The topographical and geological conditions are thus the same as those at the Abis Plant. A standard cross-sectional view of the construction site is shown in Fig. 2.3.6 and the results of the geological survey conducted as part of the field survey are shown in Attachment 6.

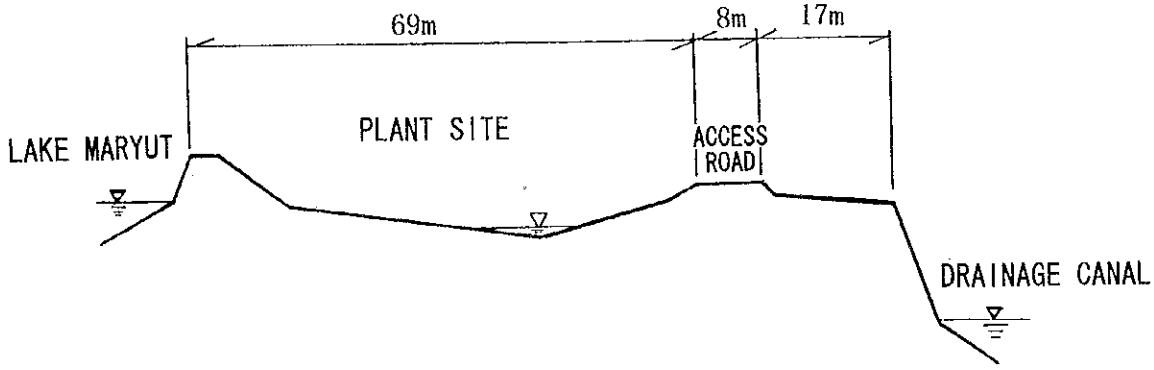


Fig. 2.3.6 Cross Section of the Plant Site

2.3.2.2 Project Site Conditions

(1) Land Use Plan in Alexandria Governorate

Alexandria Governorate, in cooperation with the University of Alexandria, has compiled a master plan relating to urban development in Alexandria having 2005 as its target year. The plan for land use per the master plan is as indicated in Fig. 2.3.7.

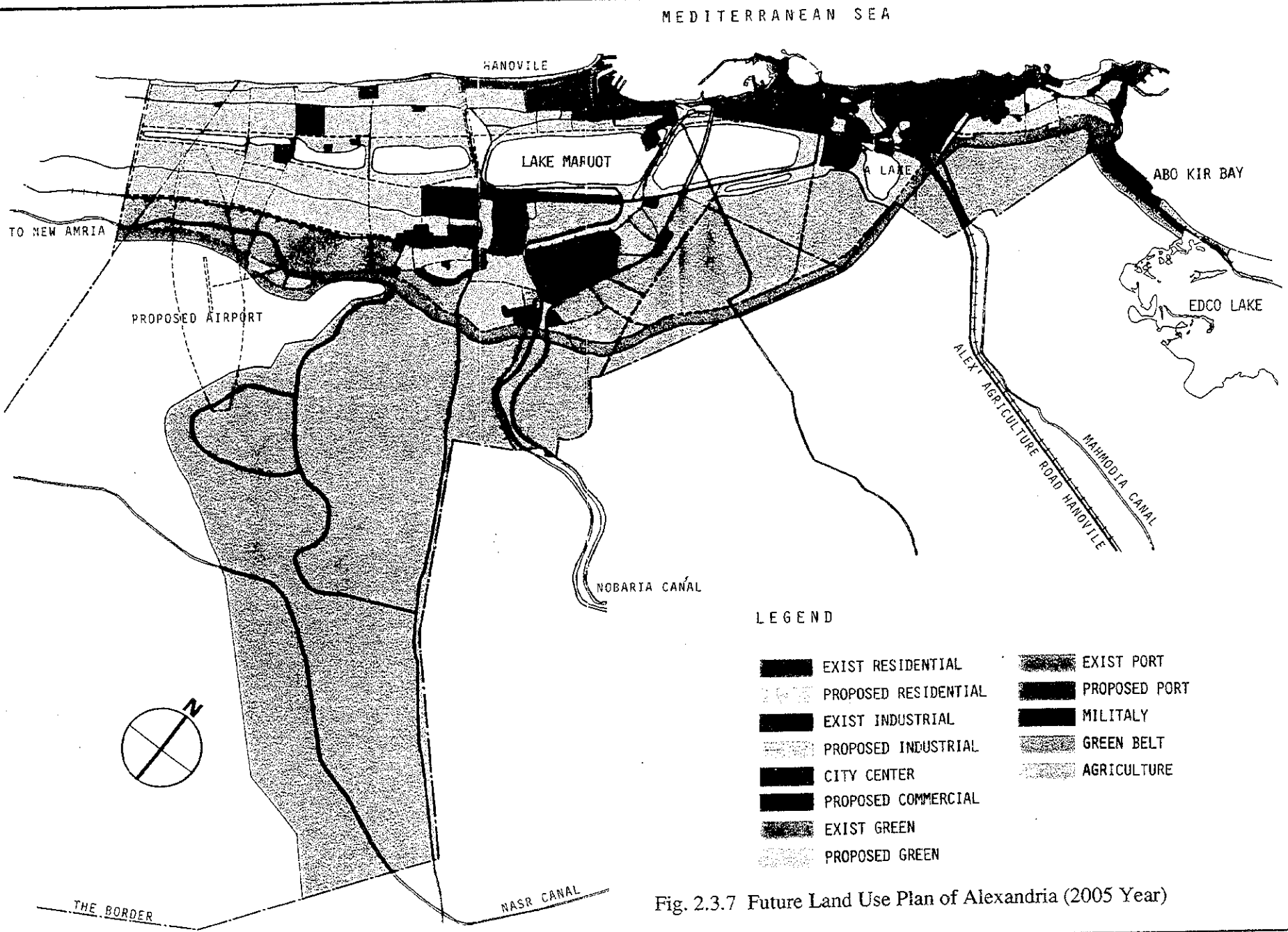


Fig. 2.3.7 Future Land Use Plan of Alexandria (2005 Year)

(2) Project Site Current Situation and Land Use Plan

1) Current Situation

The Project site of Middle District is the center of political and commercial activity and, of the six districts in Alexandria, possesses the highest population density (around 65,000 persons/km^2).

As can be seen from Fig. 2.3.8, land in Middle District is roughly divided into the three following areas; the built-up urban area lying between the coastline and the Mahmoudia Canal, the industrial area between the canal and the Agricultural road, and the agricultural area to the south of the Agricultural road. The industrial and agricultural areas also contain residential land on a minor scale.

The total land area of Middle District is 63.4 km^2. This breaks down into 9.5 km^2 in the built-up urban area, 2.2 km^2 in the industrial area and 51.7 km^2 in the agricultural area (including 2 km^2 of Lake Maryut).

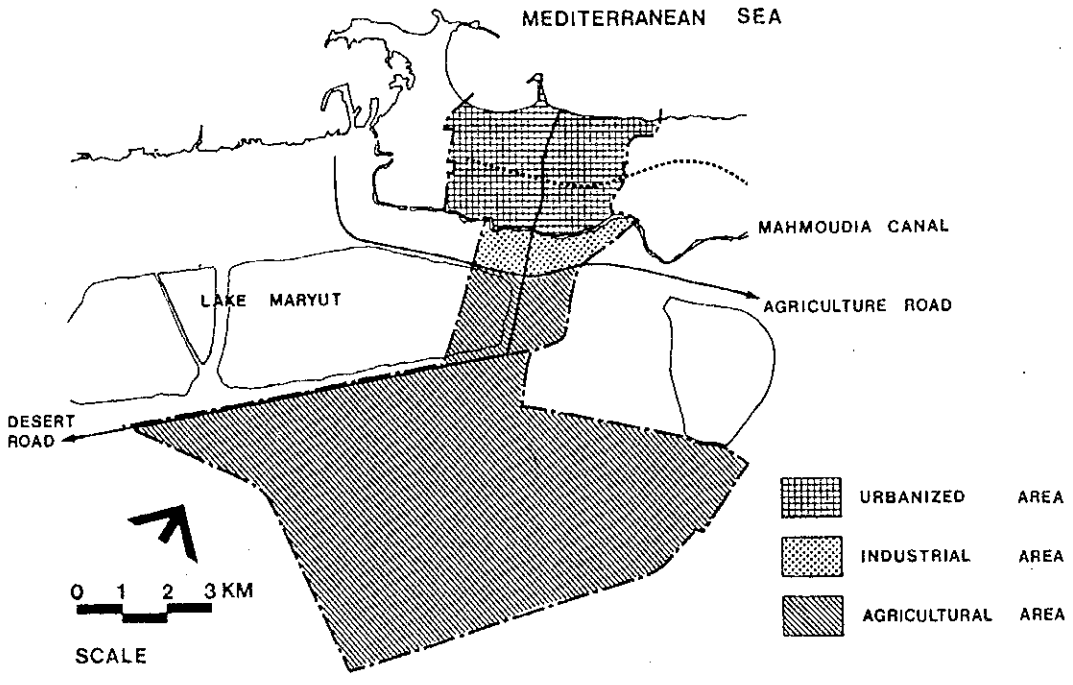


Fig. 2.3.8 Area Divided with Land Use in Middle District

The following sections provide a detailed explanation of the current situation in Middle District.

① Commerce

There are 28,600 shops in Middle District, of which around 40% or 11,000 are concentrated in Attarin, the central commercial and business area.

② Existing Road Conditions

The present total extended length of roads in the built-up urban area is 372 km. The breakdown of the total road length by road width is indicated in Table 2.3.1.

Table 2.3.1 Existing Road Lengths By Road Width
(only for the built-up urban area)

Classification	Width (m)	Length (km)
Trunk	12 or more	17
Main	7.5-12	49
Branch	Less than 7.5	306
Total		372

③ Buildings

There are roughly 26,400 buildings in Middle District, the majority of which are apartment blocks of four to six stories. The built-up urban area is so densely built up that there is no land left available for new buildings.

④ Suburban Residential Area

The Nadi El Said residential area lying south of the Agricultural Road consists of low rise buildings of two to three stories. A population of some 20,000 is squeezed into a land area of roughly 7 ha here, and the average income of the residents is relatively low. The streets are 6-8 m wide, however mostly unpaved. Solid waste collection is only carried out from between one to three times a week and some waste is unlawfully dumped in a vacant lot located at the southern tip of the area.

2) Land Use Plan

The planned land use for Middle District by the year 2000 is illustrated in Fig. 2.3.9. It can be seen from this that the pattern of land use is expected to remain almost the same as it is now.

Fig. 2.3.9 Future Land Use Plan of Middle District (2000 Year)

2.3.2.3 Current Social Infrastructure Situation

(1) Port

Alexandria Port, which is the largest port in Egypt and is located a mere 10 km or so from the Project site, shall be used as the port of disembarkation for construction equipment and materials sent from Japan and third party countries during the construction stage of the Project. As Alexandria Port is an international port, it is visited by many liners from all over the world including Japan.

Alexandria Port is equipped with all the necessary unloading facilities, which enable unloading to be done without long term demurrage. It is therefore considered that use of the said port for the Project should raise no problems.

(2) Roads

1) Roads Between Alexandria Port and the Project Area

It is roughly 5 km between Alexandria Port and the center of Middle District and with trunk and main roads running in all directions between the two, access is no problem. The scheduled construction site of the new compost plant is also close to the port at a distance of around 10 km, and because the Cairo-Alexandria Desert Road expressway comes to within roughly 1 km of the site, it provides an ideal paved access road, which will enable the delivery of construction equipment and materials at ease.

2) Roads Between Cairo and the Project Area

Part of the construction equipment and materials to be procured locally, are scheduled to be brought in from Cairo.

Cairo is linked to Alexandria by the Desert Road and the Agricultural Road. However because the Desert Road expressway is usually used for equipment and materials transportation and can also enable easier access to the scheduled new compost plant construction site compared to the Agricultural Road, the Desert Road shall be used as the delivery route.

If the Desert Road is used, the distance between Cairo and the scheduled construction site of the new compost plant will be roughly 220 km.

(3) Railroad

The railroad, having Alexandria Central Station located in Middle District as an arrival and departure point, runs as far as Cairo in the south and Marsa Matruh to the west. However, because equipment and materials transportation by road is not seen as a problem, use of the railroad for transportation purposes is not scheduled under the Project.

(4) Electricity

There is a buried, 11 kV, three phase 50 hz, high tension power line running along the Desert Road. The existing Abis Compost Plant draws this high tension electricity to switch gear located near the plant's entrance gate, where a stepdown transformer converts it for use in a 220/380 V, three phase four wire system. Similar power distribution equipment shall be used at the new compost plant too.

(5) Water Supply and Sewerage System

A buried water supply pipe of 300 mm diameter runs along the Desert Road and it is planned to lay a water supply pipe of the necessary diameter as a branch between the main pipeline and the new compost plant.

The daily water requirement of the new plant will be 105 m^3, however this amounts to a mere 1% of the flow rate of the mains pipe (about 900 m^3/day). It is therefore considered that there will be an ample supply of water even if water for fire extinguishing is also included in the plant requirement. Concerning sewerage, because there are no buried sewage pipes in the vicinity of the new plant, it is planned to use septic tanks for effluent treatment as is currently done at the Abis Compost Plant.

2.3.2.4 SWM Situation

(1) Collection and Haulage

1) Outline

Collection of municipal waste in Alexandria is carried out by three public authorities; the district cleansing divisions, the extra-governmental ADS (Association for Development of the Society) in each district and the Central Department for Cleansing and Beautification. Private sector collection is carried out by Zabaleen and sweeping sub-contractors.

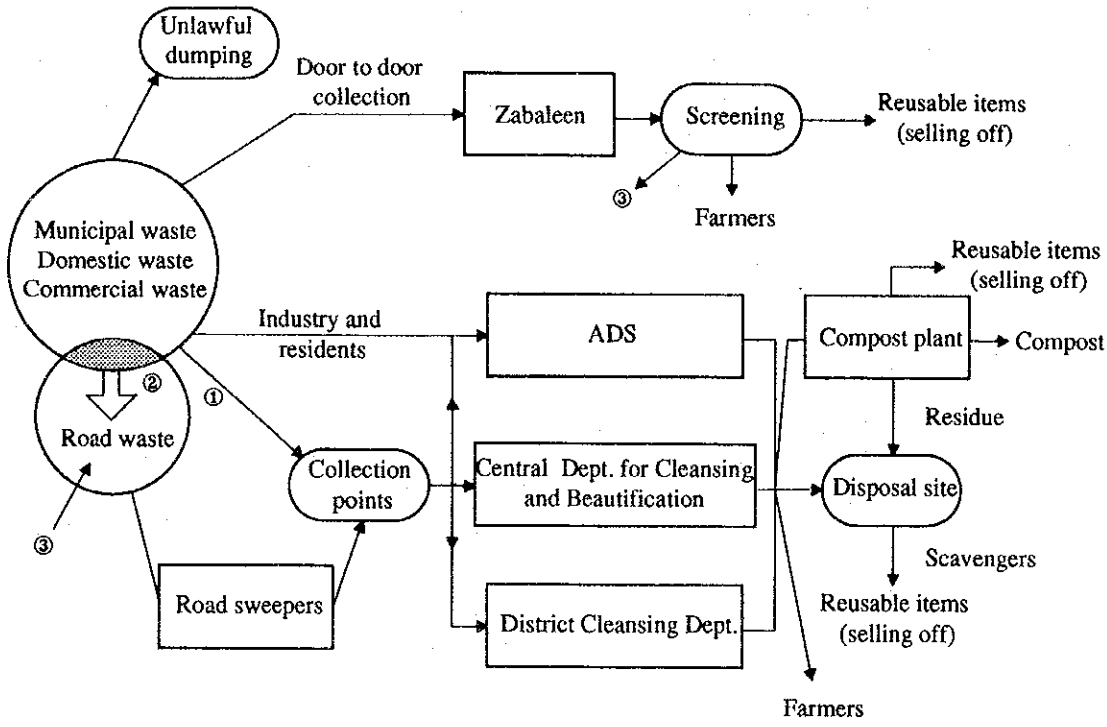
The General Follow-up Department of the Alexandria Governorate is responsible for supervision of the above mentioned public agencies and overall coordination of sweeping activities. The collection activities of each sweeping sector are indicated in Table 2.3.2.

Table 2.3.2 Collection Activities of Each Collection Sector

Sector Name	Grouping	Collection Activities District
Cleansing Department of District	Public sector	As the first shift, collection vehicles are used to collect waste from the collection stations during the morning. The waste is hauled to the final disposal site for disposal (whole of each district is covered).
ADS		As the second shift, the district's collection vehicles are used to make charged collections of each shop or building during the afternoon and cover any areas that are lacking in the district collection service (ADS make collections in parts of each district only).
Central Department for Cleansing and Beautification		The Department is requested by each district to collect waste that couldn't be collected in the first two shifts. Collection is done at night as the third shift.
Zabaleen	Private sector	Waste is directly collected from each building using mule-pulled carts of around 2 m^3 capacity. This is carried to separately owned sorting stations where bone, textiles, glass and metal is separated. The remaining organic waste is sold to farmers.
Sub-contractors		Waste is collected from part of the residential areas of each district and outlying areas under permission from each district. Other sub-contractors have concluded contracts with the Governorate to collect waste from the coastal area.

Street sweeping and street waste collection is done by the districts and collected waste is carried to the final disposal site.

Fig. 2.3.10 indicates the current flow of wastes from discharge to final disposal in Alexandria.



① Residents carry waste to collection points themselves.
② Municipal waste left on roads.
③ Zabaleen screen on roads and then dispose on roads or at the collection points.

Fig. 2.3.10 Flow Chart of Municipal Waste in Alexandria

The salient features of solid waste collection in Alexandria today can be summarized into the four following points.

- Most of the domestic waste is collected by street sweepers.
- As four sectors are involved in waste collection, the flow of waste from discharge to disposal is complex.
- The level of services provided by each sector varies and service charges are not uniformly collected.
- The scope of responsibility of each public sector is ambiguous.

As was mentioned earlier, solid waste collection in Alexandria is carried out by three public sectors throughout the city's six districts. The extra-governmental ADS in each district carry out social welfare activities and charge a small fee for waste collection services. The direct reasons for this situation are considered to be a decrease in the number of Zabaleen, the fact that the districts cannot charge fees for the collection of waste discharged by shops, and a lack of incentive funding.

The ADS in each district collect waste from shops and also collect domestic waste in Middle and West Districts.

In the past, the Zabaleen were responsible for the collection of around 70% of all solid waste, however this figure has now dropped to a fraction of what it was.

2) State of Collection Services

① Solid Waste Collection Quantities

Based upon investigation into the amount of waste carried to the final disposal site and interviews with representatives from waste management organizations, the figures for discharged waste and collected waste quantities indicated in Table 2.3.3 have been estimated. It is estimated that some 70% of the waste discharged throughout Alexandria is actually collected and disposed of.

Table 2.3.3 Solid Waste Discharge and Collection Quantities (1994)

District	Discharged Waste (tons/day)	Collected Waste (tons/day)	Collection Rate (%)
Montazah	343	206	60
East	437	306	70
Middle	425	340	80
Gomrok	153	122	80
West	210	147	70
Ameriyah	172	112	65
Total	1,740	1,233	71

② Collection Frequency

Waste collection is basically carried out once daily by each of the three sectors of district, ADS and Zabaleen. In shopping and market areas however, waste is collected two or three times a day depending on the amounts of waste discharged.

③ Collection Stations

There are some 1,300 clearly designated collection points throughout Alexandria which consist of 2 m^3 containers. There are many more waste stations not possessing such containers (herein referred to as open stations). These are not officially designated by the districts but have spontaneously arisen.

In the case of collection by ADS, in the residential areas the collection truck signals its arrival by blowing a whistle and residents carry out their waste to the truck, although the method does differ according to district. Waste from shops is collected door to door.

3) State of Waste Discharge

There are various methods of waste discharge depending on such factors as form of waste containers and collection method at the discharge point.

① Households

Waste from households is generally discharged in the following manner.

High and middle income households generally dispose of waste in plastic bags, however because few take their waste to the collection stations, door to door collection is common. Door to door collection by Zabaleen is performed at some high income households.

Waste from low income households is usually discharged onto the street or directly carried to the collection vehicles. Discharge at collection stations is rarely done. Low income households hardly ever use plastic bags but instead cans and plastic bins for waste disposal.

As a general trend regardless of household income brackets, residents who do not use plastic bags carry their waste to the collection stations, and those who do use plastic bags leave their waste at the entrances of their homes. Waste discharge is generally done between 8.00 p.m. to midnight or early in the mornings.

② Commercial Outlets and Offices

Solid waste from small factories, restaurants and small hotels, which generate large quantities of waste, is generally either carried by employees to the collection stations or is collected individually by the ADS. In the case of offices and ordinary shops, which generate relatively small quantities of waste, the waste is usually either carried to the collection stations by employees or is collected individually by road sweepers.

Plastic bags are hardly used at all in the carrying of such commercial waste. Such waste is therefore discharged at the collection stations in a loose state.

③ Special Institutions

Institutions such as large hotels, penitentiaries, large hospitals and zoos, which generate large quantities of solid waste, are provided with containers for waste discharge.

Concerning that waste from hospitals which may pose a threat to public sanitation, some of the larger hospitals carry out incineration independently, however such waste is generally discharged together with ordinary waste.

④ Markets

Many of the markets in Alexandria city are not clearly separated from general residential areas. It is therefore often the case that there is not enough space to enable waste to be discharged, which means that it is dumped into open stations on the roadside. Waste discharge times are normally afternoon and evening in consideration of market activities.

4) Collection Vehicles and Garages

① Collection Vehicles

Table 2.3.4 indicates the number of collection vehicles owned by each district and the vehicle operating levels. Table 2.3.5 shows the number and types of vehicles that have been purchased annually in recent years. Table 2.3.4 shows that of a total of 392 owned vehicles, only 228 are operational and some 40% are either deteriorated or are in a state of disrepair and not useable. The collection vehicle operating rate in Middle District is especially low compared to the other districts at a figure of around 30%.

The Truxmore collection vehicles (the main vehicle used in collection work) were bought in 1987 or seven years ago. Middle District currently possesses 22 Truxmores, which were allocated to it by the Governorak prior to 1987, however of these only five are in an operable state. Since 1991, 34 Ford and Avia vehicles have been purchased, however the loading capacities of these models are low at two tons or less, which means that they account for only a small percentage of the total collection capacity.

As well as the problems of vehicle deterioration mentioned above, the transfer of waste from the initial hand-pushed collection carts to the secondary collection vehicles is an extremely inefficient operation. For these reasons, the quantity of

waste actually collected accounts for only 70% of the total waste generation quantity, as can be seen in Table 2.3.3.

Five types of vehicle are used for waste collection; container vehicle, compactor vehicle, rotary compactor vehicle, large dump truck and small dump truck. Most vehicles are made in America, Italy and Japan. Most of the dump trucks are assembled in Egypt. All container vehicles, compactor vehicles and rotary compactor vehicles, or around 50% of the whole vehicle fleet, have been provided through foreign grant aid, while the dump trucks have been purchased out of the Governorate's own budget.

② Garages

Each district possesses one garage, which is used for vehicle parking and also to carry out minor maintenance work. All the garages are located in the suburbs and do not possess large parking spaces. The West District garage has no parking space at all and vehicles have to be left on the streets here and at other garages. All of the garages are occupied by vehicles that are not in use.

Table 2.3.4 Number of Collection Vehicles in Each District and Operating Levels

Type	Loading Capacity (m^3)	Montazah		East		Middle		West		Gomrok		Ameriyah		Central Cleansing and Beautification Dept.		Total	
		Owned	Operating	Owned	Operating	Owned	Operating	Owned	Operating	Owned	Operating	Owned	Operating	Owned	Operating	Owned	Operating
Truxmore	15	15	10	23	8	22	5	14	8	14	6	8	6	7	6	103	49 (48)
Leach	8	6	3	6	1	9	3	5	2	6	1	7	5	28	24	67	39 (54)
Carrabrezzi	8	5	3	2	1	10	2	4	2	5	3			8	4	34	15 (44)
Ford	4	3	2	3	2	3	2	3	3	3	2	3	2			18	13 (87)
Avia	4	3	3	3	3	3	3	3	3	2	2	2	2			16	16 (100)
Dump truck	10	20	13	29	22	36	10	25	19	18	11	6	6	20	15	154	96 (62)
Total		52	34 (65)	66	37 (56)	83	25 (30)	54	37 (69)	48	25 (54)	26	21 (81)	63	49 (75)	392	228 (58)

Note: figures in parentheses indicate percentages.

Table 2.3.5 Annual Vehicle Allocation Figures

Type	Operating Vehicles	Owned Vehicles	1993	1991-1992	1989-1990	1987-1988	1985-1986	1979-1984	Up to 1979
Truxmore	49	103	0	0	0	23	35	45	0
Leach	39	67	0	0	0	0	30	37	0
Carrabrezzi	15	34	0	0	0	0	0	18	16
Ford	13	18	0	18	0	0	0	0	0
Avia	16	16	16	0	0	0	0	0	0
Dump truck	96	154	11	0	12	2	22	53	54
Total	228	392	27	18	12	25	87	153	70
Percentage	58	100	7	5	3	6	22	39	18

6) Solid Waste Collection Process in Middle District

① Preparatory Work

Vehicles depart from the garage between 7.00 a.m. and 8.00 a.m. for District collection and between 2.00 p.m. and 3.00 p.m. for ADS collection. At this time, only the vehicle driver is in the vehicle and after the collection assistants are picked up at the sub-cleansing office, the vehicle heads for the collection area. The average distance from the garage to each collection area is generally 5 km or less. The field survey found the average speed of the vehicles to be 25 km/h, and including the time taken in order to pick up the collection team, it generally takes around 30 minutes to reach the collection area.

② Collection Process

a. Container Vehicles

The container vehicle, which is equipped with a side lift, stops alongside the container to unload the waste from it. Two of the assistants attach and detach the container and the other collects waste that is scattered around and throws it into the container. At the open stations, the assistants pick up waste with their bare hands, put it into green baskets and then unload the baskets into the vehicle. This loading work takes a long time because the waste hopper inlet is too narrow and also too high.

b. Compactor Vehicles

The compactor vehicle is brought to the side of the collection station and four or five assistants load waste into the vehicle using their bare hands. This form of loading requires much effort and time because the waste is generally in a loose state.

c. Open Dump Trucks

The sideboards on dump truck loading decks are raised in order to increase loading capacity. Loading requires much time due to the generally loose state of the waste. Normally, four assistants are assigned to the large dump trucks and two assistants are assigned to the small dump trucks.

In the case of ADS collection of waste from households, the arrival of the vehicle is signalled by blowing a whistle and waste is carried to the vehicle by the residents themselves. The time for collection work is roughly 15 minutes

for container vehicles, 40 minutes for small dump trucks and 60 to 90 minutes for compactor vehicles and large dump trucks.

The container vehicles have the highest collection efficiency rate and the large dump trucks the lowest.

③ Haulage and Number of Trips

When the vehicle becomes full of waste, the assistants are left behind in the collection area and the vehicle hauls the waste to the disposal site. Distances from collection areas to the Abis Disposal Site, which is the disposal site in the Project, range from 5 - 10 km, and the times taken for haulage to the disposal site are 20 - 30 minutes. The time required for unloading at the disposal site is around 10 minutes.

The number of trips made by the collection vehicles per shift varies according to the type of vehicle. Container vehicles, compactor vehicles and large dump trucks normally make three trips and small dump trucks normally make five.

Upon completion of the collection work, it takes about 15 minutes for the vehicles to return to the garage from the collection area.

(2) Intermediate Treatment

The sole solid waste intermediate treatment facility in Alexandria is the Abis Compost Plant. This plant was built with loan aid from the World Bank and started operating in January 1985.

Fig. 2.3.5 illustrates the location of the Abis Compost Plant and Fig. 2.3.11 shows the equipment layout at the plant. The following is a summary of the operating conditions at Abis Compost Plant.

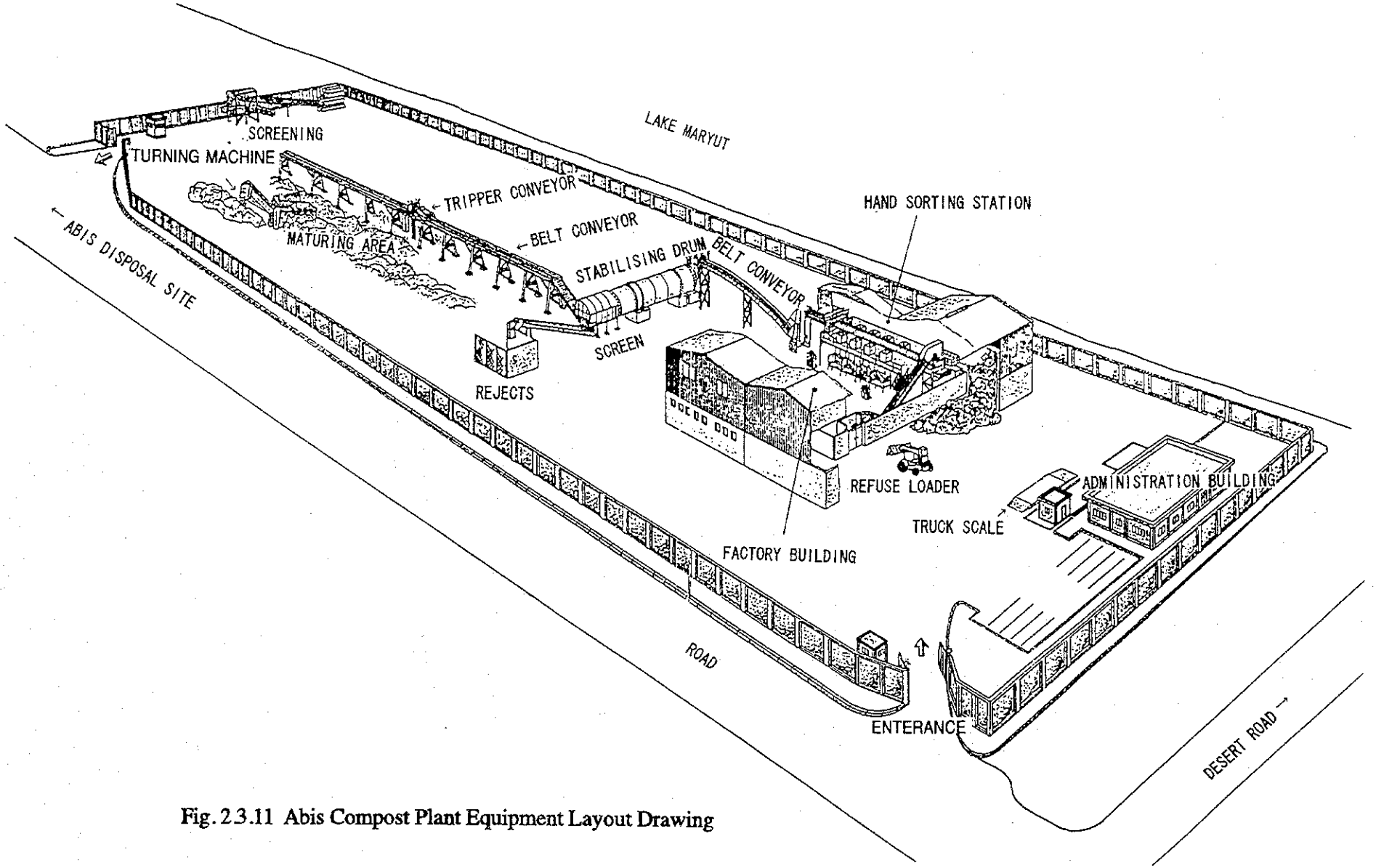


Fig. 2.3.11 Abis Compost Plant Equipment Layout Drawing

1) Abis Compost Plant Operating Results (1993/1994)

① Solid waste treatment capacity : 160 tons/day,

② Operation time : 13-14 hours/day (299 days/year),

③ Compost production quantities :

- Fine compost : 3.3 tons/day (998 tons/year)
- Coarse compost : 80.1 tons/day (24,043 tons/year)

④ Sales results:

- Compost	:	281,964 LE
- Reusable items	:	58,714 LE
Total	:	340,678 LE

⑤ Operating costs

- Equipment maintenance	:	90,612 LE
- Utilities (electricity, water, fuel)	:	85,083 LE
- Incentive	:	136,689 LE
Total	:	312,384 LE

⑥ Personnel costs : 109,200 LE

Of the above costs, personnel costs are directly furnished by the Governorate. If personnel costs are excluded, the financial balance shows a slight profit and so there are no problems in terms of continued operation.

The compost production and sales figures and accounts of the Abis Compost Plant for the past three to five years, and recent trends in compost prices are displayed in Table 2.3.6, Table 2.3.7 and Table 2.3.8.

Table 2.3.6 Compost Production and Sales (1989-1993)

(Unit: tons)

	1989	1990	1991	1992	1993
Fine compost	814	1,507	1,406	1,027	998
Coarse compost	23,547	21,688	22,658	19,543	24,043

Table 2.3.7 Trends in Compost Prices (1985-1994)

(Unit: LE/ton)

	Apr. 1985 - Mar. 1986	Apr. 1986 - Jun. 1989	Jul. 1989 - Jun. 1990	Jul. 1990 - Jun. 1991	Jul. 1991 - Jun. 1992	Jul. 1992 - Aug. 1994
Fine compost	7.5	11.0	11.0	15.0	20.0	25.0
Coarse compost	5.5	7.5	7.5	9.0	10.0	11.0

Table 2.3.8 Abis Compost Plant Accounts (1989-1993)

(Unit: LE)

	1991/92	1992/93	1993/94
Income	309,179	322,804	340,678
Expenditure	279,181	275,460	312,384
Balance	+30,105	+47,344	+28,294

2) State of Major Facilities

① Solid Waste Receiving Facilities

The solid waste brought in by the collection vehicles is all accepted, regardless of district of collection, until the treatment capacity level of 160 tons/day is reached. The gates to the plant are closed when the receiving facilities are temporarily full, when the facilities are not operating and when the day's acceptance load has been completed. When the plant gates are closed, the collection trucks unload their waste at the disposal site lying adjacent to the plant. Waste brought to the plant used to be weighed using a truck scale, however because of a broken down load cell, this has not been in use since February 1994.

The waste is deposited into the receiving hall (25 m × 10 m), where large scale waste items, which cannot be used for making compost such as tires and vegetable carrying baskets, are screened. The remaining waste is then fed into a feed hopper using wheel loaders.

Because the feed hopper is raised some 2 m off the floor, the wheel loaders need to raise their buckets to that height. The receiving hall roof is supported by three large, reinforced pillars at the center of the hall, but because these seriously limit the movement of the loaders, the work load of the operators is increased.

After the waste has been fed into the hopper, it is carried by apron conveyor to a hand sorting conveyor. Because the hopper and apron conveyor are not fitted with a set level feeder, the amount of waste is directly dependent on the amounts fed by the wheel loaders, which means that the waste is fed intermittently onto the hand sorting conveyor. Thus, when large quantities flow down the conveyor at once, hand sorting is very difficult, and when there is no flow of waste, the operators have nothing to do. This makes the hand sorting process very inefficient.

② Hand Sorting Line

Hand sorting is designed to separate items such as large waste items, long textiles and large vinyl sheets, which can cause blockage of the after treatment process homogenizer, and items worth retrieving for reuse such as glass, cans and corrugated fiberboard. However, because the speed of the hand sorting conveyor is very fast, the retrieval rates of such items are very low.

③ Homogenizer

The homogenizer specifications are as follows; 3.12 m diameter × 11 m length, 10 revolutions/minute, rated output 160 kw. There are occasional blockages of the homogenizer due to large size waste, which is failed to be screened in the pretreatment stage. The size of sieve openings in the fractionator drum were initially set at a diameter of 100 mm, but after much trial and error, this was reduced to 45 mm. When the drum becomes worn out, it is replaced with drums that are manufactured in the in-plant workshop.

④ Composting Yard

The composting yard is roughly 40 m wide by 180 m long. The raw material for compost, from which reject has been removed in the homogenizer, is carried by tripper conveyor (about 180 m long) to the composting yard where it is scheduled to ferment for one month. Reject is hauled by truck to the adjacent disposal site, however because the plant's two trucks are in a deteriorated state, this is sometimes dumped within the plant itself in large quantities. The compost in the composting yard is turned by turning machine roughly every seven to ten days. The turning machine is a self-running type, however because the procurement of electronic parts is difficult, the plant engineers have reworked all areas of it into electrical or mechanical running parts.

⑤ Maturing Yard

The maturing yard is roughly 40 m wide by 100 m long. Because of the large demand for compost, it is kept in the maturing yard for an average of only 14 days. There are some farmers who purchase compost over a few days, and on condition that the farmers only the use the compost after maturing it themselves for one month, compost that has undergone fermentation in the composting yard is sold off as coarse compost after being matured in the maturing yard.

If the customer requests so, the coarse compost is also sold as fine compost by passing it through a vibrating screen. There is also a bagging machine on the plant, however because this leads to higher costs, demand for bagged compost is low and the machine is hardly used at all.

During the seasons of peak demand for compost, it is sold off without undergoing fermentation, however aside from the sanitary problems created by this, the quality of the compost in terms of its fertilizing effect is poor.

⑥ Plant Generator

The plant has its own 700 kVA and 380 V/220 V diesel generator, which automatically comes on during power cuts. When the plant was first built five years ago, power failures commonly occurred at an average of two or three hours a day, however this has dropped to once per month for around one hour, so the generator is not used very frequently.

(3) Final Disposal Site

Alexandria currently has two final disposal sites at Abis and Ameriyah. Both sites are only two or three km away from built-up areas and because disposal is by open dumping, the level of public sanitation in the surrounding areas is poor due to air pollution caused by foul odors and spontaneous combustion, and outbreaks of harmful insects.

Table 2.3.9 indicates the areas, landfill capacities and useful lives at the two final disposal sites.

Table 2.3.9 Conditions at the Final Disposal Sites

Disposal Site	Site Area	Landfill Capacity	Useful Years
Abis	18ha (60m × 3,000m)	1,600,000 m^3	6
Ameriyah	17ha (170m × 1,000m)	650,000 m^3	7

As is indicated in Table 2.3.9, it is thought that the two existing final disposal sites will become full by the year 2000. For that reason, Alexandria Governorate is taking the necessary steps to secure land for use as a final disposal site after 2001 in New Borg el Arab City, some 70 km west of Middle District. This site has a large landfill capacity of roughly 15,000,000 m^3 and is estimated to have a useful life of seven or eight years.

Fig. 2.3.12 illustrates the locations of the existing Abis and Ameriyah Final Disposal Sites and the new site that will be used from 2001 onwards.

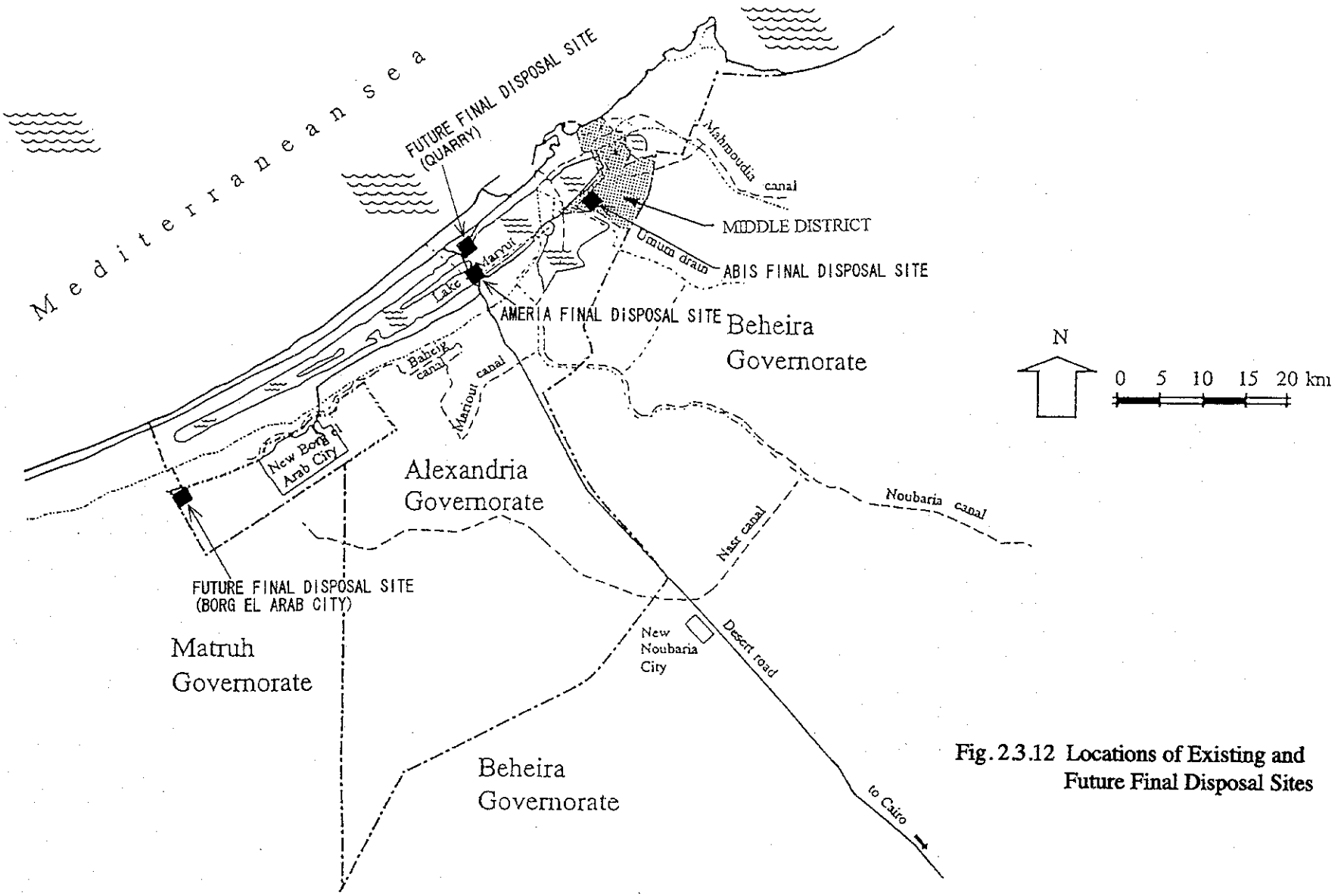


Fig. 2.3.12 Locations of Existing and Future Final Disposal Sites

2.3.2.5 Population, Waste Quantity and Waste Quality

(1) Population

According to materials provided by the Information Collection Center for Decision Making Support, the population of Alexandria city is estimated at 3,470,000 as of 1994.

Judging from national census statistics on population taken in 1966, 1976 and 1986, it is estimated that the population of Alexandria by the Project target year of 2000 will be 4,015,000, which is slightly less than the 4,099,000 forecast by the F/S.

Table 2.3.10 indicates the population estimates for now and the year 2000.

Table 2.3.10 Expected Population by District

(Unit: 1,000 persons)

District	1984 (F/S time)	1994	2000	2000 (F/S time)
Middle	755	643	715	787
East	723	845	917	817
West	531	540	583	567
Montazah	441	822	972	818
Gomrok	321	200	197	335
Ameriyah	113	420	631	775
Total	2,884	3,470	4,015	4,099

Alexandria is also faced with the unique problem of a seasonal temporary population increase (about one million) during the summer tourist season (June until August) which has an effect on waste collection activities.

(2) Solid Waste Quantity

1) Estimation of Solid Waste Discharge Quantities

The solid waste discharge quantities by district that are expected by the Project target year of 2000 are indicated in Table 2.3.10. These figures are based upon the estimates made in the F/S, expected population trends, and results of the discharge source survey conducted as part of the Basic Design Study. It is estimated that the total quantity of waste discharge in Alexandria will have increased to 2,133 tons/day by 2000 from 1,740 tons/day in 1994. Moreover the waste collection quantities in each district, estimated from the collection rates, are indicated in Table 2.3.11.

Table 2.3.11 Solid Waste Discharge Quantities in Each District

(Unit: tons/day)

District	1994	2000
Montazah	343	435
East	437	510
Middle	425	506
Gomrok	153	162
West	210	243
Ameriyah	172	277
Total	1,740	2,133

Fig. 2.3.13 indicates the flow of waste in Alexandria as of 1994.

Moreover, Table 2.3.12 indicates the discharged quantities of waste by type in Middle District. These figures are based upon the results of the waste quality analysis survey.

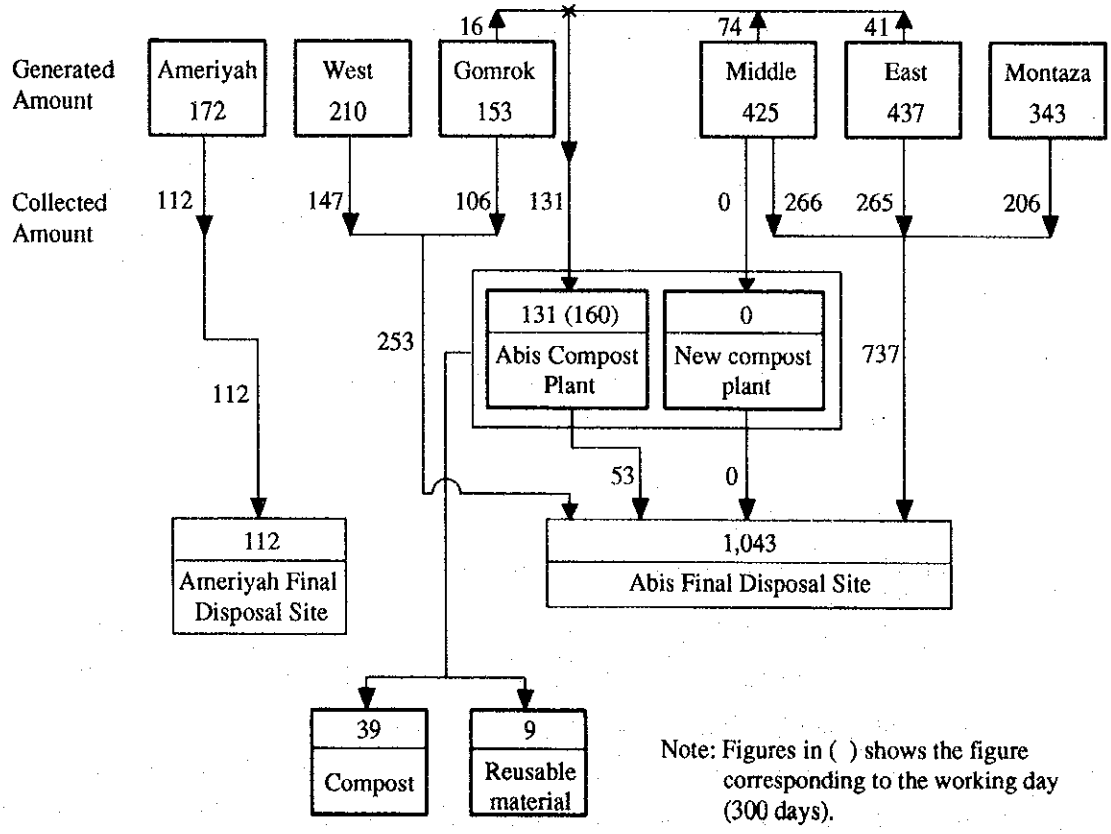


Fig. 2.3.13 Solid Waste Flow in 1994 (tons/day)

Table 2.3.12 Waste Discharge and Collection Quantities by District in Alexandria (tons/day)

	Ameriyah District		West District		Gomrok District		Middle District		East District		Montazah District		Whole Governorate	
	Discharged Quantity	Collected Quantity	Discharged Quantity	Collected Quantity	Discharged Quantity	Collected Quantity	Discharged Quantity	Collected Quantity	Discharged Quantity	Collected Quantity	Discharged Quantity	Collected Quantity	Discharged Quantity	Collected Quantity
Collection Rate (up to 1996)		65%		70%		70%		80%		70%		60%		
Collection Rate (1997 onwards)								100%						
1994	172	112	210	147	153	107	425	340	437	306	343	206	1,740	1,218
1995	190	123	216	151	155	108	439	351	449	314	358	215	1,806	1,262
1996	207	135		155	156	109	452	362	461	323	374	224	1,871	1,307
1997	225	146	227	159	158	110	466	466	474	331	389	233	1,937	1,445
1998	242	157	232	162	159	111	479	479	486	340	404	243	2,002	1,493
1999	260	169	238	166	161	112	493	493	498	348	420	252	2,068	1,540
2000	277	180	243	170	162	113	506	506	510	357	435	261	2,133	1,588
2001	295	191	249	174	164	114	520	520	522	366	450	270	2,199	1,635
2002	312	203	254	178	165	116	533	533	534	374	466	279	2,264	1,683
2003	330	214	260	182	167	117	547	547	547	383	481	289	2,330	1,730
2004	347	226	265	186	168	118	560	560	559	391	496	298	2,395	1,778
2005	365	237	271	189	170	119	574	574	571	400	512	307	2,461	1,825
2006	382	248	276	193	171	120	587	587	583	108	527	316	2,526	1,873
2007	400	260	282	197	173	121	601	601	595	417	542	325	2,592	1,920
2008	417	271	287	201	174	122	614	614	607	425	558	335	2,657	1,967
2009	435	282	293	205	176	123	628	628	620	434	573	344	2,723	2,015
2010	452	294	298	209	177	124	641	641	632	442	588	353	2,788	2,062
2011	470	305	304	212	179	125	655	655	644	451	604	362	2,854	2,110
2012	487	317	309	216	180	126	668	668	656	459	619	371	2,919	2,157

Table 2.3.13 Middle District Mean Waste Composition and Discharge Quantities
(Results of 1994 Basic Design Study Analysis)

Domestic waste quantity								
	Garbage and grass	Paper	Textiles	Plastics	Metals	Glass	Other	Total
High income households	59	23	3	6	1	8	1	100 %
	22.4	8.7	0.8	2.3	0.4	3.0	0.4	38 ton/day
Medium income households	74	14	2	5	4	1	0	100 %
	94.4	17.9	2.6	6.4	5.1	1.3	0.0	127 ton/day
Low income households	70	17	2	8	0	3	0	100 %
	45.8	11.1	1.3	5.2	0.0	2.0	0.0	66 ton/day
Total	70	16	2	8		3	0	100 %
	162.6	37.7	4.6	13.9	5.5	6.3	0.4	231 ton/day
Commercial and institutional waste quantity								
	Garbage and grass	Paper	Textiles	Plastics	Metals	Glass	Other	Total
Public facilities	7	81	0	2	1	5	4	100 %
	2.7	31.4	0.0	0.8	0.4	1.9	1.6	39 ton/day
Markets	62	12	1	2	0	1	22	100 %
	18.0	3.5	0.3	0.6	0.0	0.3	6.4	29 ton/day
Commercial	78	18	0	2	0	0	2	100 %
	75.7	17.5	0.0	1.9	0.0	0.0	1.9	97 ton/day
Street	8	6	5	6	1	7	67	100 %
	2.3	1.7	1.5	1.7	0.3	2.0	19.5	29 ton/day
Total	51	28	1	3	0	2	15	100 %
	98.8	54.1	1.7	5.0	0.7	4.3	29.4	231 ton/day
Grand Total	61	22	2	4	1	2	7	100 %
	261.4	91.9	6.4	18.9	6.2	10.5	29.8	425 ton/day

2) Survey of Waste Quantity per Person per Day (Waste Discharge Quantity Survey)

① Survey Outline

It was decided to carry out a survey of waste discharge in each of the following 11 areas in the Middle District. Factors such as area characteristics, family structures, occupations, floor spaces and numbers of employees etc. were taken into consideration in order to select those areas and survey locations which best represent the general conditions in Middle District.

Table 2.3.14 Surveyed Areas Within the Middle District

Area Division	Area Outline
High income area-1	10 households (36 residents) around Sultan Hussein St., Bani El-Abbas St. and El-Pharana St. on boundary between Attarin and Bab Sharky
High income area-2	10 households (48 residents) around Pastuer St. and Hafez Ibrahim St. in Bab Sharki.
Middle income area-1	11 households (47 residents) around Gawad Hossny St. and Dr. Shaban Haridy St. in Bab Sharki.
Middle income area-2	10 households (40 residents) around Green St.
Low income area-1	10 households (67 residents) around Baradoya Workshop St. (El Hadra) in Bab Sharki.
Low income area-2	10 households (50 residents) around El-Bab El-Geeded St.
Market	Shedia Market (3,400 m^2) in Bab Sharki.
Restaurant	Ahmed El-Mahrouk St. in Bab Sharki (720 m^2).
Shopping area	Ahmed El-Mahrouk St. in Bab Sharki.
Road sweeping area	Road (220 m × 12 m) in Bab Sharki.
Public facilities area	Middle District Offices and General Follow-up Department Office in Bab Sharki

② Method

During the eight days of survey execution, plastic bags were distributed in the residential, public facilities and shopping areas every day. These were collected and each bag's waste contents were measured and recorded as one sample. Waste from the market, restaurant and road was directly collected by truck and measured and recorded.

Fig. 2.3.14 illustrates the locations of each of the survey areas.

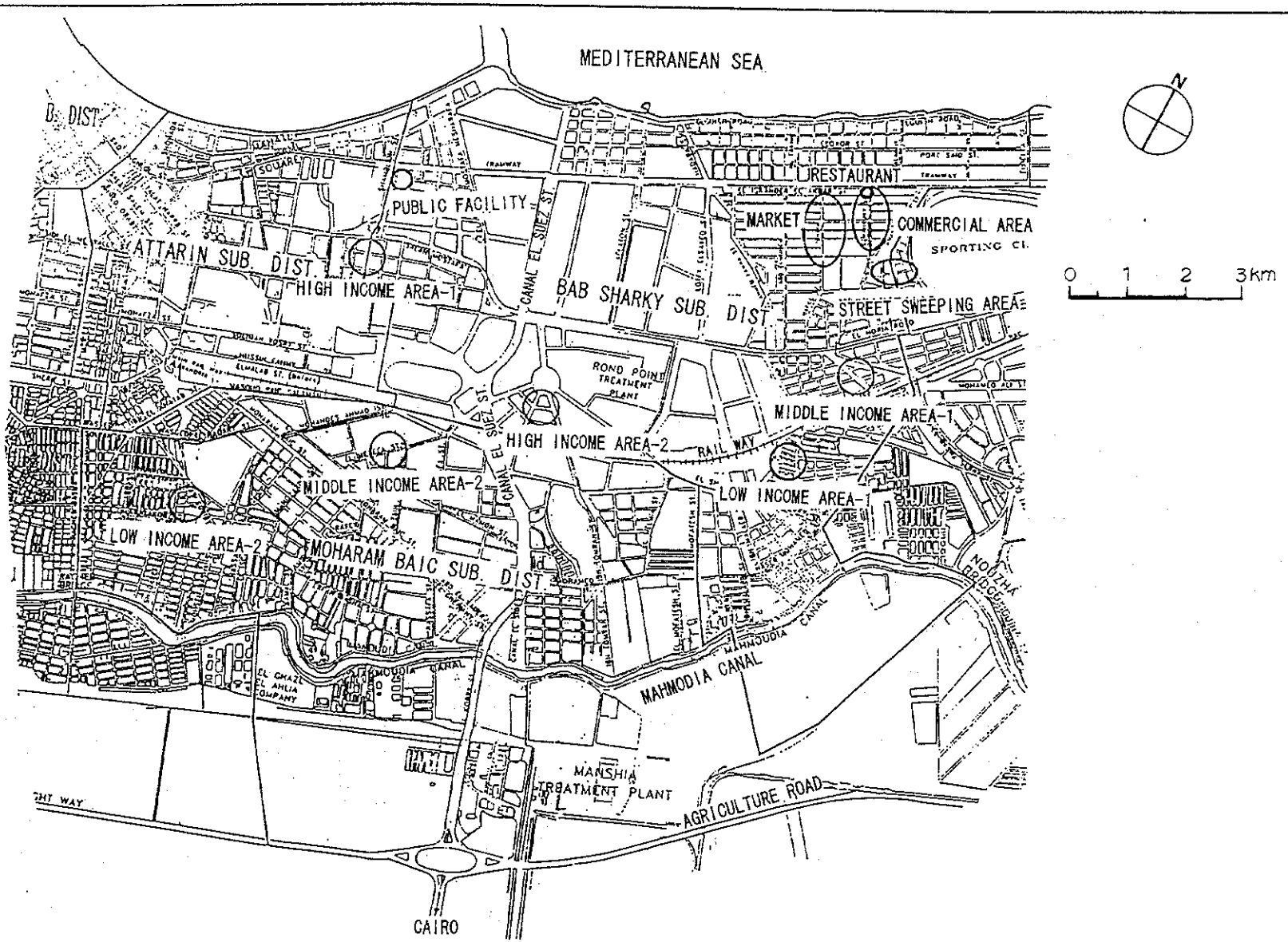


Fig. 2.3.14 Waste Quantity and Quality Survey Areas

3) Survey Results

The results of the survey are as indicated in Table 2.3.15.

Table 2.3.15 Middle District Waste Discharge Quantity Survey Results

Area	Waste quantity over 8 days	Total residents, employees or floor space	Waste quantity
High income areas	303.56 kg	691 persons	0.439 kg/person•day
Middle income areas	266.70 kg	664 persons	0.402 kg/person•day
Low income areas	277.84 kg	922 persons	0.301 kg/person•day
Public facilities area	194 kg	7,500 persons	0.026 kg/person•day
Market	13 ton	20,400 m^2	0.637 kg/m^2•day
Restaurant	4.47 ton	5,760 m^2	0.776 kg/m^2•day
Shopping area	426.84 kg	328 persons 15,342 m^2	1.301 kg/person•day 0.028 kg/m^2•day
Road sweeping area	247.6 kg	21,129 m^2	0.012 kg/m^2•day

(3) Waste Quality

1) Estimated Waste Quality Breakdown for Project

Qualitative estimates of solid waste by the target year were revised to give slightly lower levels of glass and metals, based upon comparison of the results of the F/S and the waste quality analysis results indicated below. The revised waste quality breakdown of the Basic Design Study and the waste quality breakdown estimated at the time of the F/S are indicated in Table 2.3.16.

Table 2.3.16 Revised Middle District Waste Quality Breakdown for Project

(%)

	Garbage and grass	Paper	Textiles	Plastics	Metals	Glass	Other	Total
1994 revised figures	56	22	4	6	3	2	7	100
Revised estimate for 2000	52	23	4	7	4	3	6	100
F/S estimate for 1990	57	21	6	7	4	3	2	100
F/S estimate for 2000	51	23	6	9	6	4	1	100

Tables 2.3.17 and 2.3.18 indicate the waste composition analysis results and apparent relative weights found in the F/S (1986) and the Basic Design Study (1994) for domestic waste and commercial and institutional waste respectively.

Table 2.3.17 Comparison of Domestic Waste Composition Analysis Results

1984 : Feasibility Study; mean values of analysis results of waste taken over six days in four areas.
1994 : Basic Design Study; analysis results of waste taken in one day in one area.
2000 : F/S forecast.

(Wet base weight: %)

	Low Income Area			Middle Income Area			High Income Area		
	1984	1994	2000	1984	1994	2000	1984	1994	2000
Garbage and grass	74	70	64	60	74	50	61	59	50
Paper	14	17	17	22	14	27	23	23	27
Textiles	5	2	5	4	2	3	3	3	3
Plastics	4	8	6	3	5	6	5	6	6
Metals	2	0	4	5	4	7	3	1	7
Glass	2	3	3	3	1	5	3	8	5
Other	0	0	1	5	0	2	2	1	2
Total	100	100	100	100	100	100	100	100	100
Apparent relative weight (kg/m^3)	254	278		224	362		192	323	

Table 2.3.18 Comparison of Commercial and Institutional Waste Composition Analysis Results

1984 : Feasibility Study; mean values of analysis results of waste taken over six days in four areas.
1994 : Basic Design Study; analysis results of waste taken in one day in one area.
2000 : F/S forecast.

(Wet base weight: %)

	Commercial Area			Market		Road Sweeping		Public Institutions		Restaurant	
	1984	1994	2000	1984	1994	1984	1994	1984	1994	1984	1994
Garbage and grass	55	78	41	–	62	19	8	–	7	–	87
Paper	20	18	23	–	12	22	6	–	81	–	6
Textiles	9	0	11	–	1	0	5	–	0	–	0
Plastics	10	2	14	–	2	7	6	–	2	–	2
Metals	3	0	7	–	0	2	1	–	1	–	2
Glass	2	0	3	–	1	0	7	–	5	–	3
Other	1	2	1	–	22	50	67	–	4	–	0
Total	100	100	100	–	100	100	100	–	100	–	100
Apparent relative weight (kg/m^3)	–	120	–	–	421	–	–	367	135	–	615

2) Waste Quality Survey

① Survey Outline

Eight samples equivalent to one day's waste from each of the eight areas selected for the waste quantity per person per day survey were used together with five samples taken from waste hauled to Abis Compost Plant. Measurement and analysis of the following items was performed on the 13 samples in accordance with the waste quality test method stated in the Waste Incineration Facility Testing Manual compiled by the Ministry of Health and Welfare, Environmental Sanitation Department, Water Supply Environment Division, Environmental Preparation Section and issued by the National Municipal Cleansing Forum (December 1, 1983).

② Measurement and Analysis Items

a. Unit weight by volume (Table 2.3.19)
b. Composition analysis (Table 2.3.20):
   garbage, paper, textiles, plastics, rubber, leather, wood, metals, glass, ceramics, stones, others of diameter less than 5 mm, others of diameter 5 mm or more.
c. Three component analysis (Table 2.3.21):
   water, combustibles, ash.
d. Elementary analysis (Table 2.3.22):
   carbon, hydrogen, nitrogen, oxygen, phosphorous, sulphur.
e. General metal and heavy metal analysis (Table 2.3.23):
   iron, zinc, manganese, lead, cadmium, chromium, mercury.

The results of the survey analysis are compiled into the following tables.

Table 2.3.19 Unit Weight by Volume

(ton/m^3)

High income area	0.323
Middle income area	0.362
Low income area	0.278
Public facilities area	0.136
Market	0.421
Restaurant	0.615
Shopping area	0.120
Road sweeping area	0.367

Table 2.3.20 Composition Analysis

(%)

District Division		Combustibles								Noncombustibles			
		Garbage	Paper	Textiles	Plastics	Rubber and leather	Wood	Others of diameter less than 5 mm	Others of diameter 5 mm or more	Metals	Glass	Ceramics	Stones
High income area		57.79	22.90	3.05	5.51	–	0.76	1.04	0.35	0.80	4.61	3.12	–
Middle income area		74.44	13.90	2.48	4.71	–	0.03	–	–	3.62	0.82	–	–
Low income area		69.80	17.45	2.19	6.70	0.14	0.37	–	–	0.37	0.17	1.12	1.69
Public facilities area		4.61	80.67	0.34	2.27	0.68	1.87	2.14	1.28	1.08	2.14	–	2.92
Market		60.87	11.96	1.13	1.65	0.30	1.52	18.83	2.52	0.35	0.48	–	0.39
Restaurant		87.00	6.01	0.31	2.05	–	0.38	–	–	1.57	2.31	0.37	–
Shopping area		77.57	18.41	0.15	1.63	0.54	0.56	0.80	0.16	0.16	0.02	–	–
Road sweeping area		7.46	5.93	5.09	5.89	2.11	0.44	14.36	50.80	1.20	0.47	–	6.25
Abis Compost Plant	Sample 1	38.24	12.89	2.78	7.78	0.49	1.22	13.89	3.67	2.89	1.93	0.71	13.15
	Sample 2	39.04	18.72	4.68	8.02	1.00	1.81	12.08	5.26	2.09	1.34	–	5.96
	Sample 3	36.43	15.43	2.78	5.91	0.57	1.61	20.00	6.83	0.48	1.31	0.30	8.35
	Sample 4	31.65	20.65	4.65	5.00	2.04	1.39	15.31	6.13	1.39	1.96	0.31	9.52
	Sample 5	36.81	16.10	3.81	9.19	1.29	1.43	10.00	5.57	1.57	2.14	0.57	11.52

Table 2.3.21 Three Component Analysis and Lower Calorific Values (distribution results by area)

District Division		Water (%)	Ash (%)	Combustibles (%)	Lower Calorific Value (kcal/kg)
High income area		40.15	2.91	56.94	2,321.40
Middle income area		38.25	1.61	60.14	2,476.80
Low income area		41.21	2.04	56.75	2,306.49
Public facilities area		13.57	6.40	80.03	3,519.93
Market		29.35	8.04	62.61	2,641.35
Restaurant		35.34	2.34	62.32	2,592.36
Shopping area		23.22	4.59	72.19	3,109.23
Road sweeping area		22.55	4.72	36.73	1,517.55
Abis Compost Plant	Sample 1	22.93	7.50	69.57	2,993.07
	Sample 2	28.43	10.61	60.96	2,572.62
	Sample 3	13.71	10.85	65.44	2,802.54
	Sample 4	23.24	15.63	61.13	2,611.41
	Sample 5	24.15	10.75	65.10	2,784.60

Table 2.3.22 Elementary Analysis

(%)

District Division		Carbon C	Hydrogen H	Nitrogen N	Phosphorous P	Sulphur S	Oxygen O
High income area		23.91	5.64	0.91	0.35	0.40	47.16
Middle income area		25.26	6.14	1.40	0.30	0.30	48.44
Low income area		23.84	6.50	1.30	0.24	0.10	45.88
Public facilities area		33.61	3.63	1.10	0.05	0.20	57.18
Market		26.30	4.48	2.24	0.91	0.60	42.21
Restaurant		26.17	5.43	2.14	0.95	0.90	39.84
Shopping area		30.32	3.20	0.85	0.51	0.70	57.25
Road sweeping area		15.43	1.23	0.24	1.00	0.90	22.11
Abis Compost Plant	Sample 1	29.22	3.42	0.71	0.43	0.70	54.80
	Sample 2	25.60	2.68	1.05	0.39	0.50	53.47
	Sample 3	27.48	1.75	0.56	0.64	0.90	63.46
	Sample 4	25.67	2.19	0.88	0.75	1.10	52.02
	Sample 5	27.34	2.58	0.78	0.47	0.60	55.75

Table 2.3.23 General Metal and Heavy Metal Analysis

(ppm)

District Division		Iron Fe	Zinc Zn	Manganese Mn	Lead Pb	Cadmium Cd	Chrome Cr	Mercury Hg
High income area		2.670	0.121	0.028	0.012	5.0×10^{-4}	0.046×10^{-1}	0.008
Middle income area		0.245	0.012	0.064	0.001	9.5×10^{-4}	0.075×10^{-2}	0.005
Low income area		0.580	0.026	0.015	0.023	4.5×10^{-4}	0.805×10^{-2}	0.004
Public facilities area		1.050	0.044	0.052	0.026	9.0×10^{-5}	0.755×10^{-2}	0.007
Market		2.540	0.410	0.058	0.115	1.3×10^{-3}	0.410×10^{-2}	0.004
Restaurant		2.020	0.031	0.021	0.045×10^{-1}	9.5×10^{-4}	0.400×10^{-2}	0.008
Shopping area		3.890	0.104	0.069	0.040	1.25×10^{-3}	0.540×10^{-2}	0.007
Road sweeping area		4.510	0.254	0.106	0.116	2.6×10^{-3}	0.815×10^{-2}	0.002
Abis Compost Plant	Sample 1	2.550	0.205	0.033	0.034	9.5×10^{-4}	0.023	0.002
	Sample 2	2.120	0.255	0.055	0.069	8.5×10^{-4}	0.535×10^{-2}	0.006
	Sample 3	1.980	0.104	0.057	0.031	1.05×10^{-3}	0.150	0.004
	Sample 4	2.350	0.387	0.051	1.780	1.15×10^{-3}	0.208	0.003
	Sample 5	2.230	0.568	0.055	0.074	8.5×10^{-4}	0.015	0.011

2.3.2.6 Compost Demand

(1) Compost Sales Performance at Abis Compost Plant

The sales figures for compost produced at Abis Compost Plant over the past five years are as shown in Table 2.3.6. This shows that an average quantity of 24,000 tons is sold by the plant each year, in other words the plant sells off all of its compost produce.

Farmers who purchase compost from the plant need to make special bookings a few months in advance. Farmers who are unable buy compost from the plant currently go to the compost plants in Cairo and Giza in order to make their purchases. The hearing survey found that there are around 80 such farmers.

The sales performance figures for 1993/1994 show that the Abis Compost Plant served 305 customers and that the average quantity of compost sold to each farmer was roughly 80 tons.

This means that the demand for compost on already developed farmland is roughly 30,000 tons and it is estimated that production at the plant falls short of this demand by around 6,000 tons.

Table 2.3.24 shows the number of farmers in Alexandria Governorate by cultivated land area. These figures were taken from materials compiled by the Ministry for Agriculture.

Table 2.3.24 Number of Farmers in Alexandria Governorate

Cultivated Land Area (feddan)	Number of Farmers	Cumulative Total
100 or more	44	
99-50	22	66
49-20	208	274
19-10	728	1,002
9-5	1,327	2,329
4	1,641	3,970
3	1,348	5,318
2 or less	45,220	50,538
Total	50,538	

(2) Future Demand for Compost

Table 2.3.25 shows the cultivated land area, the total yield and the total yield sales turnover of farms in Alexandria for 1991/1992.

Table 2.3.25 Cultivated Land Area, Yield and Sales Turnover by District

District	Cultivated Land Area (fefddan)	Yield (tons)	Sales Turnover (1,000 LE)
Montazah	14,087	64,185	34,202
East	69,206	341,731	150,999
Ameriyah	95,542	754,338	170,028
Borg el Arab	13,848	30,195	8,311
Total	192,683	1,190,449	332,760

As can be gathered from these figures, the value of yields per cultivated land area unit is 2,223 LE/feddan in the traditional cultivated land of the Nile Delta, while the same figure is only 1,630 LE/feddan or 30% less in the newly developed farmland areas. For this reason, the improvement of the fertility level of newly developed farmland has come to be regarded as an important issue.

The development of new farmland has been continually advanced as a national policy since the First 5-year Plan (1982/1983-1987/1988). Up to 1992, the total area of newly developed farmland amounted to roughly 140,000 feddan, and between 1984 and 1994 the area of such land in Alexandria grew by 60,000 feddan from roughly 140,000 feddan to 20,000 feddan. The plan to develop new farmland at the same rate into the future is currently in progress.

Incidentally, the following three issues were proposed within Agenda 21, which was adopted at the United Nations Environment Conference at Rio de Janeiro in 1992, as measures to advance sustainable agriculture and agricultural community development.

① The development of programs to preserve agricultural land and restore fertility

② The establishment of systems to carry out comprehensive management and control of harmful insects and agricultural chemicals

③ The preparation of effective fertility projects suited to sustainable agriculture such as the encouragement of the recycling of organic and inorganic waste for use on land

Even before the United Nations conference was held, Egypt, for which the agricultural sector accounts for over 16% of its GDP (1990/1991), has been advancing a policy to check quantities of chemical fertilizers, the use of which has rapidly increased ever since construction of the Aswan High Dam in 1961. The results of this policy are as shown in Table 2.3.26.

Table 2.3.26 Chemical Fertilizer Consumption Movements

(Unit: 1,000 tons)

	N	P	K
1953	648	92	–
1961	700	165	6
1966	1,140	244	1
1976	2,646	382	6
1987	5,104	1,272	61
1990	4,687	1,230	58
1991	2,649	649	44

Source: Egypt Statistical Yearbook (1994)

The above mentioned conditions in the Egyptian agricultural sector indicate that the potential demand for organic fertilizer and soil improvement material in recent years has been increasing throughout the country. However, the current level of production of organic fertilizer is only able to satisfy around half of the demand level, and so the necessity for the construction of compost plants to produce compost using municipal waste is growing.

In Alexandria too, requests to the Abis Compost Plant from the agricultural cooperatives and farmers wishing to buy compost have increased in recent years. As is shown in Table 2.3.27, the amount of compost demanded in this way from the Abis Compost Plant has grown to some 60,000 tons per year.

Table 2.3.27 Quantity of Requested Compost

(as of December 1994)

	Prospective Purchaser	Requested Quantity (tons)
General Farmers	1. Masoud Agdra	200
	2. Abdel Kerim Fador	200
	3. Isam Suriem	250
	4. Mohammed Ramadan	50
	5. Kadri Suriem	100
	6. Rafat Badwi	200
	7. Ifsan Elfar	200
	8. Hussein Ahmed Elfar	300
	9. Mohammed Eliwaf	200
	10. Garal Hassan	50
	11. Mohammed Zaid	150
	12. Hamid Baggioni	10
	13. Hassan Abdel Nabi	100
	14. Ali Hassan	50
	15. Shaban Fafmi Kassim	800
	16. Azam Kassim	50
	Subtotal	2,910
Agricultural Cooperatives (AC)	1. Alexandria AC	280,000
	2. Vegetable Yield Promotion AC	70,000
	3. AC for University Graduates (Fangari 3)	60,000
	4. AC for University Graduates (Fangari 5)	3,000
	5. Tiba AC	47,260
	6. Aura AC	2,880
	7. Messeyri AC	26,310
	8. Harris AC	47,040
	9. Sanad AC	3,776
	10. Maryut Joint Development Union	45,000
	11. Abis Joint Development Union	12,215
	Subtotal	597,481
	Grand Total	600,391

2.3.2.7 Environmental Problems

(1) Environmental Regulations in Egypt

Until the Law Relating to the Environment (Law No. 4) became effective in 1994, there had not been any law concerning environmental regulation in Egypt. However, it is thought that this new law will provide the basis for the preparation of specific laws and environmental criteria in the future.

The above mentioned law comprises the following areas:

Part 1 : Prevention of land environmental pollution

Part 2 : Prevention of air pollution
Part 3 : Prevention of water pollution
Part 4 : Penal regulations

Article 37 contains the provisions relating to solid waste and its contents are as follows.

1) The disposal, treatment and incineration of waste, aside from special designated sites, shall be carried out in areas away from residential, industrial and agricultural districts and public water bodies.

2) The law shall stipulate the detailed rules, regulations and minimum distances of the above mentioned appropriate sites away from the above stated areas for carrying out the disposal, treatment and incineration of solid waste.

3) Local self governing bodies shall, in cooperation with the Ministry for the Environment, designate sites suited to solid waste disposal, treatment and incineration in accordance with the contents of this clause.

The establishment of legislation relating to environmental regulation has thus only just started in Egypt. Indeed, there are no written laws and criteria concerning the implementation of the EIA for the Project, and so after holding discussions with the related agencies of the Alexandria Governorate, it was confirmed that an EIA would not be necessary.

(2) Environmental Surveys

1) Outline of Surveys

Surveys were carried out on air and water quality around Abis and Ameriyah Final Disposal Sites, and also on noise and traffic density on the access roads to the two sites.

① Air Quality Survey

One sample each was taken from upwind and downwind points (1 m high), which were set based upon consideration of the prominent wind directions at each of the disposal sites.

Analysis of the three components of ammonia (NH3), hydrogen sulphide (H2S) and methane (CH4) was performed on each of the samples.

② Water Quality Survey

Six samples of leachate and water from lakes and marshes and rivers around the two disposal sites were taken and analyzed for water quality.

③ Noise and Traffic Density Survey

Surveys of traffic going towards each disposal site were carried out at the junction points of the access roads leading to the sites over 48 hours. Seven vehicle type classifications were targeted for the surveys; trailers, large trucks, medium size trucks, small trucks, buses and passenger cars. Noise surveys were also performed for 48 hours on the same roads.

Fig. 2.3.12 shows the locations of the surveyed disposal sites and Figs 2.3.15 and 2.3.16 show the locations of each survey point.

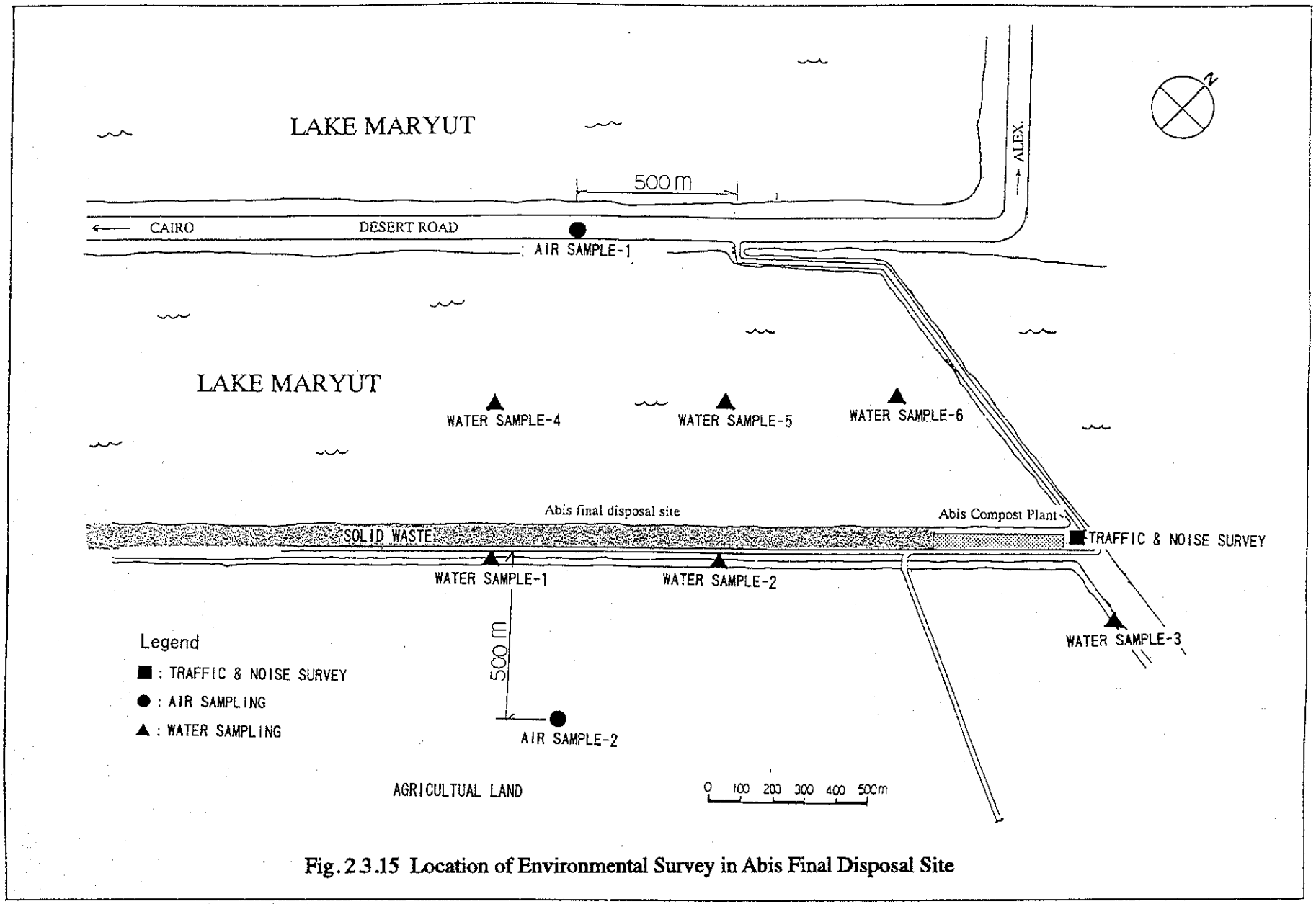


Fig. 2.3.15 Location of Environmental Survey in Abis Final Disposal Site

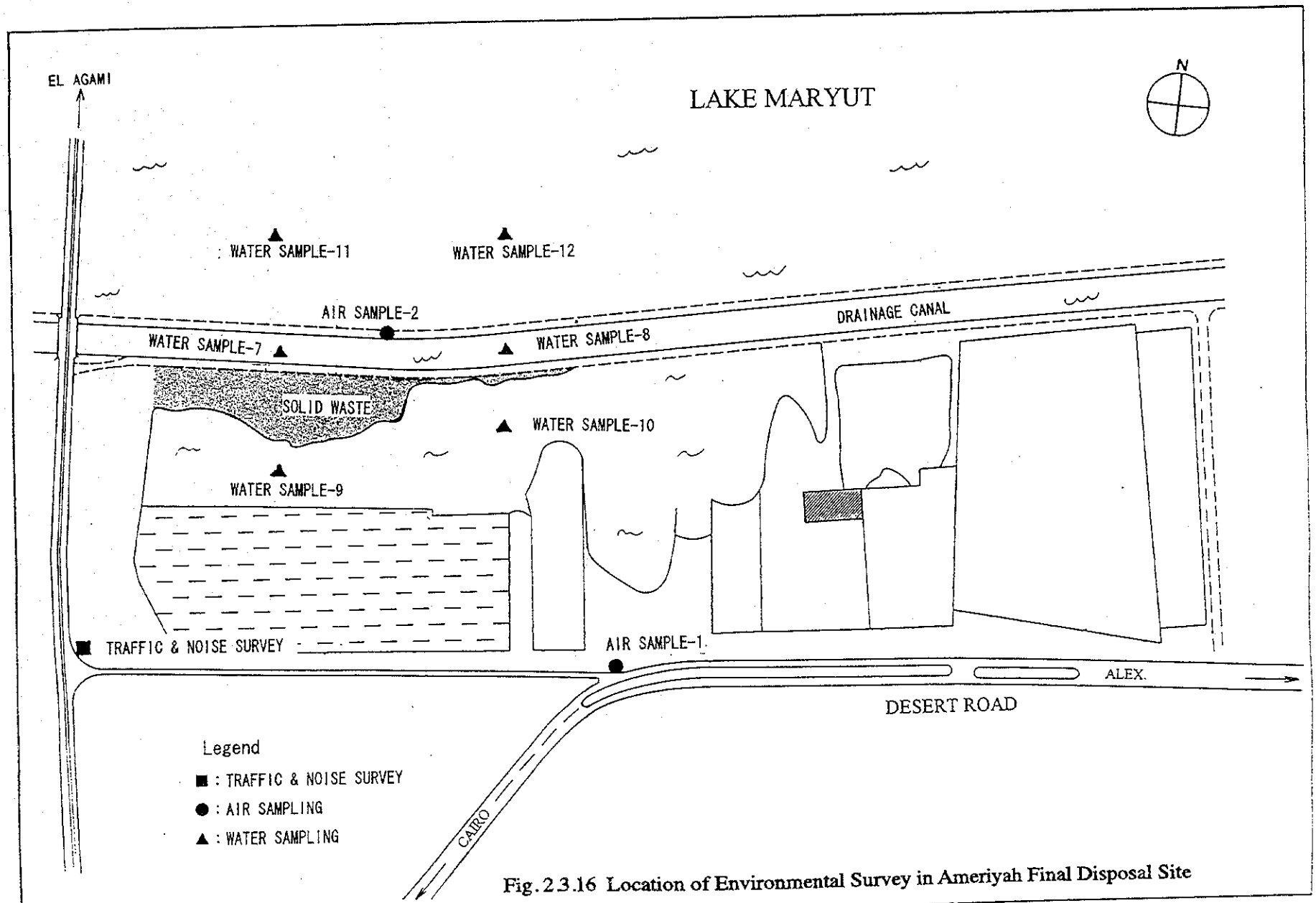


Fig. 2.3.16 Location of Environmental Survey in Ameriyah Final Disposal Site

2) Survey Results

The results of each of the surveys are as stated in the following sections.

① Air Quality Survey

The results of the air quality survey are indicated in Table 2.3.28.

Table 2.3.28 Air Quality Survey Results

	Ammonia ($\mu g/m^3$)	Methane (ppm)	Hydrogen Sulphide (ppm)
Abis Final Disposal Site 1	61.5	0.2 or less	0.05
Abis Final Disposal Site 2	242.3	0.2 or less	0.12
Ameriyah Final Disposal Site 1	68.2	0.2 or less	Not detected
Ameriyah Final Disposal Site 2	48.8	0.2 or less	Not detected

The ammonia and hydrogen sulphide levels that were detected are thought to be due to open burning and spontaneous combustion at the final disposal sites. It is considered that it would be possible to prevent the outbreak of spontaneous combustion and odors if earth covering and water sprinkling was periodically carried out at the sites.

Survey dates : Abis Final Disposal Site : 11.30 a.m., August 27, 1994
Ameriyah Final Disposal Site : 11.00 a.m., August 28, 1994

The climatic conditions at the time each of the samples was taken are indicated in Table 2.3.29.

Table 2.3.29 Climatic Conditions at Time of Air Quality Survey

Abis Final Disposal Site		Ameriyah Final Disposal Site	
Wind direction	: NW	Wind direction	: NW
Wind speed	: 3 m/s	Wind speed	: 3 m/s
Temperature	: 30.6	Temperature	: 30.6
Relative humidity	: 72%	Relative humidity	: 72%

② Water Quality Survey

The results of the water quality survey are shown in Table 2.3.30.

1. Water Systems around the Final Disposal Sites

   a. A drainage channel lies across the road on the southern side of the Abis Disposal Site. This drainage channel serves the farmland and scattered houses to the south of the site. Water from the conduit is pumped away into Lake Maryut located on the northern side of the disposal site. It is possible that leachate from Abis Final Disposal Site is permeating through the causeway, which acts as a road, and affecting water quality. Leachate is not however directly drained into the drainage channel.

   b. The northern side of Abis Final Disposal Site consists of part of Lake Maryut. The disposal site is partitioned by the causeway, however it is possible that leachate is permeating through this and affecting the water quality of the lake. Leachate is not however directly drained into the lake. Lake Maryut is a shallow lake possessing no drainage exits, and its water level varies according to the amount of incoming water and evaporation.

   c. To the northern side of the Ameriyah Final Disposal Site lies a drainage channel which drains away the storm water and wastewater from the surrounding houses and factories. This drainage channel was constructed by partitioning Lake Maryut with the causeway. The lake lies to the north of the conduit. The causeway separates this part of the lake, which is used as a salt bed, away from the part which is located to the north of Abis Disposal Site.

   d. The water area currently being used as Ameriyah Final Disposal Site is the part of Lake Maryut which was left over after construction of the causeway. Because the water has become filled through the open dumping of waste, the water of the remaining part of the lake is subject to direct pollution.

2. Evaluation of the Water Quality Analysis Results

   The level of pollution due to organic substances of the water in the drainage channel and in Lake Maryut around the Abis Final Disposal Site was found to be very advanced with extremely high BOD values. This is particularly so in Lake Maryut, the water of which contains a high level of chlorine ion due to

evaporation. The level of cadmium found in water taken from Point 5 of the lake was found to be high, although the reason for this is unknown. The cadmium levels of water taken from Points 4 and 5 in the lake were found to be low. A high coliform group count of water taken from the drainage channel indicates that the water is directly affected by the various incoming wastewaters.

Concerning the quality of water taken from around Ameriyah Final Disposal Site, the level of pollution of water taken from the drainage channel was found to be similar to that of the water taken from the drainage channel to the south of Abis Disposal Site. The body of water to the south of the site showed a high level of chlorine ion due to evaporation and also high BOD levels indicating that pollution through organic substances is very advanced. This water is obviously being affected by the landfill disposal activities, however compared to water from the drainage channel, the level of heavy metal concentration was found to be low. Water from Lake Maryut on the northern side was characterized by an extremely high concentration of chlorine ion.

Table 2.3.30 Water Quality Survey Results

Item \ Sample No.	Abis Final Disposal Site						Ameriyah Final Disposal Site						General Wastewater Criteria in Japan
	Drainage Channel			Lake Maryut			Drainage Channel		Site Area		Lake Maryut		
	1	2	3	4	5	6	7	8	9	10	11	12	
PH	7.1	7.1	7.0	7.0	7.0	7.5	7.6	7.6	7.2	7.3	6.7	6.7	5.8-8.6
E.C. (umohs/sec)	4,000	4,000	800	16,800	16,00	16,600	6,000	6,000	14,000	14,500	16,600	15,000	–
TDS (mg/ℓ)	3,305	2,532	2,730	15,760	13,953	15,762	4,040	4,178	115,064	104,193	453,490	358,177	–
Turbidity (NTU)	4	3	4	10	8	3	3	3	100	120	20	25	–
NH_4 (mg/ℓ)	0.08	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0	0	0	0	–
Cl^- (mg/ℓ)	1,150	1,000	1,000	6,850	6,500	6,250	120	120	55,000	53,500	183,000	140,000	–
NO3 (mg/ℓ)	0.08	0.05	0.24	0.06	0.08	0.08	0.24	0.2	0.3	0.16	0.32	0.24	–
BOD (mg/ℓ)	130	130	130	400	340	240	140	160	600	850	750	700	120
COD (mg/ℓ)	176	176	264	1,496	704	704	264	276	1,408	1,760	3,520	3,168	–
S.S. (mg/ℓ)	177	264	101	635	2,328	923	767	297	16,296	37,401	232,819	56,336	150
DO (mg/ℓ)	1.2	2.6	0.6	2.2	5.4	3.8	9	0	0	0	0	8.2	–
Overall hardness (mg/ℓ)	800	740	700	5,000	3,700	4,000	1,900	130	20,000	20,000	24,500	186,000	–
Cu (ppm)	0.039	0.025	0.022		0.051	0.0004	0.145	0.046	0.002	0.004	0.003	0.005	3
Cd (ppm)	0.087	0.087	0.052	0.002	0.273	0.002	0.131	0.120	0.015	0.016	0.014	0.019	0.1
Mn (ppm)	2.008	1.680	0.386	0.004	0.759	0.004	0.267	0.327	0.041	0.049	0.095	0.249	10
Cr (ppm)	0.185	0.192	0.148	0.006	0.362	0.008	0.369	0.1314	0.022	0.022	0.034	0.053	2
Fe (ppm)	6.84	5.01	0.37	0.046	2.08	0.272	3.14	3.02	0.069	0.095	0.115	0.137	10
Zn (ppm)	0.512	0.240	0.092	0.009	0.227	0.002	0.224	1.178	0.012	0.012	0.016	0.013	5
K (ppm)	20	20	20	0.7	800	0.8	15	14	2.8	3.2	1	230	–
Na (ppm)	9.3×10^3	11.1×10^3	9.7×10^3	$\times10^3$	41.1×10^3	0.42×10^3	19.1×10^3	16.9×10^3	3.38×10^3	2.87×10^3	1.16×10^3	5.31×10^3	–
Number of general bacteria samples (CFU/mℓ)	75,000	850,000	79,000	20,000	20	5,000	22,000	4,400,000	40,000,000	47,000	1,000	200,000	–
Number of coliform groups (CFU/mℓ)	3,600	43,000	23,000	230	not detected	not detected	9,100	93,000	910	360	not detected	not detected	3,000/cm^2
Temperature (°C)	33	33	33	33	33	33	33	33	33	33	33	33	–
Water temperature (°C)	29	29	29	29	29	29	29	29	30	30	34	34	–
Water depth (m)	0.5	0.5	0.5	3.0	3.5	4.0	2.5	2.5	0.5	0.5	0.3	0.25	–

③ Noise Survey Results

The results of the noise survey are shown in Table 2.3.31.

Table 2.3.31 Noise Survey Results

(Unit: dB(A))

	Abis Final Disposal Site		Ameriyah Final Disposal Site	
	August 31	September 1	August 28	August 29
AM 08.00	64	62	66	69
10.00	62	62	76	72
PM 12.00	72	64	68	65
14.00	62	72	68	65
16.00	61	62	74	70
18.00	62	61	66	72
20.00	62	62	60	62
22.00	46	52	60	62
24.00	46	51	54	56
AM 02.00	45	47	46	52
04.00	45	46	44	46
06.00	46	46	60	62

The maximum and minimum noise values taken around Abis Final Disposal Site were 72 dB (12.00 noon) and 45 dB (2.00 a.m.) respectively. The regulatory standards in Japan prescribe 70 dB (A) for daytime, 65 dB (A) for morning and evening and 60 dB (A) for nighttime in Type 4 districts.

The maximum and minimum noise values taken around Ameriyah Final Disposal Site were 76 dB (10.00 a.m.) and 44 dB (4.00 a.m.) respectively, indicating a high level of noise during the daytime.

However, because there are hardly any inhabited buildings around the two disposal sites, it is thought that the noise created by increased movement of collection vehicles after implementation of the Project will have only a minor environmental impact.

④ Traffic Density Survey Results

The results of the traffic density survey are shown in Tables 2.3.32 and 2.3.33.

As can be seen from the following survey results, the traffic densities on the access roads to the existing landfill disposal sites at Abis and Ameriyah are 2,000

vehicles/day and 10,000 vehicles/day respectively. Of those figures, haulage vehicles account for 380 vehicles/day and 40 vehicles/day respectively. The access road to Abis Disposal Site consists of two lanes and that to the Ameriyah Disposal Site has four lanes. It can thus be concluded that Project implementation will not create any problem in terms of traffic density.

Table 2.3.32 Traffic Density Survey Results (Abis Final Disposal Site)

(Unit: vehicles)

Survey performed on August 30, 1994								
	Trailer	Large truck	Medium size truck	Small truck	Bus	Passenger car	Other	Total
AM 08.00	2	31	51	110	45	20	8	267
10.00	6	79	37	109	78	46	10	365
PM 12.00	1	29	19	121	43	41	7	261
14.00	4	31	18	120	46	31	18	268
16.00	3	15	12	107	36	39	10	222
18.00	7	10	11	96	39	32	14	209
20.00	2	8	7	82	18	16	6	139
22.00	1	8	4	46	11	10	2	82
24.00	2	3	2	23	10	7	–	47
AM 02.00	1	–	1	9	1	1	–	13
04.00	2	1	2	15	2	1	–	23
06.00	6	13	15	84	41	7	4	170
Total	37	225	179	922	370	251	79	2,066
Number of waste collection vehicles					381			

(Unit: vehicles)

Survey performed on August 31, 1994								
	Trailer	Large truck	Medium size truck	Small truck	Bus	Passenger car	Other	Total
AM 08.00	4	21	27	145	45	17	8	267
10.00	3	26	18	115	63	40	14	279
PM 12.00	4	25	9	109	38	32	10	227
14.00	4	15	15	100	60	45	7	246
16.00	3	21	6	112	38	37	3	220
18.00	6	12	15	109	45	38	15	240
20.00	2	11	8	67	28	21	–	137
22.00	4	–	1	38	23	10	–	76
24.00	–	6	1	20	7	4	1	39
AM 02.00	–	1	–	10	3	–	–	14
04.00	2	1	2	16	–	4	–	25
06.00	2	12	13	96	45	9	9	186
Total	34	151	115	937	395	257	67	1,956
Number of waste collection vehicles					379			

Table 2.3.33 Traffic Density Survey Results (Ameriyah Final Disposal Site)

(Unit: vehicles)

Survey performed on August 28, 1994								
	Trailer	Large truck	Medium size truck	Small truck	Bus	Passenger car	Other	Total
AM 08.00	32	225	67	175	172	477	3	1,151
10.00	54	84	47	173	116	673	8	1,155
PM 12.00	48	98	51	169	101	790	6	1,263
14.00	47	104	70	184	127	843	10	1,385
16.00	42	94	54	150	170	765	8	1,283
18.00	39	98	51	158	118	633	8	1,105
20.00	29	69	48	121	68	529	3	867
22.00	18	57	24	56	52	332	2	541
24.00	13	45	18	30	31	210	–	347
AM 02.00	9	36	15	21	21	107	1	210
04.00	14	33	9	8	13	66	–	143
06.00	33	99	29	57	108	177	4	507
Total	378	1,042	483	1,302	1,097	5,602	53	9,957
Number of waste collection vehicles					39			

(Unit: vehicles)

Survey performed on August 29, 1994								
	Trailer	Large truck	Medium size truck	Small truck	Bus	Passenger car	Other	Total
AM 08.00	61	134	70	205	188	535	4	1,197
10.00	59	124	67	178	110	635	10	1,183
PM 12.00	42	115	75	176	49	749	8	1,214
14.00	49	126	54	191	125	734	7	1,286
16.00	38	103	63	180	161	600	9	1,154
18.00	31	90	48	187	124	650	4	1,134
20.00	27	55	37	88	86	542	1	836
22.00	22	55	31	62	67	355	1	593
24.00	14	41	21	26	38	176	1	317
AM 02.00	17	34	14	16	12	85	–	178
04.00	25	29	10	11	13	37	–	125
06.00	32	90	19	48	122	159	3	473
Total	417	996	509	1,368	1,095	5,257	48	9,690
Number of waste collection vehicles					41			

2.3.3 Budget

The SWM budget consists of an annual budget incorporated into the Alexandria Governorate general account, and the Cleansing Fund which is covered by a special local tax.

(1) Alexandria Governorate Budget

The budget and revenue and expenditure of the Alexandria Governorate over the past three years is as shown in Table 2.3.34. It can be seen from this that the budget is growing at around 20% per year, although if an annual inflation rate of almost the same figure is taken into consideration, it has remained more or less the same in real terms.

Table 2.3.34 Alexandria Governorate Budget

(Unit: LE)

Item	Fiscal Year	1992/93		1993/94		1994/95	
		Budget	Ratio (%)	Budget	Ratio (%)	Budget	Ratio (%)
1.	Revenue						
	(First Sector)						
	- Tax revenue	94,850,000	27.7	120,137,000	29.1	117,955,000	24.2
	(Second Sector)						
	- Business revenue	62,662,000	18.3	78,043,000	18.9	82,748,000	17.0
	- Government subsidy	156,827,109	45.8	179,889,727	43.6	231,280,748	47.4
	(Third Sector)						
	- Investment revenue	9,245,160	2.7	10,071,200	2.5	17,816,119	3.7
	(Fourth Sector)						
	- Loan from national bank	18,833,000	5.5	24,410,000	5.9	37,775,000	7.7
	Revenue Total	342,417,269	100.0	412,550,927	100.0	487,574,867	100.0
2.	Expenditure						
	(First Sector)						
	- Personnel expenses	236,953,000	69.2	292,084,000	70.8	342,725,000	70.3
	(Second Sector)						
	- Operating expenses	67,113,785	19.6	85,985,727	20.8	89,258,748	18.3
	(Third Sector)						
	- Investment (construction costs etc.)	29,790,000	8.7	24,910,000	6.1	43,950,000	9.0
	(Fourth Sector)						
	- Capital transfer costs	8,560,484	2.5	9,571,200	2.3	11,641,119	2.4
	Expenditure Total	342,417,269	100.0	412,550,927	100.0	487,574,867	100.0

Moreover, the recent movement in the central government general account expenditure shown in Table 2.3.35 show that this has been growing at a similar rate to the budget of the Alexandria Governorate.

Table 2.3.35 Government General Account Expenditure

Fiscal Year	Expenditure (million LE)	Increase Rate
1984/85	13,301	100
1985/86	16,079	121
1986/87	15,696	118
1987/88	19,777	149
1988/89	21,726	163
1989/90	24,435	184
1990/91	32,556	245

Origin: Statistical Yearbook 1993

(2) SWM Budget

The income source for the SWM system is composed of a contribution from the Governorate General Account, 2% of rents paid by house owners, the Cleansing Fund which comes from large vehicle registration tax, and waste collection charges collected by each ADS from residents and shop owners etc. The waste management movement of the budget for the past four years is as shown in Table 2.3.36.

Table 2.3.36 SWM Budget

(Unit: 1000 LE)

		91/92	92/93	93/94
Governorate Budget				
- Basic salaries	2,140	4,200	5,100	6,200
- Equipment maintenance	2,330	1,500	1,138	3,868
Cleansing Fund and ADS budget	1,965	4,017	6,305	7,685
Total	6,435	9,717	12,543	17,753

Note: Basic salaries are estimated to account for 2% of the Governorate Budget.

The ratio of SWM costs within the Alexandria Governorate Budget was 3.7% in 1992/1993 and 4.3% in 1993/1994. This is very low compared to the same figure in other developing countries and it can be said that the burden placed on the Governorate finances is small.

Furthermore, although basic salaries have risen in line with inflation, the rate of growth of the Cleansing Fund has been higher. The share of the Cleansing Fund within the total budget has increased greatly from 30% in 1984/1985 to 43% in 1993/1994, thus contributing to a higher rate of self financing in the SWM sector.

Concerning the equipment investment fund that is included in the Governorate General Account and that includes foreign assistance, this fluctuates from year to year.

(3) Ability of the Egyptian Side to Bear Project Expenses

The SWM setup in Alexandria in the year 2001 will be characterized by the following points after the Project has been implemented.

① Collection of all solid waste in Middle District

② A combined intermediate treatment facility (compost plant) capacity of 310 tons/day

③ Final disposal by sanitary landfill involving daily covering with earth obtained at an old stone cutting quarry site 30 km away from Alexandria city center.

The operating costs to be required for the implementation of the above mentioned SWM amount to 19,430,000 LE as can be seen in Table 2.3.37.

Table 2.3.37 SWM Operating Costs in 2001

(Unit: 1000 LE)

Collection	17,098
Intermediate treatment	1,116
Final disposal	1,216
Total	19,430

Table 2.3.38 shows the rate of increase of the solid waste management sector budget over the past three years. This indicates that the budget is increasing by a rate of 30-40% each year, although in real terms this is around 10-20% when an inflation rate of 20% is taken into account. It can be hoped that such a rate of increase can be maintained because one of the priority issues of the Third 5-year Plan is the strengthening of local government cleansing finance bases.

The operation and maintenance costs of the system and the depreciation costs of facilities and equipment in 2001 are estimated at 45,800,000 LE and it will require a real budget increase rate of just under 13% to cover these costs. It is likely that such a rate of increase will be achieved. Moreover, when one takes into consideration profits from the sale of compost produce and reusable materials and also the various economic benefits that will be brought about by the introduction of the new compost plant, it is thought that the expenditure involved in solid waste management will be amply covered.

Table 2.3.38 Income and Expenditure of SWM in Alexandria

Item			Amount (1,000 LE)	Remarks
Income	Budget of Governorate etc.		45,875	Assuming a budget increase rate of 13%
	Returns from SWM		692	Returns from the sale of compost product and reusable materials
	Economic benefits		1,070	Benefits from the introduction of the new compost plant
	Total		47,637	
Expend-iture	Operation and Maintenance Costs	Collection and haulage	17,098	
		Compost plants	1,116	
		Final disposal	1,216	
	Depreciation Costs	Collection and haulage vehicles and equipment	20,600	
		Compost plant facilities	4,209	
		Final disposal site equipment	1,612	
	Total		45,853	

2.3.4 Maintenance Plan

(1) Maintenance Setup after Project Implementation

The execution setup for the Project is as illustrated in Fig. 2.3.17.

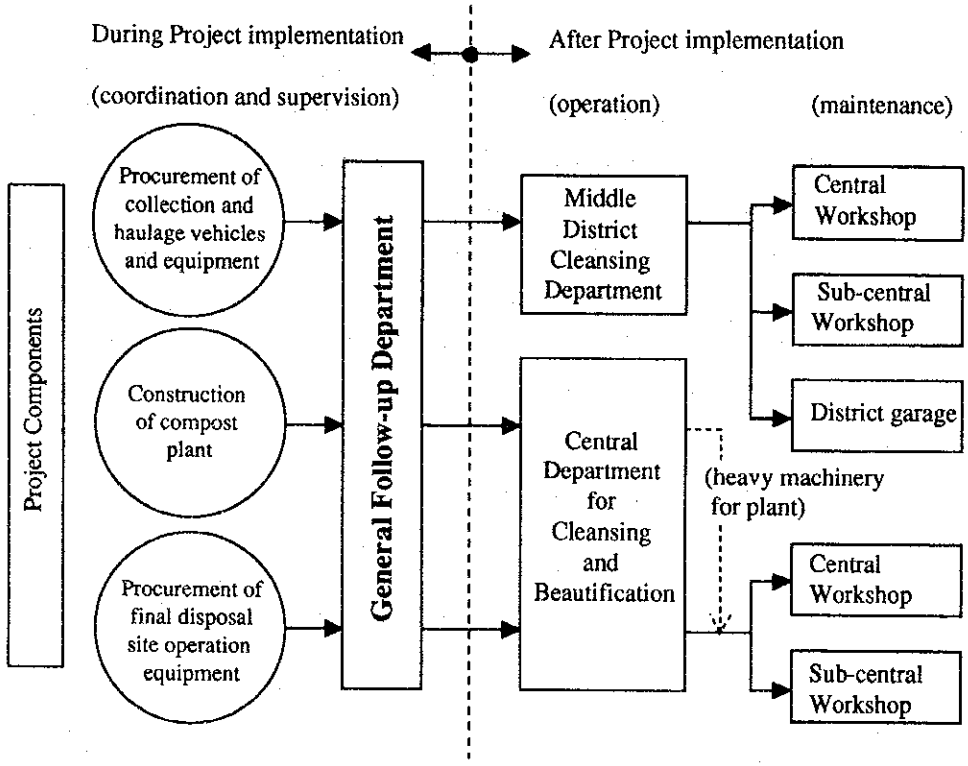


Fig. 2.3.17 Project Implementation Setup

The SWM operation setup after completion of the Project will be more or less the same as the existing setup, except that extra staffing of the Plant Management Division (see Fig. 2.3.4) of the Central Department for Cleansing and Beautification will be necessary following the introduction of the new compost plant. The Middle District Cleansing Department and ADS will continue to take responsibility for waste collection activities, however it is planned to gradually reduce nighttime collections by the Cleansing Department in line with the improved operating levels of the procured vehicles and equipment. The organizational setup of the Middle District Cleansing Department is illustrated in Fig. 2.3.18.

Maintenance and repair of collection and haulage vehicles and final disposal site operation equipment shall be carried out by the Governorate-run Central

Workshop and Sub-central Workshop, and also by the Middle District Cleansing Division garage.

The organizations of the new compost plant, Central Workshop and Sub-central Workshop after completion of the Project are indicated in Figs 2.3.19, 2.3.20 and 2.3.21 respectively.

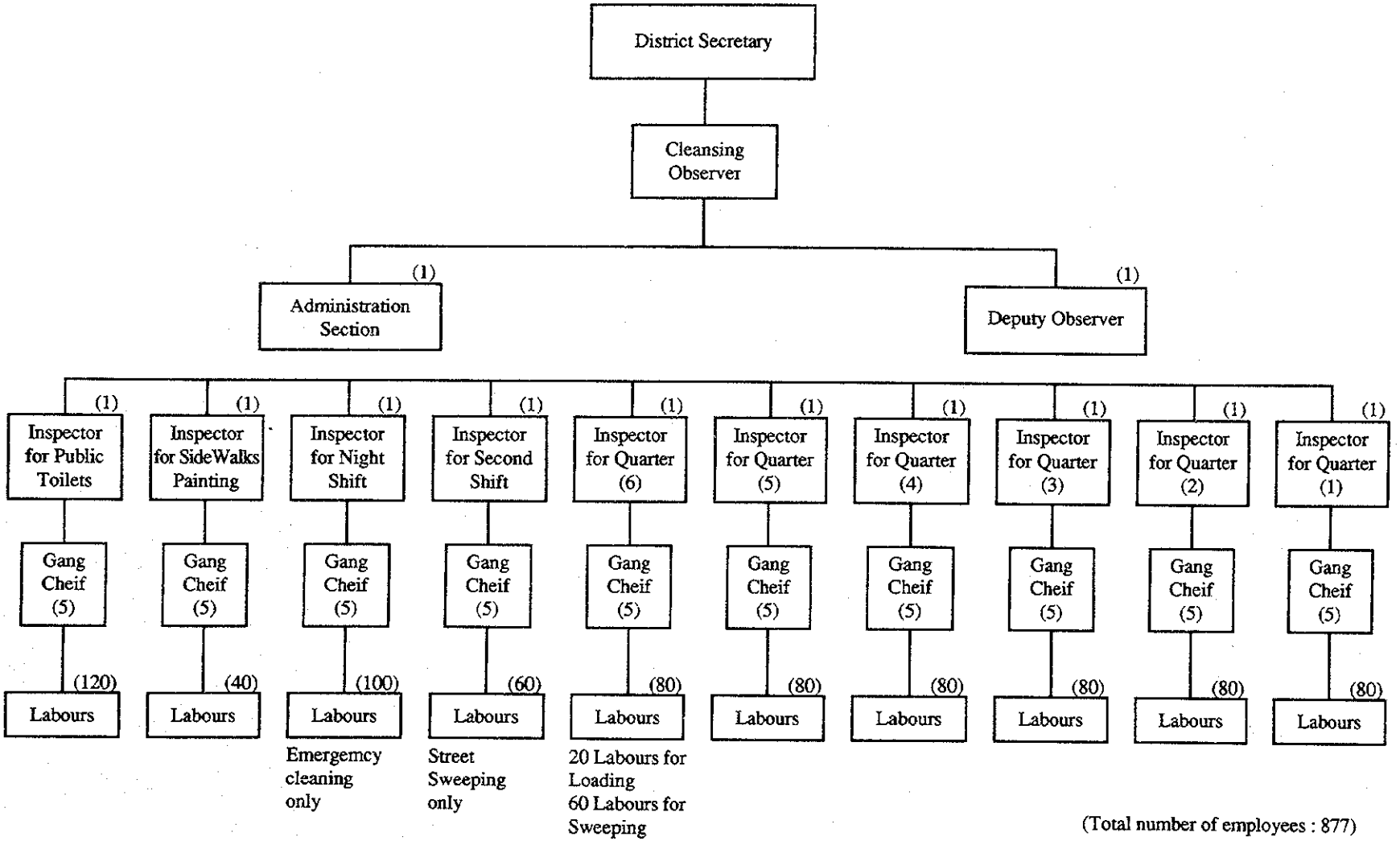


Fig. 2.3.18 Organization Chart for Cleansing Affairs in Middle District

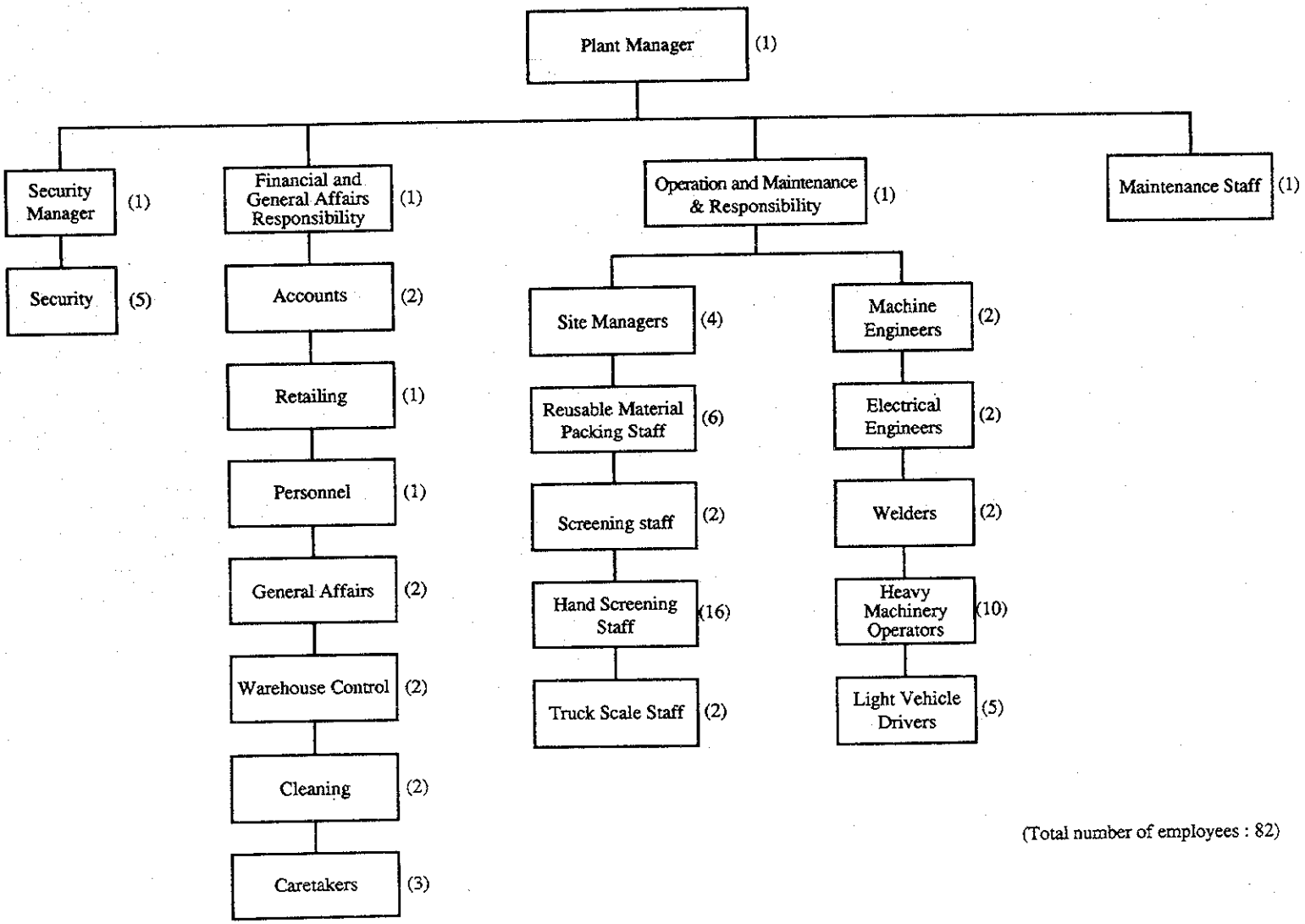


Fig. 2.3.19 Organization Chart of New Compost Plant

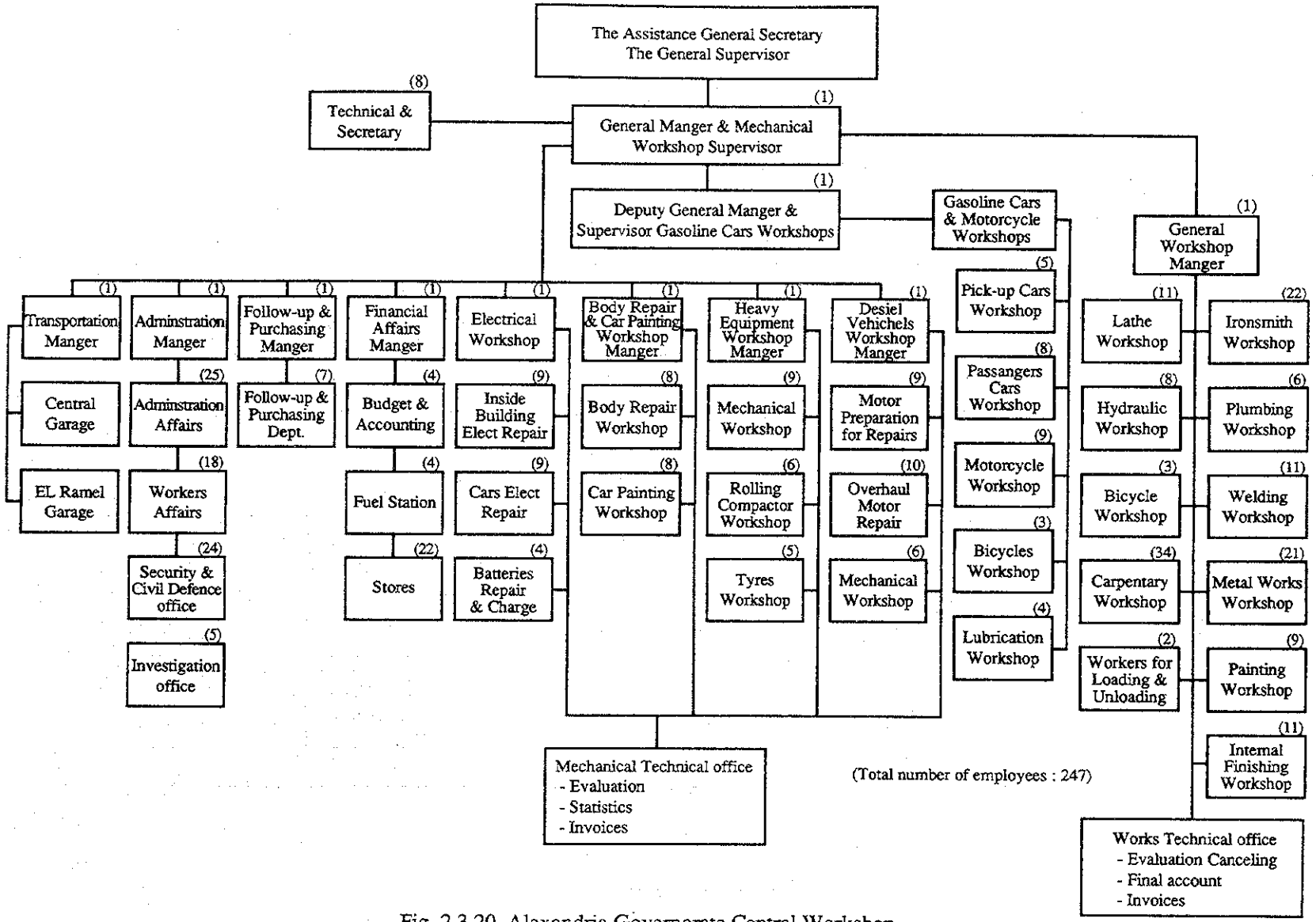


Fig. 2.3.20 Alexandria Governorate Central Workshop

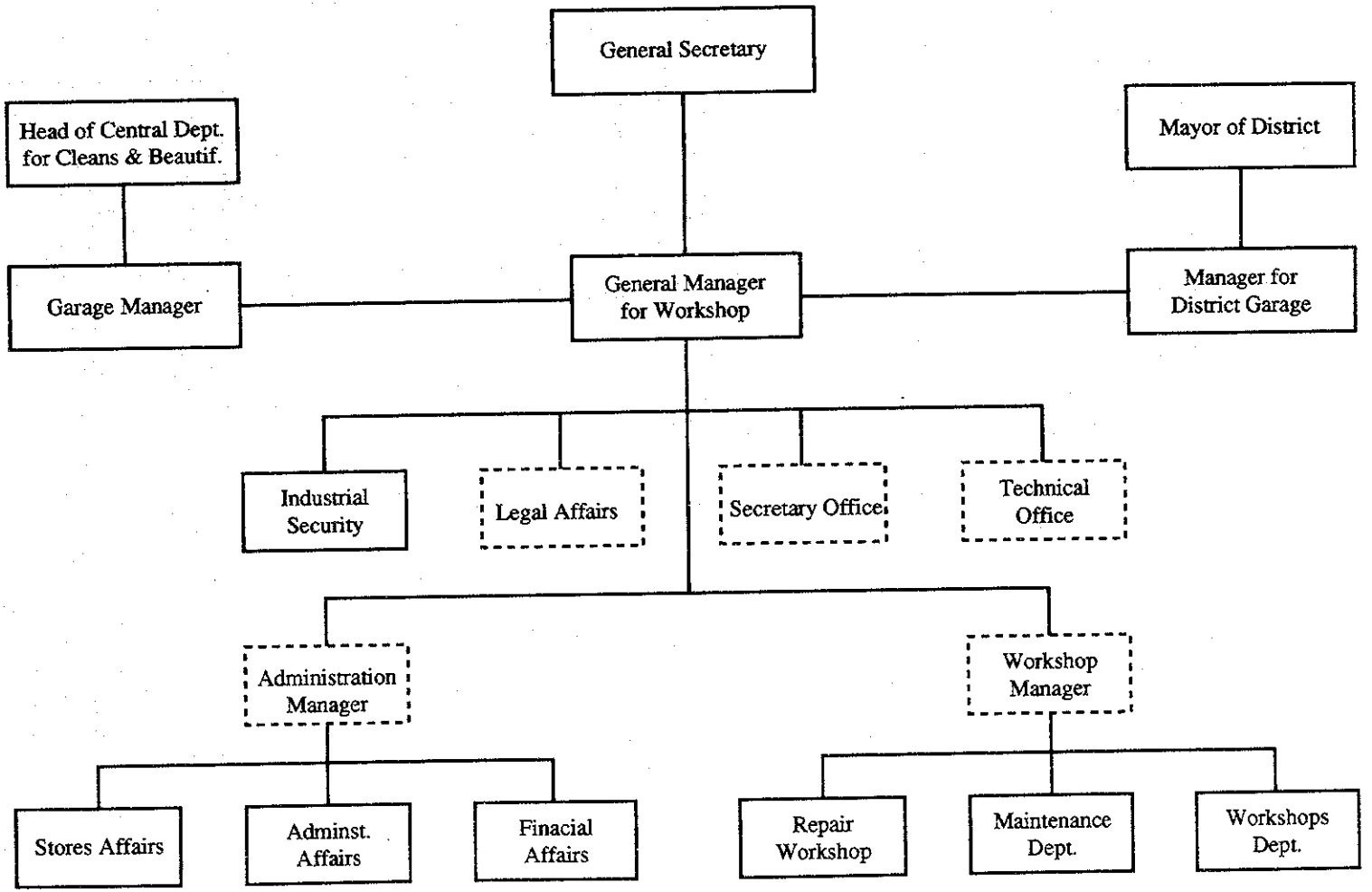


Fig. 2.3.21 Organization Chart of Sub-Central Workshop

(2) Maintenance and Repair Costs

Table 2.3.39 shows the estimated costs of maintenance and repair for SWM after Project implementation.

Table 2.3.39 Expenses for SWM

(Unit:1000 LE)

	Collection	Compost Plant	Disposal	Total
Personnel costs	524	279	135	938
Repair costs	1,048	420	303	1,771
Fuel etc.	721	379	101	1,201
Total	2,293	1,078	539	3,910

The personnel costs do not include general management and supervisory staff, however this has been taken into consideration in the repair costs.

(3) Maintenance Staffing Plan

The staffing plan for each work category after completion of the Project is as shown in Table 2.3.40. Staffing at the Middle District Garage, Central Workshop and Sub-central Workshop which are each responsible for the maintenance and repair of procured vehicles and equipment shall remain at existing levels.

Moreover, concerning the area of waste collection and haulage in Middle District, Project implementation will bring about a reduction in the number drivers and assistants. These surplus staff are to be reassigned to work at the new compost plant.

Table 2.3.40 Staffing Plan

(Unit: person)

	New Compost Plant	Final Disposal Site
Manager	1	–
Accounts and general affairs	14	–
Foremen	4	1
Analysis charge	1	–
Operating staff	19	8
Maintenance staff	7	3
Operators	30	4
Maintenance service staff	6	2
Total	82	17

Levels of incoming waste to the disposal site are low during the night and for the first two or three hours of work each morning. Therefore, because handling of the incoming waste during these times is easy, only two foremen shall be stationed on the night shift to manage the truck scale and carry out site supervision.

(4) SWM Income and Expenditure Analysis

Table 2.3.41 indicates the various sources of income of the SWM sector over the past three years, excluding the central government subsidies for basic salaries and equipment investment funds. The cost breakdown for SWM over the same period is indicated in Table 2.3.42.

Table 2.3.41 SWM Income Sources

(Unit: 1,000 LE)

	91/92	92/93	93/94
Governorate	799	829	849
Cleansing Fund	4,017	6,305	7,685
Revenue from compost sales etc.	309	323	341
Total	5,125	7,457	8,875

Table 2.3.42 SWM Costs

(Unit: 1,000 LE)

	91/92	92/93	93/94
Incentive costs	1,316	1,575	1,456
Operating costs	2,857	2,969	3,458
Investment	7	167	544
Special expenditure	580	194	9
Total	4,760	4,905	5,467

Table 2.3.43 shows the results of trial calculation of area separate costs for SWM in 1993/1994. Part of these costs have been inferred (basic salaries).

Table 2.3.43 SWM Costs for 1993/1994

(Unit: 1,000 LE)

	Collection	Road Sweeping	Disposal	Subtotal	Existing Compost Plant	Total
Basic salaries	1,300	2,100	29	3,429	109	3,538
Incentive costs	1,412	–	42	1,456	137	1,593
Repair costs	3,044	34	362	3,440	91	3,531
Water supply	4	–	–	4	5	9
Electricity	5	–	1	6	37	43
Fuel	2,247	–	147	2,394	43	2,437
Total	8,012	2,334	581	10,729	422	11,151

Note : In order to estimate total basic salaries, the estimated total number of staff including related employees in the administrative divisions, workshops and the General Follow-up Department was multiplied by the average basic salary.

* Road sweeping staff total salaries : 1,500 staff × 1,400 LE/year = 2,100,000 LE
* Collection staff total salaries : 830 staff × 1,600 LE/year = 1,328,000 LE

The above does not take incentive payments to road sweepers into consideration. Incidentally, road sweepers who are employed during the summer season by private sector car service companies receive a wage of 200 LE/month.

Excluding basic salaries, the above breakdown of income and expenditure for 1993/1994 shows that the SWM sector made a profit of 1,307,000 LE with an expenditure of 7,568,000 LE and an income of 8,875,000 LE. As for investment performance, this only accounts for a minor share of the self-raised finances (see Table 2.3.34), and when central government subsidies and foreign assistance is excluded, it only amounts to around 1,000,000 LE per year.

CHAPTER 3

BASIC DESIGN

CHAPTER 3 BASIC DESIGN

3.1 Design Policy

3.1.1 Policies on Natural Conditions

Alexandria city is composed of a roughly 35 km long and on average 3 km wide thin strip of urbanized land lying on the Mediterranean coast. The city's buildings and structures are thus prone to deterioration through salt damage, a point that will require careful consideration when planning facilities at the new compost plant.

Average temperatures by month are shown in Appendix 5, and it can be seen from this that the average winter temperature between the months of December and March is about 10°C. As the average temperature during the summer reaches around 30°C, it will be necessary to consider the installation of air conditioning in the facility planning.

Air in the city is dry with a humidity level of some 70% throughout the year. It will not therefore be necessary to pay much attention to the humidity in the planning.

Annual rainfall is low at around 200 mm, however rainwater drainage facilities shall be considered in the facility planning in view of the fact that rainwater needs to be rapidly removed from within the plant.

The average monthly wind velocity is quite strong at around 15 m/s and because there are occasional strong gusts, the facilities planning will require consideration of wind load, which is commonly adopted in Egypt.

Egypt had not suffered from an earthquake for some 70-80 years and had thus come to be regarded as a non-earthquake country. This view, however, changed with the occurrence of a quake on October 12,1992, having Faiyum city as its epicenter. The intensity of this earthquake was only rather strong with a seismic intensity of 3 on the Japanese earthquake intensity scale, however it caused a lot of damage due to the fact that buildings in the affected area are not of earthquake resistant construction. Some degree of earthquake resistance has thus come to be required in the design of all future buildings and structures.

The above mentioned natural conditions, their effects on facilities and their countermeasures were discussed with the related authorities of the Egyptian side, and the design conditions were set accordingly. In order to ensure the sufficient strength and safety, it was agreed as a rule to adopt Japanese standards as the design criteria for the compost plant.

3.1.2 Policies on Social Conditions

Egypt is an Islamic country and some 90% of the population are Moslams. Many of the country's national holidays are connected with religion, and in particular the holidays marking the end of ramadan (fasting) which is similar to new year in Japan, and the period of haji (pilgrimage to Mecca) last from 4-7 days each. Ramadan itself lasts for about one month and during this time work efficiency drops markedly.

Calculation of the construction schedule for the compost plant construction plan will require consideration of these points.

3.1.3 Policies on Local Construction Conditions

(1) Permits and Authorization for Project Implementation

In implementing the plan, it will be necessary to make sure that the Alexandria Governorate secures the necessary budget for, and definitely carries out site reclamation, extension of power and water supply lines and fencing of the plant boundary etc., which is all the work to be covered by the Government of Egypt.

In the detailed design stage, it will be necessary to hold discussions with and obtain the approval of responsible engineers from the General Follow-up Department, the Central Department for Cleansing and Beautification and the Ministry of Construction regarding detailed drawings on buildings, structures, equipment and power supply.

(2) Related Laws and Regulations

Egypt does not possess an equipment to the Building Standard Law in Japan which lays down regulations for all buildings. Design standards pertaining to load conditions such as earthquake and wind, steel structures or reinforced concrete structures are not formulated. Much construction work is therefore carried out in accordance with European and American standards.

Regarding the design for the compost plant, design values for loads such as earthquake and wind shall be decided upon discussion with the officials from the Egyptian side, while consent was obtained to follow the criteria stipulated in the standards of the Architectural Institute of Japan (AIJ) and Civil Engineering Society of Japan.

The main laws and regulations in Egypt related to execution of the Project are as follows.

Table 3.1.1 Main Laws and Regulations Related to Project Implementation

Law	Outline
Import and Export Regulation Law	A law which states items which are banned from import
Labor Law	A law concerning labor and employment conditions etc.
Sales Tax Law	A law concerning sales tax, which was introduced in May 1991

(3) Standards of Local Construction Companies

The compost plant construction does not require any special works in particular, except for the installation of mechanical and electrical equipment for the classifier. The technical level of construction companies in Egypt is rather high and they will be able to carry out works without any difficulties on this level.

The construction works shall be supervised by a Japanese construction company, however, it should be easy to secure local contractors and labor of a high technical standard.

(4) Worker Capability and Availability

The working force in Egypt is approximately 1,430,000 (the 1993 estimate from the Third 5-Year Plan), however the unemployment rate reaches as high as 15%. The Government of Egypt is thus striving to reduce unemployment levels by formulating and implementing job creation and expansion measures.

The labor standard in the construction sector in Egypt is high compared to other developing countries and there was a time when many of the country's engineers and

skilled workers went out to other Gulf states for work. These workers have gradually returned home due to the effects of the job creation and expansion measures and the 1990-1991 Gulf War.

The construction sector thus possesses an ample supply of labor and the securing of engineers and skilled workers in the execution stage of the Project can be done without any difficulties.

(5) Quality and Availability of Local Construction Equipment and Materials

Major construction materials such as reinforcing steel, structural steel, cement, wooden forms, sand and gravel are all manufactured or produced in Egypt in large quantities and it is possible to procure them locally. As for construction installations, there are some difficulties in terms of quantities and quality levels of locally procured air conditioning equipment and electrical installations such as switches, distribution panels and cables, and so these items shall be procured in Japan.

The machinery required for facilities construction in the Project can all be procured in Egypt.

(6) Transportation Route

As previously mentioned (see 2.3.2.3 (1) and (2)), the collection vehicles, sanitary landfill equipment and compost plant construction equipment and materials to be provided under the Project shall be disembarked at Alexandria Port, Egypt's largest trade port.

Alexandria Port possesses all the necessary unloading facilities to make disembarkation possible without long term anchorage. Furthermore, roads leading to the operation site of the collection vehicles (Middle District) and the construction equipment and materials destination (compost plant construction site) are in good condition and present no problems in terms of transportation.

(7) Infrastructure Conditions

The Desert Road, which acts as the main road between Cairo and Alexandria, passes within about 1 km of the compost plant construction site. Both a buried high tension power line and water supply pipeline run along the Desert Road and these shall be extended to the plant along the access road branched from the Desert Road.

3.1.4 Policies on Utilization of Local Companies, Equipment and Materials

(1) Utilization of Local Companies

Part of the scheduled site for compost plant construction is the land that has been reclaimed from the lake, and because this land is weak with an N value of 1-10 to the depth up to around 10 m, piled foundations shall be adopted as the foundations for major equipment and buildings. Moreover, high levels of precision will be required in the construction of foundations for steel structure buildings and machinery.

For these reasons, the works shall be carried out by local contractors under the supervision of Japanese engineers. Moreover, because the special conveyors and major items of machinery and electrical equipment are to be procured from Japan, it will be necessary to perform installation work under the supervision of Japanese engineers with the appropriate expertise.

(2) Local Availability of Construction Machinery

The largest construction machinery to be used in the Project is a truck crane with a lifting capacity of 250 tons, which will be used in installing the homogenizer. It has been accepted that the local leasing of this and all other construction machinery is possible.

(3) Local Availability of Vehicles, Equipment and Materials

Collection and haulage vehicles and final disposal site operating equipment cannot be procured locally and will thus be obtained in Japan. However, the composter required for compost turning cannot be procured in Japan and will thus be obtained from the third countries. Containers of 1 m^3 and 15 m^3 capacity shall be procured locally.

Based upon consideration of delivery performance, quality and precision levels of locally procured construction equipment, air conditioning equipment and electrical equipment such as switches, distribution panels and cables etc. are to be procured in Japan. All general construction materials such as H- shaped steel, concrete, reinforcing steel, sand, cement and concrete blocks etc. shall be procured locally.

3.1.5 Policies on the Management Capability of Executing Organizations

As mentioned previously (2.3.4), the operation of facilities and equipment after completion of the Project shall be divided between the Middle District Cleansing Department, which will manage the collection and haulage vehicles, and the Central Department for Cleansing and Beautification, which will manage the compost plant and the final disposal site operating equipment. The Middle District Cleansing Department and the Central Department for Cleansing and Beautification have work forces of 877 and 107 respectively, and both have experience in operating equipment and materials provided or purchased under the assistance of western countries such as USAID. It is thus considered that both organizations possess the manpower and technical expertise to operate the facilities and equipment that will be provided under the Project.

As for maintenance activities on the collection and haulage vehicles, daily inspection and repair work shall be performed at the Middle District garage, medium scale repair shall be performed at the Sub-central Workshop, and large scale repair work shall be performed at the Central Workshop. As for inspection and repair activities at the compost plant, this shall be carried out at the plant's own workshop, and the equipment and tools for maintenance shall be provided under the Project. Concerning large scale repair and maintenance activities for compost plant equipment (wheel loaders, trucks etc.) and final disposal site equipment (bulldozers, landfill compactors etc.), this shall be carried out at the Central Workshop or the Sub-central Workshop. The number of staff at the Central Workshop and Sub-central Workshop are 250 and 55 respectively, and both workshops have experience in handling equipment that has been provided or purchased by European countries and the United States in the past. It is thus considered that both workshops possess the manpower and technical expertise needed to handle the maintenance of equipment that will be provided under the Project.

3.1.6 Policies on Scope and Level of Facilities and Equipment

Based upon consideration of the above basic conditions, the basic scope and technical level of facilities to be constructed and equipment to be procured under the Project shall be as follows.

(1) Policies on Scope of Facilities and Equipment

The three Project components of compost plant construction, procurement of collection and haulage vehicles, and procurement of final disposal site operation equipment are designed to improve the living environment in Middle District, the area of highest population density in Alexandria, and to improve the SWM system throughout the whole of Alexandria by reducing solid waste quantities, improving the collection and haulage system and carrying out sanitary landfilling at the final disposal site. The scale, quantity and specifications of the compost plant facilities, the collection and haulage vehicles and the equipment for final disposal site operation are to be planned so as to ensure that these Project objectives are achieved.

(2) Policies on Technical Levels

Concerning the specifications of compost plant equipment, collection and haulage vehicles and equipment for final disposal site operation, selection shall be made based upon consideration of the technical levels of existing equipment and machinery that the Egyptian engineers are familiar with the operation and maintenance.

3.1.7 Policies on Construction Schedule

Work under the Project shall, as a rule, be completed within one fiscal year in accordance with the requirements of the Japan's Grant Aid System. The Project consists of equipment procurement and facilities construction and it is considered appropriate that the procurement of the urgently required collection and haulage vehicles and final disposal site equipment should be done in Phase 1, and the construction of the compost plant designed to reduce solid waste quantities through intermediate treatment should be done in Phase 2 as the implementation process.

The Phase 2 compost plant construction, which requires construction of facilities followed by procurement and installation of plant equipment, shall be implemented over a couple of years. Fig. 3.4.1 shows the construction schedule for these activities. The period of the work shall be 18 months from conclusion of contracts with the construction company.

3.2 Design Conditions

(1) General Conditions

The general conditions on the plan for equipment procurement and the plan for facility construction under the Project are as follows.

Table 3.2.1 General Conditions for the Equipment Procurement Plan and the Facility Construction Plan

Item	Contents
1. Project Site	
- collection and haulage vehicles procurement	} Middle District, Alexandria city
- compost plant construction	
- final disposal site operation equipment procurement	Abis Final Disposal Site
2. Meteorological Conditions	
(1) Outside temperatures	
- maximum temperature	40°C
- average monthly maximum temperature	31°C
- average monthly minimum temperature	9°C
(2) Rainfall	
- maximum monthly rainfall	56 mm
(3) Humidity	
- average monthly maximum humidity	72 %
- average monthly minimum humidity	64 %
3. Financial Analysis Data	
(1) Compost selling prices	
- fine compost	25 LE/ton
- coarse compost	11 LE/ton
(2) Reusable material retail prices	
- iron	175 LE/ton
- glass	35 LE/ton
- paper	50 LE/ton
- plastics	300 LE/ton
- textiles	20 LE/ton
(3) Utilities charges	
- electricity	0.18 LE/kwh
- water supply	0.31 LE/m^3
- Diesel oil	0.40 LE/ℓ
- Gasoline	1.00 LE/ℓ
4. Design Criteria	To be Japanese standards as a rule. However, Egyptian or international standards shall be applied where necessary.

(2) Design Population, Solid Waste Quantity and Quality

1) Design Population

The present population and forecast population for 2000 in Alexandria are as stated earlier (see Table 2.3.10). The design population for the Project shall be that of the target year of 2000.

Table 3.2.2 Design Population

(Unit: person)

District	Population
Montazah	972,000
East	917,000
Middle	715,000
Gomrok	197,000
West	583,000
Ameriyah	631,000
Total	4,015,000

2) Design Solid Waste Quantity

The design solid waste quantities in 2000 calculated from the results of the survey on the unit generation of solid waste are as shown in Table 3.2.3.

Table 3.2.3 Design Solid Waste Quantity

(Unit: person)

District	Solid Waste Quantity
Montazah	435
East	510
Middle	506
Gomrok	162
West	243
Ameriyah	277
Total	2,133

The flow of solid waste in Alexandria by the Project target year of 2000 is as shown in Fig. 3.2.1.

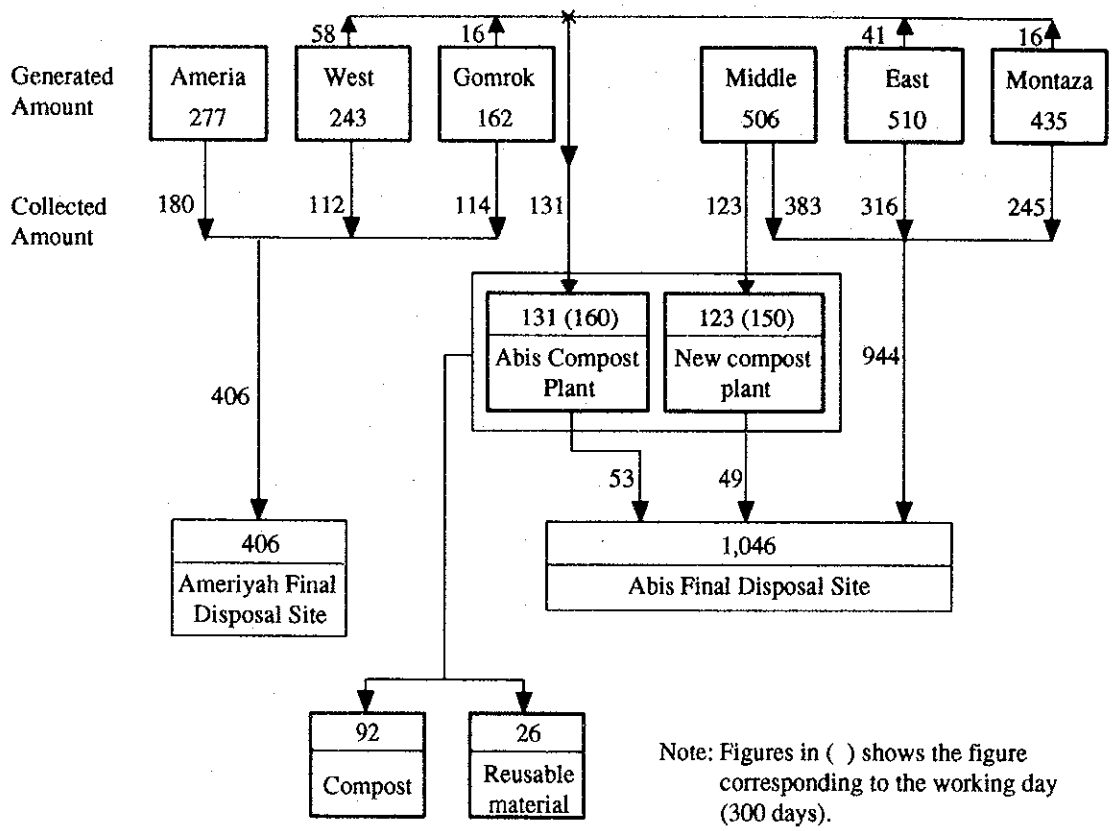


Fig. 3.2.1 Solid Waste Flow (tons/day) in Target Year (2000)

3) Design Solid Waste Quality

As stated previously (3.5.3. (3)), the quality breakdown of solid waste for the Project shall be set as is shown in Table 3.2.4.

Table 3.2.4 Design Solid Waste Quality

(%)

Garbage	Paper	Textiles	Plastics	Metals	Glass	Other
56	22	4	6	3	2	7

The solid waste unit weight by volume shall be 230 kg/m^3.

(3) Design Conditions for the Collection and Haulage Vehicle Procurement Plan

The design conditions for the calculation of the required quantity of collection and haulage vehicles are as shown in the following table.

Table 3.2.5 Conditions for Calculation of Required Collection and Haulage Vehicle

Item	Contents
• Project site	Middle District, Alexandria city
• Design population (2000)	715,000 persons
• Design waste generation quantity	506 tons/day (365 days) 588 tons/day (313 working days)
• Unit weight by volume	230 kg/m^3
• Waste collection rate	100%
• Collection shifts	Nighttime collection by the Central Department for Cleansing and Beautification shall be abolished.
• Working days	6 days/week (313 days/year)
• Collection time per day	8 hours
• Final disposal site for the Project	Abis Final Disposal Site
• Compression coefficients of collection vehicles	
* 15 m^3 compactors	2.10
* 10 m^3 compactors	1.80
* 15 m^3 arm-roll container trucks	1.00
• Waste collection shares	
* 15 m^3 compactors	50%
* 10 m^3 compactors	30%
* 10 m^3 arm-roll container trucks	20%

(4) Design Conditions for the Compost Plant Construction Plan

1) Material Balance in Compost Plant

The material balance to be incorporated into the compost plant construction plan is as indicated in Fig. 3.2.2.

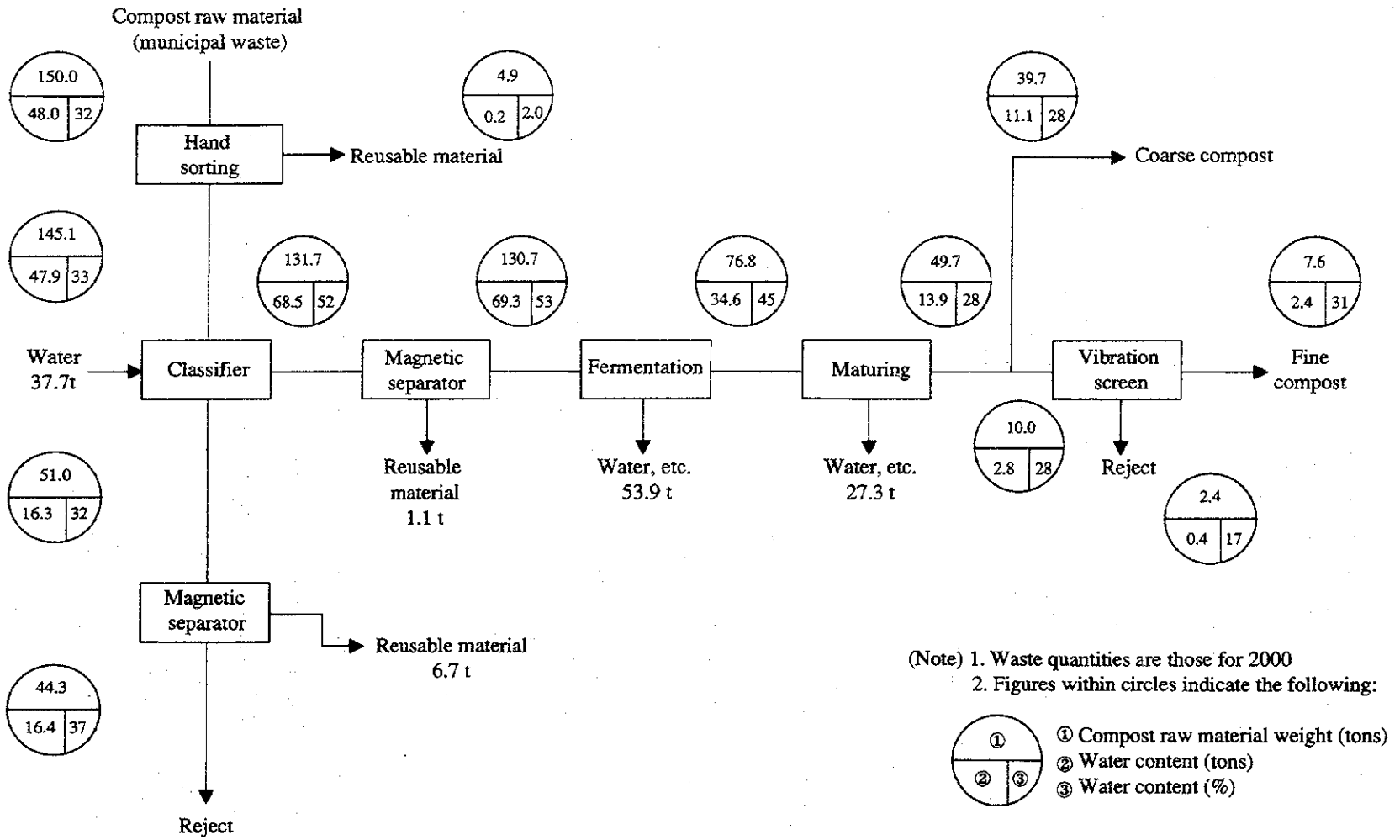


Fig. 3.2.2 Material Balance of New Compost Plant

2) Design Conditions for the Mechanical Equipment Plan

The design conditions for the mechanical equipment plan are as shown in Table 3.2.6.

Table 3.2.6 Design Conditions for Mechanical Equipment Plan

Item	Contents
1. Waste treatment capacity	150 tons/day
2. Treatment process	150 tons/day × 1 line
3. Operating time	16 hours/day (including 2 hours preparation work)
4. Belt conveyor	
- Belt carrying capacity	In accordance with compost plant material balance (Fig. 3.3.2)
- Feeding conveyor speed	Around 30 m/min.
- Hand sorting conveyor speed	10 m/min. or less
- Compost raw material conveyor speed	Around 30 m/min.
5. Turning machine	
- Turning capacity	560 m^3/hour
- Operation type	Self running
- Control method	Mechanical - electrical
6. Truck scale	
- Place to be installed	One near Abis Compost Plant entrance One within new compost plant
- Applicable vehicles	All haulage vehicles going to Abis Compost Plant and Final Disposal Site and new compost plant
- Maximum vehicle weight	30 tons (vehicle plus waste)
- Model	Load cell
7. Classifier equipment	
- Treatment capacity	5.2 tons/hour
- Type	To have pulverizing and classifying functions
8. Compost moisture content control	
- Method	Water feeding from sprinkler nozzle inside classifier and water taps in composting yard and fermentation yard
- Water supply	Plant wastewater and mains water
9. Cooling system	Closed circulation type
10. Screening equipment capacity	7.1 tons/hour
11. Drainage system	Drainage by manually operated pump from drainage pit inside receiving hopper

3) Design Conditions for the Electrical Equipment Plan

The design conditions for the electrical equipment plan are as shown in Table 3.2.7.

Table 3.2.7 Design Conditions for the Electrical Equipment Plan

Item	Contents
1. Power distribution equipment	
- Specifications	11 kV, three phase, 50 Hz
2. Transformer equipment	
- Capacity	1,000 kVA
3. Voltage	
- Main plant equipment	380 V, three phase
- Lighting equipment	220 V, single phase

4) Design Conditions for the Civil and Building Structure Plan

The design conditions for the civil and building structure plan are as shown in Table 3.2.8.

Table 3.2.8 Design Conditions for the Civil and Building Structure Plan

Item	Contents
1. Design ground level	
- In-site roads	GL ± 0 m
- Floor level inside buildings (ground floor)	
• Factory Building	GL ± 0 m
• Other buildings	GL ± 0.3 m
2. Soil conditions	See Attachment 6
3. In-site road pavement	
- Type of pavement	- Asphalt pavement
- Maximum vehicle axle load	- 15 tons
4. Rainwater drainage	
- System	- Drainage pit and drain pipe
- Drainage Pit	- Provide 50 m within site fence
- Place to be drained	- Adjacent drainage channel
5. Load conditions	
- Wind load	- Maximum wind velocity: 30 m/sec.
- Seismic coefficient	- 0.1
6. Construction materials	As a rule, to be similar materials used in existing plants and available in Egypt.

5) Design Conditions for the Building Facilities Plan

The design conditions for the building facilities plan are as shown in Table 3.2.9.

Table 3.2.9 Design Conditions for the Building Facilities Plan

Item	Contents
1. Air conditioning/ventilation	
(1) Air conditioning (Administration Building)	
- Design ambient temperatures	
* maximum	40°C
* minimum	9°C
- Design room temperatures	
* summer	27°C
* winter	20°C
(2) Ventilation (Factory Building and Workshop)	
- Temperature control	Outside temperature + 5°C
- Dust control	Ventilation frequency: 3 times/hour
- System	Forced ventilation attached to roofs and walls
2. Water supply and drainage system	
- Water supply	Mains water supplied by Alexandria Water Supply Authority
- Septic tanks	Concrete structure, permeation type
3. Indoor lighting	
- Manager's room, offices and staff rooms	400-500 Lux
- Waste hand sorting area	300-400 Lux
- Workshop, waste storage area etc.	200 Lux
4. Outdoor lighting	
- Illumination level	1 Lux
- Installation position	Inside the boundary fence
- Installation interval	Every 50 m
5. Emergency lighting	
- Illumination level	
* Maximum	5 Lux
* Minimum	1 Lux

6) Design Conditions for the Final Disposal Site Operation Equipment Procurement Plan

By the Project target year of 2000, the amount of solid waste generated in Alexandria will be 2,133 tons/day and of this, 1,604 tons/day will be collected. Of the collected waste, 254 tons/day (310 tons per working day) will be compost treated at Abis Compost Plant and the new compost plant. It is planned to dispose of the remaining 1,350 tons/day of solid waste and 102

tons/day of rejected waste produced at Abis Compost Plant and the new compost plant (1,452 tons/day in total) at the Ameriyah Final Disposal Site (409 tons/day) and Abis Final Disposal Site.

Solid waste from Middle District is either treated or disposed of at the Abis Compost Plant and Final Disposal Site. Because the Abis Final Disposal Site needs to become a sanitary landfill, the Project includes a plan to procure equipment for sanitary landfill operation. The design conditions used to calculate the required quantities of equipment for the sanitary landfill are as follows.

Table 3.2.10 Design Conditions for the Final Disposal Site Operation Equipment Procurement Plan

Item	Contents
Design population (2000)	Middle District : 715,000 persons East District : 917,000 persons Montazah District : 972,000 persons Total : 2,604, 000 persons
Design solid waste disposal quantity	Middle District : 383 tons/day East district : 316 tons/day Montazah District : 245 tons/day Compost reject : 102 tons/day Total : 1,046 tons/day (365 days) 1,220 tons/day (313 working days)
Working days	6 days/week (313 days/year)
Unit weight by volume before landfill	$\sigma = 0.35$
Unit weight by volume after landfill	$\sigma = 1.05$
Earth covering	16.6% of landfill volume

3.3 Basic Plans

3.3.1 Collection and Haulage Vehicle Procurement Plan

1) Collection and Haulage System

The collection and haulage system in the Project is as described earlier. The collection areas and collection shares for each type of vehicle are as shown in the following table.

Table 3.3.1 Collection Area and Share by Vehicle Type

Vehicle Type	Collection Area	Collection Share
15 m^3 compactors	Eastern area containing many trunk roads	50%
10 m^3 compactors	Western area containing many secondary trunk roads	30%
15 m^3 arm-roll container trucks	Areas along trunk roads where containers can be placed	20%

2) Required Quantity of Vehicles

① Collection and Haulage Routes and Collection Times

The collection and haulage routes taken by each type of vehicle and the times spent on collection are as indicated in Fig. 3.3.1.

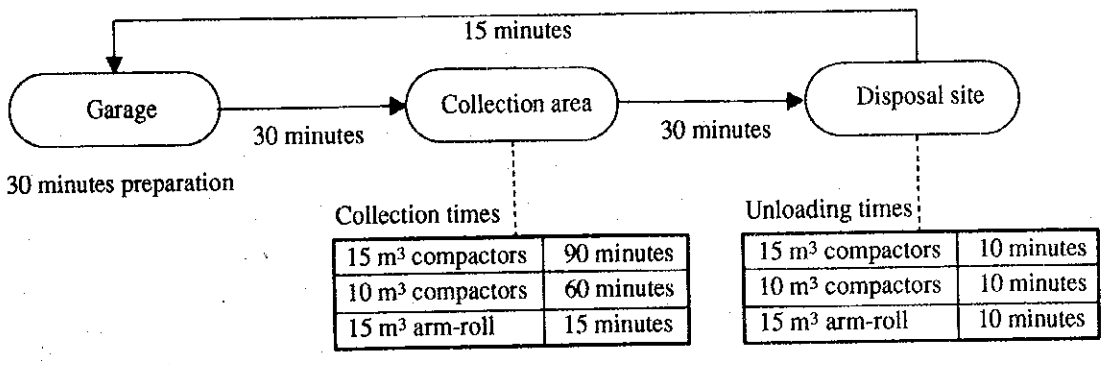


Fig. 3.3.1 Collection and Haulage Routes and Collection Times

Assuming a working day of eight hours, the number of trips made by the 15 m^3 compactors shall be 2.74, and 3.31 for 10m^3 compactors and 5.11 for 15m^3 arm-roll container truck.

Table 3.3.2 shows the collection and haulage times for each type of vehicle.

Table 3.3.2 Collection and Haulage Times by Vehicle Type

(Unit: minutes)

	Work Contents	15 m^3 compactors	10 m^3 compactors	15 m^3 arm-roll container trucks
	Preparatory work (garage)	30	30	30
First Trip				
	Movement (disposal site to collection area)	30	30	30
	Collection (collection area)	90	60	15
	Haulage (collection area to disposal site)	30	30	30
	Waste unloading (disposal site)	10	10	10
Second Trip				
	Movement (garage to collection area)	30	30	30
	Collection (collection area)	90	60	15
	Haulage (collection area to disposal site)	30	30	30
	Waste unloading (disposal site)	10	10	10
Third Trip				
	Movement (garage to collection area)	30	30	30
	Collection (collection area)	90	60	15
	Haulage (collection area to disposal site)	30	30	30
	Waste unloading (disposal site)	10	10	10
Fourth Trip				
	Movement (garage to collection area)			30
	Collection (collection area)			15
	Haulage (collection area to disposal site)			30
	Waste unloading (disposal site)			10
Fifth Trip				
	Movement (garage to collection area)			30
	Collection (collection area)			15
	Haulage (collection area to disposal site)			30
	Waste unloading (disposal site)			10
	Movement (disposal site to garage)	15	15	15
	Total	525	435	470
Number of trips every eight hours		2.74	3.31	5.11

② Number of Vehicles to be Introduced

The following formula is used to obtain the quantity of solid waste hauled in each trip:

Waste per trip (tons) = vehicle carrying capacity (m^3) × un-compressed specific gravity (tons/m^3) × compression coefficient × carrying efficiency The quantities of waste hauled in each trip by each type of vehicle, when calculated with the above formula, are shown in Table 3.3.3.

Table 3.3.3 Haulage Quantities of Each Vehicle Type per Trip

Vehicle Type	Carrying Capacity (m^3)	Waste Apparent Specific Gravity (tons/m^3)	Compression Coefficient	Carrying Efficiency	Haulage Q'ty per Trip (tons)
15 m^3 compactors	15	0.23	2.1	0.9	6.52
10 m^3 compactors	10		1.8	0.9	3.73
15 m^3 arm-roll container trucks	15		1.0	0.84	2.93

The following formula is used to obtain the quantity of solid waste hauled in one working day:

Daily waste haulage (tons) = number of trips × waste per trip (tons/trip) × operating efficiency.

The quantities of waste hauled each day by each type of vehicle, when calculated with the above formula, are shown in Table 3.3.4.

Table 3.3.4 Haulage Quantities of Each Vehicle per Day

Vehicle Type	Number of Trips (in 8 hours)	Haulage Q'ty per Trip (tons)	Operating Efficiency	Haulage Q'ty per Day (tons)
15 m^3 compactors	2.74	6.52	0.9	16.1
10 m^3 compactors	3.31	3.73	0.9	11.1
15 m^3 arm-roll container trucks	5.11	2.93	0.9	13.5

The following formula can be used to calculate the number of collection and haulage vehicles that need to be introduced.

$$\text{Required vehicles} = \frac{\text{Waste collection quantity (tons)} \times \text{vehicles} \times \text{collection share}}{\text{Haulage quantity per day (tons)}} \times \text{reserve ratio}$$

The number of required collection and haulage vehicles, when calculated using the above formula, is shown in Table 3.3.5.

Table 3.3.5 Required Collection and Haulage Vehicles

Vehicle Type	Waste Collection Q'ty (tons/day)	Collection Share	Daily Haulage Q'ty (tons)	Reserve Ratio	Required Vehicles
15 m^3 compactors	588	0.50	16.1	1.15	21
10 m^3 compactors		0.30	11.1	1.15	18
15 m^3 arm-roll container trucks		0.20	13.5	1.15	10

The collection and haulage vehicles to be provided under the Project will be stored at the Middle District Garage in the Moharam Bey Garage. The Middle District Garage, with an area of around 5,000 m^2, possesses enough space to store the vehicles. Fig. 3.3.2 shows the Moharam Bey Garage and the storage areas for the provided vehicles.

The next formula is used to calculate the required number of 15 m^3 and 10 m^3 compactor containers (1 m^3 capacity) and 15 m^3 arm-roll container truck containers (15 m^3 capacity).

$$\text{Number of containers} = \frac{\text{Collected waste quantity (tons/day)} \times \text{share}}{\text{Container capacity } (m^3) \times \text{waste apparent specific gravity } (\text{tons}/m^3) \times \text{carrying efficiency} \times \text{rate of rotation use} \times \text{reserve ratio}}$$

The number of containers, when calculated with the above formula, is shown in Table 3.3.6.

Table 3.3.6 Required Number of Containers

	Waste Collection Quantity (tons/day)	Collection Share	Container Capacity (m^3)	Waste Apparent Specific Gravity (tons/m^3)	Carrying Efficiency	Rate of Rotation Use	Reserve Ratio	Required Containers
1 m^3 containers	588	0.80	1.0	0.23	0.70	1.0	1.1	3,214
15 m^3 containers		0.20	15.0		0.75	1.5	1.1	34

Figs 3.3.3 and 3.3.4 show the distribution of 1 m^3 containers in built-up areas and the placement locations of 15 m^3 containers respectively.

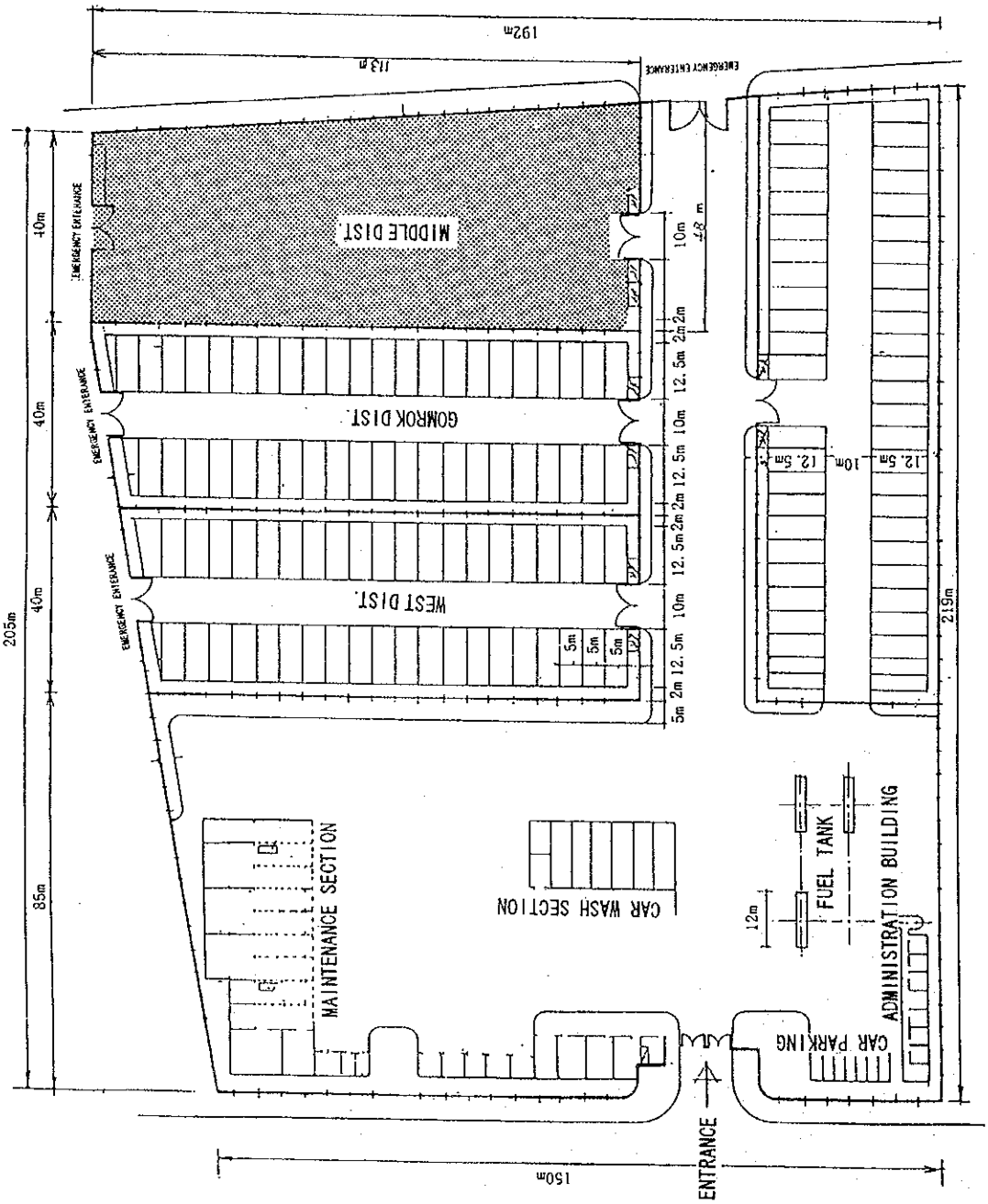


Fig. 3.3.2 Storage Site of Provided Vehicles (Moharam Bey Garage)

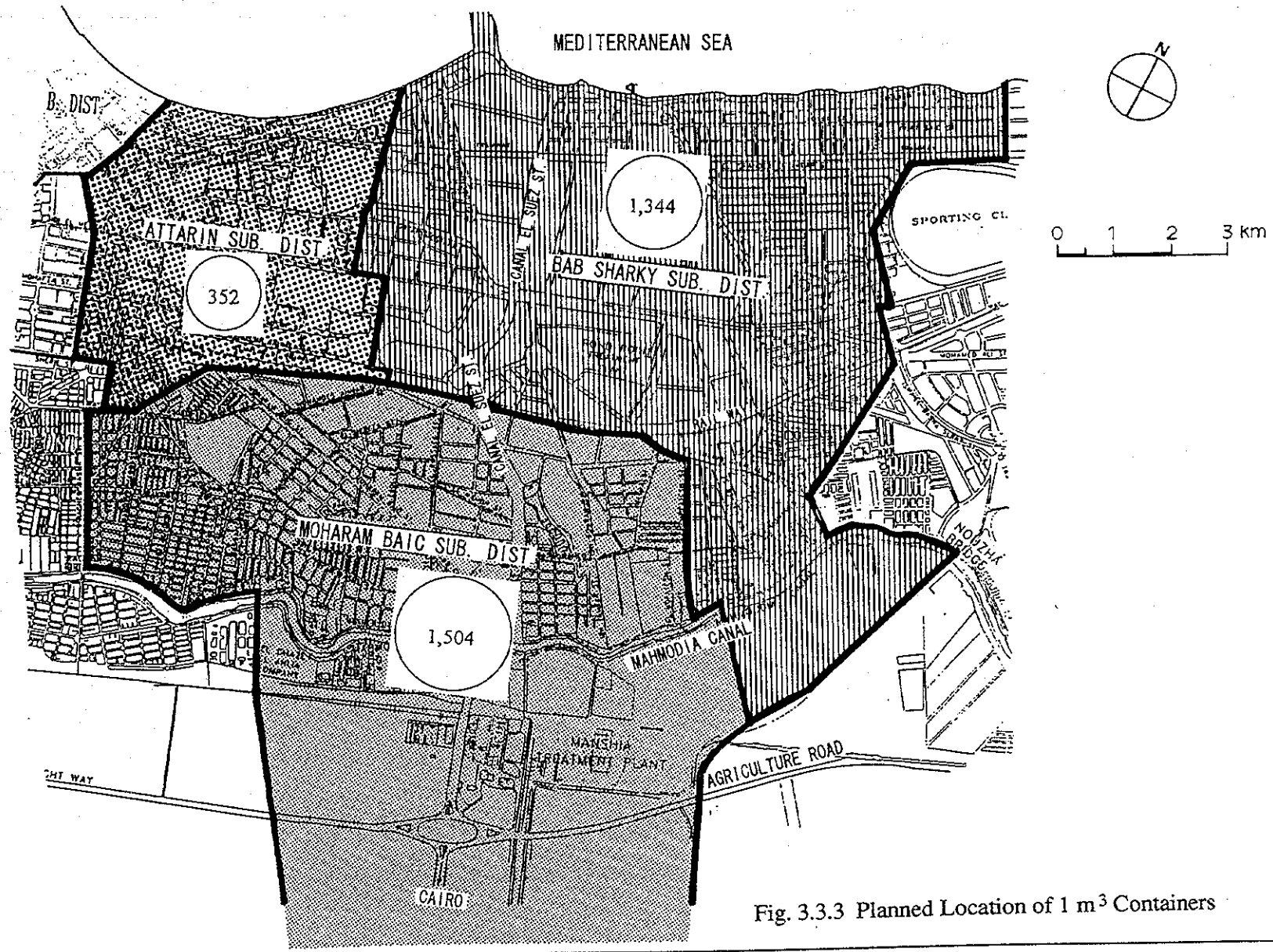


Fig. 3.3.3 Planned Location of 1 m^3 Containers

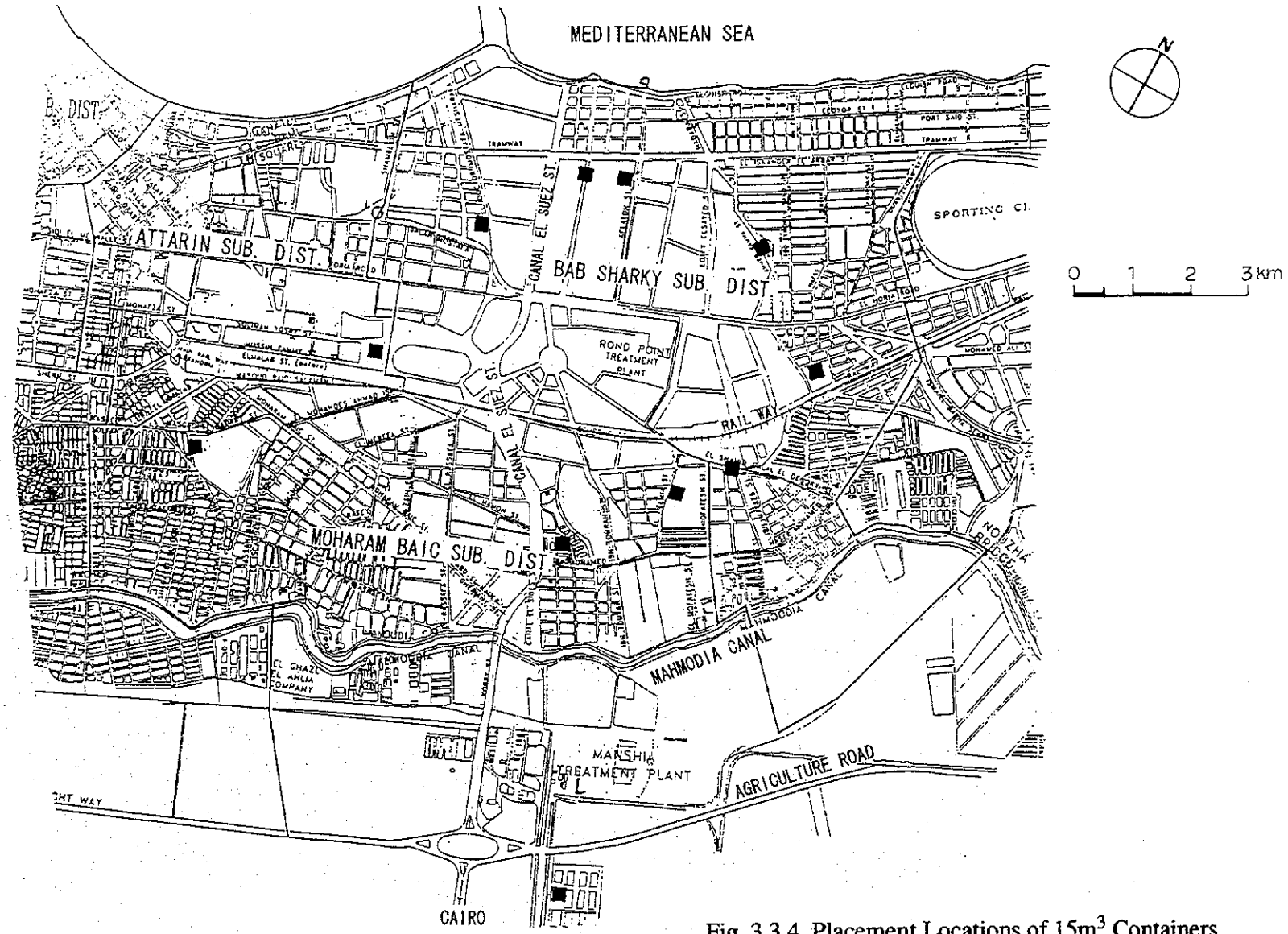


Fig. 3.3.4 Placement Locations of 15m^3 Containers

3) Vehicle Specifications

Table 3.3.7 shows the specifications of the collection and haulage vehicles to be provided under the Project.

Table 3.3.7 Specifications of Provided Collection and Haulage Vehicle

(1/3)

Item	Specifications	Remarks
1. 15 m^3 compactors		
(1) Main specifications	15 m^3 loading class	
- Vehicle type	15 m^3 loading class solid waste collection compactor truck	
- Handwheel position	Left handle, front	Because right hand traffic is standard in Egypt. Because total vehicle weight in excess of 20 ton is expected to run over poor condition roads.
- Drive type	6 × 4 rear drive	
- Maximum capacity	7,000 kg	
- Vehicle gross weight	About 21,000 kg	In order to handle 7,000 kg loads.
(2) Main dimensions		Dimensions suited to a 21,000 kg
- Total length	About 8,700 mm	compactor vehicle.
- Total width	About 2,500 mm	
- Total height	About 3,400 mm	
- Wheel base	About 4,500 mm	
- Minimum ground clearance	About 250 mm	
- Minimum turning radius	About 7,000 mm	
- Tires	11.0-20-14 PR	
(3) Engine		
- Type	Direct spray cooling diesel	Because such engines are common in Egypt and there is no problem in terms of the necessary maintenance level.
- Maximum output	About 290 HP	Necessary for a total vehicle weight of 21,000 kg.
- Displacement	Around 16,000 cc	To possess an output of 290 HP.
(4) Special Fittings		
- Body capacity	15 m^3	
- Exhaust	Hydraulic exhaust	External control is appropriate for checking safety during work.
	External lever control	
- Container lift	Hydraulic cylinder type 1,000 kg minimum	To be able to comfortably handle loading and unloading of 1 m^3 solid waste containers.
- Hopper	1.5 m^3 minimum	To be able to comfortably handle loading and unloading of 1 m^3 solid waste containers.

(2/3)

Item	Specifications	Remarks
2. 10 m^3 compactors	10 m^3 loading class	
(1) Main specifications		
- Vehicle type	10 m^3 class solid waste collection compactor truck	
- Handwheel position	Left handle, front	Because right hand traffic is standard in Egypt. Because total vehicle weight is in excess of 11 tons.
- Drive type	4 × 2 rear drive	
- Maximum capacity	4,000 kg	
- Vehicle gross weight	About 11,000 kg	In order to handle 4,000 kg loads.
(2) Main dimensions		
- Total length	About 7,200 mm	
- Total width	About 2,400 mm	
- Total height	About 3,000 mm	
- Wheel base	About 3,700 mm	
- Minimum ground clearance	About 250 mm	
- Minimum turning radius	About 6,300 mm	
- Tires	9.00-20-14 PR	
(3) Engine		
- Type	Direct spray cooling diesel	Because such engines are common in Egypt and there is no problem in terms of the necessary maintenance level.
- Maximum output	About 150 HP	Necessary for a total vehicle weight of 11,000 kg.
- Displacement	Around 6,000 cc	To possess an output of 150 HP.
(4) Special Fittings		
- Body capacity	10 m^3	
- Exhaust	Hydraulic exhaust External lever control	External control is appropriate for checking safety during work.
- Container lift	Hydraulic cylinder type 700 kg minimum	To be able to comfortably handle loading and unloading of 1 m^3 solid waste containers.
- Hopper	1 m^3 minimum	To be able to comfortably handle loading and unloading of 1 m^3 solid waste containers.
3. 15 m^3 arm-roll container trucks	For 15 m^3 containers	
(1) Main specifications		
- Vehicle type	Arm roll type truck for hauling 15 m^3 solid waste collection containers	
- Handwheel position	Left handle, front	Because right hand traffic is standard in Egypt Because gross vehicle weight is 16,000 kg
- Drive type	4 × 2 rear drive	
- Carried load	15 m^3 solid waste containers	Weight: about 5,500 kg