EXECUTIVE SUMMARY

The existing methods of Management of Municipal Solid Waste (MMSW) in India are not only unscientific but also inadequate. At present not even 5% of the total waste produced is subjected to processing methods like biomethanation, composting, etc. for its reuse.

Punjab Pollution Control Board (PPCB) engaged Punjab State Council for Science & Technology (PSCST) to carry out detailed study of MSW management practices in two towns of Punjab namely, Mandi Gobindgarh and Kartarpur to assess the quantity and quality of municipal solid waste (MSW), to study the existing mechanism of storage, collection, transportation and disposal of MSW and to develop economically viable strategies for its scientific management. This report presents the findings of Kartarpur.

Administrative structure for MSW management

Kartarpur, popularly known due to its world famous furniture market is a Class-III municipality spread over an area of 10 sq. km. The existing population has been worked out as 27,147 with additional floating population of 3,500.

The town is divided into 15 wards, each represented by elected councilors. MSW management in the town is carried out by the Municipal Council (MC) headed by the President who is consensually elected amongst the ward councilors. The administrative head of the MC is Executive Officer who carries out the work with the help of sanitary inspectors and safai sewaks. MC handles the collection and transportation of MSW from 8 wards where as rest of the 7 wards are covered by a private contractor. The overall manpower employed for MSW collection & transportation is 46 (including contractor's employees).

Present status

The storage and collection practices in Kartarpur vary from family to family. MC/Contractor employees or private sweepers engaged by the owners, collect the waste from source and then either dump it at designated Priamry Collection Centers (PCC) or throw it in the open. A total of 20 designated PCCs and approximately 10 open dump sites have been identified. Most of the PCCs are either on private property or by the sides of the roads except two on MC's land.

No segregation of MSW is being practiced at individual house. However, rag-pickers (approximately 50-60 in number) do pick up lot of recyclable waste (approximately 1.5 tons) from PCCs and open dump sites.

For estimating the quantity of MSW generated from Kartarpur, door-to-door survey of the town was done by council engineers. Solid waste from Residential, Commercial, Vegetable & Fruit market, Hotels & Restaurants, Slaughter Houses, Dairy & Cattle Shed Waste, Construction & Demolition Waste, etc. was estimated separately. It was found that the total MSW generation from the town is 10 tons/day, thus resulting to per capita generation of 325 g against a population of 30,700. Out of 10 tons, residential area alone generates 7.0 tons of waste, thus leading to 225g/capita for residential waste. Also, it was noticed, that on a particular day, from collection and transportation perspective, MC and contractor both are able to cover only 60-70% of the town.

Two tractor trolleys are being used to transport the waste from PCCs to the final landfill site, currently located on Bhullath road. As this site is very far away from MC office, so they are throwing most of the waste at Bara Sucka Talab which is unsanctioned landfill site outside the MC boundary. All the transported waste finds its way to the landfill site, no further processing is being done. It was found that only 7.25 tons out of a total waste of 10 tons reaches the landfill site. This can be attributed to the fact that lot of waste is consumed by stray animals, part of the recyclable waste is picked up by rag-pickers and a substantial part is left uncollected and littered around the town.

To get an idea of the quality of MSW from Kartarpur, council engineers collected samples at landfill site and got analyzed as per standard IS method (Quadrant Method) in the presence of MC officials of Kartarpur. Analysis results reveal that:

- Total compost-able matter which includes organic residues, paper, leather and wood is 37% for the disturbed samples.

- Recyclable material which includes plastics, polythene, rubber, metals glass, etc. constitutes 13% in disturbed sample .

- Inert inorganic material including construction waste, street sweeping, silt from drains and other non-volatile matter is 50% at landfill site.

- Calorific value ranges between 1088 to 1258 kcal/kg and moisture content was found to be high in both disturbed and undisturbed samples.

On comparison with similar studies carried out for the cities of Amritsar, Vejalpur, Namkkal, Suryapet, it can be safely assumed that MSW from Kartarpur will constitute 25% recyclable material, 35% compostable matter and the inert material forms 40% of the total.

Proposed SWM practices

It is recommended that:

- 100% segregation at source will be done.

Segregation at source is considered to be the most efficient and non-labor intensive way for MSW management as there will be no degradation and devaluation of recyclables, higher recovery of recyclables will be achieved, lesser infrastructure will be required for transportation, quality of non-recyclable waste would be much better and thus the final product like compost, bio-gas would be of better quality.

- Awareness campaigns among residents will be arranged to educate them about segregation concept. A number of workshops/ seminars would be held wherein experts in the field, social engineers would be inducted to highlight the good practices. The councilors, municipal staff and a few prominent citizens would be conducted around the cities like Surat, Vejalpur, Nammakkal etc. where the solid waste management is being handled successfully so as to give them a first-hand glimpse of the possible improvements in the city. Even the visit of workers, manning the solid waste in the model cities, would be arranged to Kartarpur to narrate their experiences and the ways in which the problems were surmounted. Help of local clubs and NGOs will also be solicited.

- 100% door-to-door collection will be done.

As per Vejalpur model, safai-sewaks will be employed for door-to-door collection, each safai-sewak covering 125 units (total units 6,500 in number) and the recyclable waste collected from each unit will be the property of the safai-sewak itself. In addition, they will be given 10 Rs. per unit by the MC.

- Proper construction of PCCs will be done.

In Chandigarh, some of the sectors have been made dustbin free. The waste from individual houses is transported in tri-cycles to the Primary Collection Centers (PCCs), one PCC caters for an area 0.5 sq. km. The PCCs have been provided with tiled flooring and roof, boundary wall on three sides and lockable gate on the 4th side. Similar design of PCCs is proposed for Kartarpur as well. Also, MC will be required to identify sites for PCCs in each ward. In case, where MC land is not available, the possibility of barter of private land with a suitable municipal land has also been discussed with the elected representatives.

- The induction of Rag-pickers is proposed into the system of collection and transportation of MSW, to account for the additional manpower requirement (total required is 110, existing is 46) as they are already familiar with the area. The efforts need to be made to improve their living conditions. It would also lift their social standing.

- Streets will be swept on the daily basis from 8:00 PM till midnight as it will not interfere with the daily chores of the people. Also, it is recommended to use road cleaning machine on G. T. Road and wherever possible. Also, a separate container for collecting street sweepings will be kept at 5 equidistant PCCs throughout the town.

- Dumper Placers will be used for transporting the compostable waste weighing around 3.5 tonne/day and sweeping waste from PCCs to disposal site whereas the inert waste meant for land filling would be carted in the tractor trolleys already available with the committee.

- Inorganic waste weighing around 4 tons/day needs to be sent to the landfill site. The landfill site is proposed to be designed to cater for coming 16 years. The selection of site would be done in compliance with the criterion listed in the detailed report. The services of reputed consultants would be roped in. Detailed Environment Impact Assessment (EIA) studies would be got done and the construction of both landfill and composting facilities would be got done with the best specifications keeping the experience of operation of similar sites in view.

- E-governance

It is proposed to introduce e-governance as being practiced in Vejalpur where biometric machines have been installed to record the presence of the MC workers/employees. This ensures efficient collection and disposal system making it transparent and accountable.

Table-1 : Abstract of Cost

The cost of the project has been assessed as Rs. 2.18 crores with the abstract as:

S.No.	Description	Estimated Costs (Rs.)
1.	Segregation and storage at source	10.81 lacs
2.	Primary Collection	62.95 lacs
3.	Secondary Collection	17.5 lacs
4.	Processing & Disposal	131.25 lacs
5.	Overhead charges for Council activities	2.00 lacs
6.	E-governance	6.5 lacs
	Total	**241.01 lacs or say 2.41 crores**

1.0 DETAILED PROJECT

1.1 Introduction

Solid waste can be defined as material that no longer has any value to the person who is responsible for its generation. At the same time, it is generally disposed off in open. The terms garbage, trash, refuse and rubbish are also commonly used to denote solid waste. Solid waste management includes all activities that seek to minimize its adverse impacts on health, environmental and aesthetics.

Growing urbanization and industrialization have led to generation of large quantities of solid waste which can be broadly classified as Municipal solid waste (MSW), Industrial solid waste (ISW) and Biomedical solid waste. MSW includes commercial and residential wastes generated in a Municipal or notified areas in either solid or semi solid form.

India produces approximately 36.5 million tones of MSW every year. The urban local bodies spend approximately Rs. 500 to Rs. 1500 per ton on solid waste for collection, transportation, treatment and disposal. About 60-70% of this amount is spent on collection, 20-30% on transportation and less than 5% on final disposal (India Country report, Taiwan). Out of the total solid waste collected, on an average 94% is dumped on land and 5% is composted. The uncollected waste finds its way into sewers, some is eaten by stray animals, some burnt on roadsides and some is left to rot in the open. All these practices lead to air and water pollution, clogging of sewers and ill health effects.

Today, no town is devoid of the heaps of garbage piled up in the street corners and road sides with the result that the total hygiene of the people and the environment has been mindlessly compromised. Today, the public and civic authorities are seriously looking into the solution of this mounting crisis.

In this context, Punjab Pollution Control Board (PPCB) awarded a project to Punjab State Council for Science & Technology (PSCST) for "Preparation of Detailed Project Report on MSW for the town of Kartarpur". The main objectives of this project are:

- To assess the quantity and quality of municipal solid waste (MSW) generated from Kartarpur.

- To study the existing mechanism of storage, collection, transportation and disposal of MSW.

- To develop economically viable strategies for scientific management of MSW.

1.2 Breif History of Kartarpur

Kartarpur is a religious and important town. It was established in the year 1693 by peace loving, great martyr and literate, Sh. Guru Angad Dev Ji. Sh. Guru Hargobind Sahib has visited this town. Sixth guru Hargobind sahib had also killed cruel Mogul General Pandey Khan, whose grave is still present at Kartarpur kishangarh road. Jagat Mata Gujri ji W/o Sh. Guru Teg Bahadur Ji known as " Hind Di Chadar" was also born in this town

Sh. Virja Nand Ji, who was guru of Swami Dayanand had visited this town and their samarak is still situated at GT Road, Kartarpur. This city is world famous for wooden furniture work.

Aad Granth Shri Guru Granth Sahib which is hand written by Bhai Gurdas Ji and fifth Guru of Sikhs Sh. Guru Arjan Dev Sahib is still lying safe with Sodhi Vansh of Kartarpur.

2.0 CITY PROFILE

2.1 Area & Population

Municipal boundary of Kartarpur spans over a total area of 10 sq. km (6 sq. km is thickly populated and 4 sq. km is dedicated to farming) with G.T. Road (National Highway No.1) passing through the town. Kartarpur is world famous for wooden furniture work. The town is divided into 15 wards as in Map I.

2.1.1 Registered Population: Statistical Abstract of Punjab reveals the population of Kartarpur as 25,152 as per 2001 census. Using various mathematical tools, the population for the year 2005 works out to be 27,147 as per details given in **Annexure – I.**

2.1.2 Floating Population: Keeping the business activities and actual survey of the town in view, it was observed that a large number of migrant labor (nearly 2000) are residing in the slums and are not covered under the census. The MC, Kartarpur has specifically identified ward no. 2, 8, 9, 10, 11, 12, 13 and14 as slum areas.

Further reconnaissance of public places such as bus stand, hospitals, Furniture market and religious places reveal that there is a substantial floating population visiting the town, mainly relating to transportation and furniture business sector etc. As such the population including unregistered voters and floating population which otherwise generates municipal waste; has been assessed as approximately 3,500.

Design Population for working out MSW Quantity

The total population contributing to municipal solid waste in the year 2005 is estimated to be 30,700 with the break up as:-

- Estimated population against registered voters : 27,150
- Floating and Unregistered Population : 3,500

2.2 Main Tourist spots in the city

It is a religious town so it attracts large number of pilgrims. The main tourist spots are Gurudwaras and are listed in table 2 below.

Table - 2 : Tourist spots

S.No.	Tourist Spot
1.	Tham Sahib Gurudwara –In the centre of city
2.	Mata Gujri Sahib Gurudwara
3.	Gurudwara Gangsar Sahib – Outside the city
4	Mangolia Restaurant-Delhi Lahore Bus stops here for snacks

2.3 Climate

Kartarpur being in North India, experiences extreme climate. It experiences three major seasons – summer, winter and the monsoon. Summers (March-June) are hot, humid and extremely harsh. Temperature varies from 40 to 47˚C. However, winters (November-February) are extremely cold when temperature ranges between 2 -15˚C. Monsoon generally arrives in last week of June and continues to first half of October with annual average rainfall as given below:

Table – 3 : Annual Rainfall Data

Year	Annual Rainfall in mm
1999	285.0
2000	155.0
2001	362.3
2002	331.7

(Source : Statistical Abstract of Punjab)

The ground water table in this town as reported by the MC is 80 feet.

2.5 Political set up

Kartarpur has been divided into 15 wards. Each ward of the MC is represented by one councilor who is elected for a five year term. The President of the council is from the 15 councilors and is consensually elected by the councilors.

2.6 Administrative set up

The administrative head of the MC is Executive Officer. He carries out day to day activities through various departments such as Health, Engineering, Taxation, Water & Sewerage, etc. The ward councilors provide the policy guidelines to the Executive Officer. The organizational structure of the Municipal Council is given in Chart 1.

2.7 Solid Waste Management

Management of MSW in Kartarpur is carried out by the Municipal Council. The work is executed under the overall supervision of the Executive Officer, who carries out the work through sanitary inspectors and safai-sewaks. Municipal Council has employed a total of 22 safai-sewaks & drivers. Out of that, 10 are males and 12 are females. Also, safai-sewaks are deployed on

Table – 4: Manpower involved for Management of MSW

Name of the official	Numbers
Executive officer	01
Sanitary Inspector	01
Safai sewaks & Drivers (MC & Contractor)	46

temporary basis in addition to the regular staff from time to time as per requirement.

The Municipal Council is handling the primary collection of solid waste of 8 wards (1-5 and 13-19). The collection from remaining 7 wards (from ward nos. 6 to 12) have been outsourced to the private contractor. Lifting form all the 15 wards is done by the contractor. The contractor has been engaged for collection and lifting because of the the shortage of staff and infrastructure with the Municipal Council.

The private contractor has also engaged 24 safai-sewaks, out of which 15 are females. These female workers are employed to sweep the streets and cleaning of drains but no safai sewak is doing the sweeping. They are only cleaning the drains. The rest of the 9 male safai sewaks are used to transport the waste.

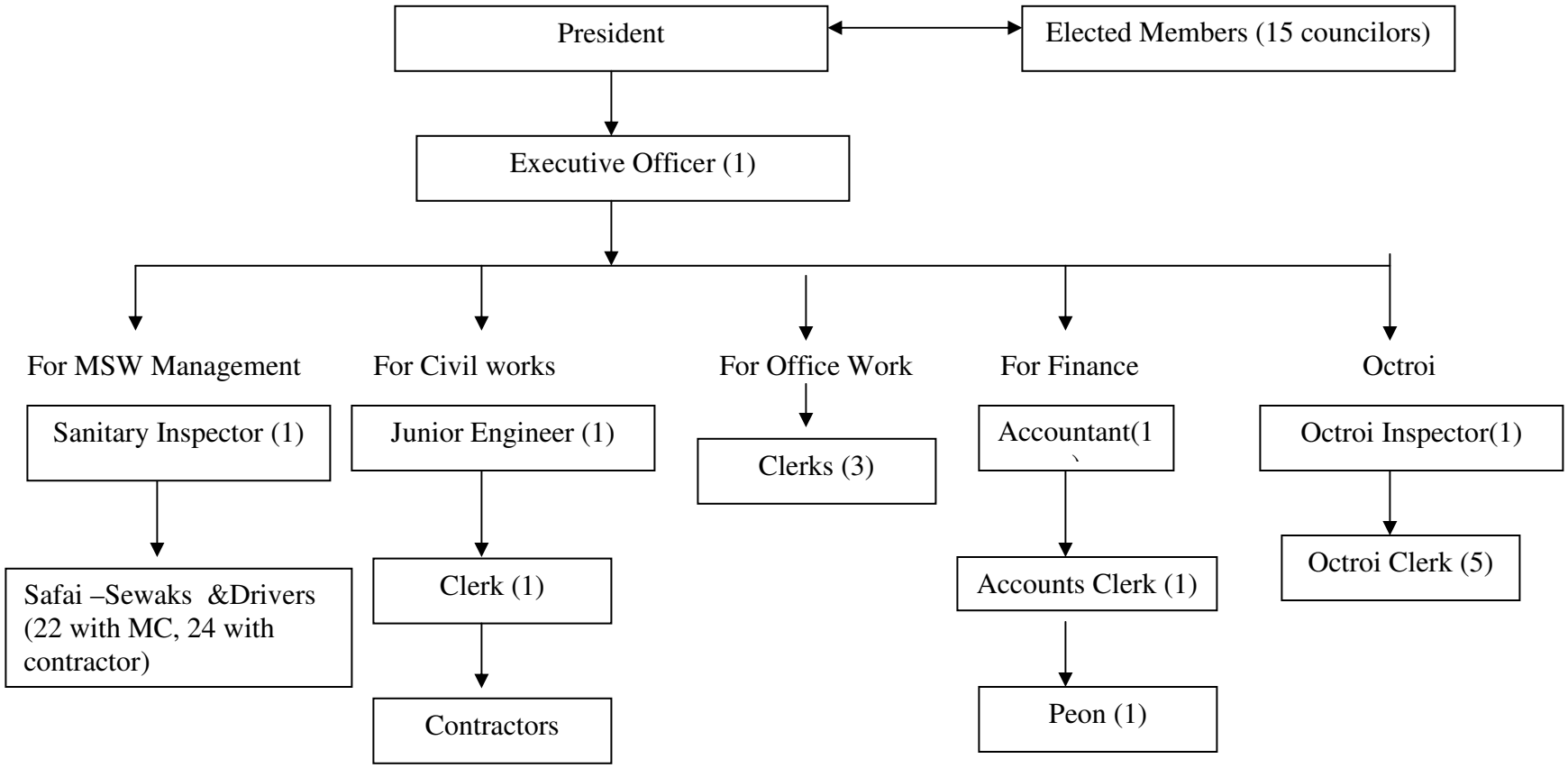

Chart 1 :- Administrative structure of Municipal Council, Kartarpur

3.0 PRESENT SCENARIO OF SWM PRACTICES

3.1 Sources & Quantum of MSW

Solid waste is a heterogeneous matter coming from various sources. To assess the quantity of MSW generated at present level, the whole town was surveyed. Various sources and types of MSW are given in Tables 5 & 6. Following paragraphs summarizes the findings under different categories:

3.1.1 Residential: As mentioned earlier in section 2.5, there are a total of 15 wards in Kartarpur. Representative 8 wards (ward #s 5, 7, 8, 10 to 14) comprising of rich, middle and weaker section were selected for the survey. In each ward surveyed, approximately 10 houses were visited personally and data with respect to the number of people in the family and primary type of waste generated, practices for waste collection, etc. was collected and studied. Polythene bags were distributed and the families were asked to collect the waste produced in one day in the given bag. On the next day, the bags were collected back and were weighed and contents were analyzed.

The per capita solid waste generation from households based on the survey works out to be 225 g/day. Sample data of solid waste generation as per household survey is given in Table -7.

Table - 5: Sources of MSW in Kartarpur

Sl. No.	Source	Typical facilities, activities & location	Types of MSW
1.	Residential	Single family dwellings	Food waste, recyclable waste (including combustibles & non-combustibles), street waste.
2.	Commercial	Offices, Institutions, Markets, Auto repair shops.	Food waste, recyclable waste (including combustibles & non-combustibles), street waste, occasionally hazardous waste
3.	Hotels & Restaurants	Hotels & Restaurants, Clubs, Community Centres, Marriage Palaces and Public Utilities	Food-waste, packaging material.
4.	Slaughter House	Slaughter houses, meat and fish markets.	Left over biological waste
5.	Dairy/Cattle Shed	Dairies	Left over cow dung, animal waste fodder, etc.
6.	Fruit & Vegetable market	Fruit & vegetable markets	Fruits & vegetable left-over
7	Miscellaneous	Construction & industrial activity, cleaning of municipal sewers, open drains, road gullies, street sweeping, etc.	Construction material i.e. grit and silt, organic waste. Street sweepings (mainly silt), silt from open drains

Table-6 : Details of different components of waste

Sl.No.	Type	Description
1.	Food Waste	The fruit or vegetable residue (Garbage) resulting from handling, preparation, cooking and eating of foods.
2.	Combustible	Paper, cardboard, plastics, textile, rubber, leather, wood, furniture and garden trimmings.
3.	Non-combustible	Glass, crockery, tin cans, aluminum cans, ferrous and non-ferrous materials, dirt and construction wastes.
4.	Street waste	Waste such as street sweeping, roadside litter, debris.

Table - 7: Sample data showing waste generation in Kartarpur

Ward No.	No. of houses surveyed	Total No. of people in the families surveyed	No. of adults in the families surveyed	No. of children in the families surveyed	Total waste produced by houses surveyed (kg)	Per capita generation (kg)
13	9	63	55	8	5.5	0.087
10, 11 & 12	7	37	28	9	9.25	0.250
8	9	55	50	5	12.75	0.232
5 & 7	9	55	51	4	13.55	0.246
14	10	64	57	7	20.25	0.300
Total	**44**	274	241	33	61.3	
Average per capita generation on the basis of survey (kg)					0.223	**say 225 g**

Total household waste generated by the entire population in Kartarpur =0.225*30,700 kg
=6.91 tons
say 7.0 tons

3.1.2 Commercial Waste: There is no proper ear-marked commercial area in Kartarpur. However, MC office has reported that there are a total of approximately 900 shops in the town. Out of which around 500 are furniture shops. Most of the waste generated from the furniture market is resaleable. As per observations, around 100 g/furniture shop find its way to the municipal bin. Also, from rest of the 400 shops, the waste generated is worked out to be 150g/day of the waste. Thus the total waste from commercial area has been estimated as 150kg/day

3.1.3 Fruit & Vegetable Market: There is one permanent fruit & vegetable market comprising of approximately 20 shops, each generating around 20 kg/ day of solid waste. Also, there are approximately 7 juice shops in the town generating around 20-25 kg/day of waste. Thus the total waste generated from fruit & vegetable market is estimated to be around 575 kg/day.

3.1.4 Hotels & Restaurants: There are 3 restaurants, 10 dhabas and 2 marriage palaces in Kartarpur. Discussion with owners/management of these establishments revealed that approximately 10-15 kg/day is generated from each dhaba, restaurants generates around 100 kg/day and marriage palaces generates around 50 kg/day of waste. Thus the total waste from hotels & restaurants is estimated to be 300 kg/day.

3.1.5 Slaughter House: There is no slaughter house in the town. However, there is one fish & meat market having 2 permanent meat shops, each generating around 25 kg of waste per day. Also, there are 20 road-side meat shops, each generating around 10 kg/day of waste. Approximate quantity of waste has been assessed as 250 kg/day.

3.1.6 Dairy Waste: A total of 5 dairies with an average of 10 animals in each are located in the town. Also, there is one gaushala (having approximately 50 cattles) located in ward #8. The waste generated here is either used in farming or as a fuel for cooking. Most of the waste generated from dairies, which reaches the Municipal bin is from floor sweepings only which is estimated as 200 kg/day.

3.1.7 Miscellaneous Waste: The miscellaneous waste includes construction waste, street sweepings and drainage silt. As per MC Bye-laws, the collection & disposal of construction waste is the responsibility of the house owner or the contractor. However, it is observed that in the majority of cases, the waste is left where it is generated. Only in cases of large construction sites, the waste is taken to low-lying areas for disposal. Rest of the waste is picked up by MC staff. The construction waste has been estimated as 300 kg/day.

The MC safai-sewaks are not doing any sweeping of steets. The whole town has open drainage system due to which the street sweepings find its way into the drains thereby clogging the drains. The safai-sewaks however, deputed for street sweeping and drainage cleaning, cleans only these clogged drains and this process keeps on repeating, due to which the drainage silt is very high. The amount of drainage silt is estimated as 1.2 tons/day. Thus, the total miscellaneous waste works out to be 1.5 tons/day.

Considering the above quantities of solid waste from various sources, the total MSW generated works out to be 9.975 tons/day say 10 tonnes, which is tabulated below:

Table - 8: Category wise waste generation in Kartarpur:

Sl.No.	**Category of soild waste generated**	**Amount of soild waste generated in 2005 (tonnes/day)**
1	Residential (225 g/capita for present designed population as 30,700)	7.000
2	Commercial	0.150
3	Fruit & Vegetable Market	0.575
4	Hotels & Restaurants	0.300
5	Slaughter House	0.250
6	Dairy waste (mainly floor sweepings)	0.200
7	Miscellaneous (including construction waste and street sweeping)	1.500
	Total	**9.975 SAY 10.0 tons/day**

Whereas MC officials reported the solid waste generation as 5 tons/day and around 80% of it i.e. 4 tons of MSW is being lifted daily except on Sundays and gazetted holdiays. To estimate the amount of MSW reaching the landfill site on a daily basis, it was found out that 2 trolleys (one big and one small) makes a total of 6 trips (3 trips by each) to the landfill site on a given day. These trolleys were weighed and the average amount of waste reaching the landfill site was estimated. Average MSW being lifted and transported daily (except Sundays and gazetted holidays) has been worked out as 7.25 tons as per details given in **Table - 9.**

Table – 9: Waste going to the landfill site

	Tractor Trolleys	
Date	**Waste carried by the big trolley (quintals)**	**Weight carried by the small trolley (quintals)**
27.04.05	17.30	7.75
31.05.05	15.45	7.75
Average	16.375	7.75

Total waste lifted daily (except on Sundays and gazetted holidays)
= (16.375 * 3) + (7.75 * 3)
= 72.375 quintals = 7.23 tons/day

Variation in solid waste generation and solid waste being lifted/transported can be attributed to the following factors as observed by the Council Engineers:

1. Around 15% of MSW, which is mainly recyclable material in form of metals, plastics, glass, rags, paper and rubber etc. is being sorted and picked up by the rag pickers. The Council arrived at this conclusion after visiting the various primary collection centres and interacting with rag-pickers and Kabariwalas. Further, it was observed that around 50-60 rag-pickers are active in the town. Each rag-picker picks around 25 kg/day. Picture – 9 shows the waste collected by rag-pickers. Thus, approximately 1.50 tons of recyclable material gets retrieved from the waste.

2. There are around 50-60 stray cattles and around 250 stray pigs in the town. As per observations made at different open dumping and PCC sites, it is estimated that they consume around 1.0 ton of MSW. Picture -2 & 3 shows a stray animal eating away waste from PCC.

3. About 1.30 tons/day (13% of total) of total solid waste (worked on the 7 day generation and 6 day lifting basis) remains uncollected. Some of this waste finds its way in open drains, some is left to rot in the open and some is burnt on road sides.

From the above facts, it is clear that of the total of 10.0 tons, about 2.5 tons of waste (1.5 tons by rag-pickers and 1 ton by animals) is being recycled or consumed. Thus 7.5 tons of MSW has to be ultimately managed as on date and 6.2 tons/day reaches the landfill site.

3.2 Current Waste Storage Practices at Source

3.2.1 Storage of Domestic Waste at Source: The practice of storing the domestic waste varies from locality to locality depending upon the literacy and economic status. Primarily, it was observed that people have dustbins in their homes for collecting all the waste generated on a daily basis, but no segregation of recyclable waste and organic wet waste is being practiced. However, the poor and weaker section, either leave the waste open in a corner of their homes or throw it outside their houses as and when it is generated.

3.2.2 Storage of Commercial, Hotel & Restaurant, Slaughter House Waste at Source: Mostly, shopkeepers and institutions have dustbins in their premises for collecting all the waste generated. Also, hotels, restaurants, marriage palaces and community centers store the waste in drums/tins to store the waste. As discussed earlier, there are no slaughter houses in the town.

3.2.3 Storage of Fruit/Vegetable Market, Dairies and Miscellaneous Waste at Source: This has already been discussed in section 3.1 under the head quantity of MSW generated.

3.3 Segregation of Recyclable Wastes

MSW can be classified as recyclable waste, compostable and inert waste. Recyclable waste includes metal, broken glass, paper, plastic, thermocol waste, etc., compostable waste is mainly organic like kitchen waste and inert waste is mainly street sweepings and construction waste.

Visits to around 45 houses in 8 wards and discussion with school children, house-wives and councilors revealed that no segregation of waste at source is being done. Also, it was felt that residents have never heard of the segregation concept and are not aware of its advantages in terms of better hygiene, health and environment.

However, rag-pickers do help in segregating at Primary Collection Center, who picks up lot of recyclable waste throughout the day from PCC. They, then sell it to the kabari walas in and around the town. The approximate amount of waste picked up by the rag-pickers is 1.5 tons as documented earlier in Section 3.1.

Thus, approximately 1/7th of the waste is collected by the rag-pickers. As such, major part of the waste is being taken out as a resource. This not only helps in cleaning the environment but also reduces pressure on the MC for collection, transportation and disposal of MSW. However, the rag-pickers were not seen using proper safety measures and thus are suffering from

various diseases like respiratory illnesses from ingesting particulates and bio-aerosols, infections from direct contact with the waste, puncture wounds leading to tetanus, hepatitis and HIV infection, headaches, nausea etc.

3.4 Collection of Waste from Source

3.4.1 Primary Collection of Domestic, Commercial and Institutional Wastes: The collection of domestic waste varies from ward to ward. In most of the wards, residents themselves dump the waste generated at the designated PCC. In the other scenario, they throw the waste outside their homes, the sweeper who comes for cleaning the drains, then collects it and dump it at the designated PCC. These sweepers either use wheel barrows or baskets to collect the waste and transport the same to the PCC. The safai sewaks of contractor do not have any wheel barrows. They collect the waste in baskets and throws it at PCC or road side.

The commercial waste generated is thrown outside the shops by the shop-keepers; the sweepers who come for sweeping the streets collect it and take it to the nearby container placed by the MC. Solid waste generated from Institutes is either taken to the Primary Collection Center by an institutional/private servant or is left outside the shop and is picked up by the street sweeper and then taken to the Primary Collection Center.

3.4.2 Primary Collection of Hotels & Restaurants Waste, Fruit & Vegetable Market, Slaughter House, Dairies, Construction and Miscellaneous Waste: The owner throw the waste outside their premises to be eaten away by the stray animals (around 300 in no.). The left-over on the streets is picked up by the street sweepers who come for cleaning the drains and they then dump it at the nearby PCC.

3.5 Street Sweeping & Frequency of Street Sweeping

No street sweeping is done in the town. The safai-sewaks deputed for sweeping the streets, just clean the drains on the street when they get clogged. This is the reason for very high silt content in the waste generated. The safai-sewaks either use wheel barrows or baskets to collect the drainage silt and transport it to the designated PCC.

3.6 Infrastructure Available

The infrastructure employed for MSW management in the town (available with the council and the private contractor) is given in **Table – 10.**

Table – 10: Infrastructure Available for management of MSW

S.No.	Equipment	Number of equipments
1.	Tractor Trolleys	2 (both belongs to MC)
2.	Water Tankers	1
3.	Wheel Barrows	20
4.	Tricycles	1 (not in good condition)
5.	Baskets, Brooms and Kahis	15 baskets, 4 kahis, 36 brooms

3.7 Waste Storage Depots

There are a total of 30 primary dumping stations. Out of which, 20 are designated Primary Collection Centers (PCCs) as shown in Pictures 1 and 2, where waste containers have been placed by the MC. Rest 10 are open undesignated dump-sites (in Picture-4). The designated PCCs are mostly on road-side. The containers at PCCs are in a poor condition, they don't have a base, thus no hydraulic system can be adopted and tractor trolleys are being used to transport the waste to landfill site. The photographs of typical PCCs are at pictures No. 1 & 2.

In case of open dumping sites, sweepers & residents throw the waste haphazardly and one can observe very unhealthy and unsightly conditions around these dumping sites. This waste is ultimately being transported to the landfill site by tractor trolleys.

3.8 Work Norms

Waste collection and lifting is done 6 days a week i.e. Monday through Saturday. Also, no SWM services are provided on gazetted holidays and Sundays. For administrative work, the timings are: 9:00 AM to 5:00 PM. For Safai-Sewaks & Drivers, the work timings are: 6:00 AM to 12:00 noon and 3:00 PM to 5:00 PM. But, usually, the safai-sewaks work at a stretch from 7:00 AM to 2:00 PM.

However, neither the staff of MC nor the contractor is able to cover their assigned area on any particular day. MC authorities have reported shortage of staff and infrastructure required for managing solid waste.

3.9 Transportation of Waste

MC workers are using wheel barrows for transporting the drainage silt and solid waste thrown on the streets by residents. From PCCs to landfill site, tractor trolleys (shown in Picture – 4 & 5) are being used.

Each tractor trolley needs a driver and two helpers. A tractor trolley, on an average spends 30 minutes at each PCC for collecting the waste. However, unloading at the landfill site takes only couple of minutes as the tractor trolley system is hydraulic.

As mentioned earlier in section 3.1 of this report, only around 7.25 tons of the waste is being transported to the disposal site daily. Maximum one-way distance that a tractor trolley travels for transporting the waste is approximately 4 kms.

3.10 Quality of MSW Generated

Knowledge of physical as well as chemical characteristics of MSW is pre-requisite for effective and techno-economic planning of collection, transportation, treatment and disposal system. For the same, a sample at the landfill site was collected and physically analyzed by the PSCST engineers.

As earlier described in section 3.1 of this report, (7.25 tones/day on 6 days basis & 6.2 tones/day on 7 days basis) 6.2 tons/day of MSW reaches the landfill site. Analysis of the sample at landfill site reveals:

- 13% recyclable material i.e. 0.81 tons/day
- 37% compostable matter i.e. 2.29 tons/day
- Inert inorganic material (primarily drainage silt) comes out to be 50% i.e. 3.1 tons/day.

To get an idea of the characteristic of waste at the source, 1.5 tons picked up by the rag-pickers from PCCs is added to the recyclable waste, 1.0 ton eaten away by stray animals is added to the compostable matter and the rest i.e. 1.3 tons is distributed in the same ratio. The final characteristic of waste then comes out be:

- 2.5 tons (0.81 + 1.5 + 0.13*1.3) i.e. (24.8% of total) of recyclable material.
- 3.7 tons (2.29 + 1.0 + 0.37*1.3) i.e. (37.7% of total) of compostable matter.
- Inert inorganic material (primarily drainage silt) comes out to be 3.8 tons (3.1 + 0.50*1.3) i.e. (37.5% of total).

3.11 Processing and Disposal of Waste

At present, no processing is being done and all the MSW generated is ultimately disposed off at the landfill site. However, as mentioned earlier in section 3.4, rag-pickers do play a very important role in segregating the recyclable material and thus reduce the load at the land fill site. There are two landfill sites, one at Sucka Talab (unsanctioned) and one on Bhaluth

road (sanctioned). The Bhaluth road one, measures 1 acre and is taken on lease by MC, Kartarpur for three years. They are paying Rs. 15,000/- per year as rent to the owner. The one on Sucka Talab is the property of Guru Sahab (in relation to Guru Angad Dev Ji). Both these sites are open area with no proper boundary wall. The contactor uses Sucka Talab for dumping all the solid waste (shown in Picture-5) as Bhulath road is too far. The dumping is done very unscientifically, without paying proper attention to the leachate collection. The effect on ground water quality due to leachate from the dumping could only be a speculation as no monitoring is being carried out in its vicinity. Also, no cover is provided on the waste at the end of the day.

4.0 RECOMMENDATIONS/PROPOSED METHODOLOTY

The basic principle and pre-requisite for effective and scientific management of MSW is proper segregation, door-to-door collection and proper lockable PCCs.

Segregation is possible at source, PCCs, transfer stations or at final disposal/processing site, but segregation at source is considered to be the most efficient and non-labor intensive way for MSW management as:

- There will be no degradation and devaluation of recyclables, thus ultimately leading to better financial returns and good quality of final products being manufactured from these recycled materials.

- Segregation at source will lead to more recovery of the recyclable material and ultimately lesser load on PCCs and final dumping sites.

- Lesser infrastructure will be required for transportation of waste to PCCs and landfill site.

- It would help in improving the health of rag-pickers as they will no longer have to scavenge through the waste at PCCs. Also, this would also enhance their social status.

- The quality of non-recyclable waste would be much better and thus the final product like compost, bio-gas would be of better quality, thus fetching more price.

Segregation at source is being practised in developed nations and few towns in India like Vejalpur in Gujarat, Suryapet in Andhra Pradesh, Namakkal in Tamilnadu, North Dum Dum and New Barrackpur falling under Calcutta municipal limits. PSCST is recommending similar concept in Kartatrpur as well and is hoping to achieve the same by:

1. Organizing awareness campaigns for the residents mainly house-wives and children about good practices in proper storage of waste, public participation in segregation at source and community based primary collection system. This task can be assigned to various interested social organizations prevailing in the town and they needs to be identified for the purpose.

2. Arranging a visit of progressive councilors, residents and employees of MC to various towns/cities where segregation is being practiced for

long time. This would instill confidence in the leading members of the society and would help in quick adoption of segregation concept in individual houses.

The details of strategies to be adopted in implementing the above recommendations under various categories are discussed in the following sections.

4.1 Storage, Collection and Transportation of Waste

PSCST's recommendations on storage and collection of MSW from source are tabulated in the Table - 13:

Table – 13: Recommendations for management of MSW in Kartarpur

S.No.	Source	Recommendations	
		Storage at source	Collection from source
1	Residential & Commercial	2 small separate bins for dry and wet waste. Owners should put proper polythene bags in the bins for storing the waste.	Door-to-door by safai-sewaks, using tricycles to transport the same to PCC. Also, all efforts should be made to hand over left-over cooked food to the safai-sewak itself, who will then be taking it to the cattle pond or gaushalas as once the open dumping is eliminated and all the PCCs are lockable, there won't be any stray animals.
2	Schools/Offices/ Institutions/Community Halls/Parks/Hotels & Restaurants/Marriage Halls	2 big (110 lts) separate HDPE bins for dry and wet waste. Besides one container for cooked waste. Proper polythene bags should be put in the bins.	Individual's responsibility to send the cooked waste to piggery units and rest of the waste will be collected door-to-door by safai-sewaks, using tricycles to transport the same to PCC.
3	Meat & Fish markets	2 separate bins for dry & wet waste fitted with proper polythene bags.	Wet waste to be sent to the piggery units. Dry waste will be picked by safai-sewaks
4	Vegetable & Fruit Market	1 big 110 lts HDPE bin for storing wet waste in individual shops presuming little dry waste.	Individual's responsibility to dump the waste in the container exclusive for the purpose at the nearby PCC
5	Street food vendors	1 bag according to the individual's sale.	Individual's responsibility to dump the waste in the container at nearby PCC
6	Dairy & Cattle-shed waste	Liquid waste should not be allowed to mix with the dung waste. 1 tin container only for sweepings of dung waste	Door-to-door collection by safai-sewaks

7	Hospitals/Pathological Laboratories/Health Care Centers	In accordance with the bye-laws for handling hospital waste	In accordance with the bye-laws for handling hospital waste
8	Construction & Demolition Waste	Responsibility of the owner to dispose it off to the low-lying areas as per MC by-laws and with prior approval. Otherwise, facility for storing the waste in container can be made available to individual on request to the MC for which MC will levy some charges.	

All the residents will be educated thoroughly on what all the recyclable (dry) and compostable (wet) waste includes and thus they will be encouraged to store the waste separately in bins meant for the same. For proper and strict enforcement, some penalty will be levied on the defaulters for which municipal by-laws needs to be amended accordingly.

4.1.1 Mechanism of Collection of waste by safai-sewaks: The waste collection from various sources will be done by safai-sewaks as mentioned in the Table- 13. The dry waste from these units will be collected separately in his/her bag and the wet waste will be put in the tricycle fitted with cover provided to him/her by the MC and will be transported to the PCC. These sewaks will use a bell or a whistle to indicate their arrival which will alert house/shop owners to bring their waste out. However, in case of working couple, they will leave the waste at a suitable location inside their homes, which is easily accessible by safai-sewaks, who will then collect the waste from there himself/herself. Photographs of proposed tricycle are annexed as Picture –15.

The total number of units, houses and shops (commercial units) together is assumed to be 6500 for a worked out population of 30,700 (details in Chapter 2.0) in the year 2005 as MC records indicate 5000 houses against a population of 25,152 in year 2001.

One safai-sewak will be collecting the waste from 125 units. Also, there will be one supervisor/mate against 15 safai-sewaks, who will serve as a link between them and higher ups in the Municipal Council. Supervisors will also look into the attendance and the performance of safai-sewaks, sweepers and chowkidars. It is recommended that all the collection and transportation to the PCCs by safai-sewaks is done between 8:00 AM and 11:00 AM everyday. The Municipal Council will be paying Rs. 10/- + 1/- = 11 per unit per month to one safai-sewak and supervisor. Also, the safai-sewaks will be making extra money by selling the dry waste collected to the kabariwalas. Good quality dry waste containing various recyclable items can fetch better price as indicated below (prevalent in Suryapet in Andhra Pradesh).

Table – 14: Prevalent price of recycle waste

Sl.No.	Product	Unit	Rate (Rs.)
1	Iron	kg	10.00
2	Sheet	kg	9.00
3	Aluminum	kg	4.00
4	Brass	kg	80.00
5	Bronze	kg	110.00
6	Stainless Steel	kg	15.00
7	Plastic	kg	10.00
8	Plastic Chappals	kg	7.00
9	Plastic Tea Cups	kg	4.00
10	Note Paper	kg	7.00
11	School Book	kg	3.00
12	News Paper	kg	4.00
13	Mica Cover (Smooth)	kg	5.00
14	Beer Bottle (New)	Piece	4.00
15	Beer Bottle (Old)	Piece	4.00
16	Quarter Bottle	Piece	1.25
17	Milk Cover	kg	10.00
18	Oil Cover	kg	6.00
19	White Records	kg	6.00
20	Glass	kg	1.00
21	Glass (Ordinary)	Piece	0.75
22	PVC	kg	20.00
23	Soda bottle	Piece	1.00
24	Beer Bottle (Small)	Piece	0.50
25	News Paper (Waste)	kg	2.50
26	Royal Apple Bottle	Piece	0.50
27	Bottle (Pound)	Piece	0.50
28	X-Ray Paper	kg	20.00

A conservative estimate reveals the earning of one safai-sewak to be around Rs. 2500 – 3000 per month (Rs. 1250 from MC + balance from selling of recyclable items).

4.1.2 Street Sweeping: It is recommended that street sweeping in the whole town is done from 8:00 PM till midnight everyday as sweeping during the day is unhygienic and interferes with the daily chores of the civics. The road/street length in the town is 25 km and each sweeper will be required to sweep 2 km of the road/street length. Each sweeper will also be responsible

for the cleaning of surface drains and removal of silt from underground drains/manholes in his/her particular 2 km length. As such 13 sweepers will be required.

The sweepers will be provided with long handled brooms, cane baskets, metal trays and tricycles for the purpose. Since, the sweepings mainly contains silt and a little organic material like leaves, paper, etc., it is recommended to have a separate container (other than the wet waste from homes & shops) in around 5 PCCs for the sweepings. The PCCs for sweepings will be identified later but preferably along the G.T. Road. Also, containers should be located in such a way that each sweeper doesn't need to traverse more than 3-4 km.

4.2 Primary Collection Centers (PCCs)

For effective elimination of open dumping places and location of existing 20 waste containers, each ward should have at least one PCC with proper boundary wall having locked gate arrangement. Further, three rows of plantation should be done all along the boundary wall so as to give hygienic and aesthetic look to the residents living nearby. As such, the total number of PCCs required at this time works out as 15.

The proposed design and facilities in each PCC are indicated in the Pictures 12 to 15 and land requirement will be approximately 150 to 200 sq. yards which is on the lower side when compared with present area occupied by open dumping places as well as PCCs. The cost of construction of one such PCC has been worked out as Rs. 2.5 to 3.0 lakhs excluding the cost of container.

Identification of site for PCC in each ward will be the responsibility of Councilor concerned and the MC. Also, the land identified for PCC should be rightly purchased and registered with the Revenue Department and ultimately be handed over to Municipal Councilor

One chowkidar will be deputed on each PCC to make sure that all the garbage is in the containers, thus requiring a total of 15 chowkidars.

4.3 Quantity & Quality of MSW after implementing the proposed recommendations

Once the above practices (100% segregation at source and 100% door-to-door collection) are implemented, and looking at the characteristics of solid waste of different towns like Vejalpur, Namakkal, Suryapet, it is assumed that solid waste from Kartarpur will constitute:

- Recyclable material including organics as 2.5 tons/day (25% of total).
- Compostable matter as 3.5 tons/day (35% of total).
- Inorganic material including construction waste as 4 tons/day (40% of total).

Thus the amount of waste reaching the PCC (to be considered for processing and disposal) is 7.5 tons (10 – 2.5 tons).

4.4 Transportation of Waste from PCC for processing/disposal

The next step is to clear around 20 containers at the PCC. Dumper placers will be used for the lifting the containers. The lifting of the container will be done in one shift. The morning shift will be from 8:00 AM – 5:00 PM.

Each dumper placer will require 1 driver and 1 helper. The amount of waste to be considered for transportation is 7.5 tons or 20 containers (capacity of each container being 1.5 tons).

It is envisioned that one dumper placer can make 10 trips in one shift, thus 2 dumper placers can make 20 trips which solves the purpose.

4.5 Routing of Vehicles

G.T. Road divides the town into two halves. Current Landfill site at Bhullath Road approaches via G.T. Road only, thus all the vehicles will be made to go via the G.T. Road to the landfill site.

For the new site to be proposed, routing of vehicles will be recommended based upon its location.

4.6 Manpower required for proper MSW management

Following table summarizes the manpower deployment in accordance with the recommendations from PSCST:

S.No.	Designation	Number
1.	Safai-Sewaks	52 (6500 units assuming each safai-sewak serving 125 units)
2.	Chowkidars at PCCs	15 (15 PCCs and one at each PCC)
3.	Street Sweepers	13 (25 km length assuming each sweeper sweeps 2 km)
4.	Supervisor / Mates	6 (one per 15 workers: includes safai-sewaks, chowkidars and sweepers)

5.	Drivers & Helpers	8 (2drivers & 2 helpers for dumper placers, 1 driver and 3 helpers for existing tractor trolley)
6	Compost Plant and Landfill Site	16
	Total	110

Thus, a total of 110 people are required as on date for proper MSW collection & transportation of MSW. At present, number of people deployed in collection & transportation in the town is 46. Also, there are almost 50-60 rag-pickers in the town who play a very important role in segregation.

It is recommended to induct almost50-60 rag-pickers for the door-to-door collection of the waste, the reasons being:

- There is the need of more manpower according to the present findings for efficient MSW management.
- Rag-pickers already have a good understanding of the area.
- For rag-pickers, specifically, major livelihood concerns are becoming critical. Rehabilitation of the rag pickers and integrating them into the main stream will provide employment opportunities and dignity of labor to them.
- Inducting rag-pickers will encourage healthy living conditions for them, as they will have a constant source of income and will be working in hygienic conditions as opposed to the present state.
- They are already familiar with the near by kabari-walas to whom they sell the recyclable waste as on date.

The remaining 16 MC employees will serve at the disposal site, treatment site and as back up staff in case, one of the other employees goes on leave. As such, there would neither be a social imbalance nor any financial burden on the MC.

4.8 Management of Information Systems

Availability of day to day information of working of the solid waste management system enables the Municipal authorities to take necessary and corrective action in case any problem arises. It also enables the authorities to identify the deficiencies in the system and take corrective action well in time.

The first step to achieve the same would be to make Kartarpur totally e-governed as is the Vejalpur Nagarpalika, India's first e-governed Nagarpalika. The entire administrative work should be made totally computerized. Property assessment, Tax, Birth & Death registration, shops & establishments registration, solid waste management, Sanitation department, Street Light department, Water Supply department, etc., all information should be available online. As a result, inspite of less staff, it will be possible to get quick, more and perfect work. Each and every citizen of the town can get the information regarding his property as well as complain status from the MC office or through internet.

It is recommended to have Bio-metrics machine similar to the Vejalpur Nagarpalika for Kartarpur. Each of the workers, clerks, peons and even the chief officer should register their everyday presence by putting a thumb on the above said machine.

Similar way, all the safai-sewaks and street sweepers should register their presence between 7:00 AM and 8:00 AM. The sanitary inspector gets the online presence report. If any of the workers is absent, then the responsibility is given to the any one among other reserved staff.

Also, the drivers of the dumper placers and tractor trolleys will be asked to register each container shifting to the dumping/processing site with the computer operator. This will help the MC to achieve a decided goal as analysis of the work can be done more easily and administration of the same becomes very easy. Because of the entire procedure being online, both the residents and administration can observe and analyze entire work being done at any moment.

5.0 TECHNOLOGICAL OPTIONS FOR TREATMENT AND DISPOSAL OF SOLID WASTE

Technologies used for treatment of municipal solid waste have changed over the time due to the changing dimensions of the problem. Any technology proposed to be adopted must be in accordance with the national plans for management of municipal solid waste. A high powered committee for urban waste management was set up by Govt. of India in 1995, under the chairmanship of Prof. J. S. Bajaj, Member, Planning Commission, Govt. of India. The committee's recommendations in brief regarding disposal of municipal solid waste are:

1. Along with land filling, composting of municipal solid waste should be the next appropriate option.

2. Private participation in setting up pilot plants utilizing appropriate technologies for municipal solid waste management should be encouraged.

5.1 Technologies Available

Various technological options available for Solid Waste Management are:

1. Sanitary Landfill
2. Composting
3. Biomethanation
4. Incineration
5. Vermiculture
6. Pelletization

Landfill gas technology proves to be the cheapest one where sufficient area of land is available for this purpose. Landfill gas recovered from the waste can be used for various purposes such as cooking, heating or power generation. Landfilling becomes unavoidable even if the waste is treated using other thermal or biological treatment technology. The inorganic portion mixed with the municipal solid waste remains unchanged during treatment and is separated from the waste during various steps, requires final disposal by landfilling.

Composting stabilizes the organic waste into humus like substance, which is used as bio-fertilizer and soil conditioner.

Biomethanation is the process in which decomposition of organic wastes takes place in closed reactors in the absence of oxygen. Biogas and organic manure are the useful products of the process.

Incinerator is widely acceptable for the waste having high calorific value and low moisture content. It reduces the volume of waste to about 20% of the initial volume of waste. The excess heat recovered is used for various purposes e.g. water heating or power generation.

Based on literature survey, the comparison of various technological options is presented in the following Table:

Method of Disposal	Merits	Demerits
Sanitary Landfill	• Low initial cost. • Easy to operate. • Low operating cost.	• Large area of land required (non-availability of wasteland for such use around Kartapur). • Causes air pollution, ground water pollution creates unhygienic conditions and nuisance in the surroundings.
Composting	• Easy to operate. • Low maintenance cost. Highly useful product for soil conditioning. • Technology suitable for Indian MSW. • Semi-skilled manpower required for operation.	• Causes air pollution. • Marketing of compost is still a difficult task.
Bio-methanation.	• Waste processing in closed reactor provides very good protection to environment. • Resource recovery in the form of bio-gas and bio-fertilizer. • Less land requirement. • Incentives available from various Govt. organizations.	• Requires controlled conditions. • High initial cost. • Technology still in experimental stage in India.
Incineration	• Requires less land. • Reduces the volume of waste to great extent. • Plastics in the MSW can	• High initial cost. • Causes environmental pollution due to stack emission and temperature rise.

	be disposed off only by this technique at present. The increasing use of plastics and non-availability of land would necessitate incineration.	• No plant operating in India. • High moisture content, high percentage of inorganics and low calorific value of Indian MSW is unsuitable for this technology. • Requires skilled personnel.

5.2 Technologies Recommended

The basic consideration in selecting municipal solid waste disposal facility should be:

- the means to reduce the volume of waste
- reuse of waste as a resource
- economic viability
- effects on the environment
- acceptability by the people

Resource recovery from municipal waste is the demand of the day. Items requiring special attention in planning for use of municipal solid waste as resource are as follows:

- Status of technological advancement
- Verification of future stable demand for recovered items and securing of entity which will receive these items.
- Setting realistic expectations for the financial gains.
- Understanding that reuse of waste will become an increasingly important issue.

According the recommended MSW management strategies at Kartarpur, the waste generated can be classified into 3 categories:

- Recyclable (2.5 tons/day)
- Compostable (3.5 tons/day)
- Inert (4.0 tons/day)

As mentioned earlier, recyclable material will be the property of the safai-sewaks and will be sold to the kabari-walas. In accordance with the MSW management handling rules - 2000, compostable matter should be treated separately and thus, not to be disposed off at the landfill site. Two possible options viz. vermiculture and composting have been assessed separately for handling the compostable matter. Details of the same are in subsequent paragraphs and the inert matter will be dumped at the landfill site. These technologies are described in detail in the following paragraphs.

5.2.1 Composting: As discussed earlier, the compostable waste is 35% of the total solid waste produced and equals 3.5 tons/day. A composting plant over an area of 14 acres and having a capacity of 500 tons/day in Jallandher, 20 kms from Kartarpur. This plant was visited and data was collected with respect to amount of waste received/processed etc. and is tabulated in the table below:

S.No.		Quantity
1.	Capacity	500 tons/day
2.	MSW received (unsegregated)	225 tons/day
3.	MSW processed	80 tons/day
4.	Manure produced	35 tons/day

The manure thus produced is sold over a price of Rs. 4 per kg. PSCST engineers talked to the owner of the plant and he agreed to process the waste from Kartarpur at the rate of Rs. 1 per kg and in turn the manure produced will be given back to the MC. The transportation charges for the same will be met by the MC.

Cost Estimates for composting

There is 3.5 tons/day of compostable matter and transportation distance will be 20 km one way.

Processing charges @ Rs. 1/kg = 1 * 3500 Rs. = 3500 Rs./day

2 tractor trolleys or dumper placers will be needed for transportation
Transportation charges = (40 km) / (10km/liter) * (30 Rs./liter) = Rs. 120
say Rs. 150 per tractor trolley (both sides)

For 2 tractor trolleys = Rs. 300 per day.

Total expenses involved = Rs. 3500 + Rs. 300 per day
= Rs. 3800 per day

Manure generated = 1.25 tons assuming 50% efficiency
Income from manure is it is sold at Rs. 3 per kg = 1250 kg * 3 Rs./kg

Income generated = Rs. 3750 per day

The current practice in composting is aerobic type, which can be operated either manually or mechanically. In sub-tropical regions like Punjab with higher ambient temperature, stabilization, open windrow type of composting is preferred. The other factors affecting the system approach are cost of labor, energy, land and socio-cultural attitudes of the community. The waste would be kept in pre-fermentation yard for 21 days and turning of windrow would be carried out mechanically using a front-end loader at suitable time intervals to keep the process aerobic. Suitable drainage arrangement would be provided in the windrowing area. Arrangement would also be made for spraying of water on windrows to maintain required moisture content of the waste.

The proposed composting plant would have the arrangement of various components. These are:

1. Weighbridge: 50 ton capacity
2. Pre-fermentation windrows: approximately 2.7m wide at bottom and 1.5m height. Length of windrows would be such that one day's municipal solid waste would make one windrow.
3. Picking belt: would be used to transfer the waste from windrow to a hopper using hydraulically operated tractor – trailer loaded with the help of front end loader. From this hopper the waste would move on a picking belt moving on pulleys.
4. Speed reduction gear assembly that is provided with the driving unit controls speed of the belt. Stones plastic, rubber, leather, glass and metals are removed on this belt.
5. Air classifier (The picking belt would unload the waste into an air classifier through a hopper where inorganic portion would be separated from the organic matter).
6. Screen (The separated organic matter, the size reduction unit and the fines would go for windrowing in the maturation yard)
7. Maturation yard (Optimum moisture would be maintained in the windrows by spraying water and turning the windrows using front-end loader would carry compost would be screened and the fine tested for its fertilizing value.
8. Nitrogen, Phosphours and Potassium may be added to keep their desired level.

The details of cost analysis for this technology have been documented in Annexure V.

5.2.2 Sanitary Land Fill: The landfill gas technology can very effectively be utilized for disposing municipal solid waste that has relatively high organic content. In this technology landfill site acts as a bio-reactor in which gas is generated by decomposition of organic matter. It has been estimated that over a period of 10 years, one tonne of municipal solid waste can produce

gas more than 100 times its own volume. This gas consists of about 40-50% methane (CH_2) and 50-60% carbon dioxide (CO_2). The gas is extracted through gas wells via a network of perforated plastic tubes laid within the waste. From the wells, it is taken to a filter, compressor, monitoring units and then piped to the end user. This gas can be used directly for kiln, boilers and furnaces or to generate electricity.

This method also reclaims useless land. In case sufficient land is available, it should be considered as one of the options for disposal of municipal solid waste. The landfill gas technology will also facilitate a bridge between the present system of waste disposal and the technologies to be adopted in future.

Facility Components : The area surrounding Kartarpur has flat terrain in general wherein trench method of landfilling would be suitable. The proposed landfilling would be carried out as mentioned below:

Cells of 6 m depth having side slopes of 1:2 would be made by excavating the soil. A part of the excavated earth would be stored between the cells; sufficient to provide a final cover of 20cm over the waste filled in cells. Excess earth would be utilized for other works such as embankment or filling at some nearby location. Surface of the trench would be compacted using compaction machinery. No foreign material (clay) is required to provide lining, as the local earth would be sufficient for this purpose.

Waste material would be filled in these cells by compacting in layers. Planning would be such that each day's filling comes up to final level of filling.

In addition to the machinery of earthwork, other facilities that are required at the landfill site would be fencing (barbed wire fending of 2.0m height), Gate Office (for controlling entry and exit to the site along with a security post) weigh bridge (of 30 tonne capacity) office (100 sq.m.area). The office would have all sanitary and electric fittings along with water supply provision. Parking shed (about 500 sq.m. area would be provided for parking the vehicles and compaction machinery), and approach road (bituminous road of 7.0 m width from main road to the landfill site).

Gas Recovery: One year after deposition of waste, there will be generation of gaseous mixture comprising mainly methane and carbon dioxide, H_2O, and volatile organic gas. The gas generated would be recovered through the system of gas wells. The withdrawal of biogas will mainly comprise of i) well points, (ii) withdrawal mechanism, and iii) distribution network.

The details of cost analysis for this technology have been documented in Annexure VI.

6.0 FUTURE PROJECTIONS OF MSW

To estimate the manpower deployment, infrastructure required, capital investment needed, etc. for MSW management at any time in future, there is a need to estimate the solid waste generated at that time. For this, mathematical tools are used to project population and MSW generation in coming years. The calculations are documented in subsequent paragraphs. A lag period of 2 years is assumed which includes time for sanction of the project and its implementation. Considering 16 years as design period, population of the town has to be worked out in the year 2027.

6.1 Population Projection till 2027

The method and growth rate adopted for projecting the population is the same as we used for projecting the population in 2005. The following table gives us the population projection up to year 2027.

Year	Recorded Population	Floating Population	Total Population
2005	27146.83	3500.00	30,647
2007	28223.36	3669.04	31,892
2017	33819.43	3381.94	37,201
2027	40525.07	20262.54	60,788

As discussed earlier, from survey and meeting with councilors, floating population is assumed to be 3500 at the time of survey which comes out to be approximately 13% of the estimated resident population. Percentage of the floating population has been assumed as 13% for 2005-2007 and subsequently, we are tapering it to 10% and 5% respectively.

6.2 Projection of MSW Generation till 2027

Literature and field experience reveal that factors influencing quantity of municipal waste generation include:

- Season of the year
- Collection Frequency
- Extent of salvaging and recycling
- Public Attitude
- Legislation
- Characteristic of waste

The existence of salvage and recycling operations within the community definitely affects the quantity of waste collected for disposal. Literature reveals that in European and developed countries, significant reduction in

the quantity of solid waste generated occurs, when and if public and consumer oriented companies are willing to change on their own volition to conserve national resources and to reduce the economic burdens associated with the management of solid waste.

Further, there is no documentation available regarding the past trend of increase in per capita MSW generation for Kartrapur or other towns in the State of Punjab. Whereas NEERI based on their studies have suggested increase of 1.33% per annum in per capita waste generation for Indian cities.

From the literature, gathering experiences about MSW generation in developing and developed countries over time, it has been assumed that per capita solid waste generation would increase @ 1.33% per annum for maximum 10 years whereas after 10 years there will be no increase in per capita generation. Total quantity of MSW generation has thus been worked out by multiplying projected population in the particular year by rate of MSW generation in that year. Details of per capita waste generation and future quantity of MSW generation for kartarpur have been reported as under:

Year	Total Population	Per Capita Generation (g/day)	MSW Generation per day (tons/day)
2005	30,647	326	10.00
2007	31,892	334.73	10.68
2017	37,201	382.01	14.21
2027	60,788	382.01	23.22

7.0 PROJECT COST

The cost of the project has been assessed as Rs. 2.18 crores to cover the following four main components :

- **Segregation and storage at source** - It involves providing one HDPE bag to each unit (6500 in no.) for segregating recyclable and non-recyclable waste. Awareness campaigns would be launched to involve voluntary participations and strict compliance.

- **Primary collection** – This involves transportation of waste from source to the Primary Collection Centers (PCCs). This includes cost of tricycles required in transportation, construction of PCCs and containers required at the PCCs for collection.

- **Secondary collection** – This involves transportation of waste from PCCs to the processing & disposal site. Cost of the dumper placers used for transporting filled containers and an inspection vehicle to be used by the supervisor for inspecting PCCs has been accounted for here.

- **Processing and disposal** – Composting and landfilling technologies have been recommended for processing and disposal respectively. Details of the land requirement and thus cost involved are given in Annexures V and VI respectively.

- **Additional Costs** – This includes manpower requirement for overall MSW management, tools required and costs involved in e-governance (computerization) has been accounted for under this head.

Abstract of Cost

S.No.	Description	Estimated Costs (Rs.)
1.	Segregation and storage at source*	10.81 lacs
2.	Primary Collection*	62.95 lacs
3.	Secondary Collection*	17.5 lacs
4.	Processing & Disposal (Composting and Landfilling)*	108.25 lacs
5.	Councils Manpower required**	12.00 lacs
6.	Computerization*	6.5 lacs
7.	Tools required***	1.80 lacs
	Total	**218.01 lacs say 2.18 crores**

*: Details in Annexure IV
**: Details in Annexure VIII
***: Details in Annexure IX

LIST OF ANNEXURES

Annexure –I

Population & MSW Projections

Year	Population	Increase in Pop.	Incremental Increase	% Increase
1901	10,840			
1921	8512	-2,328		-21.48
1941	12,150	3,638	5,966	42.74
1961	12,202	52	-3,586	0.43
1971	14,644	2,442	2,390	20.01
1981	17,818	3,174	732	21.67
1991	21,093	3,275	101	18.38
2001	25,152	4,059	784	19.24
	Average	**3,238**	**539**	**19.83**

Present Population (2005)

Arithmetical Increase Method (Population in 2001 + average increase in pop. * 4/10)	26447
Geometric Increase Method (Population in 2001{1+(avg. % increase/100)*(4/10)}	27147
Incremental Increase Method {Population in 2001+ (avg. increase in population + avg. incremental increase)*4/10}	26662.6

Out of the above 3 methods of population projection, geometrical increase method is/will be adopted for future projections as it gives maximum projection. Further, this method is considered as most suitable for the town of Kartarpur which has vast scope of future development being the most industrialized town in the State. Hence, population of Kartarpur will be taken as 27,147 for the year 2005 for all estimates.

Projecting Population using the Geometric Increase Method

Year	Recorded Population	Floating Population	Total Population	% inc in floating pop
2005	27146.83	3500.00	30,647	assumed
2007	28223.36	3669.04	31,892	13%
2017	33819.43	3381.94	37,201	10%
2027	40525.07	20262.54	60,788	5%

Future Projection of MSW

Year	Total Population	Per Capita Generation (g/day)	MSW Generation per day (tons/day)
2005	30,647	326	10.00
2007	31,892	334.73	10.68
2017	37,201	382.01	14.21
2027	60,788	382.01	23.22

Annexure –II

Detailed Information from Residential Survey

: Sample data showing waste generation from residential area in Kartarpur :

Ward No.	No. of houses surveyed	Total No. of people in the families surveryed	No. of adults in the families surveyed	No. of children in the families surveyed	Total waste produced by houses surveyed (kg)	Per capita generation (kg)
13	9	63	55	8	5.5	0.087
10,11 & 12	7	37	28	9	9.25	0.25
8	9	55	50	5	12.75	0.232
5 & 7	9	55	51	4	13.77	0.246
14	10	64	57	7	20.25	0.316
Total	44	274	241	33	61.3	

Average Per Capita generation on the basis of survey (kg) = 0.2237 gms say 225 gms.

Total household waste generated by the entire population in Kartarpur in 2005 (Kg.)

= 0.225 x 30647
=6895 Kgs.
Say 7.0 tons

Annexure-III

Physical Analysis of MSW Sample done at landfill site by Council engineers alongwith Municipal Committee officials at Kartarpur

S.No.	Ingradient	Weight (gms.)
1	Biomass	1250
2	Cloth	2750
3	Paper	750
4	Polythene	1750
5	Plastic	350
6	Metal	250
7	Stones	1500
8	Glass	250
9	Vegetable waste	1500
10	Soil and Inert	8000
	Total	18350

Analysis of the sample at land fill site reveals that

1. Recyclabe material (Polythene, Plastic, Metal, Glass) = 13%
2. Compostable matter (Paper, Cloth, Biomass and vegetable waste) = 37%
3. Inert Inorganic material (Primarily drainage silt) = 50%

Annexure IV

PROJECT COST

S.No.	Description	Qty	Rate	Total
	Segregation and storage at source			
1	Purchase of HDPE Bag @ Rs. 24/- per unit for 20000 units	6,500	24	1.56 lac
2	Meetings to create awareness	30	15000 Ea.	4.50 lac
3	Cost of resource material (movies, posters, brochures etc.)			1.00 lacs
4	Visits to different places alongwith progressive citizens of Kartarpur (Vejalpur, Surat,Gujarat; Namakkal (AP) and Suryapet (AP)			3.00 lacs
5	Engagement of resource persons and expenses on their visit (Vejalpur, Surat,Gujarat; Namakkal (AP) and Suryapet (AP)			0.75 lacs
	Total			**10.81 lacs**
	Primary Collection			
6	Construction of PCC with Masonary Brick Wall, fencing and gate	15	3 lac	45 lac
7	Plantation at PCC	15	10000	1.50 lacs
8	Closed Container Tricycles	65	9000	5.85 lacs
9	4.5 cum capacity container (23 PCC + 5 for sweeping waste + 2 container)	22	40000	8.80 lacs
10.	Tools Required (Details in Annexure-IX)	-	-	1.80 lacs
	Total			**62.95 lacs**
	Secondary Collection			
10	Dumper Placer	2	7 lac	14 lac
11	Inspection vehicle (Gypsy)	1	3.5 lac	3.5 lac
	Total			**17.5 lac**

	Processing and Disposal			
12	JCB machine	1	18 lac	18 lac
13	Tractor with Dozzer Blade (swaraj 885 is successful)	1	5lac	5 lac
14	Installation of 30 tons capacity weigh bridge with provision of our Reon and weight platform	1	11 lac	11 lac
15	Composting (details in Annexure V)	-	-	45.00 lac
16	Sanitary Landfill (details in Annexure VI)	-	-	52.25 lac
	Total			**131.25 lac**
	Computerization			
17	Computers	4	25000	1 lac
18	Bio-metric machine	4	1.25 lac	5 lac
19	Software needed to be developed	--	50,000	0.5 lac
	Total			**6.5 lac**
20	Manpower required for Council activities (VIII)	-	-	**12.00 lac**
	GRAND TOTAL			**241.01 LACS Say 2.41 crores**

Annexure V

Requirement of composting arrangements

There are two options to treat the organic waste generated per day.

1. To send the organic waste to aerobic composting plant at Bariana, Jalandhar for composting.
2. To treat the organic waste by composting at Kartarpur itself.

1. Cost Estimates for composting at Bariana, Jalandhar :

There is 3.5 tons/day of compostable matter and transportation distance is 20 km one way.

Processing charges @ Rs. 1/kg = 1 * 3500 Rs. = 3500 Rs./day

2 tractor trolleys or dumper placers will be needed for transportation
Transportation charges = (40 km) / (10km/liter) * (30 Rs./liter) = Rs. 120
say Rs. 150 per tractor trolley

For 2 tractor trolleys = Rs. 300 per day.

Total expenses involved = Rs. 3500 + Rs. 300 per day
= Rs. 3800 per day

2. Cost Estimates for composting at Kartarpur :

Total waste generated per day (2005) needing to be disposed at landfill site

(30% of total) = 3.5 tons/day

Lag period = 2 years

Projection for 2007 = 3.59 tons / day

Projection for the next 16 years = 4.35 tons / day

Capacity of compost plant (3.59+4.35) x 0.5 x 365 x 16 = 23185 tons

Land required @ 1 hectare for 30000 tons = 23185 ÷ 30000 = 0.77 hec. (Say 1 Hectare)

Cost of the land is to be met by the MC. Capital cost (grading machine, weighing and packing machines) = 35 lacs

Cost of building/concrete plinth = 10 lacs

Total cost = 45 lacs

Annexure VI

Requirement of sanitary landfill site

TYPICAL EXAMPLE (PRELIMINARY DESIGN)

BASIC DATA

Location	:	Kartarpur
Waste Generation	:	4 T/day
Design Life	:	Active Period 16 Years Closure and Post Closure Period 25 Years
Topography	:	Flat Ground
Subsoil	:	Alluvial soil
Water- table	:	24m below ground surface
Average Total Precipitation	:	300mm with peak touching 1200mm
Base Year	:	2005

LANDFILL CAPACITY, LANDFILL HEIGHT, LANDFILL AREA

a) Current Waste Generation = 4 T/day

b) Estimated Waste Generation after 16 years = 7.10 T/day

c) Total Waste Generation in 16 years = 0.5 (4+7.10)x365x16= 32120 T

=

d) Total Waste Volume (assumed density 0.85 tonnes/cu.m)= 37788 ≈ 37800 m^3

= 0.1x37800

e) Volume of Daily Cover = 3780 cu.m

=

f) Volume of Liner and Cover Systems = 0.125 x 3780

= 4725

g) First Estimate of Landfill Volume

Ci = 37800+4725

= 42525 cu.m

h) Likely Shape of Landfill

Rectangular in plan (length : Width = 2:1

Primarily above ground level, party below ground level =

i) Area Restrictions = Nil

j) Possible maximum Landfill Height = 6m

k) Area Required = 42525/6= 7087 sqm
= 0.7 hectares

i) Approximate Plan Dimensions = 60x120m

LANDFILL SECTION AND PLAN

(a) Landfill Section and Plan is evaluated the basis of
  (i) 4:1 side slope for the above-ground portion of the landfill
  (ii) 2:1 side slope for the below-ground portion of the landfill
  (iii) Material balance for daily cover, liner and final cover material through excavation at site.
  (iv) Extra space around the waste filling area for infrastructural facilities.

(b) The final plan and section adopted is shown in Fig. attached

(c) Additional 30m land is acquired around the landfill to place infrastructure facilities.
Final size of landfill = 120x180 sqm

LANDFILL PHASES

(a) Active life of landfill = 16 years

(b) Duration of one phase = 1 year

(c) Number of Phase = 16, Each phase extends from base to final cover

(d) Volume of one phase = 42525/16=2660 cu.m

(d) Plan area of phase
= 2660/6= 443 sqm (15x30 m)
=

(f) Number of daily cells = 365

(g) Plan area of one cell/on the bases of 1.0m lift of each cell
= 2660/365sqm= 7.3 sq.m
= 2x4 m

Landfill phases are shown in diagram attached

LANDFILL INFRASTRUCTURE & LAYOUT

a) Site Fencing : All around the landfill

b) Weighbridges (computerised) : Two weighbridges of 30 t capacity (entry and exit) with office

c) Administrative office : 10x10 m building

d) Site control office : 3mx5m (Portable cabin)

e) Access Roads :
  (i) Main Access Road : 7m wide; from main road to parking area after weigh bridge.
  (ii) Arterial Road : 3.5 m wide all along the periphery.

(f) Waste Inspection and Sampling Facility :
(g) Equipment Workshop & Garage : 10 x 10 m building
(h) Vehicle Cleaning : within the workshop
(h) Other Facilities
(a) Temporary Holding Area :Excavated portion of half phase to be used
(b) Surface water drain : Adjacent to arterial road along periphery
(c) leachate collection pipe : Adjacent to arterial road along periphery

(d) Leachate holding tank : 6x3.3x3m
(e) Leachate treatment facility : 10x10 (in plan) (tentative)
(f) Gas Flaring facility : 5x5 (in plan) (tentative)
(g) Surface water sedimentation tank : 15x 6x1.5m (3 hrs. capacity)

Liner and Leach collection system

a) Liner System
The liner system will comprise of the following layers below the waste:

(i) 0.30m thick drainage layer comprising of Ghaggar sand (coarse sand) or gravel (stone dust win no fines)
(j) 0.2m thick protective layer of sandy silt
(v) 1.50 mm thick HDPE geomembrance
(vi) 1.0 m thick clay layer/amended soil layer (when clay is not easily available, amended soil layer comprising of local soil + bentonite is proposed)

b) Amended Soil Layer Design Through Laboratory Testing
Sandy silt mixed with bentonite in proportions of 2,4,6,8 and 10% in laboratory and premeability determined of less than 10^{-9} m/sec. 5% bentionite +sandy silt assumed in preliminary design.

c) Leachate Evaluation
Average Total Precipitation in Kartarpur = 300mm/year
Only one year phase is operative every year =
Plan area of operating phase =3000 sqm
Assuming 80% precipitation in 4 months (monsoon period), peak leachate quantity (thumbrule basis) = 20 cu.m/day (to be confirmed by consultants)

d) Leachate Collection Pipes
Dia of HDPE pipes (perforated) = 15cm
Spacing of pipe required = 10m

e) Leachate Holding Tank

Size of holding 3 days of leachate = 6x3.3x3m

Cover system design

a) Cover system
The cover system will comprise of the following layer above the waste.

(i) 0.45m thick gas collection layer comprising of gravel (stone dust with no fines)
(ii) 0.6m thick barrier layer (sandy silt+5% bentonite)
(iii) 0.3 m thick surface layer of local top soil for vegetative growth

b) Passive Gas Vents
Passive gas vents 1m high (above ground surface) will be provided at a spacing of 30mx30m.

SURFACE WATER DRAINAGE SYSTEM

a) Surface Water Runoff

Average Total Precipitation in Katarpur = 300mm/year
Peak discharge rate reaching drainage channel = 0.02 cu.m/sec.
Dimensions of drainage channel:
Depth = 0.6m
Base width 0.6
Side slopes 3:1

b) Sedimentation Tank

To remove suspended particles of size 40 microns and above tank size required
= 15x6x1.5

ENVIRONMENTAL MONITORING SYSTEM

a) Ground Water Monitoring Wells
Numbers = 6 (I upgradient well : 5, well along the sides in downgradient direction; all wells 30m away from landfill)

b) Lysismeters
Numbers = 2 (under each phase (Total No. 32)

c) Gas Monitor
Two portable gas monitors for landfill gas

d) Samples
Stainless steel/HDPE samples (15 nos.) for
(i) Groundwater samples
(ii) Leachate samples in vertical risers/wells

Grab samplers for landfill gas (10 nos.) at
(i) Passive vents
(ii) Gas wells

e) Downhole Monitors
One multiparameter downhole groundwater monitoring system.

ESTIMATION OF LANDFILL COST BASED ON PRELIMINARY DESIGN

TABLE 1 : SITE SELECTION AND SITE CHARACTERISATION COST

Sl. No.	Item	Cost Rs x 10^5
1.	Data Collection	0.25
2.	Environmental Impact Assessment	2.00
3.	Preliminary Bore Holes	0.25
4.	Geotechnical Investigation for Design, Borrow Material, Ground Water Investigation	1.00
5.	Topographical Investigation	0.25
6.	Hydrological Investigation	0.25
7.	Geological Investigation	0.25
8.	Traffic Investigation	0.25
9.	Water and Leachate Investigation	0.50
	Total	**5.00x10^5**

Note : *This estimate is lumpsum and approximate. The values are indicative. However, actual costs will vary from site to site and should not be restricted by the range indicated in the table.*

TABLE 2 : DESIGN AND DETAILED ENGINEERING COST

Sl. No.	Item	Cost Rs x 10^5
1.	Design and Detailed Engineering	**3.00**

Note : *This estimate is lumpsum and approximate. The values are indicative. However, actual costs will vary from site to site and should not be restricted by the range indicated in the table*

Table 3

Sl. No.	Item	Cost Rs x 10^5	Cost Rs x 10^5
1	Land Acquisition*	**17.5**	
2	Cost of Infrastructure		20
3	Equipment for Landfill Construction/Operation**	20	
4	Surface Water Drainage System		3
5	Leachate Management Facility		1
6	Environmental Monitoring Facility		1
7	Gas Collection Facility		
	Total		**25**

* land acquisition cost willvary drastically from location to location; market value indicated but not included in costing.

** Equipment cost indicated but not included in costing since all earthwork/ waste placement work are computed on job basis.

*** Not included in the example but to be taken into account whenever gas is collected for energy recovery / flaring.

Table 4: Phase development Cost (yearly)

Sr. No.	Items	Cost Rs x 10^5
1	Up-dated Design of Phase	0.50
2	Preliminary Operation	3
3	Temporary Surface Water Drains	0.25
4	Monitoring Facility Below Liner	0.25
5	Liner System	3.00
6	Leachate Collection and Removal System	1.00
7	Maintenance of Existing Facility	1.00
	Total	**9.00**

TABLE 5: PHASE OPERATION COST (YEARLY)

Sr. No,	Items	Cost Rs x 10^5
1	Waste Filling, Spreading and Compaction	3
2	Daily Cover Laying, Spreading and Compaction	.5
3	Pollution Prevention During Operation	0.25
	Total	**3.75**

TABLE 6: PHASE CLOSURE COST (YEARLY)

Sr. No.	Items	Cost Rs x 10^5
1	Final Cover System	3
2	Surface Water Drainage System on Cover	1
3	Monitoring Facility on Cover	0.25
4	Vegetation Growth on Cover	0.25
	Total	**4.5**

Table 7: POST CLOSURE CARE COST (YEARLY)

Sr. No.	Items	Cost Rs x 10^5
1	Long Term Vegetative Stabilization	0.5
2	Operation of Leachate Management Facility	0.5
3	Maintenance of Cover and Drainage System	0.5
4	Environmental Monitoring	0.5
	Total	**2.00**

Table 8: INITIAL FIXED COST

Sr. No.	Items	Cost Rs x 10^5
1	Site Selection and Site Characterisation Cost (Table 1) Average	5
2	Design and Detailed Engineering Cost (Table 2) Average	3
3	Site Development Cost (Table 3)	25
	Total	**33**

Table 9: YEARLY RUNNING COST (ACTIVE)

Sr. No.	Items	Cost Rs x 10^5
1	Phase Development Cost (Table 4)	9
2	Phase Operation Cost (Table 5)	3.75
3	Phase Closure Cost (Table 6)	4.50
	Total	**17.25**

Table 10: YEARLY RUNNING COST (POST CLOSURE)

Sr. No.	Items	Cost Rs x 10^5
1	Post Closure Care Cost	2
	Total	**2**

TOTAL COST : 52.25 LACS

Annexure VII

Manpower requirement (To be borne by Municipal Council)

S.No.	Name of Activity	Mandays
1.	Safai-Sewaks	52 (assuming 6,500 units assuming each safai-sewak serving 125 units)
2.	Chowkidars at PCCs	15(15 PCCs and one at each PCC)
3.	Street Sweepers	13 (26km length assuming each sweeper sweeps 2km)
4.	Supervisor / Mates	6 (one per 15 workers: includes safai-sewaks and sweepers)
5.	Drivers & Helpers	8 (one shift, 4 driver & helper for dumper placers; 4 driver & helper for tractor trolley)
6.	Staff at Compost Plant, Disposal Site and Back-up Staff	16
	Total	**110**

Note:-

As already discussed in the report, 46 workers are already working with the Municipal Council and additional manpower of 64 workers will be engaged from the rag-pickers, widows and un-employed people through an NGO. The Municipal Council will pay these workers @ Rs.10/- per house + Rs. 1/- per house for the supervisor. The recyclable material collected by these workers will be the property of these workers.

Annexure VIII

Council's Manpower requirement for overseeing the project

S.No.	Name of Activity	Mandays				
		Addl. Dir. @ 4,000/day	**PSO @ 3,500/day**	**APE @ 1,500/day**	**PA @ 800/day**	**Secretarial Assistance 1,400/day**
1.	Awareness	5	10	20	30	30
2.	Selection & Freezing of Disposal sites	10	10	15	20	-
3.	Detailed designing including drawing preparation & preparation of estimates	15	15	20	30	30
4.	Preparation of DNIT and invitation of tenders and tender finalization	10	10	20	30	30
5.	Supervision during execution of the project	10	15	50	60	-
6.	Commissioning and operation & maintenance for 2 years	30	30	50	60	-
	Total	**3.20 lacs**	**3.15 lacs**	**2.47 lacs**	**1.84 lacs**	**1.26lacs**
	GRAND TOTAL				**11.92 lacs say 12.00 lacs**	

Annexure IX

Tools required

Description	Qty Reqd.	Life	Reqd./year	Rate	Total
Brooms	28	One/month	256	20	5,120
Kahi	30	One/4 month	90	100	9,000
Basket	30	One / 2 month	180	50	9,000
Funjar	33	One / 4 month	99	50	4,950
Uniforms	110	One / year	110	1000	110000
Appron	88	One / year	88	50	4,400
Gloves	99	One / month	1101	30	33,030
Mask	85	One / year	85	40	3,400
Total					**1,78,900**
					Say 1.80 lacs

I N D E X

Senior Environmental Engineer,
Punjab Pollution Control Board,
Nabha Road,
Patiala.
(Punjab).

Kind Attn: Shri D.K. Dua, Senior Environmental Engineer

Subject **Implementation of the provision of Municipal Solid Waste (Management & Handling) Rules, 2000 – Installation of demonstration facility**

With reference to your letter no. SEE(EPA)205/F.No/Gen MSW/8/7893 dated 7.6.205 on the above mentioned subject, please find enclosed herewith the updated DPR for Solid Waste Management for the town of Kartarpur for further action at your end.

Additional Director (CC)

Encl: As above