150	x	x	x	x	x	x			x	x
Social Security Hospital	Hospital	General	150	275	600	300	x	x	x	x	x	x			x	
Al Raee Hospital	Hospital	General	150	160	1,230	360	x	x	x	x	x	x			x	
Al-Noor Hospital	Hospital	Gyenacology	4	5	45	120		x	x	x	x				x	
Fatima Memorial Medical Complex	Hospital	Gyenacology	6	7	90	60		x	x	x	x				x	
Zainab Memorial hospital	Hospital	General	5	10	15	30	x	x	x	x					x	
Chaudary Hospital	Hospital	General	20	20	100	270	x	x	x	x	x				x	
District Headquarters Hospital	Hospital (DHQ)	General	455	1,200	1,000	2,400	x	x	x	x	x	x			x	x
MCH JhandialaBagh wala	Mother Care Health	Mother Care	0	3	30	60		x	x	x	x	x			x	
Rural Health Center Eminabad	Rural Health Center	General	10	25	75	270		x	x	x					x	x

2.1.2 Current Situation of Industrial Waste

(1) Category of Industrial Waste

According to the Punjab Environmental Protection Act (PEPA) of 2012 Clause 2. Definitions, (xxiii), "Industrial Waste" means waste resulting from an industrial activity.

"Industrial Activity" means any operation or process for manufacturing, making, formulating, synthesising, altering, repairing, ornamenting, finishing, packing or otherwise treating any article or substance with a view to its use, sale, transport, delivery or disposal, or for mining, for oil and gas exploration and development, or for pumping water or sewage or for generating, transforming or transmitting power or for any other industrial or commercial purpose. (Clause 2. Definitions, (xxii), PEPA, 2012)

"Municipal waste" includes sewage, refuse, garbage, waste from abattoirs, sludge and human excreta and the like (Clause 2. Definitions, (xxviii), PEPA, 2012).

Industrial entities are responsible for disposing their waste properly. According to PEPA Clause 11, no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the National Environmental Quality Standards. The Federal Government may levy pollution charges on any person who contravenes or fails to comply with the provisions.

In Pakistan, construction and demolition waste (hereinafter referred to as C&D waste) is not under the category of industrial waste. In other countries construction is done by private construction companies but in Gujranwala no such trend of construction companies is seen. Mostly, people construct their houses on their own or hire workers. Legally, GWMC is not bound to deal with C&D waste but the general trend in Gujranwala is that people throw C&D waste in the streets and roadsides and as its mandate, GWMC is to clean the city. Therefore, GWMC collects the C&D waste as well. Detail discussion on C&D waste is in **Subsection 2.10.3**.

Industrial waste may be toxic or not depending on the nature of waste. **Figure I.2.3** shows the flow diagram of industrial waste.

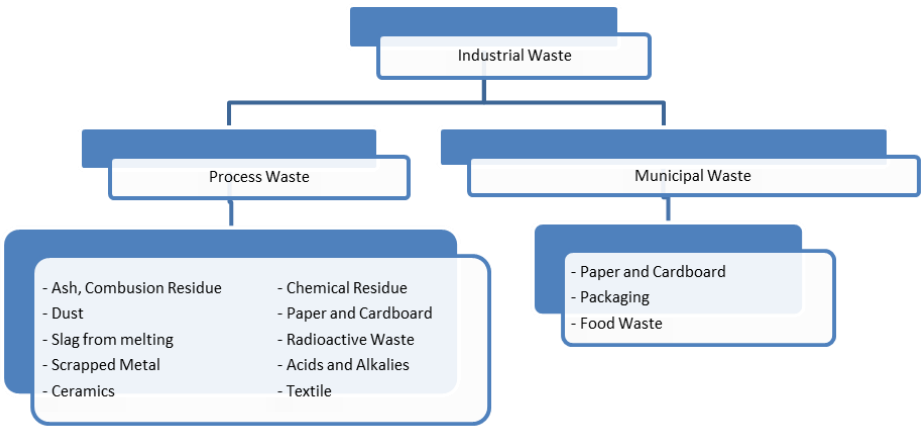

Figure I.2.3 Flow Diagram of Industrial Waste

(2) Current Situation

Gujranwala is the commercial and industrial centre of Pakistan. It is playing a major role in supporting Pakistan's economy. Gujranwala is the main centre of electrical and engineering goods manufacturing industries in Pakistan, including domestic utensils, home appliances, gas appliances, and various types of electrical/industrial machinery.

According to the Gujranwala Chamber of Commerce and Industry (GCCI) report, almost 15,000 units are operating as cottage industry (small-scaled home-based units); however, waste generated from this industry can be negligible because the amount is minimal and mostly discharged mixed with the other municipal waste. Apart from the cottage industry, therefore, the site survey for industrial waste was conducted by JICA Project Team by focusing on much larger scale industries. As a result of the survey, although about 75% of the industries did not cooperate at all despite the letter-request for cooperation from GCCI, it is identified that approximately 4,000 units are located in 64 urban union councils of Gujranwala and approximately 240 industries are situated in peri-urban area of Gujranwala as shown in **Table I.2.3**. Industries that are registered with GCCI have a National Tax Number (NTN) and are taxpayers to FBR (Federal Board of Revenue).

There are three Small Industrial Estates (hereinafter referred to as "SIE") in Gujranwala. SIE is defined as a piece of land notified as industrial area by the government. The government allots plots in the industrial estate. All the industries in this SIE are taxpayers. **Figure I.2.4** shows the locations of SIEs.

Table I.2.3 Number of Industries in Gujranwala City

Area	Town	Number of Industries*
Urban		**4,074**
	Aroop	998
	Khiyali Shah Pur	1,243
	Nandipur	505
	Qila Didar Singh	1,328
Peri-Urban		**243**
	Aroop	45
	Khiyali Shah Pur	100
	Nandipur	48
	Qila Didar Singh	50
SIE		**520**
	SIE I	179
	SIE II	327
	SIE III	14

Note:*Cottage industry is not included.

Figure I.2.4 Location Map of Small Industrial Estates (SIEs)

Major factories surveyed are from 20 different lines of production; namely, Ceramics, Chemicals, Crushing, Food, Foundry works, Furniture, Gas appliances, Home appliances, Marble, Medicine, Metal works, Packaging, Plastic products, Recycling of metals, Rubber works, Sanitary works, Soap making, Spare parts making, Textile and Utensil manufacturing. In Gujranwala the practice of recycling is very common in industries. All of the scrap is reused or recycled within the same industry or in another industry as described in **Subsection 2.5.1, Item (3)** (See **Photo I.2.4**). The results of the interviews are as shown in **Table I.2.4**.

Plastic Scraps

Rubber Scraps

Slag

Metal Scraps

Marble Scraps

Photo I.2.4 Recyclable Waste in Industries

Table I.2.4 Interview Results about Industrial Waste

General Information							Industrial Waste												Dump Procedures			
Name	Production Type	Employee	Site Area (m^2)	Top Products	Production [per Month]	Industrial Waste [per Month]	Ash, Combustion Residu	Slag from melting	Dust	Glass and ceramics	Paper & Cardboard	Scrap rubber	Textile	Scrapped Metal	Mould	Plastics	Powder waste	Waste water	Food Waste	Open Dumping	Burn in Open Place	Incineration	GWMC Container
Dawn Ceramics	Ceramics	50	2,125	Tea Mugs	300,000 Piece	300,000 kg			x						x					x			
Bright Chemicals	Chemicals	6	128	Zinc Sulphate Chemical	3,000 kg	120 kg		x												x			
Khuram Brothers.	Chemicals	4	128	Textile Dyes	40,000 L	150 pieces of drums								x		x				x			
Mughal Pottery Works	Crushing	3	1,062	Ceramics Powder	86,400 kg	-			x											x			
Noubahar Bottling Pvt. Ltd.	Food	2,000	8,499	Pepsi, Mountain Dew, 7 up	9,000,000 Piece	-					x			x		x				x			
Tariq Bakery	Food	6	126	Rusk, Bunn	-	240 kg					x								x				x
LD Steel Furnace	Foundry Works	17	9,030	Steel Billets	900,000 kg	60,000 kg	x													x			
Mushtaq Foundary	Foundry Works	12	1,062	Spare Parts	60,000 kg	10% of raw material	x													x			
Indus Industry	Furniture	45	2,000	Plastic Furniture	-	-										x				x			
Al-hammad Industry	Gas appliances	15	2,000	Cooking range,Geyser,Heater	1,300 kg	2,000 kg								x						x			
Welcome Industry	Gas appliances	70	1,593	Cooking range,Geyser,Heater	2,250 kg	-								x						x			
Ameen Enterprises	Marble	10	126	Grinding of marble	-	-			x											x			
Kaleem Marble	Marble	1	531	Marble tiles	12,000 kg	-			x								x			x			
Makkah Marble	Marble	20	2,124	Marble tiles	45,000 kg	30-40 kg											x			x			
Batala Pharmaceuticals	Medicine	80	2,124	Tablets	1,500,000 kg	2,000 kg					x					x		x			x		
M. Zaib Brothers	Metal Works	5	531	Medical Instruments	6,000 kg	240 kg								x						x			
Khiali Paper mill	Packaging	31	4,249	Paper	300,000 kg	20% of raw material					x							x					x
Saad Abdullah Paper Mill	Packaging	16	4,249	Paper	5,100,000 kg	20% of raw material					x							x					x
Minhas Industry	Plastic Products	200	2,124	PPRC pipe,Sanitary Fitting	-	450 kg								x		x				x			
Munawar Battery	Recycling of metals	1	531	Lead	-	90 kg		x						x		x				x			
S.K rubber works	Rubber Works	22	101	Rubber Sole	90,000 kg	3,000 kg						x								x			
Golden Engineering	Sanitary Works	20	1,062	Sanitay fittings	12,000 kg	8,000 kg	x	x						x						x			
Sonex Sanitary Fittings	Sanitary Works	700	-	Sanitary fittings	-	108,000 kg								x		x							x
Prime Soap	Soap Making	35	4,249	Soap	15,000 kg	-				x								x		x			
Gujranwala Steel Industry	Spare Parts Making	60	1,060	Steel bars and flats	9,000,000 kg	10,500 kg	x							x								x	
Ittehad Industry	Spare Parts Making	20	1,060	Spare Parts	9,015 kg	19,500 kg								x						x			
Popular Engineering Industry	Spare Parts Making	35	2,124	Spare Parts,Kitchen ware	-	4,000 kg								x						x			
Chaudary Silk Factory	Textile	150	1,060	Silk Cloth	2,250 kg	1.5 kg					x		x					x		x			
Anas Melamine Industry	Utensil Manufacturing	25	2,124	Dinner Sets	900 kg	-										x				x			
Sonex cooking ware	Utensil Manufacturing	500	31,872	Non stick Utensils	-	-								x		x							x
Minhas Industry	Utensil Manufacturing	75	2,124	Steel Utensils	-	-								x						x			

Some industries prefer to buy their raw materials from third parties instead of the scrap dealers because the cost is cheaper, although they know that third parties also gain profit from the sale.

There is no separate collection, storage, and disposal for hazardous waste. The industrial waste is mostly in the form of combustion residue produced from foundries, ceramics industries and sanitary works; slag is produced from chemical manufacturing, battery recycling and sanitary works; dust is produced from stone grinding, marble industry, ceramics industry and pottery works; paper and cardboard is produced from food industry, pharmaceuticals, paper mills and textiles. Scrapped metal is produced from gas appliances industry, metal works, utensils, sanitary works and spare parts making industry, and this scrapped waste is recycled and reused not wasted. Wastewater mostly is from packaging industries, soap mills, chemical-making, textile, and marble industry (See **Photo I.2.5**). Currently, both industrial and municipal wastes are disposed by the industrial establishments by themselves. There is no treatment of solid waste in industries; even wastewater is discharged into main drains without treatment.

It was noted that industries take their raw materials either from dealer shops present in Gujranwala or import them from other nearby cities as it depends upon their demand. During the survey it was observed that a majority of the waste from industries is either recycled, reused or sold and only a

small portion of combustible residues are wasted. The common practice of disposing their waste is open dumping along the road and in vacant spaces. Only few industries dispose their waste to the GWMC containers as mentioned in **Table I.2.4**.

In addition to the above result, the following facts were revealed through the interviews.

- PRTR (Pollutant Release and Transfer Register) has not yet been established in Pakistan although the Punjab Environmental Protection Act of 1997 prohibits unlicensed persons from handling hazardous substances (Clause 14) that are defined in a list of prescribed hazardous substances (Hazardous Substances Rules 2003, Clause 3). However, this Act is not well complied in any industry in Gujranwala.
- Most labourers in industries are young boys of age 14 to 25. No personal protective equipment is provided to the workers.
- Industries are willing to pay service charges if GWMC provides the service to them.

Ash Waste

Ceramic Waste

Wastewater

Plaster Waste

Photo I.2.5 Industrial Waste from Various Sources

2.1.3 Construction and Demolition Waste

(1) General

The management plan of construction and demolition waste (C&D waste) is not a part of the components of this Master Plan formulation because C&D waste is categorised into industrial waste in general and the Gujranwala Waste Management Company (GWMC) is legally not bound to deal with the C&D waste. In order to improve the cleanliness of Gujranwala City, however, GWMC is actually collecting C&D waste from its jurisdiction (i.e., 64 Union Councils). GWMC signed an agreement with the Lahore Waste Management Company (LWMC) for providing consultancy to GWMC in June 2014. The C&D waste management plan is also a part of that agreement. This subsection summarises the present situation of C&D waste based on the report of LWMC.

(2) Source of C&D Waste

According to the C&D waste management plan provided by LWMC to GWMC, definition and sources of C&D waste are listed in **Table I.2.5**

C&D waste is generated whenever any construction and demolition activity takes place such as construction of roads, underpass, flyover, bridges, plaza, remodeling, etc. It consists of inert and bio-degradable material such as concrete, plaster, metal, plastics, bricks, etc. A part of this waste goes to the municipal streams.

Table I.2.5 Sources of C&D Waste Generated in Gujranwala

Activities	Sources
Construction Activities	Renovation/construction of residential flats, homes, villas and compounds
	Public development projects by Town Municipal Administration (TMA), Highway Department, Construction & Work Department, Gujranwala Development Authority, etc.
	Private construction projects by private housing authorities
Demolition Activities	Commercial buildings, plazas, shopping centres
	Government anti encroachment drives
	Renovation of private homes

Source: Lahore Waste Management Company, Final Report on Construction and Demolition Waste Management Plan for Gujranwala, November 2014, page 10.

(3) Source of C&D Waste

Gujranwala City is experiencing rapid urbanization and industrialization that results in increase of construction activities. C&D waste due to uncontrolled and unregulated civil works is thrown usually on roadsides, footpaths, vacant plots, parks, around waste storage containers etc.

According to the LWMC C&D waste plan, percentage of C&D waste generated is mentioned as, excavated soil/rubble waste generated is about 49 tons per day (35%), concrete waste as 44 tons per day (31%), bricks/ masonry pieces as 30 tons per day (21%), road scrap material as 13 tons (9%), ceramic tiles as 6 tons per day (4%), metals as 0.14 tons per day each (0.1%) and no wood component is found in C&D waste. However, this estimation made a fatal mistake because the percentage using estimation of the total C&D waste amounts comes from the ratio of non-combustible waste as a result of the waste amount and composition survey in this Project. There is obvious difference between C&D waste and non-combustible waste. To estimate the C&D waste generation in Gujranwala, another special survey exclusively for this purpose is required.

(4) Quantification of C&D Waste

According to field surveys conducted by the LWMC team, 46 sites were identified in Gujranwala City containing C&D waste with estimated quantity of 3,555 tons. It seems to be accumulated amount on roads and vacant plots estimated based on a visual observation at the sites.

(5) Collection and Transportation, and Disposal of C&D Waste

Currently there is no proper system for C&D waste collection and transportation in Gujranwala. C&D collection arrangements are made by the generator. C&D waste generator hires the services of donkey carts or tractor trolleys depending on quantum of waste. The contractor simply collects the waste and unloads into vacant plots, low lying areas or in waste storage container placed in the vicinity and get mixed with municipal solid waste.

C&D waste is collected by GWMC and is openly dumped at Gondlanwala site along with municipal solid waste. The waste collected by private contractor is dumped in depression/low lying areas located in the vicinity of the city.

(6) Legal Situation Analysis

There is no regulation in place that directly concerns construction and demolition waste in Pakistan. Even District Government has not drafted/notified any by-laws for solid waste management in Gujranwala. Current regulations covering C&D waste are "Building and Zoning" Regulations, 2008 of Gujranwala Development Authority (GDA). These regulations only define demolition activity. According to GDA regulations-2008, Chapter 8 and 9 dealt with "Builder's Obligation" and "Role and Responsibility" as shown in the following clauses:

- **Clause 8.1.3, Written Permission for Use of Street:** No construction material or debris shall be deposited in any street without the written permission of GDA and on the condition that the builder will be responsible for clearing the street as and when required by the authority or immediately after completion of the work, whichever is earlier.
- **Clause 8.1.7, Removal of Obstructions and Debris after Completion of Work:** All debris, obstructions and erection in any street/road shall be removed within 7 days of the completion of work and the streets/road, all drains and public utility installations shall be kept in clean, tidy and serviceable conditions.
- **Clause 8.1.12, Permit to Demolish Building:** No building shall be demolished without a written permission from the Development Authority.
- **Clause 9.2.1 (iii) f.:** The builder shall be responsible for the disposal of debris/waste from construction site to the waste disposal site, as prescribed by the District Government.
- **Clause 9.2.1 (iii) g.:** The builder shall be responsible to restore the area in front of his/her plot after construction.

Cost recovery method for the lifting of demolition waste is mentioned in Punjab Local Government Ordinance 2001 (PLGO, 2001). Concerned clause is as follows:

- **Clause 64.4, Lease and Licenses for Land and Building:** The cost of demolition and removal of structure shall be payable to the local government by the lessee or licensee, as the case may be, and if the cost is not paid on demand, the local government may cause the material of the structures demolished and removed to be sold in auction, and if the proceeds of the sale are not sufficient to cover the cost, the balance shall be recoverable as arrears of land revenue, but if such proceeds exceed the cost, the excess shall be paid to the lessee or the licensee as the case may be.

Anti-Encroachment activities (immoveable) are major source of C&D waste generation in our cities. Anti-encroachment activities generates large quantum of demolition waste. Following clause of PLGO, 2001 is dealt with encroachment:

- **Clause 47, Encroachment and subsisting lease and licenses:** (1) No person shall make an encroachment movable or immoveable on an open space or land vested in or managed, maintained or controlled by a local government, or on over or under a street, road, graveyard, within its local area or a drain; (2) The local government may, after such notice as may be considered reasonable, remove the encroachment mentioned in sub-paragraph (1) with such force as may be necessary.

2.1.4 Evaluation of Hospital, Industrial, and Construction and Demolition Waste Condition

The problems and issues in relation to hospital, industrial, and construction and demolition waste management under the current situation are summarised in **Table I.2.6**. These items will be the basic elements to develop the plans, programmes and projects to comprise the recommendation on hospital, industrial, and construction and demolition waste management in the Integrated Solid Waste Master Plan in Gujranwala.

Table I.2.6 Identification of Problems and Issues on Hospital, Industrial, and Construction and Demolition Waste Management

Problem	Description of Problem	Issues for Solving the Problems
Hospital Waste		
1. Lack of data on medical facilities	The District Health Office does not even have up to date data regarding the number of clinics and hospitals at present in the Gujranwala District.	Updated database should be required regarding the number of medical facilities including government and private owned for the quantification of waste generated.
2. No check and balance mechanism on private contractors	Major hospitals and clinics have a contract with the A.T. Waste Management, a private company, for the waste collection. However, no such information and check and balance mechanism exists regarding safely disposal of the hazardous risk waste by private contractors.	Private sector does not provide any quality and environmental compliance certification to the clients. The government office also should monitor the performance of the public sector.
3. No enforcement mechanism	Hospital Waste Management Rules address only large scale hospitals and does not address small scale clinics nor regulate enforcement mechanism for the implementation of rules and regulations especially in terms of waste from private medical facilities.	In connection with the problem mentioned above, reinforcement of the current rules and regulations, and their implementation are key issues.
4. Mixing of risk waste with non-risk waste	It was observed that risk waste from smaller medical facilities is mixed with municipal waste, resulting in a major risk to sanitary workers.	No separate collection system from the smaller medical facilities forms urban and peri-urban area by any government agency.
5. Risk waste as a recyclable material	It was also observed that risk waste is collected and sold by waste pickers and some of the sanitary staff of medical facilities, and finally reaches the recyclers. This is a very hazardous and alarming situation and leads to the high possibility of infection of various diseases to waste pickers, sanitary staff and recyclers.	Waste pickers and recyclers are not being regulated by any government agencies. At least disposal of the risk waste should be strictly regulated and monitored by legislation.
6. Budget constraints	The District Health Office does not have any budget to provide BHU for hospital waste management.	No allowance of budget for the waste at BHU level comes from higher management. However, appropriate waste management needs a certain amount of money.

Problem	Description of Problem	Issues for Solving the Problems
7. Lack of awareness	Sanitary staff of medical facilities is not aware of the hazardous nature of e risk waste and they do not bother to use any personal protective equipment at the time of sweeping.	Training for sanitary staff should be carried out to handle risk waste with special care.
Industrial Waste		
1. Unavailability of industrial data	Industrial data of the entire city is not available from any government or private department. Only the list of industries that have membership with GCCI is available. Most industries are reluctant to cooperate with surveys that are going to try to clarify their activities. They normally reject disclosure of any information regarding their types and sales of production, number of employees, disposal of industrial waste, etc., to avoid payment of taxes.	It is the duty of industrial departments to collect the data and update the inventory of industries based on cooperation from them. It is essential to obtain the data for estimating the amount of waste produced from industries and formulating the waste management plan.
2. No proper enforcement of laws and regulations	There is no proper enforcement of laws, by-laws and regulations in Pakistan dealing with management of the waste discharged from industries. Although PEPA 2012 includes some clause related to industrial waste, it does not clearly demonstrate the responsibilities of industries regarding the solid waste management.	Rules and regulations that clearly mention the responsibility with strict enforcement are necessary.
3. Mixing of industrial waste with municipal waste	Most of the small scaled industries are in the residential area and waste is mixed with municipal waste. Due to no service by any company in the industrial area, waste of industrial estates is also mixed with the waste generated from households.	A separate collection system for industries and households is important to establish the proper solid waste management system in the city.
Construction and Demolition (C&D) Waste		
1. Ambiguity of classification and responsibility for C&D waste	Although C&D waste is categorised into municipal waste under the Punjab Municipal Solid Waste Management Guidelines 2011, the amount is too large to deal with municipal waste collected from households and commercial entities in general. The other laws and regulations do not clearly define the classification and responsibility for C&D waste.	The provincial government should firstly make some by-laws or regulations for C&D waste management in which rules and responsibilities should be clearly defined. Simultaneously, GWMC should consider introduction of tariff for C&D waste collection and propose it to the provincial government or city district government.
2. No reliable data on C&D waste generation amount and composition	The estimation by LWMC in terms of C&D waste amount and composition in Gujranwala is wrong so that no reliable data exists. Special surveys at the sites are indispensable for obtaining the data and will take a lot of time and resources.	The waste amount and composition data are basis of development of the management plan. Without the data, any plan covering the waste collection method and required number of vehicles and personnel cannot be prepared accurately.
3. Many illegal dumping of C&D waste	C&D wastes are piled up in front of houses, vacant plots, along the roadsides, etc., and accumulate day by day. According to the LWMC report, there are 46 of such sites in Gujranwala and the total amount is estimated at 3,555 tons.	GWMC has started the One-Time Cleaning Activity to remove the accumulated waste including C&D waste in the city area. This activity should be conducted continuously until all the illegal dumpsites are cleared by the allocation of suitable sets of vehicles and machinery.

3. RECOMMENDATIONS ON HOSPITAL AND INDUSTRIAL, AND CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

3.1 Hospital Waste Management

Recommendations for hospital waste management are as follows:

- It is necessary to treat infectious waste separately from domestic waste. The inappropriate disposal of infectious waste not only causes direct damage to the health of waste collection personnel in the hospitals but also the waste pickers and so on in the disposal sites. The re-use of medical implements such as syringes and so on will also adversely affect the ordinary patients.
- Segregation of potentially infectious materials from municipal solid waste at the point of generation may be applied to reduce both volume and cost.
- Gujranwala Waste Management Company (GWMC) should institute plans/guidelines and provide the necessary services for the medical facilities by charging a service fee. In this way GWMC can generate revenue for the services.
- Sweepers are generally unaware of the diseases spread through direct contact with medical wastes. If they know the consequences, they will definitely use personal protective equipment. Training on how to handle hospital wastes should thus be given to the sweepers since these are toxic and hazardous wastes.
- From 2016, based on the estimation of unit cost for collecting and disposing hospital wastes, GWMC should prepare the tariff setting plan for the hospital waste management with reference to waste generators' willingness to pay. The tariff collection method will be a direct collection system from waste generators by charging the individual tariff calculated from the estimated unit cost and the generated hospital waste amount.

3.2 Industrial Waste Management

The recommendations for industrial waste management are as follows:

- GWMC should institute plans/guidelines and provide waste collection services to industrial establishments by charging a certain fee.
- From 2016, based on the estimation of unit cost for collecting and disposing industrial wastes, GWMC should prepare the tariff setting plan for the industrial waste management with reference to waste generators' willingness to pay. The tariff collection method will be a direct collection system from waste generators by charging the individual tariff calculated from the estimated unit cost and the generated industrial waste amount.

3.3 Construction and Demolition Waste Management

Recommendations for construction and demolition waste management are as follows:

- On the basis of situation analysis it is recommended that provincial governments should enact rules and regulations for construction and demolition (C&D) waste management in which the rules and responsibilities are clearly defined.
- As the generator itself is responsible for C&D waste management, Lahore Waste Management Company (LWMC) proposes charging a tariff for the C&D waste collection service from the generators. Therefore, it is important that the provincial government or the city district government enact some laws or by-laws to provide the legal basis for GWMC to charge service fees. Penalties should also be stipulated in the enacted laws or by-laws.

- LWMC has proposed one time cleaning of the 46 sites filled with C&D waste by itself or by private contractor or to outsource the operations for the C&D waste collection. GWMC should use LWMC's per ton and per kilometre calculated cost for the C&D waste from all the four towns of the city and also use recommendations from the LWMC plan stated below.
- It is recommended that the City District Government Gujranwala (CDGG) and GWMC shall engage demolition contractors who have expertise, new techniques, tools, proper demolition systems, and health safety and environment working systems on board. For this, bidders shall be qualified technically in all towns and shall be called upon to bid on reserve prices set by the concerned department after having input from the engineering wing.
- The demolition contractors shall be bound to barricade properly and dump the debris to the GWMC designated crushing site. This would be the stage when actual estimation of C&D waste should be designated by considering the following data:

  1. Amount of area demolished
  2. Exact percentage range for demolished material
  3. Exact percentage range for recycled material
  4. Exact percentage range for reusable material
  5. Revenue detail and bringing this demolishing activity in tax net in future

  After 2.5 years to 3.0 years, at least, the exact form of data regarding Construction and Demolition Waste shall start to be developed.
- From 2016, based on the estimation of unit cost for collecting and disposing construction and demolition wastes, GWMC should prepare the tariff setting plan for the construction and demolition waste management with reference to waste generators' willingness to pay. The tariff collection method will be a direct collection system from waste generators by charging the individual tariff calculated from the estimated unit cost and the generated construction and demolition waste amount.