PART II

The Solid Waste Management Master Plan

Chapter 5

Planning Frameworks for a SWM Master Plan

5 Planning Frameworks for a SWM Master Plan

5.1 For Adana GM

5.1.1 Siting of Future SWM Facilities

a. Site Selection Method

Under the Greater Municipality Law, greater municipalities are responsible for selecting the sites for transfer stations, processing, and disposal facilities. For settlements with a population of over 100,000, on the other hand, permission must be obtained directly from the MoE, the Ministry of Public Works and Housing, the Ministry of Energy and Natural Resources, and the Ministry of Forests.

Looking at the present land use conditions in the target areas, the construction of SWM facilities within the city periphery would be extremely difficult. In particular, the final disposal site, which is extremely important to SWM, will be located outside of the city. As mentioned above, the selection of such a site would require the approval of a number of relevant agencies. Given these conditions, the following procedures were adopted for the selection and acquisition of sites for the construction of SWM facilities in Adana and Mersin.

Table 5-1: Site Selection Procedures

Item	Responsible Agency	Period
1. Proposal of Candidate Sites	Greater Municipalities of Adana & Mersin	Aug to 31 Oct 1998
2. Rough Survey of Each Candidate Site	Study Team	Aug to 31 Oct 1998
3. Preparation of Assessment Report on Candidate Sites	Study Team	31 Oct 1998
4. Selection of Sites for F/S Implementation	Turkish Steering Committee	Mid-Nov 1998
5. Administrative Procedures for F/S Implementation	Greater Municipalities of Adana & Mersin	Mid-Feb 1999
6. F/S Implementation	Study Team	Mid-Feb to Oct 1999
7. Site Acquisition Procedure	Greater Municipalities of Adana & Mersin	From mid-Feb 1999

b. Final Disposal Site Selection

A final disposal site is indispensable to an SWM system, regardless of the system's structure, which in this case is outlined in the technical system proposed in the M/P. Accordingly, the study team requested the Turkish counterpart (C/P) to select appropriate candidate disposal sites from the beginning of the study. The C/P presented the following 6 candidate sites:

1. Present landfill site in Sofulu
2. Adana Cimento quarry

3. Adjacent area of Adana Cimento
4. Quarries and valleys at Karahan
5. Quarries at Seyhan
6. Site at Buruk

The locations of the candidate sites proposed by the Municipality are shown in Figure 5-1.

The study team carried out surveys on the proposed candidate sites and established standards for the evaluation of site conditions. The evaluation of the candidate sites was carried out as shown in the table below.

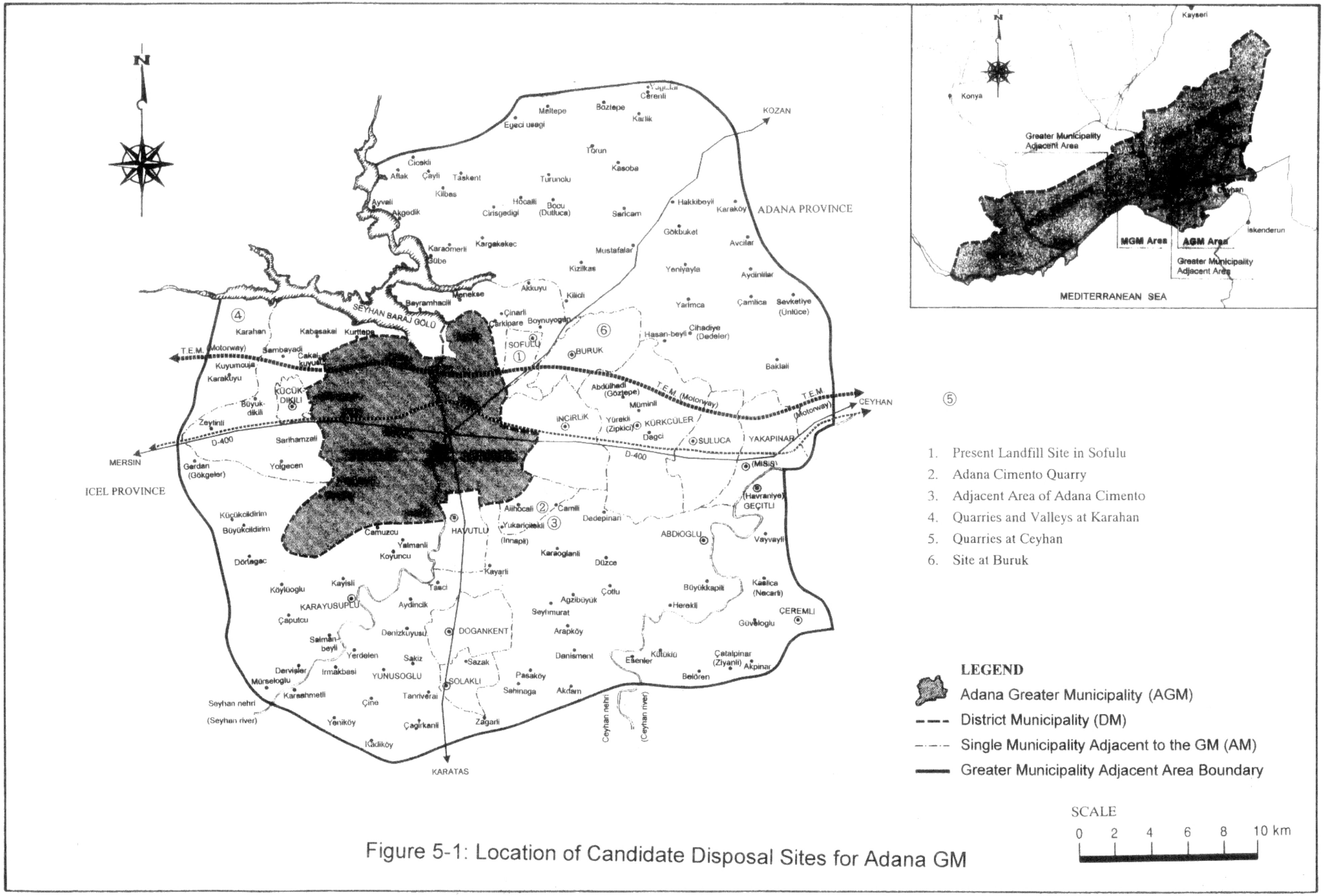

Figure 5-1: Location of Candidate Disposal Sites for Adana GM

Table 5-2: Evaluation of Candidate Final Disposal Sites for Adana GM

Site Name	Current Conditions	Evaluation	Basis
1. Present landfill site in Sofulu	• 10 km from the centre of Adana • Present dump site for Adana GM and its adjacent municipalities.	Feasible for further investigations.	• The extended landfill site holds capacity for many years disposal from Adana. • Urgently required rehabilitation works can be done in a cost effective way if combined with continued operation of the landfill. • Daily covering soil is easily available.
2. Adana Cimento quarry	• 15 km from the centre of Adana • Mining area of lime stone for Adana Cimento	Feasible for further investigations at a later stage.	• When mining operation is completed and Adana Cimento agrees for the use of waste disposal, the site will become an ideal candidate site for final disposal. • Because of huge landfill capacity, availability of covering soil, favourable surrounding land use, easy operation, etc.
3. Adjacent area of Adana Cimento	• 15 km from the centre of Adana. • A flat land with a ground full of boulder rocks embed in clay.	Not feasible.	• The site includes or is neighbouring an area with archaeological remains. • A village with chicken farming is neighbour to the site. • Earthworks would be expensive and covering soil would not be easily available.
4. Quarries and valleys at Karahan	• 23 km from the centre of Adana. • An operating soil quarry and three small valleys adjoining the quarry.	Feasible for further investigations if the Ministry of Forests gives a permission of the use as a landfill.	• Far from the population. • Access to the site is easily available, but a little bit far from the city centre. • Daily covering soil is easily available.
5. Quarries at Seyhan	• 42 km from the centre of Adana. • An operating quarry and 2 abandoned quarries.	Not feasible.	• Too far from the city centre. • The site is located less than 1 km from 2 villages and an ancient castle. • A quarry is still operating. • Covering soil would not be easily available.
6. Site at Buruk	• 20 km from the centre of Adana. • Agricultural land.	Not feasible.	• Due to the location on top of a hill the filling height of waste will be relatively small. • The cost of construction/operation is extremely high due to the construction of the embankments. • The site is not naturally protected from wind and will face huge problems of blown papers and plastics due to wind.

Based on the results of the evaluation, the Study Team recommended the present landfill site in Sofulu to be operated for maybe another 10 years to serve the Greater Municipality of Adana, and to be the final disposal site for the F/S (Feasibility Study). The continued operation of Sofulu Landfill is subject to:

- Urgently required rehabilitation works of the landfill are undertaken as soon as possible. The rehabilitation works can be carried out in a cost effective way if combined with continued operation of the landfill.
- New procedures for operating the landfill are introduced.
- The construction of residential areas immediately north and west of the landfill site is postponed.

It is recommended that the following sites be further investigated if a new landfill site is to be selected:

- Adana Cimento Quarry
  At the time when it is required that a new site be selected, it may be possible that some of the quarry is no longer operated by the factory.
- Quarries and Valleys at Karahan

The above-mentioned recommendations were agreed by the C/P (Counterpart) and Adana GM as agreed on the M/M (Minutes of Meetings) on the IT/R (Interim Report). Consequently the team commenced field investigations for the conduct of the F/S of the construction of the new landfill at the present Sofulu disposal site from February 1999.

c. Site Selection for Transfer Station

If the use of the present final disposal site at Sofulu will be continued, there will be no need to introduce a waste transfer system in exchange for the current use of vehicles directly hauling waste into the disposal site. A transfer system, however, needs for the use of tractors with trailers haulage system. Since the C/P could not present any candidate sites for the transfer station by the end of October 1998, it was agreed by the team and C/P this F/S did not cover the construction of this facility.

d. Intermediate Treatment (Resource Recovery) Facility

Since the C/P could not provide any candidate sites for the intermediate treatment (resource recovery) facility by the end of October 1998. The team recommended the facility site for the F/S be annexed to the Sofulu final disposal site in view of the following reasons:

- Problems, e.g., generation of offensive odour, etc., that usually result from the operation of a resource recovery facility (e.g., compost plant and sorting plant) cannot be completely eliminated. It is, therefore, important to locate the plant as far away as possible from inhabited areas.
- The Sofulu final disposal sites for Adana is located relatively close to the areas that need by-product of the proposed plant, compost etc. This promotes the sale of the product.
- To curtail secondary haulage costs for waste residues, which could be quite a lot, the plant should be located close to the final disposal site.

The above-mentioned recommendations were approved by the C/P and Adana GM as agreed on the M/M on the IT/R. Consequently the team commenced field investigations for the conduct of the F/S of the construction of a new resource recovery facility annexed to the Sofulu final disposal site from February 1999.

5.1.2 Forecast of Future Waste Amount and Composition

a. Population Forecast

Population forecast was carried out based on the 1997 population survey done by the State Statistic Institute (SSI) of Adana Province. The study team forecasts the population of Adana GM in 2020, by setting a basic population growth rate of 2.0 % and adding the estimated increase in the population brought about by the Yeni Adana

Project (600,000 population increase by 2020) and the North Yuregir Project (351,000 increase by 2020).

Table 5-3: Population Forecast for Adana GM (1999-2020)

Adana Greater Municipality			1999	2000	2005	2010	2012	2015	2020
District	Seyhan	Rate		4.57	4.12	3.55	3.25	3.07	2.83
		Population	859,170	898,433	1,099,454	1,308,906	1,395,243	1,527,671	1,756,713
	Yuregir	Rate		2.0	2.0	2.0	2.0	2.0	2.0
		Population	337,450	344,199	380,023	419,577	436,527	463,246	511,461
	sub-total		**1,196,620*[1]**	**1,242,632**	**1,479,477**	**1,728,483**	**1,831,770**	**1,990,917**	**2,268,173**
	Growth Rate			3.85	3.55	3.16	2.94	2.82	2.64
Adjacent Area	Seyhan Adjacent Area	Rate		2.0	2.0	2.0	2.0	2.0	2.0
		Population	36,363	37,090	40,951	45,213	47,039	49,918	55,114
	Yuregir Adjacent Area	Rate		2.0	2.0	2.0	2.0	2.0	2.0
		Population	111,761	113,996	125,861	138,961	144,575	153,424	169,591
	North Yuregir	Rate							
		Population	0	0	87,750	175,500	210,600	263,250	351,000
	sub-total		**148,124**	**151,087**	**254,562**	**359,674**	**402,214**	**466,593**	**575,505**
	Growth Rate			2.0	11.0	7.16	5.74	5.07	4.29
Total			**1,1344,744**	**1,393,718**	**1,734,039**	**2,088,157**	**2,233,984**	**2,457,510**	**2,843,679**

Source: JICA study team.
Note: *1: The figure is estimated based on the disposal amount observed at the Sofulu dumpsite in 1999.

b. Waste Amount Forecast

Future waste discharge amount (WD_x) is forecast to increase in proportion to the increase in population. Accordingly, the future waste discharge amount was calculated by multiplying the discharge rate (DR_x) at that point by the future population (P_x) ($WD_x = P_x \times DR_x$)..

The future waste discharge rate is deemed to increase in proportion with economic growth. Accordingly, based on the relationship between the GNP and the increase in waste discharge, the future waste discharge rate is forecast as shown below. (The growth rates of the GNP, GDR, and GRDP were assumed to be exactly linked, i.e., increase by the same rate.)

- Phase 1 (1998 - 2005) 2.8%/year
- Phase 2 (2006 - 2012) 2.5%/year
- Phase 3 (2013-2020) 1.2%/year

Using the above forecasts, the future waste discharge amount in Adana is estimated as shown in the following table.

Table 5-4: Forecast on Waste Discharge Amount for Adana GM

unit : ton/day

Category	1999	2005	2012	2020
MSW	**803**	**1,161**	**1,689**	**2,292**
Household	566	826	1,214	1,653
Commercial (Restaurant)	79	116	170	233
Commercial (Other Shop)	83	121	177	242
Market	14	21	30	42
Institution	8	11	16	22
Street	51	63	78	96
Park	2	3	4	5
Other Waste	**25**	**40**	**63**	**87**
Total	**828**	**1,201**	**1,752**	**2,379**

c. Forecast on Waste Composition

Future waste composition was forecast by comparing the results of the WACS with the waste data on other Turkish cities and other countries. The forecast was mainly based on the following assumptions:

- Significant changes in food consumption is not anticipated. Therefore, the discharge amount of **kitchen waste** per capita, which makes up the bulk of waste in the target area (63-65% at present), is assumed to remain the same.
- Most of residents in the target area are assumed to continue to live in condominiums. Therefore, the discharge amount of garden waste (e.g., **grass and wood, ceramics and stones and miscellaneous.**) per capita is not going to change.
- The discharge amount of wastes used for wrapping, e.g., **paper, plastics, bottles and glass,** is assumed to increase in accordance with economic growth.
- The discharge amount of wastes such as **textile, rubber and leather, and metals**, (of which discharge rate is very low.) is assumed to increase in accordance with economic growth.

Using the above forecasts, the future waste composition in Adana is forecast as shown in the following table.

Table 5-5: Forecast on Composition of MSW for Adana GM

unit : %

Waste Composition of MSW	1999	2005	2012	2020
1. Combustible Wastes	**89.71**	**88.81**	**88.01**	**87.61**
Kitchen Waste	64.41	55.05	46.85	42.75
Paper	14.80	20.57	25.63	28.16
Textile	1.62	2.25	2.80	3.08
Grass and Wood	2.66	2.29	1.95	1.78
Plastic	5.92	8.23	10.26	11.27
Rubber and Leather	0.30	0.42	0.52	0.57
2. Non-combustible Wastes	**10.29**	**11.19**	**11.99**	**12.39**
Metal	1.41	1.94	2.42	2.66
Bottle and Glass	3.08	4.28	5.33	5.86
Ceramic and Stone	2.17	1.91	1.63	1.48
Miscellaneous	3.64	3.06	2.61	2.39
TOTAL	**100**	**100**	**100**	**100**

5.1.3 Forecast of Medical Waste Generation

The medical waste generations in Adana GM including the adjacent municipalities are forecast as shown in the table below.

Table 5-6: Forecast of Medical Waste Generation for Adana

Item \ Year	1999	2005	2012	2020
Population	1,344,744	1,734,039	2,233,984	2,843,679
Waste generation ratio(kg/day/person)	0.003273	0.003578	0.003971	0.004474
Adjusted Figure (kg/day)	4,401	6,204	8,871	12,723

5.1.4 Other Pre-conditions

a. Economic Conditions

a.1 Economic Growth Rate

The GDP (gross domestic product) as well as GNP (gross national product) growth rate is assumed based on past growth rates and the decline in global growth rates, as shown in the table below.

Table 5-7: GNP and GDP Forecasts

	1997	2000	2005	2010	2012	2020
Rates of Increase (%)	8.2	5.5	5.0	4.5	4.0	4.0
GNP (trillion TL*)	29,393	34,515	44,051	54,895	59,374	81,258
GDP (trillion TL*)	28,836	33,861	43,216	83,855	58,249	79,718

Note: * 1997 Turkish Lira rate was used.

a.2 GRDP of Adana Province

Looking at the GRDP (gross regional domestic product) trend for the past 10 years, the share of Adana Province in the GDP has hardly changed at 3.4±0.2%, as shown in the table below. This study assumes, therefore, that the province's share of 3.4 % in the GDP will be maintained until 2020.

Table 5-8: Adana Province GRDP Forecast

	1997	2000	2005	2010	2012	2020
GDP (trillion TL*)	29,393	34,515	44,051	54,895	58,249	79,718
Adana Province GRDP (billion TL*)	908,832**	1,151,270	1,469,340	1,831,070	1,980,470	2,710,410

Note: * 1997 Turkish Lira rate was used.
** Actual figures provided by SSI

b. Financial Conditions

The master plan assumes that basically the municipal revenue will increase in proportion to the increase in GRDP except for the general budget allocated from national tax (Law 2380), property tax and cleansing tax. The revenues (excluding the cleansing tax) of Seyhan DM, Yuregir DM and Adana GM are calculated as shown in the table below.

Table 5-9: Revenue Forecast (Adana)

unit: million TL*

		1998	2005	2012	2020
Seyhan DM	General Budget from National Tax (Law 2380)	4,771,162	5,480,572	6,295,456	7,376,134
	Local taxes excluding Property tax & Cleansing tax And Non-tax revenue	1,882,116	2,673,575	3,603,689	4,931,842
	Property tax	916,518	1,052,792	1,209,328	1,416,920
	Total	7,569,796	9,206,939	11,108,473	13,724,896
	Total (US$ 1,000)	26,609	32,364	39,048	48,246
Yuregir DM	General Budget from National Tax (Law 2380)	2,904,860	3,336,775	3,832,908	4,490,863
	Local taxes excluding Property tax & Cleansing tax And Non-tax revenue	1,239,081	1,760,134	2,372,468	3,246,851
	Property tax	249,358	286,434	329,023	385,503
	Total	4,393,299	5,383,343	6,534,399	8,123,217
	Total (US$ 1,000)	15,443	18,923	22,970	28,555
Adana GM	General Budget from National Tax** (Law 2380)	3,060,436	3,515,483	4,038,187	4,731,381
	General Budget from National Tax (Law 3030)	6,408,193	9,102,937	12,269,767	16,791,838
	Local taxes excluding Property tax & Cleansing tax And Non-tax revenue	7,605,008	10,803,030	14,561,310	19,927,937
	Property tax	9,911	12,739	15,772	19,530
	Total	17,083,548	23,434,189	30,885,036	41,470,686
	Total (US$ 1,000)	60,052	82,376	108,567	145,777

Notes: * Turkish Liras using 1998 constant prices
** Exchange rate; US$ 1 = 284,480 TL

Cleansing tax rate is presumed to increase to cover the SWM costs in continuation of present system step by step.

c. Conditions for Cost Estimation

c.1 Exchange Rate

Cost estimation was carried out based on the prices and exchange rate as of May 31st 1999. The prices in the past years other than 1999 were calculated based on the exchange rate in October of each fiscal year.

unit: TL

Year	1993	1994	1995	1996	1997	1998	1999
Exchange Rate (US$1.00)	12,967	35,200	50,803	97,306	180,655	284,480	407,000

c.2 Equipment and Facility Life Span

Items	Life Span (year)	Residual Value (%)
Vehicles & Heavy Equipment	7	10
Machinery	15	0
Buildings	30	0

Note: The life span of civil works and the facilities, other than buildings, depends on their period of operation.

5.2 For Mersin GM

5.2.1 Siting of Future SWM Facilities

a. Site Selection Method

The site selection work for future SWM facilities for Mersin GM was conducted exactly the same as Adana GM as mentioned in 5.1.1.

b. Final Disposal Site Selection

The study team requested the Turkish counterpart (C/P) to select appropriate candidate disposal sites from the beginning of the study. The C/P presented the following 5 candidate sites:

1. Cimsa-site
2. Quarry at Habilli
3. Old Soda Quarry
4. Old Cimsa Quarry
5. Quarry at Emirler

The location of the candidate sites proposed by the Municipality are shown in Figure 5-2.

The study team carried out surveys on the proposed candidate sites and established standards for the evaluation of site conditions. The evaluation of the candidate sites was carried out as shown in the table below.

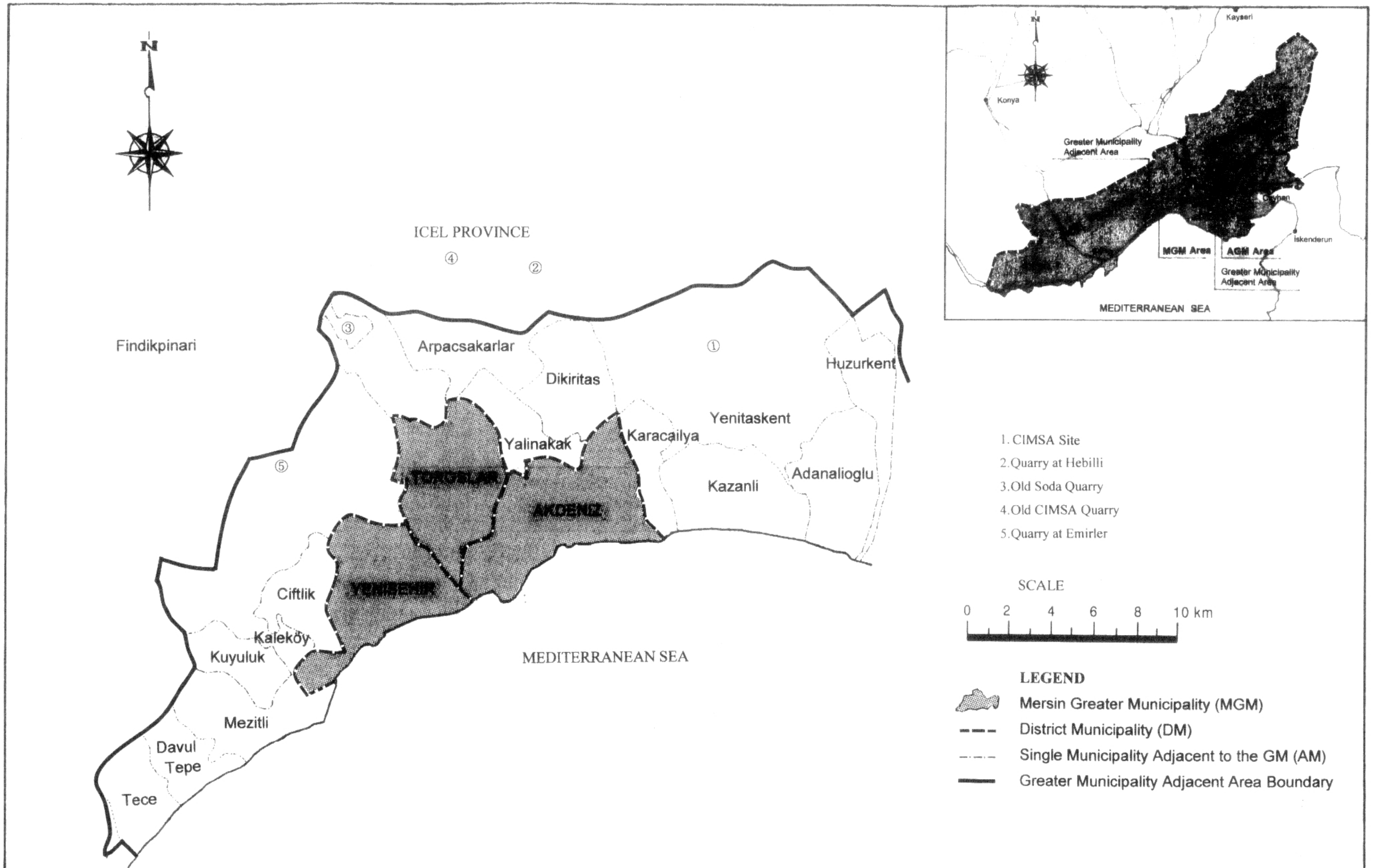

Figure 5-2: Location of Candidate Disposal Sites for Mersin GM

Table 5-10: Evaluation of Candidate Final Disposal Sites for Mersin GM

Site Name	Current Conditions	Evaluation	Basis
1. Cimsa site	• 19 km from the centre of Mersin. • The abandoned quarry and about 150 ha of the area designated as future landfill in the Mersin M/P	Feasible for further investigations.	• The site holds capacity for many years disposal from Mersin. • Daily covering soil is easily available. • It is an ideal site for final disposal because of landfill capacity, availability of covering soil, favourable surrounding land use, easy operation, etc. • The site can be recovered in accordance with the original landscape.
2. Quarry at Habilli	• 19 km from the centre of Mersin. • The abandoned quarry of about 100 ha.	Feasible for further investigations.	• The site holds capacity for many years disposal from Mersin. • Daily covering soil is easily available. • It is a suitable site for final disposal because of landfill capacity, availability of covering soil, easy operation, etc. However, the site is very close to the village Habilli. • The site can be recovered in accordance with the original landscape.
3. Old Soda quarry	• 16 km from the centre of Mersin. • The abandoned quarry of less than 10 ha.	Not feasible.	• The site is located next to a trunk road. • The site does not hold enough capacity for future landfill of Mersin. • Due to the originally very steep topography it will be very difficult to completely recover the site by the landfill operation.
4. Old Cimsa quarry	• 19 km from the centre of Mersin. • The abandoned quarry of about 10 ha.	Not feasible.	• The site does not hold enough capacity for future landfill of Mersin. • A trunk road is located at the centre of the site. • Covering soil would not be easily available. • Due to the originally very steep topography it will be very difficult to completely recover the site by the landfill operation.
5. Quarry at Emirler	• 15 km from the centre of Mersin.	Not feasible.	• The site does not hold enough capacity for future landfill of Mersin. • Covering soil would not be easily available. • The cost of construction/operation is very expensive due to the construction of the embankments and access road. • Due to the originally very steep topography it will be very difficult to completely recover the site by the landfill operation.

Based on the results of the evaluation, the Team recommended the following sites for the construction of the future landfill for the Greater Municipality of Mersin:

- The site located in the Cimsa-excavation area
- The site located at the village of Hebilli

Regarding the site located at the village of Hebilli the C/P identified very difficult to obtain consensus from people living in the village to use the site for a landfill.

The Cimsa site was selected as a future final disposal site by the C/P and Mersin GM as agreed on the M/M on the IT/R. Consequently the team commenced field investigations for the conduct of the F/S of the construction of the new landfill from February 1999.

c. Site Selection for Transfer Station

Since Cimsa site was chosen as the future disposal site of Mersin, the use of large vehicles would be more economical instead of the vehicles currently used for direct waste haulage. However, since no word has been received from the C/P by the end of October 1998 regarding the candidate sites for transfer stations they would like to propose, the construction of transfer stations in appropriate areas was assumed in the M/P for every DM, and studies was carried out to determine the need of constructing such a facility.

Since the C/P could not present any candidate sites for the transfer station by the end of October 1998, it was agreed by the team and C/P this F/S did not cover the construction of this facility.

d. Intermediate Treatment (Resource Recovery) Facility

Since the C/P could not provide any candidate sites for the intermediate treatment (resource recovery) facility by the end of October 1998. The team recommended the facility site for the F/S be annexed to the Cimsa future final disposal site in view of the following reasons:

- Problems, e.g., generation of offensive odour, etc., that usually result from the operation of a resource recovery facility (e.g., compost plant and sorting plant) cannot be completely eliminated. It is, therefore, important to locate the plant as far away as possible from inhabited areas.
- The Cimsa future final disposal sites for Mersin is located relatively close to the areas that need by-product of the proposed plant, compost etc. This promotes the sale of the product.
- To curtail secondary haulage costs for waste residues, which could be quite a lot, the plant should be located close to the final disposal site.

The above-mentioned recommendations were approved by the C/P (Counterpart) and Mersin GM as agreed on the M/M on the IT/R. Consequently the team commenced field investigations for the conduct of the F/S of the construction of a new resource recovery facility annexed to the Cimsa future final disposal site from February 1999.

5.2.2 Forecast of Future Waste Amount and Composition

a. Population Forecast

Population forecast made by the team is based on the 1990 census population (422,357) and the 1997 population (499,452) obtained from the general population survey done in 1997. As for the forecast of the population growth rate the Mersin Wastewater Study (1996) is referred. As a result the population forecast is made as shown in the Table below.

Table 5-11: Mersin GM Population Growth Rate Forecast

Year	MWWS	Mersin GM	Akdeniz	Toroslar	Yenisehir	Adjacent Area
1985 - 1990	-	6.1*[2]	-	-	-	-
1990 - 1997	-	2.4*[2]	1.03*[2]	2.95*[2]	4.31*[2]	2.6*[2]
1998 - 2000	5.5*[1]	2.9	2.0	3.5	4.5	3.0
2000 - 2005	5.0*[1]	3.0	2.0	3.5	4.5	3.0
2005 - 2010	4.5*[1]	3.1	2.0	3.5	4.5	3.0
2010 - 2015	4.0*[1]	3.0	2.0	3.5	4.0	3.0
2015 - 2020	3.5*[1]	2.9	2.0	3.5	3.5	3.0

Source: *1: Mersin Wastewater Study, 1996
*2: SSI, Icel Province

The population in 2020 was estimated and shown below based on the figures in the table above.

Table 5-12: Population Forecast for Mersin GM (1998 - 2020)

Mersin Greater Municipality		1998*[1]	2000	2005	2010	2012	2015	2020
Akdeniz	Rate	-	2.0	2.0	2.0	2.0	2.0	2.0
	Population	255,516	265,839	293,508	324,056	337,148	357,784	395,024
Toroslar	Rate	-	3.5	3.5	3.5	3.5	3.5	3.5
	Population	234,024	250,693	297,744	353,625	378,813	419,996	498,823
Yenisehir	Rate	-	4.5	4.5	4.5	4.0	4.0	3.5
	Population	145,310	158,682	197,747	246,430	266,538	299,820	356,09l
sub-total		**634,850*[1]**	**675,214**	**788,999**	**924,112**	**982,499**	**1,077,600**	**1,249,940**
Growth Rate		**-**	**3.1**	**3.2**	**3.2**	**3.1**	**3.1**	**3.0**
Adjacent Area	Rate	-	3.0	3.0	3.0	3.0	3.0	3.0
	Population	155,017	164,458	190,652	221,018	234,478	256,220	297,029
sub-total		155,017	164,458	190,652	221,018	234,478	256,220	297,029
Total		789,867	839,672	979,651	1,145,130	1,216,977	1,333,820	1,546,969

Source: JICA study team.
Note: *1 :The figure is estimated based on the disposal amount observed at the Compost Plant disposal site in 1998.

b. Waste Amount Forecast

Future waste discharge amount (WD_x) is forecast to increase in proportion to the increase in population. Accordingly, the future waste discharge amount was calculated by multiplying the discharge rate (DR_x) at that point by the future population (P_x) ($WD_x = P_x \times DR_x$).

The future waste discharge rate is deemed to increase in proportion with economic growth. Accordingly, based on the relationship between the GNP and the increase in waste discharge, the future waste discharge rate is forecast as shown below. (The growth rates of the GNP, GDR, and GRDP were assumed to be exactly linked, i.e., increase by the same rate.)

- Phase 1 (1998 - 2005) 2.8%/year

- Phase 2 (2006 - 2012) 2.5%/year
- Phase 3 (2013-2020) 1.2%/year

Using the above forecasts, the future waste discharge amount in Mersin is estimated as shown in the following table.

Table 5-13: Forecast on Waste Discharge Amount for Mersin GM

unit: ton/day

Category	1998	2005	2012	2020
MSW	**425**	**635**	**933**	**1,302**
Household	279	420	622	871
Commercial (Restaurant)	56	84	124	174
Commercial (Other Shop)	53	80	119	166
Market	13	20	29	41
Institution	2	4	5	7
Street	21	26	33	42
Park	1	1	1	1
Other Waste	**17**	**24**	**36**	**51**
Total	**442**	**659**	**969**	**1,353**

c. Forecast on Waste Composition

Future waste composition was forecast by comparing the results of the WACS with the waste data on other Turkish cities and other countries. The forecast was mainly based on the following assumptions:

- Significant changes in food consumption is not anticipated. Therefore, the discharge amount of **kitchen waste** per capita, which makes up the bulk of waste in the target area (63-65% at present), is assumed to remain the same.
- Most of residents in the target area are assumed to continue to live in condominiums. Therefore, the discharge amount of garden waste (e.g., **grass and wood, ceramics and stones and miscellaneous.**) per capita is not going to change.
- The discharge amount of wastes used for wrapping, e.g., **paper, plastics, bottles and glass,** is assumed to increase in accordance with economic growth.
- The discharge amount of wastes such as **textile, rubber and leather, and metals**, (of which discharge rate is very low.) is assumed to increase in accordance with economic growth.

Using the above forecasts, the future waste composition in Mersin is forecast as shown in the following table.

Table 5-14: Forecast on Composition of MSW for Mersin GM

unit : %

Waste Composition of MSW	1998	2005	2012	2020
1. Combustible Wastes	**93.15**	**91.96**	**91.22**	**90.79**
Kitchen Waste	63.01	52.44	44.48	40.48
Paper	18.42	25.04	29.80	32.26
Textile	2.60	3.46	4.18	4.53
Grass and Wood	2.18	1.78	1.50	1.31
Plastic	6.69	8.98	10.83	11.75
Rubber and Leather	0.25	0.31	0.43	0.46
2. Non-combustible Wastes	**6.85**	**8.04**	**8.78**	**9.21**
Metal	1.25	1.73	2.04	2.23
Bottle and Glass	3.08	4.25	4.93	5.38
Ceramic and Stone	1.38	1.10	0.96	0.84
Miscellaneous	1.14	0.96	0.85	0.76
TOTAL	100	100	100	100

5.2.3 Forecast of Medical Waste Generation

The medical waste generations in Mersin GM including the adjacent municipalities are forecast as shown in the table below.

Table 5-15: Forecast of Medical Waste Generation for Mersin

Item / Year	1998	2005	2012	2020
Population	789,867	979,651	1,216,977	1,546,969
Waste generation ratio(kg/day/person)	0.001948	0.002269	0.002643	0.003146
Adjusted Figure (kg/day)	1,539	2,223	3,216	4,867

5.2.4 Other Pre-conditions

a. Economic Conditions

a.1 Economic Growth Rate

The GDP (gross domestic product) as well as GNP (gross national product) growth rate is assumed based on past growth rates and the decline in global growth rates, as shown in shown in the table below.

Table 5-16: GNP & GDP Forecasts

	1997	2000	2005	2010	2020
Rate of Increase (%)	8.2	5.5	5.0	4.5	4.0
GNP (trillion TL*)	29,393	34,515	44,051	54,895	81,258
GDP (trillion TL*)	28,836	33,861	43,216	53,855	79,718

Note: *1997 Turkish Lira rate was used.

a.2 GRDP of Icel Province

Looking at the GRDP trend for the past 10 years, the share of Icel Province in the GDP has hardly changed at 2.8±0.2%, as shown in the table below. This study assumes, therefore, that the province's share of 2.8 % in the GDP will be maintained until 2020.

Table 5-17: Icel Province GRDP Forecast

	1997	2000	2005	2010	2012	2020
GDP (trillion TL*)	29,393	34,515	44,051	54,895	58,249	79,718
Icel Province GRDP (billion TL*)	797,356**	948,100	1,210,050	1,507,940	1,630,970	2,032,100

Note: * 1997 Turkish Lira rate was used.
** Actual figures provided by SSI

b. Financial Conditions

The master plan assumes that basically the municipal revenue will increase in proportion to the increase in GRDP except for the general budget allocated from national tax (Law 2380), property tax and cleansing tax. The revenue (excluding the cleansing tax) of Yenisehir DM, Toroslar DM, Akdeniz DM and Mersin GM are calculated as shown in the table below.

Table 5-18: Revenue Forecast (Mersin)

unit: million TL*

		1998	2005	2012	2020
Yenisehir DM	General Budget from National Tax (Law 2380)	542,764	623,466	716,166	3,345,878
	Local taxes excluding Property tax & Cleansing tax And Non-tax revenue	647,917	920,374	1,240,559	1,697,780
	Property tax	220,638	253,444	291,127	341,103
	Total	1,411,319	1,797,284	2,247,852	2,877,988
	Total (US$ 1,000)	4,961	6,318	7,902	10,117
Toroslar DM	General Budget from National Tax (Law 2380)	950,115	1,091,386	1,253,657	1,468,864
	Local taxes excluding Property tax & Cleansing tax And Non-tax revenue	659,333	936,590	1,262,417	1,727,694
	Property tax	121,062	139,062	159,739	187,160
	Total	1,730,510	2,167,038	2,675,813	3,383,718
	Total (US$ 1,000)	6,083	7,618	9,406	11,894
Akdeniz DM	General Budget from National Tax (Law 2380)	1,548,683	1,778,952	2,043,454	2,394,240
	Local taxes excluding Property tax & Cleansing tax And Non-tax revenue	498,776	708,517	955,001	1,306,976
	Property tax	263,303	302,453	347,423	407,063
	Total	2,310,762	2,789,922	3,345,878	4,108,279
	Total (US$ 1,000)	8,123	9,807	11,761	14,441
Mersin GM	General Budget from National Tax** (Law 2380)	1,961,266	2,437,484	3,035,271	3,861,487
	General Budget from National Tax (Law 3030)	4,535,724	6,443,047	8,684,499	11,885,256

		1998	2005	2012	2020
	Local taxes excluding Property tax & Cleansing tax And Non-tax revenue	1,741,453	2,473,754	3,334,340	4,563,243
	Property tax	48	60	74	95
	Total	8,238,491	11,354,345	15,054,184	20,310,081
	Total (US$ 1,000)	28,960	39,913	52,918	71,394

Notes: * Turkish Liras using 1998 constant prices
** Exchange rate; US$ 1 = 284,480 TL

Cleansing tax rate is presumed to increase to cover the SWM costs in continuation of present system step by step.

c. Conditions for Cost Estimation

c.1 Exchange Rate

Cost estimation was carried out based on the prices and exchange rate as of May 31st 1999. The prices in the past years other than 1999 were calculated based on the exchange rate in October of each fiscal year.

unit: TL

Year	1993	1994	1995	1996	1997	1998	1999
Exchange Rate (US$1.00)	12,967	35,200	50,803	97,306	180,655	284,480	407,000

c.2 Equipment and Facility Life Span

Items	Life Span (year)	Residual Value (%)
Vehicles & Heavy Equipment	7	10
Machinery	15	0
Buildings	30	0

Note: The life span of civil works and the facilities, other than buildings, depends on their period of operation.

Chapter 6

Selection of the Best Technical System Scenario

6 Selection of the Best Technical System Scenario

6.1 Selection of an Optimum Technical System

6.1.1 Selection Method

a. Criteria for Selection

Taking the current situation and background of SWM in the target area into account, the policies for the selection of a technical system are as follows:

1) Technical system proposals have to contribute to the goal for the SWM master plan, "to create the closed loop society in solid waste".
2) The implementation of technical system proposals have to be afforded by the responsible municipalities in the target areas and to be justified in terms of national economy.
3) Technical system proposals have to be consistent with the institutional requirements which are outlined in the Section 7.3 and 8.3 to ensure their efficiency.
4) Systems and technologies to be adopted should be simple so that operation and maintenance would be easy and inexpensive.
5) The foreign currency requirements for the purchase, operation and maintenance of systems should be minimised. The use of locally available materials and services should be maximised.
6) Proposed technical system should be consistent with the existing conditions and existing practices, in order to easily cope with the system.

b. Selection Procedure of an Optimum Technical System

An SWM technical system consists of various technical subsystems such as discharge and storage system, collection and haulage system, street sweeping system, intermediate treatment system, final disposal system, etc. A number of alternatives can be formed from the combination of these various subsystems. Hence, selection of the optimum technical system was carried out according to the following procedures.

1) Examining preconditions for selection of subsystems
2) Identification of potential subsystem technologies for Adana and Mersin
3) Screening potential subsystem technologies
4) Selection of an optimum technical system

6.1.2 Preconditions for Selection of Subsystems

The important factors, such as preconditions, requirements, etc., to be kept in mind regarding the selection of an optimum technical system are summarised below.

a. Sites of Future SWM Facilities

The formulation of the optimum technical system was mainly influenced by the location and number of proposed SWM facilities' sites, especially disposal sites. Through site selection work conducted in the first study work in Turkey the future SWM facilities' sites were identified and agreed on the M/M (minutes of meeting) on the IT/R (Interim Report) as shown in the table below.

Table 6-1: Sites of Future SWM Facilities

GM / SWM Facility	Adana GM		Mersin GM	
	F/S Stage	M/P Stage	F/S Stage	M/P Stage
Final Disposal Site	Present Sofulu disposal site	Not identified	Cimsa site	Not identified
Resource Recovery Facility	Present Sofulu disposal site	Not identified	Cimsa site	Not identified
Transfer Station	Not identified	Not identified	Not identified	Not identified

b. Collection and Haulage System for Private Operators

At present most of district municipalities in the target area are contracting out their SW collection/transportation and public area cleansing services to the private enterprises. The privatisation of cleansing services is being encouraged by the central government. Private operators in principle independently choose the collection and haulage system they think is most suitable. Further, they usually have limited capacity and resources. Therefore, the collection and transportation systems of private operators are ordinary excluded from the SWM master plan. However, the collection and transportation systems adopted by these contractors is covered, in view of the needs that the public sector will promote recycling of SW and introduce separate collection system for it so that the governments will control/monitor and enforce the system to the private operators.

6.1.3 Identification of Potential Subsystems

The potential technical subsystems to be screened for Adana and Mersin are listed in Table 6-2.

Table 6-2: Potential Sub-systems for SWM in Adana and Mersin

Technical Systems	Technical Sub-systems	Sub-system Components
Discharge and Storage	• Type of Storage Equipment • Source Separation	• Minor containers • Disposable containers • Medium containers • Large-bulk containers • Mixed discharge • Separate discharge • Delivery by home-owner to drop-off centres
Collection and Haulage	• Collection Frequency • Collection Method • Type of Collection Service • Collection Schedule • Type of Collection Vehicle • Transfer Station	 • Mixed collection • Separate collection • Communal container • Block (Bell) collection • Curbside collection • Door-to-door collection • Day collection • Night collection
Street Sweeping	• Cleansing Method	• Manual street sweeping • Mechanical cleaning • Vacuum cleaning • Flushing
Recycling	• Government Related • Private Sector Centred	
Intermediate treatment	• Incineration • Refuse Drive Fuel (RDF) • Composting • Biogas Production • Pyrolysis • Size Reduction • Mechanical and Manual Sorting	 • Centralised windrow composting • Centralised digester/windrow composting • Decentralised windrow composting
Final Disposal	• Location of final disposal sites • Final disposal methods • Landfill structure • Level of sanitary landfill development and operation	• Cavities in a mining quarry site, flat land or valley • Sanitary or open dumping • Anaerobic, Semi-aerobic or aerobic • 4 sanitary landfill level
Maintenance of Vehicles and Equipment	• Preventive Service Workshop • Full Service Workshop	

The results of the survey led to the selection of the optimum system outlined in the following table.

Table 6-3: Optimum Technical System

Work	Proposed System
Storage & Discharge	• Source separation: separation of compostable and Non-compostable waste • Storage container: communal containers
Collection	• Collection frequency: 6 times a week for compostable and once or twice a week for non-compostable • Collection method: separate collection • Collection system: communal container collection system (point collection) • Collection time: daytime collection • Collection vehicle: compactor trucks ($12m^3$ - $16m^3$) • Haulage system: examine direct haulage and the introduction of a transfer station in accordance with the disposal site location
Street Sweeping	• Mix system of manual and mechanical street sweeping but the ratio of manual and mechanical sweeping services shall be reviewed considering future labour forces and costs in view of cost/benefits relation.
Recycling	The following government related recycling systems will be established. • An administration system that promote production of recyclable goods/products from the manufacturing stage, with government assistance, in order to minimise waste generation (generation control) to as much as possible. • A system that enables recycling at source, in particular, separate discharge at source and promote the recycling of segregated waste materials.
Intermediate Treatment	After deliberations with the counterpart in the second and third study work in Turkey, the most suitable of the following scenarios will be selected: Scenario 1 Full Recycling • non-compostable waste: sorting plant • compostable waste biogas production • residue of sorting plant: RDF treatment • residue from biogas production and RDF treatment: sanitary landfilling Scenario 2 Composting • non-compostable waste: sorting plant • compostable waste: composting plant • residue from sorting plant and composting plant: sanitary landfilling Scenario 3 Landfill Gas Recovery • non-compostable waste: sorting plant • compostable waste: sanitary landfilling with gas recovery • residue from sorting plant: sanitary landfilling
Final Disposal	• Promote as the first priority project the construction of a sanitary landfill site that meets the standards established by MoE. • The selection of an appropriate site is very important in the development of a final disposal site. Hence, the use of one of the number of sites previously used for quarry for soil, etc. in the target areas will be promoted. • The anaerobic or aerobic structure of the landfill site will be determined depending on the best intermediate treatment system to be selected.
Equipment & Facility O/M	• Building of a small workshop for preventive maintenance. Major repairs will be entrusted over to private workshops.
Medical SWM	• Infectious and hazardous medical SW shall be strictly segregated from generation to final disposal. • After the treatment at the generation all of the infectious and hazardous medical SW generated in the target area shall be disposed of at medical SW landfills.

6.2 Selection of the Best Technical System Scenario for Adana

In the former section 6.1 through the screening potential technologies, an optimum technical system was selected. However, an optimum intermediate treatment sub-system including resource recovery sub-system could not be decided. This section presents 3 technical system scenarios for the SWM master plan for Adana and examines their advantages/disadvantages in overall SWM technical system, i.e., from collection to final disposal. After the careful discussion and examination with the C/P (counterpart) the best technical system scenario for Adana was selected.

6.2.1 Presentation of Technical System Scenarios

a. Scenarios for the Technical System

The selection of the best technical system to be realised by the M/P target year will be influenced by the social, economic, and financial conditions in 2020. One of the problems to consider in particular is whether the technical system is financially feasible. With regard to this, the following scenarios were prepared in accordance with present and estimated future financial conditions.

a.1 Scenario 1: Full recycling

Financially, this is the most expensive scenario but coincides with the full recycling system proposed by the MoE.

1.	Separate collection of two types of waste:	Compostable and non- compostable
2.	Non-compostable waste:	Sorting plant
3.	Compostable waste:	Biogas production
4.	Residue of sorting plant:	RDF treatment
5.	Residue from biogas production and RDF treatment:	Sanitary landfilling

a.2 Scenario 2: Composting

This is financially the second most expensive scenario but would help realise a recycling system that excludes the residue from the sorting plant. However, compostable waste will be recycled into ordinary compost, a method that is considered inexpensive and one that will not result in methane gas recovery.

1.	Separate collection of two types of waste:	Compostable and non- compostable
2.	Non-compostable waste:	Sorting plant
3.	Compostable waste:	Composting plant
4.	Residue from sorting plant and composting plant:	Sanitary landfilling

a.3 Scenario 3 Landfill Gas Recovery

This is financially the cheapest scenario and recycles compostable waste by the recovery of gases through anaerobic sanitary landfill operation.

1. Separate collection of two types of waste:

Compostable and non- compostable

2. Non-compostable waste: Sorting plant
3. Compostable waste: Sanitary landfilling with gas recovery
4. Residue from sorting plant: Sanitary landfilling

b. Targets for Each Scenario

The aforementioned scenarios and their targets for the year 2020 are as shown in the table below.

Table 6-4: Targets of Each Scenario for 2020 (Adana)

	Scenario 1 (Full Recycling)	Scenario 2 (Composting)	Scenario 3 (Landfill Gas Recovery)
Separate collection	100%	100%	100%
Sorting plant	all non-compostable waste	all non-compostable waste	all non-compostable waste
Biogas plant	all compostable waste	none	none
Composting plant	none	all compostable waste	none
RDF plant	all residues from sorting plant	none	none
Sanitary landfill	all residues from biogas and RDF plant	all residues from sorting and compost plants	all compostable waste and all residues from sorting plant

6.2.2 Conceptual Design

a. Future Waste Stream without Implementation of the M/P (Continuation of the Present System)

For the formulation of a SWM Master Plan (M/P) the forecast of future waste stream in the target area is indispensable. In order to clarify the difference between with and without M/P the case of the future waste stream for the continuation of the present technical system is prepared for a reference (baseline data) of the SWM M/P. Although it is not realistic, the case bases on the present waste stream and assumes its factor such as self-disposal rate, source recycling rate, etc. will not change in future. The waste stream of Adana GM in 2020 is presented in the following figure.

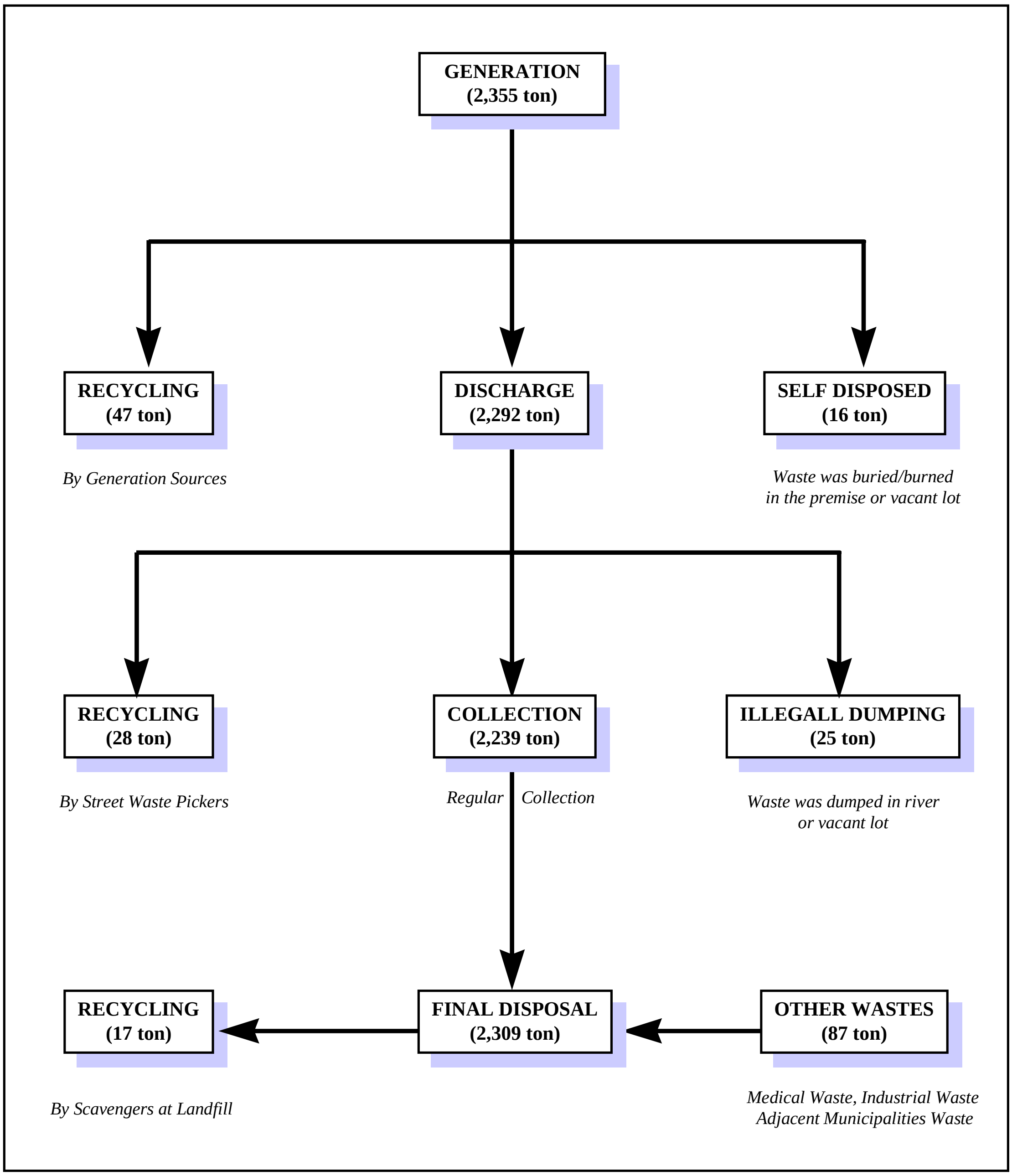

Figure 6-1: Waste Stream Diagram for Adana in Year 2020

b. Future Waste Stream for Each M/P Scenario

The future waste stream when the SWM M/P will be implemented is drawn up based on the following concepts:

1. Since the current self-disposal method such as open burning is not properly done and it gives adverse impacts on the surrounding. It should be eliminated by providing collection services by 2005.
2. The illegal dumping shall be also excluded by 2005, providing collection services and strict enforcement as well as control.

3. The current recycling rate (20.2 g/day/person) by waste generation sources will be kept until 2020
4. The recycling activities by street waste pickers will be gradually decreased and it will be disappeared by 2020.
5. The scavenging activities at the landfill shall be prohibited by January 2003 when a new recycling/composting plant will start operation.

The future waste stream for each scenario is drawn up as shown in the following table. For better understanding waste streams for 3 M/P scenarios are illustrated in the following figures.

Table 6-5: Future Waste Stream for Each M/P Scenario for Adana (2020)

ADANA Scenario1 2020year		(ton/day)	(ton/year)
Generation		2,355	
Recycling		47	
Discharge		2,308	
Collection①		2,308	
Non-Composatble	Sorting Plant(②＝①×55%)	1,269	463,331
	Recycling(③=①×13.2%)	305	
	Residue(④=①×41.8%)	964	
	RDF Plant(=④)	964	351,860
	RDF(⑤＝①×25.1%	579	
	Residue(⑥=①×16.	385	
Compostable	Bio-Gas Plant(⑦=①×45%)	1,039	379,089
	Residue(⑧=①×1.8%)	42	
	Compost(⑨=①×8.1%)	187	
	CH_4,H_2O,CO_2(⑩＝①×34.7%)	800	
	Recycling(⑪=①×0.4%)	10	
	Other Waste⑫	75	
	Final Disposal (⑥＋⑧)	427	155,855
	Final Disposal (⑥＋⑧＋⑫)	502	183,230

ADANA Scenario 2 2020year		(ton/day)	(ton/year)
Generation		2,355	
Recycling		47	
Discharge		2,308	
Collection①		2,308	
Non-Composatble	Sorting Plant(②＝①×55%)	1,269	463,331
	Recycling(③=①×13.2%)	305	
	Residue(④=①×41.8%)	964	
Compostable	Compost Plant(⑤=①×45%)	1,039	379,089
	Residue(⑥=①×1.8%)	42	
	Compost(⑦=①×8.1%)	187	
	CH_4,H_2O,CO_2(⑧＝①×34.7%)	800	
	Recycling(⑨=①×0.4%)	10	
	Other Waste⑩	75	
	Final Disposal (④＋⑥)	1,006	367,190
	Final Disposal (④＋⑥＋⑩)	1,081	394,670

ADANA Scenario3 2020year		(ton/day)	(ton/year)
Generation		2,355	
Recycling		47	
Discharge		2,308	
Collection①		2,308	
Non-Composatble	Sorting Plant(②＝①×55%)	1,269	463,331
	Recycling(③=①×13.2%)	305	
	Residue(④=①×41.8%)	964	
Compostable	Residue(⑤=①×45%)	1,039	379,089
	Other Waste⑥	75	
	Final Disposal (④＋⑤)	2,003	731,095
	Final Disposal (④＋⑤+⑥)	2,078	758,470

ADANA Continuation present system 2020year

Final Disposal = 2,435(ton/day) = 888,777 (t/year)

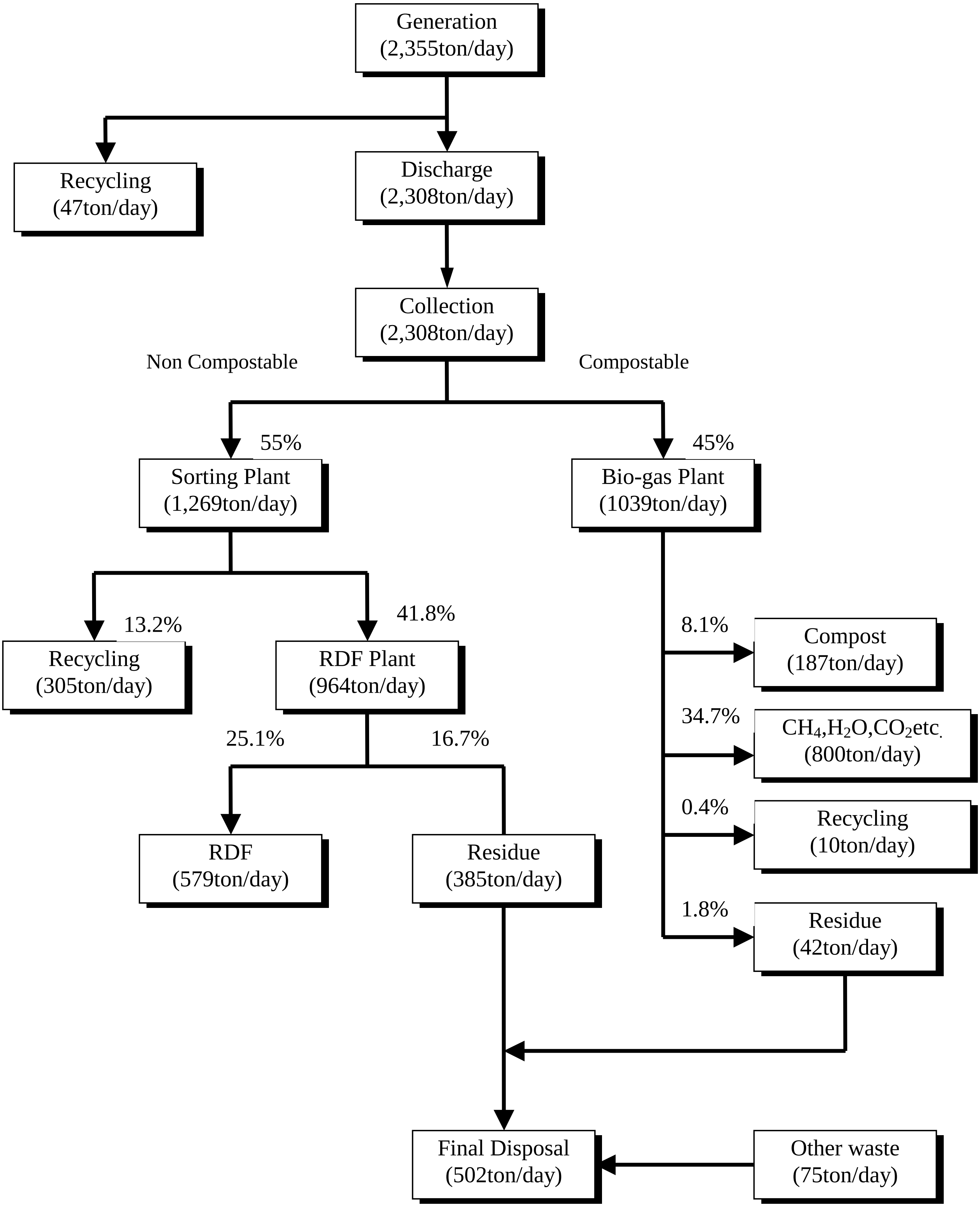

Figure 6-2: Waste Stream of M/P Scenario 1 for Adana (2020)

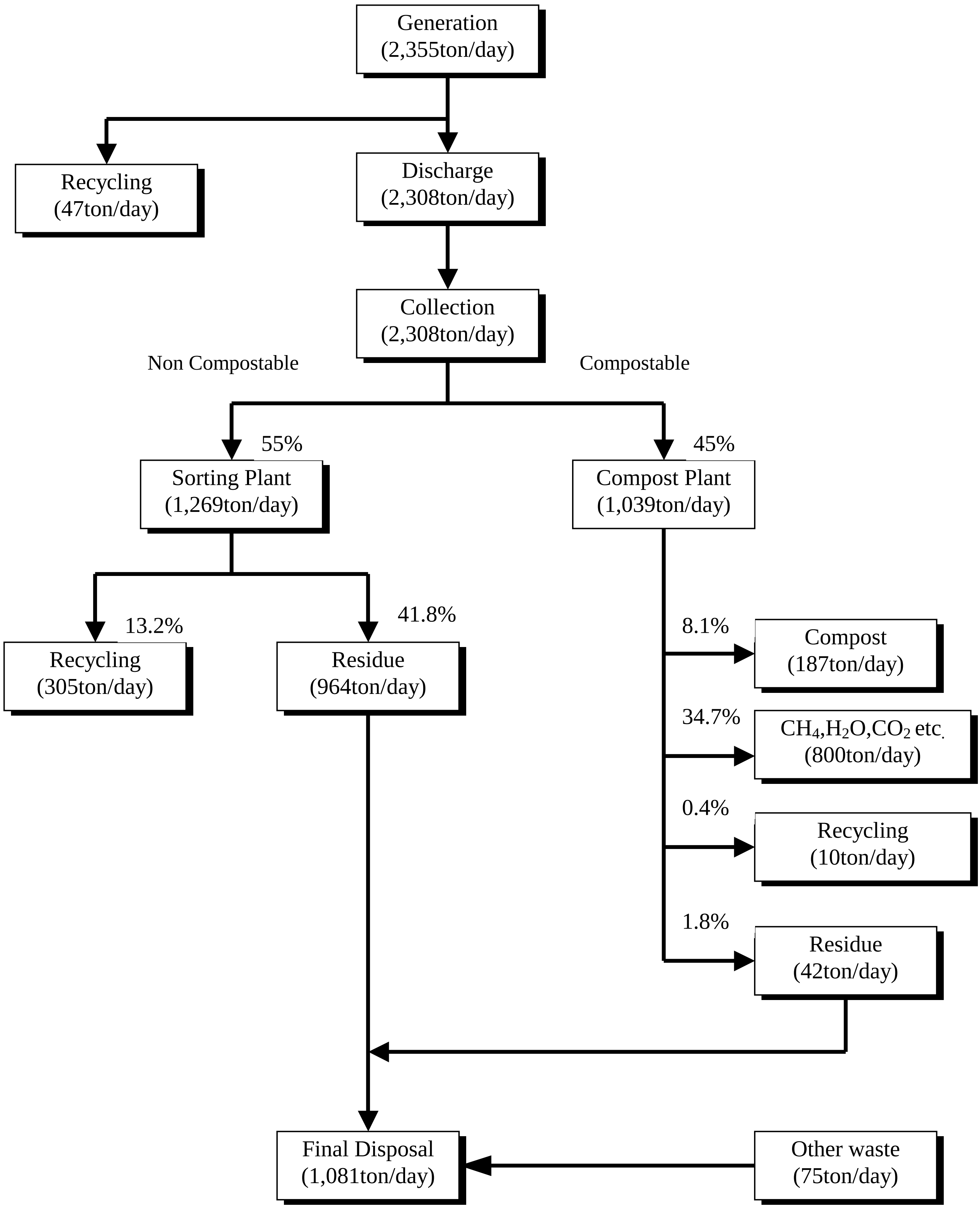

Figure 6-3: Waste Stream of M/P Scenario 2 for Adana (2020)

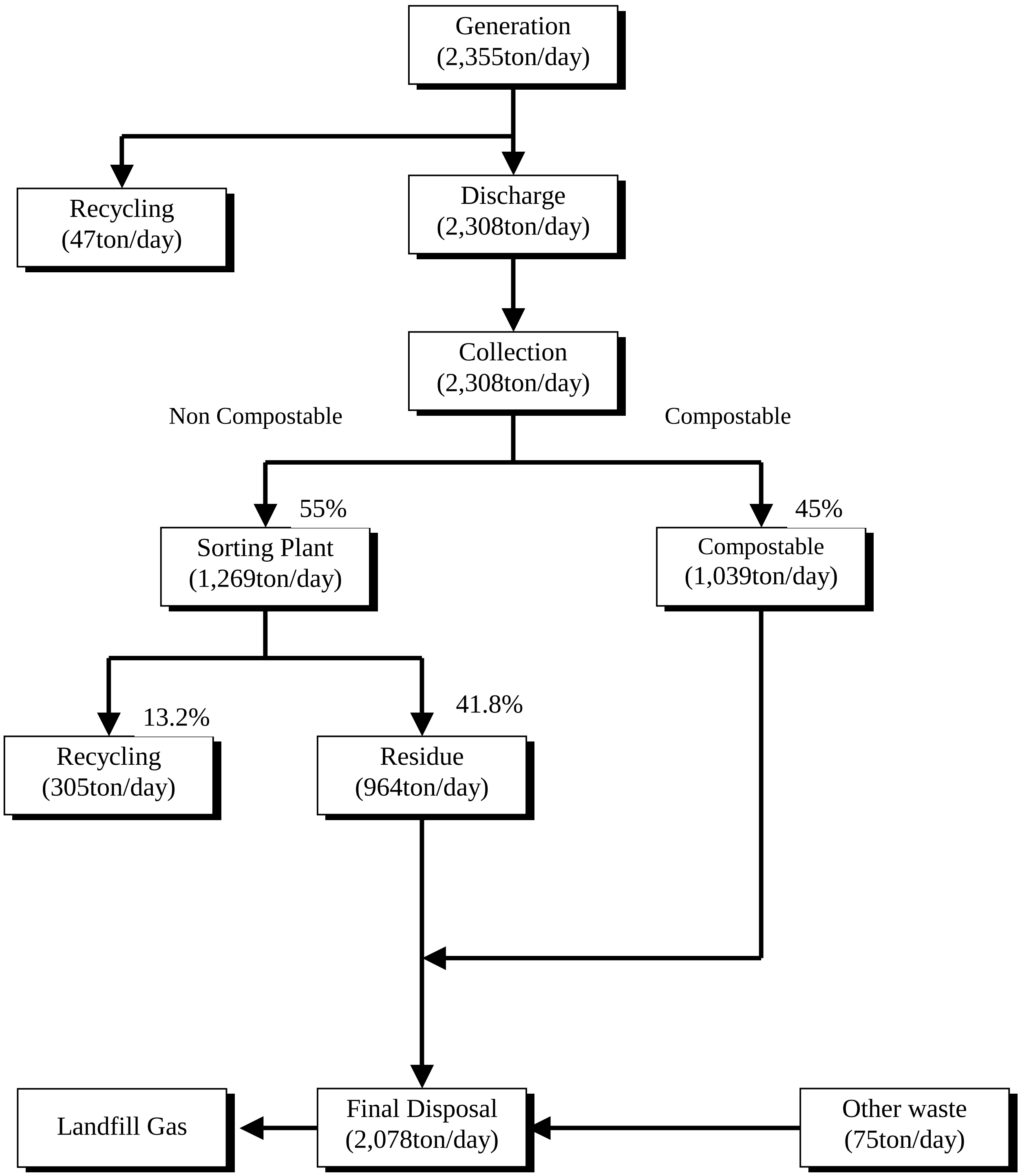

Figure 6-4: Waste Stream of M/P Scenario 3 for Adana (2020)

6.2.3 Cost Estimation

a. Cost Estimation Items

Cost Estimation of Adana GM in 2020 will be required for as follows;

- Refuse Collection & Transportation Cost
- Public Area Cleansing Cost
- Intermediate Treatment and Recycling Cost

Scenario1 -Sorting Plant
-RDF Plant
-Bio-Gas Plant

Scenario2 -Sorting Plant
-Compost Plant

Scenario3 -Sorting Plant

- Landfill Gas Collection Facility(Only Senario3)
- Final Disposal Cost

b. Unit Cost for Cost Estimation

US dollar is used for the calculation as fluctuation of Turkish Lira is sharp. Calculation is carried out using the May 1999 prices and at an exchange rate of US$ 1 = 407,000 Turkish Lira. Depreciation period for facility, heavy machinery and equipment, and the residual value are shown in the table below.

Table 6-6: Depreciation Period of Facility and Equipment

Items	Depreciation Period (Year)	Residual Value (%)
Vehicle and heavy machinery	7	10
Machinery	15	0
Building	30	0

Note: The life span of civil works and facilities other than building depends on the period of its operation.

Unit Cost of each items is shown in the table below.

Table 6-7: Unit Cost

Item		Unit Cost(US$/ton)
Refuse Collection & Transportation		22.7
Public Area Cleansing		186.0
Intermediate Treatment and Recycling	Sorting Plant	13.0
	RDF Plant	30.0
	Bio-Gas Plant	70.0
	Compost Plant	14.9
Landfill Gas Collection Facility		0.2
Final Disposal		9.6

c. Waste Amount for Each Items

c.1 Refuse Collection & Transportation and Public Area Cleansing Amount

Refuse collection and Public Area Cleansing Amount are shown in the table below.

Table 6-8: Refuse Collection & Transportation and Public Area Cleansing Amount

Item	Unit	AGM	SDM	YDM	Sub Total	Total
Refuse Collection & Transportation	ton/year	0	573,213	232,085	805,298	842,420
Public Area Cleansing	ton/year	12,062	20,797	4,263	37,122	

c.2 Recycling Intermediate Treatment Amount

Intermediate Treatment Amount are shown in the table below.

Table 6-9: Recycling Intermediate Treatment Amount

Scenario / Plant	Unit	Sorting	RDF	Bio-gas	Compost	Landfill gas
Continuation of Present System	ton/year	-	-	-	-	-
Scenario 1	ton/year	463,331	351,860	379,089	-	-
Scenario 2	ton/year	463,331	-	-	379,089	-
Scenario 3	ton/year	463,331	-	-	-	758,470

d. Landfill Disposal Amount

Landfill Disposal Amount are shown in the table below.

Table 6-10: Landfill Disposal Amount

Scenario	Unit	Landfill Disposal Amount
Continuation of Present System	ton/year	888,777
Scenario 1	ton/year	183,230
Scenario 2	ton/year	394,670
Scenario 3	ton/year	758,470

e. Comparison of Operation Cost of Each Scenario

The following table shows the operation cost, including depreciation costs, of each scenario in the year 2020. The operation cost in the table is calculated by subtracting revenues from selling materials and energy recovered by the recycling facilities. For reference, the operation cost of the continuation of present waste management system until 2020 was also calculated.

Table 6-11: Operational Cost of Each Scenario (Adana)

Adana Greater Municipality			AGM			SDM			YDM			Total (US$/year)	Discharge Amount (ton/year)	(US$/ton)	Population	(US$pc)
			Unit Cost (US$/ton)	Waste Amount (ton/year)	Cost (US$/year)	Unit Cost (US$/ton)	Waste Amount (ton/year)	Cost (US$/year)	Unit Cost (US$/ton)	Waste Amount (ton/year)	Cost (US$/year)					
Continuation Present System	Collection		—	—	—	22.7	573,213	13,011,935	22.7	232,085	5,268,330	18,265,000				
	Road & Park		186.0	12,062	2,243,532	186.0	20,797	3,868,242	186.0	4,263	792,918	6,820,000				
	Landfill		9.6	888,777	8,532,259	—	—	—	—	—	—	8,532,000				
	Administr	5%	—	—	538,790	—	—	844,009	—	—	303,062	1,681,000				
	Total		—	—	11,314,581	—	—	17,724,186	—	—	6,364,310	35,298,000	842,420	41	2,268,174	16
Scienario1	Collection		—	—	—	22.7	573,213	13,011,935	22.7	232,085	5,268,330	18,265,000				
	Road & Park		186.0	12,062	2,243,532	186.0	20,797	3,868,242	186.0	4,263	792,918	6,820,000				
	Plant	Sorting	13.0	463,331	6,023,303	—	—	—	—	—	—	6,031,000				
		Bio-gas	70.0	351,860	24,630,200	—	—	—	—	—	—	24,630,000				
		RDF	30.0	379,089	11,372,670	—	—	—	—	—	—	11,373,000				
	Landfill		9.6	183,230	1,759,008	—	—	—	—	—	—	1,759,000				
	Medical waste	Landfill	61.9	4,636	286,968	—	—	—	—	—	—	287,000				
	Administr	5%	—	—	2,315,784	—	—	844,009	—	—	303,062	3,458,000				
	Total		—	—	48,631,465	—	—	4,712,251	—	—	6,364,310	72,623,000	842,420	86	2,268,174	32
Scienario2	Collection		—	—	—	22.7	573,213	13,011,935	22.7	232,085	5,268,330	18,265,000				
	Road & Park		186.0	12,062	2,243,532	186.0	20,797	3,868,242	186.0	4,263	792,918	6,820,000				
	Plant	Sorting	13.0	463,331	6,023,303	—	—	—	—	—	—	6,031,000				
		Compost	14.9	379,089	5,648,426	—	—	—	—	—	—	5,652,000				
	Landfill		9.6	394,670	3,788,832	—	—	—	—	—	—	3,805,000				
	Medical waste	Landfill	61.9	4,636	286,968	—	—	—	—	—	—	287,000				
	Administr	5%	—	—	899,553	—	—	844,009	—	—	303,062	2,043,000				
	Total		—	—	18,890,615	—	—	17,724,186	—	—	6,364,310	42,903,000	842,420	50	2,268,174	19
Scienario3	Collection		—	—	—	22.7	573,213	13,011,935	22.7	232,085	5,268,330	18,265,000				
	Road & Park		186.0	12,062	2,243,532	186.0	20,797	3,868,242	186.0	4,263	792,918	6,820,000				
	Plant	Sorting	13.0	463,331	6,023,303	—	—	—	—	—	—	6,031,000				
		Gas-collection	0.2	758,470	151,694	—	—	—	—	—	—	152,000				
	Landfill		9.6	758,470	7,281,312	—	—	—	—	—	—	7,281,000				
	Medical waste	Landfill	61.9	4,636	286,968	—	—	—	—	—	—	287,000				
	Administr	5%	—	—	799,340	—	—	844,009	—	—	303,062	1,942,000				
	Total		—	—	16,786,150	—	—	17,724,186	—	—	6,061,248	40,778,000	842,420	48	2,268,174	18

6.2.4 Selection of the Best Technical System Scenario

The results of the comparison of the above 3 scenarios was presented to the counterparts for deliberation and the selection of the best scenario.

a. Comparative Analysis of Scenarios

The following table summarises the features of each of the 4 scenarios which include the scenario of continuation of the present system.

Table 6-12: Comparison of M/P Scenarios (Adana)

Scenario Items	Without M/P Continuation of Present System	Scenario 1 Full Recycling	Scenario 2 Composting	Scenario 3 Landfill Gas Recovery
• **Technical**	• With the exclusion of sanitary landfilling, the adoption of this technical system is not forecast to incur problems because it is identical to the system currently in use. • On the other hand, the adoption of this system would incur no developments in the solid waste management technical system. • Since sanitary landfilling has already been introduced in some Turkish cities, the transfer of relevant technology can be satisfactorily carried out.	• To successfully produce biogas the separation of putrescible waste should be very strictly carried out. • The use of biogas plants to treat municipal SW is a relatively new approach, hence there is no assurance regarding its functions. Accordingly, the application in the target area, where even sanitary landfill is not conducted, is forecast to incur problems. • The operation of RDF facilities for waste treatment is only foreseen to incur minor problems. However, there is a need to consider the fact that recipients/users of RDF should adopt air pollution control measures. Hence sufficient considerations should be paid to the adoption of this technique.	• To successfully conduct composting, the separation of putrescible waste should be rigorously carried out. • As opposed to biogas plants, the technical problems that may arise in the composting of putrescible waste are minimal as long as separate collection is practised. • Nonetheless, difficulties are foreseen in view of the current manpower (skills) of Adana GM.	• Separate collection is not stringently required for the sorting facility as it is for biogas production and composting. • Although not perceived as a difficult technique, landfill gas recovery is unheard of in Turkey. This would, therefore, require transfer of technology and training opportunity, etc. from other countries. • Of the three scenarios, this alternative is considered to incur the least technical problems.
• **Social**	• Since this scenario proposes the continued use of the current collection system, no social issues are forecast to arise. • On the other hand, site acquisition for the development of the final disposal site would be the most difficult as, of the 4 scenarios, this scenario requires the largest disposal site **(1,333,000m^3/year**).	• Since this scenario requires separate collection to be very strictly carried out, proper education of and full co-operation from the public are important. • With the establishment of an highly advanced recycling system, public awareness regarding the importance of realising a closed-loop society on solid waste will be considerably heightened. • Site acquisition would be the easiest as, of the 4 scenarios, this scenario requires the smallest disposal site capacity **(275,000m^3/year**).	• Since this scenario requires separate collection to be strictly carried out, proper education of and full co-operation from the public are important. • With the establishment of an advanced recycling system, public awareness regarding the importance of realising a closed-loop society on solid waste will be heightened. • Site acquisition would be relatively easy as it only requires a disposal site capacity of **592,000m^3/year**.	• Since this scenario requires separate collection, proper education of and co-operation from the public are important. • Except for the sorting facility, the disposal site is the most essential waste management facility, hence site acquisition is extremely important. • Because this scenario requires a huge disposal site capacity (**1,138,000m^3/year**), gaining the consensus of the residents is considered to become increasingly difficult by the year.
• **Environmental**	• Except for the conversion of the dump site into a sanitary landfill, problems brought about by current SWM, e.g., illegal dumping, scavenging, will remain unsolved.	• Excluding residues from the RDF plant and biogas production plant, the majority of the waste will be recycled into some form. • The rate of waste recycling activities is very high at **82%**. Accordingly, this scenario will	• All waste generated will be taken to the recycling facility (compost plant and sorting facility). • This will incur a **57%** recycling rate, thereby reducing the amount	• Of the waste generated, only non-putrescible waste types will be handled at the sorting facility. • This will only incur a **15%** recycling rate, thereby hardly

Scenario Items	Without M/P Continuation of Present System	Scenario 1 Full Recycling	Scenario 2 Composting	Scenario 3 Landfill Gas Recovery
	• The rate of waste recycling activities is very low at **3.9%**. Accordingly, this scenario will hardly contribute to global environmental preservation.	highly contribute to global environmental preservation.	for final disposal. • This scenario will contribute less to global environmental preservation than biogas production (Scenario 1) due to the CO_2 emission levels the aerobic fermentation of putrescible waste for composting would emit.	reducing the final disposal amount. • The recovery of landfill gas (biogas) through the anaerobic fermentation of putrescible waste in the disposal site will curtail the emission of CH_4 which is believed to accelerate global warming four or five times more than CO_2. Accordingly, this scenario will highly contribute to global environmental preservation.
• **Economic**	• Through sanitary landfilling practices, waste disposal activities in the final disposal site will be environmentally-friendly.	• Maximum waste recycling will be achieved. Thermal recycling through biogas and RDF production, and improvement in compost quality will contribute to industrial development in the region. • Recovery of recyclable materials will be carried out in the sorting plant. • The disposal amount will be significantly reduced, and the landfill life span will be extended **5.7** times more than the case of continuation of present system.	• Recycling of organic waste is possible. Improvement in compost quality will contribute to industrial development in the region. • Recovery of recyclable materials will be carried out in the sorting plant. • The disposal amount will be reduced, and the landfill life span will be extended **2.4** times more than the case of continuation of present system.	• Thermal recycling through landfill gas recovery is possible. • Recovery of recyclable materials will be carried out in the sorting plant. • The disposal amount will be slightly reduced.
• **Financial**	• Will incur the smallest financial responsibility for SWM expenses: **US$16/person/year.** • Requires that the SWM expenses should be raised **1.5** times the expenses in 1998 (10.8 US$/person)	• The cleansing expenses will incur **2.10** times more than the case of continuation of present system. • Asking the residents to shoulder the SWM expenses is forecast to be difficult.	• The cleansing expenses will incur **1.22** times more than the case of continuation of present system. • Because this scenario will contribute to economic development in the region, the scenario could be realised, although it will depend on efforts exerted to gain resident consensus.	• The cleansing expenses will incur **1.27** times more than the case of continuation of present system. • Because this scenario will contribute to economic development in the region, the scenario could be realised, although it will depend on efforts exerted to gain resident consensus.

•

b. Selection of the Best Scenario

The team presented three (3) SWM M/P scenarios for Adana GM in the IT/R and requested the C/P to carefully examine their advantages and disadvantages, problems to be encountered, issues to be solved, etc., and select by the end of the second study work in Turkey mid-April 1999. The team recommends Scenario 2: Composting based on the following reasons:

1. The revenues from the operation of the recycling facility will never exceed the depreciation cost and O&M (operation and maintenance) expenses. In general unless a tipping fee is imposed, the revenues will never outbalance the depreciation cost and O&M expenses.
2. Although scenario 1 presents an ideal recycling system, realising this system would require each resident to pay US$ 32 for the waste handling cost (2.96 times more than present costs estimated by the team).
3. Composting using the biogas plant is extremely favourable in terms of global environmental protection because the plant emits low CO_2 levels in the atmosphere. Nonetheless, it is still not a well-established technology. In particular, it is a very expensive system and quite difficult to strictly control the mixing of unsuitable waste types. In addition it requires a large amounts of wastewater treatment for the operation.
4. For RDF, the acquisition of users who have combustion facilities with air pollution countermeasures is of utmost importance.
5. Although scenario 3, which focuses on sanitary landfilling and the recovery of landfill gas, would require very little expenses, the system cannot be realised unless a large and appropriate sanitary landfill site is acquired.

The Adana GM decided to select scenario 2 for this study. However, since year 2020, the M/P target year, is very far from now, they expressed they like to be free to change the scenario in accordance with socio-economic situation, technology progress, etc. in future.

6.2.5 Environmental Issues for EIA of F/S Projects

a. Selection of F/S Projects

Since scenario 2 was selected, the projects to be covered by the F/S are as follows:

- Introduction of the separate collection of two waste types
- Construction of a sorting and composting plant
- Construction of a sanitary landfill site

b. Environmental Issues for EIA of F/S Projects

EIA shall be conducted in accordance with EIA procedures in Turkey. In the phase of formulation of M/P, the priority projects for the F/S are selected and the items for EIA for the projects are decided. The priority projects are detailed below.

1. Introduction of separate collection system
2. Construction and operation of sorting plant

3. Construction and operation of composting plant
4. Construction and operation of final disposal site

The items to be subject to the EIA should have been as instructed by Ministry of Environment, but to proceed with the study, the items were selected by the study team based on the JICA guidelines for environmental considerations for the conduct of development studies and the result was approved by Ministry of Environment.

For Adana, it was determined and agreed that the site for the F/S of the above-mentioned facilities 2, 3 and 4 is the present Sofulu disposal site. The EIA for the use of this disposal site will cover the following items:

- Economic activities
- Public health
- Hazards/risks
- Topographic and geological conditions
- Groundwater resource conditions
- Hydrological conditions
- Fauna and flora
- Landscape/aesthetics
- Air pollution
- Water pollution
- Soil contamination
- Noise and vibration
- Offensive odour

In accordance with the format of EIA prepared by Ministry of Environment, the following EIA issues need to be implemented.

Table 6-13: EIA issues to be implemented for priority projects

Items	Contents, Frequency, Points etc.	Method
1. Economic Activities	① Loss of arable lands ② Halt in scavenging activities ③ Construction & operation of sorting plant and composting plant	Hearing from Farmers and Scavengers Marketability of recyclable materials and compost
2. Public Health	④ Sanitary condition of residents ⑤ Work environment at waste treatment and disposal facilities	Data from medical facilities Hearing from residents
3. Hazards /Risks	⑥ Collapse and sliding of slope ⑦ Gas explosions ⑧ Fire breakouts	Plans and design
4. Topographic /Geological Condition	Distribution of significant topographic and geological features	Data from topographical and geological survey
5. Groundwater Resources	① Flow condition ② Possibility of diverting flow	Data from geological survey
6. Hydrological Conditions	Flow condition and runoff rate (2 times during one month x 2 points)	Flow rates are measured. Well data from other projects
7. Fauna/Flora	① Endangered species ② Condition of ecosystem (An area of radius 1 km outside of the boundary of the proposed site)	Field survey
8. Landscape/Aesthetics	① Determination of visibility area and representative view stations ② Preparation of a montage photo from two view stations on the vicinity land (An area of radius 1.5 km outside of the boundary of the proposed site)	Site survey Photographs
9. Air Quality	① Understanding of impact from the dumping site ② Forecast of impact from the sanitary landfill (2 times during one month x 2 points Dust, SO_2, NOx, Cl_2, PM, Pb)	Method of Turkish standard or EU standard
10. Water Quality	Present situation and Forecast of impact from sanitary landfill (Stream; 2 times x 3 points Groundwater; 2 times x 6 points Leachate; 2 times x 1 point Colour, pH, Total dissolved matter, DO, COD, BOD, Fecal Coliform, T-N, T-P, NH+4, Na+, Cl-, SO4, Cr_6, Hg, Cd, Pb, As)	Method of Turkish standard or EU standard
11. Soil Contamination	Conjecture from the existing sanitary landfill	Qualitative way
12. Noise/Vibration	Forecast of noise and vibration due to construction and operation of facilities	Calculation
13. Offensive Odour	Conjecture from the existing sanitary landfill	Qualitative way
14. Land use	(An area of radius 1 km outside of the boundary of the proposed site)	Site survey and development plans
15. Water Use	Groundwater; within a radius of 5 km south of the site Surface water; from the site to Seyhan River	Hearing from residents
16. Meteorological data	Wind direction/velocity, precipitation, evaporation	Data collection and analysis

6.3 Selection of the Best Technical System for Mersin

In the former section 6.1 through the screening potential technologies, an optimum technical system was selected. However, an optimum intermediate treatment sub-system including resource recovery sub-system could not be decided. This section presents 3 technical system scenarios for the SWM master plan for Mersin and examines their advantages/disadvantages in overall SWM technical system, i.e., from collection to final disposal. After the careful discussion and examination with the C/P (counterpart) the best technical system scenario for Mersin was selected.

6.3.1 Presentation of Technical System Scenarios

a. Scenarios for the Technical System

Financially, this is the most expensive scenario but coincides with the full recycling system proposed by the MoE.

1. Separate collection of two types of waste:

   Compostable and non- compostable
2. Non-compostable waste — Sorting plant
3. Compostable waste: — Biogas production
4. Residue of sorting plant: — RDF treatment
5. Residue from biogas production and RDF treatment: — Sanitary landfilling

a.2 Scenario 2: Composting

This is financially the second most expensive scenario but would help realise a recycling system that excludes the residue from the sorting plant. However, compostable waste will be recycled into ordinary compost, a method that is considered inexpensive and one that will not result in methane gas recovery.

1. Separate collection of two types of waste:

   Compostable and non- compostable
2. Non-compostable waste: — Sorting plant
3. Compostable waste: — Composting plant
4. Residue from sorting plant and composting plant: — Sanitary landfilling

a.3 Scenario 3 Landfill Gas Recovery

This is financially the cheapest scenario and recycles compostable waste by the recovery of gases through anaerobic sanitary landfill operation.

1. Separate collection of two types of waste:

   Compostable and non- compostable
2. Non-compostable waste: — Sorting plant
3. Compostable waste: — Sanitary landfilling with gas recovery
4. Residue from sorting plant: — Sanitary landfilling

b. Targets for Each Scenario

The aforementioned scenarios and their targets for the year 2020 are as shown in the table below.

Table 6-14: Targets of Each Scenario for 2020 (Mersin)

	Scenario 1 (Full Recycling)	Scenario 2 (Composting)	Scenario 3 (Landfill Gas Recovery)
Separate collection	100%	100%	100%
Sorting plant	all non-compostable waste	all non-compostable waste	all non-compostable waste
Biogas plant	all compostable waste	none	none
Composting plant	none	all compostable waste	none
RDF plant	all residues from sorting plant	none	none
Sanitary landfill	all residues from biogas and RDF plant	all residues from sorting and compost plants	all compostable waste and all residues from sorting plant

6.3.2 Conceptual Design

a. Future Waste Stream without Implementation of the M/P (Continuation of the Present System)

For the formulation of a SWM Master Plan (M/P) the forecast of future waste stream in the target area is indispensable. In order to clarify the difference between with and without M/P the case of the future waste stream for the continuation of the present technical system is prepared for a reference (baseline data) of the SWM M/P. Although it is not realistic, the case bases on the present waste stream and assumes its factor such as self-disposal rate, source recycling rate, etc. will not change in future. The waste stream of Mersin GM in 2020 is presented in the figure below.

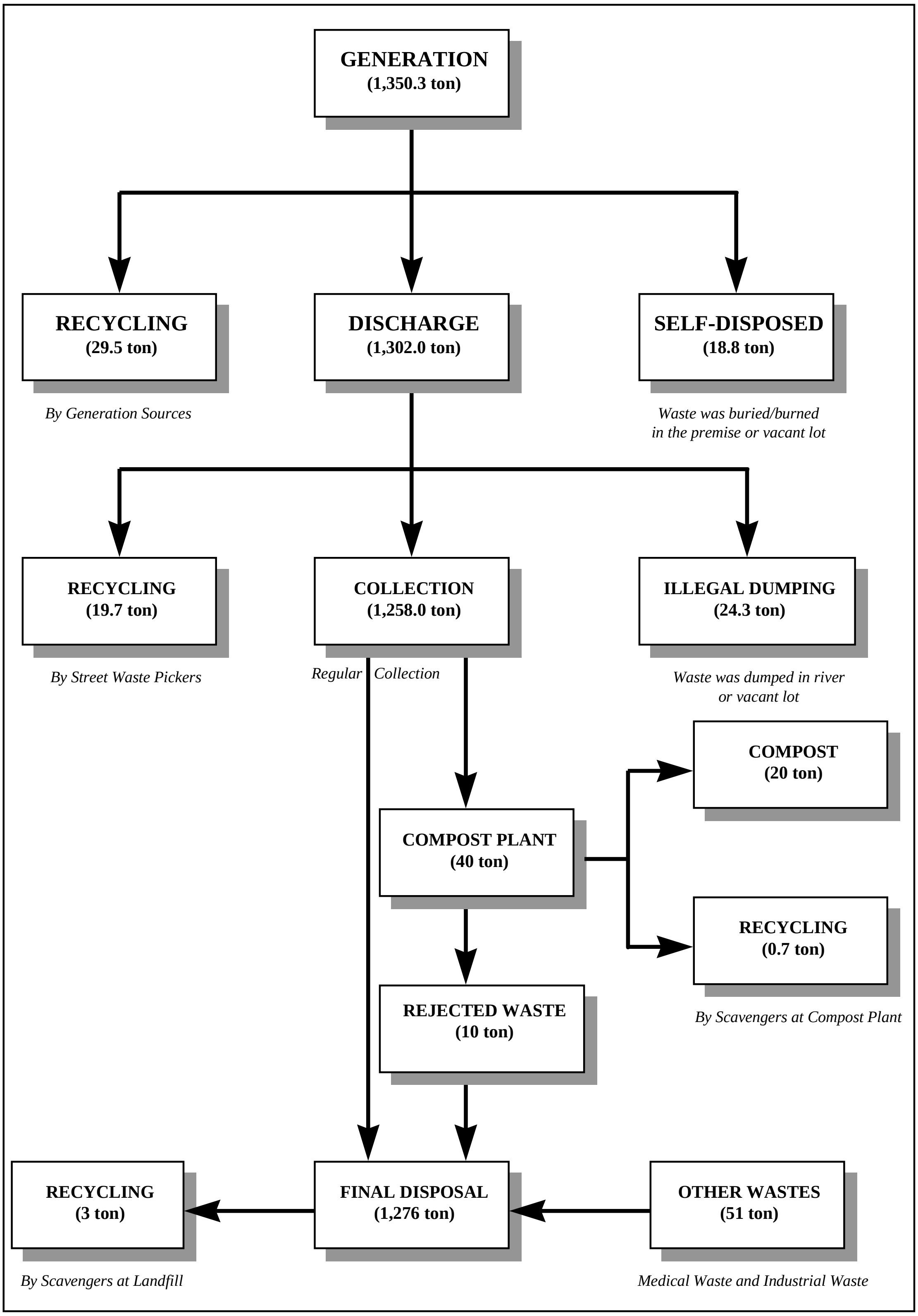

Figure 6-5: Waste Stream Diagram for Mersin in Year 2020

b. Future Waste Stream for Each M/P Scenario

The future waste stream when the SWM M/P will be implemented is drawn up based on the following concepts:

1. Since the current self-disposal method such as open burning is not properly done and it gives adverse impacts on the surrounding. It should be eliminated by providing collection services by 2005.
2. The illegal dumping shall be also excluded by 2005, providing collection services and strict enforcement as well as control.
3. The current recycling rate (20.2 g/day/person) by waste generation sources will be kept until 2020
4. The recycling activities by street waste pickers will be gradually decreased and it will be disappeared by 2020.
5. The scavenging activities at the landfill shall be prohibited by January 2003 when a new recycling/composting plant will start operation.

The future waste stream for each scenario is drawn up as shown in the following table. For better understanding waste streams for 3 M/P scenarios are illustrated in the following figures.

Table 6-15: Future Waste Stream for Each M/P Scenario for Mersin

MERSIN Scenario1 2020year			(ton/day)	(ton/year)
Generation			1,350	
Recycling			29	
Discharge			1,321	
Collection①			1,321	
Non-Composatble	Sorting Plant(②＝①×58%)		766	279,656
		Recycling(③=①×13.9%)	184	
		Residue(④=①×44.1%)	582	
	RDF Plant(=④)		582	212,430
		RDF(⑤＝①×26.5%	349	
		Residue(⑥=①×17.(	233	
Compostable	Bio-Gas Plant(⑦=①×42%)		555	202,509
		Residue(⑧=①×1.7%)	22	
		Compost(⑨=①×7.6%)	100	
		CH_4,H_2O,CO_2(⑩＝①×32.3%)	427	
		Recycling(⑪=①×0.4%)	6	
	Other Waste⑫		46	
	Final Disposal	(⑥＋⑧)	255	93,075
		(⑥＋⑧＋⑫)	301	109,865

MERSIN Scenario2 2020year			(ton/day)	(ton/year)
Generation			1,350	
Recycling			29	
Discharge			1,321	
Collection①			1,321	
Non-Composatble	Sorting Plant(②＝①×58%)		766	279,656
		Recycling(③=①×13.9%)	184	
		Residue(④=①×44.1%)	582	
Compostable	Compost Plant(⑤=①×42%)		555	202,509
		Residue(⑥=①×1.7%)	22	
		Compost(⑦=①×7.6%)	100	
		CH_4,H_2O,CO_2(⑧＝①×32.3%)	427	
		Recycling(⑨=①×0.4%)	6	
	Other Waste⑩		46	
	Final Disposal	(④＋⑥)	604	220,460
		(④＋⑥＋⑪)	650	237,447

MERSIN Scenario3 2020year			(ton/day)	(ton/year)
Generation			1,350	
Recycling			29	
Discharge			1,321	
Collection①			1,321	
Non-Composatble	Sorting Plant(②＝①×58%)		766	279,656
		Recycling(③=①×13.9%)	184	
		Residue(④=①×44.1%)	582	
Compostable	Residue(⑤=①×42%)		555	202,509
	Other Waste⑥		46	
	Final Disposal	(④＋⑤)	1,137	415,005
		(④＋⑤+⑥)	1,183	431,795

MERSIN Continuation present system 2020year

Final Disposal = 1,386(ton/day) = 505,890 (t/year)

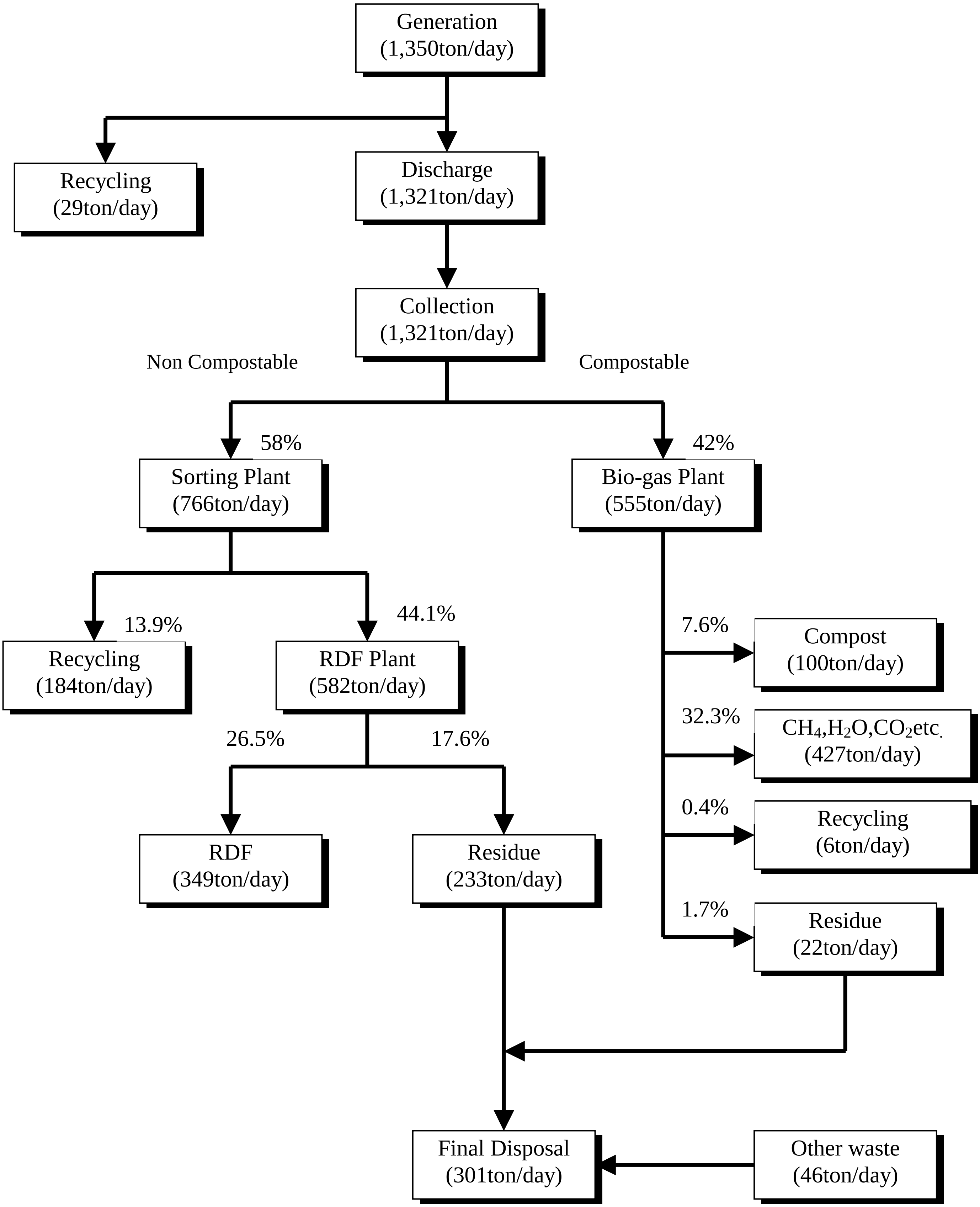

Figure 6-6: Waste Stream of M/P Scenario 1 for Mersin (2020)

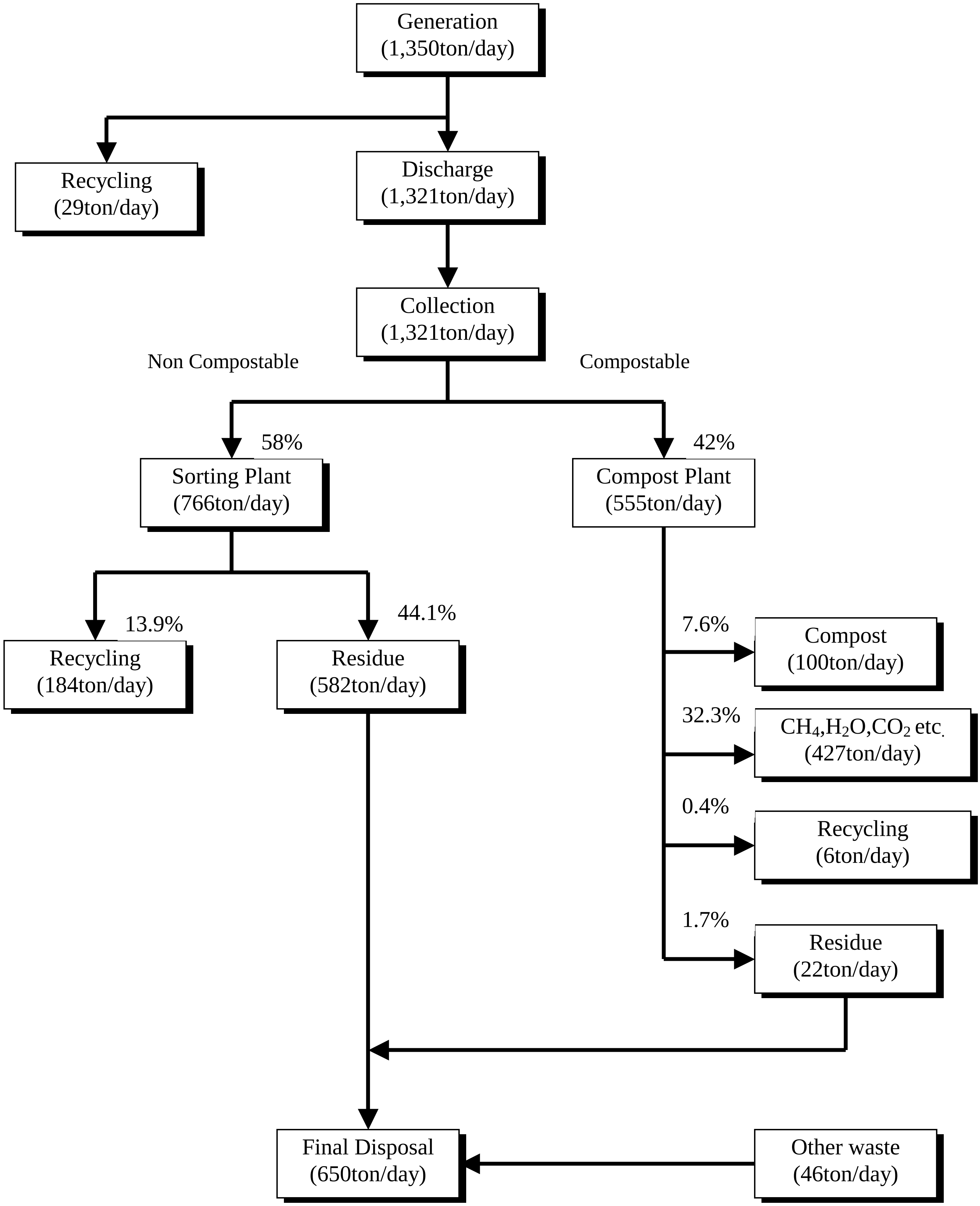

Figure 6-7: Waste Stream of M/P Scenario 2 for Mersin (2020)

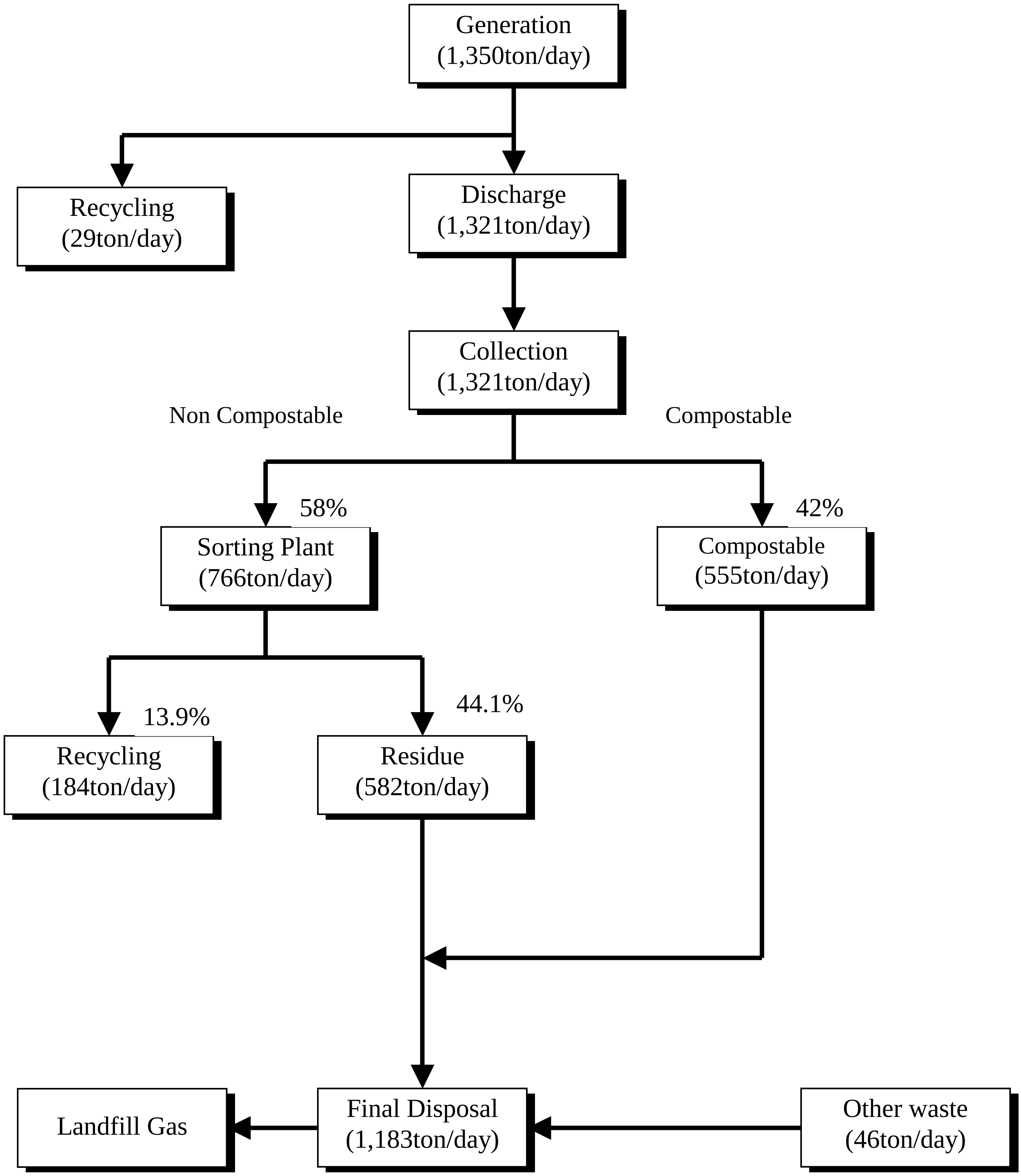

Figure 6-8: Waste Stream of M/P Scenario 3 for Mersin (2020)

6.3.3 Cost Estimation

a. Cost Estimation Items

Cost Estimation of Mersin GM in 2020 will be required for as follows;

- Refuse Collection & Transportation Cost
- Public Area Cleansing Cost
- Intermediate Treatment and Recycling Cost

Scenario1 -Sorting Plant
-RDF Plant
-Bio-Gas Plant

Scenario2 -Sorting Plant
-Compost Plant

Scenario3 -Sorting Plant

- Landfill Gas Collection Facility(Only Scenario 3)
- Final Disposal Cost

b. Unit Cost for Cost Estimation

US dollar is used for the calculation as fluctuation of Turkish Lira is sharp. Calculation is carried out using the May 1999 prices and at an exchange rate of US$ 1 =407,000 Turkish Lira. Depreciation period for facility, heavy machinery and equipment, and the residual value are shown in the table below.

Table 6-16: Depreciation Period of Facility and Equipment

Items	Depreciation Period (Year)	Residual Value (%)
Vehicle and heavy machinery	7	10
Machinery	15	0
Building	30	0

Note: The life span of civil works and facilities other than building depends on the period of its operation.

Unit Cost of each items is shown in the table below.

Table 6-17: Unit Cost

Item		Unit Cost(US$/ton)
Refuse Collection & Transportation		19.3
Public Area Cleansing		221
Intermediate Treatment and Recycling	Sorting Plant	16.9
	RDF Plant	30.0
	Bio-Gas Plant	70.0
	Compost Plant	22.4
Landfill Gas Collection Facility		0.2
Final Disposal		10.6

c. Waste Amount for Each Items

c.1 Refuse Collection & Transportation and Public Area Cleansing Amount

Refuse collection and Public Area Cleansing Amount are shown in the table below.

Table 6-18: Refuse Collection & Transportation and Public Area Cleansing Amount

Item	Unit	MGM	YDM	TDM	ADM	Sub Total	Total
Refuse Collection & Transportation	ton/year	0	105,224	171,184	189,833	466,241	482,165
Public Area Cleansing	ton/year	2,734	3,015	4,868	5,307	15,924	

c.2 Recycling Intermediate Treatment Amount

Intermediate Treatment Amount are shown in the table below.

Table 6-19: Recycling Intermediate Treatment Amount

Scenario / Plant	Unit	Sorting	RDF	Bio-gas	Compost	Landfill gas
Continuation of Present System	ton/year	-	-	-	-	-
Scenario 1	ton/year	279,656	212,430	202,509	-	-
Scenario 2	ton/year	279,656	-	-	202,509	-
Scenario 3	ton/year	279,656	-	-	-	431,795

d. Landfill Disposal Amount

Landfill Disposal Amount are shown in the table below.

Table 6-20: Landfill Disposal Amount

Scenario	Unit	Landfill Disposal Amount
Continuation of Present System	ton/year	505,890
Scenario 1	ton/year	109,865
Scenario 2	ton/year	237,447
Scenario 3	ton/year	431,795

e. Comparison of Operation Cost of Each Scenario

The following table shows the operation cost, including depreciation costs, of each scenario in the year 2020. The operation cost in the table is calculated by subtracting revenues from selling materials and energy recovered by the recycling facilities. For reference, the operation cost of the continuation of present waste management system until 2020 was also calculated.

Table 6-21: Operational Cost of Each Scenario (Mersin)

Mersin Greater Municipality			MGM			YDM			ADM				Discharge Amount (ton/year)	(US$/ton)	Population	(US$pc)
			Unit Cost (US$/ton)	Waste Amount (ton/year)	Cost (US$/year)	Unit Cost (US$/ton)	Waste Amount (ton/year)	Cost (US$/year)	Unit Cost (US$/ton)	Waste Amount (ton/year)	Cost (US$/year)	Unit Cost (US$/ton)				
Continuation	Collection		–	–	–	19.3	105,224	2,030,823	19.3	171,184	3,303,851	19.3				
Present system	Road & Park		221.0	2,734	604,214	221.0	3,015	666,315	221.0	4,868	1,075,828	221.0				
	Plant	Compost	21.7	14,600	316,820	–	–	–	–	–	–	–				
	Landfill		10.6	505,890	5,362,434	–	–	–	–	–	–	–				
	Administratior	5%	–	–	314,173	–	–	134,857	–	–	218,984	–				
	Total		–	–	6,597,641	–	–	2,831,995	–	–	4,598,663	–	492,750	38	1,249,940	15
Scienario1	Collection		–	–	–	19.3	105,224	2,030,823	19.3	171,184	3,303,851	19.3				
	Road & Park		221.0	2,734	604,214	221.0	3,015	666,315	221.0	4,868	1,075,828	221.0				
	Plant	Sorting	16.9	279,656	4,726,186	–	–	–	–	–	–	–				
		Bio-gas	70.0	202,509	14,175,630	–	–	–	–	–	–	–				
		RDF	30.0	212,430	6,372,900	–	–	–	–	–	–	–				
	Landfill		10.6	93,805	994,333	–	–	–	–	–	–	–				
	Medical Waste		101.2	1,789	181,047	–	–	–	–	–	–	–				
	Administratior	5%			1,352,716	–	–	134,857	–	–	218,984	–				
	Total		–	–	28,407,026	–	–	2,831,995	–	–	4,598,663	–	492,750	83	1,249,940	33
Scienario2	Collection		–	–	–	19.3	105,224	2,030,823	19.3	171,184	3,303,851	19.3				
	Road & Park		221.0	2,734	604,214	221.0	3,015	666,315	221.0	4,868	1,075,828	221.0				
	Plant	Sorting	16.9	279,656	4,726,186	–	–	–	–	–	–	–				
		Compost	22.4	202,509	4,536,202	–	–	–	–	–	–	–				
	Landfill		10.6	237,447	2,516,938	–	–	–	–	–	–	–				
	Medical Waste		101.2	1,789	181,047	–	–	–	–	–	–	–				
	Administratior	5%			628,229	–	–	134,857	–	–	218,984	–				
	Total		–	–	13,192,816	–	–	2,831,995	–	–	4,598,663	–	492,750	52	1,249,940	21
Scienario3	Collection		–	–	–	19.3	105,224	2,030,823	19.3	171,184	3,303,851	19.3				
	Road & Park		221.0	2,734	604,214	221.0	3,015	666,315	221.0	4,868	1,075,828	221.0				
	Plant	Sorting	16.9	279,656	4,726,186	–	–	–	–	–	–	–				
		Gas-collectic	0.2	431,795	86,359	–	–	–	–	–	–	–				
	Landfill		10.6	431,795	4,577,027	–	–	–	–	–	–	–				
	Medical Waste		101.2	1,789	181,047	–	–	–	–	–	–	–				
	Administratior	5%			508,742	–	–	134,857	–	–	218,984	–				
	Total		–	–	10,683,575	–	–	2,831,995	–	–	4,598,663	–	492,750	47	1,249,940	19

6.3.4 Selection of the Best Technical System Scenario

The results of the comparison of the above 3 scenarios was presented to the counterparts for deliberation and the selection of the best scenario.

a. Comparative Analysis of Scenarios

The following table summarises the features of each of the 4 scenarios which include the scenario of continuation of the present system.

Table 6-22: Comparison of M/P Scenarios (Mersin)

Scenario Items	Without M/P Continuation of Present System	Scenario 1 Full Recycling	Scenario 2 Composting	Scenario 3 Landfill Gas Recovery
• **Technical**	• With the exclusion of sanitary landfilling, the adoption of this technical system is not forecast to incur problems because it is identical to the system currently in use. • On the other hand, the adoption of this system would incur no developments in the solid waste management technical system. • Since sanitary landfilling has already been introduced in some Turkish cities, the transfer of relevant technology can be satisfactorily carried out.	• To successfully produce biogas the separation of putrescible waste should be very strictly carried out. • The use of biogas plants to treat municipal SW is a relatively new approach, hence there is no assurance regarding its functions. Accordingly, the application in the target area, where even sanitary landfill is not conducted, is forecast to incur problems. • The operation of RDF facilities for waste treatment is only foreseen to incur minor problems. However, there is a need to consider the fact that recipients/users of RDF should adopt air pollution control measures. Hence sufficient considerations should be paid to the adoption of this technique.	• To successfully conduct composting, the separation of putrescible waste should be rigorously carried out. • As opposed to biogas plants, the technical problems that may arise in the composting of putrescible waste are minimal as long as separate collection is practised. • Nonetheless, difficulties are foreseen in view of the current manpower (skills) of Mersin GM.	• Separate collection is not stringently required for the sorting facility as it is for biogas production and composting. • Although not perceived as a difficult technique, landfill gas recovery is unheard of in Turkey. This would, therefore, require transfer of technology and training opportunity, etc. from other countries. • Of the three scenarios, this alternative is considered to incur the least technical problems.
• **Social**	• Since this scenario proposes the continued use of the current collection system, no social issues are forecast to arise. • On the other hand, site acquisition for the development of the final disposal site would be the most difficult as, of the 4 scenarios, this scenario requires the largest disposal site **(759,000m^3/year)**.	• Since this scenario requires separate collection to be very strictly carried out, proper education of and full co-operation from the public are important. • With the establishment of an highly advanced recycling system, public awareness regarding the importance of realising a closed-loop society on solid waste will be considerably heightened. • Site acquisition would be the easiest as, of the 4 scenarios, this scenario requires the smallest disposal site capacity **(165,000m^3/year)**.	• Since this scenario requires separate collection to be strictly carried out, proper education of and full co-operation from the public are important. • With the establishment of an advanced recycling system, public awareness regarding the importance of realising a closed-loop society on solid waste will be heightened. • Site acquisition would be relatively easy as it only requires a disposal site capacity of **356,000m^3/year**.	• Since this scenario requires separate collection, proper education of and co-operation from the public are important. • Except for the sorting facility, the disposal site is the most essential waste management facility, hence site acquisition is extremely important. • Because this scenario requires a huge disposal site capacity (**648,000m^3/year**), gaining the consensus of the residents is considered to become increasingly difficult by the year.
• **Environmental**	• Except for the conversion of the dump site into a sanitary landfill, problems brought about by current SWM, e.g., illegal dumping, scavenging, will remain unsolved.	• Excluding residues from the RDF plant and biogas production plant, the majority of the waste will be recycled into some form. • The rate of waste recycling activities is very high at **81%**. Accordingly, this scenario will	• All waste generated will be taken to the recycling facility (compost plant and sorting facility). • This will incur a **55%** recycling rate, thereby reducing the amount	• Of the waste generated, only non-putrescible waste types will be handled at the sorting facility. • This will only incur a **16%** recycling rate, thereby hardly

Scenario Items	Without M/P Continuation of Present System	Scenario 1 Full Recycling	Scenario 2 Composting	Scenario 3 Landfill Gas Recovery
	• The rate of waste recycling activities is very low at **5.4 %**. Accordingly, this scenario will hardly contribute to global environmental preservation.	highly contribute to global environmental preservation.	for final disposal. • This scenario will contribute less to global environmental preservation than biogas production (Scenario 1) due to the CO2 emission levels the aerobic fermentation of putrescible waste for composting would emit.	reducing the final disposal amount. • The recovery of landfill gas (biogas) through the anaerobic fermentation of putrescible waste in the disposal site will curtail the emission of CH4 which is believed to accelerate global warming four or five times more than CO2. Accordingly, this scenario will highly contribute to global environmental preservation.
• **Economic**	• Through sanitary landfilling practices, waste disposal activities in the final disposal site will be environmentally-friendly.	• Maximum waste recycling will be achieved. Thermal recycling through biogas and RDF production, and improvement in compost quality will contribute to industrial development in the region. • Recovery of recyclable materials will be carried out in the sorting plant. • The disposal amount will be significantly reduced, and the landfill life span will be extended **5.4** times more than the case of continuation of present system.	• Recycling of organic waste is possible. Improvement in compost quality will contribute to industrial development in the region. • Recovery of recyclable materials will be carried out in the sorting plant. • The disposal amount will be reduced, and the landfill life span will be extended **2.3** times more than the case of continuation of present system.	• Thermal recycling through landfill gas recovery is possible. • Recovery of recyclable materials will be carried out in the sorting plant. • The disposal amount will be slightly reduced.
• **Financial**	• Will incur the smallest financial responsibility for SWM expenses: **US$ 15/person/year.** • Requires that the SWM expenses should be raised **2.21** times the expenses in 1998 (6.8 US$/person)	• The cleansing expenses will incur 2**.18** times more than the case of continuation of present system. • Asking the residents to shoulder the SWM expenses is forecast to be difficult.	• The cleansing expenses will incur **1.37** times more than the case of continuation of present system. • Because this scenario will contribute to economic development in the region, the scenario could be realised, although it will depend on efforts exerted to gain resident consensus.	• The cleansing expenses will incur **1.24** times more than the case of continuation of present system. • Because this scenario will contribute to economic development in the region, the scenario could be realised, although it will depend on efforts exerted to gain resident consensus.

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b. Selection of the Best Scenario

The team presented three (3) SWM M/P scenarios for Mersin GM in the IT/R and requested the C/P to carefully examine their advantages and disadvantages, problems to be encountered, issues to be solved, etc., and select by the end of the second study work in Turkey mid-April 1999. The team recommends Scenario 2: Composting based on the following reasons:

1. The revenues from the operation of the recycling facility will never exceed the depreciation cost and O&M (operation and maintenance) expenses. In general unless a tipping fee is imposed, the revenues will never outbalance the depreciation cost and O&M expenses.
2. Although scenario 1 presents an ideal recycling system, realising this system would require each resident to pay US$ 33 for the waste handling cost (4.85 times more than present costs estimated by the team).
3. Composting using the biogas plant is extremely favourable in terms of global environmental protection because the plant emits low CO_2 levels in the atmosphere. Nonetheless, it is still not a well-established technology. In particular, it is a very expensive system and quite difficult to strictly control the mixing of unsuitable waste types. In addition it requires a large amounts of wastewater treatment for the operation.
4. For RDF, the acquisition of users who have combustion facilities with air pollution countermeasures is of utmost importance.
5. Although scenario 3, which focuses on sanitary landfilling and the recovery of landfill gas, would require very little expenses, the system cannot be realised unless a large and appropriate sanitary landfill site is acquired.

The Mersin GM decided to select scenario 2 for this study. However, since year 2020, the M/P target year, is very far from now, they expressed they like to be free to change the scenario in accordance with socio-economic situation, technology progress, etc. in future.

6.3.5 Environmental Issues for EIA of F/S Projects

a. Selection of F/S Projects

If scenario 2 is selected, the projects to be covered by the F/S are as follows:

- Introduction of the separate collection of two waste types
- Construction of a sorting and composting plant
- Construction of a sanitary landfill site

b. Environmental Issues for EIA of F/S Projects

EIA shall be conducted in accordance with EIA procedures in Turkey. In the phase of formulation of M/P, the priority projects for the F/S are selected and the items for EIA for the projects are decided. The priority projects are detailed below.

1. Introduction of separate collection system
2. Construction and operation of final disposal site

3. Construction and operation of sorting plant
4. Construction and operation of composting plant

The items to be subject to the EIA should have been as instructed by Ministry of Environment, but to proceed with the study, the items were selected by the study team based on the JICA guidelines for environmental considerations for the conduct of development studies and the result was approved by Ministry of Environment.

For Mersin, it was determined and agreed that the site for the F/S of the above-mentioned facilities 2, 3 and 4 is Cimsa site. The EIA for the use of this disposal site will cover the following items:

- Economic activities
- Traffic and public facilities
- Public health
- Hazards/risks
- Groundwater resource conditions
- Hydrological conditions
- Fauna and flora
- Landscape/aesthetics
- Air pollution
- Water pollution
- Soil contamination
- Noise and vibration
- Offensive odour

In accordance with the format of EIA prepared by Ministry of Environment, the following EIA issues need to be implemented.

Table 6-23: EIA Issues to be Implemented for Priority Projects

Survey	Contents, Frequency, Points etc.	Method
1. Economic Activities	① Halt in clay extraction ② Halt in scavenging activities ③ Construction & operation of sorting plant and composting plant	Hearing of quarry activities Hearing from scavengers Marketability of recyclable materials and compost
2. Traffic Volume	① Determination of current traffic volume ② Forecast of future traffic volume and impact (3points from 7 am to 7pm: large and small vehicle, motorbike, bicycle, pedestrian)	Field survey (hourly count)
3. Public Health	① Sanitary condition of residents ② Work environment at waste treatment and disposal facilities	Data from medical facilities Hearing from residents
4. Hazards /Risks	① Collapse of slope ② Gas explosions ③ Fire breakouts	Plans and design
1. Groundwater Resources	① Flow condition ② Possibility of diverting flow	Data from geological survey
1. Hydrological Conditions	Flow condition and runoff rate (Surface water; 2 times during one month x 2 points Groundwater; 2 times during three months x 3 points)	Flow rates are measured. Groundwater table Collection of well data
7. Fauna/Flora	① Endangered species ② Condition of ecosystem (An area of radius 1 km outside of the boundary of the proposed site)	Field survey
8. Landscape/Aesthetics	① Determination of visibility area and representative view stations ② Preparation of a montage photo from two view stations on the vicinity land (An area of radius 1.5 km outside of the boundary of the proposed site)	Site survey Photographs
9. Air Quality	① Understanding of impact from the dumping site ② Forecast of impact from the sanitary landfill (2 times during one month x 2 points: Dust, SO_2, NOx, Cl_2, PM, Pb)	Method of Turkish standard or EU standard
10. Water Quality	Present situation and forecast of impact from sanitary landfill(Stream; 2 times x 3 points Groundwater; 2 times x 6 points Leachate; 2 times x 1 point Colour, pH, Total dissolved matter, DO, COD, BOD, Faecal Coliform, T-N, T-P, NH+4, Na+, Cl-, SO4, Cr6, Hg, Cd, Pb, As)	Method of Turkish standard or EU standard
11. Soil Contamination	Conjecture from the existing sanitary landfill	Qualitative
12. Noise/Vibration	Forecast of noise and vibration due to construction and operation of facilities	Calculation
13. Offensive Odour	Conjecture from the existing sanitary landfill	Quantitative
14. Land use	An area of radius 1 km outside of the boundary of the proposed site	Site survey and development plans
15. Water Use	Groundwater; within a radius of 5 km south of the site Surface water; from the site to the point of 5 km downstream	Hearing from residents
16. Meteorological data	Wind direction/velocity, precipitation, evaporation	Data collection and analysis