PART *III*

Feasibility Study for the Priority Projects

Chapter 9

Pilot Project

9 Pilot Project

9.1 Plan of Pilot Project

9.1.1 Objectives

The M/P projects may encounter many difficulties when they are implemented. To determine the problems that may arise and to find a way to overcome these difficulties, pilot projects were conducted during the course of this study with the Turkish counterparts. The objectives of the pilot projects are summarised below.

1. To assess the feasibility of the technical system proposed in the M/P (i.e., feasibility of separate collection, etc.).
2. To acquire base data so that the design outline of the F/S can be devised (i.e., rehabilitation and closure of present open dumpsite, improvement method of compost quality and verification of its marketability, etc.).
3. Raise public awareness and increase public participation in SWM.
4. Demonstrate improvement measures to residents and authorities concerned with SWM.

9.1.2 Selection of Pilot Projects

a. Experiment on Sofulu Disposal Site Improvement

Regardless of the scenario selected for the M/P, the sanitary landfill would still be given highest priority in this study. The numerous problems, therefore, that are foreseen to arise with the rehabilitation and closure of the present open dumpsite should be overcome. Because the relevant agencies, including the MoE, are strongly requesting the adoption of a realistic, feasible method, the development and proposal of methods that are agreeable to these agencies, both in terms of advantages and disadvantages, are highly crucial. The study team and Adana GM, therefore, decided to urgently improve the present disposal site at Sofulu as a pilot project with the co-operation of relevant Turkish agencies.

b. Experiment on Separate Collection and Compost Quality Improvement

The MoE published an “Environmental Manual for Municipalities (Belediyeler Icin Cevre El Kitabi)” in 1998. In the manual the ministry expresses their intention to recycle more than 90 % of municipal solid waste (MSW) by reuse, recycling and recovery. The Turkish Solid Waste Regulation, amended in September 15th, 1998, obliges separate waste collection to municipalities. Furthermore, in the SWM M/P of the target cities the recycling of kitchen waste (by composting), constituting more than 63 % of the MSW composition, is one of the most important issues. It is therefore important to identify the feasibility of the separate collection but proving the appropriateness of these undertakings is a major issue. The study team and Mersin GM decided to improve the existing compost plant and its production method, to introduce the separate discharge and collection of compostable and non-compostable wastes, and to install a recovery line for non-compostable waste to determine whether

the compost's quality will improve. In addition, the verification of compost marketability was also conducted.
The pilot projects were conducted in the second and third study works in Turkey (mid-February 1999 to mid-April 1999, and beginning of May 1999 to mid-June 1999). However, the sanitary landfill operation at Sofulu disposal site and improved compost production were continued by Adana GM and Mersin GM respectively.

9.1.3 Implementation Schedule

The pilot projects were conducted in the second and third study works in Turkey (mid-February 1999 to mid-April 1999, and beginning of May 1999 to mid-June 1999), as shown in the table below. However, the sanitary landfill operation at Sofulu disposal site and improved compost production were continued by Adana GM and Mersin GM respectively.

Table 9-1: Implementation Schedule of the Pilot Project

Item	98 Dec	99 Jan	99 Feb	99 Mar	99 Apr	99 May	99 Jun	99July	99 Aug
1.Draft Plan	■	■							
2.JICA Approval		▲							
3.Preparation Tender Document			■	■					
4.Contract					▲				
5-1. Sofulu Improvement by the JICA team					■	■	■		
5-2. Sofulu Improvement by the AGM					■	■	■	■	■
6.-1 Separate Collection and Compost Quality Improvement by the JICA team						■	■		
6.-2 Separate Collection and Compost Quality Improvement by the MGM						■	■	■	■

9.2 Experiment on the Improvement of the Sofulu Disposal Site in Adana GM

9.2.1 Background

Sofulu Landfill is located 10 km north of Adana city centre next to Old Kozan Road as shown in Figure 9-1. The figure indicates the present city plan for Adana. A new housing area (high density) will be constructed immediately to the west of the landfill and another one (scattered) to the north of the landfill.

The operation of the Sofulu dump site started in 1990 but no precautions whatsoever were taken to protect the environment. The landfill has operated as a simple open

dump for ten years, and people have been complaining for many years because of the continuous smoke coming from the landfill.

9.2.2 Plan of the Experiment

a. Targets

The targets of the improvement by the experiment are summarised as follows:

- Extinguish fire,
- Control and minimise leachate generation
- Minimise adverse impacts other than the fire and leachate

b. Plan of the Experiment

b.1 Overall Plan

In order to combine the rehabilitation work and the future use of the Sofulu site as a sanitary landfill , an overall plan was prepared as shown in Figure 9-2. The Sofulu disposal site will be developed and operated in 3 phases. Phase 1 is the main improvement target area of the experiment. Cross section A-A in Figure 9-3 indicates mounting up of the dumped area, necessary for the minimisation of leachate generation and for the site's future land use.

b.2 Leachate control system

Adana city's annual rain fall is 650 mm, as opposed to evaporation of 1,600 mm, a 2.4 times difference. A pilot facility was constructed at the disposal site to verify the effectiveness of the leachate treatment system that uses this precipitation/evaporation differential. A brief outline of the leachate circulation system is as follows.

Leachate from Landfill➔Main Leachate Drain➔Regulation Pond

➔Pump Station➔Leachate Pipe➔Valve & Leachate Feeding Drum➔

➔Leachate Feeding Drain➔ Landfill

b.3 Fire Prevention

The following fire extinguishing measures, included in the design, were countermeasures to extinguish spontaneous fires at the site.

- Sprinkling of water
- Flatting steep slope
- Soil covering

b.4 Other Measures

- Gas removal facility
- Drainage facilities to block rainwater intrusion from outside of the disposal area
- Mitigation of adverse impacts on the surrounding environment (A green belt, approximately 30m wide, was constructed at the disposal site facility.)

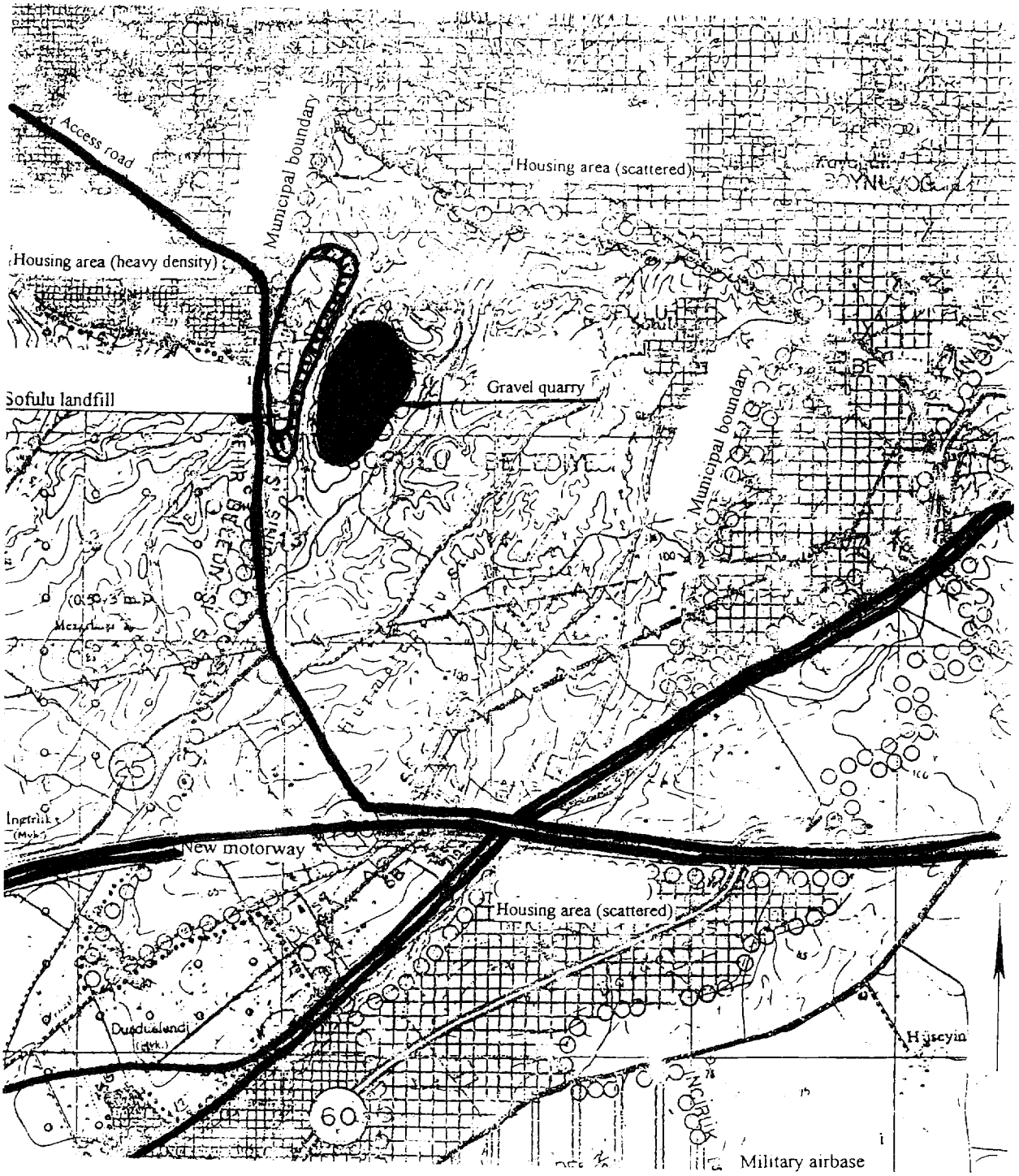

Figure 9-1: Location, Adana City Master Plan 1996

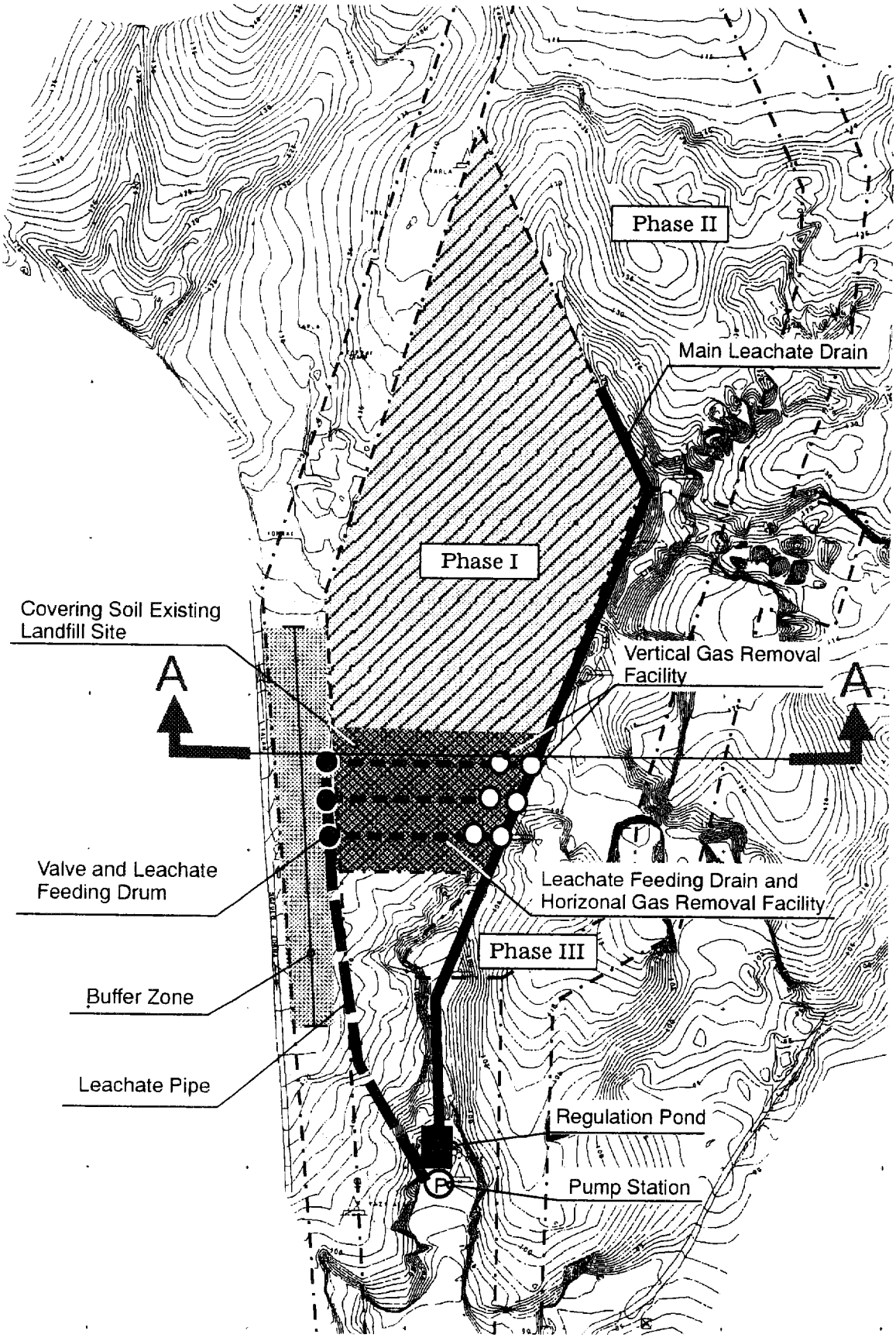

Figure 9-2: Overall Plan of the Experiment on the Improvement of Sofulu Disposal Site

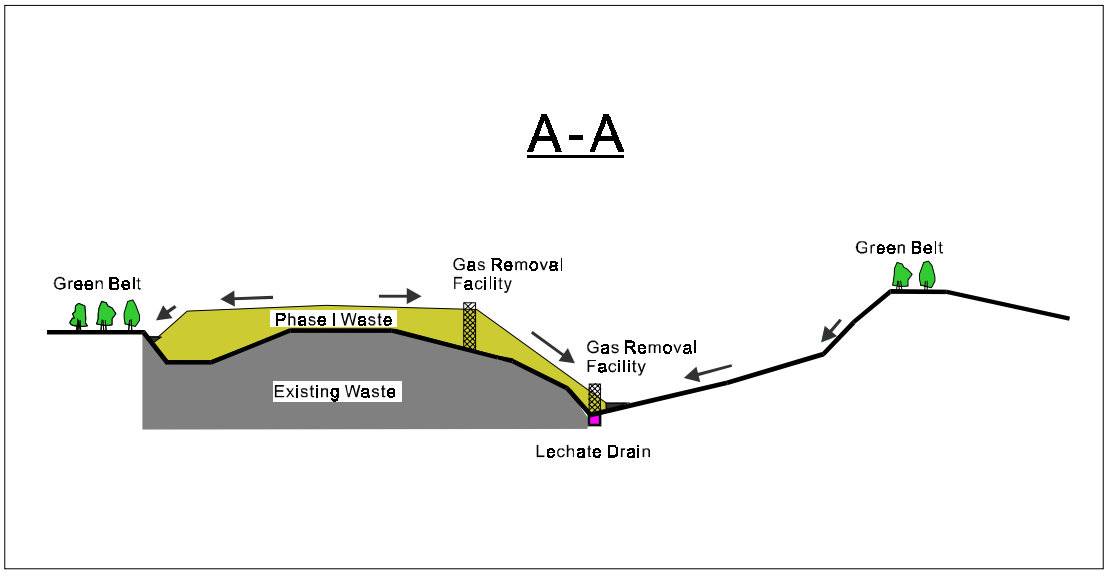

Figure 9-3: Cross Section of Phase 1 Landfill Operation

9.2.3 Implementation of the Experiment

a. Division of the Work

The experiment was conducted in collaboration with the Adana GM and the JICA study team as follows:

Table 9-2: Work Division of the Sofulu Disposal Site Improvement

Work Items	Machinery & Facilities Requirement	Responsible Body
1. Leachate control	Leachate drains Regulation pond Pumping station Circulation facility	JICA
2. Fire extinguishing • Flattening steep slope • Soil covering and sprinkling of water	Heavy machinery, dump truck, fire trucks	Adana GM
3. Prevention of spontaneous fires	Gas removal facilities	JICA
4. Reduction of leachate generation	Drainage facilities to stop rainwater infiltration from outside of the area	Adana GM
5. Mitigation of adverse impacts on surrounding environment	Buffer zone	Adana GM

b. Implementation Schedule

The experiment was conducted according to the schedule as shown in the following table. The works to be done by the team, such as leachate control facility, etc., were completed by mid-June 1999. The Adana GM has continued their works and completed them by mid-September. Even after the experiment Adana GM has continued sanitary landfill operations at the Sofulu disposal site.

Table 9-3: Implementation Schedule of the Sofulu Improvement

Work Items	99 Apr	99 May	99 Jun	99 July	99 Aug	99 Sep
1. Leachate control						
2. Fire extinguishing						
3. Prevention of spontaneous fires						
4. Reduction of leachate generation						
5. Mitigation of adverse impacts on surrounding environment						
6. Assessment of the improvement work by a questionnaire survey to the people						

9.2.4 Findings

There are significant improvements achieved at the Sofulu dump site by the experiment. In addition, many important experiences/data were obtained through it, which are presented below.

a. Urgent Need of Soil Cover

Although there are many important issues for the sanitary landfill, as stipulated in the Turkish Solid Waste Control Regulation, the most critical matter is soil covering. As everybody notices the major adverse impact of the Sofulu dump site is the fire and smoke and it could not extinguish without cover soil on the waste disposed. In this experiment a part of the Sofulu dump site has been covered by soil and it stopped the fire and smoke from that part. However, the other parts of the landfill are still uncovered and create fire/smoke. Although it costs a lot, the Adana GM understood importance and urgent needs of soil cover through the experiment.

b. Unloading Operation

Although the MoE (Ministry of Environment) is strongly requesting municipalities in the country to adopt a sanitary landfill which should not cause fire and smoke. However, most of the municipalities in the country are suffering from the smoke of the landfill including the capital Ankara. As far as the team observed the fire/smoke are occurred at steep slopes on which soil cover could not be done. These steep slopes are created because waste unloading operation is done at the upper part of the landfill. Through the experiment the Adana GM experienced the principal waste unloading operation should be done from the bottom of the landfill which requires access road to the working face.

c. Leachate Circulation System

One of the most important issue of the experiment is to find out the applicability of a leachate circulation system as a leachate treatment method for the rehabilitation of the dump site. Since the leachate circulation system constructed in the experiment is a temporary one, it can prevent leachate from discharging into public water courses in

dry season, i.e., from April to October. For the prevention of leachate in rainy season it requires expansion of the regulation pond volume and pumping capability. The system works very well in dry season and the construction cost of the system is very cheap, about a little bit over US$ 100,000. The team considers it might be an applicable and cheap method for the rehabilitation of open dump sites. Because the final soil cover and storm water drains to be done by the rehabilitation can reduce the amount of leachate generation.

9.3 Experiment of the Separate Collection and Compost Quality Improvement in Mersin GM

9.3.1 Background

The MoE intends to recycle 90% of MSW. In order to realise this target it is indispensable to recover organic waste, especially kitchen waste, which occupies more than 60% of the MSW in the target cities.

The MoE states in the Environmental Manual for Municipalities that composting is the most suitable method of the organic waste recycling. In Turkey two composting plants have been constructed and are operated in Izmir and in Mersin Greater Municipalities. However, the performance of the two plants could not be sufficient. It might be main cause of bad performance that both municipalities do not apply separate collection system for composting.

As concluded from the results of the interviews with the farmers in the first study work in Turkey, the quality of composts produced at the present Mersin composting plant is very poor, which is mainly why farmers stop to use the product. Therefore, the improvement of compost quality by the experimental separate collection, etc. has been carried out as pilot project in the second and third study works in Turkey.

9.3.2 Plan of the Experiment

Main works and the roles of the study team and Mersin GM are summarised in the table below.

Table 9-4: Outline of Experiment on Separate Collection & Composting Quality Improvement and Division of Work

Items	Outline	Equipment & Materials	Responsible Body
Separate Collection	Gain residents' co-operation	Installation of a notice requesting for co-operation Preparation of pamphlets Holding assemblies and meetings	JICA JICA Mersin GM
	Implement separate collection	Distribution of plastic bags Installation of containers for separate collections Collection of segregated waste	JICA JICA Mersin GM
Compost Quality Improvement	Improvement of existing facility	Installation of recovery lines for non-compostable waste	JICA
	Recovery of non-compostable waste	Allocation of several workers	Mersin GM
	Facilitation of fermentation	Mixing and moistening of compost	Mersin GM
	Improvement of the management of the compost plant	Preparation of operation manual	JICA
	Pilot project assessment	Survey on compost market and the appropriate price of compost	JICA

9.3.2 Implementation of the Experiment of the Separate Collection

a. Implementation Schedule

The experiment of the separate collection was conducted according to the following schedule:

Table 9-5: Implementation Schedule for Separate Collection

Activities	May																June							
	Week 1				Week 2				Week 3				Week 4				Week 1				Week 2			
Separate Collection (May 10 – May 9)																								
1. Gain Resident's Co-operation																								
a. Installation of notice/signboard	■																							
b. Distribution of leaflets No.1 & No.2	■																							
2. Implementation of Separate Collection																								
a. Distribution of plastic bags				■								■												
b. Installation of waste bins				■																				
c. Installation of containers				■																				
d. Waste separation at source					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
e. Collection of C & NC wastes						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
f. Monitoring of separate collection activities						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
3. Assemblies and Meetings with the Residents																								
a. Meeting with president of the GSHC	■		■																					
b. Meeting with the residents of the GSHC				■			■											■						

b. Public Education to Gain Resident's Co-operation

b.1 Objectives

The main objective of the public education and co-operation programs is to raise public awareness on SWM issues through the proper waste handling practices (reuse,

reduction and recycling), to promote common responsibility for sustainable development and particularly the city environment in co-operation with the citizens.

In order to achieve the objectives, the followings are proposed:

- Raise public awareness on SWM issues.
- Introduce public co-operation and participation as a mean of keeping the city environmentally clean.

b.2 Experiment to Promote Separate Collection System for Composting

The main objective of the pilot project "Compost Quality Improvement and Separate Collection" is to investigate a possibility of the introduction of a separate refuse collection system and gain public co-operation.

Public education and co-operation on SWM is meant to let the public know all about the production and management of refuse. This is achieved by providing information about the origins, linkages and consequences of the problem on solid waste, with the objective of enlightening the minds of the public and eventually, gaining their co-operation and support.

b.3 Public Education through Meetings and Assemblies

The meetings were consisted on the followings:

- Explain why it is necessary to separate wastes.
- Instruction for proper discharge of compostable and non-compostable wastes.
- Appropriate use of plastic bags, dustbins, waste bins, and containers for compostable and non-compostable wastes.

b.4 Education Book

The education book has been published to draw the attention of close linkage between the living environment and the waste. It emphasises the benefits to be obtained if care is devoted to achieve the followings three simple targets:

1. Minimising the waste quantity.
2. Recycling the waste.
3. Landfilling the unrecyclable waste in a way that not harms the environment.

c. Implementation of Experiment on Separate Collection

c.1 Selection of the Experiment Site

Guven Sitesi Housing Complex (GSHC), located in Guvenevler "mahalle" (ward) at the south-east sector of Yenisehir district was selected as an experimental site for the separate collection by the team and counterpart due to the following reasons:

- As an experiment certain scale of population is necessary. The GSHC has 25 buildings of ten stories in an area of approximately 4.6ha. as shown in Figure9-6. In total 1,000 households and 5,140 residents (about 1% of whole population of Mersin GM) living the complex.

- There is enough space for the installation of containers for separately discharged compostable waste without disturbing current refuse collection system.

c.2 Gain Resident's Co-operation

In order to obtain resident's co-operation for separate discharge of compostable and non-compostable wastes the team and counterpart conducted the following works:

- Installation of a notice board to ask co-operation of the residents of the Guven Sitesi Housing Complex and inform general public in Mersin Greater Municipality about the separate collection experiment.
- Delivery of pamphlets and education books to instruct the residents of the GSHC to conduct a proper separate discharge of their waste.
- Holding assemblies and meetings with the residents and their representatives.

c.3 Implementation of Separate Collection

The separate collection was implemented for one month (from May 10 to June 9, 1999). Prior to the commencement of the separate collection experiment the team and counterpart conducted the following activities:

- Distribution of green plastic bags which shall be used by households for the separate discharge of compostable waste.
- Distribution of waste bins which shall be used by "kapicis" (doorkeepers: who take care of waste collection from households of each building) for compostable waste collection.
- Installation of new colours green containers for compostable waste for collection service. Current containers are used for the collection of non-compostable waste.

The following figure shows the location of green plastic containers (for compostable wastes) besides the existing metal containers (for non-compostable wastes). Every two buildings (80 householders) as illustrated in the figure use both containers (green plastic and silver metallic). Also, waste bins (for compostable) provided for the experiment are placed at every stair landing area together with the existing ones for non-compostable wastes, which are used by 4 householders. The wastes discharged by the householders into the separated waste bins are collected by the doorkeepers and disposed into the corresponding containers installed outdoor in the complex. Later the compostable wastes and non-compostable wastes are collected separately by the private contractors and bringing them to the existing composting plant and landfill respectively.

Figure 9-4: Guven Sitesi Housing Complex (GSHC) and Location of Containers

9.3.3 Implementation of Experiment on Compost Quality Improvement

a. Implementation Schedule

The experiment of the compost quality improvement was conducted for 5 months from April to August 1999

Most of experiment work were conducted in the third study works in Turkey (11 May to 10 June 1999) in accordance with the schedule shown in the Figure below.

Table 9-6: Implementation Schedule for Compost Quality Improvement in Mersin (1999)

Outline	Second Study Work in Turkey						Third Study Work in Turkey						Second Study work in Japan																	
	April						May						June						July						August					
1. Improvement of Existing Facility																														
a. Installation of recovery line for non-compostable waste							■	■																						
2. Recovery of non-compostable waste																														
a Allocation of 2-3 workers for non-compostable waste									■	■	■																			
b. Allocation of 1 worker to pick up harmful waste to he plant												■	■	■																
3. Facilitation and Fermentation																														
a. Arrangement of equipment for turning and watering									■	■	■	■	■	■	■	■	■	■	■	■										
4. Improvement of the management of the compost plant																														
a. preparation of operation manual	■	■	■	■	■	■	■	■																						
5. Monitoring compost Quality																														
a. Installation of small laboratory							■	■																						
b. Implementation of laboratory test									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
6. Pilot Project Assessment																														
a. Compost Market Survey																														
b. Chemical Analysis of compost in a formal laboratory																										■	■	■	■	

b. Monitoring the Pilot Project Implementation

b.1 Co-operation of Turkish Side to the Experiment

Municipal waste collection service in Guven Sistesi Housing Complex(GSHC) has been conducted by the private company based on the contract with the Yenisehir District Municipality(YDM). A collection vehicle for compostable waste is scheduled to get to the GSHC at 7:00 am. The punctuality performance of vehicle's arrival time was very good. The time error was within only 5 minutes during experiment period.

b.2 Monitoring the Compost Quality Improvement

b.2.1 Discharge of Wastes of the GSHC

Yenisehir District Municipality(YDM) has been extending public waste collection service to GSHC seven days/week even national holidays. Since the disposal site is under the control of MDM, the hauled weight is measured for five days/week from Monday to Friday. It is not measured on Saturday and Sunday, because these days are off duty for disposal site workers employed by MGM.

The doormen of GSHC, who collect the waste discharged by residents at a stair landing area and discharge it into the container for public collection service are off duty on Sunday. Thus, compostable waste discharge amount is naturally smaller on Monday. Data of the first day data was omitted because of residents' unfamiliarity to the separate collection. Therefore, total 23 days data was used to analyse the experiment.

i. Waste Discharge Ratio of GSHC

GSHC is regarded as middle income residential area. The waste discharge ratio of GSHC is 420 grams/person/day taking into account the population 5,140 as shown in Table9-6. This value is considered reasonable, because the value is between middle (477gram/person/day) and low income(391gram/person/day) residential area which was clarified in WACS in 1998.

ii. Difference of Discharge Ratio between Compostable and Non-compostable Waste

According to table below, compostable waste occupies 49.1 % and non-compostable waste 50.1 %. On the other hand, the value was 71.8 % in the WACS carried out in 1998. The difference of about 20 % is considered mainly due to incomplete separation of compostable waste and non-compostable waste.

Table 9-7: Composition of Compostable Waste and Non-compostable Waste (1999)

Date		Compostable waste (A) (kg)	Non-compostable waste (B) (kg)	Total (A)+(B) (kg)	Ratio (A)/((A)+(B)) (%)
May 12	Wed.	600	900	1,500	40.0
13	Thu.	1,100	800	1,900	57.9
14	Fri.	1,000	1,200	2,200	45.5
17	Mon.	400	1,640	2,040	19.6
18	Tue.	1,600	1,100	2,700	59.3
20	Thu.	950	1,200	2,150	44.2
21	Fri.	1,300	1,200	2,500	52.0
22	Sat.	1,100	700	1,800	61.1
23	Sun.	900	800	1,700	52.9
24	Mon.	400	1,400	1,800	22.2
25	Tue.	1,600	1,200	2,800	57.1
26	Wed.	1,000	1,100	2,100	47.6
27	Thu.	1,260	770	2,030	62.1
28	Fri.	1,100	1,000	2,100	52.4
31	Mon.	120	1,290	1,410	8.5
June 1	Tue.	1,900	1,000	2,900	65.5
2	Wed.	630	1,400	2,030	31.0
3	Thu.	1,000	900	1,900	52.6
4	Fri.	1,040	900	1,940	53.6
7	Mon.	1,490	1,830	3,320	44.9
8	Tue.	1,600	1,030	2,630	60.8
9	Wed.	1,070	780	1,850	57.8
10	Thu.	1,180	1,050	2,230	52.9
Total		24,340	25,190	49,530	49.1
Discharge ratio of GSHC				420 g/person/day	

iii. Moisture Content of Compostable Waste at Collection Point of GSHC

Water content of compostable waste was measured by using the sample of waste on the conveyor belt discharged from feed hopper. However, by visual observation, considerable amount of water flows out not only from the pre-treated compost production line but also while compostable waste is dumped to the feed hopper from collection vehicle at the compost plant. Therefore, modification is made on the moisture content value at the time the collection vehicle arrives at weigh-bridge of final disposal site as shown in the table below.

As shown in the table below, the Moisture content after pre-treatment is 56% on average.

Table 9-8: Estimate of Moisture Content of Compostable Waste on Collection Vehicle's Arrival at the Weighbridge of Disposal Site (1999)

Date			Compostable waste (kg)		Moisture Content (%)	
			Compostable Waste	Pre-treated material	Pre-treated material	Compostable Waste
May	18	Tue.	1,600	820	65	82
	26	Wed.	1,000	370	65	87
	27	Thu.	1,260	700	53	74
	28	Fri.	1,100	820	59	70
June	1	Tue.	1,900	1,490	59	68
	2	Wed.	630	600	53	55
	3	Thu.	1,000	760	44	57
	4	Fri.	1,040	860	44	54
	8	Tue.	1,600	1,190	58	69
	9	Wed.	1,070	840	55	65
Average			---	---	56	68

iv. Ratio of Rejected Non-compostable Material in Compostable Waste

As shown in the following table the weight ratio of non-compostable material mixed with compostable waste is 7.5%. The value is approximately half of WACS value conducted by Study Team in 1998.

Table 9-9: Weight Ratio of Rejected Non-compostable Material from Compostable Waste (1999)

Date			Compostable waste (A)	Reject material (kg) (B)								
				Metal	Ceramic	Plastic bag	Plastics	Green Plastic Bags	Rubber	Glass	Textile	Total
May	12	Wed.	600	0.0	0.0	---	7.5	4.8	0.0	1.2	1.3	14.8
	13	Thu.	1,100	0.3	0.0	---	41.1	26.3	0.0	2.2	5.6	75.5
	14	Fri.	1,000	1.2	0.0	---	42.1	26.9	0.0	8.0	7.8	86.0
	17	Mon.	400	3.8	1.7	---	39.4	25.2	1.9	1.6	15.3	88.9
	18	Tue.	1,600	3.6	0.0	---	25.4	36.0	1.4	10.2	7.4	84.0
	20	Thu.	950	1.4	0.0	---	6.8	43.8	0.0	11.4	13.0	76.4
	21	Fri.	1,300	2.2	1.0	35.6	5.2	26.5	3.2	10.0	7.8	91.5
	26	Wed.	1,000	2.0	0.0	30.0	6.8	21.0	0.8	8.0	10.9	79.5
Total			7,950	14.5	2.7	65.6	174.3	210.5	7.3	52.6	69.1	596.6
Ratio (B)/(A)(%)			100.0	0.2	0.0	0.8	2.2	2.6	0.1	0.7	0.9	7.5
Ratio by WACS (%)			100.0	0.7	1.0	6.4			0.2	2.6	3.4	14.2

v. Mix Ratio of Compostable Waste in Non-compostable Material Collected Separately by Regular Collection Service

The result of physical composition analysis of non-compostable material mixed with compostable waste is shown in the table below. The mixed ratio of compostable waste, namely, kitchen waste, grass/wood contained in non-compostable waste is 33.4 %.

Table 9-10: Physical Composition Analysis of Non-compostable Material Mixed with Compostable Waste (1999)

date		Physical Composition											Apparent
		Kitchen Waste	Paper	Textile	Grass Wood	Plastic	Leather Rubber	Metal	Bottle Glass	Ceramic Stone	Miscella-neous	Total	Specific Gravity (kg/m^3)
22 May	g	3,400	3,400	1,200	200	1,800	400	200	1,200	1,200	1,200	14,200	80
Sat.	%	23.9	23.9	8.5	1.4	12.7	2.8	1.3	8.5	8.5	8.5	100.0	
23 May	g	4,000	1,800	600	200	1,000	50	100	600	600	200	9,150	80
Sun.	%	43.7	19.7	6.6	2.2	10.9	0.4	1.1	6.6	6.6	2.2	100.0	
9 June	g	2,950	3,000	600	100	1,000	100	200	400	---	---	8,350	90
Wed.	%	35.3	35.9	7.2	1.2	12.0	1.2	2.4	4.8	---	---	100.0	
10 June	g	4,000	2,950	1,900	230	1,000	400	100	50	600	---	11,230	90
Thu.	%	35.6	26.3	16.9	2.0	8.9	3.6	0.9	0.4	5.4	---	100.0	
Total	g	14,350	11,150	4,300	730	4,800	950	600	2,250	2,400	1,400	42,930	90
Week	%	33.4	26.0	10.0	1.7	11.2	2.2	1.4	5.2	5.6	3.3	100.0	

vi. Moisture Content of Compostable Waste

Moisture content by Pilot Project and WACS

There are two data on the value of moisture content of compostable waste. One is 68% (2.1kg-water/kg-dry solid) as shown in Table 9-8 by pilot project, and the other is 75.6 % (3.1kg-water/kg-dry solid) by WACS, which is 1.0 kg-water/kg-dry solid larger than pilot project value.

Moisture Content of Compostable Waste for the Compost Production Planning

Moisture Content of compostable waste calculated from the result of WACS, is obtained using the mix ratio of compostable waste and non-compostable materials in weight(92.5% and 7.5%) by the pilot project as shown in the table below.

The following table shows moisture content of compostable waste estimated by the WACS. The moisture content is estimated as 75.6 %(3.1 kg-water/dry solid), which is higher than 68% measured in the pilot project. The difference of moisture content value between pilot project and WACS is considered due to water leakage somewhere from collection point to weigh-bridge.

However, according to WACS, moisture content of garden waste(grass and wood) is about 70 % by WACS, which is almost same as 75.6 %. Therefore, garden waste is not considered it does not affect the moisture content of the compostable waste.

Table 9-11: Moisture Content of Compostable Waste by the result of WACS in 1998

Compostable Waste 100 kg	Compostable	92.5 kg	Dry Solid	22.5 kg	(	24.4 %)
			Water	70.0 kg	(	75.6 %)
	Non-compostable	7.5 kg	Dry Solid	4.1 kg	(	55.2 %)
			Water	3.4 kg	(	44.8 %)

vii. Material Balance of Compostable Waste

Material Balance of Separate Collection is shown in the figure below from generation to raw material.

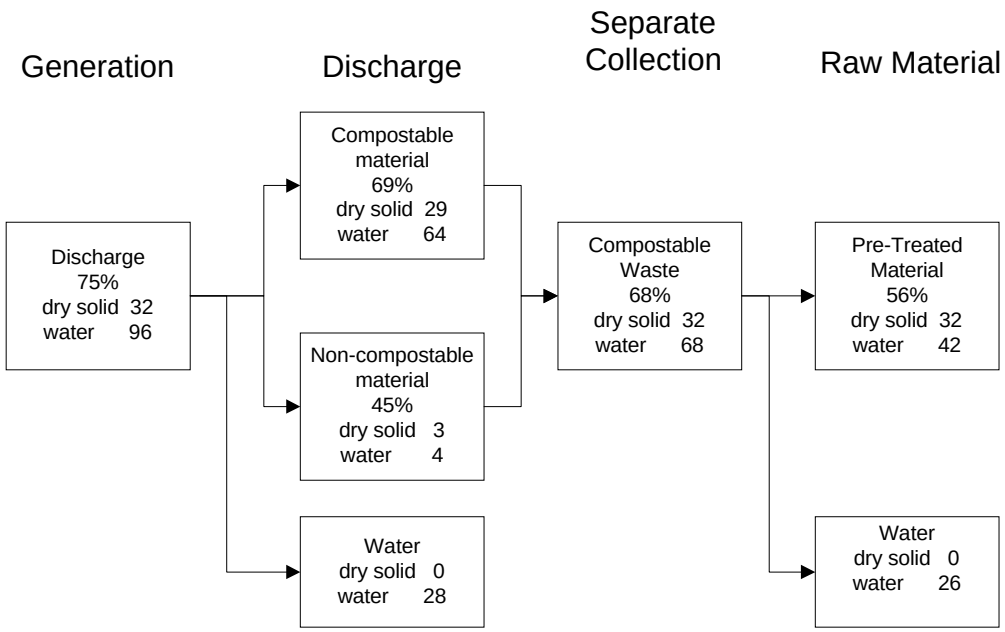

Figure 9-5: Material Balance of Separate Collection

9.3.4 Compost Market Survey

a. Objectives of the Survey

Once the solid waste have been converted to a humus, they are ready for the final step of composting operation, marketing. The study team, therefore, investigates end-uses for the compost product and price to find the feasibility of new compost plant.

b. Method of the Survey

b.1 Preparation of Samples

Due to the strike of the workers of the compost plant commencement of the experiment was delayed. Therefore the study team could not produce improved compost while they stayed in Turkey, by the mid-June 1999. In stead the team obtained the following types of sample compost for the questionnaire survey by sieving the fine compost produced by the existing compost plant in Mersin:

- Very fine compost (VFC) sieved by a 8 m/m screen, and
- Extremely very fine compost (EVFC) sieved by a 2.5 m/m screen

b.2 Selection of Villages

Originally, the study team plans to select 25 villages from each province as random for a questionnaire survey. From these villages, they can be divided further to 20 villages from hilly area and 5 from flat area. In total 50 villages were selected for the survey.

b.3 Questionnaire Survey

The questionnaire survey in each village was proceeded to the whole group of farmers gathered in a pub. Number of farmers listening, discussing and giving their opinion in each village was somewhere around 10-20 persons.

c. Results of Survey

Cukurova Region, an important agricultural area in Turkey, is located east part of the Mediterranean Zone. The region comprises of 3 provinces namely; Adana, Icel and Hatay. Due to the large agricultural area, preferable climate to the crop and enough water supply of the region, there is possibility to raise the various crops in this area. Furthermore, since the Seyhan dam constructed on the Seyhan river in 1956, irrigated agricultural land has been increased.

d. Findings

- Income from field crop farm per ha is much less than fruit orchard, vine yard or vegetable garden. The cost to apply compost to field crop farm will be shared from 10-80% from total income. While compost application expense for fruit orchard and vine yard will be only 1-3% from total income.
- There is no demand for field crop farm due to the main reason that income from field crop is not enough to apply compost. On the other hand, it is clearly found that demand of compost is incredible huge amount for fruit orchard, vine yard and vegetable farm. It can be summarised as follows;

Province	Compost Demand (ton/Year)
Adana	3,757,500
Icel	1,263,616
Total	5,021,116

- Demand of compost is fluctuated according to cultivation period. Demand will be overwhelmingly increased from October-January for fruit orchard, vine yard and green house vegetable. Then, demand of compost will be low and increased again in April for open vegetable farm. Therefore, the production of compost should be considered about stockyard for compost during low demand season.
- Expected price of compost that farmer's willingness to pay in the target area is summarised as follows;

Province	Price of Compost (Mil. TL/ton)	
	Fine	Coarse
Adana	5.9	2.8
Icel	5.9	3.1
Average	5.9	2.9

- Quality of compost is the prime reason for farmers to apply compost as organic fertiliser to their farmland. If the result of yield crop is clearly improved after using compost from MSW, there is a high possibility to increase price more.
- Almost farmers do not know the ratio amount of compost to be applied in their field and how often it should be. Normally, farmers fill organic fertiliser or compost at the amount by their own ideas.

9.4 Evaluation of the Pilot Project

9.4.1 Sofulu Disposal Site Improvement

The followings are the main findings from the experiment:

- A leachate circulation system as one type of leachate treatment method (without discharging leachate into a public water area) is applicable for the rehabilitation of the dump site.
- Since average annual precipitation (about 650 mm) of the target area is far less than evaporation, it is quite inexpensive method, especially on operation cost. Because it only requires a few electricity for operation of the system.
- The steep slope created by open dumping operation, which is a common view not only of Sofulu but also of many dumpsites in the country, is the main cause of spontaneous fire. It makes covering soil operation on the burning parts extremely difficult. The flattening the slope to extinguish fire is quite dangerous and requires considerable input of heavy equipment, expensive operation.
- The Adana GM acknowledged the sanitary landfill operation should be carried out from bottom of the site and required numbers of heavy machinery.

9.4.2 Separate Collection

a. Waste Collection Shift

At present, both the GSHC and all the district areas in Mersin receive waste collection services for general waste every day. During the pilot project on separate collection, a two shift collection service, one for compostable waste at 7:00 a.m. and the other for non-compostable waste at 9:30 a.m., was carried out. Residents discharged compostable waste into the non-compostable containers after the first shift collection. Therefore separate collection, introduced at a city level, should be provided on alternate days, e.g., Monday, Wednesday, Friday, and Sunday for compostable wastes, and Tuesday, Thursday, and Saturday for non-compostable wastes. Waste collection on alternate days would ensure that the waste is clearly separated, and it would reduce both time and transportation costs.

b. Separate Receptacles

Because most kitchens do not have a separate receptacle for different waste types, there is a need to promote the use of separate receptacles, or waste bins, for compostable and non-compostable wastes.

c. Wastewater Strainer

Residents often discharge kitchen waste into double lined plastic bags to avoid wastewater from leaking. This makes the removal of non-compostable materials at the recovery area very hard and unhygienic. Therefore to reduce wastewater and to eliminate the use of double lined bags, the use of a strainer, or water filter, in the kitchen sink is recommended. Residents should be informed on the use of strainers, that must become part of general life, through a public campaign.

d. Continuous Information

Most of the residents are willing to participate in separate collection. However, because residents are not well informed on how to separate waste, there is a need to constantly provide information to the residents through meetings and assemblies; SWM authorities should constantly monitor the waste separation activities, and select a representative to promote public awareness campaigns.

e. Public Education Programs

The AGM and the MGM, together with the district municipalities, with other relevant organisations, and with the residents should actively carry out campaigns on separate collection, and initiate public education programs to promote co-operation with SWM. SWM authorities and educational establishments must encourage waste separation and recycling programs at schools to widen the application of separate collection.

The pilot project on separate collection revealed the importance of such education programs for the master plan to succeed. Work meetings, assemblies, and solid waste education materials, such as pamphlets and education booklets, and other campaign items, such as visual projections and demonstrations, all proved to be successful during the study. In the future these and other similar materials should be used by the waste management authorities to promote separate collection and recycling.

9.4.3 Compost Quality Improvement

a. Fundamental Issues

The pilot project conducted by the JICA study term had two components: separate collection and compost production. The purpose of the latter component was to look at the following.

- Improvement of the existing facility.
- Recovery of non-compostable wastes.
- Facilitation of fermentation.
- Management improvement of the compost plant.

It should be noted that the pilot project produced compost from separately collected compostable wastes unlike the existing plant.

The results of the study analysis regarding the improvement of compost quality are described below.

b. Physical Composition Analysis

The table below presents the result of physical composition analysis.

The findings drawn from the analysis are as follows.

- Fine compost, i.e., underflow material of 25mm sieves, contains more compostable matter than coarse compost.

- Fine compost has more plastics and less ceramic or stone than mature compost before being sieved. The contents of other components do not show any change.

These findings of this physical composition analysis suggest that the quality of mature compost can be upgraded by sieving.

Table 9-12: Physical Composition Analysis

Item	Mersin Compost Plant	
	1998*	
	Present Compost	
	Coarse	Fine
Compostable matter	60.2%	87.8%
Paper	1.0%	1.1%
Textile	5.7%	1.3%
Grass and Wood	1.0%	0.6%
Plastic	11.9%	5.8%
Rubber and Leather	0.7%	0.4%
Metal	0.0%	0.0%
Bottle and Glass	0.5%	0.4%
Ceramic and Stone	19.0%	2.6%
Total	100%	100%

Note : Analysis by JICA Study Team in October 1998.

c. Sieve Analysis

The result of the sieve analysis is shown in the table below.

- The particle size of compost produced by the pilot project tends to be smaller than that of compost from the Mersin compost plant.
- As for compost products of the pilot project, manual sorting does not make any difference in particle size distribution.

This sieve analysis implies that the large particles contained in raw materials become smaller by separately collecting compostable materials. Manual sorting will be unnecessary since it does not influence particle size distribution.

Table 9-13: Sieve Analysis

Item	Mersin Compost Plant		Compost Produced from Pilot Project	
	1998*		1999**	
			With Manual Sorting	Without Manual Sorting
	Coarse	Fine	Fine	Fine
over 19 mm sieve	45.3%	15.8%		
% passing 19 mm sieve	20.6%	12.9%		
% passing 11.2 mm sieve			14.2%	9.4%
% passing 8 mm sieve	10.6%	4.7%		
% passing 5 mm sieve			25.2%	18.2%
% passing 2 mm sieve	23.5%	43.7%	44.1%	49.3%
% passing 0.5 mm sieve		22.9%	15.4%	23.0%

Note : *Analysis by JICA Study Team in October 1998.
**Analysis by JICA Study Team for pilot project in August 1999.

d. Chemical Analysis

The result of chemical analysis is presented in the table below.

- The chemical components of compost produced at the Mersin compost plant and compost produced by the pilot project do not show any major differences.
- The C/N ratio, one of the key factors to evaluate compost quality, is in an appropriate range in the both cases, although there is a discrepancy.

It is presumed from this chemical analysis, therefore, that the separate collection of compostable wastes does not influence compost quality.

Table 9-14: Chemical Analysis

Item	Mersin Compost Plant		Compost Produced from Pilot Project
	1991*	1998**	1999***
	Present Compost		Without Manual Sorting
	Fine	Fine	Fine
Dry matter, DM (%)	87%	83.8%	---
Carbon (mg/kg DM)		25.1%	26.0%
Nitrogen (mg/kg DM)		1.3%	2.3%
pH	8.6	8.5	7.71
Pb (mg/kg DM)	36	66.6	109.8
Cd (mg/kg DM)	0.6	11.0	52.5
Cr (mg/kg DM)	12 to 16	124.5	11.69
Cu (mg/kg DM)	117 to 251	247.2	9.9
Ni (mg/kg DM)	86	55.0	28.33
Hg (mg/kg DM)	0.1 to 0.2	Trace	Trace
Zn (mg/kg DM)		49.7	208.3

Note : * Chemical analysis carried out by DTI, Denmark for the Feasibility Study on Rehabilitation of Composting Plant and Construction of Sanitary Landfill, Ramboll & Hannemans, December 1991.
** Analysis by JICA Study Team in October 1998.
*** Analysis by JICA Study Team for pilot project in June 1999