Annex 4

Planning Frameworks for a SWM Master Plan

Contents

List of Tables

List of Figures

Page :

4 Planning Frameworks for a SWM Master Plan

4.1 Siting of Future SWM Facilities

4.1.1 Site Selection Method

a. Land Acquisition

a.1 General Land Acquisition Procedures

The land acquisition process which is conducted by municipalities starts with collecting data on the nature of the existing ownership of the land. If the land is unregistered, municipalities should first apply to the National Real Estate Directorate to register the land with the Treasury. The Directorate determines the boundaries and type of land for registration. For all kinds of registered public or treasury land, land acquisition process follows with the application of municipalities to the local offices of the National Real Estate Directorate with the purpose of acquiring the property rights of the public or treasury land.

In case of privately owned lands, municipalities can expropriate or purchase the land with the decision of the Municipal Council. For this purpose, municipalities first prepare plans that show land boundaries and its type, and site information on the owner's registers of tax and title deed and contact address. Based on the decision given by the Municipal Council, municipalities apply to Deed and Cadastrate Office indicating the title of the land. The Local Commission determines the price of the land.

However, expropriation is mostly a problematic procedure. A better and more rapid alternative is purchase of land with the consent of the landowner.

a.2 Legislation

Municipality can obtain the property right of public, private or treasury land with the intervention of Land Office, which is a branch of the Ministry of Reconstruction. For this purpose the municipality must apply to the Office. The reasons and purposes of the land demand should be explained in this application. According to the Law of the Land Office, act 1164, the Office provides land for the public utility by the ways of agreement, taking over or buying. For the unregistered land (which is also public land), the National Real Estate Directorate registers the land first with the Treasury. Directorate will determine the boundaries and properties of the area. The Office gives the land by selling, renting or giving right of use to the municipality. Municipality must seriously take into consideration the purchasing conditions, that is no right to use the land for other purposes, and should be punctual with the time plan, which is forwarded to the Office.

For the ownership of the private land, the municipality can expropriate or purchase the land for the benefit of the public, according to "The Expropriation Law" (No.2942). If the land is inside the municipality boundaries, "municipality council" (*Belidiye Encumeni*) can take decisions on public benefits and can expropriate the land. Before the expropriation, the municipality must also prepare the plan of the land that is showing the boundaries, area and use of the land, determine owner of the

land and owner's address, collect information about registers of tax and title deed. After the council has had its decision the municipality will apply to deed office for the explanation on the title land. The local commission determines the price of the land. If the land is outside the municipality boundary, these decisions and procedures will be taken by "province directing committee".

a.3 Land Acquisition for SWM

Under the Greater Municipality Law, greater municipalities are responsible for selecting the sites for transfer stations, processing, and disposal facilities.

According to the Solid Waste Control Regulations (introduced in 1991) under the Environment Law (1983), municipalities and, where appropriate, greater municipalities are responsible for granting licenses for waste disposal sites. The provincial governor is responsible for granting site licenses outside municipality boundaries. Before granting a license, the municipality or authority must also obtain permission from the Local Environment Board for settlements with a population of less than 10,000. For settlements with a population of over 10,000, 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.

b. Major SWM Facilities

The results of the first work in Turkey indicate that the following SWM facilities are highly likely going to be very important in the target areas.

1. Final disposal site
2. Transfer station
3. Resource recovery facility (e.g., compost plant and sorting plant)

c. Site Selection Method

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 previously mentioned, 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 4-1: 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

4.1.2 Final Disposal Sites for Adana GM

A final disposal site is indispensable to an SWM system, regardless of the system's structure, which 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 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 described below.

This section of the report describes and evaluates the candidate landfill sites to serve the Greater Municipality of Adana. Recommendations for the future landfill site of Adana are also included.

The locations and photos of the candidate sites proposed by the Municipality are shown in Figure 4-1 and Figure 4-2.

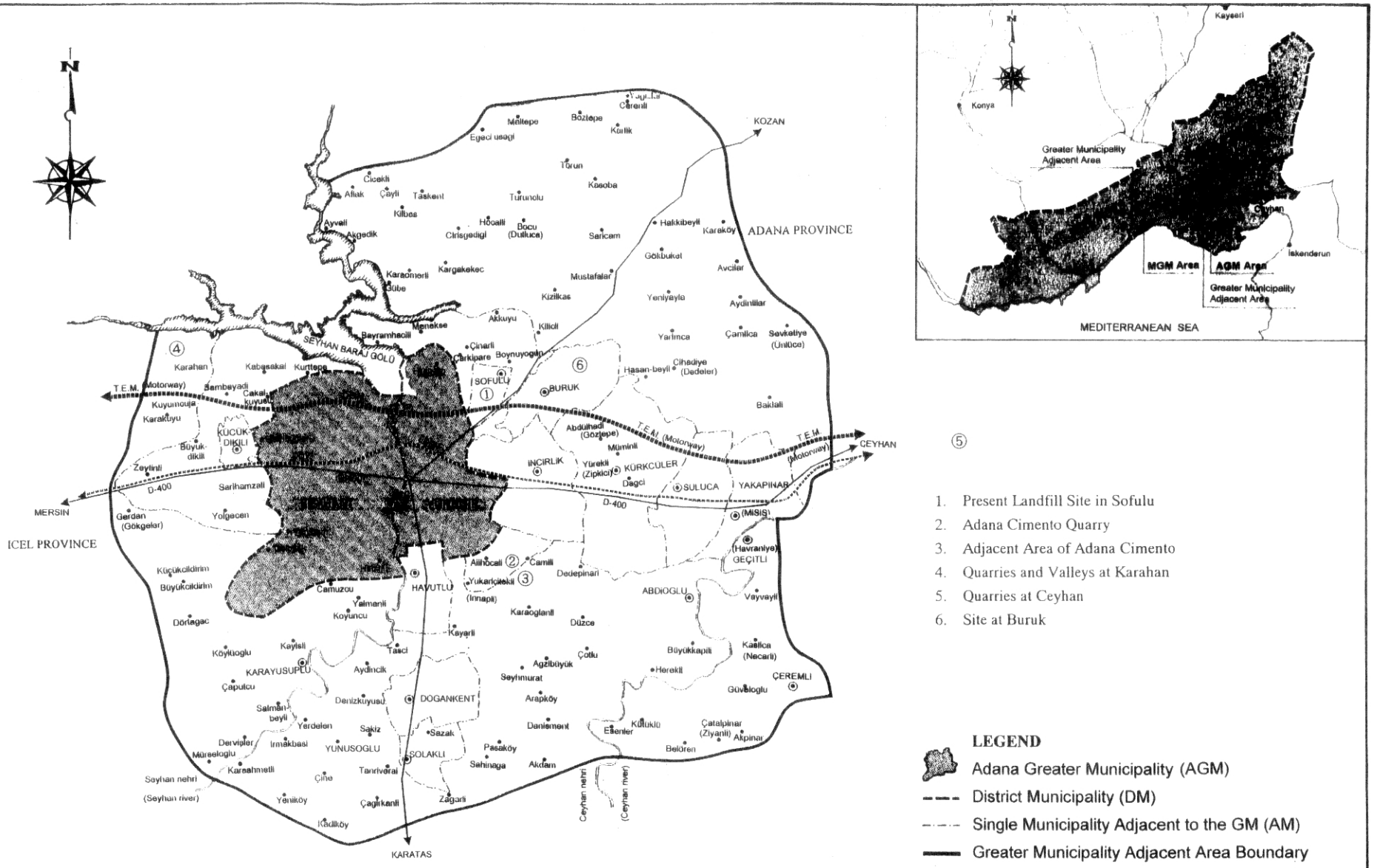

Figure 4-1: Location of Candidate Disposal Sites for Adana GM

Present Landfill Site in Sofulu (Foreground is the site for extension)

Adana Cimento Quarry

Adjacent Area of Adana Cimento

Figure 4-2: Photographs of Candidate Disposal Sites for Adana GM (1)

Quarries and Valleys at Karahan

Quarries at Seyhan

Site at Buruk

Figure 4-3: Photographs of Candidate Disposal Sites for Adana GM (2)

a. Present Landfill Site in Sofulu

a.1 Location of the Proposed Landfill Site

The landfill is located at Old Kozan Road in the municipality of Sofulu as shown in Figure 4-1. It is located approximately 10km by road north of the Adana City Centre.

The present landfill covers an area of approximately 20ha on the western side of a valley. It is proposed that the extended landfill should cover an area of approximately 100ha including the upper part of the valley, the eastern side of the valley, and an abandoned quarry south of the landfill.

Subject to future development of the City, the landfill may in future be even more extended to the east where presently some huge gravel quarries are operated. In accordance with the Adana Master Plan (1996), a new housing area (heavy density) is planned to be erected immediately west of the landfill site and a new housing area (scattered) is planned north of the landfill.

a.2 Conditions of the Proposed Landfill Site

The proposed extended landfill site holds capacity for at least 10 years disposal from Adana.

The village of Sofulu is located approximately 1.5km east of the boundary of the extended landfill site. The present landfill is situated on the western side of a valley. However not at the upper part, and no facilities have been constructed to divert clean run-off water. Thus, an unnecessary big quantity of leachate is generated, and at the bottom of the valley is a stream with water that is a mixture from leachate and clean run-off water. No proper facilities are available for collection and treatment of leachate. Leachate from the stream is collected in a pond south of the landfill.

The present waste front along the maturation area is very steep, and in some places more than 10m high. Because it is so steep the waste front cannot be covered with soil. The Landfill is always smoking, causing bad smells not only to people living near the landfill, but also to people near the city centre of Adana. Rehabilitation works for the present landfill are urgently required.

Even if Sofulu landfill is closed after a new landfill has been developed on a new site, the rehabilitation works at Sofulu landfill will remain. The rehabilitation works at Sofulu landfill could be carried out in a cost effective way, if the works are combined with the continued operation of the landfill. Soil for daily coverage of waste is easily available.

Access road to the extended landfill at the bottom of the valley has to be constructed. The site is located in an area where interest in groundwater is little. Conditions regarding ownership have to be investigated.

a.3 Advantages and Disadvantages

Advantages and disadvantages for the proposed extended landfill site are summarised as follows.

a.3.1 Advantages

- The extended landfill site holds capacity for many years disposal from Adana.
- Soil for daily soil coverage of waste is easily available.
- Urgently required rehabilitation works for the present landfill can be carried out in a cost effective way if combined with continued operation of the landfill site.

a.3.2 Disadvantages

- The construction of residential areas immediately north and west of the landfill site has to be postponed.

a.4 Summary

The proposed extended landfill site in Sofulu is considered **feasible for further investigations**.

b. Adana Cimento Quarry and Adjacent Area

b.1 Location and Condition of Proposed Landfill Sites

Adana Cimento is situated approximately 15km east of the City Centre of Adana. Three sites were presented near the factories of Adana Cimento.

b.1.1 Site South of Adana Cimento

The site includes or is neighbouring an area with archaeological remains. Further, a village with mayor chicken farming is neighbour to the site. The site comprise a flat area that has a ground full of boulder rocks embed in clay. Earthworks would be expensive and soil for daily soil coverage would not be easily available, unless an agreement with Adana Cimento could be obtained regarding free delivery of soil that cannot be used in the production of cement. The site was recommended by a geologist due to the prevalence of clay, not considering other requirements to a landfill site.

b.1.2 Site Southeast of Adana Cimento

The proposed site is located immediately south-east of the premises of Adana Cimento. The site comprises a flat area full of boulder rocks. Earthworks would be expensive and soil for daily soil coverage would not be easily available, unless an agreement with Adana Cimento could be obtained regarding free delivery of soil that cannot be used in the production of cement. The site is neighbouring huge fields mainly cultivated with peanuts and cotton.

b.1.3 Site Located in the Excavation Area at Adana Cimento

The excavation area is huge and holds capacity for many years disposal from Adana. Soil for daily soil coverage of waste is easily available, and access to the bottom of the quarry is easily available. However, most of the excavation area is still operated by Adana Cimento.

The operation of a landfill in the excavation is considered very difficult, also because many blastings are carried out. The geological and hydrogeological conditions of the site have not yet been investigated.

b.2 Summary

Three sites were presented and evaluated. Two sites were evaluated to be **infeasible** for the construction of the future landfill of the Greater Municipality of Adana.

The site located in the quarry of Adana Cimento is considered to be **feasible for further investigations at a later stage** when a suitable part of the quarry is no longer operated by Adana Cimento.

c. Quarries and Valleys at Karahan

c.1 Location of the Proposed Landfill Site

The proposed site is located 4km west of Karahan at the main road Adana/Karaisali, as shown in Figure 4-1. The site is located approximately 23km west of the City Centre of Adana, 10km west of the present City border. The site is located approximately 2km south of the western corner of Seyhan Baraj Golu Lake.

c.2 Conditions of the Proposed Landfill Site

Two (2) villages are located to the west and south-west at a distance of 2 - 3km. The geological and hydrogeological conditions of the site have not yet been investigated. The proposed site comprises:

- **A Quarry That is Still Operated**

  In the quarry a clay material is excavated maybe by the Highway Department or Rural Affairs Department. The excavated material is mixed with gravel and used for road construction. The area of the quarry is roughly estimated at 50ha. The main road, Adana/Karaisali, passes right through the quarry and traffic on this road is quite heavy. Access to the quarry is easily available.

- **Three Small Valleys Adjoining the Quarry**

  The area of the valleys is roughly estimated at 50ha. The valleys are scarcely covered with bushes and few small trees. Thus, the Ministry of Forest may not easily approve the construction of a landfill in the valleys. At the end of the valleys, at a distance of approximately 300m, run-off water from the valleys is discharged into a stream. Access to the valleys can be obtained by constructing an approximately 1km access road.

  The capacity of the proposed site is considered to be enough for many years. However, the quarry is still in operation, and it considered extremely difficult to operate a landfill in the quarry unless the main road, Adana/Karaisali, is relayed. Soil for daily soil coverage is easily available.

c.3 Advantages and Disadvantages

Advantages and disadvantages for the proposed landfill site are summarised as follows.

c.3.1 Advantages

- Access to the site is easily available. However the site is located at a distance of approximately 23km from Adana City Centre.

- Soil for daily coverage of waste is easily available.

c.3.2 Disadvantages Regarding the Quarry

- It will be very difficult to operate a landfill in the quarry since the quarry is still in operation and the present main road, Adana/Karaisali, passes right through the quarry

c.3.3 Disadvantages Regarding the Valleys

- The Ministry of Forest may perhaps disapprove the construction of a landfill in the valleys.

c.4 Summary

The proposed landfill site that is located west of Karahan in some small valleys adjoining a clay quarry is considered **feasible for further investigation**.

The 3 small valleys are proposed utilised for the first phases of the landfill. The quarry may be used at a later stage when the it is no longer operated and the main road, Adana/Karaisali, has been relayed. It should be investigated if the Ministry of Forrest may resist that the valleys are used for the construction of a landfill.

d. Quarries at Seyhan

d.1 Location of the Proposed Landfill Site

The proposed site is located 6km west of Seyhan, approximately 42km east of the City Centre of Adana. The location is shown in Figure 4-1. The site is located approximately 500m from the Seyhan Nerie River. An ancient castle is located on the opposite side of the river bank.

d.2 Conditions of the Proposed Landfill Site

The capacity of the proposed site is considered to be enough for many years. However, the quarry is still in operation, and it will be extremely difficult also to operate a landfill in the quarry. Two (2) abandoned quarries were also presented; but their capacity was too small. In the quarry, stones are excavated and crushed into gravel. The availability of soil for daily coverage is considered inadequate since the ground mostly consists of rocks.

Two (2) villages are located at a distance of less than 2km as well as an ancient castle. The landfill is visible to visitors to this recreational tourist centre. Access to the quarry is easily available.

d.3 Advantages and Disadvantages

Advantages and disadvantages for the proposed landfill site are summarised as follows.

d.3.1 Advantages

- Access to the site is easily available. However the site is located at a distance of approximately 42km from the Adana City Centre.

d.3.2 Disadvantages

- It will be very difficult to operate a landfill in the stone quarry since the quarry is still in operation.
- The requirements for soil for daily soil coverage of waste will not be fulfilled unless some of the required soil is imported from outside of the landfill site.
- The site is located near 2 villages and less than 2km from an ancient castle.

d.4 Summary

The proposed landfill site which is located in a quarry west of Seyhan is evaluated to be **infeasible** for the construction of the future landfill for the Greater Municipality of Adana. The main reasons are:

- The site is located at a distance of more than 40km from the City Centre of Adana.
- The quarry is located less than 2km from 2 villages and an ancient castle.
- The quarry is still in operation.
- Soil for daily soil coverage will not be easily available.

e. Site at Buruk

e.1 Location of Proposed Landfill Site

The proposed site is located north of Buruk, approximately 20km north of the city centre of Adana. The location is shown in Figure 4-1. The site is located on top of hill between two valleys. A power transmission line is situated next to the proposed landfill site.

e.2 Conditions of the Proposed Landfill Site

The proposed site is located in a rural area with fields of mainly cotton. Most of the area is owned by privates and used for agricultural purposes. The site is located far from residential areas. An approximately 5km long new access road has to be constructed to gain access to the site from the main road, Adana-Kozan. The terrain is rather hilly causing large earthworks to be involved in the construction of the access road. The area is approximately 25ha and is located on a hilltop. The geological and hydrogeological conditions of the site have not yet been investigated.

e.3 Advantages and Disadvantages

Advantages and disadvantages for the proposed landfill site are summarised as follows.

e.3.1 Advantages

- The site is located far from residential areas. However, it is located at a distance of approximately 20km from Adana City Centre.

e.3.2 Disadvantages

- As the landfill is located on top of a hill the filling height will be relative small compared to a landfill located in an excavation or in a valley. The capacity of a landfill in the proposed location is too small to fulfil the Municipality's requirement for dumping of waste for more than 8-10 years.
- The construction of a landfill in the proposed location will require construction of protecting soil embankments. As the landfill has to be expanded in the height, also the soil embankments will have to be extended in the height. The requirements for soil for the construction of protecting soil embankments and for daily soil coverage of waste will not be fulfilled unless some of the required soil is imported from outside of the landfill site.
- The construction of a landfill on top of a hill is technically infeasible. Problems with wind blown paper will be huge.
- The initial construction works for the landfill will include huge earthworks for the construction of protecting soil embankments. A landfill located in an excavation or in a valley would require considerably less earthwork in the construction phase.
- New protecting soil embankments will be required during the operation and expansion in the height of the landfill. Also these earthworks will be huge compared to a landfill located in an excavation or in a valley.
- An approximately 5km long new access road has to be constructed to gain access to the site from the main road, Adana-Kozan.

e.4 Summary

The proposed landfill site which is located on a hill north of Buruk is evaluated to be technically and financially **infeasible** for the construction of the future landfill for The Greater Municipality of Adana. The main reasons are:

- As the landfill is located on top of a hill the filling height of waste will be relative small compared to landfills located in excavations or in valleys. Thus, the capacity of the landfill will be too small to fulfil the Municipality's requirement for disposal of waste for more than 8-10 years.
- The initial construction works for the landfill will include huge earthworks for the construction of protecting soil embankments, and new protecting soil embankments will be required during the operation and expansion in the height of the landfill. The requirements for soil for the construction of protecting soil embankments and for daily soil coverage of waste will not be fulfilled unless some of the required soil is imported from outside of the landfill site.
- A landfill located in an excavation or in a valley would require considerably less earthworks, and soil for daily soil coverage can more easily be obtained in such locations
- It will be very difficult to operate a landfill in the proposed location. The site is not naturally protected from wind and will face huge problems due to paper blown by wind.

f. Recommendations

The above-mentioned evaluation is summarised in the table below.

Table 4-2: 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 from February 1999.

4.1.3 Final Disposal Sites for Mersin GM

The city plan for the surroundings of the present landfill site is in great contradiction with the landfill. Immediately south and west of the site are existing or planned housing areas and 500m to the east is a new housing area under construction. Thus, it will be very difficult to operate a landfill on this site for many more years. It is recommended that the present landfill be closed and rehabilitated as soon as possible. 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

This section of the report describes and evaluates the candidate disposal sites for Mersin GM. Recommendations on the future landfill site for Mersin are also included.

The locations and photos of the candidate sites pointed out by the Municipality are presented in Figure 4-4 and Figure 4-5.

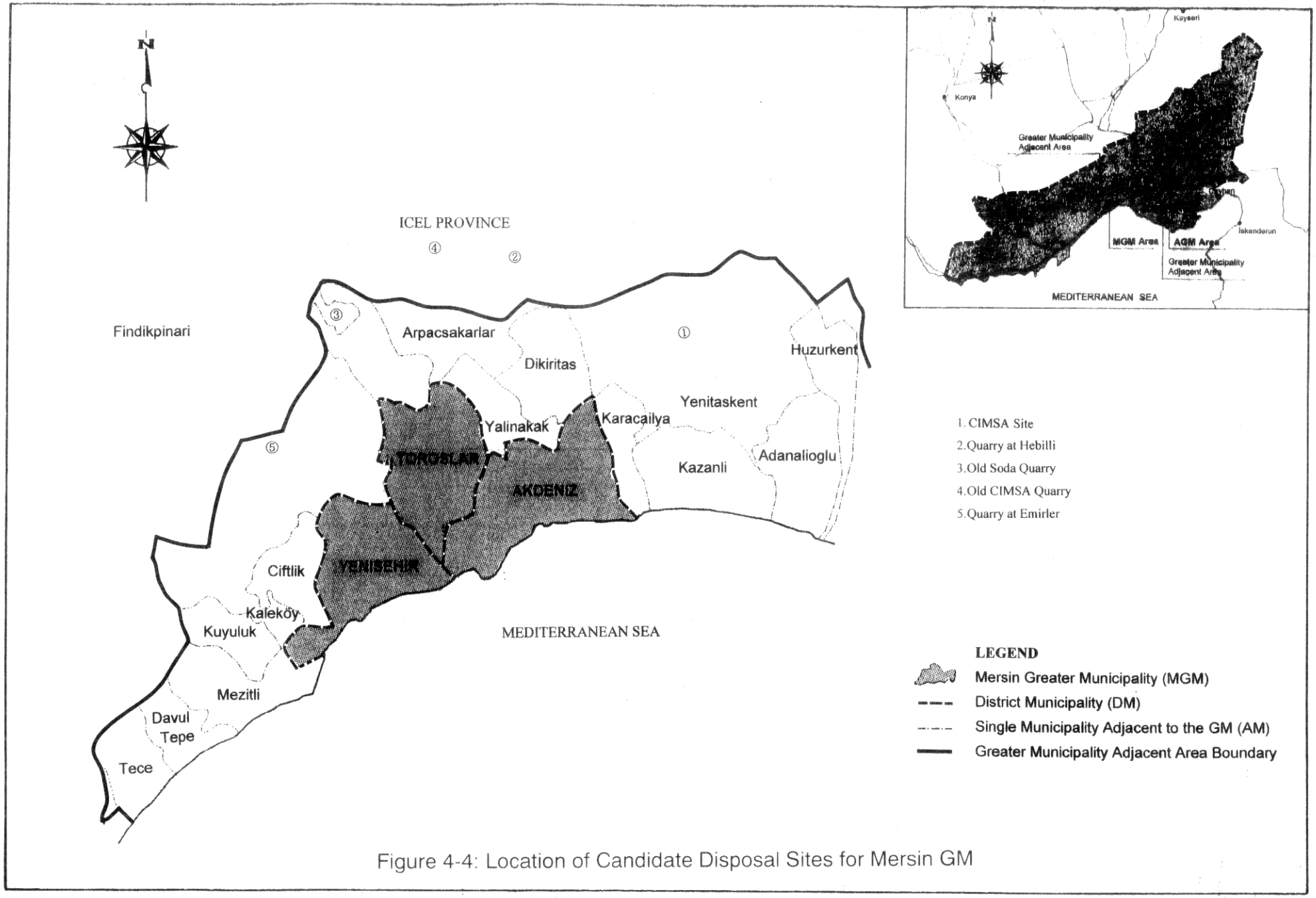

Figure 4-4: Location of Candidate Disposal Sites for Mersin GM

Cimsa Site

Quarry at Hebilli

Old Soda Quarry

Figure 4-5: Photographs of Candidate Disposal Sites for Mersin GM (1)

Old Cimsa Quarry

Quarry at Emirler

Figure 4-6: Photographs of Candidate Disposal Sites for Mersin GM (2)

a. CIMSA-Site

a.1 Location of the Proposed Landfill Site

The proposed site is located in a hilly area north of the CIMSA-factories, 19km by road from Mersin City Centre. Road conditions from Mersin to the site can be described as follows:

- 12km highway from the City Centre to the CIMSA-factories
- 3km asphalt paved road from the factories
- 4km gravel paved road to the site

In accordance with the Mersin Master Plan (1996), the site (360ha) is pointed out to be the future landfill for the Metropolitan Municipality of Mersin (refer to Figure 4-4). However, the very same area has been pointed out for the project named "Second Industrial Zone of Mersin".

a.2 Conditions of the Proposed Landfill Site

Approximately 150ha of the area (360ha) that has been pointed out in the Mersin Master Plan for the future landfill of Mersin has been excavated by CIMSA.

It is considered that the excavation area cannot be used for industrial facilities unless very considerable earthworks are undertaken prior to utilising the area for the Second Industrial Zone. The site holds capacity for many years disposal from Mersin. Since 1991 CIMSA has not been operating in the southern part of the excavation area, and CIMSA has also informed that the northern part of the area is not vital for their operations.

The village of Burhan is located approximately 1km north of the boundary of the CIMSA-Quarry. However, the village is located at a lower elevation implying that landfill operations can be hidden from the village, also if the northern part (minimum 50ha) of the quarry is selected for the future landfill of Mersin. Limestone and clay was excavated in the quarry. If found appropriate by this study and subject to further investigations, clay for the construction of a bottom liner may be available on the site. Soil for daily coverage of waste is easily available.

Due to the original topography of the site, the whole quarry can be filled up in accordance with the original landscape. The completed landfill area can be used as open space of the industrial zone. Access to the bottom of the quarry is easily available. Conditions regarding ownership have to be investigated. The hydrogeological conditions of the site have not yet been investigated.

a.3 Advantages and Disadvantages

Advantages and disadvantages for the proposed landfill site are summarised as follows.

a.3.1 Advantages

- The site holds capacity for many years disposal from Mersin.
- Soil for daily soil coverage of waste is easily available.
- Access to the bottom of the quarry is easily available.
- The site can be recovered in accordance with the original landscape.

a.3.2 Disadvantages

- The village of Burhan is located approximately 1km north of the boundary of the CIMSA-Quarry. However, the village is located at a lower elevation and the landfill operations can be hidden from the village, also if the northern part (minimum 50ha) of the quarry is selected for the future landfill of Mersin.

a.4 Summary

The proposed landfill site that is located in the CIMSA-quarry north of its factory is considered **feasible for further investigations**. The following issues should be clarified as soon as possible:

- It must be clarify whether the whole site or part of it (minimum 50ha) can be used for the future landfill of Mersin or not.
- When the Provincial Governor and the Mayor of Greater Mersin Municipality has agreed upon the area to be used for the future landfill, it must be agreed with CIMSA that their operations in the area must stop no later than December 1999.

b. Quarry at Hebilli

b.1 Location of Proposed Landfill Site

The proposed site is located at the village of Hebilli, 19km by road north of Mersin City Centre as shown in Figure 4-4.

Road conditions from Mersin to the site can be described as follows:

- 8km main highway from the City Centre to Karacailyas
- 4km main road from Karacailyas
- 7km winding road that leads through many small villages. The road is presently being renovated.

b.2 Conditions of the Proposed Landfill Site

The village of Hebilli is located at a distance of approximately 300m from the eastern boundary of the site. The village is located on a higher elevation than the site. It will not be possible to hide landfill activities from the village.

Sand and limestone were excavated in the quarry. The quarry is no longer operated.

Due to the original topography of the site, the whole quarry can be filled up in accordance with the original landscape. The area of the quarry is provisionally estimated at 100ha. The site holds capacity for many years disposal from Mersin. Access to the bottom of the quarry is available. Soil for daily soil coverage of waste is easily available. Conditions regarding ownership have to be investigated.

The geological and hydrogeological conditions of the site have not yet been investigated.

b.3 Advantages and Disadvantages

Advantages and disadvantages for the proposed landfill site are summarised as follows.

b.3.1 Advantages

- The site holds capacity for many years disposal from Mersin.
- Access to the bottom of the quarry is available.
- Soil for daily soil coverage of waste is easily available.
- The site can be recovered in accordance with the original landscape.

b.3.2 Disadvantages

- The village Hebilli is located very close to the site. It will not be possible to hide landfill activities from the village.
- The road to the site leads through many villages.

b.4 Summary

In spite of the nearby village of Habille, and considering that the Provincial Governor may not approve the CIMSA-site, the proposed landfill site located in the quarry at the village of Habilli is considered **feasible for further investigations**.

In fact, leaving out of account the nearby village, the site at Habilli is considered much better for the future landfill of Mersin than the CIMSA-site.

c. Old Soda Quarry

c.1 Location of the Proposed Landfill Site

The proposed site is located 16km north the City Centre of Mersin. The location is shown in Figure 4-4. The site is located next to a main road that carries a lot of traffic, especially in the summer time when people visit their summer houses in the mountains. It will not be possible to hide the landfill activities on this site.

The road to the site leads through a 6km narrow mountain road.

c.2 Conditions of the Proposed Landfill Site

The quarry holds capacity for only very few year's disposal from Mersin. No villages are located near the site. Access to the quarry is easily available.

c.3 Summary

The proposed landfill site called Old Soda Quarry is evaluated to be **infeasible** for the construction of the future landfill for Mersin Metropolitan Municipality. The main reasons are:

- The site is located next to a main road
- The proposed site does not hold enough capacity for the future landfill of Mersin to be constructed on this site.
- Due to the original very steep topography it will be very difficult to completely recover the site by the landfill operation.

d. Old CIMSA Quarry

d.1 Location of the Proposed Landfill Site

The proposed site is located not far from the village of Karapinar, approximately 19km by road north of Mersin City Centre. The road to the site leads through an 8km narrow mountain road that leads to other villages in the mountains.

The quarry is situated on both sides of the road. It will not be possible to hide the landfill activities from the road.

d.2 Conditions of the Proposed Landfill Site

The site was previously used by CIMSA who excavated limestone on the site. The quarry is no longer in operation. However, it is considered that the quarry does not hold enough capacity for the future landfill of Mersin. Access to the bottom of the quarry is easily available.

Since the ground consists of limestone, soil for daily coverage of waste is not easily available. No nearby residential areas are found.

d.3 Summary

The proposed landfill site called Old CIMSA Quarry is evaluated to be **infeasible** for the construction of the future landfill for Mersin Greater Municipality. The main reasons are:

- The proposed site does not hold enough capacity for the future landfill of Mersin. The quarry is located on both sides of a main road.
- Soil for daily soil coverage of waste is not easily available.
- Due to the original very steep topography of the site, it will be very difficult to completely recover the site by the landfill operation.

e. Quarry at Emirler

e.1 Location of the Proposed Landfill Site

The proposed site is located not far from the village of Emirler, approximately 15km by road north-west of Mersin City Centre as shown in Figure 4-4. The last 5km of the road to the site is a narrow mountain road, however in good condition. At the bottom of the valley, approximately 1km from the site is a village with many green houses.

e.2 Conditions of the Proposed Landfill Site

The site is situated at the upper end of a valley. Since the bottom slope of the valley is rather steep, the site does not hold enough capacity for the future landfill of Mersin. Stones are excavated in mountain sides on both sides of the valley and are used for production of gravel. Since the ground mostly consist of rock, it will be difficult to find soil for daily coverage of waste. The quarry is in operation.

It will be very difficult to divert surface water from the upper part of the valley. It will be very expensive to construct and operate a landfill on this site.

e.3 Summary

The proposed landfill site not far from the village of Emirler is evaluated to be **infeasible** for the construction of the future landfill for Mersin Greater Municipality. The main reasons are:

- The proposed site does not hold enough capacity for the future landfill of Mersin.
- Soil for daily soil coverage of waste is not easily available.
- It will be very expensive to construct and operate a landfill on this site.

f. Conclusion

The above-mentioned evaluation is summarised in the table below.

Table 4-3: 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 Habille. • 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 ÇIMSA 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.

4.1.4 Site Selection for Other Facilities

a. 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.

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.

b. 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 and 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 Sofulu and Cimsa future final disposal sites are 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/Mersin GMs 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 new resource recovery facilities annexed to the Sofulu and Cimsa future final disposal site from February 1999.

4.1.5 Sites for the F/S

Based on the evaluation of the candidate SWM facility's sites, the Team proposed to conduct the F/S for the following sites at the meeting of the discussion on the P/R (1):

1. The extended use of the present Sofulu disposal site as the final disposal site of Adana GM and construction at the same site of a by-product plant with appropriate recycling facilities. It is foreseen that this site shall be capable for a further 10 years operation after the indispensable rehabilitation. Both the rehabilitation and further use of the Sofulu area shall be in strictly confirming with the relevant regulations as to the site selection and the construction.
2. The construction of a disposal site at the ÇIMSA site as the Mersin disposal site and construction of a composting plant with appropriate recycling facilities at the same site.

The proposal was approved by the meeting and stipulated in the M/M on the P/R (1).

4.2 Forecast of Future Waste Amount and Composition

4.2.1 Population Forecast

a. Population Estimate for Adana

Future population projection up to the year 2020 made by the team is based on two factors, growth trend and development population growth. These factors are calculated separately and summed up as a total.

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), due to the following reasons:

- The Adana City Development M/P does not contain population estimates.
- The "Adana SWM Project, 1997" projected a moderate population growth rate, 3.0 % from 1997 to 2005, 2.5 % from 2006 to 2010 and 2.0 % from 2010 to 2020.
- The actual population growth rate from 1990 to 1997 is 1.7 %.

- According to the interview with the SSI staff, SSI expects the national growth rate to fall to around 2 % by the year 2020.

The population in 2020 was estimated and shown below by adding the estimates of the ongoing Yeni Adana Project and North Yuregir Project.

Table 4-4: 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.

a.1 Comparison of Population Estimate

Due to the concern of the representatives of AGM about the existing population figures (Data on 1995-90 from Adana M/P and Data on 1997 from general population survey done by SSI of Adana Provincial Office in 1997), other available population figures were examined and reviewed in the third study work in Turkey.

The team received a data concerning population estimate presented in the "Sub-Regional Planning Perspective", Cukuruva Metropolitan Development Project, Prime Ministry Planning Organisation, June 1986, from AGM and prepared the comparison tables of the population estimate as shown in the table and figure below:

Table 4-5: Comparison Table of Population Estimate (Adana)

Year	SSI *1	PMSPO *2	JICA Study Team *3	Growth Rate	
				PAMSO	JST
1,997	1,033,571	1,285,017			
1,998		1,329,787		3.5	
1,999		1,376,117	1,196,620	3.5	
2,000		1,424,053	1,242,632	3.5	3.85
2,005		1,639,035	1,479,477	3.0	3.55
2,010		1,878,057	1,728,483	3.0	3.16
2,015			1,990,917		2.87
2,020			2,268,174		2.64

Source
*1: Population in 1997 presented by the general population survey by SSI (State Statistics Institute) of Adana Province.
*2: Population estimate presented in the "Sub-Regional Planning Perspective", Cukuraova Metropolitan Development Project, PMSPO (Prime Ministry State Planning Organisation), June 1986.
*3: JICA study team.

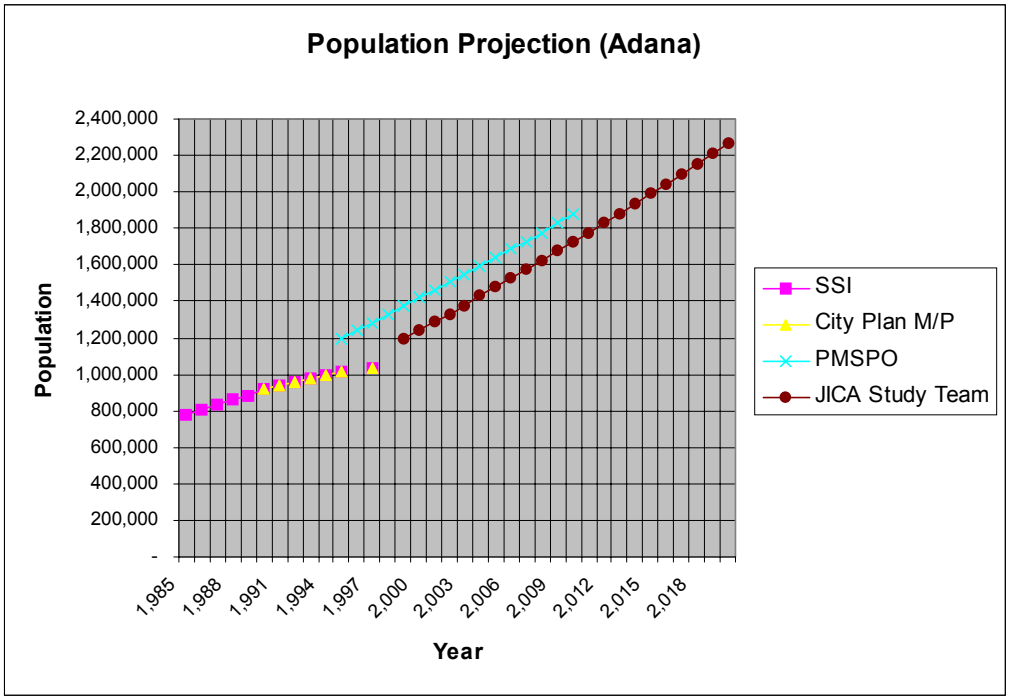

Figure 4-7: Comparison Chart of Population Estimate (Adana)

After comparing those population estimates the team suggested to use the population made by the team due to the following reasons:

- The 1997 population data of the SSI (State Statistics Institute) appears to be small as the counterpart as well as disposal amount data indicates.
- Since the population forecast shown in the report of Sub-Regional Planning Perspective, Cukuruva Metropolitan Development Project, Prime Ministry State Organisation, June 1986 (PMSPO) was based on a 1997 projected figures, the future population forecast vary comparing the population estimated by the team based on the disposal amount at Sofulu dumpsite.

- However, the population estimate of the PMSPO does not have break down for the district municipalities.

b. Population Estimate for Mersin

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 4-4 due to the following reasons:

- Since the Mersin City Development M/P was prepared in two scales (1/25,000 and 1/5,000) covering different areas, the future population forecasts vary. Matters are further complicated by the fact that the plan does not have a target year, with relevant persons concerned surmising the completion to be around 2010. Also, no answers were obtained concerning the method of calculation used.

- The Mersin Wastewater Study (1996) conducted a simple study on population growth. The estimates, however, were found to be over estimate in comparison with the population obtained by the general population survey done in 1997, and are subject to the review.

- Some of the estimates were revised in view of the ongoing large-scale housing development in Toroslar and Yenisehir. (As the housing development is privately financed, general data is not available.) The population increase by the development shall be taken into account.

Table 4-6: 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 4-7: Mersin GM Population Forecast

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.1 Comparison of Population Estimate

Due to the contradiction encountered on the population figures mentioned in the IT/R, other available population figures were examined and reviewed in the third study work in Turkey.

The Team received several data concerning population from MGM, such as Mersin Wastewater Study (1997), a study for the Mersin Water and Sewerage Administration (MESKI) and other studies included in the mentioned study. For the projection of the future population the data of 1997 from State Statistical Institute (SSI), and proposed growth rates of Lahmeyer Suyapi Study (1992), and Cukuruva Metropolitan Report (1985) have been taken into consideration as shown in the Table 4-5.

Based on these growth rates and projected population, a comparison table of the population estimate has been prepared as shown in the table and figure below:

Table 4-8: Comparison Table of Population Estimate (Mersin)

Year	SSI *1	Wastewater Study *2	Lahmeyer Suyapi *3	Cukuruva Project *4	JICA S.T. *5	Growth Rate			
						LS	CP	WW	JST
1997	499,452	624,964	624,964	624,964	615,688				
1998		659,330	660,710	660,710	634,850	5.7	5.7	5.5	3.1
2000		733,859	729,850	733,550	675,213	5.7	5.7	5.5	3.1
2005		936,610	909,090	937,100	788,998	4.5	5.0	5.0	3.2
2010		1,167,187	1,118,000	1,197,150	924,111	4.5	5.0	4.5	3.2
2015		1,420,061	1,306,790	N/A	1,077,600	3.1		4.0	3.1
2020		1,686,587	1,527,400	N/A	1,249,940	3.1		3.5	3.0

Source:
*1: Population in 1997 presented by the general population survey by SSI (State Statistics Institute) of Icel Province.
*2: Population estimate presented in the Mersin Wastewater Study, 1997, a study for the Mersin Water and Sewerage Administration (MESKI) provided by MGM.
*3: Population estimate of Lahmeyer Suyapi Study (Mersin Sewerage Project, Force Mains between the Central Pumping Station and WWTP, 1992) considering projected growth rates presented in Mersin Wastewater Study provided by MGM.
*4: Population estimate of Cukuruva Metropolitan Region Report, 1985 (Wastewater Project) considering projected growth rates presented in Mersin Wastewater Study provided by MGM.
*5: JICA study team.

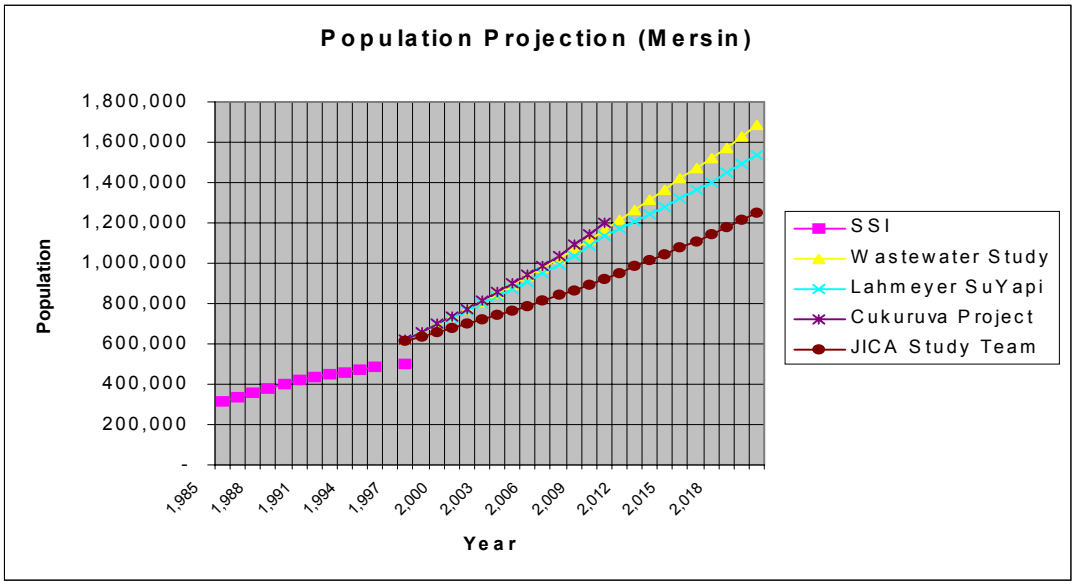

Figure 4-8: Comparison of Population Estimate (Mersin)

After comparing those population estimates the team suggested to use the population made by the team due to the following reasons:

- The 1997 population data of the SSI (State Statistic Institute) appears to be too small as the counterpart as well as disposal amount data indicates).
- "Mersin Wastewater Study" 1997, provides several population estimate as shown in the table above. Then the MWWS report concluded their own population estimate.
- According to the interview with the SSI staff, SSI expects the national population growth rate to fall to about 2% by the year 2020. The population growth of the MWWS (3.5 in 2020 and 5.5 in 2,000) appears to be too large against the figure of 2%. In addition the estimate of MWWS does not have break down for the district municipalities.

4.2.2 Waste Discharge Amount Forecast

4.2.2.1 Waste Discharge Amount Forecast for Adana

Municipal solid waste (MSW) has always been with people and has grown in volume as the country's population has grown and become more and more urbanised.

Therefore, in order to formulate a master plan to target year 2020, the estimation of the future waste discharge amount is necessary to be predicted.

a. Forecast Frame

Based on the Waste Amount and Composition Survey (WACS) by the study for summer and winter season, the results were used as a basic reference to forecast MSW discharge amount in the target area.

The forecast frame will include interim estimation for the years 1999, 2005, 2012 and 2020 for the planning period of the master plan. The types of waste to be forecasted are described below. The definition of each type of waste is referred to 2.1.1, *Objectives and Definitions*.

a.1 MSW

- Household waste
- Commercial waste
- Market waste
- Institutional waste
- Street sweeping waste
- Bulky waste

a.2 Other Wastes

b. Factors in Waste Discharge Amount Increase

The waste discharge ratio is widely depended on the economic situations, cultural, lifestyle of people, consumption trends in societies, etc. Among these, economical situation will highly influenced to waste discharge amount. Therefore, in order to estimate future waste amount, it is necessary to take the key indicators and the following factors into account.

- Population growth rate
- Economic growth rate
- Social welfare and purchasing power of the consumers/families

b.1 Population Growth Rate

The most direct influence on waste discharge amount is the increasing of population and number of other discharge sources. The projected population in the target area for the planning period is described in 4.2.1, *Population Forecast.*

b.2 Relation Between GDP and Waste Discharge Amount

To determine the relation between economic growth and the waste discharge amount, the statistic regarding the relationship of them in Japan from year 1963-1988 is examined.

An increase in the GDP (as an economic growth rate) is expected to have a big impact on the generation of waste per capita of developing countries than of developed countries. Also, at a certain welfare level, increase in GDP will remarkably change the composition of waste.

Japan has fine statistics allowing for the analysis of the relation of GDP and waste generation in a developing economy (1963-1970) and a developed economy (1975-1988). The years 1970-1975 are excluded due to fluctuations in data resulting from a new treatment law and economic recession and instability caused by the oil crisis.

b.2.1 Developing Economy

Based on the data of Japan for the period 1963-1970, a developing economy can be characterised as follows:

- Average increase in discharge amount/capita 5.789 %/year
- Average increase in GNP[1] 10.438 %/year

b.2.2 Developed Economy

Based on the data of Japan for the period 1975-1988, a developed economy is characterised as follows:

- Increase in waste generation per capita 1.276 %/year
- Increase in GDP 4.415 %/year

b.2.3 Conclusions

Based on these figures, the study team assumed that the change in GDP will affect waste discharge amount as follows;

- Flexibility for a developing economy 0.55 of GDP - change in %
- Flexibility for a developed economy 0.29 of GDP - change in %

A 4% annual increase in GDP would result to increase in waste generation due to increased welfare, 2.2% (4% x 0.55) and 1.2% (4% x 0.29) for developing economies and developed ones, respectively.

The ratio to be selected will depend on the estimated actual capacity of the economy. Although the increase in the GDP ratio may be high, the actual value could be low, thus effecting a lower impact ratio than the figures shown in the data of Japan.

According to the estimation of the study team regarding economic growth rate in 4.3.1, *Economic Conditions*, the average of GRDP, as almost same rate as GDP, in the target area is estimated to be as follows;

- 1998-2000 +5.5%
- 2001-2005 +5%
- 2006-2010 +4.5%
- 2011-2020 +4%

The annual increase in GRDP would have an influence to increase in waste discharge amount due to increased welfare and purchasing power of people. The study team concluded that economy in the target area is reaching from developing economy to developed economy in year 2011. Therefore, the increase in waste discharge per capita per year is estimated as follows;

- 1998-2000 5.5 x 0.55 = 3.025%/year
- 2001-2005 5 x 0.55 = 2.75%/year
- 2006-2010 4.5 x 0.55 = 2.475%/year
- 2011-2020 4 x 0.29 = 1.16%/year

[1] GNP was used due to the unavailability of a GDP.

Based on the above figure, the team concluded the increase in waste discharge per capita per year is as follows;

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

However, the increase of waste discharge ratio per year as shown above will not apply to public cleansing services such as street sweeping and park but their amount will be implicitly increased in accordance with the growth of population, expansion of the city, etc.

c. Forecast on Waste Amount

Based on the above-mentioned assumption, the forecast on MSW and other wastes in Adana is described below.

c.1 Forecast On Waste Discharge Ratio

The outcome of forecast on waste discharge ratio is tabulated in the following table.

Table 4-9: Forecast on Waste Discharge Ratio for Adana GM

Category	Unit	1999	2005	2012	2020
MSW					
Household	g/person/day	473	558	663	729
Restaurant	g/table/day	1,020	1,204	1,431	1,574
Other Shop	g/shop/day	1,180	1,393	1,656	1,822
Market	g/stall/day	5,900	6,963	8,276	9,105
Institution	g/person/day	142	167	198	218
Street Sweeping	g/km/day	70,683	70,683	70,683	70,683
Park	g/m^2/day	4	4	4	4
Bulky Waste*	g/person/day	0	N/A*	N/A*	N/A*
Other Waste	g/person/day	21	23	30	33

Note: * Although bulky waste is recycled and is not disposed of at the landfill at present, it will be discharged and need to be disposed in future. It is, however, very difficult to forecast when and how much it will be discharged.

c.2 Forecast On Number of Discharge Sources

The team forecasts that the number of waste discharge sources will increase in accordance with the population as and shown in the following table.

Table 4-10: Forecast on Number of Waste Discharge for Adana GM

Discharge Source	Unit	1999	2005	2012	2020
Population	person	1,196,620	1,479,477	1,831,770	2,268,174
Restaurant	table	77,790	96,178	119,080	147,450
Other Shop	shop	70,000	86,547	107,156	132,685
Market	stall	2,407	2,975	3,682	4,559
Institution	person	53,813	66,533	82,375	101,999
Street Sweeping	km.	718	888	1,100	1,363
Park	m^2	600,000	741,828	918,472	1,137,290

Other waste is waste from medical institutions and industries, and MSW from other municipalities than Adana GM, which is disposed of at the Sofulu Dump site at present. Therefore, the team assumes the discharge ratio of other waste will increase the same as household waste, etc. It also assumes the discharge amount of it will increase in accordance with the population growth of Adana GM.

c.3 Forecast On Waste Discharge Amount

From the results of the above tables, finally, the study team calculated future waste discharge amount in Adana and presented in the following table.

Table 4-11: 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**

4.2.2.2 Waste Discharge Amount Forecast for Mersin

To plan effectively for solid waste management, information and data on the expected future amount of the solid wastes are important.

Therefore, in order to formulate a master plan to target year 2020, the estimation of the future waste discharge amount is necessary to be predicted.

a. Forecast Frame

As same as forecast method applied for Adana, based on the Waste Amount and Composition Survey (WACS) by the study team for summer and winter season, the results were used as a basic reference to forecast MSW discharge amount in the target area.

The forecast frame will include interim estimation for the years 1998, 2005, 2012 and 2020 for the planning period of the master plan. The types of waste to be forecasted are described below. The definition of each type of waste is referred to 2.1.1, *Objectives and Definitions*.

a.1 MSW

- Household waste
- Commercial waste
- Market waste
- Institutional waste
- Street sweeping waste
- Bulky waste

a.2 Other Wastes

b. Factors in Waste Discharge Amount Increase

The waste discharge ratio is widely depended on the economic situations, cultural, lifestyle of people, consumption trends in societies, etc. Among these, economical situation will highly influenced to waste discharge amount. Therefore, in order to estimate future waste amount, it is necessary to take the key indicators and the following factors into account.

- Population growth rate
- Economic growth rate
- Social welfare and purchasing power of the consumers/families

b.1 Population Growth Rate

The most direct influence on waste discharge amount is the increasing of population and number of other discharge sources. The projected population in the target area for the planning period is described in 4.2.1, *Population Forecast.*

b.2 Relation Between GDP and Waste Discharge Amount

To determine the relation between economic growth and the waste discharge amount, the statistic regarding the relationship of them in Japan from year 1963-1988 is examined.

An increase in the GDP (as an economic growth rate) is expected to have a big impact on the generation of waste per capita of developing countries than of developed countries. Also, at a certain welfare level, increase in GDP will remarkably change the composition of waste.

Japan has fine statistics allowing for the analysis of the relation of GDP and waste generation in a developing economy (1963-1970) and a developed economy (1975-1988). The years 1970-1975 are excluded due to fluctuations in data resulting from a new treatment law and economic recession and instability caused by the oil crisis.

b.2.1 Developing Economy

Based on the data of Japan for the period 1963-1970, a developing economy can be characterised as follows:

- Average increase in discharge amount/capita 5.789 %/year
- Average increase in GNP[2] 10.438 %/year

b.2.2 Developed Economy

Based on the data of Japan for the period 1975-1988, a developed economy is characterised as follows:

- Increase in waste generation per capita 1.276 %/year
- Increase in GDP 4.415 %/year

[2] GNP was used due to the unavailability of a GDP.

b.2.3 Conclusions

Based on these figures, the study team assumed that the change in GDP will affect waste discharge amount as follows;

- Flexibility for a developing economy 0.55 of GDP - change in %
- Flexibility for a developed economy 0.29 of GDP - change in %

A 4% annual increase in GDP would result to increase in waste generation due to increased welfare, 2.2% (4% x 0.55) and 1.2% (4% x 0.29) for developing economies and developed ones, respectively.

The ratio to be selected will depend on the estimated actual capacity of the economy. Although the increase in the GDP ratio may be high, the actual value could be low, thus effecting a lower impact ratio than the figures shown in the data of Japan.

According to the estimation of the study team regarding economic growth rate in 4.3.1, *Economic Conditions*, the average of GRDP, as almost same rate as GDP, in the target area is estimated to be as follows;

- 1998-2000 +5.5%
- 2001-2005 +5%
- 2006-2010 +4.5%
- 2011-2020 +4%

The annual increase in GRDP would have an influence to increase in waste discharge amount due to increased welfare and purchasing power of people. The study team concluded that economy in the target area is reaching from developing economy to developed economy in year 2011. Therefore, the increase in waste discharge per capita per year is estimated as follows;

- 1998-2000 5.5 x 0.55 = 3.025%/year
- 2001-2005 5 x 0.55 = 2.75%/year
- 2006-2010 4.5 x 0.55 = 2.475%/year
- 2011-2020 4 x 0.29 = 1.16%/year

Based on the above figure, the team concluded the increase in waste discharge per capita per year is as follows;

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

However, the increase of waste discharge ratio per year as shown above will not apply to public cleansing services such as street sweeping and park but their amount will be implicitly increased in accordance with the growth of population, expansion of the city, etc.

c. Forecast on Waste Amount

Based on the above-mentioned assumption, the forecast on MSW and other wastes in Mersin is described below.

c.1 Forecast On Waste Discharge Ratio

The outcome of forecast on waste discharge ratio is tabulated in the following table.

Table 4-12: Forecast on Waste Discharge Ratio for Mersin GM

Category	Unit	1998	2005	2012	2020
MSW					
Household	g/person/day	439	533	633	697
Restaurant	g/table/day	1,398	1,696	2,016	2,218
Other Shop	g/shop/day	1,062	1,288	1,532	1,685
Market	g/stall/day	10,550	12,800	15,215	16,737
Institution	g/person/day	63	77	91	99
Street Sweeping	g/km/day	33,848	33,848	33,848	33,848
Park	g/m^2/day	1	1	1	1
Bulky Waste*	g/person/day	0	N/A*	N/A*	N/A*
Other Waste	g/person/day	23	28	33	37

Note * Although bulky waste is recycled and is not disposed of at the landfill at present, it will be discharged and need to be disposed in future. It is, however, very difficult to forecast when and how much it will be discharged.

c.2 Forecast On Number of Discharge Sources

The team forecasts that the number of waste discharge sources will increase in accordance with the population as shown in the following table.

Table 4-13: Forecast on Number of Waste Discharge for Mersin GM

unit : /day

Discharge Source	Unit	1998	2005	2012	2020
Population	person	634,850	788,998	982,499	1,249,940
Restaurant	table	39,895	49,581	61,741	78,548
Other Shop	shop	50,000	62,140	77,380	98,443
Market	stall	1,248	1,551	1,931	2,457
Institution	person	38,048	47,286	58,882	74,911
Street Sweeping	km.	624	776	967	1,230
Park	m^2	730,000	907,253	1,129,754	1,437,280

c.3 Forecast On Waste Discharge Amount

From the results of the above tables, finally, the study team calculated future waste discharge amount in Mersin and presented in the following table.

Table 4-14: 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**

4.2.3 Waste Composition Forecast

4.2.3.1 Waste Composition Forecast for Adana

Generally, composition of solid waste depends on characteristics of the area/city such as lifestyle of people, climate, urbanisation, cultural, etc. Whenever its influence factors in waste composition change, the characteristics of waste will be gradually changed. Changing in waste composition is also depended to new products and different consumption pattern of people.

Since there is no existing data on the change of waste composition available in the target area, in order to forecast the future waste composition the waste composition in other cities is referred as shown in Table 4-15.

Table 4-15: Waste Composition in Other Cities in Turkey*

unit : %

Composition	Istanbul	Izmir	Antalya	Bursa	Denzili	Adana**	Mersin**
Organic and ashes	**60**	**55**	**64**	**71**	**65**	**67**	**65**
Recyclable	**40**	**33**	**36**	**29**	**35**	**27**	**32**
• Paper	8	12	19	10	6	15	18
• Plastic	14	12	8	7	6	6	7
• Glass	5	4	2	2	3	3	3
• Metal	2	3	2	1	5	1	1
• Textile	3	2	2	2	4	2	3
• Other	8	0	1	7	11	0	0
Other (non-recycle)	**0**	**12**	**0**	**0**	**0**	**6**	**3**
Total	100	100	100	100	100	100	100

Source : * Adana Solid Waste Management Project, Feasibility Report, Nov. 1997.
** Results of MSW from WACS by JICA Study Team.

Then, the analysis focused on the comparison of the outcomes of WACS and MSW composition (except street sweeping and park) in the target area and data from the JICA's study in Lublin city, Poland. Because its way of living of people in Poland is similar to Turkey. Together with Poland, the study team presented results on waste composition in Penang, Malaysia and Tokyo, Japan as shown in the following table.

Table 4-16: Waste Composition in Target Area Compare with Other Cities

Category	Results of WACS				Penang*1	Lublin*2	Tokyo
	Household Waste		MSW		Malaysia	Poland	Japan
	Adana	Mersin	Adana	Mersin	1987	1992	1993
1. Combustibles	**94.96**	**95.63**	**89.71**	**93.15**	**88.10**	**87.22**	**88.80**
Kitchen Waste	75.53	70.77	64.41	63.01	32.80	61.11	23.70
Paper	9.88	13.80	14.80	18.42	25.50	14.18	39.70
Textile	1.77	3.43	1.62	2.60	3.40	3.10	4.20
Grass and Wood	1.62	1.04	2.66	2.18	14.40	4.41	7.00
Plastic	5.87	6.42	5.92	6.69	11.20	2.33	12.00
Rubber and Leather	0.29	0.17	0.30	0.25	0.80	2.09	1.00
2. Non-combustibles	**5.04**	**4.37**	**10.29**	**6.85**	**12.00**	**12.79**	**12.00**
Metal	0.53	0.72	1.40	1.25	2.60	3.29	4.90
Bottle and Glass	3.33	2.55	3.08	3.08	1.40	6.69	4.70
Ceramic and Stone	1.14	0.96	2.17	1.38	0.20	2.81	1.40
Miscellaneous	0.04	0.14	3.64	1.14	7.80	0.00	0.00
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00
ASG (kg/ton)	410	290	290	290	190	180	N/A

Source: *1 The Study on Solid Waste Management Study for Pulau Penang and Seberang Perai Municipalities, Final Report, JICA Study Team.

*2 The Study on the Solid Waste Management for Poznan City, the Republic of Poland, Final Report, May 1993, JICA Study Team.

From the above table it can be seen that kitchen waste from MSW occupies very high percentage (68%) in Adana. Therefore, the study team set a condition to forecast that amount of kitchen waste ratio will not be increased in the future. This condition is also apply to other types of waste such as grass and wood, ceramic and stone and miscellaneous. The results of forecast on waste discharge amount in the target area are also taken into account in order to calculate future waste composition in each type of waste. Based on these conditions, the study team forecast future waste composition in Adana as stated below.

The study team calculated on future waste composition of MSW (except street sweeping and park) in Adana as shown in the following table.

Table 4-17: Results of Calculation to Forecast on Future Waste Composition for Adana GM

Type of Waste	Year 1999					Year 2005			Year 2012			Year 2020		
	MSW (%)	Total Discharge Amount (Ton/Day)	Total Discharge by Type of Waste (Ton/Day)	Population	Discharge Ratio Per Capita (g.)	Population	Total Discharge by Type of Waste (Ton/Day)	MSW (%)	Population	Total Discharge by Type of Waste (Ton/Day)	MSW (%)	Population	Total Discharge by Type of Waste (Ton/Day)	MSW (%)
Kitchen Waste	64.41	803	517	1,196,620	432	1,479,477	639	55.05	1,831,770	791	46.85	2,268,174	980	42.75
Paper	14.80	803	119	1,196,620	99	-	238	20.57	-	433	25.63	-	645	28.16
Textile	1.62	803	13	1,196,620	11	-	26	2.25	-	47	2.80	-	71	3.08
Grass and Wood	2.66	803	21	1,196,620	18	1,479,477	27	2.29	1,831,770	33	1.95	2,268,174	41	1.78
Plastic	5.92	803	48	1,196,620	40	-	95	8.23	-	173	10.26	-	258	11.27
Leather and Rubber	0.30	803	2	1,196,620	2	-	5	0.42	-	9	0.52	-	13	0.57
Combustibles	**89.71**		**720**		**602**		**1,030**	**88.81**		**1,486**	**88.01**		**2,008**	**87.61**
Metal	1.40	803	11	1,196,620	9	-	23	1.94	-	41	2.42	-	61	2.66
Bottle and Glass	3.08	803	25	1,196,620	21	-	50	4.28	-	90	5.33	-	134	5.86
Ceramic and Stone	2.17	803	17	1,196,620	15	1,479,477	21	1.91	1,831,770	26	1.63	2,268,174	32	1.48
Miscellaneous	3.64	803	30	1,196,620	24	1,479,477	37	3.06	1,831,770	46	2.61	2,268,174	57	2.39
Non-combustibles	**10.29**		**83**		**69**		**131**	**11.19**		**203**	**11.99**		**284**	**12.39**
Total	100		803		671		1,161	100		1,689	100		2,292	100

The summary of forecast on future waste composition in Adana is tabulated in Table 4-18.

Table 4-18: 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**

As can be seen from the table, the study team predicted the trend of future waste composition in Adana as the following summary.

a.1 Combustible Wastes

The percentage of combustible waste will be decreased gradually from 93% at the time being to 90% in the year 2020. At present, Kitchen waste which occupies very high percent of MSW about 64% will be clearly decreased up to 43% in year 2020. On the other hand, paper, textile and plastic components will be increased noticeably from 15%, 2% and 6% at the present time to 28%, 3% and 11% respectively in year 2020.

a.2 Non-combustible Wastes

In contrast with combustible wastes, the percentage of non-combustible wastes will be increased gradually from 10% at present to 12% in year 2020. Among non-combustible wastes, metal and bottle and glass will increase sharing in future waste composition from 1% and 3% at the time being to 3% and 6% respectively in year 2020. Other components are considered as minor change.

4.2.3.2 Waste Composition Forecast for Mersin

Composition of solid waste depends on characteristics of the area/city such as lifestyle of people, climate, urbanisation, cultural, etc. Whenever its influence factors in waste composition change, the characteristics of waste will be gradually changed. Changing in waste composition is also depended to new products and different consumption pattern of people.

Since there is no existing data on the change of waste composition available in the target area, in order to forecast the future waste composition the waste composition in other cities (refer to Table 4-15).

Then, the analysis focused on the comparison of the outcomes of WACS and MSW composition (except street sweeping and park) in Mersin and data from the JICA's study in Lublin city, Poland. Because its way of living of people in Poland is similar to Turkey (refer to Table 4-16).

From the table it can be seen that kitchen waste from MSW occupies very high percentage (71%) in Mersin. Therefore, the study team set a same condition as Adana for Mersin to forecast that amount of kitchen waste ratio will not be increased in the future. This condition is also apply to other types of waste such as grass and wood, ceramic and stone and miscellaneous. The results of forecast on waste discharge amount in the target area are also taken into account in order to calculate future waste composition in each type of waste. Based on these conditions, the study team forecast future waste composition in Mersin as stated below.

The study team calculated on future waste composition of MSW (except street sweeping and park) in Mersin as shown in the following table.

Table 4-19: Results of Calculation to Forecast on Future Waste Composition for Mersin GM

Type of Waste	Year 1998					Year 2005			Year 2012			Year 2020		
	MSW (%)	Total Discharge Amount (Ton/Day)	Total Discharge by Type of Waste (Ton/Day)	Population	Discharge Ratio Per Capita (g.)	Population	Total Discharge by Type of Waste (Ton/Day)	MSW (%)	Population	Total Discharge by Type of Waste (Ton/Day)	MSW (%)	Population	Total Discharge by Type of Waste (Ton/Day)	MSW (%)
Kitchen Waste	63.01	425	268	634,850	422	788,999	333	52.44	982,499	415	44.48	1,249,940	527	40.48
Paper	18.42	425	78	634,850	123	-	159	25.04	-	278	29.80	-	420	32.26
Textile	2.60	425	11	634,850	17	-	22	3.46	-	39	4.18	-	59	4.53
Grass and Wood	2.18	425	9	634,850	14	788,999	11	1.73	982,499	14	1.50	1,249,940	17	1.31
Plastic	6.69	425	29	634,850	46	-	57	8.98	-	101	10.83	-	153	11.75
Leather and Rubber	0.25	425	1	634,850	2	-	2	0.31	-	4	0.43	-	6	0.46
Combustibles	**93.15**		**396**		**624**		**584**	**91.96**		**251**	**91.22**		**1,182**	**90.79**
Metal	1.25	425	5	634,850	8	-	11	1.73	-	19	2.04	-	29	2.23
Bottle and Glass	3.08	425	13	634,850	20	-	27	4.25	-	46	4.93	-	70	5.38
Ceramic and Stone	1.38	425	6	634,850	9	788,999	7	1.10	982,499	9	0.96	1,249,940	11	0.84
Miscellaneous	1.14	425	5	634,850	8	788,999	6	0.96	982,499	8	0.85	1,249,940	10	0.76
Non-combustibles	**6.85**		**29**		**45**		**51**	**8.04**		**82**	**8.78**		**120**	**9.21**
Total	100		425		669		635	100		933	100		1,302	100

The summary of forecast on future waste composition in Mersin is tabulated in Table 4-20.

Table 4-20: 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

As can be seen from the table, the study team predicted the trend of future waste composition in Mersin as the following summary.

b.1 Combustible Wastes

The percentage of combustible waste will be decreased gradually from nearly 93% at the time being to 91% in the year 2020. At present, Kitchen waste which occupies very high percent of MSW about 63% will be clearly decreased up to 40% in year 2020. On the other hand, paper, textile and plastic components will be increased noticeably from 18%, 2% and 7% at the present time to 32%, 5% and 12% respectively in year 2020.

b.2 Non-combustible Wastes

In contrast with combustible wastes, the percentage of non-combustible wastes will be increased gradually from 7% at present to 9% in year 2020. Among non-combustible wastes, metal and bottle and glass will increase sharing in future waste composition from nearly 1% and 3% at the time being to more than 2% and 5% respectively in year 2020. Other components are considered as minor change.

4.2.4 Medical Waste Discharge Forecast

a. Examination of Relationships

In order to establish a waste management plan for the future, it is necessary to project the amount of waste produced annually by the two cities until the target year. The projections for Adana and Mersin are based on the following four factors that are thought to affect the generation of infectious waste.

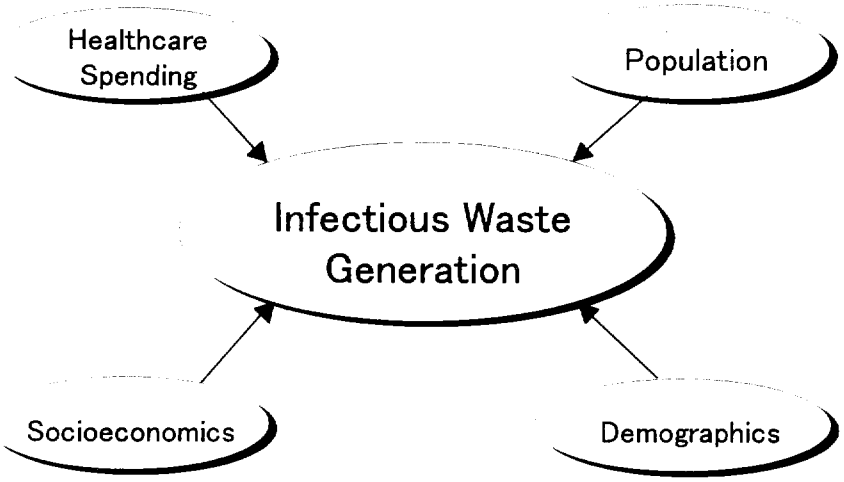

Figure 4-9: Factors that Affect Infectious Waste Generation

a.1 Population

For all waste types, more consumers means more waste produced. It is possible to estimate the amount of medical and general waste produced in each city by multiplying the per capita generation rates by the projected population for a given year. Figure 4-9 illustrates this relationship.

Although population increase does not show a strict relationship in comparative analyses, there is a strong relationship between the two, and for the purpose of this report the population increase rates in each of the cities over the master plan period were used to estimate the increase in waste generation at a constant generation rate.

a.2 Healthcare Spending as % of GDP (PPP$)

"Consumption leads to production" is the most logical assumption when estimating the amount of all waste types generated by any activity, and healthcare provision is no exception. Although in Turkey the health industry is predominantly public, both the private and public institutions, whether from the social welfare budget or from private contributions, rely upon financial input for it's activities.

As a result, healthcare spending, as a percentage of GDP, by far has the strongest relationship with changes in generation rate than any other variable.

c. Socio-economic Factors

Prosperity, increase in disposable income, and increase in average family spending have all shown to increase medical waste generation because the number of people using the western healthcare system, as opposed to traditional or alternative medicine, increases. A prosperous economy sees not only an increase in personal spending on healthcare, but also an increase in the number of migrant workers moving to urban areas to seek employment. This, inevitably leads to the increase in the number of people who require healthcare in the two cities.

d. Demographics

To a lesser degree demographic changes affect the amount of medical waste produced by medical institutions. The reduction in infant mortality and maternal mortality, the

rise in life expectancy, and the improvement in nutrition and in hygiene all contribute to the increase in the amount of medical waste generated.

4.2.5 Forecast

a. Medical Waste

The forecast for medical waste generation is based on all of the previous conditions that equally play a vital role in the projection of infectious waste generated in the city. The projected figures incorporate not only the population increase (generation rate variable), but also the changes in healthcare spending, socio-economic factors, and demographic changes.

The population based projections, however, have very little adjustments because the other variables are highly volatile, and the theoretical increase would be only slight. Also the improvements in polymer engineering and the development of the recycling industry would reduce the rate of increase, thus creating a strictly non-linear increase in generation rates. Turkey's kg/cap/year figure is almost comparable to high income countries, although there is a scope for immense increase (the UK & the USA generate on average 3.5 kg - 4.5 kg of infectious waste per day). On the other hand the city authorities should endeavour to keep generation rates in the future to Germany's current rates (0.4kg/inh/y) by recycling and source reduction.

Table 4-21: Forecast of Medical Waste Generation for Adana GM

Year	1998	1999	2000	2005	2010	2012	2015	2020
Population	1,269,259	1,344,744	1,393,718	1,734,039	2,088,157	2,233,984	2,457,510	2,843,679
Inf. Waste (kg/cap/y)	-	1.19	1.21	1.31	1.41	1.45	1.52	1.63
Inf. Waste (kg/d)	-	4,401	4,630	6,205	8,050	8,872	10,206	12,722

N.B. The per capita generation rates are gradually increased to 1.63 kg/cap/year assuming that by 2020 the generation rates would reach the average generation rates of industrialised countries.

Table 4-22: Forecast of Medical Waste Generation for Mersin GM

Year	1998	2000	2005	2010	2012	2015	2020
Population	789,867	839,672	979,651	1,145,130	1,216,977	1,333,820	1,546,969
Inf. Waste (kg/cap/y)	0.71	0.74	0.83	0.92	0.96	1.03	1.15
Inf. Waste (kg/d)	1,539	1,709	2,223	2,898	3,217	3,763	4,866

N.B. The per capita generation rates are gradually increased to 1.15 kg/cap/year, assuming that by 2020 the generation rates would reach the minimum generation rates of industrialised countries, because Mersin has an incinerator for infectious waste.

4.2.6 Reported Infectious Waste Generation

Records of infectious waste generation at the provincial government are updated monthly, and their reports for 1998 were used to compare the reported tax based generation and the amounts stated by the hospitals in the questionnaire.

	Total Daily Generation from Adana (Kg/d)	Total Daily Generation from Mersin (Kg/d)
Questionnaire	4400.8 ±	1539.4 ±
Provincial Government	5786 ±	716.9 ±

For the purpose of this study the report uses the figure from the questionnaire, for the figure from the provincial government is based on the reported generation amounts based on number of bags generated from the district municipalities and the greater municipalities. However, our study revealed that none of the hospitals were visited by representatives from the municipalities to count the number of bags generated per day. And it is highly probable that the provincial governments figures may be rough estimates of the cities' generation rates.

4.3 Other Pre-conditions

4.3.1 Economic Condition

a. 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 4-23: 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.

b. 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 4-24: 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

c. 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 4-25: 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

4.3.2 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.

a. Adana Greater Municipality

The Adana GM revenues are presumed as follows in this master plan:

1) General budget allocated from national tax in proportion to the size of the population (Law 2380) is presumed to increase only in proportion to the size of the population, considering the trends of Turkish taxation system changes such as decentralization of tax collection, decline of the income tax rate on salary and wage, enforcement of municipality duties and fees collection, and etc. As a result, the share of the general budget in the municipal revenue will relatively decline.

2) On the other hand, general budget allocated from national taxes in proportion to the amount of national tax revenue collected in the centre of province (Law 3030) is presumed to increase in proportion to GRDP.

3) Property tax is presumed to increase only in proportion to the size of population of the municipality, considering that the value of the property basically remains the same for five years and it will not increase to set off with inflation as was observed in other countries when re-evaluated.

4) Local tax except for property tax and cleansing tax is presumed to increase in proportion to GRDP.

5) Non-tax revenue is also presumed to increase in proportion to GRDP.

6) Revenue of aids and funds is presumed to increase in proportion to GRDP.

As a result, the revenues otherwise the cleansing tax of Seyhan DM, Yuregir DM and Adana GM are calculated as shown in Table 4-26.

Table 4-26: 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	14,561,309	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

Note: * Turkish Liras using 1998 constant prices

Cleansing tax rate is presumed to increase to cover the SWM costs in continuation of present system step by step. The target will be as following;

Phase I (2005) Cleansing tax will cover 50% of overall SWM costs

Phase II (2012) Cleansing tax will cover 75% of overall SWM costs

Phase III (2020) Cleansing tax will cover 100% of overall SWM costs

After the cost estimation of Feasibility Study is done, the portion to be transferred will be reviewed to cover the overall SWM costs.

b. Mersin Greater Municipality

The Mersin GM revenues are presumed as follows in this master plan:

1) General budget allocated from national tax in proportion to the size of the population (Law 2380) is presumed to increase only in proportion to the size of the population, considering the trends of Turkish taxation system changes such as decentralisation of tax collection, decline of the income tax rate on salary and wage, enforcement of municipality duties and fees collection, and etc. As a result, the share of the general budget in the municipal revenue will relatively decline.

2) On the other hand, general budget allocated from national taxes in proportion to the amount of national tax revenue collected in the centre of province (Law 3030) is presumed to increase in proportion to GRDP.

3) Property tax is presumed to increase only in proportion to the size of population of the municipality, considering that the value of the property basically remains the same for five years and it will not increase to set off with inflation as was observed in other countries when re-evaluated.

4) Local tax except for property tax and cleansing tax is presumed to increase in proportion to GRDP.

5) Non-tax revenue is also presumed to increase in proportion to GRDP.

6) Revenue of aids and funds is presumed to increase in proportion to GRDP.

As a result, the revenue of Yenisehir DM, Toroslar DM, Akdeniz DM and Mersin GM are calculated as shown in Table 4-27.

Table 4-27: 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	839,105
	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	1,411,314	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	7,617	9,406	11,894
Akdeniz DM	General Budget from National Tax (Law 2380)	1,548,683	1,778,953	2,043,456	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	347,424	407,063
	Total	2,310,762	2,789,922	1,220,057	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	8,684,449	11,885,257
	Local taxes excluding Property tax & Cleansing tax And Non-tax revenue	1,741,453	2,473,754	3,334,340	4,563,244
	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

Cleansing tax rate is presumed to increase to cover the SWM costs in continuation of present system step by step. The target will be as following;

Phase I (2005) Cleansing tax will cover 50% of overall SWM costs,

Phase II (2012) Cleansing tax will cover 75% of overall SWM costs of DMs,

Phase III (2020) Cleansing tax will cover 100% of overall SWM cost

4.3.3 Conditions for Cost Estimate

a. 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	400,700

b. 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.

c. Unit cost

Table 4-28: Unit Cost

Description	Unit	Unit cost (US$)
Personnel		
manager	man. Month	980.0
engineer	man. month	810.0
site manager	man. month	740.0
driver, operator, mechanic	man. month	430.0
secretary, clerk	man. month	210.0
collection worker, labourer, watchmen	man. month	270.0
Earthwork		
machine excavation, 200 m transport, and stockpiling of soil	m^3	1.5
machine excavation, 500 m transport, and stockpiling of soil	m^3	1.9
machine excavation, 1,000 m transport, and stockpiling of soil	m^3	2.4
construction of embankment, machine filling and compacting of soil	m^3	2.9
s/t geomenbran with geotextile t=2mm	m^2	16.0
Installation of geomenbran with geotextile t=2mm	m^2	2.1
s/t compacted clay layer	m^3	4.3
s/t vegetation soil	m^3	6.1
Drainage		

Description	Unit	Unit cost (US$)
provide 100 mm PVC-drainage pipe (earthwork is not included)	m	0.8
provide 150 mm PVC-drainage pipe (earthwork is not included)	m	1.7
provide 200 mm PVC-drainage pipe (earthwork is not included)	m	2.5
Perforated pvc pipe dai.=80mm	m	1.2
Perforated pvc pipe dai.=100mm	m	1.7
Perforated pvc pipe dai.=125mm	m	2.4
Perforated pvc pipe dai.=160mm	m	3.6
Perforated pvc pipe dai.=200mm	m	7.3
Concrete pipe dai.=300mm	m	3.0
Concrete pipe dai.=400mm	m	5.0
Concrete pipe dai.=500mm	m	7.0
Concrete work		
s/t/p reinforced concrete paving (200mm) on prepared gravel base (300mm) and sub grade	m^2	12.0
s/t/p premixed concrete 180 kg/cm^2	m^3	38.0
s/t/p premixed concrete 240 kg/cm^2	m^3	40.0
Road work		
s/t/p concrete road pavement (t = 0.15m)	m^2	20.0
s/t/p hot-mix asphalt road pavement (t = 0.1m)	m^2	10.0
s/t/p gravel road (t=0.3m) and subgrade preparation	m^2	4.9
Miscellaneous		
s/t/p turf	set (m^2)	42.0
s/t/p plant trees 2 to 5 m in height	tree	49.0
Gate 8m wide	set	890.0
s/t/p fence (timber pole H=2.5m, barbed wire)	m	7.4
s/t/p steel pipe(Dai.=100mm)	m	40.0
Basic materials		
diesel oil	lit.	0.5
gasoline	lit.	1.0
crushed rock	m^3	14.0
sand	m^3	15.0
reinforcing bar	ton	332.0
Building Works		
Garage from a steel structure with steel cladding including foundation and floor	m^2	131.0
Office building R/C including all works	m^2	270.0
Sorting Plant & Compost Plant	m^2	123.0
Heavy vehicles and equipment (brand-new)		
s/t Bulldozer (19-20 ton)	Nos.	253,000
s/t Bulldozer (24-25 ton)	Nos.	322,000
s/t Excavator (21 ton) (Bucket capacity 1.0m^3)	Nos.	126,000
s/t Crawler loader(Bucket capacity 1.8 m^3)	Nos.	164,000
s/t Crawler loader (Bucket capacity 2.5 m^3)	Nos.	182,000
s/t Dump truck (capacity 34 ton)	Nos.	57,000
s/t Dump truck (capacity 26 ton 12~18 m^3)	Nos.	37,000
s/t Compactor vehicle (16m^3) (16 ton)	Nos.	64,000
s/t Compactor vehicle (14m^3)	Nos.	60,000
s/t Compactor vehicle (12m^3) (12 ton)	Nos.	58,000
Water Tanker (9,000lit.)	Nos.	50,000

Note : s: supply of material, t: transport, p: placement