



JAPAN INTERNATIONAL COOPERATION AGENCY



CITY DISTRICT GOVERNMENT GUJRANWALA
LOCAL GOVERNMENT AND COMMUNITY DEVELOPMENT DEPARTMENT
GOVERNMENT OF THE PUNJAB
ISLAMIC REPUBLIC OF PAKISTAN

PROJECT FOR INTEGRATED SOLID WASTE MANAGEMENT MASTER PLAN IN GUJRANWALA



**FINAL REPORT
VOLUME 4 DATA BOOK**

NOVEMBER 2015



CTI ENGINEERING INTERNATIONAL CO., LTD.



NJS CONSULTANTS CO., LTD.



EX RESEARCH INSTITUTE LTD.

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All Pakistan Rupee amounts including project costs shown in this report are stated in 2015 prices unless otherwise indicated. The amounts are estimated on the basis of foreign prices by applying the interbank currency exchange rates as of 1st of September 2015, namely; USD1 = Rs. 102.92 = JPY 121.22.

COMPOSITION OF FINAL REPORT

Volume 1	EXECUTIVE SUMMARY
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Volume 3	SUPPORTING REPORT
Section A	Waste Amount and Composition Analysis
Section B	Waste Collection and Transportation
Section C	Final Disposal
Section D	Intermediate Treatment and 3R Promotion
Section E	Environmental Education and Public Awareness Raising
Section F	Economic and Financial Aspect
Section G	Environmental and Social Considerations
Section H	Institutional Strengthening and Organizational Restructuring
Section I	Hospital, Industrial, and Construction and Demolition Waste Management
Volume 4	DATA BOOK

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Section C	FINAL DISPOSAL
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Section G	ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

SECTION B

***WASTE COLLECTION AND
TRANSPORTATION***

**PROJECT
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FINAL REPORT

VOLUME 4

DATA BOOK

SECTION B

WASTE COLLECTION AND TRANSPORTATION

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B.1 Time and Motion Survey



PROJECT FOR
INTEGRATED SOLID WASTE MANAGEMENT MASTER PLAN IN GUJRANWALA

TIME AND MOTION SURVEY

DECEMBER, 2014 – APRIL, 2015



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BY THE GUIDANCE OF JICA PROJECT TEAM

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List of Abbreviations

JICA	:	Japan International Cooperation Agency
CDGG	:	City District Government Gujranwala
GWMC:		Gujranwala Waste Management Company
SWM	:	Solid Waste Management
JPT	:	JICA Project Team
UU	:	Urban Unit
UC	:	Union Council
WM	:	Waste Manager
RA	:	Research Assistant
SA	:	Survey Assistant
TS	:	Transfer Station
TT	:	Tractor Trolley

B.1.1 INTRODUCTION

Solid Waste Management (hereinafter referred to as “SWM”) has become a serious problem in Punjab due to rapid urbanisation, uncontrolled population, lack of resources, institutional weaknesses and lack of civic sense towards solid waste management.

The Government of Japan received the official request for the Technical Cooperation to formulate the Master Plan to address improvement of SWM in Gujranwala. In response to the request of the Government of Islamic Republic of Pakistan, the Government of Japan decided to conduct the Project for “Integrated Solid Waste Management Master Plan in Gujranwala”, Punjab, Pakistan in cooperation with the concerned authorities of the Government of Islamic Republic of Pakistan.

In Gujranwala, no organized data, record and information were available for the waste management activities especially for the efficiency of waste collection and transportation vehicles in operation. **Table DB.1.1** shows the list of operational vehicles owned by Gujranwala Waste Management Company (hereinafter referred to as “GWMC”). Currently, one hundred and two (102) vehicles are utilized for waste collection and transportation. The oldest vehicle was procured in the year 1977 and the latest one was procured in the year 2014. Mini dumpers were introduced by GWMC at the end of 2014. Most of the Arm Roll Trucks were procured in 2009 and the Tractor Trolleys were procured in 1996 by City District Government Gujranwala (hereinafter referred to as “CDGG”) then all the vehicles were transferred to GWMC in 2014.

Table DB.1.1 Operational Vehicles in GWMC

Items	Functional	Non-Functional	Total
Arm Roll Truck (5m ³)	22	0	22
Arm Roll Truck (10m ³)	4	0	4
Tractor Trolley	36	0	36
Mini Dumper	40	0	40
Total	102	0	102

Approximately 900 hand carts are used for the primary collection. Initially 35 mini dumpers and then in 2015, 5 more have also been added in the collection system. Out of 37, one tractor trolley was modified into tractor blade. 239 containers are placed at different locations of the city Gujranwala comprises of 64 UCs. Domestic waste collected from the 64 urban union councils in Gujranwala City transported to Gondlanwala. Currently, Gondlanwala is used as a temporary disposal site for the municipal solid waste of Gujranwala city. The site is located approximately 8 km away from the centre of the city towards north-northwest. Waste disposal at this site started in March 2014. Approximate area of the dumping site is 4.7 ha (12 Acres) and average depth of land depression is 8 to 9 m. **Figure DB.1.1** shows the waste collection and transportation scheme conducted by GWMC.

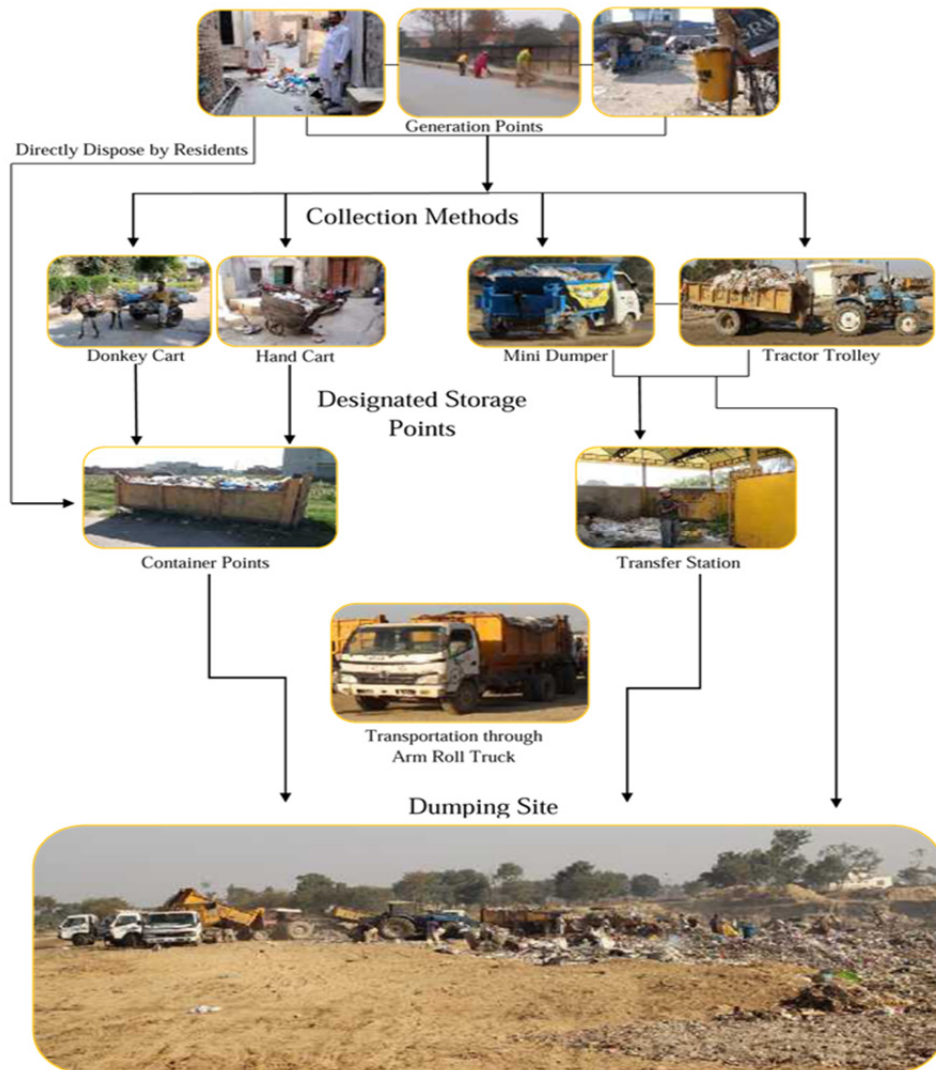


Figure DB.1.1 Waste Collection and Transportation Scheme conducted by GWMC

Time and Motion Survey is carried out in terms of necessity for grasping a basic data and information for the work efficiency of the collection and transportation vehicles by type for a reference to formulate the integrated solid waste management master plan, especially for the waste collection and transportation plan.

The survey is carried out by the JICA Project Team with collaboration of Gujranwala Waste Management Company and the Urban Unit, Punjab Government (hereinafter referred to as “UU”).

B.1.2 OUTLINE AND PURPOSE OF SURVEY

Time and Motion Survey was conducted two times for different seasons. First survey was conducted from 9th December to 24th December, 2014 with 8 operational vehicles. Survey was carried out for 5 days per vehicle and total 40 samples were collected. Similarly, Second survey was conducted from 30th March to 22nd April, 2015 by different vehicles on the same procedure followed in first survey.

Four (4) teams consisting of Waste Managers, Research Assistants (hereinafter referred to as “Counterparts”) and Survey Assistants carried out the Survey under the guidance of JICA Project Team. Time and Motion Survey comprises the recording of time for travelling, loading and unloading waste, tracking of the collection route & travelling distance, waste collection amount, fuel consumption and waste collection and operation efficiency, etc.

JICA project team and the counterparts collected all necessary data and information for conducting the survey including the Type/Capacity/No. of Vehicles, Collection area, Waste discharge methods in collection areas, collection points.

B.1.2.1 Objective

- i. To grasp the operation conditions of the different types of waste collection and transportation vehicles in service
- ii. To evaluate the loading, unloading, travelling and total operational time in the points of the loading, unloading and total operation time in relation with the waste collection and transportation amount, travelling distance and fuel consumption
- iii. To develop a basic data to formulate waste collection and transportation plan

B.1.3 METHODOLOGY

All the activities from the starting point of the collection vehicles (i.e. GWMC Workshop hereinafter referred to as “Garage” located at Sheikhpura road) to the collection points and returned to the garage were recorded by time and the routes by GPS device. The main activities carried out during the field survey are summarized as follows:

- a) Chasing the objective collection vehicles and record the time for each stop/departure by GPS time.
- b) Recording the milage of odometer respectively for start of collection work, end of collection work, arrival at disposal site for unloading, start of 2nd/3rd collection work etc.
- c) Recording the track of the collection route of each objective vehicle by GPS device.
- d) Recording the fuel consumption of each vehicle, and
- e) Noted the road conditions, traffic conditions, condition of collection points, workers behaviour, etc.

B.1.4 SURVEY RESULTS

The primary purpose of mini dumper is to collect the waste from narrow streets and roads where tractor trolley and arm-roll truck are not accessible. Tractor trolley is used for both waste collection and transportation whereas arm roll truck is to transport the waste collected by hand carts and donkey carts (primary collection) to dump site.

The survey results are evaluated based on the average values computed and tabulated in **Table DB.1.2** for the key factors of waste collection and transportation activities. As mentioned above, due to the different services allotted to each type of vehicles, the values cannot be compared simply but comparison or evaluation of the performance or the efficiency of three types of vehicles are described based on **Table DB.1.2** in the following subsections.

Table DB.1.2 Overall Waste Collection and Transportation Analysis by Vehicle Type

No.	Evaluation Items	Vehicle Type									
		Arm Roll Truck			Tractor Trolley			Mini Dumper			
		S-01	S-02	Average	S-01	S-02	Average	S-01 (T/S)	S-02 (T/S)	Average	S-02 (D/S)
1	Average Waste Handling Amount (kg/shift)	12,050	16,640	14,345	3,502	3,870	3,686	2,430	3,170	2,800	2050
2	Average Milage (km/shift)	144	137	141	51	45	48	49	57	53	88
3	Average Fuel Consumption (liters/shift)	35	34	35	14	16	15	9	9	9	13
4	Average Number of Trips (times/shift)	5	4	5	2	2	2	5	6	6	4
5	Average Number of Crews (Persons)	1	1.0	1	2.7	2.3	2.5	2.5	2	2.3	2
6	Average Loading Time (minutes)	40	31	36	193	233	213	282	237	260	251
7	Average Unloading Time (minutes)	40	37	39	12	15	14	31	16	24	30
8	Average Travelling Time (minutes)	364	405	385	265	284	275	234	224	229	333
9	Average Total Operating Time (minutes)	445	474	460	471	533	502	547	477	512	615
10	Average Milage per Unit Fuel Consumption (km/liter)	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	2,5141	1,089	997	1,043	517	803	660	490
13	Average Waste Handling Amount per Travelling Time (kg/hr)	1,986	2,465	2,226	793	818	806	623	849	736	369
14	Average Waste Handling Amount per Total Time (kg/hr)	1,625	2,106	1,866	446	436	441	267	399	333	200
15	Average Waste Handling Amount per Unit Fuel Consumption (kg/liter)	344	489	417	250	242	246	270	352	311	158

B.1.4.1 Average Waste Handling Amount (kg/shift)

This value indicates the average handling waste amount per day or shift for each type of vehicle utilizing for waste transportation or collection and transportation or only for waste collection operation. An Arm-roll truck is used only for transferring waste container. The arm-roll truck collects 14.35 tons of waste per shift average and transfers it to the disposal site. The amount of the waste is 3.9 times more than that of a tractor trolley although it cannot be compared simply with the performance of tractor trolley which is used both for waste collection and waste transportation.

Mini-dumpers collect less waste amount compared with tractor trolley which collect and transport waste since mini-dumper has many collection points and waste loading amount per hour is low (660kg/hr).

Arm roll truck handled 12 tons in 1st survey and 16.6 tons in 2nd survey by making 5 and 4 trips respectively. Efficiency in case of average waste handling amount is 38% more than that of 1st survey. Similarly tractor trolley handled 3.5 tons and 3.87 tons which is 11% more than that of 1st survey and mini dumper (T/S) handled 2.4 tons and 3.2 tons respectively, 30% more than that of 1st survey which indicates that the efficiency of primary collection has been increased. Reference shall also be made to the **Figure DB.1.2**.

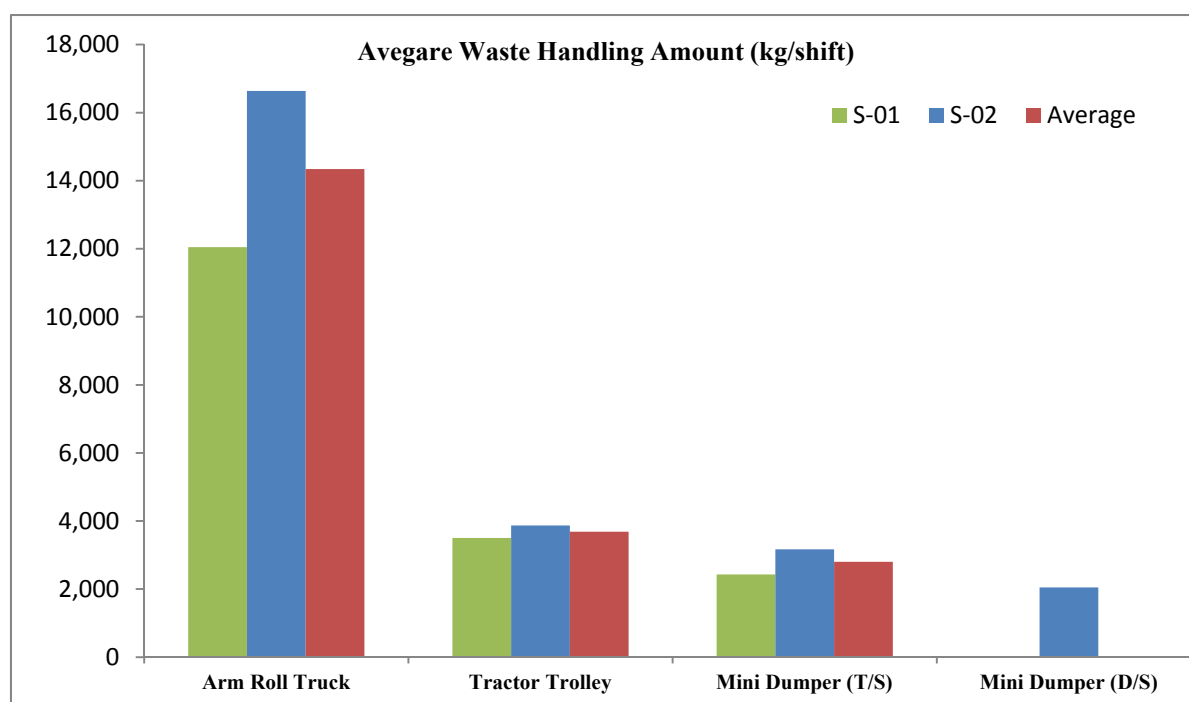


Figure DB.1.2 Average Waste Handling Amount for Survey-01 & 02

B.1.4.2 Average Mileage per Unit Fuel Consumption (km/liter)

Average mileage per unit fuel consumption of mini dumper is calculated as 5.9 km per liter which is the highest value among the three objective vehicles. The engine capacity of mini dumper is designed at 800cc, which is relatively small engine capacity compared with that of the other two vehicles and it reflects the fuel consumption efficiency of the vehicle.

Average mileage per unit fuel consumption of tractor trolley is calculated at 3.2 km per liter which is the worst value among the three vehicles. Tractor trolley is not good at travelling long distance. In addition, the vehicle is used for more than 10 years. Therefore, it is considered that the vehicle is decrepit.

In both of the surveys, efficiency of Arm roll truck in case of average mileage per unit fuel consumption is almost the same but the efficiency of tractor trolley decreases 20% as compared to 1st survey and similarly mini dumper (T/S) performed 17% more efficiently. Reference shall be also made to the **Figure DB.1.3**.

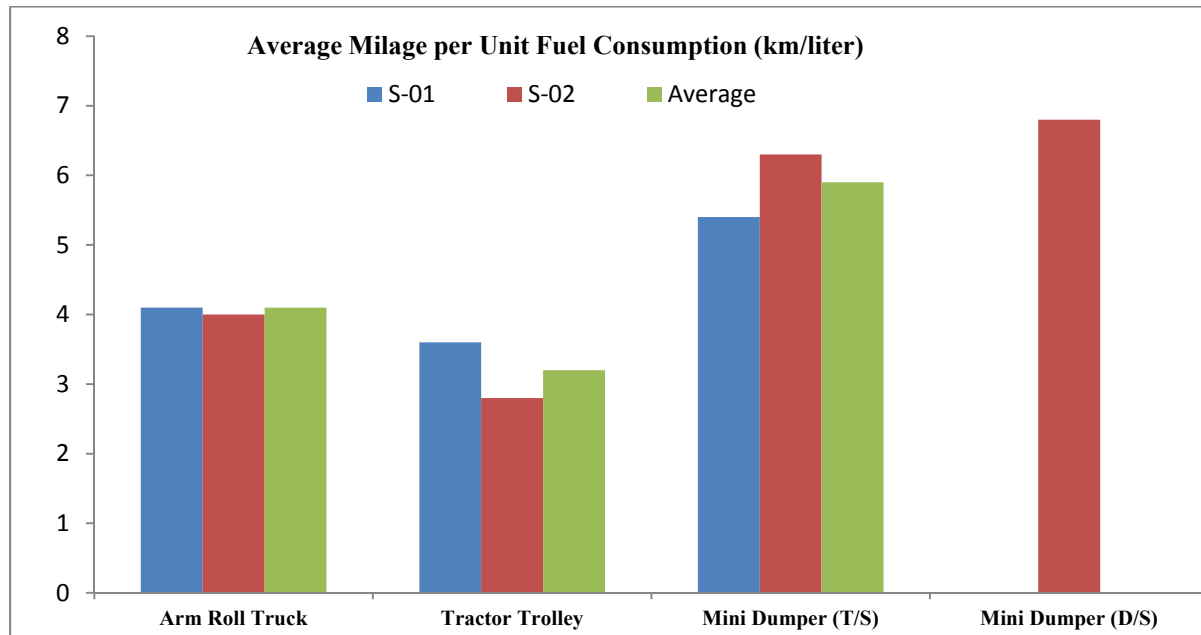


Figure DB.1.3 Average Mileage per Unit Fuel Consumption for Survey-01 & 02

B.1.4.3 Average Waste Handling Amount per Total Time (kg/hr)

This value also cannot be compared simply due to the difference of the utilization purpose or service of each type of vehicle. An 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 the vehicles. The mini dumper performed approximately 333 and 200 kg/hr which is 76% and 45% of the value performed by the tractor trolley in case of transfer station and disposal site respectively.

From the result of average waste handling amount per total operating time of arm roll truck and mini dumper, it indicates that the capacity of 6 units of mini dumper is equivalent to the capacity of one unit of arm roll truck if it transfers the waste from transfer station to dumping site.

Efficiency of arm roll truck in case of average waste handling amount per total time (kg/hr) is 30% more than that of the 1st survey. And efficiency of mini dumper increased 49% but tractor trolley decreased by 2%. Reference shall be also made to the **Figure DB.1.4**.

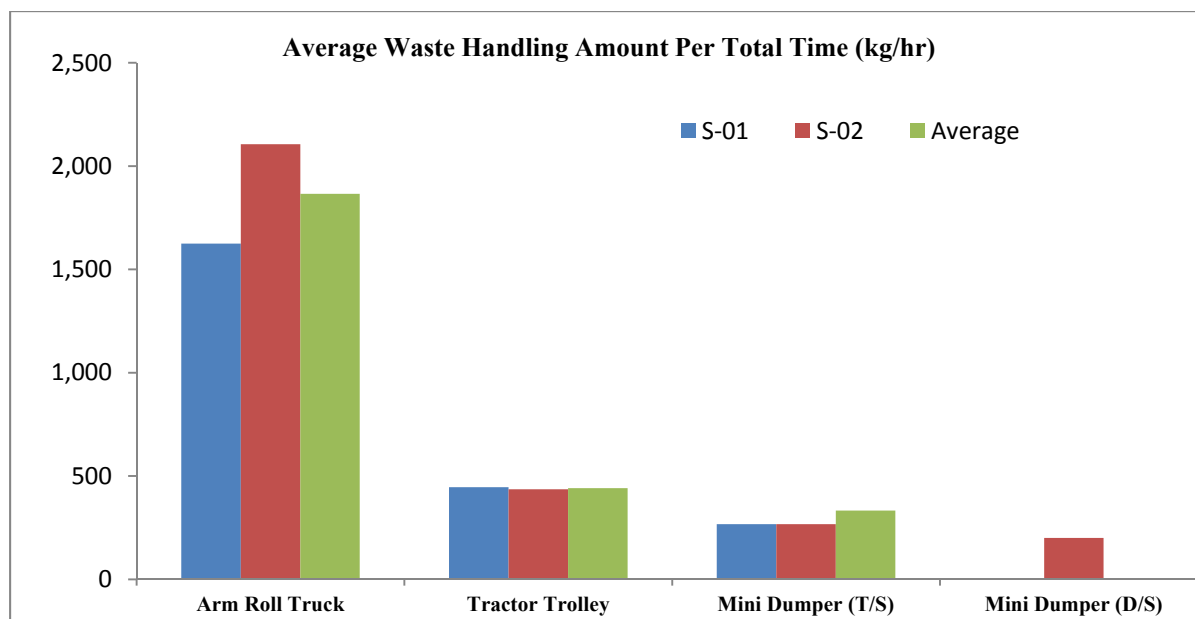


Figure DB.1.4 Average Waste Handling Amount per Total Time for Survey-01 & 02

The key factors regarding loading, unloading and travelling times are explained in detail in **Table BD.1.3** Mini dumper (T/S and D/S) spent 8 hrs and 32 minutes and 10 hrs and 15 minutes respectively for total operational time which is 11.3 and 34 % more than that of arm roll. Whereas tractor trolley spent 8 hrs and 22 minutes for total operational time which is 9% more than that of arm roll truck and 2% and 18% less than that of mini dumper (T/S, D/S) respectively.

Table DB.1.3 Facts about Operational Time during Survey

Objective	Arm Roll Truck	Tractor Trolley	Mini Dumper	
			T/S	D/S
Loading Time	36 minutes (7.8 % of total time)	3:33(h:min) (42.4% of total time)	4:20(h:min) (50.7% of total time)	4:11 (h:min) (40.8 % of total time)
	a) Driver had to wait for filling of container 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) Residents reluctant to place the container near to their houses, time consumed in changing the place.	a) Lack of designated crew staff for loading. b) Delay due to late sweeping by sanitary staff on roads and streets. c) Traffic congestion at School and Office timing. d) Routes in access to container were also served by mini dumper.		
Unloading Time	39 minutes (8.5 % of total time)	14 minutes (2.8% of total time)	24 minutes (4.7 % of total time)	30 minutes (4.9 % of total time)
	a) Traffic load due to onetime cleaning activity. b) Delay in alignment/leveling of remaining waste of previous day at Gondlanwala. c) Delay due to dumping of other vehicles at designated points d) Rain caused the traffic congestion as access road is unpaved.	a) Staring of TT-6946 got free at Gondlanwala during dumping and repaired within 6 days. b) Fuel tank of TT-6946 was leaked	a) Delay due to dumping of other mini dumpers at transfer station.	
Travel Time	6:25 (h:min) (83.7% of total time)	4:35 (h:min) (54.8% of total time)	3:49 (h:min) (44.7% of total time)	5:33 (h:min) 54 % of total

		time)	time)	time)
	a) Container was not filled/partially filled at the arrival of arm roll truck and driver had to travel to find some other allotted points for loading filled/partially filled container. b) Allotted containers are not from adjacent UCs and far from each other. c) During transportation, drivers didn't care about the other vehicles or public passing around. d) Engine Problem in Hino-14	a) Travelled at a speed of 5-6km/hr b) Steering Liver of TT-451 got free and it took 90 minutes c) Route of TT-451 was not appropriate; streets were very narrow causing the problem in turning and traffic congestion problem.	a) GAJ-49 spend 40 minutes for transporting the waste to Gondlanwala and back to collection point.	

B.1.4.4 Average Waste Handling Amount per Unit Fuel Consumption (kg/liter)

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 respectively 417 kg, 246 kg, 311 and 158 kg per liter. This means that arm-roll truck collects and transport 1.7 times amount of waste per liter compared with that of the tractor trolley in the area where a mini dumper does not collect waste.

In case of waste collection and waste transportation by the combination of mini dumper and arm roll truck with transfer station, mini dumper needs to have $417/311=1.3$ liter of fuel for collecting 417 kg of waste which is the waste amount transported by arm roll truck. In this case, 417 kg of waste is collected and transported by mini dumper and arm roll truck with $1+1.3=2.3$ liter of fuel. Thus, this combination of two types of vehicle has the capability of waste collecting and transporting 181 kg of waste ($417\text{kg}/2.3\text{liter}$) per liter.

Compared the value with that of the result of tractor trolley, which was 246 kg/liter, the average waste handling amount per fuel consumption of these two vehicles is approximately 74% of the value performed by the tractor trolley. Whereas mini dumper (D/S) handled only 158 kg/liter which is only 64% of the value performed by the tractor trolley and 51% of the value performed by the mini dumper (T/S).

Efficiency of arm roll truck and mini dumper, in case of average waste handling amount per unit fuel consumption (kg/liter) is 30% more than that of the 1st survey, as primary collection efficiency and waste handling amount in 2nd survey was increased but tractor trolley decreased by 3%. Reference shall be also made to the **Figure DB.1.5**.

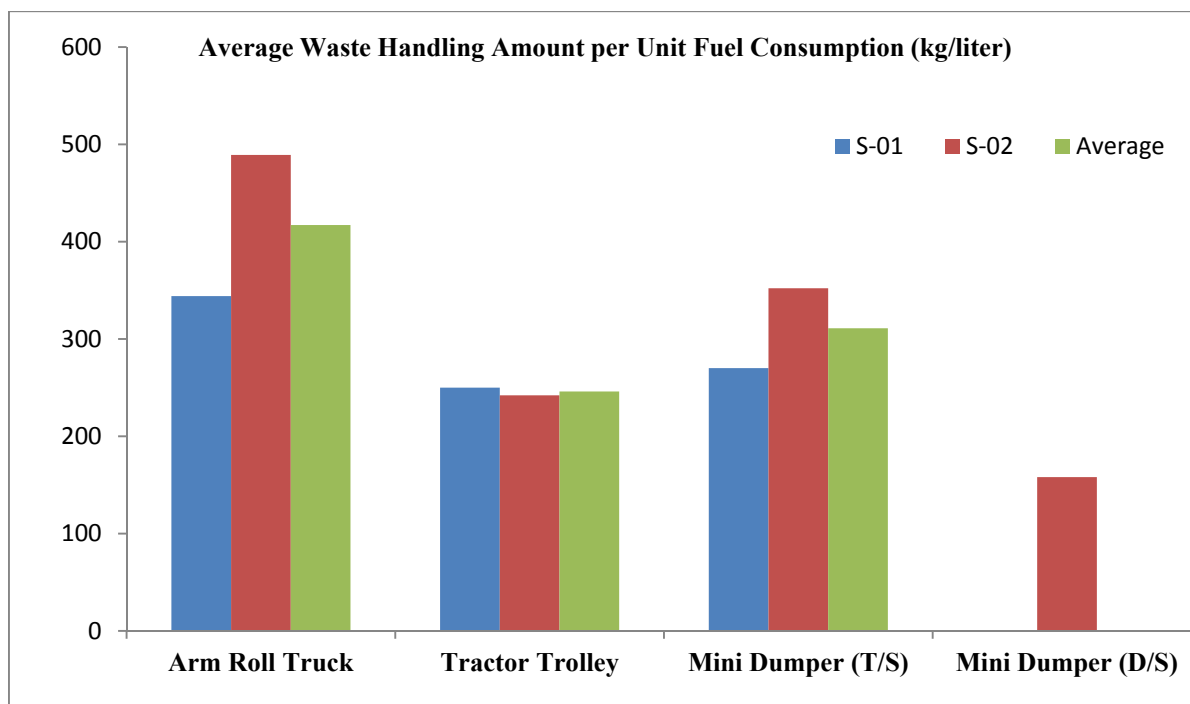


Figure DB.1.5 Average Waste Handling Amount per Unit Fuel Consumption for Survey-01 & 02

B.1.5 CONCLUSIONS AND RECOMMENDATIONS

B.1.5.1 Conclusions

The followings summarize the main items from the output of the time and motion survey conducted in December 2014 and April 2015.

1. An Arm Roll Truck (5m³) travels 141 km with 35 liters of fuel by making five (5) trips to transport 14 tons per day on average.
2. Tractor Trolley travels 48 km with 15 liters of fuel for 2 trips to transport 3.7 tons per day on average
3. Mini Dumper travels 53 km with 9 liters of fuel for 6 trips to transport 2.8 tons of waste to temporary transfer station per shift on average.
4. Mini Dumper travels 88 km with 13 liters of fuel for 4 trips to transport 2.1 tons of waste to Gondlanwala per shift on average.
5. Trend of loading time with respect to the total operational time of each type of vehicle is ;
Mini Dumper-T/S (51%) > Tractor Trolley (42%)> Mini Dumper-D/S (41%)> Arm Roll Truck (8%)
6. Trend of travel time with respect to the total operational time of each type of vehicle is;
Arm Roll Truck (84%) > Tractor Trolley (55%) > Mini Dumper-D/S (54%)> Mini Dumper-T/S (45%)
7. Trend of unloading time with respect to total operational time of each type of vehicle is;
Arm Roll Truck (8%) > Mini Dumper-T/S & D/S (5%)> Tractor Trolley (3%)
8. Ratio of average waste collection/transportation amount (ton/shift) is;
Arm Roll Truck (3)> Tractor Trolley (0.8)> Mini Dumper-T/S (0.6)> Mini Dumper-D/S

(0.43)

9. Milage per Unit Fuel Consumption (km/liter) is;
Mini Dumper-D/S (6.8)>Mini Dumper-T/S (5.9)> Arm Roll Truck (4.1)> Tractor Trolley (3.2)
10. Waste handling amount per unit distance (kg/km) is;
Arm Roll Truck (103)> Tractor Trolley (78)> Mini Dumper-T/S (53)> Mini Dumper-D/S (23)
11. Waste handling amount per total operation time (kg/hr) is;
Arm Roll Truck (1,866)>Tractor Trolley (441)>Mini Dumper-T/S (333)>Mini Dumper-D/S (200)
12. Waste handling amount per unit fuel consumption (kg/liter) is;
Arm Roll Truck (417) >Mini Dumper-T/S (311) > Tractor Trolley (246)> Mini Dumper-D/S (158)
13. Carrying capacity per hour of Arm roll truck is controlled by the carrying capacity of mini dumper. In order to meet the carrying capacity of Arm-roll truck, 6 Mini dumpers shall be dispatched to one Arm-roll truck in case of their combination for collection and transportation.
14. Carrying capacity per fuel consumption of Mini dumper-T/S (311 kg/liter) + Arm-roll truck (417 kg/liter) is calculated equivalent to 181 kg/liter, which is lower than that of the Tractor Trolley (246 kg/liter) because of dispatching two vehicles to complete waste collection and transportation.

B.1.5.2 Recommendations

From the results of T&M survey, the matters to be recommended with respect to improvement of the operation of waste collection and transportation vehicles are summarized below.

1. Fuel consumption of tractor trolley is as low as 3.2 km/liter and the travelling performance is low. In addition, most of the tractor trolleys are aging, so that the maintenance costs are increased. Tractor trolley shall be replaced with other appropriate type of vehicles sooner as possible since the tractor trolley is not an appropriate type of vehicle for waste collection and transportation operation. .
2. Loading efficiency of mini dumper (T/S & D/S) is low as 660 & 490 kg/hr caused the numbers of collection points including door to door operation. The loading efficiency must be improved by increasing the number of workers to two persons and asking cooperation of the residents for the method of waste discharging from the households.
3. The efficiency of the combination work by mini dumper and arm roll truck for collection and transportation work is 74% of the performance of tractor trolley in terms of fuel consumption. Since the distance to the disposal site is less than 10 km from the centre of the city and it does not spend time and fuel so much so this kind of waste transfer operation shall be limited to the minimal to save the cost.

In addition to the recommendations above, the following matters observed and learned during the survey are also recommended for improvement of the operation.

1. The parking lot for each vehicle at GWMC garage should be fixed because the early comer drivers have to wait for the late comers and it results delay to start waste collection service.
2. Log books for each vehicle should be checked as most of the drivers are not used to check the vehicles at the start of operation, which causes the problems (puncture etc.) during the work.
3. Waste collection points and routes for each vehicle should be defined for routine work as the driver has to call and ask sometimes about the next collection points and it causes the wastage of time.
4. Route of Mini Dumper should be different from that of hand cart and donkey cart to avoid duplication of the service area and the service area can be maximized.
5. Adjacent container points should be allocated to each Arm Roll Truck to avoid extra travelling distance for loading and transporting the waste.

B.2 Number of waste collection vehicles

Table DB.2.1 Number of waste collection vehicles in 64 UCs

Necessary Vehicles in 64UCs				2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Existing	Armroll truck	10m3	Sub-total	4	4	4												
	Armroll truck	5m3	2002															
	Armroll truck	5m3	2003	2	2	2												
	Armroll truck	5m3	2005	14	14	14												
	Armroll truck	5m3	2011	6	6	6												
	Armroll truck	5m3	Sub-total	22	22	22												
	Tractor trolley	3.2m3	1977	2	2	2												
	Tractor trolley	3.2m3	1978	2	2	2												
	Tractor trolley	3.2m3	1982	1	1	1												
	Tractor trolley	3.2m3	1984	4	4	4												
	Tractor trolley	3.2m3	1985	1	1	1												
	Tractor trolley	3.2m3	1989	2	2	2												
	Tractor trolley	3.2m3	1993	2	2	2												
	Tractor trolley	3.2m3	1995	2	2	2												
	Tractor trolley	3.2m3	1996	11	11	11												
	Tractor trolley	3.2m3	1998	2	2	2												
	Tractor trolley	3.2m3	2000	6	6	6												
	Tractor trolley	3.2m3	2007	2	2	2												
	Tractor trolley	3.2m3	2008	1	1	1												
	Tractor trolley	3.2m3	Sub-total	37	37	37												
	Mini-dumper	1m3	2014	5	5	5	5	5	5	4	4	3	3	2	2	1	0	
	Mini-dumper	1m3	Primary collection	30	30	30	30	30	30	27	24	21	18	15	12	9	6	3
	Mini-dumper	1m3	Sub-total	35	35	35	35	35	35	31	28	24	21	17	14	10	6	3
	Armroll truck	10m3	2015															
M/P			2016															
			2017															
	Armroll truck	10m3	Sub-total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Armroll truck	5m3	2016				5	5	5	5	5	5	5	5	4	3	2	1
			2017												1	1	1	1
			2021												1	1	1	1
			2022													1	1	1
			2023													1	1	1
			2024														1	1
	Armroll truck	5m3	Sub-total	0	0	0	5	5	5	5	5	5	5	5	6	6	6	6
	Connector	10m3	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2016	10	10	10	10	10	10	10	10	9	8	7	6	5	4	3
			2017		15	15	15	15	15	15	15	15	13	12	10	9	7	6
			2018			40	40	40	40	40	40	40	40	38	32	28	24	20
			2019				10	10	10	10	10	10	10	10	9	8	7	6
			2020				15	15	15	15	15	15	15	15	15	13	12	10
			2022						15	15	15	15	15	15	15	15	15	13
			2023							10	10	10	10	10	10	10	10	10
			2024								12	12	12	12	12	12	12	12
			2025								15	15	15	15	15	15	15	15
			2026									15	15	15	15	15	15	15
			2027										20	20	20	20	20	20
			2028											20	20	20	20	20
			2029												20	20	20	20
			2030															20
	Connector	13m3	Sub-total	13	28	68	78	83	90	109	117	128	140	148	160	171	185	200
	Connector	7m3	2015	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
			2017	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
			2018		20	20	20	20	20	20	20	20	20	18	16	14	12	10
			2019			40	40	40	40	40	40	40	40	38	32	28	24	20
			2021					14	14	14	14	14	14	14	14	14	12	11
			2022						10	10	10	10	10	10	10	10	10	10
			2024								10	10	10	10	10	10	10	10
			2025									15	15	15	15	15	15	15
			2026										20	20	20	20	20	20
			2027											20	20	20	20	20
			2028												20	20	20	20
			2029													20	20	20
			2030														20	20
	Connector	7m3	Sub-total	38	58	98	98	98	112	112	128	128	138	148	163	184	212	240
	Connector	4m3	2015			40	40	40	40	40	40	40	40	40	36	32	28	24
			2016												4	4	4	4
			2017													4	4	4
			2021												4	4	4	4
			2022													4	4	4
			2023														4	4
	Connector	4m3	Sub-total	0	0	40	40	40	40	40	40	40	40	40	40	40	40	40
	Mini-dumper	1m3																
	Primary collection		2016				0	0	0	0	0	0	0	0	0	0	0	0
			2023				0	0	0	0	0	0	0	0	0	0	0	0
			2024									0	0	0	0	0	0	0
			2025										0	0	0	0	0	0
			2027											2	2	2	2	2
			2028												4	4	4	4
			2029													4	4	4
			2030															4
	Mini-dumper	1m3	Sub-total	0	0	0	0	0	0	0	0	0	0	0	2	6	10	13

Table DB.2.2 Waste collection amount on each waste collection vehicle in 64 UCs

Waste collection Capacity by	Type of Vehicle	capacity (ton)	number of trips	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Existing	Arm-roll truck	10m3	5	5	100	100	100	0	0	0	0	0	0	0	0	0	0	0
		5m3	2.5	5	275	275	275	0	0	0	0	0	0	0	0	0	0	0
	Tractor trolley	3.2m3	1.6	3	177.6	177.6	177.6	0	0	0	0	0	0	0	0	0	0	0
	Mini-dumper	1m3	0.5	5	12.5	12.5	12.5	12.5	12.5	12.5	10	10	7.5	7.5	5	5	2.5	0
M/P	Arm-roll truck	10m3	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Arm-roll truck	5m3	2.5	5	0	0	0	62.5	62.5	62.5	62.5	62.5	62.5	75	75	75	75	75
	Comactor	13m3	6.5	1	84.5	182	442	507	604.5	604.5	702	760.5	832	910	962	1040	1111.5	1228.5
	Comactor	7m3	3.5	2	266	406	686	686	686	784	784	840	882	945	1015	1071	1148	1204
	Comactor	4m3	2	3	0	0	240	240	240	240	240	240	240	240	240	240	240	240
	Mini-dumper	1m3	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total				916	1,153	1,933	1,508	1,606	1,704	1,799	1,913	2,024	2,165	2,297	2,431	2,577	2,748	2,921
Planned Waste Collection Amount in 64UCs				889	1,129	1,410	1,496	1,586	1,683	1,786	1,895	2,011	2,135	2,265	2,405	2,560	2,724	2,898

Table DB.2.3 Number of waste collection vehicles in 34 UCs

34UC	34UCS			2014	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Existing	Arm-roll truck	10m3	2007				2	2	2									
	Arm-roll truck	10m3	Sub-total				2	2	2									
	Arm-roll truck	5m3	2002				4	4	4									
			2007				3	2	2									
			2009				14	14	14									
			2011				9	6	6									
	Arm-roll truck	5m3	Sub-total				22	22	22									
	Tractor-bulky	3.2m3	1977				2	2	2									
			1978				2	2	2									
			1982				1	1	1									
			1994				4	4	4									
			1998				1	1	1									
			1999				2	2	2									
			1999				2	2	2									
			1999				2	2	2									
			1999				11	11	11									
			1999				3	2	2									
			2000				6	6	6									
			2007				2	2	2									
			2009				6	6	6									
	Tractor-bulky	3.2m3	Sub-total				37	37	37									
	Mini-dumper	1m3	2014				6	6	6									
MP	Arm-roll truck	10m3	2020						0	0	0	0	0	0	0	0	0	0
	Arm-roll truck	10m3	Sub-total		0	0	0	0	0	0	0	0	0	0	0	0	0	0
		5m3	2021						0	0	0	0	0	0	0	0	0	0
			2029						0	0	0	0	0	0	0	0	0	0
	Arm-roll truck	5m3	Sub-total		0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Connector	13m3	2019		0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2017		0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2018				0	0	0	0	0	0	0	0	0	0	0	0
			2019				0	0	0	0	0	0	0	0	0	0	0	0
			2020				0	0	0	0	0	0	0	0	0	0	0	0
			2021						12	12	12	12	12	12	12	12	12	12
			2022						12	12	12	12	12	12	12	12	12	12
			2023						13	13	13	13	13	13	13	13	13	13
			2024						13	13	13	13	13	13	13	13	13	13
			2025						13	13	13	13	13	13	13	13	13	13
			2026						14	14	14	14	14	14	14	14	14	14
			2027						14	14	14	14	14	14	14	14	14	14
			2028						14	14	14	14	14	14	14	14	14	14
			2029						14	14	14	14	14	14	14	14	14	14
	Connector	13m3	Sub-total		0	0	0	0	0	12	12	12	12	12	12	12	12	12
	Connector	7m3	2019		0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2017		0	0	0	0	0	0	0	0	0	0	0	0	0	0
			2018				0	0	0	0	0	0	0	0	0	0	0	0
			2019				0	0	0	0	0	0	0	0	0	0	0	0
			2020						13	13	13	13	13	13	13	13	13	13
			2021						13	13	13	13	13	13	13	13	13	13
			2022						13	13	13	13	13	13	13	13	13	13
			2023						13	13	13	13	13	13	13	13	13	13
			2024						13	13	13	13	13	13	13	13	13	13
			2025						13	13	13	13	13	13	13	13	13	13
			2026						13	13	13	13	13	13	13	13	13	13
			2027						13	13	13	13	13	13	13	13	13	13
			2028						13	13	13	13	13	13	13	13	13	13
			2029						13	13	13	13	13	13	13	13	13	13
	Connector	7m3	Sub-total		0	0	0	0	0	13	13	13	13	13	13	13	13	13
	Connector	4m3	2019				0	0	0	0	0	0	0	0	0	0	0	0
			2020						2	2	2	2	2	2	2	2	2	2
			2021						2	2	2	2	2	2	2	2	2	2
			2022						2	2	2	2	2	2	2	2	2	2
			2023						2	2	2	2	2	2	2	2	2	2
	Connector	4m3	Sub-total		0	0	0	0	0	0	0	0	0	1	3	4	6	8
	Mini-dumper	1m3	2028				0	0	0	0	0	0	0	0	0	0	0	0
			2027															
			2028															
			2029															
	Mini-dumper	1m3	Sub-total		0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table DB.2.4 Waste collection amount on each waste collection vehicle in 34 UCs

Waste collection Capacity by	Type of Vehicle	capacity (ton)	number of trips	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Existing	Arm-rol truck	10m3	5	0	0	0	100	100	100	0	0	0	0	0	0	0	0	0
		5m3	2.5	0	0	0	275	275	275	0	0	0	0	0	0	0	0	0
	Tractor trolley	3.2m3	1.6	0	0	0	177.6	177.6	177.6	0	0	0	0	0	0	0	0	0
	Mini-dumper	1m3	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M/P	Arm-rol truck	10m3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Arm-rol truck	5m3	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Comactor	13m3	6.5	1	0	0	0	0	78	156	188.5	234	273	312	351	396.5	429	474.5
	Comactor	7m3	3.5	2	0	0	0	0	105	105	161	210	245	280	322	371	427	490
	Comactor	4m3	2	0	0	0	0	0	0	0	0	0	0	6	18	24	36	48
	Mini-dumper	1m3	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total				0	0	0	552.6	552.6	735.6	261	349.5	444	518	598	691	791.5	892	1012.5
Planned Waste Collection Amount in 34UC's				0	0	0	55	117	185	260	344	436	514	592	684	786	886	1006

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Table DB.3.1 Number of waste collection containers in 64UCs

[illegible]

Table DB.3.2 Number of waste collection containers in 34UCs

Necessary Containers in 34UCs			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Existing	10m3	5				10	10	10									
	5m3	2.5				90	80	70	0	0	0	0	0	0	0		
M/P	10m3	5															
	sub-total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5m3	2.5															
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.8m3	0.4															
			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				0	0	0	0	0	0	0	0	0	0	0	0	0	0
					0	0	0	0	0	0	0	0	0	0	0	0	0
						0	0	0	0	0	0	0	0	0	0	0	0
							0	0	0	0	0	0	0	0	0	0	0
								450	450	450	450	450	405	360	315	270	225
									300	300	300	300	300	270	240	210	180
										150	150	150	150	150	135	120	105
											250	250	250	250	250	225	200
												200	200	200	200	200	160
													200	200	200	200	200
														300	300	300	300
															350	350	350
																350	350
																	450
			0	0	0	0	0	450	750	900	1150	1350	1505	1730	1990	2225	2520
Existing	10m3	5	0	0	0	50	50	50	0	0	0	0	0	0	0	0	0
	5m3	2.5	0	0	0	225	200	175	0	0	0	0	0	0	0	0	0
M/P	10m3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5m3	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.8m3	0.4	0	0	0	0	0	180	300	360	460	540	602	692	796	890	1008
			0	0	0	275	250	405	300	360	460	540	602	692	796	890	1008
			0	0	0	55	117	185	260	344	436	514	592	684	786	886	1,006

B.4 Number of waste collection workers

Table DB.4.1 Number of waste collection workers

Number of workers				2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
SAUC																			
Arm-roll truck	10m3	Driver	1	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	
		worker	1	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	Driver	1	22	22	22	0	0	0	0	0	0	0	0	0	0	0	0	
		worker	1	22	22	22	0	0	0	0	0	0	0	0	0	0	0	0	
Tractor Trolley	3.2m3	Driver	1	37	37	37	0	0	0	0	0	0	0	0	0	0	0	0	
		worker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mini-dumper(primary)	1m3	Driver	1	35	35	35	35	35	35	31	28	24	21	17	14	10	6	3	
		worker	1	35	35	35	35	35	35	31	28	24	21	17	14	10	6	3	
Arm-roll truck	10m3	Driver	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		worker	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	Driver	1	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	
		worker	1	0	0	0	5	5	5	5	5	5	5	5	5	5	5	5	
Connector	13m3	Driver	1	13	28	68	75	93	93	108	117	128	140	148	160	171	185	200	
		worker	2	25	55	130	155	185	185	215	234	250	280	295	320	342	378	412	
Connector	7m3	Driver	1	38	58	98	98	98	112	112	120	125	135	145	153	164	172	181	
		worker	2	75	115	195	195	195	224	224	240	252	270	290	306	328	344	362	
Connector	4m3	Driver	1	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	
		worker	2	0	0	80	80	80	80	80	80	80	80	80	80	80	80	80	
Mini-dumper(primary)	1m3	Driver	1	0	0	0	0	0	0	0	0	0	0	0	2	6	10	13	
		worker	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Driver		155	195	270	275	293	293	295	270	253	301	315	335	357	383	409	
		worker		163	233	473	472	502	530	555	587	617	655	689	728	772	804	851	
Supervisor				54	54	54	54	54	54	54	54	54	54	54	54	54	54		
Inspector				5	5	5	5	5	5	5	5	5	5	5	5	5	5		
SAUC																			
Arm-roll truck	10m3	Driver	1	0	0	0	4	4	4	0	0	0	0	0	0	0	0	0	
		worker	1	0	0	0	4	4	4	0	0	0	0	0	0	0	0	0	
	5m3	Driver	1	0	0	0	22	22	22	0	0	0	0	0	0	0	0	0	
		worker	1	0	0	0	22	22	22	0	0	0	0	0	0	0	0	0	
Tractor Trolley	3.2m3	Driver	1	0	0	0	37	37	37	0	0	0	0	0	0	0	0	0	
		worker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Arm-roll truck	10m3	Driver	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		worker	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	Driver	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		worker	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Connector	13m3	Driver	1	0	0	0	0	0	12	24	29	36	42	48	54	61	66	73	
		worker	2	0	0	0	0	0	24	48	58	72	84	96	108	122	135	148	
Connector	7m3	Driver	1	0	0	0	0	0	15	30	35	42	48	54	61	66	73	79	
		worker	2	0	0	0	0	0	30	60	69	84	96	108	122	135	148	161	
Connector	4m3	Driver	1	0	0	0	0	0	0	0	0	0	0	1	3	4	5	6	
		worker	2	0	0	0	0	0	0	0	0	0	0	2	6	8	12	16	
Mini-dumper	1m3	Driver	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		worker	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Driver		0	0	0	63	63	90	39	52	65	77	89	103	118	133	151	
		worker		0	0	0	25	25	80	78	104	122	154	179	206	236	269	302	
Supervisor				0	0	0	34	34	34	34	34	34	34	34	34	34	34		
Inspector							5	5	5	5	5	5	5	5	5	5	5		
Total (driver)				155	195	270	275	294	294	295	270	253	301	315	335	357	383	409	
Total (worker)				163	233	473	468	525	510	534	551	742	810	921	1025	1100	1200	1318	
Total (Supervisor)				54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	
Total (Inspector)				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
5 ton truck	Bulk	Driver	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
		worker	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Wheel loader		Driver	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
		worker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
street sweeper	street	Driver	1	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	
Water Tank	street	Driver	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
	Total (driver)	3	3	3	3	3	3	3	7	7	7	7	7	7	7	7	7	7	
		Total (worker)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Guard				2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

B.5 Implementation cost for Waste Collection and Transportation

Table DB.5.1 Procurement cost and replacement cost for waste collection vehicles and containers

Procurement cost																			
64UC			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total	
Arm-roll truck	10m3	5,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	3,500,000	0	0	0	0	0	0	0	0	0	0	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	17,500,000	
Comactor	13m3	9,200,000	92,000,000	138,000,000	368,000,000	92,000,000	138,000,000	0	138,000,000	92,000,000	110,400,000	138,000,000	138,000,000	184,000,000	184,000,000	257,600,000	257,600,000	2,327,600,000	
Comactor	7m3	4,500,000	81,000,000	90,000,000	180,000,000	0	0	63,000,000	0	45,000,000	45,000,000	67,500,000	90,000,000	81,000,000	90,000,000	90,000,000	90,000,000	1,012,500,000	
Comactor	4m3	3,500,000	0	0	140,000,000	0	0	0	0	0	0	0	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	210,000,000	
Mini-dumper	1m3	1,000,000	0	0	0	0	0	0	0	0	0	0	0	2,000,000	4,000,000	4,000,000	3,000,000	13,000,000	
Container	10m3	360,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	200,000	0	0	0	0	0	0	0	6,000,000	0	0	0	0	0	0	0	6,000,000	
	0.8m3	28,000	16,800,000	19,600,000	16,800,000	37,800,000	6,020,000	7,140,000	7,140,000	7,700,000	8,120,000	8,820,000	9,520,000	9,464,000	10,864,000	13,664,000	22,624,000	202,076,000	
			189,800,000	247,600,000	704,800,000	129,800,000	144,020,000	70,140,000	145,140,000	150,700,000	163,520,000	214,320,000	255,020,000	293,964,000	306,364,000	382,764,000	390,724,000	3,788,676,000	
34UC																			
Arm-roll truck	10m3	5,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	3,500,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Comactor	13m3	9,200,000	0	0	0	0	0	110,400,000	110,400,000	46,000,000	64,400,000	55,200,000	55,200,000	55,200,000	64,400,000	46,000,000	64,400,000	671,600,000	
Comactor	7m3	4,500,000	0	0	0	0	0	67,500,000	0	36,000,000	31,500,000	22,500,000	22,500,000	27,000,000	31,500,000	36,000,000	40,500,000	315,000,000	
Comactor	4m3	3,500,000	0	0	0	0	0	0	0	0	0	0	5,000,000	10,000,000	5,000,000	10,000,000	10,000,000	40,000,000	
Mini-dumper	1m3	1,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Container	10m3	360,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	200,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	0.8m3	28,000	0	0	0	0	0	12,600,000	8,400,000	4,200,000	7,000,000	5,600,000	4,340,000	6,300,000	7,280,000	6,580,000	8,260,000	70,560,000	
			0	0	0	0	0	190,500,000	118,800,000	86,200,000	102,900,000	83,300,000	87,040,000	98,500,000	108,180,000	98,580,000	123,160,000	1,097,160,000	
Total			189,800,000	247,600,000	704,800,000	129,800,000	144,020,000	260,640,000	263,940,000	236,900,000	266,420,000	297,620,000	342,060,000	392,464,000	414,544,000	481,344,000	513,884,000	4,885,836,000	
Replacement cost																			
64UC			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total	
Arm-roll truck	10m3	5,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	3,500,000	0	0	0	0	0	0	0	0	0	0	0	3,500,000	3,500,000	3,500,000	3,500,000	14,000,000	
Comactor	13m3	9,200,000	0	0	0	0	0	0	0	9,200,000	9,200,000	27,600,000	64,400,000	73,600,000	82,800,000	92,000,000	101,200,000	460,000,000	
Comactor	7m3	4,500,000	0	0	0	0	0	0	0	9,000,000	18,000,000	27,000,000	45,000,000	45,000,000	40,500,000	54,000,000	49,500,000	288,000,000	
Comactor	4m3	3,500,000	0	0	0	0	0	0	0	0	0	0	14,000,000	14,000,000	14,000,000	14,000,000	14,000,000	70,000,000	
Mini-dumper	1m3	1,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Container	10m3	360,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	200,000	0	0	0	0	0	0	0	0	0	0	0	0	600,000	600,000	600,000	1,800,000	
	0.8m3	28,000	0	0	0	0	980,000	2,660,000	4,620,000	6,300,000	10,080,000	10,780,000	11,760,000	12,936,000	14,336,000	14,336,000	15,176,000	103,964,000	
			0	0	0	0	980,000	2,660,000	4,620,000	24,500,000	37,280,000	65,380,000	135,160,000	149,036,000	155,736,000	178,436,000	183,976,000	937,764,000	
34UC																			
Arm-roll truck	10m3	5,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	3,500,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Comactor	13m3	9,200,000	0	0	0	0	0	0	0	0	0	0	0	0	0	18,400,000	27,600,000	46,000,000	
Comactor	7m3	4,500,000	0	0	0	0	0	0	0	0	0	0	0	0	0	9,000,000	4,500,000	13,500,000	
Comactor	4m3	3,500,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mini-dumper	1m3	1,000,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Container	10m3	360,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	5m3	200,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	0.8m3	28,000	0	0	0	0	0	0	0	0	0	0	1,260,000	2,100,000	2,520,000	3,220,000	4,340,000	13,440,000	
			0	0	0	0	0	0	0	0	0	0	1,260,000	2,100,000	2,520,000	30,620,000	36,440,000	72,940,000	
Total			0	0	0	0	980,000	2,660,000	4,620,000	24,500,000	37,280,000	65,380,000	136,420,000	151,136,000	158,256,000	209,066,000	220,416,000	1,010,704,000	

Table DB.5.2 Maintenance cost for waste collection vehicles and containers

Maintenance Cost			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
64UC																	
Existing	Arm-roll truck	10m3	250,000	1,000,000	1,000,000	1,000,000	0	0	0	0	0	0	0	0	0	0	0
	5m3		175,000	3,850,000	3,850,000	3,850,000	0	0	0	0	0	0	0	0	0	0	0
	Tractor trolley	3.2m3	175,000	6,475,000	6,475,000	6,475,000	0	0	0	0	0	0	0	0	0	0	0
	Mini-dumper	1m3	50,000	1,750,000	1,750,000	1,750,000	1,750,000	1,750,000	1,550,000	1,400,000	1,200,000	1,050,000	850,000	700,000	500,000	300,000	150,000
M/P	Arm-roll truck	10m3	250,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5m3		175,000	0	0	0	875,000	875,000	875,000	875,000	875,000	875,000	1,050,000	1,050,000	1,050,000	1,050,000	1,050,000
	Comactor	13m3	460,000	5,980,000	12,880,000	31,280,000	35,880,000	42,780,000	42,780,000	49,680,000	53,820,000	58,880,000	64,400,000	68,080,000	73,600,000	78,660,000	86,940,000
	Comactor	7m3	225,000	8,550,000	13,050,000	22,050,000	22,050,000	22,050,000	25,200,000	25,200,000	27,000,000	28,350,000	30,375,000	32,625,000	34,425,000	36,900,000	38,700,000
	Comactor	4m3	175,000	0	0	7,000,000	7,000,000	7,000,000	7,000,000	7,000,000	7,000,000	7,000,000	7,000,000	7,000,000	7,000,000	7,000,000	7,000,000
	Mini-dumper	1m3	50,000	0	0	0	0	0	0	0	0	0	0	0	100,000	300,000	500,000
	Container	10m3	18,000	72,000	72,000	72,000	0	0	0	0	0	0	0	0	0	0	0
	5m3		10,000	0	0	0	0	0	0	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
	0.8m3		1,400	1,330,000	2,310,000	3,150,000	5,040,000	5,341,000	5,698,000	6,055,000	6,440,000	6,846,000	7,287,000	7,763,000	8,236,200	8,779,400	9,371,600
				29,007,000	41,387,000	76,627,000	72,595,000	79,796,000	83,303,000	90,360,000	96,835,000	103,451,000	111,287,000	117,668,000	125,411,200	133,489,400	144,161,600
34UC																	
Existing	Arm-roll truck	10m3	250,000	0	0	0	1,000,000	1,000,000	1000000	0	0	0	0	0	0	0	0
	5m3		175,000	0	0	0	3,850,000	3,850,000	3850000	0	0	0	0	0	0	0	0
	Tractor trolley	3.2m3	175,000	0	0	0	6,475,000	6,475,000	6475000	0	0	0	0	0	0	0	0
	Mini-dumper	1m3	50,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M/P	Arm-roll truck	10m3	250,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5m3		175,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Comactor	13m3	460,000	0	0	0	0	5,520,000	11,040,000	13,340,000	16,560,000	19,320,000	22,080,000	24,840,000	28,060,000	30,360,000	33,580,000
	Comactor	7m3	225,000	0	0	0	0	3,375,000	3,375,000	5,175,000	6,750,000	7,875,000	9,000,000	10,350,000	11,925,000	13,725,000	15,750,000
	Comactor	4m3	175,000	0	0	0	0	0	0	0	0	0	175,000	525,000	700,000	1,050,000	1,400,000
	Mini-dumper	1m3	50,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Container	10m3	18,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5m3		10,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.8m3		1,400	0	0	0	0	630,000	1,050,000	1,260,000	1,610,000	1,890,000	2,107,000	2,422,000	2,786,000	3,115,000	3,528,000
				0	0	0	0	9,525,000	15,465,000	19,775,000	24,920,000	29,085,000	33,362,000	38,137,000	43,471,000	48,250,000	54,258,000
	Total			29,007,000	41,387,000	76,627,000	72,595,000	79,796,000	92,828,000	105,825,000	116,610,000	128,371,000	140,372,000	151,030,000	163,548,200	176,960,400	209,199,800

Table DB.5.3 Operation cost (machinery) for waste collection vehicles and containers

	Operation Cost (machinery)																		
	64J C			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Existing	Arm-roll truck	10m3	819,325	3,277,300	3,277,300	3,277,300	0	0	0	0	0	0	0	0	0	0	0	0	
		5m3	819,325	18,025,147	18,025,147	18,025,147	0	0	0	0	0	0	0	0	0	0	0	0	
	Tredortrolley	3.2m3	324,000	11,988,000	11,988,000	11,988,000	0	0	0	0	0	0	0	0	0	0	0	0	
	Mini-dumper	1m3	196,000	6,860,000	6,860,000	6,860,000	6,860,000	6,860,000	6,860,000	6,076,000	5,488,000	4,704,000	4,116,000	3,332,000	2,744,000	1,960,000	1,176,000	588,000	
M.P	Arm-roll truck	10m3	819,325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		5m3	819,325	0	0	0	4,096,624	4,096,624	4,096,624	4,096,624	4,096,624	4,096,624	4,915,949	4,915,949	4,915,949	4,915,949	4,915,949	4,915,949	
	Corredor	13m3	392,727	5,105,455	10,966,364	26,705,455	30,632,727	36,523,636	36,523,636	42,414,545	45,949,091	50,289,091	54,981,818	58,123,636	62,836,364	67,156,364	74,225,455	80,901,818	
	Corredor	7m3	288,000	10,944,000	16,704,000	26,224,000	26,224,000	26,224,000	32,256,000	32,256,000	34,960,000	36,288,000	38,880,000	41,760,000	44,064,000	47,232,000	48,536,000	52,128,000	
	Corredor	4m3	196,000	0	0	7,840,000	7,840,000	7,840,000	7,840,000	7,840,000	7,840,000	7,840,000	7,840,000	7,840,000	7,840,000	7,840,000	7,840,000	7,840,000	
	Mini-dumper	1m3	196,000	0	0	0	0	0	0	0	0	0	0	0	0	392,000	1,176,000	1,960,000	2,548,000
	Sub-total			56,199,901	67,850,810	102,919,901	77,653,352	83,544,261	87,576,261	92,683,170	97,933,715	103,197,715	109,914,443	115,971,586	122,792,313	130,280,313	138,663,404	148,921,767	
	34J C																		
Existing	Arm-roll truck	10m3	819,325	0	0	0	3,277,300	3,277,300	3,277,300	0	0	0	0	0	0	0	0	0	
		5m3	819,325	0	0	0	18,025,147	18,025,147	18,025,147	0	0	0	0	0	0	0	0	0	
	Tredortrolley	3.2m3	324,000	0	0	0	11,988,000	11,988,000	11,988,000	0	0	0	0	0	0	0	0	0	
	Mini-dumper	1m3	196,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
M.P	Arm-roll truck	10m3	819,325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		5m3	819,325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Corredor	13m3	392,727	0	0	0	0	0	4,712,727	9,425,455	11,389,091	14,138,182	16,494,945	18,850,909	21,207,273	23,856,364	25,920,000	28,689,091	
	Corredor	7m3	288,000	0	0	0	0	0	4,320,000	4,320,000	6,624,000	8,640,000	10,080,000	11,520,000	13,248,000	15,264,000	17,568,000	20,160,000	
	Corredor	4m3	196,000	0	0	0	0	0	0	0	0	0	0	196,000	588,000	784,000	1,176,000	1,568,000	
	Mini-dumper	1m3	196,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Sub-total			0	0	0	30,013,147	30,013,147	36,045,875	13,745,455	18,013,091	22,778,182	26,574,945	30,566,909	35,043,273	40,004,364	44,664,000	50,397,091	
	Total			56,199,901	67,850,810	102,919,901	107,666,499	113,557,408	126,622,135	106,428,624	115,946,806	125,975,897	136,488,988	146,538,495	157,835,586	170,284,677	184,317,404	199,318,858	

Table DB.5.4 Operation cost (personnel) for waste collection vehicles and containers

Operator Cost (personnel)			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Existing	Arrival truck	10m3	396,000	1,584,000	1,584,000	1,584,000	0	0	0	0	0	0	0	0	0	0	0	4,752,000
	5m3	396,000	8,712,000	8,712,000	8,712,000	0	0	0	0	0	0	0	0	0	0	0	0	26,136,000
	Tractor-bulldozer	3.2m3	216,000	7,992,000	7,992,000	7,992,000	0	0	0	0	0	0	0	0	0	0	0	23,976,000
	Mini-dumper	1m3	396,000	13,860,000	13,860,000	13,860,000	13,860,000	13,860,000	12,276,000	11,088,000	9,504,000	8,316,000	6,732,000	5,544,000	3,960,000	2,376,000	1,188,000	144,144,000
M/P	Arrival truck	10m3	396,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5m3	396,000	0	0	0	1,980,000	1,980,000	1,980,000	1,980,000	1,980,000	1,980,000	1,980,000	2,376,000	2,376,000	2,376,000	2,376,000	2,376,000	25,740,000
	Connector	13m3	576,000	7,488,000	16,128,000	39,168,000	44,528,000	53,568,000	62,208,000	67,392,000	73,728,000	80,640,000	85,248,000	92,160,000	96,496,000	106,864,000	118,656,000	1,002,240,000
	Connector	7m3	216,000	8,208,000	12,528,000	21,168,000	21,168,000	24,192,000	24,192,000	25,920,000	27,216,000	29,160,000	31,320,000	33,048,000	35,424,000	37,152,000	39,096,000	360,960,000
	Connector	4m3	576,000	0	0	23,040,000	23,040,000	23,040,000	23,040,000	23,040,000	23,040,000	23,040,000	23,040,000	23,040,000	23,040,000	23,040,000	23,040,000	299,520,000
	Mini-dumper	1m3	396,000	0	0	0	0	0	0	0	0	0	0	0	792,000	2,376,000	3,960,000	5,148,000
	Supervisor		252,000	16,128,000	16,128,000	16,128,000	16,128,000	16,128,000	16,128,000	16,128,000	16,128,000	16,128,000	16,128,000	16,128,000	16,128,000	16,128,000	16,128,000	241,920,000
	Inspector		372,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	44,640,000
	Sub-total			65,364,000	78,324,000	133,044,000	124,080,000	132,720,000	135,744,000	142,800,000	148,524,000	154,572,000	162,240,000	167,820,000	176,064,000	184,776,000	196,872,000	2,211,552,000
	34U/C																	0
Existing	Arrival truck	10m3	396,000	0	0	0	1,584,000	1,584,000	1,584,000	0	0	0	0	0	0	0	0	4,752,000
	5m3	396,000	0	0	0	0	8,712,000	8,712,000	8,712,000	0	0	0	0	0	0	0	0	26,136,000
	Tractor-bulldozer	3.2m3	216,000	0	0	0	7,992,000	7,992,000	7,992,000	0	0	0	0	0	0	0	0	23,976,000
	Mini-dumper	1m3	396,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M/P	Arrival truck	10m3	396,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5m3	396,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Connector	13m3	576,000	0	0	0	0	6,912,000	13,824,000	16,704,000	20,736,000	24,192,000	27,648,000	31,104,000	35,136,000	38,016,000	42,048,000	256,320,000
	Connector	7m3	216,000	0	0	0	0	3,240,000	3,240,000	4,968,000	6,480,000	7,560,000	8,640,000	9,896,000	11,448,000	13,176,000	15,120,000	83,808,000
	Connector	4m3	576,000	0	0	0	0	0	0	0	0	0	576,000	1,728,000	2,304,000	3,456,000	4,608,000	12,672,000
	Mini-dumper	1m3	396,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Supervisor		252,000	0	0	0	8,568,000	8,568,000	8,568,000	8,568,000	8,568,000	8,568,000	8,568,000	8,568,000	8,568,000	8,568,000	8,568,000	103,816,000
	Inspector		372,000	0	0	0	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	2,976,000	38,712,000
	Sub-total			0	0	0	25,852,000	29,832,000	36,694,000	28,908,000	33,216,000	38,760,000	43,296,000	48,408,000	54,312,000	60,432,000	66,192,000	546,192,000
	Total			65,364,000	78,324,000	133,044,000	153,912,000	162,552,000	175,728,000	171,408,000	181,740,000	193,332,000	205,536,000	216,228,000	230,376,000	245,208,000	263,064,000	2,757,744,000

B.6 Operation and maintenance cost for waste collection vehicles and containers

Table DB.6.1 Operation and maintenance cost for waste collection vehicles and containers

Collection Vehicles and containers	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
64JC																
Procurement cost	188,800,000	247,600,000	704,800,000	129,800,000	144,020,000	70,140,000	145,140,000	150,700,000	163,520,000	214,320,000	255,020,000	293,964,000	306,364,000	382,764,000	390,724,000	3,788,676,000
Replacement cost	0	0	0	0	960,000	2,660,000	4,620,000	24,500,000	37,280,000	65,380,000	136,190,000	149,036,000	155,736,000	178,436,000	183,976,000	937,764,000
Maintenance Cost	29,007,000	41,387,000	76,627,000	72,595,000	79,796,000	83,303,000	90,360,000	96,835,000	103,451,000	111,287,000	117,696,000	125,411,200	133,489,400	144,161,600	154,941,800	1,460,320,000
Operation Cost (machinery)	56,196,901	67,850,810	102,919,901	77,653,352	83,544,261	87,576,261	92,663,170	97,933,715	103,197,715	109,914,443	115,971,586	122,792,313	130,280,313	139,653,404	148,921,767	1,537,092,912
Operation Cost (personnel)	65,394,000	78,324,000	133,044,000	124,080,000	132,720,000	135,744,000	142,800,000	148,524,000	154,572,000	162,240,000	167,820,000	176,064,000	184,776,000	196,872,000	208,608,000	2,211,552,000
Sub total	340,370,901	435,161,810	1,017,390,901	404,128,352	441,060,261	379,423,261	475,603,170	518,492,715	562,020,715	663,141,443	791,636,586	867,267,513	910,645,713	1,041,887,004	1,087,171,567	9,935,404,912
34JC																
Procurement cost	0	0	0	0	0	190,500,000	118,800,000	86,200,000	102,900,000	83,300,000	87,040,000	98,500,000	108,180,000	96,580,000	123,160,000	1,097,160,000
Replacement cost	0	0	0	0	0	0	0	0	0	0	1,290,000	2,100,000	2,520,000	30,620,000	36,440,000	72,940,000
Maintenance Cost	0	0	0	0	0	9,525,000	15,465,000	19,775,000	24,920,000	29,085,000	33,392,000	38,137,000	43,471,000	48,250,000	54,250,000	316,240,000
Operation Cost (machinery)	0	0	0	30,013,147	30,013,147	39,045,875	13,745,455	18,013,091	22,778,182	26,574,545	30,566,909	35,043,273	40,004,364	44,664,000	50,397,091	380,859,078
Operation Cost (personnel)	0	0	0	29,832,000	29,832,000	39,984,000	28,608,000	33,216,000	38,760,000	43,266,000	48,408,000	54,312,000	60,432,000	66,192,000	73,320,000	546,192,000
Sub total	0	0	0	59,845,147	59,845,147	279,054,875	176,618,455	157,204,091	188,358,182	182,255,545	200,636,909	228,092,273	254,607,364	288,306,000	337,575,091	2,413,399,078
Procurement cost	188,800,000	247,600,000	704,800,000	129,800,000	144,020,000	260,640,000	263,940,000	236,900,000	266,420,000	297,620,000	342,080,000	392,484,000	414,544,000	481,344,000	513,884,000	4,885,836,000
Replacement cost	0	0	0	0	0	960,000	2,660,000	4,620,000	24,500,000	37,280,000	65,380,000	136,420,000	151,136,000	158,256,000	209,056,000	1,010,704,000
Maintenance Cost	29,007,000	41,387,000	76,627,000	72,595,000	79,796,000	92,828,000	105,825,000	116,610,000	128,371,000	140,372,000	151,030,000	163,548,200	176,960,400	192,411,600	209,199,800	1,776,568,000
Operation Cost (machinery)	56,196,901	67,850,810	102,919,901	107,666,499	113,567,408	126,622,135	106,428,624	115,946,806	125,975,897	136,488,888	146,536,495	157,835,586	170,284,677	184,317,404	199,318,858	1,917,951,990
Operation Cost (personnel)	65,394,000	78,324,000	133,044,000	153,912,000	162,552,000	175,728,000	171,408,000	181,740,000	193,332,000	205,536,000	216,228,000	230,376,000	245,208,000	263,064,000	281,928,000	2,757,744,000
Total total	340,370,901	435,161,810	1,017,390,901	463,973,499	500,905,408	658,478,135	652,221,624	675,696,806	751,378,897	845,396,888	992,276,495	1,095,359,786	1,165,253,077	1,330,193,004	1,424,746,658	12,348,803,990

B.7 Street cleaning

Table DB.7.1 Cleaning Length per Vehicle

		M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
sw1		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48
sw2		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48
sw3			0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0		0	0
plan		96	96	96	96	96	96		96	96	96	96	96	96		96	96	96	96	96	96		96	96	96	96	96	96		96	96
		96	192	288	384	480	576		672	768	864	960	1056	1152		1248	1344	1440	1536	1632	1728		1824	1920	2016	2112	2208	2304		2400	2496
WT1		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48
WT2		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48
WT3		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48
WT4		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48	48	48	48	48		48	48
plan		192	192	192	192	192	192		192	192	192	192	192	192		192	192	192	192	192	192		192	192	192	192	192	192		192	192
		192	384	576	768	960	1152		1344	1536	1728	1920	2112	2304		2496	2688	2880	3072	3264	3456		3648	3840	4032	4224	4416	4608		4800	4992

Table DB.7.2 Cost for street cleaning

			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Procurement plan																
Streetsweeping		2016	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
		2021						2	2	2	2	2	2	2	2	1	1
		2024									1	1	1	1	1	1	1
		2026											2	2	2	2	2
		2027															
		2029														1	1
			2	2	2	2	2	4	4	4	4	4	6	6	6	6	6
Water Jet		2016	4	4	4	4	4	4	4	4	3	3	3	2	2	2	1
		2021															
		2024									1	1	1	1	1	1	1
		2026											2	2	2	2	2
		2027												1	1	1	1
		2030															1
			4	4	4	4	4	4	4	4	4	4	6	6	6	6	6
Streetsweeping		12,000,000	24,000,000					24,000,000					24,000,000				
Water Jet		9,200,000	36,800,000					0				0	18,400,000				9,200,000
Procurement cost			60,800,000	0	0	0	0	24,000,000	0	0	0	0	42,400,000	0	0	0	9,200,000
Streetsweeping		12,000,000									12,000,000			0		12,000,000	
Water Jet		9,200,000									9,200,000			9,200,000		0	
Replacement cost			0	0	0	0	0	0	0	0	21,200,000	0	0	9,200,000	0	12,000,000	0
Maintenance Cost																	
Streetsweeping		600,000	380,000	380,000	380,000	380,000	380,000	760,000	760,000	760,000	760,000	760,000	1,140,000	1,140,000	1,140,000	1,140,000	1,140,000
Water Jet		460,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000
Maintenance Cost			2,780,000	2,780,000	2,780,000	2,780,000	2,780,000	3,160,000	3,160,000	3,160,000	3,160,000	3,160,000	4,740,000	4,740,000	4,740,000	4,740,000	4,740,000
Operation Cost (machinery cost)																	
Streetsweeping		348,598	697,197	697,197	697,197	697,197	697,197	1,394,394	1,394,394	1,394,394	1,394,394	1,394,394	2,091,590	2,091,590	2,091,590	2,091,590	2,091,590
Water Jet		348,598	1,394,394	1,394,394	1,394,394	1,394,394	1,394,394	1,394,394	1,394,394	1,394,394	1,394,394	1,394,394	2,091,590	2,091,590	2,091,590	2,091,590	2,091,590
Operation Cost (machinery cost)			2,091,590	2,091,590	2,091,590	2,091,590	2,091,590	2,788,787	2,788,787	2,788,787	2,788,787	2,788,787	4,183,181	4,183,181	4,183,181	4,183,181	4,183,181
Operation Cost (Personnel cost)																	
Streetsweeping		216,000	792,000	792,000	792,000	792,000	792,000	1,584,000	1,584,000	1,584,000	1,584,000	1,584,000	2,376,000	2,376,000	2,376,000	2,376,000	2,376,000
Water Jet		216,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	864,000	1,296,000	1,296,000	1,296,000	1,296,000	1,296,000
Operation Cost (Personnel cost)			1,656,000	1,656,000	1,656,000	1,656,000	1,656,000	2,448,000	2,448,000	2,448,000	2,448,000	2,448,000	3,672,000	3,672,000	3,672,000	3,672,000	3,672,000
Procurement cost			60,800,000	0	0	0	0	24,000,000	0	0	0	0	42,400,000	0	0	0	9,200,000
Replacement cost			0	0	0	0	0	0	0	0	21,200,000	0	0	9,200,000	0	12,000,000	0
Maintenance Cost			2,780,000	2,780,000	2,780,000	2,780,000	2,780,000	3,160,000	3,160,000	3,160,000	3,160,000	3,160,000	4,740,000	4,740,000	4,740,000	4,740,000	4,740,000
Operation Cost (machinery cost)			2,091,590	2,091,590	2,091,590	2,091,590	2,091,590	2,788,787	2,788,787	2,788,787	2,788,787	2,788,787	4,183,181	4,183,181	4,183,181	4,183,181	4,183,181
Operation Cost (Personnel cost)			1,656,000	1,656,000	1,656,000	1,656,000	1,656,000	2,448,000	2,448,000	2,448,000	2,448,000	2,448,000	3,672,000	3,672,000	3,672,000	3,672,000	3,672,000
Total			67,327,590	6,527,590	6,527,590	6,527,590	6,527,590	32,396,787	8,396,787	8,396,787	29,596,787	8,396,787	54,995,181	21,795,181	12,595,181	24,595,181	21,795,181

B.8 Bulky waste

Table DB.8.1 Cost for bulky waste

			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Procurement plan																
5 ton Truck		2,016	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1
		2,024									1	1	1	1	1	1	1
			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Wheel loader		2,016	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
		2,024									1	1	1	1	1	1	1
			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5 ton Truck		3,800,000	7,600,000														
Wheel loader		12,000,000	12,000,000														
Procurement cost			19,600,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 ton Truck		3,800,000		0	0	0	0	0	0	0	3,800,000						
Wheel loader		12,000,000		0	0	0	0	0	0	0	12,000,000						
Replacement cost			0	0	0	0	0	0	0	0	15,800,000	0	0	0	0	0	0
Maintenance Cost																	
5 ton Truck		190,000	380,000	380,000	380,000	380,000	380,000	380,000	380,000	380,000	380,000	380,000	380,000	380,000	380,000	380,000	380,000
Wheel loader		600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000
Maintenance Cost			980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000
Operation Cost (machinery cost)																	
5 ton Truck		895,795	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590	1,791,590
Wheel loader		349,920	349,920	349,920	349,920	349,920	349,920	349,920	349,920	349,920	349,920	349,920	349,920	349,920	349,920	349,920	349,920
Operation Cost (machinery cost)			2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510
Operation Cost (Personnel cost)																	
5 ton Truck		396,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000
Wheel loader		216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000	216,000
Operation Cost (Personnel cost)			1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000
Procurement cost			19,600,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement cost			0	0	0	0	0	0	0	0	15,800,000	0	0	0	0	0	0
Maintenance Cost			980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000	980,000
Operation Cost (machinery cost)			2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510	2,141,510
Operation Cost (Personnel cost)			1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000	1,008,000
Total			23,729,510	4,129,510	4,129,510	4,129,510	4,129,510	4,129,510	4,129,510	4,129,510	19,929,510	4,129,510	4,129,510	4,129,510	4,129,510	4,129,510	4,129,510

B.9 Illegal dumping sites

Table DB.9.1 Cost for illegal dumping sites

Sr. No.		waste amount	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
URBAN UCS																												
	OTC	2524																										
	zone-1	4424.8	3224.8	2024.8	824.8	0																						
	zon-2	2030.4				1655.2	455.2	0																				
	OTC	2524																										
	zone-3	6821.6						6076.8	4876.8	3676.8	2476.8	1276.8	76.8	0														
	zone-4	2754.4												1631.2	431.2	0	0											
	zone-5	4660																1554.4	354.4	0								
	OTC	2524																		3814.4	2614.4	1414.4	214.4	0				
	zone-6	2224.8																						1239.2	39.2	0		
	zone-7	348.8																								1064	0	
	zone-8	998.4																									862.4	0
	Total	24,263																										
	Ston		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	total		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Wheel loader		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	total		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	procurement cost	19,600,000																		0								0
	replacement cost																			0								0
	Maintenance Cost	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	65,833	
	Personnel cost	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	72,000	
	Operation cost	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	93,960	
	Indirect Cost																											
	Total Cost	19,831,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	231,793	
	Outsourcing Cost	1,010,967	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	1,054,775	

B.10 C&D waste

Table DB.10.1 Cost for C&D waste

Industrial waste (141 ton/ day)						5 ton Truck	Wheel loader
				Deficiation	maintenance	3	1
5 ton Truck			3,800,000	475000		1,425,000	
Wheel loader			12,000,000	1500000			1,500,000
Procurement cost							
Maintenance Cost							
5 ton Truck			190,000		190,000	570,000	
Wheel loader			600,000		600,000		600,000
Maintenance Cost							
Operation Cost							
5 ton Truck			895,795			2,687,386	
Wheel loader			43,740				43,740
			216,000			648,000	
			216,000				216,000
Operation Cost						5,330,386	2,359,740
Total						7,690,126	

B.11 Parking Area

Table DB.11.1 Cost for parking area

		Number of cars	155	190	310	325	340	383	343	370	397	426	457	490	527	568	612
		Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
					2	2	2	2	2	2	2	2	2	2	2	2	2
												1	1	1	1	1	1
															1	1	1
Parking			2	2	4	4	4	4	4	4	4	5	5	5	6	6	6
Procurement cost	48,606,040	118,581,680	0	388,848,320	0	0	0	0	0	0	0	243,030,200	0	0	291,636,240	0	0
Replacement cost																	
Maintenance Cost	5%	6,725,552	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302	2,430,302
Operation Cost (machinery cost)	360,000	720,000	720,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,440,000	1,800,000	1,800,000	1,800,000	2,160,000	2,160,000	2,160,000
Operation Cost (Personnel cost)	198,000	396,000	396,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	792,000	990,000	990,000	990,000	1,188,000	1,188,000	1,188,000
Total		126,423,232	3,546,302	393,510,622	4,662,302	4,662,302	4,662,302	4,662,302	4,662,302	4,662,302	4,662,302	248,250,502	5,220,302	5,220,302	297,414,542	5,778,302	5,778,302

B.12 Cost for no separation/ Cost for Zero option

Table DB.12.1 Cost for no separation

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Procurement cost	408,381,680	247,600,000	1,138,648,320	136,800,000	144,020,000	272,040,000	276,540,000	230,900,000	265,720,000	539,950,200	385,020,000	391,764,000	715,280,240	484,144,000	526,484,000	6,163,292,440
Replacement cost	0	0	0	0	980,000	2,660,000	4,620,000	24,500,000	74,980,000	66,080,000	140,360,000	165,536,000	162,856,000	225,656,000	225,016,000	1,093,244,000
Maintenance Cost	40,282,552	48,367,302	85,198,969	80,510,302	87,711,302	100,493,302	114,120,302	124,605,302	136,331,302	148,297,302	160,163,302	172,421,502	186,063,702	201,429,902	218,223,102	1,904,219,447
Operation Cost (machinery cost)	69,970,648	81,621,557	119,351,048	121,757,101	127,648,010	141,409,934	119,272,423	128,790,605	138,819,696	149,692,787	160,029,362	171,038,453	183,951,544	197,892,271	212,801,726	2,124,047,165
Operation Cost (Personnel cost)	69,828,000	83,688,000	134,844,000	152,364,000	158,304,000	175,332,000	169,536,000	180,228,000	190,920,000	202,602,000	213,726,000	226,398,000	241,644,000	257,880,000	275,304,000	2,732,598,000
Total	588,462,880	461,276,859	1,478,042,336	491,431,403	518,663,312	691,935,236	684,088,725	689,023,907	806,770,998	1,106,622,289	1,059,298,664	1,127,157,955	1,489,795,486	1,367,002,173	1,457,828,828	14,017,401,052

Table DB.12.2 Cost for Zero option

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Procurement cost	218,581,680	0	388,848,320	0	0	24,000,000	4,000,000	3,000,000	4,000,000	246,030,200	46,400,000	7,000,000	300,636,240	8,000,000	17,200,000	1,267,696,440
Replacement cost	0	0	0	127,400,000	4,000,000	3,800,000	4,000,000	10,800,000	61,360,000	4,160,000	5,560,000	24,760,000	18,160,000	36,260,000	18,360,000	318,620,000
Maintenance Cost	25,472,552	21,177,302	20,518,969	15,310,302	15,510,302	16,080,302	16,080,302	16,470,302	17,450,302	17,450,302	19,030,302	19,030,302	19,030,302	19,030,302	19,030,302	276,672,447
Operation Cost (machinery cost)	55,865,193	55,865,193	55,645,593	58,412,946	58,412,946	59,110,143	59,110,143	59,110,143	59,110,143	59,470,143	60,864,536	60,864,536	61,224,536	61,224,536	61,224,536	885,515,267
Operation Cost (Personnel cost)	50,928,000	50,928,000	50,604,000	58,416,000	58,632,000	59,640,000	59,856,000	59,856,000	59,856,000	60,054,000	61,278,000	61,278,000	61,476,000	61,476,000	61,476,000	875,754,000
Total	350,847,425	127,970,495	515,616,882	259,539,248	136,555,248	162,630,445	143,046,445	149,236,445	201,776,445	387,164,645	193,132,838	172,932,838	460,527,078	185,990,838	177,290,838	3,624,258,154

SECTION C

FINAL DISPOSAL

**PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

FINAL REPORT

VOLUME 4

DATA BOOK

SECTION C

FINAL DISPOSAL**

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C.1 INCOMING WASTE AMOUNT SURVEY AT GONDLANWALA DISPOSAL SITE, GUJRANWALA

SUMMARY REPORT

MARCH 2015



PREPARED BY: SAMI ULLAH
RESEARCH ASSOCIATE, THE URBAN UNIT (USPMU)
BY THE GUIDANCE OF JICA PROJECT TEAM

Incoming Waste Amount Survey at Gondlanwala, Temporary Dumping Site Gujranwala Waste Management Company (GWMC), Gujranwala.

Summary of Report

Incoming waste amount study at Gondlanwala dump point was conducted in this project titled “JICA Integrated Solid Waste Management Master Plan for Gujranwala, keeping in view for estimation of total amount being disposed at this site on daily and monthly basis and to estimate life span of the Gondlanwala site. Three types of fleets are in mechanism by the GWMC for the disposal of solid waste collected from the urban city under his jurisdiction. Mini-Dumpers (35 No.), Arm Roll trucks (26 No.) and Tractor Trolleys (37 No.) collects the waste from streets, roads, designated points and containers to unload or dispose off at dump point.

Data was collected for the six month from September, 2014 to February, 2015 from truck scale computer room installed and constructed under the scheme of this project. Net waste amount weighed per month was sum up using daily basis data. As described in **Table 1** monthly waste amount unloaded in tons per month varied from 12,976 tons to 16,734 tons during the study period whereas cumulative waste amount was estimated 149,144 tons from March 2014 to February 2015 as shown in **Figure 1** whereas monthly waste amount shown in **Figure 2**. Gondlanwala dump site was started in the month of March 2014 for disposal of waste from the city. March 2014 to September 2014, waste amount was estimated on the basis of number of trips, capacity of vehicles and using private truck scale.

Table DC.1.1 Monthly and Cumulative Waste Disposal Amount at Gondlanwala

onth	Monthly Waste Disposal Amount at Gondlanwala Disposal Site (ton/month)	Cumulative Waste Disposal Amount at Gondlanwala Disposal Site (ton)
September, 2014	13,159	76,708
October	16,734	93,442
November	12,688	106,130
December, 2014	12,976	119,106
January, 2015	15,239	134,145
February	14,799	149,144

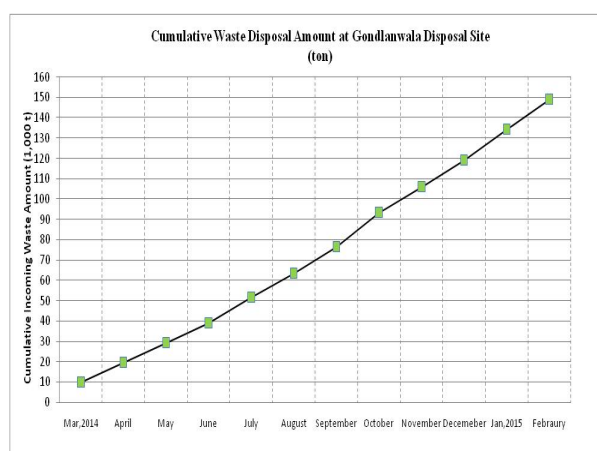


Figure DC.1.1 Cumulative Waste Disposal Amount (ton)

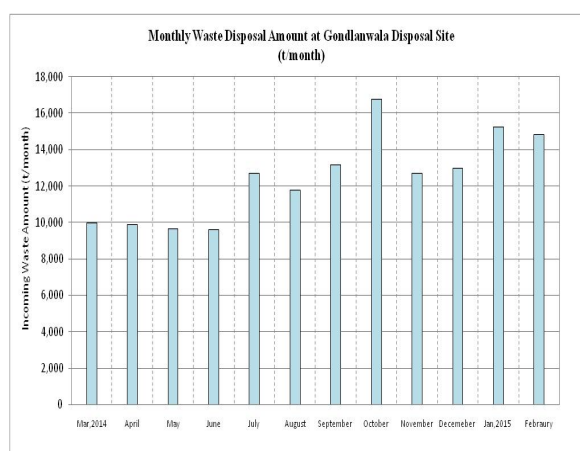


Figure DC.1.2 Monthly Waste Disposal Amount (t/month)

Total area acquired at Gondlanwala for dumping of solid waste is 63,700 m². Average depth of this site is 8 m measured from the topographic map survey conducted under this project. Assuming 0.9 ton/m³ density of the disposed waste (obtained from Bulk Density Survey), remaining life of the disposal site was estimated 1.8 years (21 months) also described in presented in **Table 2**.

Table DC.1.2 Estimation of Remaining Lifespan of Gondlanwala Disposal Site (as of February, 2015)

Area (m2)	Depth (m)	Volume (m3)
63,700	8	509,600
Filled Volume (m3)		165,716
Remaining Volume (m3)		343,884
Remaining Volume (tons)		309496
Remaining Life (month)		21.7
Remaining Life (year)		1.8

So, there is a dire need to complete proposed landfill project at Bhakhraywali in two years by the end of remaining lifetime of the current Gondlanwala disposal site.

C.2

LANDFILL WASTE BULK DENSITY SURVEY

February 2015

ARKHAM WAHID

Research Assistant, The Urban Unit

BY THE GUIDANCE OF JICA PROJECT TEAM

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Appendix 1: Survey Photographs

1. INTRODUCTION:

Gujranwala is an industrial city in Gujranwala District, Punjab Province of Pakistan. It is the fourth most populous metropolitan areas in Pakistan, and is one of the fastest growing cities in the world. Gujranwala is 226 meters (744 ft) above sea level. It shares borders with Ghakhar Mandi, Alipur Chatha, Kamonke and several small towns and villages. About 80 kilometers (50 miles) south is the provincial capital, Lahore, Sialkot and Gujrat lies to its north. The city has many commercial and industrial centers.

Anthropogenic activities in society generate large quantities of wastes posing a problem for their disposal. Improper disposal leads to spreading of diseases and unhygienic condition besides spoiling the aesthetics. Municipal solid waste management has emerged as one of the greatest challenges facing environmental protection agencies in Gujranwala.

Many factors including uncontrolled population, institutional weaknesses, urbanization, lack of resources lack of civic sense towards solid waste disposal have contributed to inadequate Solid Waste Management (hereinafter referred to as “SWM”) in Punjab. Gujranwala City was identified as the highest priority among the cities (Faisalabad, Gujranwala, Lahore, Multan, Rawalpindi, Sargodha and Sialkot) surveyed by the Japan International Cooperation Agency (hereinafter referred to as “JICA”) in 2009 regarding SWM.

With this background, “Integrated Solid Waste Management Master Plan in Gujranwala” is being prepared by the coordination of JICA and Government of the Punjab (hereinafter referred to as “GOPb). Several surveys and studies have been conducted under the umbrella of this project and Landfill waste bulk density Survey is one of them.

Waste Bulk Density plays a critical role in planning and designing of the final disposal plan. Data generated from bulk density studies is used for the planning and designing of the landfill and it gives us idea about the lifespan of landfill or disposal site for future years. The JICA Project Team (hereinafter referred to as “JPT”) has decided to conduct landfill waste bulk density survey for one time at Chianwali dumping site and Gondlanwala dumping site.

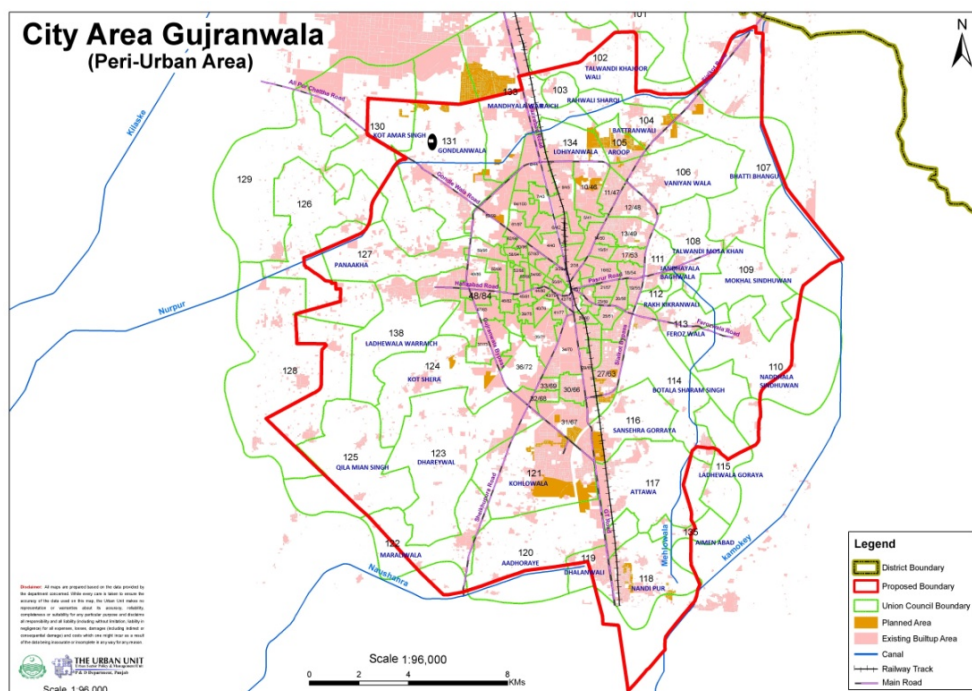


Figure DC.2.1 Map of Gujranwala

2. OUTLINE AND PURPOSE OF SURVEY

2.2 Outline of Survey

The “Waste bulk density survey” carried out only once for JICA Project.

2.3 Purpose of Survey

The purpose of the survey is to find out the bulk density which will be used further for the Bhakhraywali landfill planning. Specific objective of the survey is:

- Estimating the bulk density of the solid waste at the dumping sites, Chianwali & Gondlanwala

The results of the survey will be very beneficial parameter for planning, scheduling and designing of Municipal solid waste management infrastructure (herein referred as MSWM). Waste bulk density is an important measure used to define the capacity of waste storage and collection facilities required. Based on waste density and the capacity of trucks, the amount of waste collected can be measured in tons (weight). The high density measured reflects the less effectiveness of compaction vehicles for waste transportation. The parameter is affected by many factors such as seasonal variation and the way that waste is put into containers.

3. SURVEY METHOD

3.1 Survey Team

Survey was conducted by Arkham Wahid, Research Assistant deputed by the team leader for this survey.

3.2 Survey Period

The field survey was carried out on February 10, 2015.

3.3 Survey Location

Sampling locations were Chianwali and Gondlanwala disposal sites. Three boreholes each were excavated at Chianwali and Gondlanwala disposal sites for sampling of filled waste volume and weight. Six samples were taken in total. Figure DC2.2 and Figure DC.2.3 show location of Chianwali and Gondlanwala disposal sites.

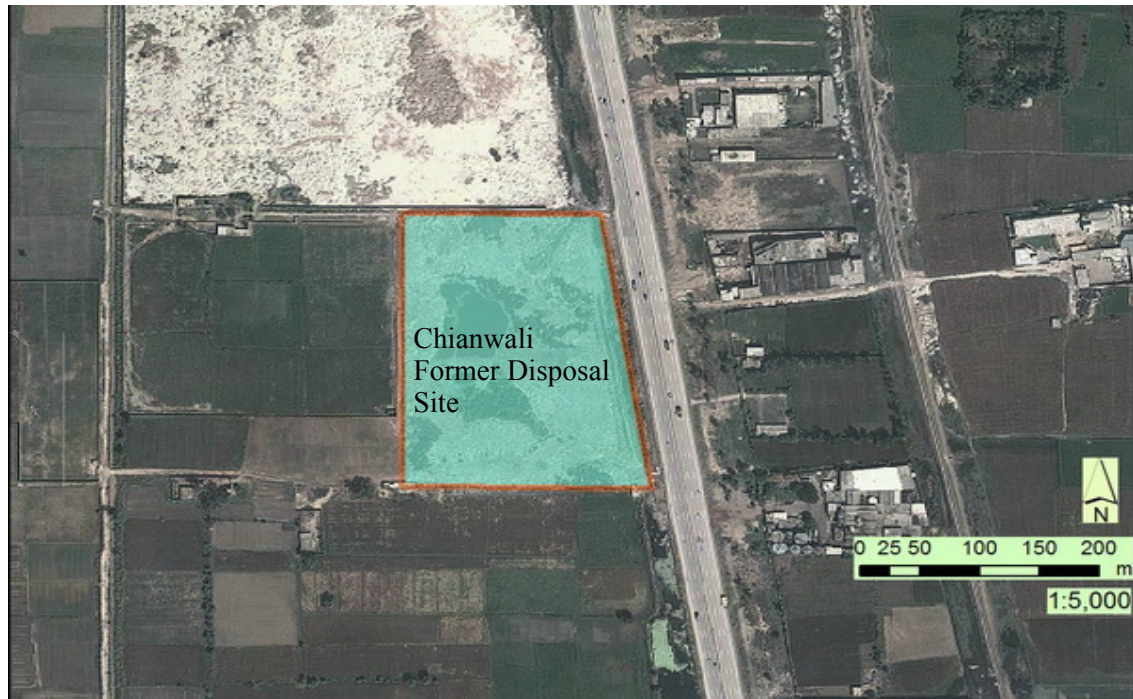


Figure DC.2.2 Chianwali Disposal Site

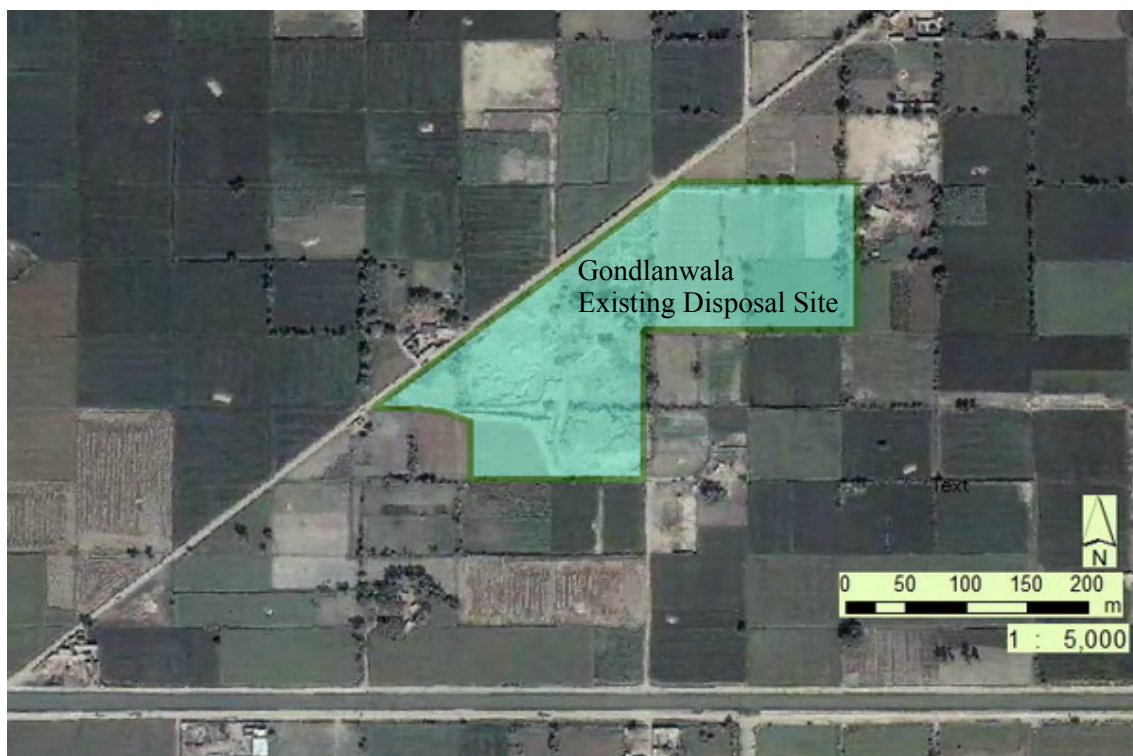


Figure DC.2.3 Gondlanwala Disposal Site

3.4 Survey Method

The sample of the filled waste is taken by an excavator. The size of the pit is 1.0-2.0 meter (approximately) rectangular and 1.0-2.0 meter deep approximately. After excavation of the pit, the actual size of borehole is measured and calculated the volume of the borehole specimen. The

excavated sample is loaded to the tractor trolleys for hauling to the weighbridge in Gondlanwala for measuring the net weight of the excavated sample waste. The Bulk Density is computed by division of the weight by the volume of each sample and then the average bulk density for both sites will be calculated.

4. DATA PROCESSING AND RESULT OF SURVEY

4.2 Chianwali Dumping Site:

Three pits were excavated at the Chianwali dumping site through excavator. Excavated waste is loaded on a tractor trolley and weighed at the Gondlanwala weigh bridge. The dimensions of the excavated pit and weight of waste from each pit is shown in Table DC.2.1. The volume of Pit 1 is 4.03 m³, volume of Pit 2 is 2.20 m³ and of Pit 3 is 3.69 m³.

Table DC.2.1 Bulk Density at Chianwali Dumping Site

Landfill Waste Bulk Density				
Particulars	Chianwali			
	Pit- 1	Pit 2	Pit 3	Average
Length (m)	2	1.85	1.9	1.92
Width (m)	1.88	1.13	1.85	1.62
Depth (m)	1.08	1.05	1.05	1.06
Volume (m ³)	4.03	2.20	3.69	3.31
Waste Amount (kg)	4880	2200	4040	3706.67
Density (kg/m ³)	1210.5	999.3	1094.6	1120.6

Figure DC.2.4 show that density of Pit 1 is 1210.5 kg/m³, Pit 2 is 999.3 kg/m³ and Pit 3 is 1094 kg/m³, Average of which is 1120 kg/m³. Density of Pit 1 is higher as compared to other 2 pits.

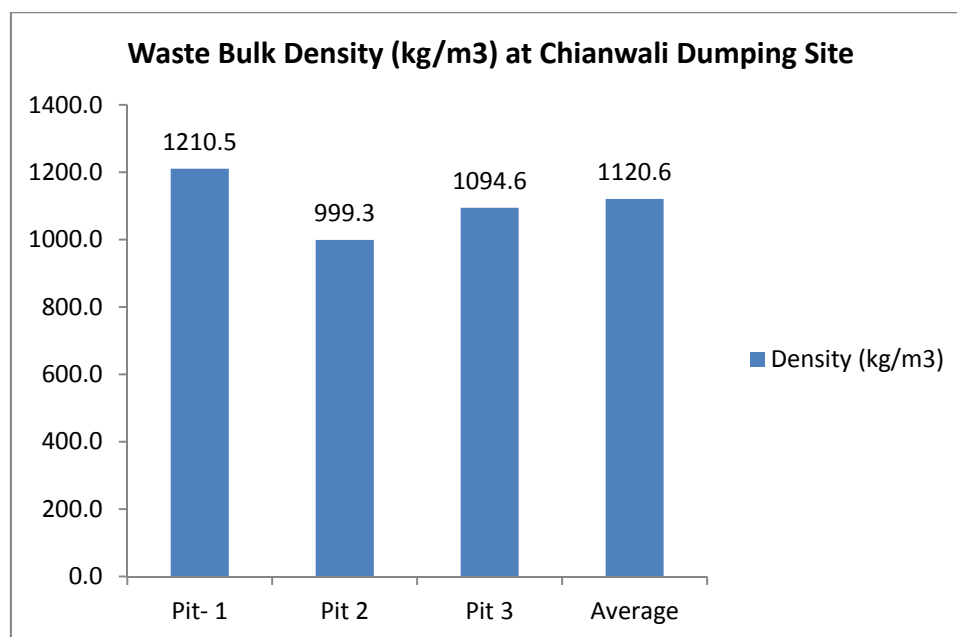


Figure DC.2.2 Bulk density at Chianwali

4.3 Gondlanwala Dumping Site:

Bulk density of solid waste samples collected at Gondlanwala disposal site seems lesser as that of Chianwali disposal site. Dimensions of pits excavated are shown in Table DC.2.2 below.

Table DC.2.2 Bulk Density at Gondlanwala Dumping Site

Landfill Waste Bulk Density				
Particulars	Gondlanwala			
	Pit- 1	Pit 2	Pit 3	Average
Length (m)	2.15	2.02	2.25	2.14
Width (m)	2.13	2.1	2.025	2.09
Depth (m)	0.975	1.15	1.08	1.07
Volume (m ³)	4.47	4.87	4.94	4.76
Waste Amount (kg)	3100	3680	2760	3180
Density (kg/m ³)	693.20	755.61	559.16	668.15

Figure 5 show that the value of bulk density is ranging from 559 – 755 kg/L with an average value of 668.15 Kg/L, lesser than that of Chianwali .Pit 2 has high density as compared to other 2 pits.

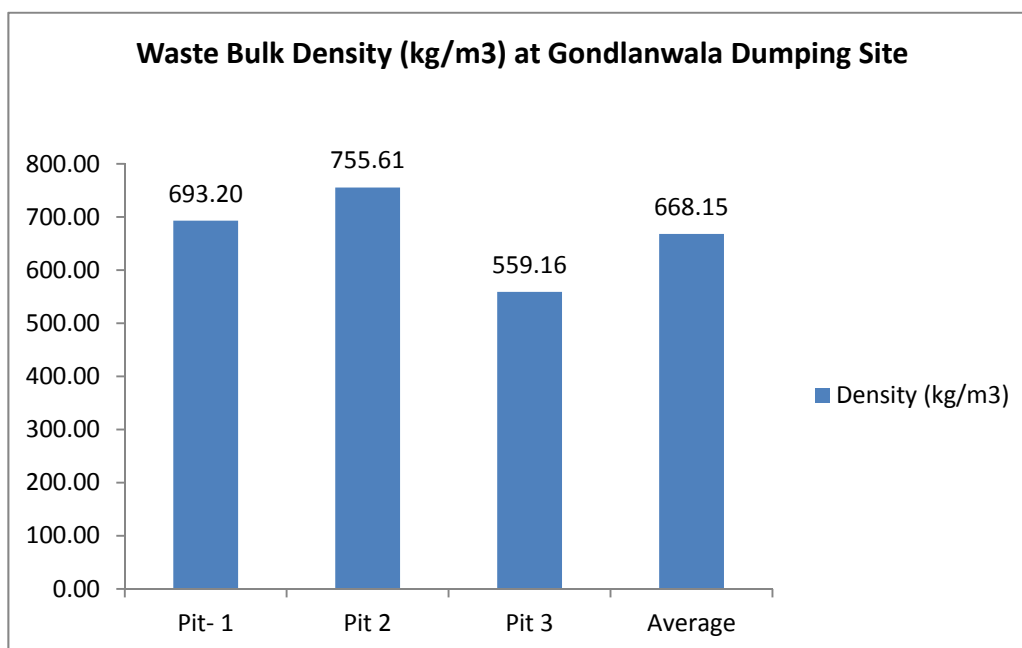


Figure DC.2.3 Bulk density at Gondlanwala

5. EVALUATION OF SURVEY RESULTS

The survey data is evaluated for both Chianwali and Gondlanwala Site.

Table DC.2.3 shows the comparison of Bulk density of both sites. Bulk density at Chianwali is higher than bulk density at Gondlanwala.

Table DC.2.3 Comparison of bulk density at Chianwali and Gondlanwala

Sr. No.	Sample	Bulk density (kg/m ³)		Volume (m ³)		Waste Amount (kg)	
		Chianwali	Gondlanwala	Chianwali	Gondlanwala	Chianwali	Gondlanwala
1	Pit 1	1210.5	693.2	4.03	4.47	4880	3100
2	Pit 2	999.3	755.61	2.2	4.87	2200	3680
3	Pit 3	1094.6	559.16	3.69	4.94	4040	2760
	Average	1120.6	668.15	3.31	4.76	3706.2	3180

Figure DC.2.6 shows that bulk density of Chianwali is greater than that of Gondlanwala disposal site. Similarly the weight of waste samples excavated at Chianwali is more than Gondlanwala samples excavated.

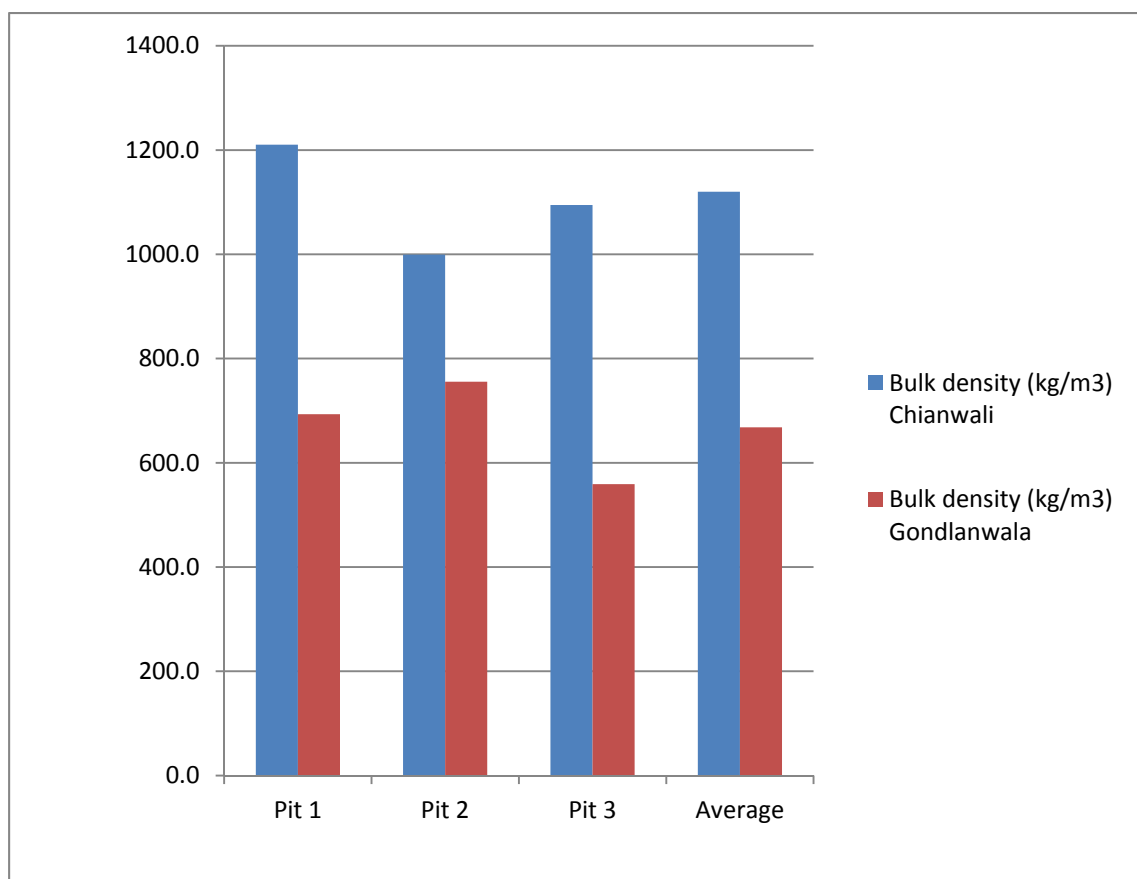


Figure DC.2.4 Comparison of bulk density at Chianwali and Gondlanwala

By this bulk density we can find out the life span of the Gondlanwala dumping site. Density indicates that waste is disposed without compaction, therefore reducing the disposal site life.

Table DC.2.4 shows that Gondlanwala dumping site will be closed after 445 days.

Table DC.2.4 Life span of Gondlanwala Disposal Site

Ideal Dumping Capacity of Gondlanwala					
Density(kg/m ³)	Area(m ²)	Depth(m)	Waste Generation(tons/day)	Dumping Capacity(tons)	Ideal life time(days)
668	47000	8.5	800	266866	333.5825
Expected life time of Gondlanwala according to daily Operations					
Density(kg/m ³)	Area(m ²)	Depth(m)	Daily waste Collection(tons/day)	Dumping Capacity(tons)	Expected Life(days)
668	47000	8.5	600	266866	444.7766667

6. CONCLUSION AND RECOMMENDATIONS

The results of this survey revealed that Chianwali waste is comparatively compressed as compared to Gondlanwala waste. Chianwali was operational in 2008 and was closed in 2014. Whereas Gondlanwala was operational in 2014.

Average Bulk Density at Chianwali (1120.6 kg/m³) > Average Bulk density at Gondlanwala (668.15 kg/m³).

Possible reason can be Biological degradation of organic matter in Chianwali as compared to Gondlanwala disposal site.

For planning, scheduling and designing of the Bhakhraywali landfill site it is recommended that collection vehicles with compactors should be used for the collection of solid waste hence increasing the life span of the site.

1000 kg/m³ density should be used for planning of Bhakhraywali landfill site keeping in consideration the bulk density of Chianwali (1120.6 kg/m³) and Gondlanwala disposal site (668.15 kg/m³).

C.3

Population Projection in 98 UCs

(Total Population in 64 Urban-UCs & 34 Peri-urban UCs)

**Table DC.3.1 Population Projection in 98 Union Councils
(64 Urban & 34 Peri-Urban) (by Town/UC-wise) (person)**

Sr. No.	Name of Town	UC Name	UC No.	GWMC Zones	1998	2014	2018	2020	2024	2030
URBAN UCS										
1	Qila Dedar Singh	Noor Bawa	39/3	Zone - 7	16,739	30,354	35,223	37,944	44,032	55,044
2		Chah Tailiany	75/39	Zone - 7	17,347	31,457	36,503	39,322	45,630	57,041
3		Data Gunj Bakhsh	76/40	Zone - 7	14,249	25,839	29,984	32,299	37,482	46,854
4		Chah Malian Wala	77/41	Zone - 5	16,730	30,338	35,206	37,925	44,009	55,015
5		Bakhta Wala	78/42	Zone - 5	15,931	28,889	33,523	36,113	41,907	52,386
6		Mubarak Shah	79/43	Zone - 7	19,899	36,084	41,873	45,107	52,344	65,433
7		Gulshan Abad	80/44	Zone - 7	19,875	36,041	41,823	45,053	52,281	65,353
8		Bagh Banpura	81/45	Zone - 7	19,381	35,145	40,783	43,933	50,982	63,729
9		Khalid Colony	82/46	Zone - 6	17,860	32,387	37,582	40,484	46,978	58,725
10		Kotli Rustam	85/49	Zone - 8	14,759	26,764	31,058	33,457	38,825	48,533
11		Qazafi Pura	86/50	Zone - 8	17,951	32,552	37,774	40,692	47,220	59,028
12		Rehman Pura	87/51	Zone - 8	19,388	35,158	40,798	43,949	51,000	63,753
13		Sultan Pura	88/52	Zone - 8	18,189	32,984	38,276	41,233	47,848	59,811
14		Muslim Town	89/53	Zone - 8	17,419	31,587	36,656	39,487	45,822	57,281
15		Guru Nanak Pura	90/54	Zone - 7	20,623	37,397	43,397	46,749	54,250	67,816
16		Lakarwala Pull	91/55	Zone - 7	19,048	34,541	40,083	43,179	50,106	62,636
17		Garjakh	94/58	Zone - 8	16,574	30,055	34,877	37,571	43,599	54,500
18		Nawab Chowk	95/59	Zone - 8	18,144	32,902	38,180	41,129	47,728	59,663
19		Islam Pura	96/60	Zone - 8	17,242	31,266	36,283	39,085	45,355	56,697
20	Khiali Shah Pur	Allabuksh	64/28	Zone - 4	20,020	36,304	42,128	45,382	52,663	65,833
21		Rana Colony	65/29	Zone - 4	20,124	36,492	42,346	45,617	52,935	66,171
22		Hashami Colony	66/30	Zone - 5	16,795	30,456	35,342	38,071	44,179	55,227
23		Theri Sansi	67/31	Zone - 5	17,979	32,603	37,834	40,756	47,295	59,121
24		Khaili Shahpur	68/32	Zone - 5	18,540	33,620	39,014	42,028	48,771	60,966
25		Gulzar Colony	69/33	Zone - 5	16,689	30,263	35,118	37,830	43,900	54,878
26		Nighar Cinema	70/34	Zone - 5	18,205	33,013	38,310	41,269	47,890	59,865
27		Kacha Khaili Road	71/35	Zone - 6	16,303	29,563	34,306	36,955	42,885	53,609
28		Noshera Sansi	72/36	Zone - 6	17,669	32,041	37,181	40,053	46,479	58,103

29		Qila Sundar Singh	73/37	Zone - 6	19,838	35,974	41,745	44,969	52,184	65,234
30		Cheragh Nagar	74/38	Zone - 6	17,522	31,774	36,871	39,718	46,090	57,616
31		Ramzan Pura	83/47	Zone - 6	17,123	31,050	36,032	38,815	45,043	56,307
32		Shah Rukh Colony	84/48	Zone - 6	16,981	30,793	35,733	38,493	44,669	55,840
33	Aroop	Model Town	40/4	Zone - 1	20,541	37,249	43,225	46,563	54,034	67,547
34		Amir Park	41/5	Zone - 2	18,235	33,067	38,372	41,335	47,968	59,964
35		Akram Colony	42/6	Zone - 1	18,388	33,344	38,694	41,683	48,371	60,467
36		Gulshan Iqbal Park Rd, Shaheen Abad	43/7	Zone - 1	14,192	25,735	29,863	32,170	37,330	46,665
37		Climax Abad	44/8	Zone - 1	19,590	35,524	41,222	44,406	51,531	64,417
38		Ehtasham Colony	45/9	Zone - 2	18,061	32,751	38,005	40,940	47,508	59,389
39		Kachi Fatto Mand	46/10	Zone - 2	17,308	31,386	36,422	39,235	45,530	56,915
40		Paki Fatto Mand	47/11	Zone - 2	18,369	33,310	38,653	41,638	48,318	60,401
41		Chak Jagna	48/12	Zone - 2	16,052	29,108	33,777	36,386	42,224	52,782
42		Gulzar Colony	49/13	Zone - 2	17,694	32,086	37,234	40,110	46,546	58,185
43		Noor Pura	50/14	Zone - 2	15,469	28,051	32,551	35,065	40,691	50,866
44		Gobind Garh	52/56	Zone - 7	17,686	32,071	37,216	40,090	46,522	58,155
45		Dubban Pura	53/57	Zone - 1	16,043	29,092	33,760	36,368	42,203	52,755
46		Bara Latif Shah	57/61	Zone - 1	17,784	32,249	37,424	40,314	46,782	58,479
47		Afzal Pura	58/62	Zone - 8	14,205	25,759	29,892	32,201	37,368	46,712
48		Gulshan Mohammad Town	59/63	Zone - 1	17,806	32,289	37,469	40,363	46,839	58,551
49		Shaheen Abad/ Zahid Colony	100/64	Zone - 1	19,250	34,908	40,508	43,636	50,637	63,299
50	Nandi Pur	Shamas Abad	37/1	Zone - 3	18,770	34,037	39,498	42,549	49,376	61,723
51		New Civil Line	38/2	Zone - 3	18,995	34,445	39,971	43,058	49,967	62,463
52		Dalta Road	51/15	Zone - 3	16,472	29,870	34,663	37,341	43,332	54,168
53		Satellite Town	52/16	Zone - 3	16,259	29,484	34,214	36,857	42,771	53,465
54		Madina Colony	53/17	Zone - 3	16,432	29,797	34,578	37,249	43,225	54,034
55		Fareed Town	54/18	Zone - 3	16,421	29,777	34,555	37,224	43,196	53,998
56		Ali Town	55/19	Zone - 3	17,484	31,705	36,791	39,632	45,990	57,491
57		Faqeer Pura	56/20	Zone - 3	19,400	35,180	40,824	43,977	51,033	63,793
58		Wahdit Colony	57/21	Zone - 3	18,589	33,709	39,117	42,139	48,900	61,128

59		Bilal Pura	58/22	Zone - 3	16,217	29,408	34,127	36,762	42,660	53,328
60		Shazad Shaheed Colony	59/23	Zone - 4	19,964	36,202	42,010	45,255	52,516	65,648
61		Mujahid Pura	60/24	Zone - 4	15,478	28,067	32,570	35,085	40,714	50,896
62		Arfat Colony	61/25	Zone - 4	17,052	30,922	35,882	38,653	44,854	56,070
63		Kot Habib-Ullah	62/26	Zone - 4	17,515	31,761	36,857	39,704	46,074	57,594
64		Peapoles Colony	63/27	Zone - 4	19,652	35,636	41,354	44,548	51,695	64,623
Total of Urban 64 UCs					1,132,509	2,053,665	2,383,140	2,567,203	2,979,086	3,724,039
PERI-URBAN UCS										
1	Qila Dedar Singh	Chak Ugo	126	Zone-17	14,545	26,376	30,607	32,971	38,261	47,829
2		Papnakha	127	Zone-17	20,311	36,832	42,741	46,042	53,429	66,789
3		Chahal Kalan	128	Zone-16	16,341	29,632	34,387	37,042	42,985	53,735
4		Kot Amer Singh	130	Zone-17	16,363	29,672	34,433	37,092	43,043	53,807
5		Ladhewala Waraich I	138	Zone-16	16,562	30,033	34,852	37,543	43,567	54,461
6		Ladhewala Waraich II	139	Zone-16	17,366	31,491	36,543	39,366	45,682	57,105
7	Khiali Shah Pur	Botala Sharam Singh	114	Zone-13	17,236	31,255	36,270	39,071	45,340	56,678
8		Sainsera Goraya	116	Zone-13	14,881	26,985	31,314	33,733	39,145	48,934
9		Attawa	117	Zone-14	18,769	34,035	39,496	42,546	49,372	61,719
10		Nand Pur	118	Zone-14	19,744	35,803	41,548	44,757	51,937	64,925
11		Dhillanwali	119	Zone-14	19,524	35,404	41,085	44,258	51,358	64,202
12		Audo Rai (Qila Nodh Singh)	120	ZONE-15	18,441	33,440	38,806	41,803	48,510	60,640
13		Kholowala/ Their Sansi	121	Zone-15	19,291	34,982	40,594	43,730	50,746	63,435
14		Murailwala	122	Zone-15	19,068	34,577	40,125	43,224	50,159	62,702
15		Dhariwal	123	Zone-15	13,620	24,698	28,661	30,874	35,828	44,787
16		Kot Shera	124	Zone-16	17,710	32,115	37,267	40,146	46,587	58,236
17		Qila Mian Singh	125	Zone-16	20,080	36,413	42,255	45,518	52,821	66,030
18		Eminabad Town	135	Zone-14	19,136	34,701	40,268	43,378	50,338	62,926
19	Aroop	Talwandi Khajoorwali	102	Zone-11	19,679	35,685	41,411	44,609	51,766	64,711
20		Talwandi Rahwali / Rahwali Sharqi	103	Zone-11	19,478	35,321	40,988	44,154	51,237	64,050
21		Butteranwali	104	Zone-11		33,259				

					18,341		38,595	41,576	48,247	60,311
22		Aroop	105	Zone-11	20,233	36,690	42,577	45,865	53,224	66,533
23		Wanianwala	106	Zone-11	18,217	33,034	38,334	41,295	47,920	59,904
24		Gondalanwala	131	Zone-18	20,131	36,505	42,362	45,634	52,955	66,198
25		Mandiala Warriach	133	Zone-18	19,480	35,325	40,992	44,158	51,243	64,057
26		Lohianwala	134	Zone-11	19,156	34,737	40,310	43,424	50,390	62,991
27	Nandi Pur	Bhatti Bango	107	Zone-12	17,513	31,758	36,853	39,699	46,068	57,589
28		Talwandi Musa Khan	108	Zone-12	16,705	30,292	35,153	37,868	43,943	54,932
29		Mokhal Sindhwan	109	Zone-12	18,966	34,393	39,910	42,993	49,891	62,367
30		Nadala Sindhwan	110	Zone-13	17,481	31,700	36,785	39,627	45,984	57,483
31		Jandiala Bagh Wala	111	Zone-12	18,049	32,730	37,981	40,914	47,478	59,351
32		Rakh Kikranwali	112	Zone-12	18,881	34,238	39,732	42,800	49,667	62,087
33		Ferozwala	113	Zone-13	16,905	30,655	35,573	38,321	44,469	55,589
34		Ladhewala Goraya	115	Zone-13	13,891	25,190	29,231	31,489	36,541	45,678
Total of Peri-Urban 34 UCs					612,094	1,109,957	1,288,037	1,387,520	1,610,132	2,012,772
Total Population of 98 Union Councils (64 Urban & 34 Peri-Urban)					1,744,603	3,163,622	3,671,177	3,954,723	4,589,218	5,736,811

C.4

Population Projection in ISWM Project Area

**Table DC.4.1 Population Projection in ISWM Project Area (JICA Project Area)
in 64 Urban UCs and 34 Peri-urban UCs (by Town/UC-wise) (person)**

Sr. No.	Name of Town	UC Name	UC No.	GWMC Zones	1998	2014	2018	2020	2024	2030
URBAN UCS										
1	Qila Dedar Singh	Noor Bawa	39/3	Zone - 7	16,739	30,354	35,223	37,944	44,032	55,044
2		Chah Tailiany	75/39	Zone - 7	17,347	31,457	36,503	39,322	45,630	57,041
3		Data Gunj Bakhsh	76/40	Zone - 7	14,249	25,839	29,984	32,299	37,482	46,854
4		Chah Malian Wala	77/41	Zone - 5	16,730	30,338	35,206	37,925	44,009	55,015
5		Bakhta Wala	78/42	Zone - 5	15,931	28,889	33,523	36,113	41,907	52,386
6		Mubarak Shah	79/43	Zone - 7	19,899	36,084	41,873	45,107	52,344	65,433
7		Gulshan Abad	80/44	Zone - 7	19,875	36,041	41,823	45,053	52,281	65,353
8		Bagh Banpura	81/45	Zone - 7	19,381	35,145	40,783	43,933	50,982	63,729
9		Khalid Colony	82/46	Zone - 6	17,860	32,387	37,582	40,484	46,978	58,725
10		Kotli Rustam	85/49	Zone - 8	14,759	26,764	31,058	33,457	38,825	48,533
11		Qazafi Pura	86/50	Zone - 8	17,951	32,552	37,774	40,692	47,220	59,028
12		Rehman Pura	87/51	Zone - 8	19,388	35,158	40,798	43,949	51,000	63,753
13		Sultan Pura	88/52	Zone - 8	18,189	32,984	38,276	41,233	47,848	59,811
14		Muslim Town	89/53	Zone - 8	17,419	31,587	36,656	39,487	45,822	57,281
15		Guru Nanak Pura	90/54	Zone - 7	20,623	37,397	43,397	46,749	54,250	67,816
16		Lakarwala Pull	91/55	Zone - 7	19,048	34,541	40,083	43,179	50,106	62,636
17		Garjakh	94/58	Zone - 8	16,574	30,055	34,877	37,571	43,599	54,500
18		Nawab Chowk	95/59	Zone - 8	18,144	32,902	38,180	41,129	47,728	59,663
19		Islam Pura	96/60	Zone - 8	17,242	31,266	36,283	39,085	45,355	56,697
20	Khiali Shah Pur	Allabuksh	64/28	Zone - 4	20,020	36,304	42,128	45,382	52,663	65,833
21		Rana Colony	65/29	Zone - 4	20,124	36,492	42,346	45,617	52,935	66,171
22		Hashami Colony	66/30	Zone - 5	16,795	30,456	35,342	38,071	44,179	55,227
23		Theri Sansi	67/31	Zone - 5	17,979	32,603	37,834	40,756	47,295	59,121
24		Khaili Shahpur	68/32	Zone - 5	18,540	33,620	39,014	42,028	48,771	60,966
25		Gulzar Colony	69/33	Zone - 5	16,689	30,263	35,118	37,830	43,900	54,878
26		Nighar Cinema	70/34	Zone - 5	18,205	33,013	38,310	41,269	47,890	59,865
27		Kacha Khaili Road	71/35	Zone - 6	16,303	29,563	34,306	36,955	42,885	53,609
28		Nosherasansi	72/36	Zone - 6	17,669	32,041	37,181	40,053	46,479	58,103

29		Qila Sundar Singh	73/37	Zone - 6	19,838	35,974	41,745	44,969	52,184	65,234
30		Cheragh Nagar	74/38	Zone - 6	17,522	31,774	36,871	39,718	46,090	57,616
31		Ramzan Pura	83/47	Zone - 6	17,123	31,050	36,032	38,815	45,043	56,307
32		Shah Rukh Colony	84/48	Zone - 6	16,981	30,793	35,733	38,493	44,669	55,840
33	Aroop	Model Town	40/4	Zone - 1	20,541	37,249	43,225	46,563	54,034	67,547
34		Amir Park	41/5	Zone - 2	18,235	33,067	38,372	41,335	47,968	59,964
35		Akram Colony	42/6	Zone - 1	18,388	33,344	38,694	41,683	48,371	60,467
36		Gulshan Iqbal Park Rd, Shaheen Abad	43/7	Zone - 1	14,192	25,735	29,863	32,170	37,330	46,665
37		Climax Abad	44/8	Zone - 1	19,590	35,524	41,222	44,406	51,531	64,417
38		Ehtasham Colony	45/9	Zone - 2	18,061	32,751	38,005	40,940	47,508	59,389
39		Kachi Fatto Mand	46/10	Zone - 2	17,308	31,386	36,422	39,235	45,530	56,915
40		Paki Fatto Mand	47/11	Zone - 2	18,369	33,310	38,653	41,638	48,318	60,401
41		Chak Jagna	48/12	Zone - 2	16,052	29,108	33,777	36,386	42,224	52,782
42		Gulzar Colony	49/13	Zone - 2	17,694	32,086	37,234	40,110	46,546	58,185
43		Noor Pura	50/14	Zone - 2	15,469	28,051	32,551	35,065	40,691	50,866
44		Gobind Garh	92/56	Zone - 7	17,686	32,071	37,216	40,090	46,522	58,155
45		Dubban Pura	93/57	Zone - 1	16,043	29,092	33,760	36,368	42,203	52,755
46		Bara Latif Shah	97/61	Zone - 1	17,784	32,249	37,424	40,314	46,782	58,479
47		Afzal Pura	98/62	Zone - 8	14,205	25,759	29,892	32,201	37,368	46,712
48		Gulshan Mohammad Town	99/63	Zone - 1	17,806	32,289	37,469	40,363	46,839	58,551
49		Shaheen Abad/ Zahid Colony	100/64	Zone - 1	19,250	34,908	40,508	43,636	50,637	63,299
50	Nandi Pur	Shamas Abad	37/1	Zone - 3	18,770	34,037	39,498	42,549	49,376	61,723
51		New Civil Line	38/2	Zone - 3	18,995	34,445	39,971	43,058	49,967	62,463
52		Dalta Road	51/15	Zone - 3	16,472	29,870	34,663	37,341	43,332	54,168
53		Satellite Town	52/16	Zone - 3	16,259	29,484	34,214	36,857	42,771	53,465
54		Madina Colony	53/17	Zone - 3	16,432	29,797	34,578	37,249	43,225	54,034
55		Fareed Town	54/18	Zone - 3	16,421	29,777	34,555	37,224	43,196	53,998
56		Ali Town	55/19	Zone - 3	17,484	31,705	36,791	39,632	45,990	57,491
57		Faqeer Pura	56/20	Zone - 3	19,400	35,180	40,824	43,977	51,033	63,793
58		Wahdit Colony	57/21	Zone - 3	18,589	33,709	39,117	42,139	48,900	61,128
59		Bilal Pura	58/22	Zone - 3	16,217	29,408	34,127	36,762	42,660	53,328

60		Shazad Shaheed Colony	59/23	Zone - 4	19,964	36,202	42,010	45,255	52,516	65,648
61		Mujahid Pura	60/24	Zone - 4	15,478	28,067	32,570	35,085	40,714	50,896
62		Arfat Colony	61/25	Zone - 4	17,052	30,922	35,882	38,653	44,854	56,070
63		Kot Habib-Ullah	62/26	Zone - 4	17,515	31,761	36,857	39,704	46,074	57,594
64		Peapoles Colony	63/27	Zone - 4	19,652	35,636	41,354	44,548	51,695	64,623
Total of Urban UCs					1,132,509	2,053,665	2,383,140	2,567,203	2,979,086	3,724,039
PERI-URBAN UCS										
1	Qila Dedar Singh	Chak Ugo	126	Zone-17	4,215	7,644	8,871	9,556	11,089	13,862
2		Papnakhia	127	Zone-17	17,667	32,038	37,178	40,049	46,474	58,094
3		Chahal Kalan	128	Zone-16	4,573	8,293	9,623	10,367	12,030	15,038
4		Kot Amer Singh	130	Zone-17	6,765	12,267	14,236	15,336	17,796	22,246
5		Ladhewala Waraich I	138	Zone-16	16,562	30,033	34,851	37,543	43,567	54,462
6		Ladhewala Waraich II	139	Zone-16	17,366	31,491	36,544	39,367	45,683	57,106
7	Khiali Shah Pur	Botala Sharam Singh	114	Zone-13	16,426	29,786	34,565	37,234	43,208	54,013
8		Sainsera Goraya	116	Zone-13	14,881	26,985	31,314	33,733	39,145	48,934
9		Attawa	117	Zone-14	16,133	29,255	33,949	36,571	42,439	53,050
10		Nand Pur	118	Zone-14	19,641	35,617	41,331	44,523	51,666	64,584
11		Dhillanwali	119	Zone-14	14,953	27,115	31,466	33,897	39,335	49,172
12		Audo Rai (Qila Nodh Singh)	120	Zone-15	13,781	24,991	29,000	31,240	36,252	45,317
13		Kholowala/ Their Sansi	121	Zone-15	19,291	34,982	40,594	43,730	50,745	63,434
14		Murailwala	122	Zone-15	14,609	26,491	30,742	33,116	38,429	48,038
15		Dhariwal	123	Zone-15	13,620	24,698	28,661	30,874	35,826	44,785
16		Kot Shera	124	Zone-16	17,710	32,115	37,267	40,145	46,585	58,236
17		Qila Mian Singh	125	Zone-16	15,769	28,596	33,185	35,748	41,483	51,857
18		Eminabad Town	135	Zone-14	8,953	16,235	18,840	20,295	23,551	29,441
19	Aroop	Talwandi Khajoorwali	102	Zone-11	8,628	15,645	18,155	19,557	22,694	28,370
20		Talwandi Rahwali / Rahwali Sharqi	103	Zone-11	19,478	35,321	40,988	44,153	51,237	64,049
21		Butteranwali	104	Zone-11	18,341	33,259	38,595	41,576	48,246	60,311
22		Aroop	105	Zone-11	20,233	36,690	42,577	45,866	53,225	66,535
23		Wanianwala	106	Zone-11	18,217	33,034	38,334	41,295	47,920	59,903
24		Gondalanwala	131	Zone-18	14,976	27,158	31,515	33,949	39,396	49,247

25		Mandiala Warriach	133	Zone-18	9,842	17,847	20,710	22,310	25,890	32,364
26		Lohianwala	134	Zone-11	19,156	34,737	40,310	43,424	50,391	62,991
27	Nandi Pur	Bhatti Bango	107	Zone-12	15,180	27,527	31,943	34,411	39,932	49,917
28		Talwandi Musa Khan	108	Zone-12	16,705	30,292	35,153	37,868	43,944	54,933
29		Mokhal Sindhwan	109	Zone-12	18,966	34,393	39,910	42,993	49,890	62,365
30		Nadala Sindhwan	110	Zone-13	9,252	16,777	19,469	20,973	24,338	30,423
31		Jandiala Bagh Wala	111	Zone-12	18,049	32,730	37,980	40,913	47,477	59,349
32		Rakh Kikranwali	112	Zone-12	18,881	34,238	39,732	42,801	49,668	62,088
33		Ferozwala	113	Zone-13	16,905	30,655	35,574	38,321	44,469	55,589
34		Ladhewala Goraya	115	Zone-13	5,963	10,814	12,548	13,518	15,687	19,610
Total of Peri-Urban UCs					501,689	909,749	1,055,710	1,137,253	1,319,707	1,649,713
Total Population of JICA Project Area					1,634,198	2,963,414	3,438,850	3,704,456	4,298,793	5,373,752

C.5

Domestic Waste Amount Projection in ISWM Project Area

**Table DC.5.1 Domestic Waste Generation Amount Projection in ISWM Project Area
(JICA Project Area) in 64 Urban & 34 Peri-Urban (by Town/UC-wise) (ton/day)**

Sr. No.	Name of Town	UC Name	UC No.	GWMC Zones	2014	2018	2020	2024	2030
URBAN UCS									
1	Qila Dedar Singh	Noor Bawa	39/3	Zone - 7	12.1	14.7	16.1	19.4	25.7
2		Chah Tailiany	75/39	Zone - 7	12.6	15.2	16.7	20.1	26.6
3		Data Gunj Bakhsh	76/40	Zone - 7	10.3	12.5	13.7	16.5	21.9
4		Chah Malian Wala	77/41	Zone - 5	12.1	14.6	16.1	19.4	25.7
5		Bakhta Wala	78/42	Zone - 5	11.6	13.9	15.3	18.4	24.5
6		Mubarak Shah	79/43	Zone - 7	14.4	17.4	19.1	23.0	30.6
7		Gulshan Abad	80/44	Zone - 7	14.4	17.4	19.1	23.0	30.5
8		Bagh Banpura	81/45	Zone - 7	14.1	17.0	18.6	22.4	29.8
9		Khalid Colony	82/46	Zone - 6	13.0	15.6	17.2	20.7	27.4
10		Kotli Rustam	85/49	Zone - 8	10.7	12.9	14.2	17.1	22.7
11		Qazafi Pura	86/50	Zone - 8	13.0	15.7	17.3	20.8	27.6
12		Rehman Pura	87/51	Zone - 8	14.1	17.0	18.6	22.4	29.8
13		Sultan Pura	88/52	Zone - 8	13.2	15.9	17.5	21.1	27.9
14		Muslim Town	89/53	Zone - 8	12.6	15.2	16.7	20.2	26.8
15		Guru Nanak Pura	90/54	Zone - 7	15.0	18.1	19.8	23.9	31.7
16		Lakarwala Pull	91/55	Zone - 7	13.8	16.7	18.3	22.0	29.3
17		Garjakh	94/58	Zone - 8	12.0	14.5	15.9	19.2	25.5
18		Nawab Chowk	95/59	Zone - 8	13.2	15.9	17.4	21.0	27.9
19		Islam Pura	96/60	Zone - 8	12.5	15.1	16.6	20.0	26.5
20	Khiali Shah Pur	Allabuksh	64/28	Zone - 4	14.5	17.5	19.2	23.2	30.7
21		Rana Colony	65/29	Zone - 4	14.6	17.6	19.3	23.3	30.9
22		Hashami Colony	66/30	Zone - 5	12.2	14.7	16.1	19.4	25.8
23		Theri Sansi	67/31	Zone - 5	13.0	15.7	17.3	20.8	27.6
24		Khaili Shahpur	68/32	Zone - 5	13.4	16.2	17.8	21.5	28.5
25		Gulzar Colony	69/33	Zone - 5	12.1	14.6	16.0	19.3	25.6
26		Nighar Cinema	70/34	Zone - 5	13.2	15.9	17.5	21.1	28.0
27		Kacha Khaili Road	71/35	Zone - 6	11.8	14.3	15.7	18.9	25.0
28		Noshera Sansi	72/36	Zone - 6	12.8	15.5	17.0	20.5	27.1
29		Qila Sundar Singh	73/37	Zone - 6	14.4	17.4	19.1	23.0	30.5
30		Cheragh Nagar	74/38	Zone - 6	12.7	15.3	16.8	20.3	26.9
31		Ramzan Pura	83/47	Zone - 6	12.4	15.0	16.5	19.8	26.3
32		Shah Rukh Colony	84/48	Zone - 6	12.3	14.9	16.3	19.7	26.1
33	Aroop	Model Town	40/4	Zone - 1	14.9	18.0	19.7	23.8	31.5
34		Amir Park	41/5	Zone - 2	13.2	16.0	17.5	21.1	28.0
35		Akram Colony	42/6	Zone - 1	13.3	16.1	17.7	21.3	28.2
36		Gulshan Iqbal Park Rd, Shaheen Abad	43/7	Zone - 1	10.3	12.4	13.6	16.4	21.8

37	Nandi Pur	Climax Abad	44/8	Zone - 1	14.2	17.1	18.8	22.7	30.1	
38		Ehtasham Colony	45/9	Zone - 2	13.1	15.8	17.4	20.9	27.7	
39		Kachi Fatto Mand	46/10	Zone - 2	12.6	15.2	16.6	20.0	26.6	
40		Paki Fatto Mand	47/11	Zone - 2	13.3	16.1	17.7	21.3	28.2	
41		Chak Jagna	48/12	Zone - 2	11.6	14.1	15.4	18.6	24.6	
42		Gulzar Colony	49/13	Zone - 2	12.8	15.5	17.0	20.5	27.2	
43		Noor Pura	50/14	Zone - 2	11.2	13.5	14.9	17.9	23.8	
44		Gobind Garh	92/56	Zone - 7	12.8	15.5	17.0	20.5	27.2	
45		Dubban Pura	93/57	Zone - 1	11.6	14.0	15.4	18.6	24.6	
46		Bara Latif Shah	97/61	Zone - 1	12.9	15.6	17.1	20.6	27.3	
47		Afzal Pura	98/62	Zone - 8	10.3	12.4	13.7	16.4	21.8	
48		Gulshan Mohammad Town	99/63	Zone - 1	12.9	15.6	17.1	20.6	27.3	
49		Shaheen Abad/ Zahid Colony	100/64	Zone - 1	14.0	16.9	18.5	22.3	29.6	
50		Nandi Pur	Shamas Abad	37/1	Zone - 3	13.6	16.4	18.0	21.7	28.8
51			New Civil Line	38/2	Zone - 3	13.8	16.6	18.3	22.0	29.2
52			Dalta Road	51/15	Zone - 3	11.9	14.4	15.8	19.1	25.3
53	Satellite Town		52/16	Zone - 3	11.8	14.2	15.6	18.8	25.0	
54	Madina Colony		53/17	Zone - 3	11.9	14.4	15.8	19.0	25.2	
55	Fareed Town		54/18	Zone - 3	11.9	14.4	15.8	19.0	25.2	
56	Ali Town		55/19	Zone - 3	12.7	15.3	16.8	20.2	26.8	
57	Faqeer Pura		56/20	Zone - 3	14.1	17.0	18.6	22.5	29.8	
58	Wahdit Colony		57/21	Zone - 3	13.5	16.3	17.9	21.5	28.5	
59	Bilal Pura		58/22	Zone - 3	11.8	14.2	15.6	18.8	24.9	
60	Shazad Shaheed Colony		59/23	Zone - 4	14.5	17.5	19.2	23.1	30.7	
61	Mujahid Pura		60/24	Zone - 4	11.2	13.5	14.9	17.9	23.8	
62	Arfat Colony		61/25	Zone - 4	12.4	14.9	16.4	19.7	26.2	
63	Kot Habib-Ullah		62/26	Zone - 4	12.7	15.3	16.8	20.3	26.9	
64	Peapoles Colony		63/27	Zone - 4	14.3	17.2	18.9	22.7	30.2	
Total of Urban 64 UCs					821.2	991.5	1,088.5	1,310.9	1,739.1	
PERI-URBAN UCS										
1	Qila Dedar Singh	Chak Ugo	126	Zone-17	2.7	3.2	3.6	4.3	5.7	
2		Papnakha	127	Zone-17	11.2	13.6	15.0	18.1	24.1	
3		Chahal Kalan	128	Zone-16	2.9	3.5	3.9	4.7	6.2	
4		Kot Amer Singh	130	Zone-17	4.3	5.2	5.7	6.9	9.2	
5		Ladhewala Waraich I	138	Zone-16	10.5	12.8	14.0	17.0	22.5	
6		Ladhewala Waraich II	139	Zone-16	11.0	13.4	14.7	17.8	23.6	
7	Khiali Shah Pur	Botala Sharam Singh	114	Zone-13	10.4	12.7	13.9	16.9	22.4	
8		Sainsera Goraya	116	Zone-13	9.4	11.5	12.6	15.3	20.3	

9		Attawa	117	Zone-14	10.2	12.4	13.7	16.6	22.0
10		Nand Pur	118	Zone-14	12.5	15.1	16.7	20.1	26.7
11		Dhillanwali	119	Zone-14	9.5	11.5	12.7	15.3	20.4
12		Audo Rai (Qila Nodh Singh)	120	Zone-15	8.7	10.6	11.7	14.1	18.8
13		Kholowala/Thei r Sansi	121	Zone-15	12.2	14.9	16.4	19.8	26.3
14		Murailwala	122	Zone-15	9.3	11.3	12.4	15.0	19.9
15		Dhariwal	123	Zone-15	8.6	10.5	11.5	14.0	18.5
16		Kot Shera	124	Zone-16	11.2	13.6	15.0	18.2	24.1
17		Qila Mian Singh	125	Zone-16	10.0	12.1	13.4	16.2	21.5
18		Eminabad Town	135	Zone-14	5.7	6.9	7.6	9.2	12.2
19	Aroop	Talwandi Khajoorwali	102	Zone-11	5.5	6.6	7.3	8.9	11.7
20		Talwandi Rahwali / Rahwali Sharqi	103	Zone-11	12.4	15.0	16.5	20.0	26.5
21		Butteranwali	104	Zone-11	11.6	14.1	15.5	18.8	25.0
22		Aroop	105	Zone-11	12.8	15.6	17.2	20.8	27.5
23		Wanianwala	106	Zone-11	11.6	14.0	15.4	18.7	24.8
24		Gondalanwala	131	Zone-18	9.5	11.5	12.7	15.4	20.4
25		Mandiala Warriach	133	Zone-18	6.2	7.6	8.3	10.1	13.4
26		Lohianwala	134	Zone-11	12.2	14.8	16.2	19.7	26.1
27	Nandi Pur	Bhatti Bango	107	Zone-12	9.6	11.7	12.9	15.6	20.7
28		Talwandi Musa Khan	108	Zone-12	10.6	12.9	14.2	17.1	22.7
29		Mokhal Sindhwan	109	Zone-12	12.0	14.6	16.1	19.5	25.8
30		Nadala Sindhwan	110	Zone-13	5.9	7.1	7.8	9.5	12.6
31		Jandiala Bagh Wala	111	Zone-12	11.5	13.9	15.3	18.5	24.6
32		Rakh Kikranwali	112	Zone-12	12.0	14.5	16.0	19.4	25.7
33		Ferozwala	113	Zone-13	10.7	13.0	14.3	17.3	23.0
34		Ladhewala Goraya	115	Zone-13	3.8	4.6	5.1	6.1	8.1
Total of Peri-Urban 34 UCs					318.2	386.3	425.3	514.9	683.0
Total Domestic Waste Generation Amount of JICA Project Area					1,139.4	1,377.8	1,513.8	1,825.8	2,422.1

C.6

Construction Cost of Final Disposal Facilities

C.6.1 Construction Quantity Take-off

C.6.2 Construction Unit Cost and Cost Estimates

C.6.1 Construction Quantity Take-off

Table DC.6.1 Construction Quantity Take-off

BAKHRAWALI LANDFILL SITE				
Sr. No	Item	Dimensions	Unit	Remarks
Leachate Collection Main/Pipe/Conduit				
1	Collection Main/Pipe/Conduit 1	650	Meter (m)	
	Collection Main/Pipe/Conduit 2	605	Meter (m)	
Lateral Pipes connected with Main/Pipe/Conduit				
2	Lateral Pipes connected with Main/Pipe/Conduit 1	2,575	Meter (m)	
	Lateral Pipes connected with Main/Pipe/Conduit 2	1,950	Meter (m)	
Junction Pit				
3	Junction Pit on Main/Conduit 1	3 Locations		
	Junction Pit on Main/Conduit 2	3 Locations		
4	HDPE Sheet Slope Lengths	1,795	Meter (m)	
Bottom Areas for HDPE				
5	Area of 1st Section	17,325	Sq. Meter (m2)	
	Area of 2nd Section	97,125	Sq. Meter (m2)	
	Area of 3rd Section	15,238	Sq. Meter (m2)	
	Area of 4th Section	23,800	Sq. Meter (m2)	
	TOTAL	153,488	Sq. Meter (m2)	
6	Total Fence Length	2,160	Meter (m)	
7	Total Perimeter Road Length	2,000	Meter (m)	
8	Diverge Irrigation Channel Length	825	Meter (m)	
9	Approach Road Total Length	725	Meter (m)	
	Approach Road Filling Section Length	320	m	Section Area
10	Intermediate Dike Lengths	300	Meter (m)	
Leachate Pond Area				
11	Leachate Pond Upper Area	2,340	Sq. Meter (m2)	
	Leachate Pond Bottom Area	1,178	Sq. Meter (m2)	
12	Pavement Parking Area	1,455	Sq. Meter (m2)	
13	Office and Storage 1 Unit			
14	Weigh Bridge			
15	Entrance & Exit Gate	2		6m
Number on Gas Vents on Leachate Main Conduit & Lateral Pipes				
16	Number on Gas Vents on Leachate Main Conduit 1 & Lateral Pipes	123		20 + Lateral Line
	Number on Gas Vents on Leachate Main Conduit 2 & Lateral Pipes	94		16 + Lateral Line
17	Monitoring Well	2		
	1) Shallow Monitoring Well	2		
17	2) Deep Monitoring Well	2		
18	Landscaping Area			
	Landscaping Area 1	28,000	Sq. Meter (m2)	
	Landscaping Area 2	7,125	Sq. Meter (m2)	
19	Landfill Upper Area			
	Landfill Upper Area 1st Section	12,000	Sq. Meter (m2)	
	Landfill Upper Area 2nd Section	14,800	Sq. Meter (m2)	
	Landfill Upper Area 3rd Section	70,200	Sq. Meter (m2)	
	Landfill Upper Area 4th Section	72,850	Sq. Meter (m2)	
	Landfill Upper Area 5th Section	28,125	Sq. Meter (m2)	
	TOTAL	197,975	Sq. Meter (m2)	
20	Excavation Area	108,000	m2	(Note: Depth has to multiply with the numeric)
21	Filling Volume	177,000	m3	
22	Force Main	1,795	Meter (m)	
Access Road				
23	Length of One Side of Access Road	2600	Meter (m)	
	Total Length of Access Road (Both Sides)	5200	Meter (m)	
Excavation of Pavement Area				
24	Entrance Road	4290	Cubic Meter (m3)	
	Exit Road	2730	Cubic Meter (m3)	
	Total	7020	Cubic Meter (m3)	
Sub-Base				
25	Entrance Road	14300	Sq. Meter (m2)	
	Exit Road	9100	Sq. Meter (m2)	
	Total	23400	Sq. Meter (m2)	
Weight Of Asphalt Concrete				
26	Entrance Road	1495	Tons	
	Exit Road	897	Tons	
	Total	2392	Tons	
Bhakhrawali Site Area				
27	Bhakhrawali Site Area (Section A)	25520	Sq. Meter (m2)	
	Bhakhrawali Site Area (Section B)	46330	Sq. Meter (m2)	
	Bhakhrawali Site Area (Section C)	60264	Sq. Meter (m2)	
	Bhakhrawali Site Area (Section D)	78246	Sq. Meter (m2)	
	Bhakhrawali Site Area (Section E)	33600	Sq. Meter (m2)	
	Total	243960	Sq. Meter (m2)	

Gondlanwala Improvement Plan				
Sr. No.	Item	Dimensions	Unit	
1	Approach Road	380	m	22
2	Unloading Stage	1,250	m3	
3	Leachate Collection Main/Conduit	490	m	
4	Junction Pit on Leachate Collection Main	10	place	
5	Leachate Suction Well	1	Unit	
6	Pumping Units	2		
7	Power Supply	1		
8	Force Main	980	m	30-40m leachate lift pipes?
9	Intermediate Dike	35	m	
10	Monitoring Wells	2		
	1) Shallow Monitoring Wells	1		
	2) Deep Monitoring Wells	1		
11	Bottom Filling Work			
	1st Section	16,200	m2	
	2nd Section	14,000	m2	
	3rd Section	7,800	m2	
	TOTAL	38,000	m2	
12	Improvement of Existing Road			
	Length of Existing Road	620	m	
	Excavation of Pavement Area	1,023	m3	
	Sub-base	3,410	m2	
	Weight of Asphalt Concrete	3,100	tons	
	Perimeter Earthen Drain	1,510	m	
13	Perimeter Fencing Length	1,510	m	
15	Gas Vents	125	Place	
16	Gondlanwala Site Area			
	Gondlanwala Site Area (Section A)	12012	Sq. Meter (m2)	
	Gondlanwala Site Area (Section B)	10890	Sq. Meter (m2)	
	Gondlanwala Site Area (Section C)	3944	Sq. Meter (m2)	
	Gondlanwala Site Area (Section D)	1755	Sq. Meter (m2)	
	Gondlanwala Site Area (Section E)	5220	Sq. Meter (m2)	
	Gondlanwala Site Area (Section F)	1755	Sq. Meter (m2)	
	Gondlanwala Site Area (Section G)	3835	Sq. Meter (m2)	
	Gondlanwala Site Area (Section H)	4071	Sq. Meter (m2)	
	Gondlanwala Site Area (Section I)	3451.5	Sq. Meter (m2)	
	Gondlanwala Site Area (Section J)	3451.5	Sq. Meter (m2)	
	Gondlanwala Site Area (Section K)	7839	Sq. Meter (m2)	
	Gondlanwala Site Area (Section L)	5500	Sq. Meter (m2)	
	Total	63724	Sq. Meter (m2)	

CHIANWALI CLOSURE PLAN				
Sr. No.	Item	Dimensions	Unit	Remarks / Specifications
Maintenance Road				
1	Maintenance Road 1	2,275	m2	Pavement Areas
	Maintenance Road 1	1,005	m2	Gravel Pavement
Repair of Existing Brick Wall				
2	Repair of Existing Brick Wall 1 H2.75m	66	m	
	Repair of Existing Brick Wall 2, H2.1m	60	m	
3	Gate (1)	6	m	
4	Leachate Suction Well (1)	1	place	RC:2(W)x3(L)x3(D)m
5	Pumping Units	2		
	Leachate Pond	1	place	3(W)x6(L)x2.5(D)m
6	Power Supply			
7	Force Main (1)	690	m	
8	Monitoring Wells	2		
	1) Shallow Monitoring Well	1		
	2) Deep Monitoring Well	1		
9	Gas Vents	66	place	
	Gas Collection Horizontal Pipe	1,150	m	
10	Earth Cover	29,900	m3	
	Excavation for Perimeter Road	11,850	m3	
	Dozing and Leveling Waste Layer	29,900	m3	
11	Chianwali Site Area	35096.41873	Sq. Meter (m2)	

Calculation of Required Number of Landfill Machine and O&M Cost Calculation References

Landfill Machine	Existing						
	Bucket Tractor	3					
Calculation of Required No. of Heavy Machine							
	Year		2014	2016	2018	2024	2030
	Incoming Waste Amount (t)		410		1000	1600	2500
	Incoming Waste Volume (m3)		820		2000	3200	5000
	Operation Hour (hr)		6		6	6	6
	Hourly Handling Amount		137		333	533	833
	Handling Capacity per Hour		50		50	50	50
	Required No. of Machine		3		7	11	17
	Req'd No. of Procurement		0		4	4	6
	Replacement					3	4
Procurement Schedule							
			2014	2016	2017	2023	2029
	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
Operation Cost	Present Fuel Consumption						
				80 Litter/2days/1unit			
				240 Litter/2days/3units			
	Handling Waste Amount (ton)			410 ton/day			
	Fuel Consumption per ton			0.30 Litter/ton			
Other Operation Cost	Insecticide			50,000 Rp/month			

C.6.2 Construction Unit Cost and Cost Estimates

Table DC.6.2 Construction Unit Cost

Landfill Construction Work Unit Cost							
Sr. No.	Unit Cost Items	Unit	Unit Price (Rs.)	Remarks	Unit	Unit Price (Rs.)	Remarks (Reference: Govt. Market Material Price, Gujranwala)
1	Earth Work						
	1.1 Excavation (Ordinary soil)	cu.m	160				
	1.2 Filling and compaction (Depth 0.3m)	cu.m	287				Converted 86Rp/m2 into 86/0.3=287
	1.3 Earth	cu.m	285	material cost delivered at site			
	1.4 Sand	cu.m	706	material cost delivered at site	100cft	950	Sand local at site
	1.5 Gravel	cu.m	1,150	material cost delivered at site			
2	Roads						
	2.1 Subbase	sq.m	6,000	Thickness? (15cm)	cu.m	923-1048	Including labour but without transportation cost +101.25 for side brick including labour; The carriage for the whole distance to the site of work shall be calculated on the basis of the rates of the actual means of transport used in carriage, i.e. road and/or rail, as the case may be.
	2.2 Road Base & Base Course	sq.m	7,500	Thickness?	cu.m	1,704	Including labour but without transportation cost +101.25 for side brick of the road including labour; ditto
	2.3 Wearing course	sq.m	7,000 to 2,0000	Thickness? 4 types, which type do you want to use? Depends upon	100 cft	2,000	
	2.4 Bituminous work				sq.m (6mm-25mm)	84-480	The carriage for the whole distance to the site of work shall be calculated on the basis of the rates of the actual means of transport used in carriage, i.e. road and/or rail, as the case may be.
	2.5 Asphalt surface coat	per ton	10,000	Thickness? Per ton, rate varies and depends upon the plant distance, the price may decrees or increased	sq.m (6mm-25mm)	478-1616	Asphalt flooring, including preparation of proper base remelting, setting out, and finishing complete; including labour but without transportation
	2.6 Concrete surface coat	sq.m	5,860	Thickness? 20 cm; rates depends upon thickness	sq.m	2973-4690.80	40 mm to 50 mm
	2.7 Cement Concrete				cu.m	5731-9987.35	
3	Concrete Work						
	3.1 Structural Concrete including reinforcing 35kN	cu.m	17,650		cu.m	9894-14006.15	
	3.2 Concrete Slab 30kN	cu.m	8,850				
	3.3 Lean concrete 20kN	cu.m	3,600				
	3.4 Gravel compaction 10cm	cu.m	2,000				
4	Fencing						
	4.1 Barbed wire (2m H)	m	3,500	Including foundation	m	882.45	Providing and fixing barbed wire fencing, with 4 horizontal and two cross wires, with R.C.C. 1:2:4 posts, 5.5"x6"x9" (1.68mx150mmx225 mm) at 8 ft. (2.45 m) centre to centre, reinforced with 4 No. 3/8" (10 mm) dia vertical bars and 1/8" (3 mm) dia stirrups 12" (300 mm) centre to centre, complete in all materials
	4.2 Chain link (2m H)	m	7,000	Including foundation			
	4.3 Gate (W=8m, H=2m)	lumpsum	200,000	Iron steel with 20 to 24 gage (iron thickness) Rs. 450000/- If iron gage 16 or 18 then rate will be 300,000/-			
5	Perimeter Drain						
	5.1 Cement lining drain (1m)	m	5,000				
	5.2 Reinforced Concrete drain (H=0.3m, W=1m)	m	7,000				
6	Lining						
	6.1 Clayey soil lining (0.6m)	sq.m	2,000		100cft	450	Good earth/clay
	6.2 Bentonite lining (0.6m)	sq.m	9,000				
	6.3 HDPE lining (1.5mm)	sq.m	13,700		sq.m	2000-4000	without labour and transportation

7 Leachate Collection System							
	7.1	Main collection HDPE (600mm Dia.) pipe	m	18,000		m	1,100 8bar, material cost
	7.2	Main collection Reinforce Concrete (600mm Dia.) with cover	m	7,000		ft	684 Material Cost: RCC sewer pipes conforming to ASTM C-76-79 (class III wall B) 600 mm (24") id
	7.3	Lateral leachate collection HDPE (150mm Dia.)	m	8,500		m	400-500 8bar, material cost
	7.4	Gravel 25mm to 50mm	cu.m	9,000			
8 Gas Vent							
	8.1	PVC 150mm Dia.				ft	375 material cost
	8.2	HDPE Pipe Gas Vent (H=4.0m & Dia.=150mm)	m	16,000		m	400-500 8bar, material cost
	8.3	Gabion	cu.m	9,900			
9 Building							
	9.1	Office building (200 sq.m)	sq.m	21,520	Includes foundation, wall, roofing, floor etc.		
	9.2	Storage building	sq.m	19,370	Includes foundation, wall, roofing, floor etc.		
	9.3	Weighbridge house	sq.m	17,200	Includes foundation, wall, roofing, floor etc.		
	9.4	Guard house	sq.m	16,140	Includes foundation, wall, roofing, floor etc.		
10 Monitoring Well							
	10.1	Monitoring Well with water level meter, Depth=30m & Dia.=150mm	Lumpsum	60,000	only for bore hole if pipe material including then rate is 90000/-		
	10.2	Monitoring Well with water level meter, Depth=60m & Dia.=150mm	Lumpsum	15,000	only for bore hole if pipe material including then rate is 200,000/-		
	11	Brick Wall	sq.m	1,850	9" thickness wall		
	12	Steel Skelton Structure	sq.m	15,900			
Asphalt Pavement Cost Analysis							
	2.5	Asphalt surface coat	per ton	10,000	Thickness? Per ton, rate varies and depends upon the plant distance, the price may decrease or increased	sq.m (6mm-25mm)	478-1616 Asphalt flooring, including preparation of proper base remelting, setting out, and finishing complete; including labour but without transportation
		Conversion to 5cm Thick Asphalt surface coat					
		Bulk Density of Asphalt Concrete	2.3	ton/m3			
		Cost per m3	23,000	Rs/m3			
		Pavement volume per m2, 50mm thick	0.05	m3			
		Pavement cost per m2	1,150	Rs/m2			

Table DC.6.3 Construction Cost Estimate of Bhakhraywali Disposal Facilities

Bhakhraywali Waste Disposal Facility Construction Cost						
Construction Item	Descriptions	Unit	Quantity	Unit Price	Cost	Remarks
1 Improvement of Access Road along the Irrigation Canal						
Stripping of Existing Pavement	Depth 0.3m	m3	7,020	160	1,123,200	Both sides of the canal
Construction of Subbase(North side)	Depth 0.3m	m2	9,100	3,000	27,300,000	
Construction of Subbase (South side)	Depth 0.3m	m2	14,300	3,000	42,900,000	
Pavement (North side)	50mm	m2	7,800	1,150	8,970,000	
Pavement (South side)	50mm	m2	13,000	1,150	14,950,000	
Construction of Bridge	Length 15m, Maximum Load 30 ton	Lumpsum		Lumpsum	10,000,000	
Subtotal					105,243,200	
2 Earth Work						
Excavation (Containment)		m3	648,000	160	103,680,000	Slope
Earthfill at Water Area in the Containment		m3	177,000	160	28,320,000	Transportation cost
Earthfill and Compaction for Intermediate Dike		m3	6,600	287	1,892,000	2m High
Earthfill and Compaction for Approach Road		m3	7,040	287	2,018,133	First Section only, 2m High
Subtotal					135,910,133	Earth Work Balance
3 Pavement Work for Roads						
Entrance Road	Width 5m, Asphalt Concrete	m2	1,000	4,150	4,150,000	Incl. Subbase
Parking Area	Asphalt Concrete	m2	1,455	3,320	4,830,600	Lower grade AS
Perimeter Road	Width 3m, Gravel	m2	6,000	2,045	12,270,600	
Intermediate Dike	Width 3m, Gravel	m2	900	2,045	1,840,590	
Approach Road	Width 3m, Gravel	m2	2,175	2,045	4,448,093	
Perimeter Road Underdrain	Dia 150 mm x 4m + 2 Pits per place	Place	6	200,000	1,200,000	For drainage from polder
Subtotal					28,739,883	
4 Impermeable Layer Work						
Soil Liner	Depth 0.6m	m2	153,488	2,000	306,975,000	
Bottom HDPE Liner	Thickness 1.5mm or 60Mil	m2	153,488	1,400	214,882,500	Bottom
Slope HDPE Liner	Thickness 1.5mm or 60Mil	m2	43,978	1,400	61,568,500	Slope
Subtotal					583,426,000	
5 Installation of Leachate Collection & Circulation System						
Excavation for Main Conduit	Avg. Area per m=3.25m2/m	m3	4,079	160	652,600	
Excavation for Lateral Pipe	Ave. Cut Area per m=2.16 m2/m	m3	9,774	160	1,563,840	
Reinforced Concrete Main Conduit	RC: 0.6m(W) x 0.6m(D)	m	1,255	6,142	7,708,461	Material + Labor
PE Lateral Pipes	Perforated PE Pipe Dia. 150mm	m	4,525	1,200	5,430,000	Material + Labor
Gravel for Main Conduit	25-50mm, Avg. 3.99m3/m	m3	16,274	1,150	18,715,344	
Gravel for Lateral Pipes	25-50mm, Avg 3.34m3/m	m3	38,998	1,150	44,847,999	
Crushed Stone for Main Conduit	37.5-90mm, Avg. 2.34 m3/m	m3	4,192	1,150	4,820,455	
Crushed Stone for Lateral Pipes	37.5-90mm, Avg. 2.54m3/m	m3	11,494	1,150	13,217,525	
Junction Pit for Main Conduit	2.0(W)x2.0(L)x3.0m(Avg.D)	place	6	300,000	1,800,000	
Leachate Pond	Include in the cost of bottom HDPE liner					
Leachate Circulation Pump Well	RC-2(W)x3(L)x4(D)m	place	1	Lumpsum	1,000,000	
Leachate Circulation Force Main	PVC Dia. 150mm	m	1,795	1,200	2,154,000	
Leachate Circulation Spray Nozzles	Interval at 20m	PC	90	2,000	179,500	
Leachate Circulation Pump including Sensor & Panel		units	2	1,500,000	3,000,000	
Subtotal					105,089,724	
6 Installation of Gas Vent						
Gabion	1.0(W)x1.0(L)x1.0m(D)	place	217	4,950	1,074,150	
Gas Vent Pipe-Vertical	PVC: Dia.150mm, 4m & Fittings	place	217	4,800	1,041,600	Extend the same high d
Gas Vent Pipe-Horizontal	PVC: Dia.150mm Fittings	m	0			Extension during the la
Subtotal					2,115,750	

7	Building Work						
	Site Office & Storage	8(W) x 24(L)m	m2	192	21,520	4,131,840	
	Weighbridge House	4(W)x4(L)m	m2	16	17,200	275,200	
	Guard House	2(W)x4(L)m	m2	8	16,140	129,120	
	Subtotal					4,536,160	
8	Weighbridge Equipment						
	Load Cells, platform, Computerized Weighing Sys.	40 ton, 12m	set		Lumpsum	2,500,000	
	Subtotal					2,500,000	
9	Power Supply and Lighting						
	Installation of Power Supply Line	Jumping from Public Line and Power	m	2,600	2,000	5,200,000	
	Lighting for Buildings		3 buildings	1	Lumpsum	1,500,000	
	Outdoor Lighting	Basement, Pole & Light	place	8	200,000	1,600,000	
	Subtotal					8,300,000	
10	Associated Works						
	Perimeter Fence		m	2,160	2,000	4,320,000	Take sugi: Additional Cost derived from PC1 application document
	Entrance & Exit Gates	6(W)x2.5(H)m	place	2	500,000	1,000,000	
	Landscaping	Planting trees, flower shrubs & flower	m2	35,125	200	7,025,000	
	Relocation of irrigation channel	RC:0.3(w)x0.3(D)m	m	825	2,000	1,650,000	
	Monitoring Well-Shallow Well	PVC:Dia, 150mm, 20m(D) & Screen	place	2	90,000	180,000	
	Monitoring Well-Deep Well	PVC:Dia, 150mm, 60m(D) & Screen	place	2	200,000	400,000	
	Garage for Landfill Machine	8(W) x 24(L)m, Roofing & As Pavement	m2	192	10,760	2,065,920	
	Subtotal					16,640,920	
11	Wheel Washing Bay-Additional Work	This item should be included in the associated works				4,300,000	
Total Construction Cost of Bhakhraywadi including the cost of washing bay						996,801,770	

Cost for Replacement/Extension during the landfill operation							
6	Installation of Gas Vent						
	Gabion	1.0(W)x1.0(L)x1.0m(D)	place	0	4,950	0	
	Gas Vent Pipe-Vertical	PVC: Dia.150mm, 4m & Fittings	place	217	4,800	1,041,600	Extend the same height
	Gas Vent Pipe-Horizontal	PVC: Dia.150mm Fittings	m	5,430	1,200	6,516,000	Extension during the la
							Include in the Operation a
Procurement Cost of Landfill Machines& Equipment (Gondlanwala & Bhakhraywadi)							
	Required No. of Landfill Machine	Output Capacity		2016	2018	2024	2030
	Bulldozer (Chain Dozer)	90-110kW			2	2	3
	Wheel Loader	90-110kW, Bucket 2-2.5 m3		1		1	2
	Excavator	120-150kW, Bucket 1.2-1.5m3		1		1	1
	Other Equipment	Engine Pump, Hose, Blower, Etc.			1		1
	Replacement (Bucket Tractor)	41kW, Buckets?m3				3	
	Replacement (Bulldozer)						2
	Replacement (Wheel Loader)						1
	Replacement (Excavator)						1
	Procurement Cost of Landfill Machine	Output Capacity	Cost per Unit (1,000 Rs)	2016	2017	2023	2029
	Bulldozer (Chain Dozer)	90-110kW	18,000	0	36,000	36,000	54,000
	Wheel Loader	90-110kW, Bucket 2-2.5 m3	15,000	15,000	0	15,000	30,000
	Excavator	120-150kW, Bucket 1.2-1.5m3	15,000	15,000	0	15,000	15,000
	Other Equipment	Engine Pump, Hose, Blower, Etc.			1,000		1,000
	Replacement (Bucket Tractor)	41kW, Buckets?m3	5,500	0	0	16,500	0
	Replacement (Bulldozer)		18,000	0	0	0	36,000
	Replacement (Wheel Loader)		15,000	0	0	0	15,000
	Replacement (Excavator)		15,000	0	0	0	15,000
	T total			30,000	37,000	82,500	166,000
Land Cost for Bhakhraywadi		150,000,000					
Civil & Building Work Cost						836,762,808	
Civil & Building Work Cost Require Maintenance						148,738,963	
Mechanical & Electrical Work Cost						11,300,000	
Total Construction Cost						996,801,770	996,801,770

Table DC.6.4 Construction Cost Estimate of Gondlanwala Improvement Work

Gondranwala Waste Disposal Site Improvement Work Cost		Gondranwala Cost Estimates					
	Construction Item	Descriptions	Unit	Quantity	Unit Price	Cost	Remarks
1	Improvement of Access Road	Length 620m					
	Stripping of Existing Pavement	Depth 0.3m	m3	1,023	160	163,680	
	Construction of Subbase	Depth 0.3m	m2	3,410	3,000	10,230,000	
	Construction of Subbase (South side)	Depth 0.3m	m2	0	3,000	0	
	Pavement	50mm	m2	3,100	1,150	3,565,000	
	Pavement (South side)	50mm	m2	0	1,150	0	
	Construction of Bridge	Length 15m, Maximum Load 30 ton	Lumpsum	0	Lumpsum	0	
					0		
	Subtotal					13,958,680	
					0		
2	Earth Work						
	Excavation (Containment)		m3	0	160	0	
	Earth fill at Water Area in the Containment		m3	38,000	160	6,080,000	Low Area (water area)
	Earth fill and Compaction for Intermediate Dike		m3	770	287	220,733	2m High
	Earth fill and Compaction for Approach Road		m3	9,610	287	2,754,867	
					0		
	Subtotal					9,055,600	Earth Work Balance
					0		
3	Pavement Work for Roads						
	Entrance Road	Width 5m, Asphalt Concrete	m2	0	4,150	0	
	Parking Area	Asphalt Concrete	m2	0	3,320	0	Lower grade AS
	Perimeter Road	Width 3m, Gravel	m2	0	2,045	0	
	Intermediate Dike	Width 3m, Gravel	m2	105	2,045	214,736	
	Approach Road	Width 3m, Gravel	m2	1,140	2,045	2,331,414	
	Perimeter Road Underdrain	Dia 150 mm x 4m + 2 Pits per place	Place	0	200,000	0	For drainage from polder
					0		
	Subtotal					2,546,150	
					0		
4	Impermeable Layer Work						
	Soil Liner	Depth 0.6m	m2	0	2,000	0	
	Bottom HDPE Liner	Thickness 1.5mm or 60Mil	m2	0	1,400	0	Bottom
	Slope HDPE Liner	Thickness 1.5mm or 60Mil	m2	0	1,400	0	Slope
					0		
	Subtotal					0	
					0		
5	Installation of Leachate Collection & Circulation System						
	Excavation for Main Conduit	Avg. Area per m=3.25m2/m	m3	1,593	160	254,800	
	Excavation for Lateral Pipe	Ave. Cut Area per m=2.16 m2/m	m3	0	160	0	
	Reinforced Concrete Main Conduit	RC: 0.6m(W) x 0.6m(D)	m	490	6,142	3,009,678	Material + Labor
	PE Lateral Pipes	Perforated PE Pipe Dia. 150mm	m	0	1,200	0	Material + Labor
	Gravel for Main Conduit	25-50mm, Avg. 3.99m3/m	m3	6,354	1,150	7,307,186	
	Gravel for Lateral Pipes	25-50mm, Avg. 3.34m3/m	m3	0	1,150	0	
	Crushed Stone for Main Conduit	37.5-90mm, Avg. 2.34 m3/m	m3	1,637	1,150	1,882,090	
	Crushed Stone for Lateral Pipes	37.5-90mm, Avg. 2.54m3/m	m3	0	1,150	0	
	Junction Pit for Main Conduit	2.0(W)x2.0(L)x3.0m(Avg.D)	place	10	300,000	3,000,000	
	Leachate Pond	18-18(W)x10-10(L)x2.5(D)m	Place	1	0	600,000	
	Leachate Circulation Pump Well	RC:2(W)x3(L)x4(D)m	place	1	Lumpsum	1,000,000	
	Leachate Circulation Force Main	PVC Dia 150mm	m	980	1,200	1,176,000	
	Leachate Circulation Spray Nozzles	Interval at 20m	PC	49	2,000	98,000	
	Leachate Circulation Pump including Sensor & Panel		units	2	750,000	1,500,000	
					0		
	Subtotal					19,827,754	
					0		
6	Installation of Gas Vent						
	Gabion	1.0(W)x1.0(L)x1.0m(D)	place	125	4,950	620,400	
	Gas Vent Pipe-Vertical	PVC: Dia.150mm, 4m & Fittings	place	125	4,800	601,600	Extend the same high during the landfill
	Gas Vent Pipe-Horizontal	PVC: Dia.150mm Fittings	m	0	0	0	Extension during the landfill operation install along the leachate conduit & Pipes
						0	
	Subtotal					1,222,000	

7	Building Work				0		
	Site Office & Storage	8(W) x 24(L)m	m2	0	21,520	0	
	Weighbridge House	4(W)x4(L)m	m2	0	17,200	0	
	Guard House	2(W)x4(L)m	m2	0	16,140	0	
					0		
	Subtotal				0	0	
					0		
8	Weighbridge Equipment				0		
	Load Cells, platform, Computerized Weighing Sys.	40 ton, 12m	set	0	Lumpsum	0	
					0		
	Subtotal				0	0	
					0		
9	Power Supply and Lighting				0		
	Installation of Power Supply Line	Jumping from Public Line and Power Supply Line	m	50	2,000	100,000	
	Lighting for Buildings		3 buildings	0	Lumpsum	0	
	Outdoor Lighting	Basement, Pole & Light	place	8	200,000	300,000	
					0		
	Subtotal				0	400,000	
					0		
10	Associated Works				0		
	Perimeter Fence		m	1,510	2,000	3,020,000	
	Entrance Gate	6(W)x2.5(H)m	place	1	500,000	500,000	
	Landscaping	Planting trees, flower shrubs & flower beds	m2	0	200	0	
	Relocation of irrigation channel	RC:0.3(w)x0.3(D)m	m	0	2,000	0	
	Monitoring Well-Shallow Well	PVC:Dia. 150mm, 20m(D) & Screen	place	1	90,000	90,000	
	Monitoring Well-Deep Well	PVC:Dia. 150mm, 60m(D) & Screen	place	1	200,000	200,000	
					10,760		
	Subtotal				0	3,810,000	
					0		
	Total Construction Cost of Gondlanwala				0	50,820,184	
	Cost for Replacement/Extension during the landfill operation				0		
6	Installation of Gas Vent				0		
	Gabion	1.0(W)x1.0(L)x1.0m(D)	place	0	4,950	0	
	Gas Vent Pipe-Vertical	PVC: Dia.150mm, 4m & Fittings	place	125	4,800	601,600	Extend the same height during the landfill
	Gas Vent Pipe-Horizontal	PVC: Dia.150mm Fittings	m	2,350	1,200	2,820,000	Extension during the landfill operation install along the leachate conduit & Pipes
						3,421,600	Include in the Annual O&M Cost??

Table DC.6.5 Construction Cost Estimate of Chianwali Safe Closure Work

Chianwali Waste Disposal Site Closure Work Cost							
	Construction Item	Descriptions	Unit	Quantity	Unit Price	Cost	Remarks
1	Improvement of Access Road	Length 620m					
	Stripping of Existing Pavement	Depth 0.3m	m3	0	160	0	
	Construction of Subbase	Depth 0.3m	m2	0	3,000	0	
	Construction of Subbase (South side)	Depth 0.3m	m2	0	3,000	0	
	Pavement	50mm	m2	0	1,150	0	
	Pavement (South side)	50mm	m2	0	1,150	0	
	Construction of Bridge	Length 15m, Maximum Load 30 ton	Lumpsum	0	Lumpsum	0	
					0		
	Subtotal				0	0	
					0		
2	Earth Work				0		
	Excavation for Perimeter Road		m3	11,850	160	1,896,000	
	Dozing and Levelling		m3	29,900	160	4,784,000	
	Final Cover Soil		m3	29,900	287	8,571,333	
	Earthfill and Compaction for Approach Road		m3	0	287	0	
					0		
	Subtotal				0	15,251,333	Earth Work Balance
					0		
3	Pavement Work for Roads				0		
	Entrance Road	Width 5m, Asphalt Concrete	m2	0	4,150	0	
	Parking Area	Asphalt Concrete	m2	0	3,320	0	
	Perimeter Road-1	Width 5m, Gravel	m2	2,275	2,045	4,652,603	
	Perimeter Road-2	Width 3m, Gravel	m2	1,005	2,045	2,055,326	
	Approach Road	Width 3m, Gravel	m2	0	2,045	0	
	Perimeter Road Underdrain	Dia 150 mm x 4m + 2 Pits per place	Place	1	200,000	200,000	For drainage from polder
					0		
	Subtotal				0	6,907,928	
					0		
4	Impermeable Layer Work				0		
	Soil Liner	Depth 0.6m	m2	0	2,000	0	
	Bottom HDPE Liner	Thickness 1.5mm or 60Mil	m2	0	1,400	0	Bottom
	Slope HDPE Liner	Thickness 1.5mm or 60Mil	m2	0	1,400	0	Slope
					0		
	Subtotal				0	0	
					0		
5	Installation of Leachate Collection & Circulation System				0		
	Excavation for Main Conduit	Avg. Area per m=3.25m2/m	m3	0	160	0	
	Excavation for Lateral Pipe	Ave. Cut Area per m=2.16 m2/m	m3	43	160	6,912	
	Reinforced Concrete Main Conduit	RC: 0.6m(W) x 0.6m(D)	m	0	6,142	0	Material + Labor
	PE Lateral Pipes	Perforated PE Pipe Dia. 150mm	m	20	1,200	24,000	Material + Labor
	Gravel for Main Conduit	25-50mm, Avg.:3.99m3/m	m3	0	1,150	0	
	Gravel for Lateral Pipes	25-50mm, Avg 3.34m3/m	m3	80	1,150	91,770	
	Crushed Stone for Main Conduit	37.5-90mm, Avg. 2.34 m3/m	m3	0	1,150	0	
	Crushed Stone for Lateral Pipes	37.5-90mm, Avg. 2.54m3/m	m3	51	1,150	58,420	
	Junction Pit for Main Conduit	2.0(W)x2.0(L)x3.0m(Avg.D)	place	0	300,000	0	
	Leachate Pond	3(W)x6(L)x2.5(D)m	place	1	0	0	
	Leachate Circulation Pump Well	RC:2(W)x3(L)x3(D)m	place	1	Lumpsum	1,000,000	
	Leachate Circulation Force Main	PVC Dia 150mm	m	690	1,200	1,000,000	
	Leachate Circulation Spray Nozzles	Interval at 20m	PC	35	2,000	1,000,000	
	Leachate Circulation Pump including Sensor & Panel		units	2	750,000	1,500,000	Lumpsum
					0		
	Subtotal				0	4,681,102	
					0		
6	Installation of Gas Vent				0		
	Gabion	0.5(W)x0.5(L)x0.5m(D)	place	66	1,238	82,225	x 0.25/1.0
	Gas Vent Pipe-Vertical	PVC: Dia.150mm,2.0m & Fittings	place	66	2,400	159,467	x 2/4
	Gas Vent Pipe-Horizontal	PVC: Dia.150mm Fittings	m	1,150	1,200	1,380,000	
					0		
	Subtotal				0	1,621,692	

7	Building Work				0		
	Site Office & Storage	8(W) x 24(L)m	m2	0	21,520	0	
	Weighbridge House	4(W)x4(L)m	m2	0	17,200	0	
	Guard House	2(W)x4(L)m	m2	0	16,140	0	
					0		
	Subtotal				0	0	
					0		
8	Weighbridge Equipment				0		
	Load Cells, platform, Computerized Weigh	40 ton, 12m	set	0	Lumpsum	0	
					0		
	Subtotal				0	0	
					0		
9	Power Supply and Lighting				0		
	Installation of Power Supply Line	Jumping from Public Line and Power	m	150	2,000	300,000	
	Lighting for Buildings		3 buildings	0	Lumpsum	0	
	Outdoor Lighting	Basement, Pole & Light	place	8	200,000	1,600,000	
					0		
	Subtotal				0	1,900,000	
					0		
10	Associated Works				0		
	Perimeter Fence Repair		m	126	2,000	252,000	
	Entrance Gate	6(W)x2.5(H)m	place	1	500,000	500,000	
	Landscaping	Planting trees, flower shrubs & flower	m2	0	200	0	
	Relocation of irrigation channel	RC:0.3(w)x0.3(D)m	m	0	2,000	0	
	Monitoring Well-Shallow Well	PVC:Dia, 150mm, 20m(D) & Screen	place	1	90,000	90,000	
	Monitoring Well-Deep Well	PVC:Dia, 150mm, 60m(D) & Screen	place	1	200,000	200,000	
					10,760		
	Subtotal				0	1,042,000	
					0		
Total Construction Cost of Chianwali					0	31,404,055	
Cost for Replacement/Extension during the landfill operation					0		
6	Installation of Gas Vent				0		
	Gabion	1.0(W)x1.0(L)x1.0m(D)	place	0	4,950		
	Gas Vent Pipe-Vertical	PVC: Dia.150mm, 4m & Fittings	place	0	4,800		Extend the same height during the landfill
	Gas Vent Pipe-Horizontal	PVC: Dia.150mm Fittings	m	0	1,200		Extension during the landfill operation install along the leachate conduit & Pipes

Table DC.6.6 Construction Cost Estimate of Gondlanwala Safe Closure Work

Gondranwala Waste Disposal Site Closure Work Cost						
Construction Item	Descriptions	Unit	Quantity	Unit Price	Cost	Remarks
1 Improvement of Access Road	Length 620m					
Stripping of Existing Pavement	Depth 0.3m	m3		160	0	
Construction of Subbase	Depth 0.3m	m2		3,000	0	
Construction of Subbase (South side)	Depth 0.3m	m2		3,000	0	
Pavement	50mm	m2		1,150	0	
Pavement (South side)	50mm	m2		1,150	0	
Construction of Bridge	Length 15m, Maximum Load 30 ton	Lumpsum		Lumpsum	0	
Subtotal				0	0	
2 Earth Work						
Excavation (Containment)		m3	0	160	0	
Dosing and Grading		m3	25,000	160	4,000,000	Grading filled waste
Final Earth Cover (Earth fill and Compaction)		m3	50,000	287	14,333,333	1m High Earth Cover
Earth fill and Compaction for Approach Road		m3		287	0	
Subtotal				0	18,333,333	Earth Work Balance
3 Pavement Work for Roads						
Entrance Road	Width 5m, Asphalt Concrete	m2		4,150	0	
Parking Area	Asphalt Concrete	m2		3,320	0	Lower grade AS
Perimeter Road	Width 3m, Gravel	m2		2,045	0	
Intermediate Dike	Width 3m, Gravel	m2		2,045	0	
Approach Road	Width 3m, Gravel	m2		2,045	0	
Perimeter Road Underdrain	Dia 150 mm x 4m + 2 Pits per place	Place		200,000	0	For drainage from polder
Subtotal				0	0	
4 Impermeable Layer Work						
Soil Liner	Depth 0.6m	m2		2,000	0	
Bottom HDPE Liner	Thickness 1.5mm or 60Mil	m2		1,400	0	Bottom
Slope HDPE Liner	Thickness 1.5mm or 60Mil	m2		1,400	0	Slope
Subtotal				0	0	
5 Installation of Leachate Collection & Circulation System						
Excavation for Main Conduit	Avg. Area per m=3.25m2/m	m3		160	0	
Excavation for Lateral Pipe	Ave. Cut Area per m=2.16 m2/m	m3		160	0	
Reinforced Concrete Main Conduit	RC: 0.6m(W) x 0.6m(D)	m		6,142	0	Material + Labor
PE Lateral Pipes	Perforated PE Pipe Dia. 150mm	m		1,200	0	Material + Labor
Gravel for Main Conduit	25-50mm, Avg. 3.99m3/m	m3		1,150	0	
Gravel for Lateral Pipes	25-50mm, Avg. 3.34m3/m	m3		1,150	0	
Crushed Stone for Main Conduit	37.5-90mm, Avg. 2.34 m3/m	m3		1,150	0	
Crushed Stone for Lateral Pipes	37.5-90mm, Avg. 2.54m3/m	m3		1,150	0	
Junction Pit for Main Conduit	2.0(W)x2.0(L)x3.0m(Avg.D)	place		300,000	0	
Leachate Pond	18-18(W)x10-10(L)x2.5(D)m	Place		0		
Leachate Circulation Pump Well	RC-2(W)x3(L)x4(D)m	place		Lumpsum		
Leachate Circulation Force Main	PVC Dia 150mm	m		1,200	0	
Leachate Circulation Spray Nozzles	Interval at 20m	PC		2,000	0	
Leachate Circulation Pump including Sensor & Panel		units		750,000		
Subtotal				0	0	
6 Installation of Gas Vent						
Gabion	0.5(W)x0.5(L)x0.5m(D)	place		4,950	0	
Gas Vent Pipe-Vertical	PVC: Dia.150mm.2.0m & Fittings	place	125	2,400	300,800	x 2/4
Gas Vent Pipe-Horizontal	PVC: Dia.150mm Fittings	m	1,800	1,200	2,160,000	300x6: interval 40m
Subtotal				0	2,460,800	
7 Building Work						
Site Office & Storage	8(W) x 24(L)m	m2		21,520	0	
Weighbridge House	4(W)x4(L)m	m2		17,200	0	
Guard House	2(W)x4(L)m	m2		16,140	0	
Subtotal				0	0	
8 Weighbridge Equipment						
Load Cells, platform, Computerized Weighing Sys.	40 ton, 12m	set		Lumpsum	0	
Subtotal				0	0	
9 Power Supply and Lighting						
Installation of Power Supply Line	Jumping from Public Line and Power Supply Line	m		2,000	0	
Lighting for Buildings		3 buildings		Lumpsum	0	
Outdoor Lighting	Basement, Pole & Light	place		200,000		
Subtotal				0	0	
10 Associated Works						
Perimeter Fence		m	1,510	2,000	3,020,000	
Entrance Gate	6(W)x2.5(H)m	place		500,000	0	
Landscaping	Planting trees, flower shrubs & flower beds	m2		200	0	
Relocation of Irrigation channel	RC:0.3(w)x0.3(D)m	m		2,000	0	
Monitoring Well-Shallow Well	PVC Dia, 150mm, 20m(D) & Screen	place		90,000	0	
Monitoring Well-Deep Well	PVC Dia, 150mm, 60m(D) & Screen	place		200,000	0	
Subtotal				10,760	3,020,000	
Total Construction Cost of Gondlanwala fpr Closure Work				0	23,814,133	

C.7

Leachate Flow Calculation for 3 Disposal Sites (Bhakhraywali, Gondlanwala and Chianwali)

Table DC.7.1 Calculations of Weather Parameters for Gujranwala (Common data for 3 sites)

Month	Rainfall (1994–2013)	Evaporation (1988–2011)	Temperature (1994–2013)		Avg. Temp. (°C)
	Rainfall (mm)	Evaporation (mm)	Max. Temperature	Min. Temperature	
	Avg. (mm)	Avg. (mm)	Avg. Max. Temp. (°C)	Avg. Min. Temp. (°C)	
1	44.52	1.50	17.41	5.18	11.30
2	52.57	2.41	21.05	8.29	14.70
3	41.04	3.51	26.78	13.18	20.00
4	27.23	5.02	33.32	18.22	25.80
5	17.44	8.11	38.58	23.12	30.80
6	71.14	8.42	38.85	25.49	32.20
7	305.51	5.94	33.22	25.64	29.40
8	305.34	4.60	33.13	25.29	29.20
9	76.45	4.98	33.06	23.41	28.20
10	32.78	7.11	31.01	17.59	24.30
11	8.99	2.27	26.19	10.82	18.50
12	13.74	1.41	20.41	6.08	13.20
Total	996.75	55.30	352.98	202.28	277.60
Avg.	83.10	4.60	29.40	16.90	23.10
Max	305.51	8.42	38.85	25.64	32.20
Min	8.99	1.41	17.41	5.18	11.30

Calculated

Formula:

$$ET = P - CP^2$$

ET = effective evapotranspiration (mm/yr)

P = average annual rainfall over the watershed
(mm)

T = average annual
temperature

$$C = 1 / (0.8 + 0.14T)1000$$

P= 996.75 mm

Temp.= 23.10 °C

C= 0.000247893

ET= 750.50 mm

Table DC.7.2 Leachate Flow Calculations for Bhakhraywali, Proposed Sanitary Landfill Site

Landfill Area	
Phase	Area(m ²)
1(A2)	100000
2 (A1)	100000
TOTAL	200000

Water Balance in Landfill Area

Inflow Equation $= I \cdot A / 1000 + S_i + G + W$

where

I = Rainfall intensity (mm)

A = Catchment area of leachate (m²)

S_i = Surface stormwater run-off from the outside of landfill area

G = Springwater in the landfill area (m³/year)

W = Water content amount retained in filled waste and cover soil

Outflow Equation $= E \cdot A / 1000 + S_o + Q$

where

E = Evapotranspiration amount

S_o = Surface stormwater run-off from the landfill area

Q = Leachate generation amount

Thus, water balance within the landfill area will be;

$$S_i + G + W - (S_o + Q) + (I - E) \cdot A / 1000 = C_w + R_w$$

where

C_w = Water content fluctuation amount retained in cover soil

R_w = Water content fluctuation amount retained in waste

Assuming,

$G = 0$ (Surface trenches prepared)

$S_i = 0$ (Stormwater drains prepared)

$W =$ negligible

$C_w \text{ \& } R_w =$ negligible

Then, leachate generation flow is obtained by the following equation.

Calculation of Leachate Amount

Rainfall amount within the leachate catchment area $= I \cdot A / 1000$ (m³/year)

$I = 996.75$ mm/year $A = 200000$ m²

Total RF **199349.6** m³/year

$E = 750.50$ mm/year

Assuming,

$S_o = 1$

$$Q = (I - E) \cdot A / 1000 - S_o$$

$Q =$ **49249** m³/year

Daily Leachate Amount Calculation by Water Balance Model

$$Q=(C/1000)*I*A$$

Q: Leachate volume (m³/day)

I: Rainfall intensity (mm/day)

C: Leaching coefficient

A: Landfill area (m²)

$$Q1=776 \text{ m}^3/\text{day} \quad (\text{Phase 2})$$

$$Q=Q1+Q2=(1/1000)*I*(C1*A1+C2*A2)$$

C1: Run-off coefficient of leachate in the landfill area in progress

C2: Run-off coefficient of leachate in the completed landfill area

A1: Landfill area in progress (m²)

A2: Completed landfill area (m²)

C1 is calculated as follows.

$$Q1=(I-E1)*A1/1000$$

$$I=9.855161 \quad (\text{Using Max Rain fall month in 1994-2013 average})$$

$$E1=2.1$$

$$A1=100000 \text{ m}^2 \quad (\text{Phase 2})$$

$$Q1=775.5 \text{ m}^3/\text{day}$$

$$\text{Or } Q1=C1/1000*I*A1$$

$$Q1=775.6 \text{ m}^3/\text{day}$$

$$C1=1-(E1/I)$$

$$C1=0.787$$

C2 is calculated as follows.

$$Q2=(I-E2)*A2/1000-S_o$$

$$Q2=C2/1000*I*A2=774.6 \text{ m}^3/\text{day}$$

$$C2=1-((E2+1000*S_o/A2)/I)$$

$$C2=C1*(1-((E2-E1+1000*S_o/A2)/I-E1))$$

$$C2=C1*(1-((1000*S_o/A2)/I-E1))$$

$$C2=0.786$$

In general, $1000*S_o/A2(I-E1)=0.4$ (Survey result in Japan)

$$C2 \doteq C1*(1-0.4)=0.6C1$$

$$C2 \doteq 0.472$$

Designed Leachate Volume

$$Q=(1/1000)*I*(C1*A1+C2*A2)$$

$$I=2.7 \text{ mm/day} \quad (\text{Avg.})$$

$$I=9.9 \text{ mm/day} \quad (\text{Max})$$

$$C1=0.787$$

$$C2=0.786$$

$$A1=100000 \text{ m}^2 \quad (\text{Phase 2})$$

$$A2=100000 \text{ m}^2 \quad (\text{Phase 1})$$

$$Q=430 \quad (\text{Avg.})$$

$$Q=1550 \quad (\text{Max})$$

Table DC.7.3 Leachate Flow Calculations for Gondlanwala, Current Disposal Site

Dumping Site Area	
Area (m ²)	63724

Water Balance in Landfill Area

$$\text{Inflow Equation} = I \cdot A / 1000 + S_i + G + W$$

where

I= Rainfall intensity (mm)

A= Catchment area of leachate (m²)

S_i= Surface stormwater run-off from the outside of landfill area

G= Springwater in the landfill area (m³/year)

W= Water content amount retained in filled waste and cover soil

$$\text{Outflow Equation} = E \cdot A / 1000 + S_o + Q$$

where

E= Evapotranspiration amount

S_o= Surface stormwater run-off from the landfill area

Q= Leachate generation amount

Thus, water balance within the landfill area will be;

$$S_i + G + W - (S_o + Q) + (I - W) \cdot A / 1000 = C_w + R_w$$

where

C_w= Water content fluctuation amount retained in cover soil

R_w= Water content fluctuation amount retained in waste

Assuming,

G= 0 (Surface trenches prepared)

S_i= 0 (Stormwater drains prepared)

W= negligible

C_w & R_w = negligible

Then, leachate generation flow is obtained by the following equation.

Calculation of Leachate Amount

Rainfall amount within the leachate catchment area = $I \cdot A / 1000$ (m³/year)

I= 996.75 mm/year A= 63724 m²

Total RF 63516.77 m³/year

E= 750.50 mm/year

Assuming,

S_o= 1

$$Q = (I - E) \cdot A / 1000 - S_o$$

Q= 15691 m³/year

Daily Leachate Amount Calculation by Water Balance Model

$$Q = (C/1000) * I * A$$

Q: Leachate volume (m³/day)

I: Rainfall intensity (mm/day)

C: Leaching coefficient

A: Landfill area (m²)

C: Run-off coefficient of leachate in the dumping site area is calculated as follows.

$$C = 1 - (E/I)$$

I= 9.855161 (Using Max Rain fall month in 1994–2013 average)

E= 2.1

C = 0.787

Q = 494.2 m³/day

Designed Leachate Volume

$$Q = (1/1000) * I * (C * A)$$

I=	2.7	mm/day	(Avg.)
	9.9	mm/day	(Max)

Q=	130	(Avg.)
	490	(Max)

Table DC.7.4 Leachate Flow Calculations for Chianwali, Former Disposal Site

Dumping Site Area		Water Balance in Landfill Area
Area (m ²)	35096	

Inflow Equation $= I \cdot A / 1000 + S_i + G + W$

where

I = Rainfall intensity (mm)

A = Catchment area of leachate (m²)

S_i = Surface stormwater run-off from the outside of landfill area

G = Springwater in the landfill area (m³/year)

W = Water content amount retained in filled waste and cover soil

Outflow Equation $= E \cdot A / 1000 + S_o + Q$

where

E = Evapotranspiration amount

S_o = Surface stormwater run-off from the landfill area

Q = Leachate generation amount

Thus, water balance within the landfill area will be;

$$S_i + G + W - (S_o + Q) + (I - W) \cdot A / 1000 = C_w + R_w$$

where

C_w = Water content fluctuation amount retained in cover soil

R_w = Water content fluctuation amount retained in waste

Assuming,

$G = 0$ (Surface trenches prepared)

$S_i = 0$ (Stormwater drains prepared)

$W =$ negligible

C_w & $R_w =$ negligible

Then, leachate generation flow is obtained by the following equation.

Calculation of Leachate Amount

Rainfall amount within the leachate catchment area $= I \cdot A / 1000$ (m³/year)

$I = 996.7480$ mm/year $A = 35096$ m²

Total RF **34982.29** m³/year

$E = 750.50$ mm/year

Assuming,

$S_o = 1$

$Q = (I - E) \cdot A / 1000 - S_o$

$Q =$ **8641** m³/year

Daily Leachate Amount Calculation by Water Balance Model

$Q=(C/1000)*I*A$

Q: Leachate volume (m³/day)

I: Rainfall intensity (mm/day)

C: Leaching coefficient

A: Landfill area (m²)

$C=1-(E/I)$

I= 9.855161 (Using Max Rain fall month in 1994–2013 average)

E= 2.1

C = 0.787

Q = 272.2 m³/day

Designed Leachate Volume

$Q=(1/1000)*I*(C*A)$

I= 2.7 mm/day (Avg.)
9.9 mm/day (Max)

Q= 70 (Avg.)
270 (Max)

SECTION D
INTERMEDIATE TREATMENT
AND 3R PROMOTION

**PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA**

FINAL REPORT

VOLUME 4

DATA BOOK

SECTION D

INTERMEDIATE TREATMENT AND 3R PROMOTION

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D.1 WASTE PICKERS SURVEY

1. INTRODUCTION AND OUTLINE OF SURVEY

Waste Picker survey is one of the field surveys within the framework of the project carried out by the Japanese International Cooperation Agency Project Team (herein referred to a “JICA”). Recycling of municipal solid waste in Pakistan relies largely on the informal recovery of resource materials by waste pickers, junk shops and the dealers, and they render valuable services to the society by recovering unusable waste 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, perhaps bolstered by feelings of inferiority. All quantitative data on waste management in cities of Pakistan has, until recently, been both scarce and unreliable, perhaps even more, so far, for data on recycling rates. The waste picker survey is focused on gathering information from the waste pickers in Gujranwala city and the existing disposal site with regard to their recycling activities.

Key objective of the survey is:

- 1) To collect and analyse the current activities of the waste pickers in the Gujranwala city.
- 2) To collect and analyse the current activities of the waste pickers at the Gondlanwala disposal site.

Interview survey was carried out for the waste pickers working in Gondalawala site for 20 persons for the age more than 15 years old. In addition, the interview survey for the waste picker working in town was also conducted for the activity areas of high income group area, middle income group area and low income group area for 20 waste pickers. Waste Manager, Research Assistant and Survey Assistant were part of the survey team .The questionnaire was prepared based on the contents in the Inception report with some minor adjustment of the actual conditions. The questionnaire was finalized in consultation with the JICA Project Team. The survey was carried out in December 2014.

The questionnaire included the following types of queries: general information about the waste pickers, waste picking activity area, how long they are engaged in such activities. These questions included their comprehension on the kinds of recyclables they segregate, from where they collect the recyclable, to whom they sell and at what price do they sell. Furthermore, their willingness to continue working as waste picker was also assessed. The questionnaire also included selective questions regarding the findings of waste pickers about changes in recyclable waste and amount of recyclables. Some of the questions were asked about their concerns regarding their work.

Five (5) samples were selected from high income group area, 10 from middle income group area and five (5) from low income group area. Twenty (20) samples were selected from Gondlanwala dumping site area for the age more than 15 years.

2. RESULTS OF SURVEY

The survey data is evaluated for the recovery amount and selling price of recyclables collected by the waste pickers in Gujranwala city and at Gondlanwala disposal site on the basis of sample groups surveyed.

A. Gujranwala Town Areas

Table DD.1.1 shows the amount of each recyclable collected per waste picker per day on average, unit price of each recyclable, selling price of each recyclable on average for waste pickers in city. The range of unit price and selling price for each recyclable is evaluated.

Table DD.1.1 Evaluated data for Gujranwala City

Sr. No.	Recyclable	Avg. Sold Quantity (kg/day)	Avg. Unit Price (Rs/kg)	Avg. Sold Amount (Rs/day)	Unit Price Range (Rs/kg)	Sold Amount Range (Rs/day)
1	Cardboard	37	8	253	4 to 10	40 to 1,000
2	Paper (other)	13	8	83	5 to 15	75 to 100
3	Plastic (PET)	13	26	322	20 to 30	125 to 750
4	Plastic (Other)	19	8	306	8 to 30	80 to 1,200
5	Food Waste	10	15	165	10 to 22	75 to 440
6	Glass (Bottles)	24	3	88	2 to 5	8 to 320
7	Metal (Other)	11	44	400	30 to 80	60 to 750
8	Metal (Steel)	3	25	75	25	75
9	Shoes	9	5	55	3 to 15	6 to 180
10	Hair	0.21	3,800	800	3,000 to 4,000	400 to 1,200
11	Bones	10	8	91	5 to 10	25 to 400

The graph in **Figure DD.1.1** shows the amount of recyclables collected and their selling prices per day, almost each type of recyclable is segregated in Gujranwala city by the waste pickers. The recyclable easily collected from the waste is cardboard i.e. 37 kg/day per waste picker on average. But the selling amount of hairs is the highest among other type of recyclables i.e. 800 Rs/ day followed by metals at 400 Rs. /.

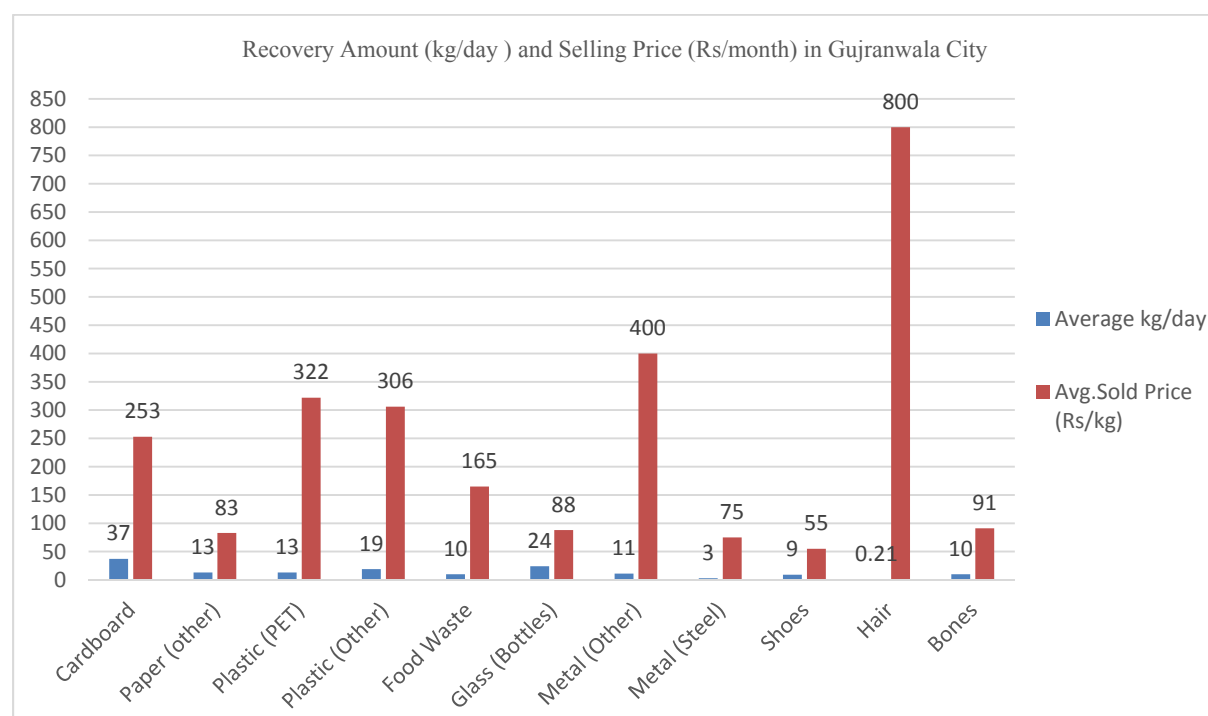


Figure DD.2.1 Evaluated Graph for Gujranwala City

B. Gondlanwala Disposal Site

Table DD.1.2 shows the amount of each recyclable collected per waste picker per day on average, unit price of each recyclable, selling price of each recyclable on average for waste pickers at Gondalawala Dumping Site. The range of unit price and selling price for each recyclable is evaluated.

Table DD.1.2 Evaluated data for Gondlanwala Disposal Site

Sr. No.	Recyclable	Avg. Sold Quantity (kg/day)	Avg. Unit price (Rs/kg)	Avg. Sold Amount (Rs/day)	Unit Price Range (Rs/kg)	Sold Amount Range (Rs/day)
1	Cardboard	15	7	105	6 to 7	36 to 175
2	Paper (other)	2	30	60	30	60
3	Plastic (PET)	12	20	239	20 to 22	100 to 540
4	Plastic (Other)	10	16	143	7 to 22	80 to 240
5	Glass (Bottles)	33	3	122	2 to 4	30 to 600
6	Glass (Broken)	29	3.5	98	3 to 4	60 to 200
7	Metal (Other)	1	80	80	80	80
8	Metal (Steel)	2	35	70	35	70
9	Shoes	20	4	83	3 to 7	15 to 200
10	Rubber	6	5	29	3 to 7	15 to 42
11	Hair	0.19	4,000	772	4000	320 to 2,000
12	Bones	11	9	106	5 to 10	20 to 200

The graph in **Figure DD.1.2** shows the amount of recyclables collected in large amount from the waste at Gondlanwala disposal site. Recovered quantity of shoes and glass bottles amount at 53 kg/day and 52 kg/day respectively per waste picker on average. But the selling amount of hairs is the highest among other recyclables i.e. 772 Rs/day followed by.

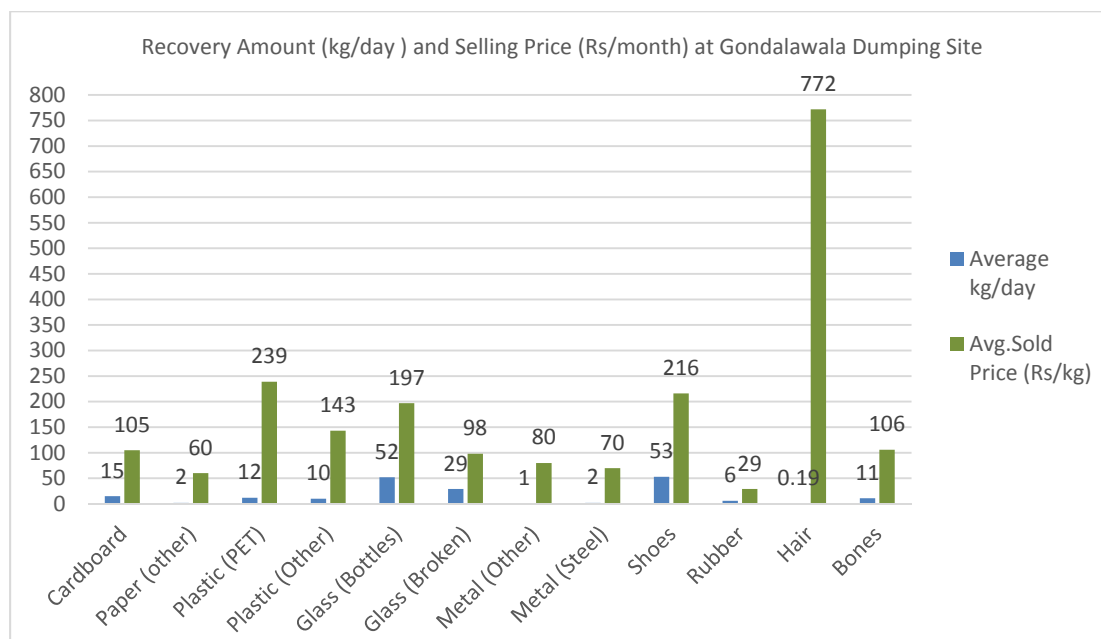


Figure DD.1.2 Evaluation graph for Gondalawala dumping site

The graph in **Figure DD.1.3** indicates that cardboard, paper (others), plastic (PET and other), Metal (steel and others) and hair are recovered more in the town area as compared to that recyclables in

Gondlanwala disposal site. Waste pickers working in town area do not segregate rubber and broken glasses while food waste is segregated or recovered only by the waste pickers in town area.

Recovery amount of glass bottles, shoes and bones in Gondlanwala disposal site is more as compared to that recyclables in town area, while rubber and broken glass are recovered only in the disposal site. None of the disposal site waste picker is involved in food waste recovery.

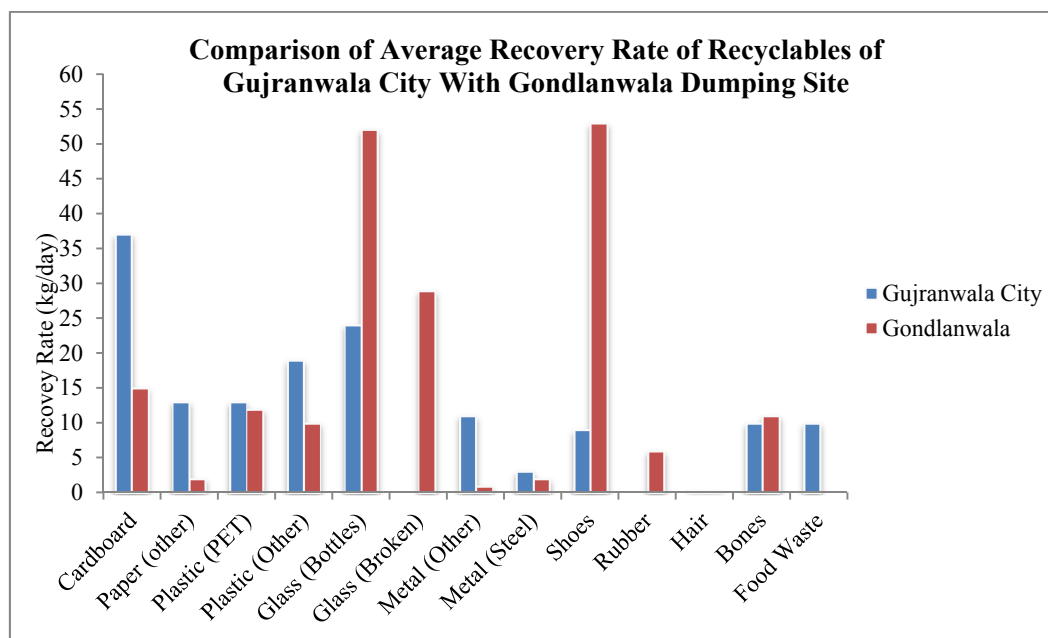


Figure DD.1.3 Comparison of Average Recovery Rate of Recyclables of Gujranwala City with Gondalawala Dumping Site

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 CONCLUSIONS

The survey was conducted for the groups of waste pickers working in town area and in the Gondlanwala disposal site by focusing on their involvement in recovery activities revealed their notable role played in waste management. In both areas, the majority of the waste pickers engage in resource recovery are young people in the age between 15 and 25 years old. Dependency of family ranges between 1 and 15.

Major type of recyclables found in both areas are:

- Recovery amount of Cardboard in Gujranwala City (37 kg/day/person) > Gondalawala Disposal Site (15 kg/day/person)
- Recovery amount of Paper in Gujranwala City (13 kg/day/person) > Gondalawala Disposal Site (2 kg/day/person)
- Recovery amount of Plastic (PET and other) in Gujranwala City (32 kg/day/person) > Gondalawala Disposal site (22 kg/day/person)
- Recovery amount of Glass in Gujranwala City (24 kg/day/person) < Gondalawala Disposal Site (33 kg/day/person)
- Recovery amount of Shoes in Gujranwala City (9 kg/day/person) < Gondalawala Disposal site (20 kg/day/person)

- Recovery amount of Hair in Gujranwala City (0.21 kg/day/person) > Gondalawala Disposal Site (0.19 kg/day/person)
- Recovery amount of Bones in Gujranwala City (10 kg/day/person) < Gondalawala Disposal Site (19 kg/day/person)

Average selling price by 20 waste pickers in Gujranwala city is 1084 Rs/day which is less than average selling price by 20 waste pickers at Gondalawala Disposal site i.e. 1264 Rs/day. Average Recovery amount per waste picker in city is 82 kg/day whereas at Gondalawala Disposal Site recovery amount per waste picker is 55 kg/day. Monthly income of waste pickers at Gondalawala Disposal Site is 30,000 Rs/month which is almost same as that of the waste pickers in the city i.e. 29,500 Rs/month.

Waste pickers play an important role in collection of resource materials from the discarded waste and add the value for recycling and reuse in the society. Several thousands of people are engaged in waste linked business throughout the city and elsewhere. The survey showed that the majority of the households discarded hazardous wastes together with other wastes. Those hazardous wastes are corrosive, toxic, ignitable or reactive items that encounter the risks or injury or poisoning particularly to children and people who sort the waste. The waste pickers never wear protective gear for avoiding themselves from injuries or sickness.

3.2 RECOMMENDATIONS

The results of this survey revealed that the recovery of resource materials in waste is carried out actively by the involvement of waste pickers, junk shops and dealer. Adding the resource materials recovered directly from the large waste generators to the dealers or to the factories, the recovery amount in the current recycling market in Gujranwala is estimated more than 70 ton/day. The amount recovered by them is contributing in waste diversion or reduction of landfill amount in addition to the material recycling. In order to strengthen further the recycling activities through involvement especially of the waste pickers and other stakeholders, the following measures are recommended as a result of the waste picker survey.

- GWMC or CDGG shall register the waste pickers or the group leaders involved in resource recovery work in addition to the registration of junk shops and dealers in compliance with The Punjab Waste Management Act and the relevant laws and regulations.
- Establishment of a liaison council among the stakeholders including waste pickers, junk shops, dealers, factories, GWMC, CDGG, etc. to exchange the opinions for the benefits of further development of resource recovery activities.
- Support and assistance by the GWMC and/or CDGG to the waste pickers and the minorities such as Afghan refugees for improvement of their health risks and living conditions towards a holistic approach for upgrading the municipal solid waste management in Gujranwala through involvement of professional resource recovery workers,
- Introduction of separate collection of domestic hazardous waste by GWMC and a through separate collection and disposal of hospital waste and industrial hazardous waste under the responsibility of the waste generators to avoid mixing of those hazardous waste into municipal waste collection, and
- Provision of support and assistance to the waste pickers at Gondlanwala disposal site. They disturb the landfill operation work from time to time but prohibiting them from waste picking will not solve the problem. Since the resource recovery work is their only mean to earn a living. GWMC should provide alternates opportunities for them to earn a living if GWMC will ban them from entering to the landfill site.

D.2 SUMMARY OF IWCS

1. Introduction and Outline of Survey

The waste composition data plays a crucial role in planning and designing of solid waste system. The data generated from waste composition studies is used in several ways, including determining the quantity of material available for recovery, measuring the effectiveness of existing recycling programs, and right-sizing recycling facilities and intermediate treatment facilities. So, the JPT conducted the incoming waste composition survey from 9th December, 2014 to 13th December, 2014 for the better understanding of the composition of solid waste hauled into the disposal site, Gondlanwala. This survey is carried out only for once during the period of the JICA project. The purpose of the survey is to characterize the waste composition of disposed municipal solid waste streams as a whole. The specific objectives of the survey are;

- Determining the composition of waste collected from Gujranwala waste collection area and hauled to Gondlanwala for disposal,
- Estimating the potential of resource or recyclable materials mixed in the incoming waste at the existing disposal site in Gondlanwala, and
- Comparing the result of the recyclable material ratio with that of the WACS for estimation of the recyclable materials recovered in town.

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. The total number of samples and sampling areas selected for the incoming waste composition survey is shown in **Table DD.2.1** and **Figure DD.2.1**.

Table DD.2.1 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 x B
High Income Group Area	1	2	2
Middle Income Group Area	2	2	4
Low Income Group Area	2	2	4
Total			10

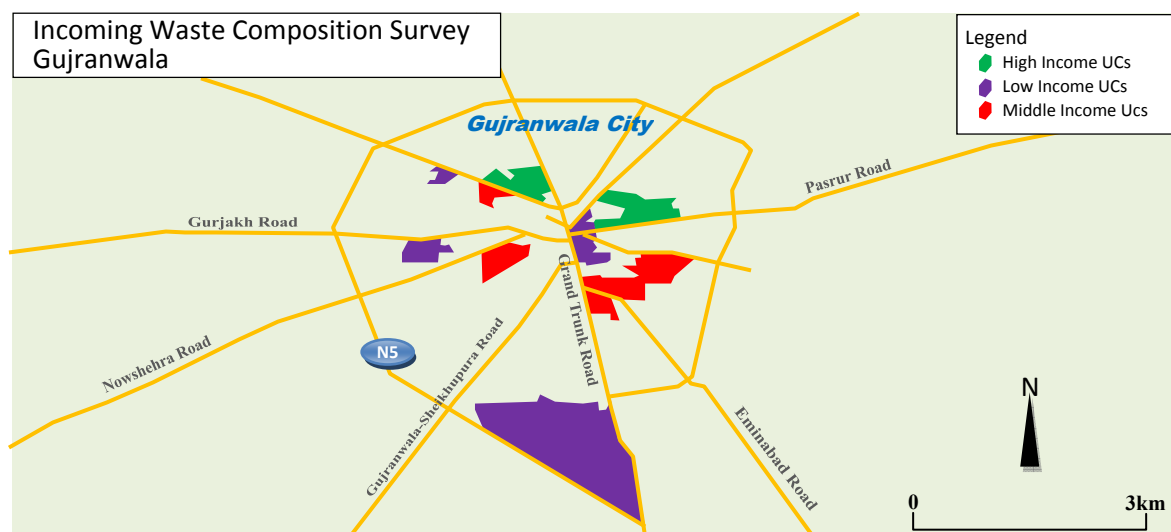


Figure DD.2.1 Selective Areas for Incoming Waste Composition Survey

The method for incoming waste composition survey was developed by following the requirements in the terms of reference (hereinafter referred to as “TOR”) of WACS subcontract and the instructions of the JPT taking into consideration of the site conditions. The composition of 1563.51 kg waste stream from 10 areas was analyzed in the course of the survey. The waste was sorted into 16 pre-determined different fractions. The detail of the followed procedure is shown in **Figure DD.2.2**.

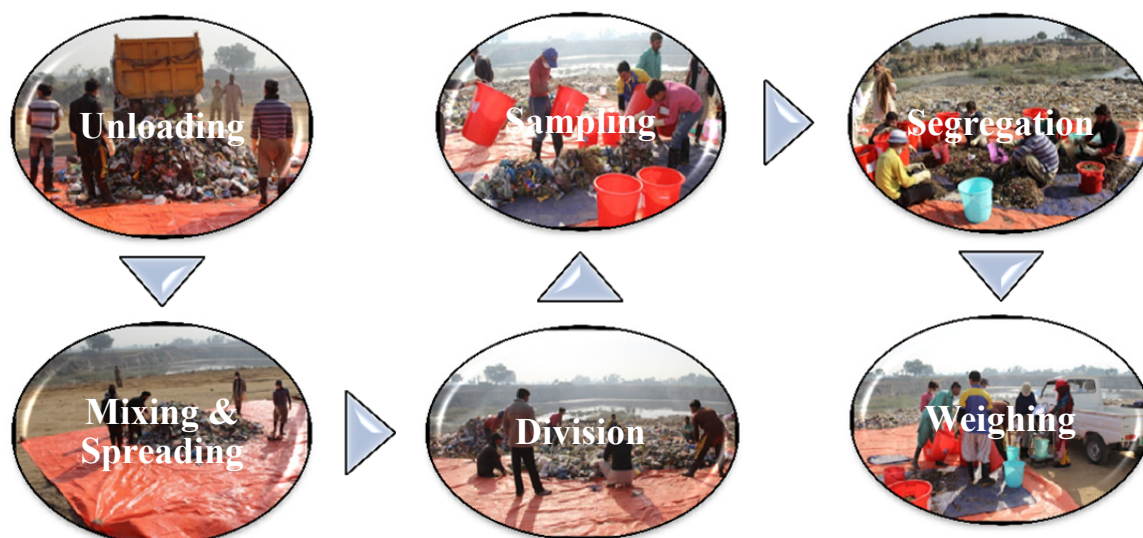


Figure DD.2.2 Survey Procedures

2. Results of Survey

The average percentages of different waste categories in representative samples at Gondlanwala from three (3) income groups is shown in **Figure DD.2.3**. The figure shows that the kitchen waste is in the highest proportion (i.e., 25 to 32 %) among all waste categories in three income groups. Another prominent waste category among all income groups are sieve remainings (more than 10 %). The comparison depicts that there is as such no big difference in the percentages of each waste component for three income groups.

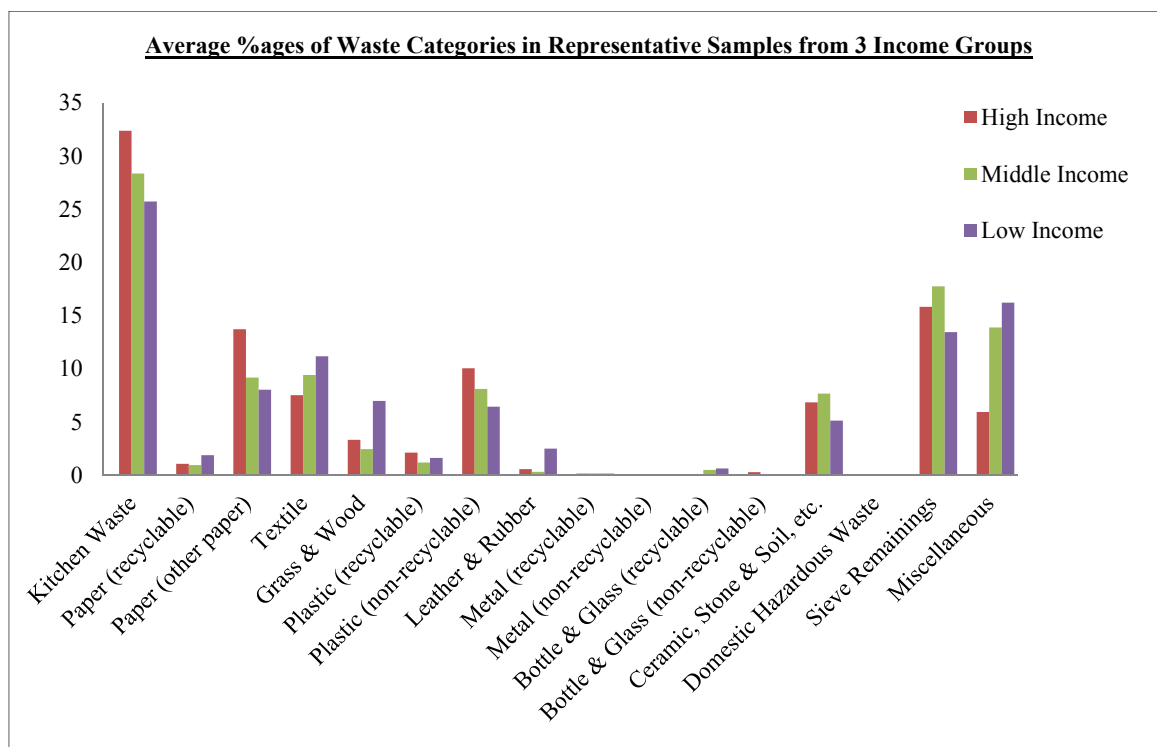


Figure DD.2.3 Income Level Based Waste Composition at Gondlanwala

2.1 Processing of Waste Composition by Weighted Average of Income Groups

On an assumption, Gujranwala city has been divided into high income level (10 %), middle income level (60 %) and low income level (30 %). Moreover, the results of two composition surveys (WACS and incoming waste composition survey) were compared to assess the potential of possible resource recovery and intermediate treatment options including material recovery facilities (hereinafter referred to as “MRF”), composting plant, refuse derived fuel plant (hereinafter referred to as “RDF”), bio-gasification, waste-to-energy plant, etc.

Figure DD.2.4 and **Figure DD.2.5** compares the weighted average percent composition of Gujranwala waste being disposed at Gondlanwala and generated from residential dwellings. At Gondlanwala, the kitchen waste contributes to 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 disposal site, Gondlanwala. On the other hand, almost 59 % kitchen waste results from residential sources. Other eminent waste categories are non-recyclable paper (13 %), non-recyclable plastic (7 %), textile (5 %) and sieve remainings (4 %).

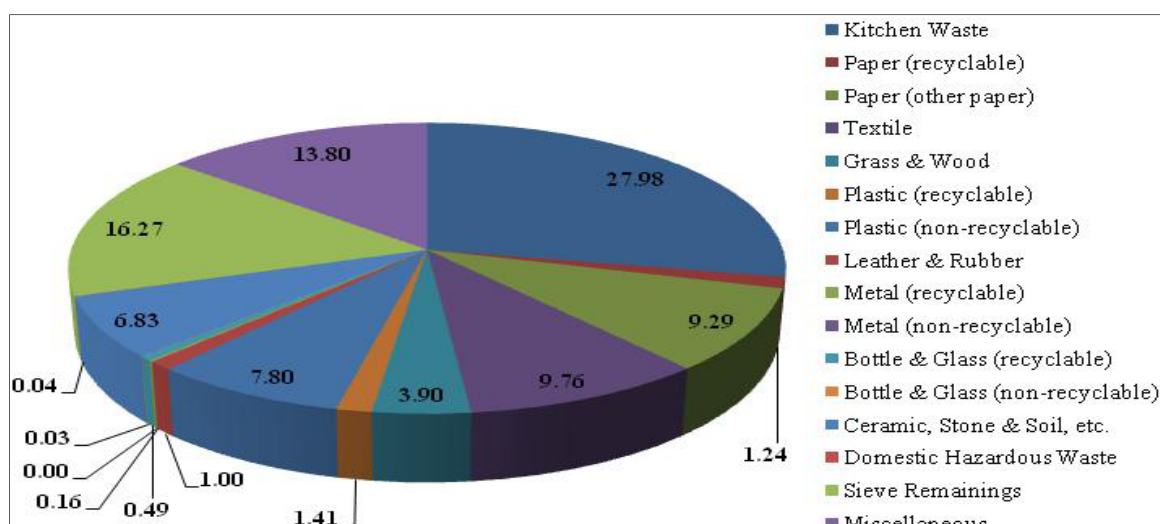
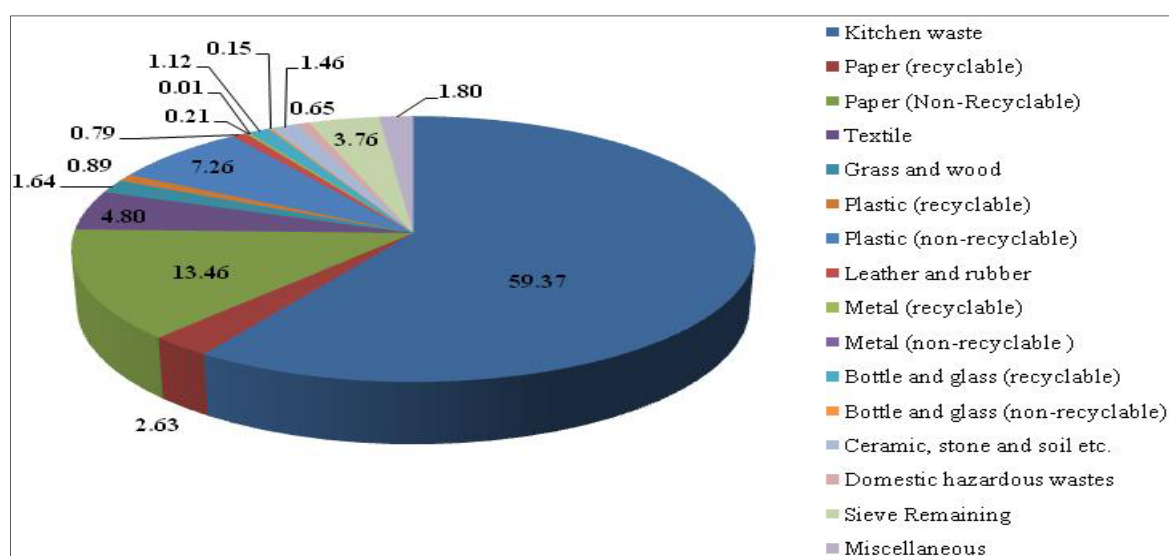


Figure DD.2.4 Weighted Average Waste Composition of Gujranwala Disposed at Gondlanwala



Data Source: 2nd WACS Report, February 2015, JICA Project Team

Figure DD.2.5 Weighted Average Waste Composition of Gujranwala Residential Sources

2.2 MRF and Recycling Potential of Incoming Waste at Gondlanwala

The percentages of different recyclables including paper, plastic, metal, bottle & glass, and leather & rubber being disposed along with solid waste collected from three (3) income groups by arm-roll trucks and tractor trolleys are indicated in **Figure DD.2.6**. The weighted average of recyclables amounts to around 4 % out of total waste disposed amount. The incoming waste composition survey points out that the discharge of recyclables from high income group is very few. It is due to the reason that most of the recyclables are segregated by maids / servants in high income areas. Moreover, recyclables' sorting activity is also being done at containers by town scavengers and by crew staff of collection vehicles (tractor trolleys). The recycling potential of comingled waste from middle and low income groups is relatively high particularly regarding paper and plastic. It depicts relatively low trend at source segregation in these income groups.

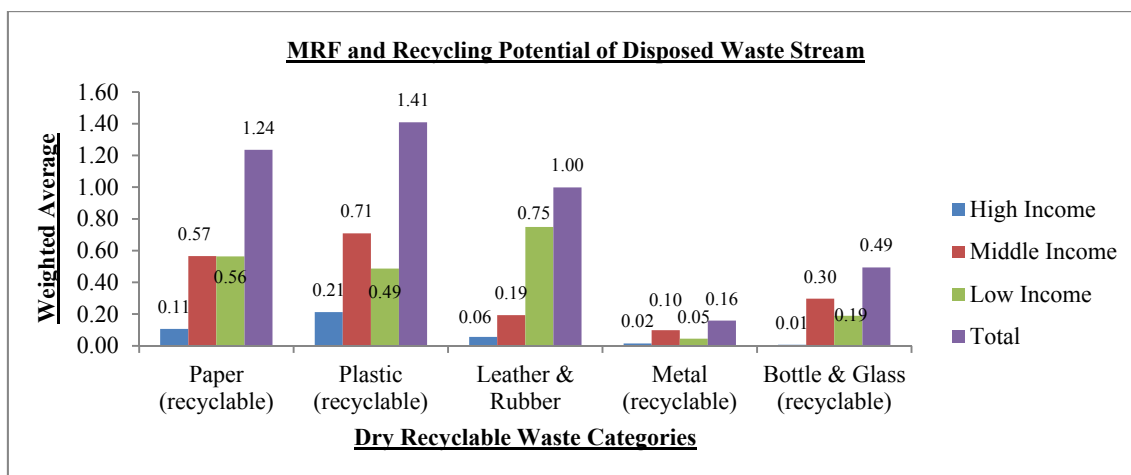
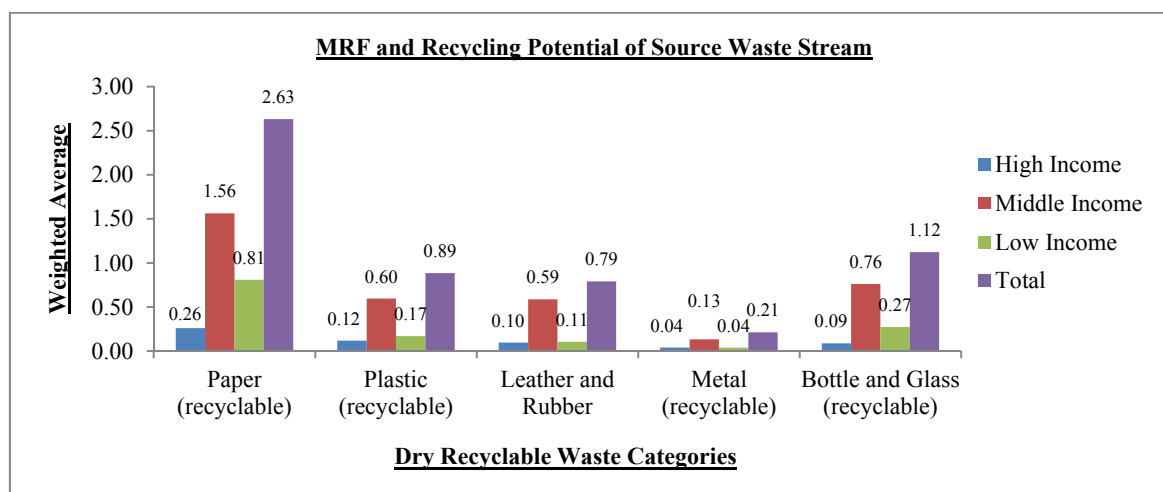


Figure DD.2.6 Dry Recyclable Items of Incoming Waste at Gondlanwala

The recycling potential of Gujranwala residential source waste is shown in **Figure DD.2.7**. The weighted average of dry recyclables is estimated to about 6 % out of total waste generated from residential dwellings. The high income source waste shows weak recycling potential. Middle and low income groups' waste streams have shown considerable percentage for paper 2 % as compared to other recyclable categories. Among the three (3) income groups, the highest weighted recycling potential is observed in middle income group (i.e., about 4 %).



Data Source: 2nd WACS Report, February 2015, JICA Project Team

Figure DD.2.7 Dry Recyclable Items at Gujranwala Residential Sources

The results of both composition surveys have not strengthened the idea of centralized material recovery facility option.

2.3 Bio-gasification and Composting Potential of Incoming Waste at Gondlanwala

Among the possible resource recovery options, bio-gasification and composting is found to be feasible as the organic content in waste disposed at Gondlanwala is figured about 32 % and the **Figure DD.2.8** summarizes this weighted average. The percentage of waste composition of organic waste includes kitchen waste and grass & wood is found to be the highest among all categories in both composition surveys. The highest proportion of kitchen waste comes to Gondlanwala from middle income level group. The generation of kitchen waste in high income group is the lowest that is about 3 %.

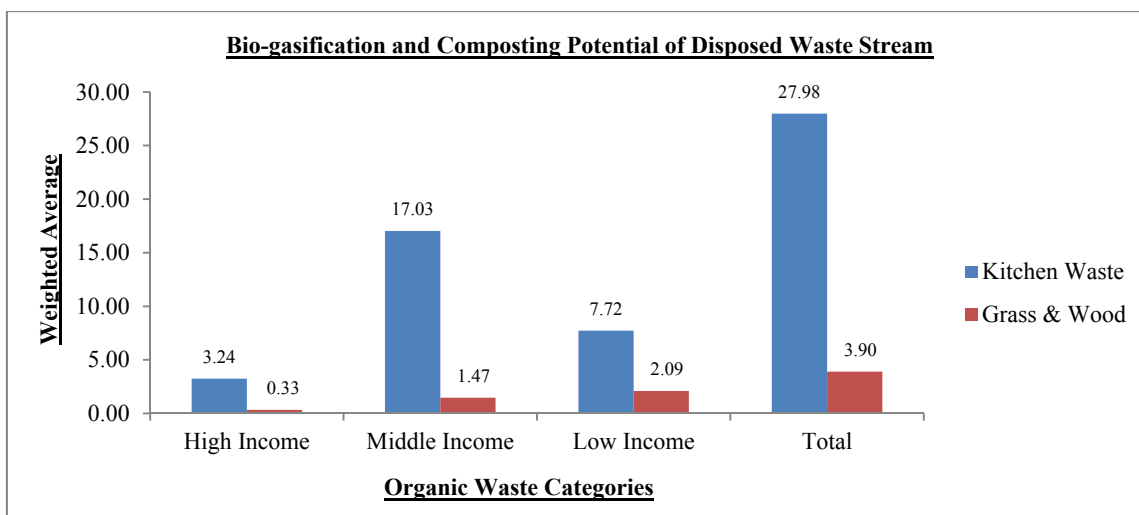
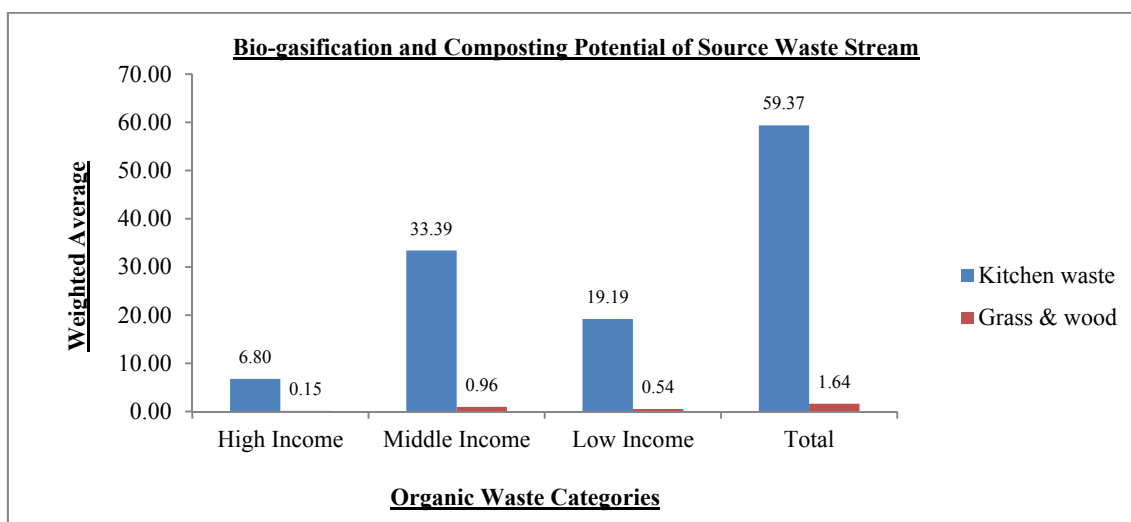


Figure DD.2.8 Organic Items of Incoming Waste at Gondlanwala

The weighted average of organic content in Gujranwala residential sources' waste is estimated to about 61 %, showing the viability of bio-gasification and composting. **Figure DD.2.9** summarizes this weighted average. The WACS results regarding kitchen waste percentages are compatible with those of incoming waste composition survey. WACS shows that middle and low income groups discharge more kitchen waste (34 % and 20 %, respectively) than that of the high income group (i.e., 7 %).



Data Source: 2nd WACS Report, February 2015, JICA Project Team

Figure DD.2.9 Organic Items at Gujranwala Residential Sources

2.4 Incineration and RDF Potential of Incoming Waste at Gondlanwala

The RDF potential of the overall disposed waste stream at Gondlanwala is estimated to about 34%. **Figure DD.2.10** portrays the splitting of incineration and RDF potential of disposed waste into individual categories. The commingled waste hauled to Gondlanwala for disposal has appreciable amounts of prominent combustible waste items including textile and non-recyclable paper & plastic. The waste hauled to disposal site from middle income areas has the highest percentages of combustible categories, on average amounting to about 19 %.

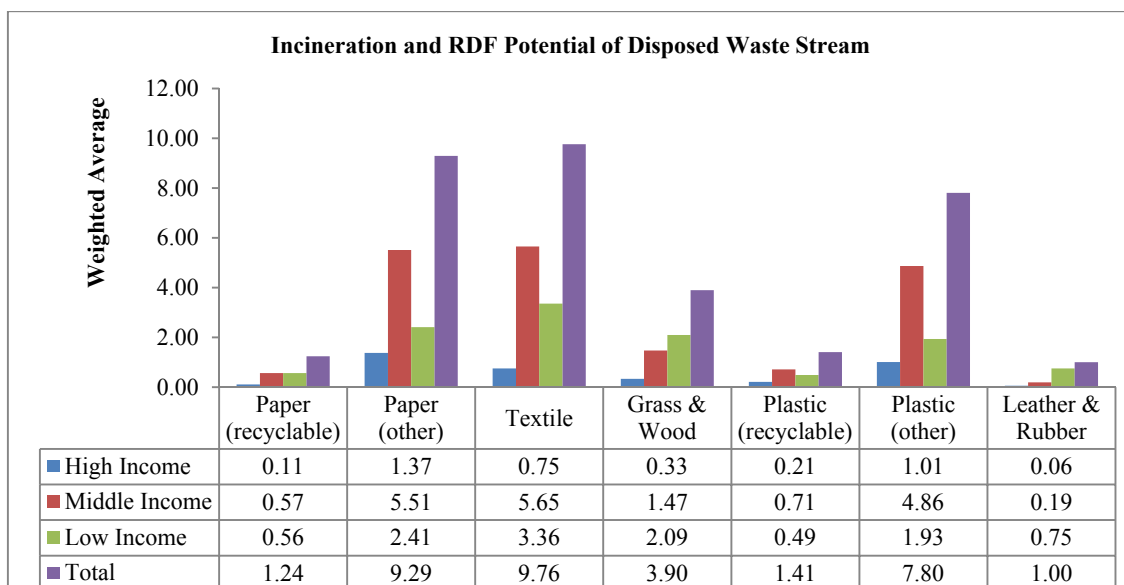
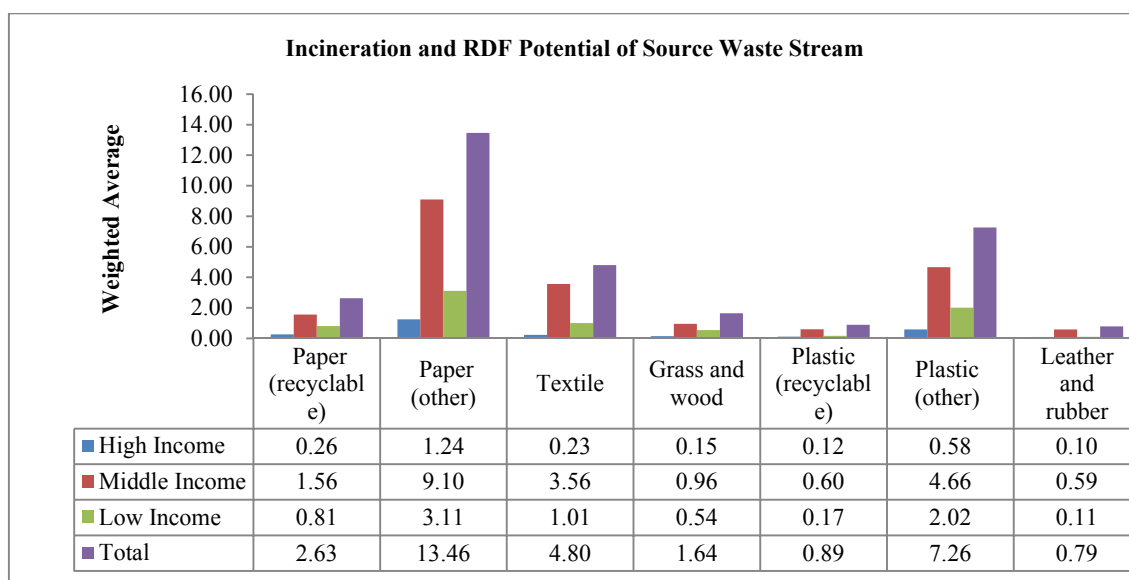


Figure DD.2.10 Combustible Items of Incoming Waste at Gondlanwala

The incineration and RDF potential of residential source waste is estimated to about 31 % (**Figure DD.2.11**). The percentages for non-recyclable paper (13 %), non-recyclable plastic (7 %) and textile (5 %) in waste stream originating from source are mounting among other combustible waste classes.



Data Source: 2nd WACS Report, February 2015, JICA Project Team

Figure DD.2.11 Combustible Items at Gujranwala Residential Sources

The results of both composition surveys (incoming waste composition survey and WACS) have demonstrated appreciable amounts of combustible items at source and disposed wastes' arising. These combustible waste categories can be incorporated into incineration and/or RDF plant.

3. Conclusions and Recommendations

3.1 Conclusions

The following conclusions can be drawn from the analysis of ten (10) waste samples subjected to incoming waste composition survey:

- The waste stream reaching for disposal at Gondlanwala from collection area (64 urban union councils) has the high percentage of organic waste represented by kitchen waste and grass and wood (about 32%). These wastes are good biodegradable waste. So, the municipal waste from Gujranwala has good potential for bio-gasification and/or compost if GWMC manages to collect organic waste separately.
- The combustible waste ratio represented by plastics, paper, etc. in Gujranwala is high. So, installation of incineration plant and/or RDF plant can be a good option for the strategies for waste reduction and renewable energy generation.
- The amount of dry recyclables or resource materials hauled to Gondlanwala is considerably low. Accordingly, the option for construction of centralized material recovery facilities is negative.

3.2 Recommendations

- The material recovery options can be prioritized as follows on the basis of the results of the incoming waste composition survey:

Small-scale MRF < Bio-gasification and/or Composting < Incineration and/or RDF

- 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. This existing system shall be maintained or strengthened by the support and/or assistance of GWMC.
- The middle income group may be the suitable target group for pilot scale projects for resource recovery.
- Incoming waste composition survey should be carried out at least once in a year for obtaining the basic information for 3R activities and intermediate treatment facilities.

D.3.1 SIMULATION-1

Intermediate Treatment & 3R Plan for the JICA M/P Project in Gujranwala

Simulation Results of the Proposed Central Compost Plant /RDF Plant in Gujranwala

Proposed Intermediate Treatment Plant	Input Waste Amount (ton/day)	Production Amount (ton/day)	IRR Evaluation	Remarks
Compost Plant	250	125	17.2	Ok
	20	10	3.7	Not feasible
RDF Plant	250	100	NG	Subsidy may be required.
	500	200	NG	

Notes: Simulation Case-1: As a more realistic and severe case, this simulation was set up for reference purpose, in which annual compost production increases progressively from early stages in several years.

March, 2015

**GWMC
and
JICA Study Team**

Table DD.3.1 Proposed Gujranwala Compost Plant - input waste amount 250 ton/day

Item		Investment Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year	Total
	Land (Rs.)	30,000,000	0	0	0	0	0	0	0	0	0	0	30,000,000
	Facilities and Equipment (Rs.)	400,000,000	0	0	0	0	0	0	0	0	0	0	400,000,000
	Initial Investment Total	430,000,000	0	0	0	0	0	0	0	0	0	0	430,000,000
	Personnel Cost (Rs.)	0	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	102,000,000
	Administration expenses (Rs.)	0	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	96,900,000
	Operation Cost (Rs.)	0	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	59,760,000
	Maintenance Cost (Rs.)	0	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	200,000,000
	Operation and Maintenance Cost Total	0	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	259,760,000
	Cost	430,000,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	689,760,000
1	Production of Composts per Day (ton/day)	0	63	75	88	100	113	125	125	125	125	125	n.a.
2	Working Days per Annum (30 days x12 months = 360 days)	0	360	360	360	360	360	360	360	360	360	360	n.a.
3	Working Ratio	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	n.a.
4 = 1x2x3	Production of Composts per Annum (Kg)	0	18,000,000	21,600,000	25,200,000	28,800,000	32,400,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	n.a.
5 = 4/50kg	Production of Bags of Composts per Annum (Bag: 50kg per Bag)	0	360,000	432,000	504,000	576,000	648,000	720,000	720,000	720,000	720,000	720,000	n.a.
6	Unit Price per Bag of Composts (Rs./Bag: 50kg per Bag)	0	250	250	250	250	250	250	250	250	250	250	n.a.
7 = 5x6	Sales of Composts per Annum (Rs.)	0	90,000,000	108,000,000	126,000,000	144,000,000	162,000,000	180,000,000	180,000,000	180,000,000	180,000,000	180,000,000	1,530,000,000
Revenue = 7 (Sales of Composts per Annum)		0	90,000,000	108,000,000	126,000,000	144,000,000	162,000,000	180,000,000	180,000,000	180,000,000	180,000,000	180,000,000	1,530,000,000
Profit (Revenue - Cost)		-430,000,000	44,134,000	62,134,000	80,134,000	98,134,000	116,134,000	134,134,000	134,134,000	134,134,000	134,134,000	134,134,000	840,240,000

IRR =		17.2%	%
Working Days per Annum		360	
Working Ratio		0.8	
Unit Price per Bag (50kg)		250	

Table DD.3.2 Proposed Gujranwala Compost Plant - input waste amount 20 ton/day

Item		Investment Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year	Total
	Land (Rs.) (provided by the government)	0	0	0	0	0	0	0	0	0	0	0	0
	Facilities and Equipment (Rs.)	20,000,000	0	0	0	0	0	0	0	0	0	0	20,000,000
	Initial Investment Total	20,000,000	0	0	0	0	0	0	0	0	0	0	20,000,000
	Personnel Cost (Rs.)	0	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	60,000,000
	Administration expenses (Rs.)	0	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000	24,000,000
	Operation Cost (Rs.)	0	2,574,000	2,574,000	2,574,000	2,574,000	2,574,000	2,574,000	2,574,000	2,574,000	2,574,000	2,574,000	25,740,000
	Maintenance Cost (Rs.)	0	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	10,000,000
	Operation and Maintenance Cost Total	0	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	35,740,000
Cost		20,000,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	11,974,000	55,740,000
1	Production of Composts per Day (ton/day)	0	10	10	10	10	10	10	10	10	10	10	n.a.
2	Working Days per Annum (30 days x12 months = 360 days)	0	360	360	360	360	360	360	360	360	360	360	n.a.
3	Working Ratio	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	n.a.
4 = 1x2x3	Production of Composts per Annum (Kg)	0	2,880,000	2,880,000	2,880,000	2,880,000	2,880,000	2,880,000	2,880,000	2,880,000	2,880,000	2,880,000	n.a.
5 = 4/50kg	Production of Bags of Composts per Annum (Bag: 50kg per Bag)	0	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	n.a.
6	Unit Price per Bag of Composts (Rs./Bag: 50kg per Bag)	0	250	250	250	250	250	250	250	250	250	250	n.a.
7 = 5x6	Sales of Composts per Annum (Rs.)	0	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	144,000,000
Revenue = 7 (Sales of Composts per Annum)		0	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	14,400,000	144,000,000
Profit (Revenue - Cost)		-20,000,000	2,426,000	2,426,000	2,426,000	2,426,000	2,426,000	2,426,000	2,426,000	2,426,000	2,426,000	2,426,000	88,260,000

IRR =		3.7%	%
Working Days per Annum		360	
Working Ratio		0.8	
Unit Price per Bag (50kg)		250	

Table DD.3.3 Proposed Gujranwala RDF Plant - input waste amount 500 ton/day

Item		Investment Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year	Total
	Land (Rs.)	0	0	0	0	0	0	0	0	0	0	0	0
	Facilities and Equipment (Rs.)	100,000,000	0	0	0	0	0	0	0	0	0	0	100,000,000
	Initial Investment Total	100,000,000	0	0	0	0	0	0	0	0	0	0	100,000,000
	Personnel Cost (Rs.)	0	10,080,000	9,000,000	9,000,000	9,000,000	9,000,000	9,000,000	9,000,000	9,000,000	9,000,000	9,000,000	91,080,000
	Administration expenses (Rs.)	0	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	18,216,000
	Operation Cost (Rs.)	0	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	51,000,000
	Maintenance Cost (Rs.)	0	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	50,000,000
	Operation and Maintenance Cost Total	0	29,756,000	28,676,000	28,676,000	28,676,000	28,676,000	28,676,000	28,676,000	28,676,000	28,676,000	28,676,000	101,000,000
Cost		100,000,000	29,756,000	28,676,000	28,676,000	28,676,000	28,676,000	28,676,000	28,676,000	28,676,000	28,676,000	28,676,000	201,000,000
1	Production RDF Amount per Day (ton/day)	0	200	200	200	200	200	200	200	200	200	200	n.a.
2	Working Days per Annum (30 days x12 months = 360 days)	0	360	360	360	360	360	360	360	360	360	360	n.a.
3	Working Ratio	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	n.a.
4 = 1x2x3	Production Amount per Annum (ton)	0	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	n.a.
5	Unit Price of Products (Rs. per ton)	0	650.0	650.0	650.0	650.0	650.0	650.0	650.0	650.0	650.0	650.0	n.a.
6 = 4x5	Sales of Products per Annum (Rs.)	0	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	374,400,000
Revenue = 7 (Sales of Products per Annum)		0	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	37,440,000	374,400,000
Profit (Revenue - Cost)		-100,000,000	7,684,000	8,764,000	8,764,000	8,764,000	8,764,000	8,764,000	8,764,000	8,764,000	8,764,000	8,764,000	173,400,000

IRR =		-3%	%
Working Days per Annum		360	
Working Ratio		0.8	
Unit Price of Product (Rs. per ton)		650.0	

Notes: Some subsidy by the government is required to justify the IRR of the DRF 200 ton/day case.

Table DD.3.4 Proposed Gujranwala RDF Plant - input waste amount 500 ton/day

Item		Investment Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year	Total
	Land (Rs.)	0	0	0	0	0	0	0	0	0	0	0	0
	Facilities and Equipment (Rs.)	100,000,000	0	0	0	0	0	0	0	0	0	0	100,000,000
	Initial Investment Total	100,000,000	0	0	0	0	0	0	0	0	0	0	100,000,000
	Personnel Cost (Rs.)	0	10,080,000	10,080,000	10,080,000	10,080,000	10,080,000	10,080,000	10,080,000	10,080,000	10,080,000	10,080,000	100,800,000
	Administration expenses (Rs.)	0	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	9,576,000	95,760,000
	Operation Cost (Rs.)	0	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	5,100,000	51,000,000
	Maintenance Cost (Rs.)	0	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	50,000,000
	Operation and Maintenance Cost Total	0	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	101,000,000
Cost		100,000,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	29,756,000	201,000,000
1	Production Amount per Day (ton/day)	0	100	120	140	160	180	200	200	200	200	200	n.a.
2	Working Days per Annum (30 days x12 months = 360 days)	0	360	360	360	360	360	360	360	360	360	360	n.a.
3	Working Ratio	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	n.a.
4 = 1x2x3	Production Amount per Annum (ton)	0	28,800	34,560	40,320	46,080	51,840	57,600	57,600	57,600	57,600	57,600	n.a.
5	Unit Price of Products (Rs. per ton)	0	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	n.a.
6 = 4x5	Sales of Products per Annum (Rs.)	0	1,512,000	1,814,400	2,116,800	2,419,200	2,721,600	3,024,000	3,024,000	3,024,000	3,024,000	3,024,000	25,704,000
Revenue = 7 (Sales of Products per Annum)		0	1,512,000	1,814,400	2,116,800	2,419,200	2,721,600	3,024,000	3,024,000	3,024,000	3,024,000	3,024,000	25,704,000
Profit (Revenue - Cost)		-100,000,000	-28,244,000	-27,941,600	-27,639,200	-27,336,800	-27,034,400	-26,732,000	-26,732,000	-26,732,000	-26,732,000	-26,732,000	-175,296,000

IRR =		#NUM!	%
Working Days per Annum		360	
Working Ratio		0.8	
Unit Price of Product (Rs. per ton)		52.5	

Table DD.3.5 Proposed Gujranwala RDF Plant - input waste amount 250 ton/day

Item		Investment Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year	Total
	Land (Rs.)	0	0	0	0	0	0	0	0	0	0	0	0
	Facilities and Equipment (Rs.)	50,000,000	0	0	0	0	0	0	0	0	0	0	50,000,000
	Initial Investment Total	50,000,000	0	0	0	0	0	0	0	0	0	0	50,000,000
	Personnel Cost (Rs.)	0	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	60,000,000
	Administration expenses (Rs.)	0	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	57,000,000
	Operation Cost (Rs.)	0	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	33,600,000
	Maintenance Cost (Rs.)	0	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	25,000,000
	Operation and Maintenance Cost Total	0	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	58,600,000
Cost		50,000,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	17,560,000	108,600,000
1	Production Amount per Day (ton/day)	0	100	100	100	100	100	100	100	100	100	100	n.a.
2	Working Days per Annum (30 days x12 months = 360 days)	0	360	360	360	360	360	360	360	360	360	360	n.a.
3	Working Ratio	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	n.a.
4 = 1x2x3	Production Amount per Annum (ton)	0	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	n.a.
5	Unit Price of Products (Rs. per ton)	0	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	n.a.
6 = 4x5	Sales of Products per Annum (Rs.)	0	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	15,120,000
Revenue = 7 (Sales of Products per Annum)		0	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	15,120,000
Profit (Revenue - Cost)		-50,000,000	-16,048,000	-16,048,000	-16,048,000	-16,048,000	-16,048,000	-16,048,000	-16,048,000	-16,048,000	-16,048,000	-16,048,000	-93,480,000

IRR =		#NUM!	%
Working Days per Annum		360	
Working Ratio		0.8	
Unit Price of Product (Rs. per ton)		52.5	

Table DD.3.6 Estimated Costs and Benefits per Year for the Proposed Gujranwala Central Composting Plant
Gujranwala City (64 UCs)

			Initial Investment Year	
Cost Estimation			Rs./Year	Rs. x 1,000/year
1.	Initial Investment Cost			430,000
	(1) Construction of the Central Composting Plant		400,000,000	
	(2) Land (5 ha area)		30,000,000	
2.	Maintenance Cost			20,000
	(5% of (1))		20,000,000	
3.	Operation Cost			
	(1) Personnel expenses		10,200,000	
	Number of staff	17 staff		
		12 months		
		50,000 unit price		
	(2) Administration Expenses		9,690,000	
	(95% of (1))			
	(3) Electricity			
	shredder	75 kW		
	unit	2		
	hr	6		
	kWh/day	1080		
	300days	324,000		
	unit charge	18 (Rs/kWh/day)		
			5,832,000	
(4)	Fuel	Total fuel expenses per year		
	Loader	1 unit		
	Consumption	2 litter		
	Running dist.	10 km/day		
	Operation days	300 days/year		
	Fuel unit price	80 Rs./litter		
			144,000	
	Subtotal of (2) + (3) + (4)			15,666
	Subtotal of (1) + (2) + (3) + (4)			25,866
				475,866
Benefit Estimation of Composting (125 ton/year)			Rs./Year	Rs. x 1,000/year
	Input waste amount	250 ton/day		
	compost product amount	125 ton/day	50%	
	30days x 12 months	360 day x year		
	Net working rate	80 %		
	compost amount	36,000,000 kg/year		
	50kg/bag	720,000 bags		
	Rs. 250/50kg/bag	180,000,000 Rs.		
	Total yearly product	180,000,000 Rs./year		
Total			180,000,000	180,000

source:

City District Government Gujranwala

solid waste management department, March 2013

Table DD.3.7 Estimated Costs and Benefits per Year for Central Composting in Gujranwala (2030)
Gujranwala City (64 UCs)

Cost Estimation			Rs./Year	Rs. x 1,000/year
1.	Initial Investment Cost			20,000
	(1) Construction of the Central Composting Plant		20,000,000	
	(2) Land		0	
2.	Maintenance Cost (5% of (1))		1,000,000	1,000
3.	Operation Cost			
	(1) Personnel expenses	5,999,952	6,000,000	
	Number of staff	14 staff		
		12 months		
		35,714 unit price		
	(2) Administration Expenses (assumption 40% of (1))		2,400,000	
	(3) Electricity			
	shredder	75 kW		
	unit	1		
	hr	6		
	kWh/day	450		
	300days	135,000		
	unit charge	18 (Rs./kWh/day)		
			2,430,000	
(4)	Fuel	Total fuel expenses per year		
	Loader	1 unit		
	Consumption	2 litter		
	Running dist.	10 km/day		
	Operation days	300 days/year		
	Fuel unit price	80 Rs./litter		
			144,000	
	Subtotal of (2) + (3) + (4)			4,974
	Subtotal of (1) + (2) + (3) + (4)			12,000
				64,500
Benefit Estimation of Composting (20 ton/year)			Rs./Year	Rs. x 1,000/year
	Input waste amount	20 ton/day		
	compost product amount	10 ton/day	50%	
	30days x 12 months	360 day x year		
	Net working rate	80 %		
	compost amount	2,880,000 kg/year		
	50kg/bag	57,600 bags		
	Rs. 250/50kg/bag	14,400,000 Rs.		
	Total yearly product	14,400,000 Rs./year	14,400,000	
Total				14,400

Table DD.3.8 Estimated Costs and Benefits per Year for RDF Plant in Gujranwala (2030)
Gujranwala City (64 UCs)

Cost Estimation				Rs./Year	Rs. x 1,000/year
1.	Initial Investment Cost				1,024,000
	(1)	Construction of the RDF Plant		100,000,000	
	(2)	Land		0	
2.	Maintenance Cost (5% of (1))			5,000,000	50,000
3.	Operation Cost				
	(1)	Personnel expenses	10,080,000	10,080,000	
		Number of staff	24 staff		
			12 months		
			35,000 unit price		
	(2)	Administration Expenses (95% of (1))		9,576,000	
	(2)	Electricity			
		shredder/ conveyor	75 kW		
		unit	2		
		hr	6		
		kWh/day	900		
		300days	270,000		
		unit charge	18 (Rs/kWh/day)		
				4,860,000	
	(3)	Fuel	Total fuel expenses per year		
		Loader/trolley	2 unit		
		Consumption	2 liter		
		Running dist.	10 km/day		
		Operation days	300 days/year		
		Fuel unit price	80 Rs./litter		
				240,000	
	Subtotal of (1) + (2) + (3) + (4)			15,876,000	15,876
					1,089,876
Product Estimation				Rs./Year	Rs. x 1,000/year
	Input waste amount	500 ton/day			
	RDF amount	200 ton/day	40%		
	30days x 12 months	360 day x year			
	Net working rate	0.8			
	RDF amount	57,600 ton/year			
	Rs.	52.5 Rs./ton			
	Total	3,024,000 Rs./year		3,024,000	
Total					3,024

Table DD.3.9 Estimated Costs and Benefits per Year for RDF Plant in Gujranwala (2030)
Gujranwala City (64 UCs)

Cost Estimation				Rs./Year	Rs. x 1,000/year
1.	Initial Investment Cost				50,000
	(1) Construction of the RDF Plant			50,000,000	
	(2) Land			0	
2.	Maintenance Cost (5% of (1))			2,500,000	2,500
3.	Operation Cost				
	(1) Personnel expenses			6,000,000	
	Number of staff	14 staff			
		12 months			
		35,714 unit price			
	(2) Administration Expenses (95% of (1))			5,700,000	
	(3) Electricity				
	shredder/ conveyor	75 kW			
	unit	1			
	hr	6			
	kWh/day	600			
	300days	180,000			
	unit charge	18 (Rs/kWh/day)			
				3,240,000	
	(4) Fuel	Total fuel expenses per year			
		Loader/trolley	1 unit		
		Consumption	2 litter		
		Running dist.	10 km/day		
		Operation days	300 days/year		
		Fuel unit price	80 Rs./litter		
				120,000	
	Subtotal of (1) + (2) + (3) + (4)			15,020,000	15,020
					243,020
Product Estimation				Rs./Year	Rs. x 1,000/year
	Input waste amount	250 ton/day			
	RDF amount	100 ton/day	40%		
	30days x 12 months	360 day x year			
	Net working rate	0.8			
	RDF amount	28,800 ton/year			
	Rs.	52.5 Rs./ton			
	Total	1,512,000 Rs./year		1,512,000	
Total					1,512

Table DD.3.10 Personnel cost for the proposed Gujranwala compost & RDF plant

	post	unit Rs. /month	Composting section		RDF section		
			2015 number	Rs./month	2030 number	Rs./month	
managing staff	office managing director	380,000	1	380,000	0		0
	operation/market manager	65,000	1	65,000	70,000	1	70,000
	admin./contract/financ. manag	60,000	1	60,000	0		0
	mechanical engr.	55,000	1	55,000	60,000	1	60,000
	marketting manager	55,000	0	0	60,000	1	60,000
		0		0	0		0
		0	4	560,000	66%	3	190,000
technical/ site staff	assit. manager	40,000	1	40,000	50,000	1	50,000
	supervisor	25,000	1	25,000	30,000	1	30,000
	sanitary w.	25,000	1	25,000	30,000	1	30,000
	general w.	20,000	8	160,000	25,000	8	200,000
	guard	15,000	1	15,000	20,000		0
	driver	18,000	1	18,000	20,000		0
			13	283,000	34%	11	310,000
			17	113,827		14	120,606
				10,116,000			6,000,000
				10,200,000			6,000,000

D.3.2 SIMULATION-2

Intermediate Treatment & 3R Plan for the JICA M/P Project in Gujranwala

Simulation Results of the Proposed Central Compost Plant /RDF Plant in Gujranwala

Proposed Intermediate Treatment Plant	Input Waste Amount (ton/day)	Production Amount (ton/day)	IRR Evaluation	Remarks
Compost Plant	250	125	23.8	Ok
RDF Plant	250	100	NG	Subsidy may be required.

Notes: Simulation Case-2: As a more potential case, this simulation was set up for reference purpose, in which annual compost production increases step by step and reaches the target compost amount in three years.

Table DD.3.11 Proposed Gujranwala Compost Plant - input waste amount 250 ton/day

Item		Investment Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year	Total
	Land (Rs.)	42,000,000	0	0	0	0	0	0	0	0	0	0	42,000,000
	Facilities and Equipment (Rs.)	400,000,000	0	0	0	0	0	0	0	0	0	0	400,000,000
	Initial Investment Total	442,000,000	0	0	0	0	0	0	0	0	0	0	442,000,000
	Personnel Cost (Rs.)	0	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	10,200,000	102,000,000
	Administration expenses (Rs.)	0	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	9,690,000	96,900,000
	Operation Cost (Rs.)	0	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	5,976,000	59,760,000
	Maintenance Cost (Rs.)	0	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	200,000,000
	Operation and Maintenance Cost Total	0	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	259,760,000
Cost		442,000,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	45,866,000	701,760,000
1	Production of Composts per Day (ton/day)	0	88	113	125	125	125	125	125	125	125	125	n.a.
2	Working Days per Annum (30 days x12 months = 360 days)	0	360	360	360	360	360	360	360	360	360	360	n.a.
3	Working Ratio	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	n.a.
4 = 1x2x3	Production of Composts per Annum (Kg)	0	25,200,000	32,400,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	n.a.
5 = 4/50kg	Production of Bags of Composts per Annum (Bag: 50kg per Bag)	0	504,000	648,000	720,000	720,000	720,000	720,000	720,000	720,000	720,000	720,000	n.a.
6	Unit Price per Bag of Composts (Rs./Bag: 50kg per Bag)	0	250	250	250	250	250	250	250	250	250	250	n.a.
7 = 5x6	Sales of Composts per Annum (Rs.)	0	126,000,000	162,000,000	180,000,000	180,000,000	180,000,000	180,000,000	180,000,000	180,000,000	180,000,000	180,000,000	1,728,000,000
Revenue = 7 (Sales of Composts per Annum)		0	126,000,000	162,000,000	180,000,000	180,000,000	180,000,000	180,000,000	180,000,000	180,000,000	180,000,000	180,000,000	1,728,000,000
Profit (Revenue - Cost)		-442,000,000	80,134,000	116,134,000	134,134,000	134,134,000	134,134,000	134,134,000	134,134,000	134,134,000	134,134,000	134,134,000	1,026,240,000

IRR =	23.8%	%
Working Days per Annum	360	
Working Ratio	0.8	
Unit Price per Bag (50kg)	250	

Table DD.3.12 Proposed Gujranwala RDF Plant - input waste amount 250 ton/day

Item		Investment Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year	Total
	Land (Rs.)	0	0	0	0	0	0	0	0	0	0	0	0
	Facilities and Equipment (Rs.)	70,000,000	0	0	0	0	0	0	0	0	0	0	70,000,000
	Initial Investment Total	70,000,000	0	0	0	0	0	0	0	0	0	0	70,000,000
	Personnel Cost (Rs.)	0	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	60,000,000
	Administration expenses (Rs.)	0	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	5,700,000	57,000,000
	Operation Cost (Rs.)	0	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	33,600,000
	Maintenance Cost (Rs.)	0	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	35,000,000
	Operation and Maintenance Cost Total	0	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	68,600,000
Cost		70,000,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	18,560,000	138,600,000
1	Production Amount per Day (ton/day)	0	100	100	100	100	100	100	100	100	100	100	n.a.
2	Working Days per Annum (30 days x12 months = 360 days)	0	360	360	360	360	360	360	360	360	360	360	n.a.
3	Working Ratio	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	n.a.
4 = 1x2x3	Production Amount per Annum (ton)	0	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	n.a.
5	Unit Price of Products (Rs. per ton)	0	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5	n.a.
6 = 4x5	Sales of Products per Annum (Rs.)	0	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	15,120,000
Revenue = 7 (Sales of Products per Annum)		0	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	1,512,000	15,120,000
Profit (Revenue - Cost)		-70,000,000	-17,048,000	-17,048,000	-17,048,000	-17,048,000	-17,048,000	-17,048,000	-17,048,000	-17,048,000	-17,048,000	-17,048,000	-123,480,000

IRR =		#NUM!	%
Working Days per Annum		360	
Working Ratio		0.8	
Unit Price of Product (Rs. per ton)		52.5	

Table DD.3.13 Estimated Costs and Benefits per Year for the Proposed Gujranwala Central Composting Plant
Gujranwala City (64 UCs)

			Initial Investment Year	
Cost Estimation			Rs./Year	Rs. x 1,000/year
1.	Initial Investment Cost			430,000
	(1) Construction of the Central Composting Plant		400,000,000	
	(2) Land (5 ha area)		30,000,000	
2.	Maintenance Cost			20,000
	(5% of (1))		20,000,000	
3.	Operation Cost			
	(1) Personnel expenses		10,200,000	
	Number of staff	17 staff		
		12 months		
		50,000 unit price		
	(2) Administration Expenses		9,690,000	
	(95% of (1))			
	(3) Electricity			
	shredder	75 kW		
	unit	2		
	hr	6		
	kWh/day	1080		
	300days	324,000		
	unit charge	18 (Rs/kWh/day)		
			5,832,000	
	(4) Fuel	Total fuel expenses per year		
	Loader	1 unit		
	Consumption	2 litter		
	Running dist.	10 km/day		
	Operation days	300 days/year		
	Fuel unit price	80 Rs./litter		
			144,000	
	Subtotal of (2) + (3) + (4)			15,666
	Subtotal of (1) + (2) + (3) + (4)			25,866
				475,866
Benefit Estimation of Composting (125 ton/year)			Rs./Year	Rs. x 1,000/year
	Input waste amount	250 ton/day		
	compost product amount	125 ton/day	50%	
	30days x 12 months	360 day x year		
	Net working rate	80 %		
	compost amount	36,000,000 kg/year		
	50kg/bag	720,000 bags		
	Rs. 250/50kg/bag	180,000,000 Rs.		
	Total yearly product	180,000,000 Rs./year		
Total			180,000,000	180,000

source:

City District Government Gujranwala

solid waste management department, March 2013

Table DD.3.14 Estimated Costs and Benefits per Year for RDF Plant in Gujranwala (2030)
Gujranwala City (64 UCs)

Cost Estimation				Rs./Year	Rs. x 1,000/year
1.	Initial Investment Cost				70,000
	(1)	Construction of the RDF Plant		70,000,000	
	(2)	Land		0	
2.	Maintenance Cost (5% of (1))			3,500,000	3,500
3.	Operation Cost				
	(1)	Personnel expenses	6,000,000	6,000,000	
		Number of staff	14 staff		
			12 months		
			35,714 unit price		
	(2)	Administration Expenses (95% of (1))		5,700,000	
	(3)	Electricity			
		shredder/ conveyor	75 kW		
		unit	1		
		hr	6		
		kWh/day	600		
		300days	180,000		
		unit charge	18 (Rs/kWh/day)		
				3,240,000	
	(4)	Fuel	Total fuel expenses per year		
			Loader/trolley	1 unit	
			Consumption	2 litter	
			Running dist.	10 km/day	
			Operation days	300 days/year	
			Fuel unit price	80 Rs./litter	
				120,000	
	Subtotal of (1) + (2) + (3) + (4)			15,020,000	15,020
					243,020
Product Estimation				Rs./Year	Rs. x 1,000/year
		Input waste amount	250 ton/day		
		RDF amount	100 ton/day	40%	
		30days x 12 months	360 day x year		
		Net working rate	0.8		
		RDF amount	28,800 ton/year		
		Rs.	52.5 Rs./ton		
		Total	1,512,000 Rs./year	1,512,000	
	Total				1,512

Table DD.3.15 Personnel cost for the proposed Gujranwala compost & RDF plant

	post	unit Rs. /month	Composting section		RDF section		
			2015 number	Rs./month	2030 number	Rs./month	
managing staff	office managing director	380,000	1	380,000	0	0	
	operation/market manager	65,000	1	65,000	70,000	1	70,000
	admin./contract/financ. manager	60,000	1	60,000	0	0	
	mechanical engr.	55,000	1	55,000	60,000	1	60,000
	marketing manager	55,000	0	0	60,000	1	60,000
		0	4	560,000	0	0	
technical/site staff	assit. manager	40,000	1	40,000	50,000	1	50,000
	supervisor	25,000	1	25,000	30,000	1	30,000
	sanitary w.	25,000	1	25,000	30,000	1	30,000
	general w.	20,000	8	160,000	25,000	8	200,000
	guard	15,000	1	15,000	20,000	0	0
	driver	18,000	1	18,000	20,000	0	0
			13	283,000		11	310,000
			17	113,827	14	120,606	
				10,116,000		6,000,000	
						6,000,000	

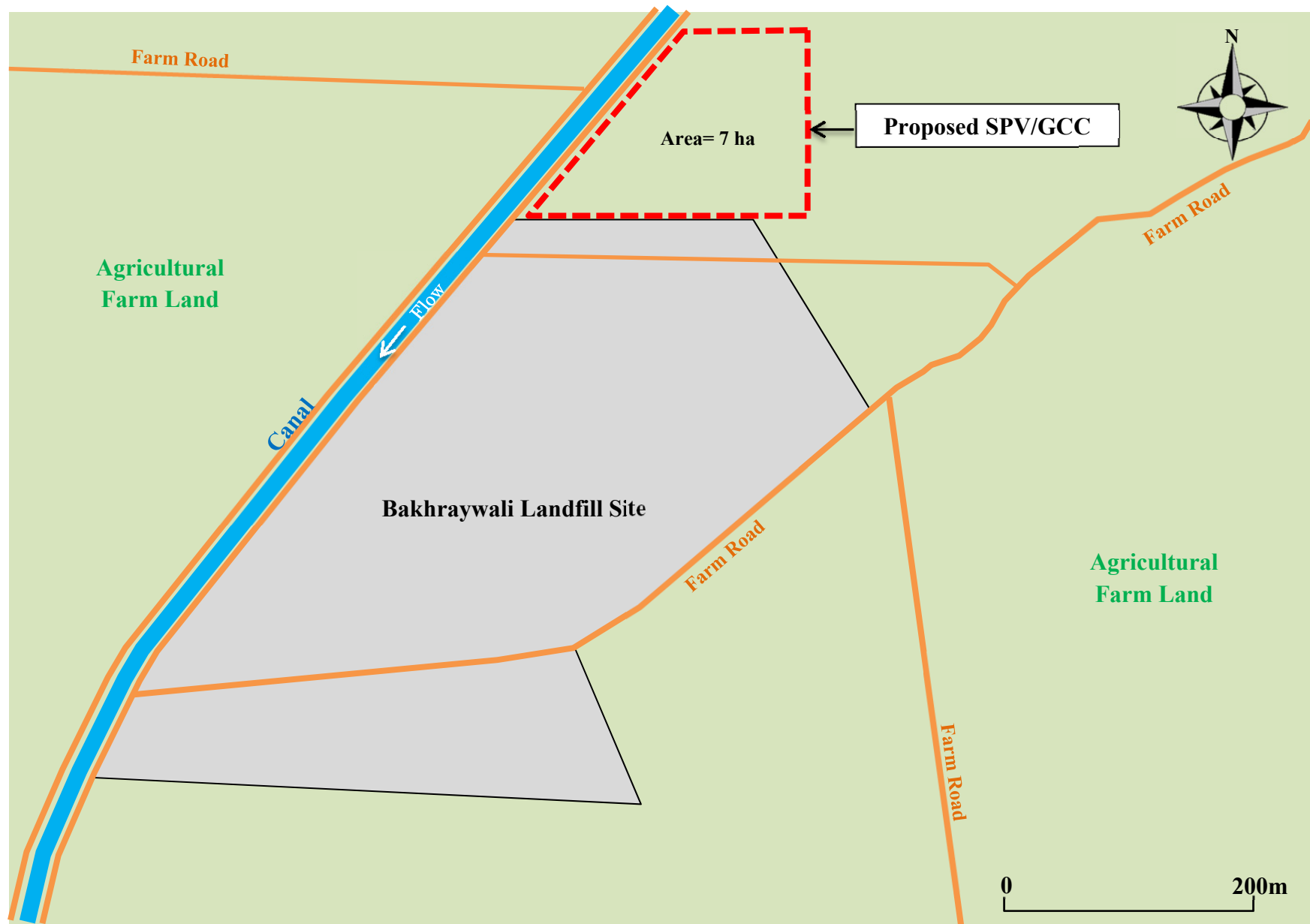


Figure DD.4.1 Preliminary Location Plan of Gujranwala Compost (GCC) Area

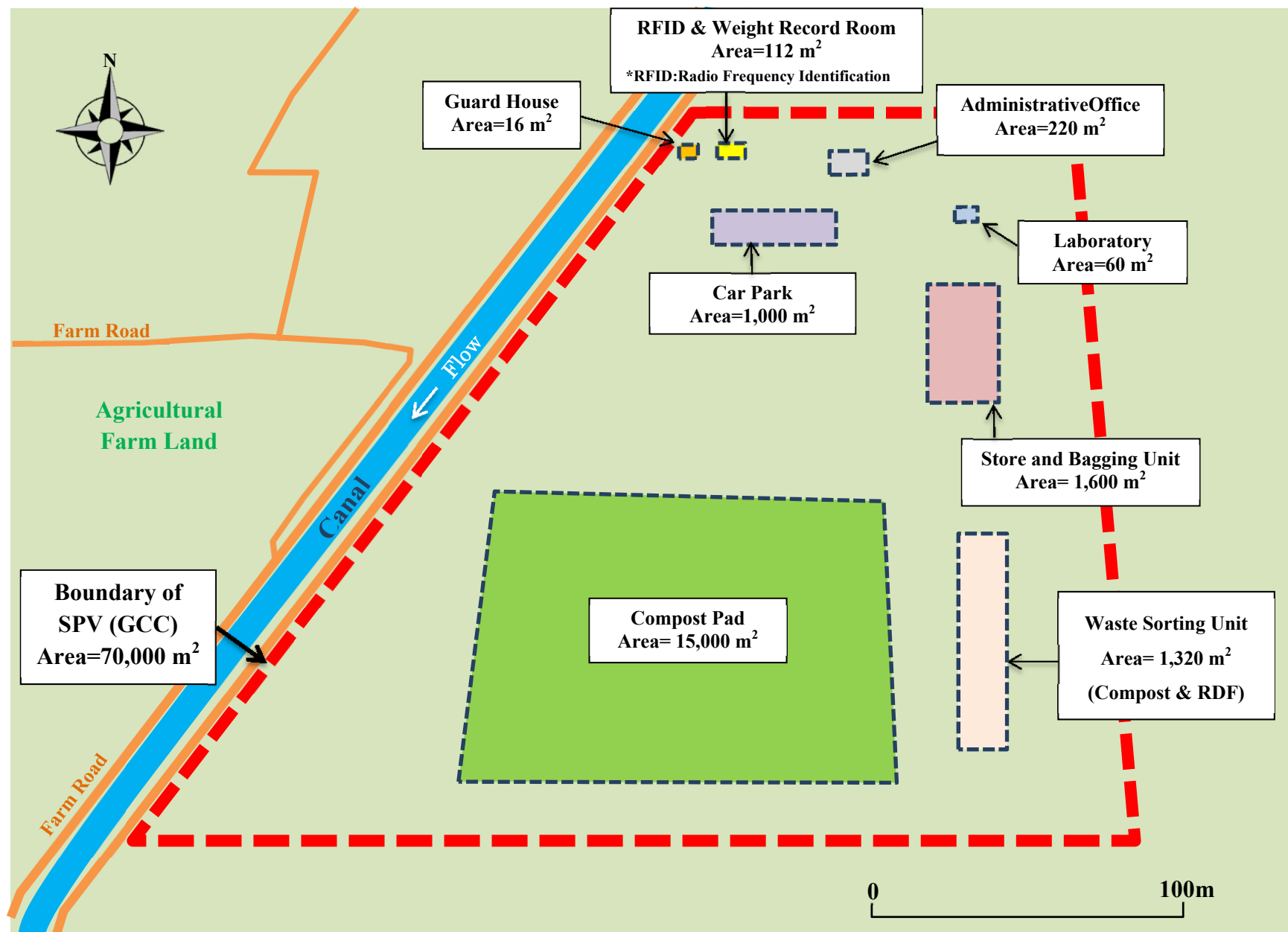


Figure DD.4.2 Preliminary Layout Plan of Gujranwala Compost (GCC) Plant

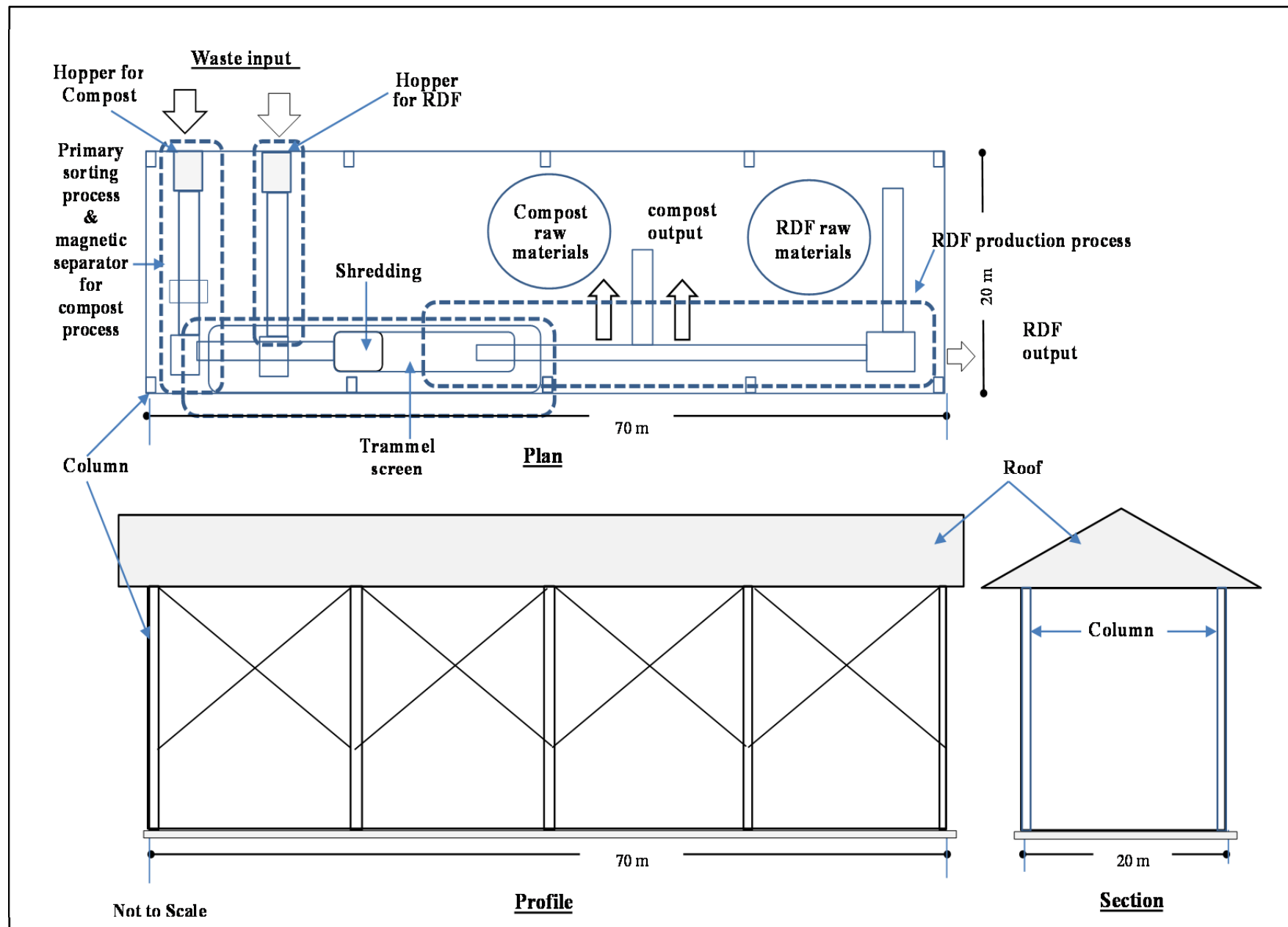


Figure DD.4.3 Conceptual Layout of Gujranwala Compost & RDF Plant

D.5
Proposed Compost / RDF Plant in Gujranwala
Cost Estimation

August 2015

Table DD.5.1 Preliminary cost estimates for the proposed Gujranwala compost /RDF plant

Land acquisition and house facilities

Specification	Unit cost		ha	unit	Quantity	Subtotal Cost thousand Rs.
	unit	Rs./m ²				
Total land area	m ²	600		m ²	70,000	42,000,000
Sources: Land prices from CDGG (City District Government Gujranwala)						42,000,000
Required structural facility						
1 admin. Office	m ²	220	0	Rs.	21,500	4,730,000
2 Laboratory office	m ²	60	0	Rs.	21,500	1,290,000
3 RFID/weight bridge platform	m ²	112	0	Rs.	17,200	1,926,400
4 Guard house	m ²	16	0	Rs.	1,600	25,600
sub-total	m ²	408	0	Rs.		7,972,000
1 Screen bagging & store facility	m ²	1,600	0	Rs.	16,000	25,600,000
2 waste sorting facility	m ²	1,320	0	Rs.	16,000	21,120,000
3 car parking area	m ²	1,000	0	Rs.	3,500	3,500,000
sub-total	m ²	3,920	0	Rs.		50,220,000
1 windrow area	m ²	15,000	2	Rs.	5,000	75,000,000
2 open & green area / botanical garden	m ²	50,672	5	Rs.	200	10,134,400
sub-total	m ²	65,672	7	Rs.		85,134,400
Total	m ²	70,000	7	Rs.		143,326,400

Detailed design of Gujranwala compost /RDF plant					
10% of total investment cost	=	40,000,000	=	Rs. X 10%	400,000,000

360,000,000

0.11

Facilities cost : Rs.		160,000,000		
		143,326,400		
		16,673,600	0.10	OK

Equipment		102,700,000		
-----------	--	-------------	--	--

Equipment machinery, facility and miscellaneous

Item	Unit price		Quantity		Total cost Rs.	Remarks
	unit	Rs.	unit	amount		
equipment					2,000,000	
Stitching and bagging unit	set	2,000,000	set	1	2,000,000	store & bagging unit
machinery					11,100,000	
wheel loaders	set	10,000,000	set	1	10,000,000	
Tractor/Trolleys (370)	set	1,100,000	set	1	1,100,000	
facility					33,140,000	
Weighbridge	set	2,500,000	set	1	2,500,000	
tube well (4cfs)	set	16,040,000	set	1	16,040,000	
Concrete slab for steel skeleton structures	m ³	5,000	m ²	2,920	14,600,000	25cm concrete slab
miscellaneous					47,186,800	
Drainage facility	m	7,000	m	1,200	8,400,000	consisting U pipe + collecting box +
	m	5,000	m	1,030	5,150,000	U 0.3mH, 0.3mW
Canvas pipe	ft.	100	ft.	328	32,800	
Steel pipe (6" Diameter)	ft.	600	ft.	1,650	990,000	
Gate Valve (for 6" Dia.)	set	12,000	set	12	144,000	
perimeter fence	m	1,800	m	1,200	2,160,000	h= 2.0m, 4 horizontal lines with 2 cross lines and concrete base
compound roads	m	12,000	m	700	8,400,000	w=5.0m, t0.3m surface, t0.3m subgrade, t0.3m base
Diesel generating set (110 KV capacity)	unit	4,500,000	set	1	4,500,000	
WPP bag with inner liner	unit	25	set/year	0	0	50kg bag 25%, 20kg bag 50%, 5kg bag 25%
over-head storage tank	unit	80,000	unit	2	160,000	Rs. 80,000/1000 gallons, provided with admin. Office
Plastic sheet	m ²	115	m ²	150,000	17,250,000	=
Total					93,426,800	

Facility & Equipment Cost

200,000,000	160,000,000
102,700,000	143,326,400
93,426,800	
3,873,200	16,673,600
0.02	0.10
	360,000,000
	339,453,200
	20,546,800
	0.06

Table DD.5.2 Imported equipment by Menart/ Belgium company

Equipment	Specification	Compost/RDF	Unit	number of unit	Unit Price		Remarks (operation)
					Euro	Rs	
Compost processing							
1 Sorting line including hopper & conveyor (1)	TS 1860	Compost	set	1	120,000	15,600,000	from 2020~
2 Shredder	P145DS	Compost	set	1	170,000	22,100,000	from 2020~
3 Double refining trammel screen (1)	TS 1850 double refining	Compost	set	1	150,000	19,500,000	from 2020~
4 Pre-treatment screen	TS 1850	Compost	set	1	130,000	16,900,000	from 2020~
5 Self propelled windrow turner	SPM 4300	Compost	set	1	220,000	28,600,000	from 2020~
Sub-total					790,000	102,700,000	
RDF processing							
6 Sorting line (2)	TS 1860	RDF	set	1	120,000	15,600,000	from 2030~
7 Baler					150,000	19,500,000	
8 shredder	P145DS	Compost	set	1	170,000	22,100,000	
9 palleting							
Sub-total					440,000	57,200,000	
Total					1,230,000	159,900,000	

Source: Lahore Compost Ltd., GWMC

Menart Company, Belgium

Notes: Exchange rate of Euro to Rupees: 1 Euro = 130 Rs.

1 Euro=

130 Rs

Table DD.5.3 Comparison between Existing Lahore Compost company (LCC) and Proposed Gujranwala Compost Plant

Description	Lahore	Gujranwala	Gujranwala
	Existing	(initial planning)	Implementation of Final Compost/RDF Plant (2020~)
Total area	15 ha (2006-)	5 ha (plan:2020-2030)	7 ha (plan: 2030-)
Total population (million persons)	10 million persons (2015)	3 million persons (2015)	5.8 million persons (2030)
Total input compost	1,000 t/d	250 t/d	Organic + RDF compost 500 t/d
Organic compost	500 t/d	250 t/d	Component RDF 250 t/d Organic compost 250 t/d
final compost	200~250 t/d	125 t/d	RDF 100 t/d Organic compost 125 t/d
after windrow processing 60~90 days			
Required facility area			80%
1 admin. Office	275 m ²	0.028 ha	92 m ² 0.009 ha
2 Laboratory office	75 m ²	0.008 ha	25 m ² 0.002 ha
3 RFID / weight bridge platform	140 m ²	0.014 ha	47 m ² 0.005 ha
4 Guard house	16 m ²	0.002 ha	5 m ² 0.001 ha
sub-total	506 m ²	0.051 ha	169 m ² 0.017 ha
1 Screen bagging & store facility	2,000 m ²	0.200 ha	667 m ² 0.067 ha
2 waste sorting facility	1,320 m ²	0.132 ha	440 m ² 0.044 ha
3 car parking area	5,000 m ²	0.500 ha	1,666 m ² 0.167 ha
sub-total	8,320 m ²	0.832 ha	2,773 m ² 0.277 ha
1 windrow area	56,000 m ²	5.600 ha	18,662 m ² 1.866 ha
2 open & green area	85,210 m ²	8.521 ha	28,397 m ² 2.840 ha
sub-total	141,210 m ²	14.121 ha	47,059 m ² 4.706 ha
Total	150,036 m ²	15 ha	50,000 m ² 5 ha
			50,000

Notes: Life spans for plant & equipment are assumed at 16 years period, based on
Source: GWMC, JICA Study Team

Specification	Unit	Quantity	Unit cost	Cost	Phase I (x 1000 Rs.)	Phase II (x 1000 Rs.)
	unit		Rs./m ²	thousand Rs.	2020-2035	2030~
	m ²	220	21,500	4,730	4,730	
	m ²	60	21,500	1,290	1,290	
	m ²	112	17,200	1,926	1,926	
	m ²	16	1,600	26	26	
				7,972	7,972	0
	m ²	1,600	16,000	25,600	25,600	
	m ²	1,320	16,000	21,120	14,784	6,336
	m ²	1,000	3,500	3,500	3,500	
				50,220	43,884	6,336
	m ²	15,000	5,000	75,000	75,000	
	m ²	50,672	0	0		
				75,000	75,000	0
Total cost				133,192	126,856	6,336

		1320	70%	924	Compost
		m ²	30%	396	RDF
				1320	
waste sorting facility	m ²	1,320	0	Rs.	16,000
		396			16,000

6,336,000	Structure bldg.
57,200,000	Equipment
63,536,000	subtotal
6,464,000	10%
70,000,000	Extension const. cost

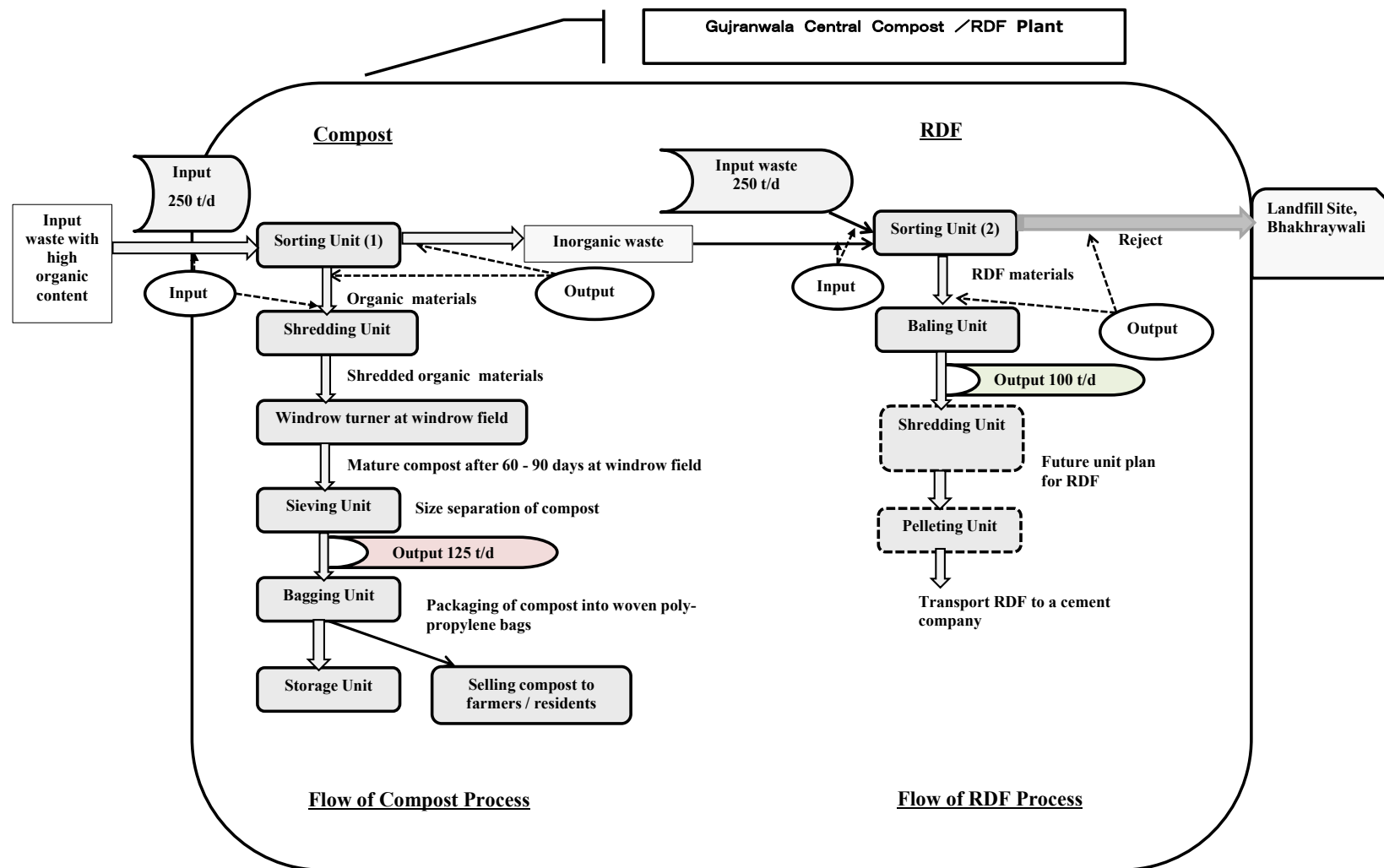


Figure DD.5.1 Flow Chart of Compost and RDF Production at the proposed Gujranwala Central Compost/RDF Plant (2030)

Table DD.5.4 Estimated Costs and Benefits per Year for the Proposed Gujranwala Central Composting Plant
Gujranwala City (64 UCs)

			Initial Investment Year	
Cost Estimation			Rs./Year	Rs. x 1,000/year
1. Initial Investment Cost				442,000
(1) Construction of the Central Composting Plant			400,000,000	
(2) Land (7 ha area)			42,000,000	
2. Maintenance Cost				20,000
(5% of (1))			20,000,000	
3. Operation Cost				
(1) Personnel expenses			10,200,000	
Number of staff 17 staff 12 months 50,000 unit price				
(2) Administration Expenses			9,690,000	
(95% of (1))				
(3) Electricity				
shredder/conveyor 75 kW				
unit 2				
hr 6				
kWh/day 1080				
300days 324,000				
unit charge 18 (Rs/kWh/day)				
			5,832,000	
(4) Fuel				
Total fuel expenses per year				
Loader/trolley 1 unit				
Consumption 2 litter				
Running dist. 10 km/day				
Operation days 300 days/year				
Fuel unit price 80 Rs./litter				
			144,000	
Subtotal of (2) + (3) + (4)				15,666
Subtotal of (1) + (2) + (3) + (4)				25,866
				503,532
Benefit Estimation of Composting (125 ton/year)			Rs./Year	Rs. x 1,000/year
Input waste amount 250 ton/day				
compost amount 125 ton/day				
30days x 12 months 360 day x year				
Net working rate 80 %				
compost amount 36,000,000 kg/year				
50kg/bag 720,000 bags				
Rs. 250/50kg/bag 180,000,000 Rs.				
Total yearly product 180,000,000 Rs./year				
Total			180,000,000	180,000

source:

*Land unit price: City District Government Gujranwala
solid waste management department, March 2015

Table DD.5.5 Estimated Annual Costs and Benefits for RDF Plant in Gujranwala (2030)
Gujranwala City (64 UCs)

Cost Estimation				Rs./Year	Rs. x 1,000/year
1. Initial Investment Cost					70,000
(1) Construction of the RDF Plant (extension of DRF section)				70,000,000	
(2) Land				0	
2. Maintenance Cost (5% of (1))				3,500,000	3,500
3. Operation Cost					
(1) Personnel expenses				6,000,000	
Number of staff					

Table DD.5.6 Personnel cost for the proposed Gujranwala compost & RDF plant

	post	unit Rs. /month	Composting section			RDF section	
			2015 number	Rs./month		2030 number	Rs./month
managing staff	office managing director	380,000	1	380,000		0	0
	operation/market manager	65,000	1	65,000		70,000	70,000
	admin./contract/financ. manager	60,000	1	60,000		0	0
	mechanical engr.	55,000	1	55,000		60,000	60,000
	marketing manager	55,000	0	0		60,000	60,000
		0	4	0		0	0
technical /site staff	assit. manager	40,000	1	40,000	66%	3	190,000
	supervisor	25,000	1	25,000		50,000	50,000
	sanitary w.	25,000	1	25,000		30,000	30,000
	general w.	20,000	8	160,000		1	30,000
	guard	15,000	1	15,000		25,000	200,000
	driver	18,000	1	18,000		8	0
			13	283,000	34%	11	0
			17	113,827		14	310,000
				10,116,000			120,606
				10,200,000			6,000,000
							6,000,000

Table DD.5.7 Project Cost Input Sheet for Economic Analysis

Component		Cost	Local/Foreign	Short-term			Mid-term						Long-term						Total	
				2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030		
Intermediate Treatment and 3R	Initial Investment Cost	Land	Local Cost				42,000												42,000	
		Facilities	Local Cost			40,000	160,000									4,000	10,000		214,000	
			Foreign Cost				0												0	
		Equipment	Local Cost				60,000											18,000	78,000	
	Foreign Cost					140,000											42,000	182,000		
	Operation and Maintenance Cost	Personnel Cost	Skilled Labour					4,743	5,963	6,098	6,437	6,776	6,776	6,776	6,776	6,776	6,776	6,776	9,056	72,952
			Unskilled Labour					2,397	3,013	3,082	3,253	3,424	3,424	3,424	3,424	3,424	3,424	3,424	7,144	39,434
		Operation Cost	Local Cost					14,099	15,039	15,196	15,509	15,666	15,666	15,666	15,666	15,666	15,666	15,666	24,686	178,525
			Foreign Cost					0	0	0	0	0	0	0	0	0	0	0	0	0
	Replacement Cost	Maintenance Cost	Local Cost					18,000	18,400	19,000	19,600	20,000	20,000	20,000	20,000	20,000	20,000	20,000	23,000	218,000
			Foreign Cost					0	0	0	0	0	0	0	0	0	0	0	0	0
		Facilities	Local Cost																	0
			Foreign Cost																	0
	Equipment	Local Cost																	0	
		Foreign Cost																	0	
Intermediate Treatment and 3R Total				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	1,024,911	
Total	Initial Investment Cost	Land	Local Cost	0	0	0	42,000	0	0	0	0	0	0	0	0	0	0	0	42,000	
		Facilities	Local Cost	0	0	40,000	160,000	0	0	0	0	0	0	0	0	4,000	10,000	0	214,000	
			Foreign Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Equipment	Local Cost	0	0	0	60,000	0	0	0	0	0	0	0	0	0	0	18,000	78,000	
	Foreign Cost		0	0	0	140,000	0	0	0	0	0	0	0	0	0	0	42,000	182,000		
	Operation and Maintenance Cost	Personnel Cost	Skilled Labour	0	0	0	0	4,743	5,963	6,098	6,437	6,776	6,776	6,776	6,776	6,776	6,776	6,776	9,056	72,952
			Unskilled Labour	0	0	0	0	2,397	3,013	3,082	3,253	3,424	3,424	3,424	3,424	3,424	3,424	7,144	39,434	
		Operation Cost	Local Cost	0	0	0	0	14,099	15,039	15,196	15,509	15,666	15,666	15,666	15,666	15,666	15,666	15,666	24,686	178,525
			Foreign Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Replacement Cost	Maintenance Cost	Local Cost	0	0	0	0	18,000	18,400	19,000	19,600	20,000	20,000	20,000	20,000	20,000	20,000	20,000	23,000	218,000
			Foreign Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Facilities	Local Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Foreign Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Equipment	Local Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Foreign Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Grand Total				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	1,024,911	

SECTION F
ECONOMIC AND FINANCIAL
ASPECT

**PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

FINAL REPORT

VOLUME 4

DATA BOOK

SECTION F

ECONOMIC AND FINANCIAL ASPECT**

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Table DF.1.1 Detailed Financial Cost for Master Plan

Component			Cost	Local/Foreign	Short-term			Mid-term				Long-term							Total			
					2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030			
Final Disposal		Initial Investment Cost	Land	Local Cost	150,000				300,000											450,000		
			Facilities	Local Cost	596,593	542,591	57,340			541,455	541,455	57,333		541,455	541,455	57,333				3,477,010		
			Foreign Cost																	0		
		Operation and Maintenance Cost	Equipment	Local Cost	3,400	13,150	3,400					11,300	4,125			11,300				5,000	51,675	
			Personnel Cost	Local Cost	30,000	37,000							66,000							100,000	233,000	
			Skilled Labour	Local Cost	4,389	4,389	6,535	6,535	6,535	6,535	6,535	6,535	8,215	8,215	8,215	8,215	8,215	8,215	8,215	10,735	108,015	
		Replacement Cost	Unskilled Labour	Local Cost	1,484	1,484	1,484	1,484	1,484	1,484	1,484	1,484	1,484	1,484	1,484	1,484	1,484	1,484	1,484	1,484	22,260	
			Operation Cost	Local Cost	12,301	14,591	19,273	20,143	18,860	19,867	20,950	22,113	25,039	22,113	25,039	26,033	27,019	28,107	29,284	30,459	32,042	346,081
			Foreign Cost																		0	
		Maintenance Cost	Local Cost	495	1,395	4,331	4,668	4,668	4,668	4,668	7,068	9,048	9,048	9,048	9,048	11,448	11,448	11,448	14,448	107,897		
Facilities	Local Cost																		0			
Foreign Cost																			0			
Equipment	Local Cost																		0			
Foreign Cost																			0			
Final Disposal Total					798,662	614,600	92,363	32,831	331,547	574,008	586,392	181,983	43,786	586,234	598,521	106,587	50,431	225,906	58,710	4,882,562		
Collection and Transport		Initial Investment Cost	Land	Local Cost																0		
			Facilities	Local Cost																0		
			Foreign Cost																	0		
		Operation and Maintenance Cost	Equipment	Local Cost	408,382	247,600	1,093,648	129,800	144,020	284,640	263,940	236,900	266,420	540,650	384,460	392,464	706,180	481,344	523,084	6,103,532		
			Foreign Cost																	0		
			Skilled Labour	Local Cost																	0	
		Personnel Cost	Local Cost	69,288	81,816	136,500	157,368	166,008	179,976	175,656	185,988	197,580	209,982	221,898	236,046	251,076	268,932	287,796	2,825,910			
		Unskilled Labour	Local Cost	69,972	81,059	116,284	121,030	126,921	140,683	120,490	130,008	140,037	150,910	162,354	173,651	186,460	200,492	215,494	2,135,845			
		Foreign Cost																		0		
		Maintenance Cost	Local Cost	40,283	47,972	82,817	78,785	85,986	99,398	112,395	123,180	134,941	146,942	159,180	171,698	185,110	200,562	217,350	1,886,599			
Foreign Cost																		0				
Replacement Cost	Facilities	Local Cost																	0			
	Foreign Cost																		0			
	Equipment	Local Cost	0	0	0	0	980	2,660	4,620	24,500	74,280	65,380	136,420	160,336	158,256	221,056	220,416	1,068,904				
Foreign Cost																		0				
Collection and Transport Total					587,925	458,447	1,429,249	486,983	523,915	707,357	677,101	700,576	813,258	1,113,864	1,064,312	1,134,195	1,487,082	1,372,386	1,464,140	14,020,790		
Intermediate Treatment and 3R		Initial Investment Cost	Land	Local Cost				42,000												42,000		
			Facilities	Local Cost			40,000	160,000									4,000	10,000		214,000		
			Foreign Cost				0													0		
		Operation and Maintenance Cost	Equipment	Local Cost				60,000											18,000		78,000	
			Foreign Cost				140,000												42,000		182,000	
			Skilled Labour	Local Cost				3,356	4,219	4,315	4,554	4,840	4,840	4,840	4,840	4,840	4,840	4,840	4,840	6,612	52,095	
		Personnel Cost	Local Cost				3,784	4,757	4,865	5,136	5,360	5,360	5,360	5,360	5,360	5,360	5,360	5,360	9,588	60,291		
		Unskilled Labour	Local Cost				14,099	15,039	15,196	15,509	15,666	15,666	15,666	15,666	15,666	15,666	15,666	15,666	24,686	178,525		
		Foreign Cost				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Maintenance Cost	Local Cost				18,000	18,400	19,000	19,600	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	23,000	218,000		
Foreign Cost				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Replacement Cost	Facilities	Local Cost																	0			
	Foreign Cost																		0			
	Equipment	Local Cost																	0			
Foreign Cost																		0				
Immediate Treatment and 3R					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	1,024,911		
Environmental Education and Public Awareness		Initial Investment Cost	Land	Local Cost																0		
			Facilities	Local Cost																0		
			Foreign Cost																	0		
		Operation and Maintenance Cost	Equipment	Local Cost	1,250	0	0	0	0	0	625	0	0	0	0	0	0	625	0	0	2,500	
			Foreign Cost	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150		
			Skilled Labour	Local Cost	960	1,037	1,114	1,190	1,267	1,368	2,810	3,018	3,227	3,435	3,684	3,968	4,491	6,122	7,853	45,544		
		Personnel Cost	Local Cost	792	792	792	792	792	792	792	792	792	792	792	792	792	792	792	792	11,880		
		Unskilled Labour	Local Cost	1,022	570	651	1,741	3,435	2,074	3,575	3,219	4,184	6,166	5,220	5,363	5,761	6,436	8,819	58,236			
		Foreign Cost				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Maintenance Cost	Local Cost	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	1,200		
Foreign Cost				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
Replacement Cost	Facilities	Local Cost	0	0	0	0	0	0	100	100	100	100	100	100	200	200	200	200	1,500			
	Foreign Cost				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	Equipment	Local Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Foreign Cost				0	0	0	0	0	0	0	0	0	0	1,250	0	0	0	1,250				
Environmental Education and Public Awareness Total					4,254	2,479	2,637	3,803	5,574	4,414	7,982	7,209	8,383	10,573	11,376	10,403	11,949	13,630	17,744	122,410		
Environmental Monitoring		Initial Investment Cost	Land	Local Cost																0		
			Facilities	Local Cost																0		
			Foreign Cost																	0		
		Operation and Maintenance Cost	Equipment	Local Cost																		

Table DF.1.2 Detailed Financial Benefit for Master Plan

Category of Benefit			No.	Description	Short-term			Mid-term					Long-term						Total	
					2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029		2030
Economic Benefit	Reduction in Waste Disposal Cost	1	Waste Disposal Amount per Annum for Cost Saving (ton)	0	0	441,093	485,152	532,695	584,289	640,158	700,507	765,614	828,775	893,790	966,472	1,046,555	1,129,477	1,221,432	10,236,009	
		2	Unit Waste Disposal Cost (Rp. per ton)	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	n.r.
		3=1x2	Saved Disposal Cost (Rp.1000)	0	0	275,992	303,560	333,307	365,590	400,547	438,307	479,045	518,565	559,244	604,722	654,829	706,714	764,250	6,404,671	
	Reduction in Waste Collection and Transport Cost	1	Waste Collection and Transport Amount for Cost Saving (ton)	0	0	441,093	485,152	532,695	584,289	640,158	700,507	765,614	828,775	893,790	966,472	1,046,555	1,129,477	1,221,432	10,236,009	
		2	Unit Waste Collection and Transport Cost (Rp. per ton)	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	n.r.
		3=1x2	Saved Collection and Transport Cost (Rp.1000)	0	0	597,549	657,235	721,642	791,536	867,222	948,977	1,037,177	1,122,741	1,210,817	1,309,280	1,417,768	1,530,102	1,654,674	13,866,721	
	Benefit Accrued from Total Saved Cost		7=3+6	Total Saved Cost (Rp.1000)	0	0	873,541	960,795	1,054,949	1,157,126	1,267,769	1,387,284	1,516,222	1,641,306	1,770,062	1,914,001	2,072,598	2,236,816	2,418,924	20,271,392
	Profit Accrued from Waste Recovery	1	Material Recovery (Without Case: Rp.1000)	38,930	49,471	61,753	67,921	74,577	81,801	89,622	98,071	107,186	116,029	125,131	135,306	146,518	158,127	171,000	1,521,442	
		2	Material Recovery (With Case: Rp.1000)	38,930	49,471	61,753	77,624	85,231	93,486	102,425	112,081	122,498	149,180	160,882	173,965	188,380	203,306	219,858	219,858	
		3	Unit Cost per Recovered Material (Rp. per kg)	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	n.r.	
		4=(2-1)x3	Incremental Profit through Material Recovery (Rp.1000)	0	0	0	25,228	27,700	30,383	33,288	36,426	39,812	86,193	92,954	100,513	108,842	117,466	127,029	825,834	
		5	Biodegradable Waste Recovery (Without Case):Rp.1000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		6	Biodegradable Waste Recovery (With Case: Rp.1000)	0	0	0	58,218	63,923	70,115	76,819	84,061	91,874	124,316	134,068	144,971	156,983	169,422	183,215	1,357,985	
		7	Unit Cost per Compost (Rp. per kg)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	n.r.	
		8=(6-5)x7	Incremental Profit through Biodegradable Waste Recovery (Rp.1000)	0	0	0	58,218	63,923	70,115	76,819	84,061	91,874	124,316	134,068	144,971	156,983	169,422	183,215	1,357,985	
		9	Combustible Waste Recovery (Without Case: Rp.1000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		10	Combustible Waste Recovery (With Case: Rp.1000)	0	0	0	0	0	0	0	0	0	124,316	134,068	144,971	156,983	169,422	183,215	912,975	
		11	Unit Cost per Combustible Waste (Rp. per ton)	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	n.r.	
		12=(10-9)x11	Incremental Profit through Combustible Waste Recovery (Rp.1000)	0	0	0	0	0	0	0	0	0	1,305	1,408	1,522	1,648	1,779	1,924	9,586	
	Benefit Accrued from Waste Recovery		13=4+8+12	Total Profit Accrued from Waste Recovery (Rp.1000)	0	0	0	83,446	91,624	100,498	110,107	120,487	131,686	211,814	228,430	247,006	267,473	288,666	312,167	2,193,405
Economic Benefit Total (Rp.1000)				0	0	873,541	1,044,241	1,146,573	1,257,624	1,377,876	1,507,771	1,647,908	1,853,120	1,998,492	2,161,007	2,340,071	2,525,482	2,731,091	22,464,797	
Social Benefit	Revealed Users' Willingness to Pay	1	Users' Willingness to Pay in Low-income Area (Rp.1000)	0	0	0	0	0	0	0	0	0	58,035	60,234	62,517	64,887	67,346	69,898	382,917	
		2	Users' Willingness to Pay in Middle-income Area (Rp.1000)	0	0	0	0	0	0	98,727	102,469	106,352	110,383	114,566	118,909	123,415	128,093	132,947	1,035,861	
		3	Users' Willingness to Pay in High-income Area (Rp.1000)	0	0	0	0	0	0	32,584	33,819	35,101	36,431	37,812	39,245	40,732	42,276	43,878	341,879	
Revealed Users' Willingness to Pay		4=1+2+3	Total User's Willingness to Pay (Rp.1000)	0	0	0	0	0	0	131,311	136,288	141,453	204,849	212,613	220,671	229,034	237,714	246,724	1,760,657	
Social Benefit Total (Rp.1000)				0	0	0	0	0	0	131,311	136,288	141,453	204,849	212,613	220,671	229,034	237,714	246,724	1,760,657	
Environmental Benefit	Reduction in Methane Gas through Final Disposal	1	Amount of Methane Gas (Without Case: ton)	0.0	0.0	16,805.6	18,484.3	20,295.7	22,261.4	24,390.0	26,689.3	29,169.9	31,576.3	34,053.4	36,822.6	39,873.7	43,033.1	46,536.6	389,992	
			Amount of Methane Gas (With Case: ton)	0.0	0.0	16,805.6	18,484.3	20,295.7	22,261.4	24,390.0	26,689.3	29,169.9	31,576.3	34,053.4	36,822.6	39,873.7	43,033.1	46,536.6	389,992	
		3=1-2	Incremental Reduced Amount of Methane Gas (ton)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	
		4	Unit Monetary Value of Methane Gas Reduction (Rp. per ton)	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	n.r.	
	Monetary Value of Methane Gas through Final Disposal		5=3x4	Total Reduction of Methane Gas through Final Disposal (Rp.1000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Environmental Benefit (Rp.1000)				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Residual Value		1	Residual Value for Facilities (Rp.1000)	0	0	0	0	0	0	0	0	0	0	0	0	706,180	481,344	523,084	1,710,608	
Benefit Accrued from Residual Value (Rp.1000)				0	0	0	0	0	0	0	0	0	0	0	0	706,180	481,344	523,084	1,710,608	
Benefit Grand Total (Rp.1000)				0	0	873,541	1,044,241	1,146,573	1,257,624	1,509,187	1,644,059	1,789,361	2,057,969	2,211,105	2,381,678	2,569,105	2,763,197	2,977,815	24,225,454	
Economic Benefit Grand Total (Rp.1000)				0	0	670,006	800,933	879,421	964,597	1,157,547	1,260,993	1,372,440	1,578,463	1,695,917	1,826,747	1,970,503	2,119,372	2,283,984	18,500,923	
Benefit Grand Total for Sensitivity Analysis (Rp.1000)				0	0	786,187	939,817	1,031,915	1,131,861	1,358,268	1,479,653	1,610,425	1,852,172	1,989,994	2,143,510	2,312,194	2,486,877	2,680,034	21,802,908	

Table DF.1.3 Detailed Calculation Table for FIRR (Financial Internal Rate of Return)

Item	Short-term			Mid-term						Long-term						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Total Cost	1,465,224	1,145,173	1,590,018	956,403	920,563	1,403,766	1,407,158	964,700	937,188	1,854,299	1,806,801	1,334,923	1,650,646	1,763,982	1,643,967	20,844,811
Total Benefit	0	0	873,541	1,044,241	1,146,573	1,257,624	1,509,187	1,644,059	1,789,361	2,057,969	2,211,105	2,381,678	2,569,105	2,763,197	2,977,815	24,225,454
Total Net Benefit	-1,465,224	-1,145,173	-716,478	87,838	226,009	-146,142	102,030	679,359	852,173	203,670	404,304	1,046,755	918,459	999,214	1,333,848	3,380,643
FIRR=	7.42%															
FNPV=	428,749															
Item	Short-term			Mid-term						Long-term						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Total Cost	1,611,747	1,259,691	1,749,020	1,052,043	1,012,620	1,544,142	1,547,873	1,061,170	1,030,906	2,039,729	1,987,481	1,468,415	1,815,710	1,940,381	1,808,364	22,929,292
Total Benefit	0	0	873,541	1,044,241	1,146,573	1,257,624	1,509,187	1,644,059	1,789,361	2,057,969	2,211,105	2,381,678	2,569,105	2,763,197	2,977,815	24,225,454
Total Net Benefit	-1,611,747	-1,259,691	-875,480	-7,802	133,953	-286,519	-38,686	582,889	758,454	18,240	223,624	913,263	753,395	822,816	1,169,451	1,296,162
FIRR=	2.86%															
FNPV=	-1,048,208															
Item	Short-term			Mid-term						Long-term						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Total Cost	1,465,224	1,145,173	1,590,018	956,403	920,563	1,403,766	1,407,158	964,700	937,188	1,854,299	1,806,801	1,334,923	1,650,646	1,763,982	1,643,967	20,844,811
Total Benefit	0	0	786,187	939,817	1,031,915	1,131,861	1,358,268	1,479,653	1,610,425	1,852,172	1,989,994	2,143,510	2,312,194	2,486,877	2,680,034	21,802,908
Total Net Benefit	-1,465,224	-1,145,173	-803,832	-16,586	111,352	-271,904	-48,889	514,953	673,237	-2,127	183,194	808,587	661,549	722,895	1,036,066	958,098
FIRR=	2.35%															
FNPV=	-1,091,083															
Item	Short-term			Mid-term						Long-term						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Total Cost	1,611,747	1,259,691	1,749,020	1,052,043	1,012,620	1,544,142	1,547,873	1,061,170	1,030,906	2,039,729	1,987,481	1,468,415	1,815,710	1,940,381	1,808,364	22,929,292
Total Benefit	0	0	786,187	939,817	1,031,915	1,131,861	1,358,268	1,479,653	1,610,425	1,852,172	1,989,994	2,143,510	2,312,194	2,486,877	2,680,034	21,802,908
Total Net Benefit	-1,611,747	-1,259,691	-962,834	-112,226	19,296	-412,281	-189,605	418,483	579,518	-187,557	2,513	675,095	496,484	546,497	871,670	-1,126,383
FIRR=	-2.84%															
FNPV=	-2,568,039															

Table DF.1.4 Detailed Calculation Table for Cost Recovery (Case 1)

Item		No.	Description	Short-term			Mid-term						Long-term						Total	
				2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030		
A	Estimated Amount of Tariff to be Collected	1	Number of Households	276,820	287,312	298,202	309,503	321,232	333,408	346,043	359,158	372,771	386,900	401,561	416,781	432,577	448,970	465,988	5,457,225	
		2	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0	n.r.	
		3	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0	50.0	50.0	50.0	50.0	n.r.	
	Low-income Area	4=1x2x3	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	0	0	0	58,035	60,234	62,517	64,887	67,346	69,898	382,917	
	Estimated Amount of Tariff to be Collected	5	Number of Households	219,381	227,696	236,326	245,282	254,579	264,227	274,241	284,635	295,423	306,619	318,240	330,302	342,820	355,813	369,298	4,324,883	
		6	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	n.r.	
		7	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	n.r.	
	Middle-income Area	8=5x6x7	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	98,727	102,469	106,352	110,383	114,566	118,909	123,415	128,093	132,947	1,035,861	
	Estimated Amount of Tariff to be Collected	9	Number of Households	31,031	32,207	33,428	34,695	36,009	37,374	38,791	40,261	41,787	43,370	45,014	46,720	48,491	50,329	52,236	611,742	
		10	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	n.r.	
		11	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	n.r.	
	High-income Area	12=9x10x11	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	32,584	33,819	35,101	36,431	37,812	39,245	40,732	42,276	43,878	341,879	
	Total Estimated Amount of Tariff to be Collected (Rp.1000)				0	0	0	0	0	0	131,311	136,288	141,453	204,849	212,613	220,671	229,034	237,714	246,724	1,760,657
	B	Operation Cost	1	Operation Cost for Final Disposal (Rp.1000)	18,174	20,464	27,292	28,163	26,879	27,886	28,969	30,132	34,738	35,732	36,718	37,806	38,983	40,158	44,262	476,355
			2	Operation Cost for Collection and Transport (Rp.1000)	139,260	162,875	252,784	278,398	292,929	320,659	296,146	315,996	337,617	360,892	384,252	409,697	437,536	469,424	503,290	4,961,755
			3	Other Operation Cost (Rp.1000)	13,998	14,287	19,592	33,509	46,522	49,175	69,214	56,627	59,963	79,875	67,142	68,127	88,227	75,410	96,838	838,508
		Total Operation Cost	4=1+2+3	Total Operation Cost	171,432	197,626	299,668	340,070	366,329	397,720	394,329	402,755	432,319	476,499	488,112	515,630	564,747	584,992	644,389	6,276,618
		Maintenance Cost	4	Maintenance Cost for Final Disposal (Rp.1000)	495	1,395	4,331	4,668	4,668	4,668	4,668	7,068	9,048	9,048	9,048	11,448	11,448	11,448	14,448	107,897
			5	Maintenance Cost for Collection and Transport (Rp.1000)	40,283	47,972	82,817	78,785	85,986	99,398	112,395	123,180	134,941	146,942	159,180	171,698	185,110	200,562	217,350	1,886,599
			6	Other Maintenance Cost (Rp. 1000)	80	80	80	80	18,080	80	80	80	80	80	80	80	80	80	80	19,200
			7=4+5+6	Total Maintenance Cost (Rp.1000)	40,858	49,447	87,228	83,533	108,734	104,146	117,143	130,328	144,069	156,070	168,308	183,226	196,638	212,090	231,878	2,013,696
Total Operation and Maintenance Cost (Rp.1000)				212,290	247,073	386,896	423,603	475,063	501,866	511,472	533,083	576,388	632,569	656,420	698,856	761,385	797,082	876,267	8,290,314	
Net Revenue (Rp.1000)				-212,290	-247,073	-386,896	-423,603	-475,063	-501,866	-380,161	-396,795	-434,934	-427,720	-443,808	-478,186	-532,351	-559,368	-629,544	-6,529,658	
Cost Recovery Rate (%)				0.0	0.0	0.0	0.0	0.0	0.0	25.7	25.6	24.5	32.4	32.4	31.6	30.1	29.8	28.2	21.2	
Required Amount to be Covered by Provincial Tax (Rp.1000)				212,290	247,073	386,896	423,603	475,063	501,866	380,161	396,795	434,934	427,720	443,808	478,186	532,351	559,368	629,544	6,529,658	

Table DF.1.5 Detailed Calculation Table for Cost Recovery (Case 2)

Item	No.	Description	Short-term			Mid-term						Long-term						Total
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Estimated Amount of Tariff to be Collected	1	Number of Households	276,820	287,312	298,202	309,503	321,232	333,408	346,043	359,158	372,771	386,900	401,561	416,781	432,577	448,970	465,988	5,457,225
	2	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0	n.r.
	3	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	60.0	60.0	60.0	60.0	60.0	n.r.
Low-income Area	4=1x2x3	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	0	0	0	69,642	72,281	75,021	77,864	80,815	83,878	459,500
Estimated Amount of Tariff to be Collected	5	Number of Households	219,381	227,696	236,326	245,282	254,579	264,227	274,241	284,635	295,423	306,619	318,240	330,302	342,820	355,813	369,298	4,324,883
	6	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	n.r.
	7	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	n.r.
Middle-income Area	8=5x6x7	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	115,181	119,547	124,078	128,780	133,661	138,727	143,984	149,441	155,105	1,208,504
Estimated Amount of Tariff to be Collected	9	Number of Households	31,031	32,207	33,428	34,695	36,009	37,374	38,791	40,261	41,787	43,370	45,014	46,720	48,491	50,329	52,236	611,742
	10	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	n.r.
	11	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	n.r.
High-income Area	12=9x10x11	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	37,239	38,650	40,115	41,636	43,214	44,851	46,551	48,316	50,147	390,719
Total Estimated Amount of Tariff to be Collected (Rp.1000)			0	0	0	0	0	0	152,420	158,197	164,193	240,058	249,156	258,599	268,399	278,572	289,130	2,058,723
Operation Cost	1	Operation Cost for Final Disposal (Rp.1000)	18,174	20,464	27,292	28,163	26,879	27,886	28,969	30,132	34,738	35,732	36,718	37,806	38,983	40,158	44,262	476,355
	2	Operation Cost for Collection and Transport (Rp.1000)	139,260	162,875	252,784	278,398	292,929	320,659	296,146	315,996	337,617	360,892	384,252	409,697	437,536	469,424	503,290	4,961,755
	3	Other Operation Cost (Rp.1000)	13,998	14,287	19,592	33,509	46,522	49,175	69,214	56,627	59,963	79,875	67,142	68,127	88,227	75,410	96,838	838,508
	4=1+2+3	Total Operation Cost	171,432	197,626	299,668	340,070	366,329	397,720	394,329	402,755	432,319	476,499	488,112	515,630	564,747	584,992	644,389	6,276,618
Maintenance Cost	4	Maintenance Cost for Final Disposal (Rp.1000)	495	1,395	4,331	4,668	4,668	4,668	4,668	7,068	9,048	9,048	9,048	11,448	11,448	11,448	14,448	107,897
	5	Maintenance Cost for Collection and Transport (Rp.1000)	40,283	47,972	82,817	78,785	85,986	99,398	112,395	123,180	134,941	146,942	159,180	171,698	185,110	200,562	217,350	1,886,599
	6	Other Maintenance Cost (Rp. 1000)	80	80	80	80	18,080	80	80	80	80	80	80	80	80	80	80	19,200
	7=4+5+6	Total Maintenance Cost (Rp.1000)	40,858	49,447	87,228	83,533	108,734	104,146	117,143	130,328	144,069	156,070	168,308	183,226	196,638	212,090	231,878	2,013,696
Total Operation and Maintenance Cost (Rp.1000)			212,290	247,073	386,896	423,603	475,063	501,866	511,472	533,083	576,388	632,569	656,420	698,856	761,385	797,082	876,267	8,290,314
Net Revenue (Rp.1000)			-212,290	-247,073	-386,896	-423,603	-475,063	-501,866	-359,052	-374,886	-412,195	-392,511	-407,265	-440,258	-492,985	-518,511	-587,138	-6,231,591
Cost Recovery Rate (%)			0.0	0.0	0.0	0.0	0.0	0.0	29.8	29.7	28.5	37.9	38.0	37.0	35.3	34.9	33.0	24.8
Required Amount to be Covered by Provincial Tax (Rp.1000)			212,290	247,073	386,896	423,603	475,063	501,866	359,052	374,886	412,195	392,511	407,265	440,258	492,985	518,511	587,138	6,231,591

Table DF.1.6 Detailed Calculation Table for Cost Recovery (Case 3)

Item	No.	Description	Short-term			Mid-term						Long-term						Total
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Estimated Amount of Tariff to be Collected	1	Number of Households	276,820	287,312	298,202	309,503	321,232	333,408	346,043	359,158	372,771	386,900	401,561	416,781	432,577	448,970	465,988	5,457,225
	2	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	n.r.
	3	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	n.r.
Low-income Area	4=1x2x3	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	51,906	53,874	55,916	58,035	60,234	62,517	64,887	67,346	69,898	544,612
Estimated Amount of Tariff to be Collected	5	Number of Households	219,381	227,696	236,326	245,282	254,579	264,227	274,241	284,635	295,423	306,619	318,240	330,302	342,820	355,813	369,298	4,324,883
	6	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	n.r.
	7	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	n.r.
Middle-income Area	8=5x6x7	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	98,727	102,469	106,352	110,383	114,566	118,909	123,415	128,093	132,947	1,035,861
Estimated Amount of Tariff to be Collected	9	Number of Households	31,031	32,207	33,428	34,695	36,009	37,374	38,791	40,261	41,787	43,370	45,014	46,720	48,491	50,329	52,236	611,742
	10	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	n.r.
	11	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	n.r.
High-income Area	12=9x10x11	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	32,584	33,819	35,101	36,431	37,812	39,245	40,732	42,276	43,878	341,879
Total Estimated Amount of Tariff to be Collected (Rp.1000)			0	0	0	0	0	0	183,217	190,161	197,369	204,849	212,613	220,671	229,034	237,714	246,724	1,922,352
Operation Cost	1	Operation Cost for Final Disposal (Rp.1000)	18,174	20,464	27,292	28,163	26,879	27,886	28,969	30,132	34,738	35,732	36,718	37,806	38,983	40,158	44,262	476,355
	2	Operation Cost for Collection and Transport (Rp.1000)	139,260	162,875	252,784	278,398	292,929	320,659	296,146	315,996	337,617	360,892	384,252	409,697	437,536	469,424	503,290	4,961,755
	3	Other Operation Cost (Rp.1000)	13,998	14,287	19,592	33,509	46,522	49,175	69,214	56,627	59,963	79,875	67,142	68,127	88,227	75,410	96,838	838,508
	4=1+2+3	Total Operation Cost	171,432	197,626	299,668	340,070	366,329	397,720	394,329	402,755	432,319	476,499	488,112	515,630	564,747	584,992	644,389	6,276,618
Maintenance Cost	4	Maintenance Cost for Final Disposal (Rp.1000)	495	1,395	4,331	4,668	4,668	4,668	4,668	7,068	9,048	9,048	9,048	11,448	11,448	11,448	14,448	107,897
	5	Maintenance Cost for Collection and Transport (Rp.1000)	40,283	47,972	82,817	78,785	85,986	99,398	112,395	123,180	134,941	146,942	159,180	171,698	185,110	200,562	217,350	1,886,599
	6	Other Maintenance Cost (Rp. 1000)	80	80	80	80	18,080	80	80	80	80	80	80	80	80	80	80	19,200
	7=4+5+6	Total Maintenance Cost (Rp.1000)	40,858	49,447	87,228	83,533	108,734	104,146	117,143	130,328	144,069	156,070	168,308	183,226	196,638	212,090	231,878	2,013,696
Total Operation and Maintenance Cost (Rp.1000)			212,290	247,073	386,896	423,603	475,063	501,866	511,472	533,083	576,388	632,569	656,420	698,856	761,385	797,082	876,267	8,290,314
Net Revenue (Rp.1000)			-212,290	-247,073	-386,896	-423,603	-475,063	-501,866	-328,255	-342,922	-379,019	-427,720	-443,808	-478,186	-532,351	-559,368	-629,544	-6,367,962
Cost Recovery Rate (%)			0.0	0.0	0.0	0.0	0.0	0.0	35.8	35.7	34.2	32.4	32.4	31.6	30.1	29.8	28.2	23.2
Required Amount to be Covered by Provincial Tax (Rp.1000)			212,290	247,073	386,896	423,603	475,063	501,866	328,255	342,922	379,019	427,720	443,808	478,186	532,351	559,368	629,544	6,367,962

Table DF.1.7 Detailed Calculation Table for Cost Recovery (Case 4)

Item	No.	Description	Short-term			Mid-term						Long-term						Total
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Estimated Amount of Tariff to be Collected	1	Number of Households	276,820	287,312	298,202	309,503	321,232	333,408	346,043	359,158	372,771	386,900	401,561	416,781	432,577	448,970	465,988	5,457,225
	2	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	n.r.
	3	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	n.r.
Low-income Area	4=1x2x3	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	62,288	64,648	67,099	69,642	72,281	75,021	77,864	80,815	83,878	653,535
Estimated Amount of Tariff to be Collected	5	Number of Households	219,381	227,696	236,326	245,282	254,579	264,227	274,241	284,635	295,423	306,619	318,240	330,302	342,820	355,813	369,298	4,324,883
	6	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	n.r.
	7	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	n.r.
Middle-income Area	8=5x6x7	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	115,181	119,547	124,078	128,780	133,661	138,727	143,984	149,441	155,105	1,208,504
Estimated Amount of Tariff to be Collected	9	Number of Households	31,031	32,207	33,428	34,695	36,009	37,374	38,791	40,261	41,787	43,370	45,014	46,720	48,491	50,329	52,236	611,742
	10	Proposed Tariff per Month (Rp.)	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	n.r.
	11	Collection Efficiency (%)	0.0	0.0	0.0	0.0	0.0	0.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	n.r.
High-Income Area	12=9x10x11	Estimated Amount of Tariff to be Collected (Rp.1000)	0	0	0	0	0	0	37,239	38,650	40,115	41,636	43,214	44,851	46,551	48,316	50,147	390,719
Total Estimated Amount of Tariff to be Collected (Rp.1000)			0	0	0	0	0	0	214,708	222,846	231,292	240,058	249,156	258,599	268,399	278,572	289,130	2,252,758
Operation Cost	1	Operation Cost for Final Disposal (Rp.1000)	18,174	20,464	27,292	28,163	26,879	27,886	28,969	30,132	34,738	35,732	36,718	37,806	38,983	40,158	44,262	476,355
	2	Operation Cost for Collection and Transport (Rp.1000)	139,260	162,875	252,784	278,398	292,929	320,659	296,146	315,996	337,617	360,892	384,252	409,697	437,536	469,424	503,290	4,961,755
	3	Other Operation Cost (Rp.1000)	13,998	14,287	19,592	33,509	46,522	49,175	69,214	56,627	59,963	79,875	67,142	68,127	88,227	75,410	96,838	838,508
	4=1+2+3	Total Operation Cost	171,432	197,626	299,668	340,070	366,329	397,720	394,329	402,755	432,319	476,499	488,112	515,630	564,747	584,992	644,389	6,276,618
Maintenance Cost	4	Maintenance Cost for Final Disposal (Rp.1000)	495	1,395	4,331	4,668	4,668	4,668	4,668	7,068	9,048	9,048	9,048	11,448	11,448	11,448	14,448	107,897
	5	Maintenance Cost for Collection and Transport (Rp.1000)	40,283	47,972	82,817	78,785	85,986	99,398	112,395	123,180	134,941	146,942	159,180	171,698	185,110	200,562	217,350	1,886,599
	6	Other Maintenance Cost (Rp. 1000)	80	80	80	80	18,080	80	80	80	80	80	80	80	80	80	80	19,200
	7=4+5+6	Total Maintenance Cost (Rp.1000)	40,858	49,447	87,228	83,533	108,734	104,146	117,143	130,328	144,069	156,070	168,308	183,226	196,638	212,090	231,878	2,013,696
Total Operation and Maintenance Cost (Rp.1000)			212,290	247,073	386,896	423,603	475,063	501,866	511,472	533,083	576,388	632,569	656,420	698,856	761,385	797,082	876,267	8,290,314
Net Revenue (Rp.1000)			-212,290	-247,073	-386,896	-423,603	-475,063	-501,866	-296,764	-310,237	-345,096	-392,511	-407,265	-440,258	-492,985	-518,511	-587,138	-6,037,556
Cost Recovery Rate (Per cent)			0.0	0.0	0.0	0.0	0.0	0.0	42.0	41.8	40.1	37.9	38.0	37.0	35.3	34.9	33.0	27.2
Required Amount to be Covered by Provincial Tax (Rp.1000)			212,290	247,073	386,896	423,603	475,063	501,866	296,764	310,237	345,096	392,511	407,265	440,258	492,985	518,511	587,138	6,037,556

Table DF.1.8 Detailed Economic Cost for Master Plan[illegible]

Table DF.1.9 Detailed Economic Benefit for Master Plan

Category of Benefit			No.	Description	Short-term			Mid-term						Long-term						Total	
					2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030		
Reduction in Waste Disposal Cost	1	Waste Disposal Amount per Annum for Cost Saving (ton)		0	0	441,093	485,152	532,695	584,289	640,158	700,507	765,614	828,775	893,790	966,472	1,046,555	1,129,477	1,221,432	10,236,009		
	2	Unit Waste Disposal Cost (Rp. per ton)		625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	625.7	n.r.		
	3=1x2	Saved Disposal Cost (Rp.1000)		0	0	275,992	303,560	333,307	365,590	400,547	438,307	479,045	518,565	559,244	604,722	654,829	706,714	764,250	6,404,671		
Reduction in Waste Collection and Transport Cost	1	Waste Collection and Transport Amount for Cost Saving (ton)		0	0	441,093	485,152	532,695	584,289	640,158	700,507	765,614	828,775	893,790	966,472	1,046,555	1,129,477	1,221,432	10,236,009		
	2	Unit Waste Collection and Transport Cost (Rp. per ton)		1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	1,354.7	n.r.		
	3=1x2	Saved Collection and Transport Cost (Rp.1000)		0	0	597,549	657,235	721,642	791,536	867,222	948,977	1,037,177	1,122,741	1,210,817	1,309,280	1,417,768	1,530,102	1,654,674	13,866,721		
Benefit Accrued from Total Saved Cost			7=3+6	Total Saved Cost (Rp.1000)		0	0	873,541	960,795	1,054,949	1,157,126	1,267,769	1,387,284	1,516,222	1,641,306	1,770,062	1,914,001	2,072,598	2,236,816	2,418,924	20,271,392
Profit Accrued from Waste Recovery	1	Material Recovery (Without Case: Rp.1000)		38,930	49,471	61,753	67,921	74,577	81,801	89,622	98,071	107,186	116,029	125,131	135,306	146,518	158,127	171,000	1,521,442		
	2	Material Recovery (With Case: Rp.1000)		38,930	49,471	61,753	77,624	85,231	93,486	102,425	112,081	122,498	149,180	160,882	173,965	188,380	203,306	219,858	1,839,071		
	3	Unit Cost per Recovered Material (Rp. per kg)		13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	n.r.		
	4=(2-1)x3	Incremental Profit through Material Recovery (Rp.1000)		0	0	0	25,228	27,700	30,383	33,288	36,426	39,812	46,193	52,954	60,513	69,842	81,466	97,029	825,834		
	5	Biodegradable Waste Recovery (Without Case) (Rp.1000)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	6	Biodegradable Waste Recovery (With Case: Rp.1000)		0	0	0	58,218	63,923	70,115	76,819	84,061	91,874	124,316	134,068	144,971	156,983	169,422	183,215	1,357,985		
	7	Unit Cost per Compost (Rp. per kg)		5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	n.r.		
	8=(6-5)x7	Incremental Profit through Biodegradable Waste Recovery (Rp.1000)		0	0	0	58,218	63,923	70,115	76,819	84,061	91,874	124,316	134,068	144,971	156,983	169,422	183,215	1,357,985		
	9	Combustible Waste Recovery (Without Case: Rp.1000)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	10	Combustible Waste Recovery (With Case: Rp.1000)		0	0	0	0	0	0	0	0	0	124,316	134,068	144,971	156,983	169,422	183,215	912,975		
	11	Unit Cost per Combustible Waste (Rp. per kg)		52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	52.50	n.r.		
	12=(10-9)x11	Incremental Profit through Combustible Waste Recovery (Rp.1000)		0	0	0	0	0	0	0	0	0	1,305	1,408	1,522	1,648	1,779	1,924	9,586		
Benefit Accrued from Waste Recovery			13=4+8+12	Total Profit Accrued from Waste Recovery (Rp.1000)		0	0	0	83,446	91,624	100,498	110,107	120,487	131,686	211,814	228,430	247,006	267,473	288,666	312,167	2,193,405
Economic Benefit Total (Rp.1000)				0	0	873,541	1,044,241	1,146,573	1,257,624	1,377,876	1,507,771	1,647,908	1,853,120	1,998,492	2,161,007	2,340,071	2,525,482	2,731,091	22,464,797		
Revealed Users' Willingness to Pay	1	Users' Willingness to Pay in Low-income Area (Rp.1000)		0	0	0	0	0	0	0	0	0	0	58,035	60,234	62,517	64,887	67,346	69,898	382,917	
	2	Users' Willingness to Pay in Middle-income Area (Rp.1000)		0	0	0	0	0	0	0	98,727	102,469	106,352	110,383	114,566	118,909	123,415	128,093	132,947	1,035,861	
	3	Users' Willingness to Pay in High-income Area (Rp.1000)		0	0	0	0	0	0	0	32,584	33,819	35,101	36,431	37,812	39,245	40,732	42,276	43,878	341,879	
Revealed Users' Willingness to Pay			4=1+2+3	Total User's Willingness to Pay (Rp.1000)		0	0	0	0	0	131,311	136,288	141,453	204,849	212,613	220,671	229,034	237,714	246,724	1,760,657	
Social Benefit Total (Rp.1000)				0	0	0	0	0	0	0	131,311	136,288	141,453	204,849	212,613	220,671	229,034	237,714	246,724	1,760,657	
Reduction in Methane Gas through Final Disposal	1	Amount of Methane Gas (Without Case: ton)		0.0	0.0	16,805.6	18,484.3	20,295.7	22,261.4	24,390.0	26,689.3	29,169.9	31,576.3	34,053.4	36,822.6	39,873.7	43,033.1	46,536.6	389,992		
	2	Amount of Methane Gas (With Case: ton)		0.0	0.0	8,402.8	9,242.1	10,147.8	11,130.7	12,195.0	13,344.7	14,584.9	15,788.2	17,026.7	18,411.3	19,936.9	21,516.5	23,268.3	194,996		
	3=1-2	Incremental Reduced Amount of Methane Gas (ton)		0.0	0.0	8,402.8	9,242.1	10,147.8	11,130.7	12,195.0	13,344.7	14,584.9	15,788.2	17,026.7	18,411.3	19,936.9	21,516.5	23,268.3	194,996		
	4	Unit Monetary Value of Methane Gas Reduction (Rp. per ton)		7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	7,565.3	n.r.		
Monetary Value of Methane Gas through Final Disposal			5=3x4	Total Reduction of Methane Gas through Final Disposal (Rp.1000)		0	63,570	69,920	76,771	84,207	92,259	100,956	110,339	119,442	128,812	139,287	150,828	162,779	176,032	1,475,203	
Environmental Benefit (Rp.1000)				0	0	63,570	69,920	76,771	84,207	92,259	100,956	110,339	119,442	128,812	139,287	150,828	162,779	176,032	1,475,203		
Residual Value			1	Residual Value for Facilities (Rp.1000)		0	0	0	0	0	0	0	0	0	0	706,180	481,344	523,084	1,710,608		
Benefit Accrued from Residual Value (Rp.1000)				0	0	0	0	0	0	0	0	0	0	0	0	706,180	481,344	523,084	1,710,608		
Benefit Grand Total (Rp.1000)				0	0	937,110	1,114,161	1,223,344	1,341,831	1,460,146	1,585,015	1,715,700	1,852,412	1,995,917	2,146,915	2,305,932	2,474,976	2,654,407	25,700,657		
Economic Benefit Grand Total (Rp.1000)				0	0	718,764	854,561	938,305	1,029,184	1,128,309	1,235,427	1,350,427	1,474,070	1,603,075	1,744,716	1,898,580	2,068,189	2,244,223	2,431,001	19,712,404	
Benefit Grand Total for Sensitivity Analysis (Rp.1000)				0	0	646,887	769,105	844,474	926,266	1,015,478	1,104,584	1,201,363	1,311,363	1,503,067	1,615,245	1,740,222	1,877,570	2,019,801	2,177,100	17,741,163	

Table DF.1.10 Detailed Calculation Table for EIRR (Economic Internal Rate of Return)

Item	Short-term			Mid-term						Long-term						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Total Cost	1,131,972	889,072	1,222,332	768,992	709,785	1,080,718	1,084,127	764,259	724,593	1,428,210	1,392,294	1,030,622	1,273,154	1,409,135	1,270,368	16,179,634
Total Benefit	0	0	718,764	854,561	938,305	1,029,184	1,228,309	1,338,427	1,457,070	1,670,075	1,794,716	1,933,580	2,086,189	2,244,223	2,419,001	19,712,404
Total Net Benefit	-1,131,972	-889,072	-503,569	85,569	228,520	-51,533	144,182	574,168	732,477	241,865	402,422	902,958	813,035	835,088	1,148,633	3,532,770
EIRR=	9.62%															
ENPV=	916,380															
Item	Short-term			Mid-term						Long-term						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Total Cost	1,245,169	977,979	1,344,566	845,892	780,764	1,188,789	1,192,540	840,685	797,052	1,571,031	1,531,524	1,133,684	1,400,470	1,550,048	1,397,404	17,797,597
Total Benefit	0	0	718,764	854,561	938,305	1,029,184	1,228,309	1,338,427	1,457,070	1,670,075	1,794,716	1,933,580	2,086,189	2,244,223	2,419,001	19,712,404
Total Net Benefit	-1,245,169	-977,979	-625,802	8,670	157,541	-159,605	35,769	497,742	660,018	99,044	263,192	799,896	685,719	694,175	1,021,596	1,914,807
EIRR=	5.21%															
ENPV=	-229,628															
Item	Short-term			Mid-term						Long-term						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Total Cost	1,131,972	889,072	1,222,332	768,992	709,785	1,080,718	1,084,127	764,259	724,593	1,428,210	1,392,294	1,030,622	1,273,154	1,409,135	1,270,368	16,179,634
Total Benefit	0	0	646,887	769,105	844,474	926,266	1,105,478	1,204,584	1,311,363	1,503,067	1,615,245	1,740,222	1,877,570	2,019,801	2,177,100	17,741,163
Total Net Benefit	-1,131,972	-889,072	-575,445	113	134,689	-154,452	21,351	440,325	586,770	74,857	222,950	709,600	604,416	610,666	906,733	1,561,530
EIRR=	4.72%															
ENPV=	-321,266															
Item	Short-term			Mid-term						Long-term						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Total Cost	1,245,169	977,979	1,344,566	845,892	780,764	1,188,789	1,192,540	840,685	797,052	1,571,031	1,531,524	1,133,684	1,400,470	1,550,048	1,397,404	17,797,597
Total Benefit	0	0	646,887	769,105	844,474	926,266	1,105,478	1,204,584	1,311,363	1,503,067	1,615,245	1,740,222	1,877,570	2,019,801	2,177,100	17,741,163
Total Net Benefit	-1,245,169	-977,979	-697,678	-76,786	63,711	-262,524	-87,062	363,900	514,311	-67,964	83,721	606,538	477,100	469,753	779,696	-56,433
EIRR=	-0.17%															
ENPV=	-1,467,274															

SECTION G
ENVIRONMENTAL AND SOCIAL
CONSIDERATIONS

**PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN
IN
GUJRANWALA

FINAL REPORT

VOLUME 4

DATA BOOK

SECTION G

ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

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G.1 Interview Survey of Environmental Awareness at Existing Landfill Site, Gujranwala

G.1.1 INTRODUCTION

Interview survey was carried out to the residents in the vicinity of Gondlanwala site for 45 samples/ households located approximately 1km radius of the disposal site. The questionnaire was prepared based on the description in the Inception Report and items of the sub-contracted Social Survey for adjustment. The survey was carried out by the team of Waste Manager and Survey Assistant for 4 days. Orientation or rehearsal was conducted prior to the field survey. The survey was started in the 1st week of December.

Currently, Gondlanwala is used as the temporary disposal site for the municipal solid waste of Gujranwala city. The site is located approximately 8 km away from the centre of the city towards north-northwest. Approximate area of the dumping site is 4.7 ha (12 Acres) and average depth of land depression is 8 to 9m. The site will be utilized by GWMC until the new sanitary landfill facilities becomes operational. Waste disposal at this site started in March 2014 for disposal of domestic waste from the 64 urban union councils in Gujranwala City.

The site is expected to be used for 2 to 3 years for the estimated volume of about 400,000 m³. Dumping is carried out actively and the available area is decreasing day by day. The loaded waste amount of each vehicle is weighed by the weighbridge. Then, the waste is unloaded onto the top of the dumping site for spreading and compaction by two units of tractor shovels.

The open dumping method is used for disposal, so that environmental degradation especially groundwater contamination, breeding of pests such as flies, etc., have become significant problems. GWMC is taking measures for draining contaminated water at the bottom of the dumping area and spraying insecticides but the effects are not quite significant.

Waste pickers, most of them look like under 18 years old male, collect recyclable materials at the waste unloading area and on the slope where wastes slide down to the bottom of the dumping area. The number of waste pickers was estimated to around 20 people, initially, but about 35-40 people divided into three groups working daily from September. Health hazards and risk of recovery operation is a matter of concern. The information about waste pickers working at Gondlanwala is being collected by another interview survey.

Surface water ponding at the bottom of the dumping area is contaminated, causing groundwater contamination. There are three farm houses within the distance of 500m from Gondlanwala disposal site. The total number of people residing in these three houses is about 50. They live on breeding of about 150 livestock and agriculture stock 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.

Before this survey, environmental awareness survey of the existing dumping site was not conducted. This survey was conducted for the first time to know the problems of residents and their level of awareness regarding environment and solid waste management.

G.1.2 PURPOSE OF SURVEY

The purpose of the Interview Survey of Environmental Awareness at Existing Dumping Site, Gujranwala is to grasp the awareness level regarding environmental issues and concerns/problems among the residents in the vicinity of the existing dumping site in Gondlanwala, Gujranwala.

G.1.3 METHODOLOGY

The field survey was carried out in 4 days in the first week of December 2014. The questionnaire was finalized in discussion among the staff of the JICA Project Team and GWMC. The

questionnaire items included the queries for the kinds of i) General information about the residents, ii) Awareness level of residents regarding solid waste and its management and iii) Their opinions for solid waste management. Furthermore, it included the questions to grasp the problems of residents facing due to the landfill operation of the dump site and their opinions about the current waste disposal operation.

Table DG.1.1 Number of Samples for Interview Survey

RurryalaWarraich Village is situated north-east of the existing disposal site. Village Sara Wala and Qadam Abad are located north-west side while Gondlanwala Village is located south-east side of the existing disposal site. Figure DG.1.1 shows the interview survey target households distributed in the villages mentioned above.

Figure DG.1.1 Targeted Area of Resident Interview Survey and Location of Selected Households

The data of the questionnaire was processed in order to understand the problems that the respondents were facing due to dumping site. The results obtained from statistical analysis of questionnaires were represented in graphical form and discussed below.

age group. From the survey it is find out that four percent (44 %) respondents are labour, 33% are farmers, 13% do their own business, and 2% are Government employees.

The key findings have been summarized here.

Eighty seven 87% residents living nearby existing dumping site has no access to solid waste management services. Only 13% have hired a private sanitary worker by paying waste collection fee to him. They pay fee in the range of 100-150 Rupees per month. Out of these 13% respondents, 6.5% are satisfied with the current solid waste management services and others are not satisfied. Although in Gondlanwala village, the provision of solid waste collection services is the responsibility of TMA Aroop but due to lack of budget these services are not provided.

Ninety percent 90% respondents discharge solid waste in the nearby empty plots, 5.1 % respondents disposes solid waste in the existing landfill site, 2.6% of the respondent burn waste and 2.6% discharge waste in the canal. As mentioned earlier, collection service is not provided by the government in these areas, so people do manage domestic waste by themselves.

Sixty four percent (64%) respondents separate the recyclables from waste and other 36% respondents do not separate recyclables. The reason why they do not separate recyclables is they were not using newspaper, pet bottles or other things like that, they belonged to low income group and mostly respondents were labourer by profession.

Thirty six percent (36%) respondents do not aware about compost made from organic portion of the waste. The majority of 64% of the respondents have an idea of compost from organic waste.

One hundred percent (100 %) respondents have understanding about the diseases that spreads through waste if not manage properly. They know that if waste is not disposed properly, diseases may spread, and it cause health damage.

When asked about the “Do you think this disposal site contributes for Gujranwala city?” This is a multiple choice question; all respondents said that existing disposal site may contribute for Gujranwala city but not for us. Their main opinions associated with the questions are i) it is a problem for us. ii) Beauty of the area is lost due to dumping of waste, iii) now it looks a dirty place.

G.1.4.1 Problems Facing by Respondents

Respondents were asked whether they have felt any problem due to this disposal site, all respondents replied that they are facing a number of problems due to this dumping site. This is an open ended question, we received a list of problems from every respondent and many of these problems are overlapping. So coding is done for each problem.

Figure DG.1.2 shows the major problem of the respondents from the existing dumping site is odour. One hundred percent (100 %) respondents have bad odour problem. Then the second major problem is flies/ mosquitoes. Ninety one percent (91%) of the respondents have problem of flies. Thirty eight percent (38 %) respondents is noticing the change of water taste. Four percent (4 %) respondents feel smell in water. Eighteen percent (18%) respondents said that water in this area is contaminated. Before the current operation the drinking water of this area is very clean and pure but now the taste of water is different.

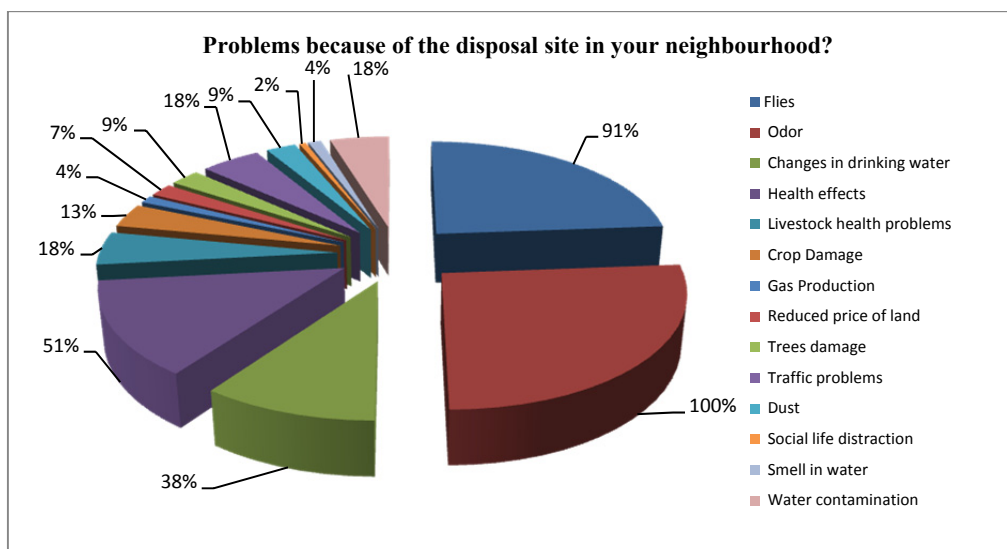


Figure DG.1.2 Percentage of problems respondents were facing

Fifty one percent (51%) respondents say that their children remain sick most of the time. The main health problems they are facing; gastrointestinal problems, hepatitis, breathing problems etc. They say that the children suffer more than elders.

Eighteen percent (18%) respondents say that they are facing with the problem of livestock's health. As people are breeding buffaloes, goats, cows etc. in their deras / house yard. This percentage is less because only a few respondents breed livestock in their house yard. This percentage is from the deras/animal farms where visited.

Thirteen percent (13%) respondents say that their crop is damaged. They say that the production of wheat, rice is decreased this year.

Two out of 45 people four percent (4%) respondents say that methane gas is produced in their deras. Gas production is noticed only those respondents who live nearby the existing dumping site in deras. Seven percent (7 %) respondents say that the price of land nearby the existing dumping site is dropped.

Nine percent (9 %) respondents say that trees are damaged. Eighteen percent (18%) respondents are facing the problem of traffic congestion as road is single / one-way. They say that minor accidents also occurred due to heavy traffic.

Nine percent (9 %) respondents say that dust is more due to unpaved road. Two percent (2%) respondents say that their social life is destructed because their relatives do not visit them due to bad smell and flies.

G.1.4.2 Opinions for Waste Pickers at the Gondlanwala Disposal Site

Forty two percent (42%) respondents are eligible to answer this question and 58% are not eligible to answer this question as they did not know about the activity of waste pickers at Gondlanwala Disposal Site as given in Table DG.1.2.

It is find out that 68% respondents say that waste pickers contribute for reducing disposal waste amount. They say that waste pickers should come. While 32% respondents say that the activity of waste pickers at Gondlanwala existing disposal site should be stopped because of security problems. The respondents say that the waste pickers steal things from their houses.

Table DG.1.2 Opinion about Waste Pickers at Gondlanwala Disposal Site

Opinion about waste pickers at Gondlanwala Disposal Dumping Site					
	Frequency	Percentage	19 Respondents out of 45		
Yes	19	42	Opinion	Number Out of 19	Percentage
			Stop their activity at Gondlanwala	6	32
			Should come they reduce our waste stream	13	68
			Total	19	100
No	26	58			
Total	45	100			

G.1.4.3 Opinions for Solid Waste Management

When asked about their opinions for SWM, Only 87% respondents are eligible to answer this question and 13% are not eligible to answer this question.

Table DG.1.3 shows that forty four (44%) respondents say to stop the current operation at Gondlanwala dumping site, 10% respondents say to evacuate water from the dump site, 41% say to spray insecticide daily, 33% say to cover the waste daily with soil, 13% respondents say to sprinkle water on road daily, and 8 % say to construct the road properly to reduce the damages.

Table DG.1.3 Opinion for the Current Operation of the Existing Gondlanwala Disposal Site

Opinion for the current operation in the final disposal site					
	Frequency	Percentage	39 Respondents out of 45 Answered		
Yes	39	87	Opinion	No. out of 39	Percentage
			Stop this operation at Gondlanwala	17	44
			Evacuate water from dump site	4	10
			Spray	16	41
			Daily Soil Cover	13	33
			Sprinkle water daily on roads	5	13
			Construct road properly	3	8
No	6	13			
Total	45	100			

G.1.5 EVALUATION OF SURVEY RESULT

G.1.5.1 Level of Awareness

From the survey data of 45 respondents, it is evaluated that the level of awareness is high in Gondlanwala village as compared to other villages as shown in Figure DG.1.3 below. Twenty seven percent (27%) people out of 64% of Gondlanwala understand the recycling practices and 9.6% aware about the compost that is made from the organic waste. Awareness level is the lowest in the village Saar Wala, only 8% respondents aware about the recycling practices and no one aware about compost. It is observed that the level of awareness link with education. Awareness level regarding risks associated with waste is the highest in all the villages surveyed.

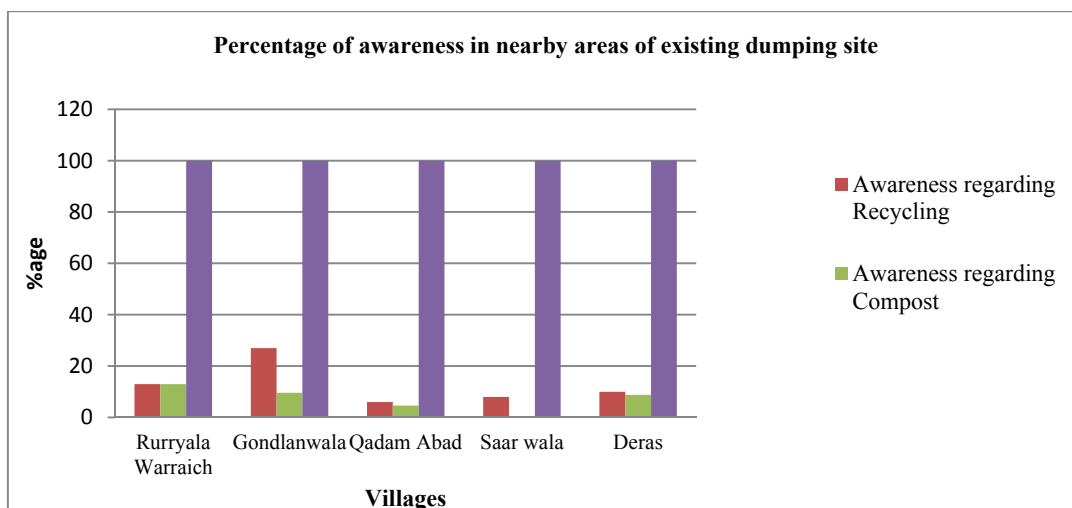


Figure DG.1.3 Level of Awareness in different respondents

G.1.5.2 Types of Problems facing by Respondents

When asked about the problems they have ever faced from the existing dumping site, all 45 respondents say that they are facing with the problem of bad smell/odour. Although Gondlanwala village is very far from the existing dumping site but 15 respondents (33%) out of 45 reply the odour problem.

Respondents who worry about water contamination also reply concern about the influence to the health. Respondents in Rurryala warraich (6%), Gondlanwala (4%) and Farmlands (4%) are particularly concern about water contamination problem.

Those who say the problem of livestock health cultivate farmlands (9%). It shall be noted that the traffic problem is pointed out by most of the people in RurryalaWarraich as they use single approach road going to their village. Problems such as gas production, trees damage, social life disturbance and price of land drop are replied only by the respondents of farmlands as shown in Table DG.1.4.

Table DG.1.4 Problems of Respondents of Gondlanwala

Problems	RurryalaWarraich	Gondlanwala	Saar Wala	Qadam Abad	Farm lands
Number of respondents in each village					
Flies	9	15	5	4	8
Odour	10	15	5	4	11
Drinking water taste is different	2	4	0	3	8
Health effects	5	8	2	3	5
Health problems of Livestock	1	1	0	2	4
Crop damage	0	0	0	4	2
Gas production	0	0	0	1	1
Price of land is reduced	1	0	0	0	2
Trees damage	0	2	0	0	2
Traffic problems	4	2	0	0	2
Dust	2	0	0	0	2
Social life distraction	0	0	0	0	1
Smell in water	0	1	0	0	1
Water Contamination	3	2	0	1	2

G.1.5.3 Opinions for the Current Landfill Operation

Twenty two (22) out of 39 (56%) of respondents agree to some extent that the current operation at the existing dumping site should be carried out but after some arrangements. One third of the

respondents, 17 out of 39 (44%), say that they do 'totally not agreed' to the current operation and they say to stop this operation as soon as possible.

Four (4) out of 39 respondents (10%) say to evacuate water first from the existing dumping site and then use it. Sixteen (16), out of 39 respondents (41%), requested to spray insecticide so that the problem of flies/ mosquitoes can be overcome.

Thirteen (13) out of 39 (33%) respondents say to cover the waste with soil daily while 5 out of 39 (13%) respondents say to sprinkle water on road to overcome the problem of dust. Three (3), out of 39 (8%), say to construct the road properly.

G.6 CONCLUSIONS AND RECOMMENDATIONS

G.1.6.1 Conclusion

This survey on awareness of residents reveals the fact that the knowledge, perception and awareness of solid waste management are clearly related to the education of a person. The better educated people are, the more they look for understanding of solid waste management services. It is concluded from the survey that awareness level regarding solid waste management is not so poor especially regarding the risks associated with waste. One hundred percent (100 %) respondents know the risks associated with solid waste if the management is not practice properly and about 64% people have the idea of recycling. But 36% people have no idea of compost.

All of the forty five respondents living nearby the existing dumping site reported that they all are facing a lot of problems. And the major problems are bad smell/odour, flies/ mosquitoes, health effects and change in water taste. All the respondents, 100%, are facing the problem of odour/ bad smell, 91% respondents are facing the problem of flies/ mosquitoes, and 51% claimed about the health effects. It is also recorded that children are more vulnerable to health problems as compared to adults.

One serious challenge noted by the majority of the residents is a lack of intention of GWMC on cleaning arrangements at the existing dumping site. These problems can be overcome if proper arrangements are provided in that area.

G.1.6.2 Recommendations

Waste collection service is not provided in the survey area. So the people manage their waste in different way or inappropriately by themselves. Provision of waste collection services to them may induce cooperative manner to the landfill operation.

Current environmental and social impacts should be improved through practicing appropriate landfill management. In view of the current situation, emergency measures must first be taken to mitigate at least, the following:

- Daily soil conversion the waste.
- Daily pest control.
- Improvement of a proper access road
- Installation of leachate collection, pumping and evaporation system.