No. 7

THE FEASIBILITY STUDY ON REFUSE COLLECTION, TREATMENT AND DISPOSAL IN ALEXANDRIA OF THE ARAB REPUBLIC OF EGYPT

MAIN REPORT

MARCH 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Arab Republic of Egypt, the Government of Japan decided to conduct a feasibility study on the Refuse Collection, Treatment and Disposal Project in Alexandria and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA established an advisory committee on this Project chaired by Dr. Sachiho Naito and sent to Egypt a survey team during the periods of 11 August to 10 December 1984 and 29 June to 10 October 1985.

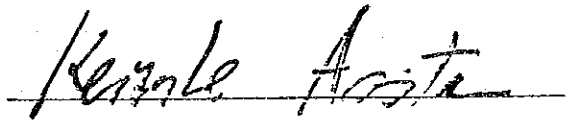
A field survey was carried out on the whole area of the Governorate of Alexandria and a detailed survey was conducted on the Middle District designated as an object of the feasibility study, with the cooperation of the officials concerned of the Central Government and the Alexandria Governorate.

Further studies were made in Japan based on the result of the field survey, and the Final Report is now ready for submission.

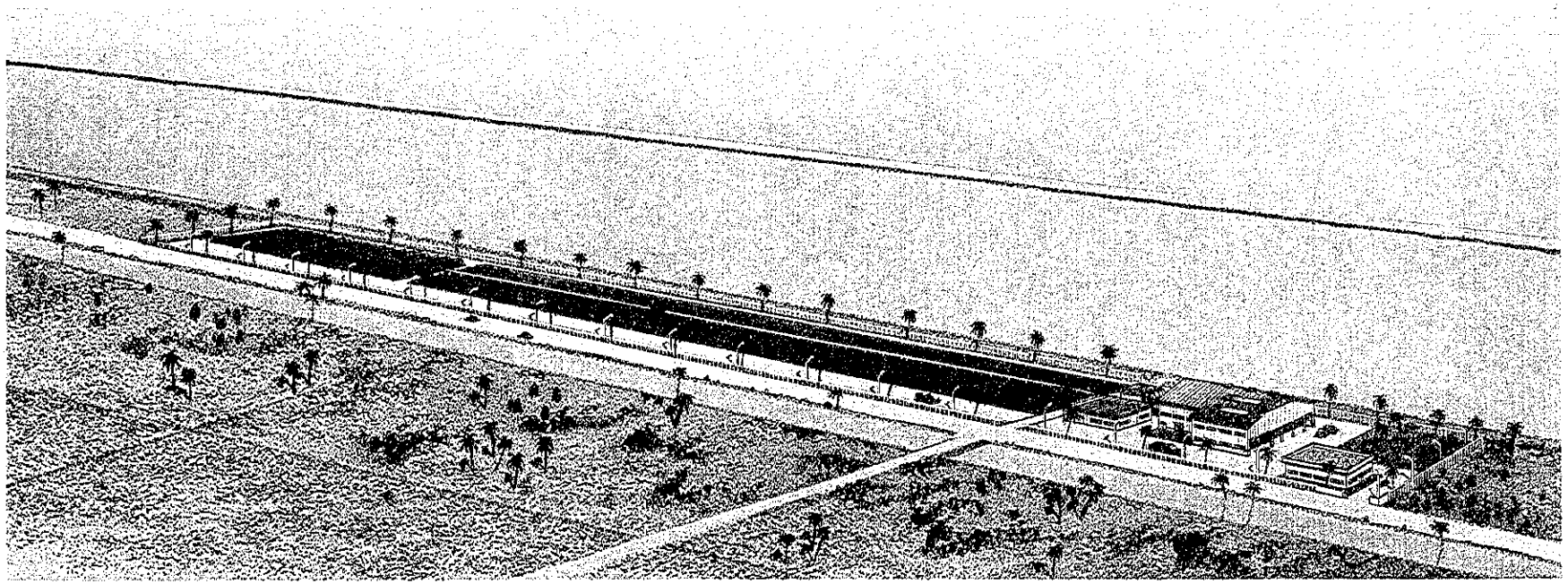
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Arab Republic of Egypt and the Governorate of Alexandria for their close cooperation extended to the JICA study team.

March, 1986



Keisuke Arita
President
Japan International Cooperation Agency



INTRODUCTION

In response to the request of the Government of the Arab Republic of Egypt for the technical cooperation in conducting the feasibility study on refuse collection, treatment and disposal system in the City of Alexandria, the Government of Japan has agreed to provide the service of a team of Japanese experts to undertake the feasibility study within the general framework of technical cooperation between Japan and Egypt which is set forth in the Agreement on Technical Cooperation between the Government of Japan and the Governement of the Arab Republic of Egypt entered into force on the 31st of January, 1984.

The Progress Reports I and II, drawn up on the basis of the results of the two field surveys which extended over approximately 8 months, and were carried out jointly with the offices of the General Follow-up Department (hereinafter referred to as "counterpart") of Alexandria Governorate, have already been presented.

After that, the JICA Study Team has set itself to the task of drawing up the Feasibility Study on the basis of data and information collected successfully thanks to the enthusiastic cooperation of the counterpart, and now it is ready to present the relevant report.

Generation of waste is an unavoidable consequence of the socio-economic activities of the human being, however on the other hand, its prompt elimination from the sphere of the said activities, as well as the elimination of its harmful properties, stabilization and restoration to the nature, is an important task assigned to the human being in these days, when natural environment conservation is a subject being proclaimed on an earthwide basis.

In the recent years the production activities in the various fields accompanying the economic development are changing rapidly and the development pace is accelerating, and both the variety and the volume of the wastes generated as a result of the said activities are increasing at an astonishing rate. These wastes contain substances exerting conspicuously baneful influence on the natural environment in considerable quantity, and the stabilization of their noxious properties is becoming increasingly difficult.

Under the circumstances, authorities of cities all over the world in charge of waste management are being faced at problems varying degrees of seriousness, requiring proper solution, and as a matter of fact not only the administrative authorities in charge of the matter but also scholars armed with scientific background and experience, as well as technical personnel of private firms are nowadays contriving together to solve the said problems.

On the other hand, it must be borne in mind that the political and economic activities of the human being have the intrinsic tendency of focusing their efforts on production fields in pursuit of economic benefits, and the solid waste management, which belongs to the so-called venous industrial sector which does not bring about direct values and benefits, as well as the technical developments required to upgrade its level, are prone to be left behind.

The said state of affairs occurred also in Japan, and only a few scholars have been carrying out researches on the matter for more than twenty years. Only after the oil crisis in 1973 the solution of the solid waste management problem, including salvage of the natural resource from wastes, began to attract the attention, concurrently with the worldwide tendency of natural resources conservation.

It must be borne in mind however, that the characteristics of solid wastes are changing both qualitatively and quantitatively, concurrently with changes and development occurring in the socio-economic activities. Such being the case, continuous research and development are required in connection with solid wastes, as long as those related to production are progressing.

Needless to say that the solid waste management problems of Alexandria has its own peculiarities, but from the aforesaid intrinsic standpoint the situation is the very same, and improvement of the solid waste management system must be put forward on the basis of a long-range plan, in order to preserve the scenic beauty of Alexandria as a world-famous resort city, and to restore it to the lofty position it once held among the ancient cities of the world during the Greek and Roman civilizations.

The current state of the solid waste management system of Alexandria, which is developing rapidly under the said circumstances, is outlined in the followings.

- For the most part the executive entity in charge of the solid waste management system has switched from the Zabbaleen, which has a long history, to the Districts, which are public institution, while the ADS activity is being strengthened so as to support the Districts.

- So far it used to be relatively easy to secure landfill sites in the neighbourhood, but site acquisition is becoming increasingly difficult of late.

- The level of financial independency is low, and the solid waste management system is relying on aids provided by foreign countries and subsidies of the Central Government for funds required in connection with facility improvement and renovation of equipment.

- The Abis Compost Plant (10 t/hr) has started its operation as an intermediate treatment facility, but the compost selling price of 9 LE/t is lower than that one planned at the beginning.

This report contains the Master Plan covering the totality of Alexandria, which is the proposition for improving the solid waste management system of the city drawn up with the aforementioned facts as background, and the feasibility study on three projects consisting of collection service improvement, sanitary landfill at Moharam Bey Square Dump Site and the New Compost Plant in the Middle District requiring priority improvement and implementation, with 2000 as target year.

In essence, this report regards the "accomplishment of the objective with minimum expenditure" as the first axiom, and proposes the sanitary landfilling as best alternative regarding solid waste management system.

From another standpoint, it is also true that great hopes are rising for expansion of compost plants in connection with the intertwining of needs related to three distinct factors;

i) the desert forestation program being developed in nationwide scale as a state-policy of Egypt

ii) the improvement of the farming productivity and the effective utilization of the potential value of waste materials

iii) the extension of the service life of the landill sites through the volume reduction of solid wastes.

The feasibility of the construction of a compost plant with 300 t/d capacity is examined from the aforementioned standpoint, in addition to the sanitary landfilling.

This feasibility study is carried out on many premises, but in particular the increase of crop yield brought about improvement of farming productivity resulting from the application of compost exerts a sensitive effect on the cost benefit ratio, as mentioned in the text of the report.

As a matter of fact, there is no data referring to the improvements attained through application of compost in Egypt, and in this study the said improvement is assumed to be 30%, based on the experimental data obtained in Japan.

Furthermore, the conditions regarding the introduction of foreign loans and the conditions of the subsidies to be provided by the Central Government exert decisive influence on the feasibility of the compost plant development.

Under these circumstances, it is particularly important to analyze and check the various conditions involved from various standpoints, so as to prevent the failure in the attainment of the intrinsic purpose of the solid waste management system due to the financial burden attributable to the introduction of further compost plants, as mentioned in the recommendations.

This study, started in March 1984 in response to the request of the Alexandria Governorate to JICA, was carried out with the invaluable support and kind cooperation of the counterparts under the command of Mr. Saad Rafael, General Manager of the Follow-up Department of the Alexandria Governorate, and it is a pleasure for the JICA Study Team to present the Final Report to the Alexandria Governorate.

Precondition of Feasibility Study

Exchange rate	:	1.00 US$ = 1.33 LE = 205 ¥
Loan condition		
- Foreign	:	5-year grace period and 20-year repayment with 4% interest per year
- Local	:	5% of annual interest
Inflation	:	not considered
Market area for compost	:	within Alexandria Governorate (660 t/d)
Compost selling price		
- Fine compost	:	9 LE/t
- Coarse compost	:	7 LE/t
Selling price of reusable material		
- Iron	:	9 LE/t
- Glass	:	20 LE/t
- Paper	:	40 LE/t
- Plastic	:	120 LE/t
- Textile	:	20 LE/t
Unit price of utilities		
- Electricity	:	0.0482 LE/Kwh
- Water	:	0.12 LE/m^3
- Fuel	:	0.203 LE/l
Average wage for each rank		
- Managerial personnel	:	1,800 LE/year
- Technical staff	:	1,800 LE/year
- Driver	:	2,400 LE/year
- Worker	:	1,440 LE/year
- Sweeper	:	960 LE/year

Collection charge

- Ordinary households : 9 LE/year
- Business establishement
  - * Small scale : 1.8 PT/kg
  - * Large scale : 2.3 PT/kg

Personnel to be required in 2000

- Collection and sweeping : 786 persons
- Transfer station : 49 persons
- MBSDS : 28 persons
- Compost plant : 105 persons

Compost plant specifications

- Yearly operation day : 300 days
- Daily operation hour : 8 hr/shift x 2 shifts = 16 hours
- Daily treatment capacity : 300 t/d
- Hourly treatment capacity : 23.57 t/hr
- Fermenting period : 5 weeks
- Maturing period : 4 weeks
- Resources recovery rate in year 2000
  - * Fine compost : 24%
  - * Reusable material : 7%

Amortization

- Machinery : 15 years
- Civil and building structure : 30 years
- Vehicle : 5 years

Maintenance cost

- Plant facilities : 2% of machinery and installation cost
- Vehicle : 8% of vehicle purchasing cost

Effectiveness of compost application as soil conditioner

- Increasing rate of crop yield : 30%
- Decreasing rate of irrigation water : 40%

ABBREVIATION

ADS	:	ASSOCIATION FOR DEVELOPMENT OF SOCIETY
AGOSD	:	ALEXANDRIA GENERAL ORGANIZATION FOR SANITARY DRAINAGE
ALT.	:	ALTERNATIVE
ARC	:	AGRICULTURAL RESEARCH CENTER
B/C	:	BENEFIT/COST
BHN	:	BASIC HUMAN NEEDS
DWC	:	DRINKING WATER CANAL
EIRR	:	ECONOMIC INTERNAL RATE OF RETURN
EDS	:	EASTERN DISPOSAL SITE
F/S	:	FEASIBILITY STUDY
IBRD	:	INTERNATIONAL BANK OF RECONSTRUCTION AND DEVELOPMENT
JICA	:	JAPAN INTERNATIONAL COOPERATION AGENCY
MBSDS	:	MOHARAM BEY SQUARE DUMP SITE
NPV	:	NET PRESENT VALUE
O/M	:	OPERATION AND MAINTENANCE
PLAN 2005	:	ALEXANDRIA COMPREHENSIVE MASTER PLAN 2005
S.R.	:	SUPPORTING REPORT
S.W.M.	:	SOLID WASTE MANAGEMENT
USAID	:	UNITED STATES AID
WDS	:	WESTERN DISPOSAL SITE

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CHAPTER 1. BACKGROUND AND OUTLINE OF THE STUDY

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1.1 Background and Outline

1.1.1 Background

Alexandria, a bright, modern city facing the Mediterranean Sea, is located about 200 km northwest of Cairo. With a population of 2,600,000 it is the second largest city in Egypt next only to Cairo. It is an economically important city, wherein 40% of the nation's industrial production is concentrated and has the largest trading port in Egypt. Also it is renowned all over the world as a time-honoured tourist city built by Alexander the Great.

Because of its population growth and the rapid concentration of population into cities today, however, the modernization of urban areas and improvement of urban environment are becoming urgent problems in Egypt. Securing of public health and preservation of its beautiful land are also recognized as important tasks. And big cities like Alexandria are expected to assume leading roles in realizing these goals.

In spite of this recognition, solid waste management (hereinafter referred to as s.w.m) in Alexandria is out-dated in every aspect, from discharge to disposal, and needs urgent drastic improvement. Waste collection service in Alexandria is performed by each of its six districts, because of shortages in personnel and equipments, wastes are littered everywhere, except on the main streets, detracting from the beauty of the city and deteriorating the urban environment.

Wastes are being treated and disposed of by landfilling at three landfill sites. Since the landfill is performed by so-called open dumping method, it deteriorates the hygienic environment of the surrounding residential areas, causing offensive odor, littering of wastes and breeding of pests.

Although Alexandria has prepared the Alexandria Comprehensive Master Plan 2005 (hereinafter referred to as Plan 2005) to cope with concentration of population into urban area and to modernize the city, it has not formulated any subordinate plan referring to the s.w.m. yet.

In view of the foregoing situation, Alexandria has taken up the improvement of the s.w.m. as its urgent and important political task with the aim at improvement of its present urban environment into one befitting an international tourist city and also at improvement of public health. It has requested Japan, which advances in the s.w.m., to formulate a Master Plan for the s.w.m. which:

a. is based on a highly realizable s.w.m. technology with due consideration to Egypt's socio-economic background and technical level, and which
b. will enable recovery and utilization of reusable materials from wastes, and also to conduct a feasibility study on the priority project for specified areas.

1.1.2 Purposes

This study has two purposes. One is to prepare a Master Plan for the s.w.m. system in Alexandria to improve public hygiene and preserve the current environment from technical, economic and social viewpoints by fully grasping the present situation and problems. And the other is to envisage a new s.w.m system capable of being implemented as an urgent work in specified areas for the target year 2000, and to look for possibilities of implementing same in other areas in the future when they receive the allocation of funds.

The purpose of this study is classified into the following matters.

(1) General Matters

a. To eliminate an adverse effect on public health by improving the existing s.w.m. service.

b. To bring about a more efficient s.w.m. and to establish the administrative organization suitable for the increasing charge laid on the s.w.m. according to the population growth.

c. To upgrade the s.w.m. services by clarifying the proper functional roles of the personnel, private consignees and other relevant persons involved in each field of the s.w.m.

d. To realize effective recovery of reusable materials from wastes.

(2) Specific matters

a. To collect and analyze technical, economic and social data necessary for formulating the plan.

b. To establish remedial measures for solving the problems originating from the s.w.m. service itself, or in other words, to improve the degraded public health and to recover the beauty of the city, etc.

c. To look for solutions of the problems related to the s.w.m., such as human education and community program for environmental conservation, public health and recovery of reusable materials.

d. To consider resource saving, etc. which can be expected from sorting facilities associated with the s.w.m.

e. To recommend an administrative structure necessary for the s.w.m. considering technical training, legislation, administrative actions and the like therein.

1.1.3 Scope of Study

(1) Area to be Covered

The area to be covered in the study was limited to Alexandria. The city consists of six districts which are, from east to west, Montazah, East, Middle, Gomrok, West, and Ameriyah.

(2) Wastes to be Covered

So-called municipal wastes mainly composed of household waste including commercial and business establishment waste are covered in the study. However, wastes which should properly be disposed of by the industry itself, such as liquid waste and sludge, wastes from port facilities and ships, construction wastes and agricultural wastes are excluded from the scope of study.

(3) Scope of Study

The study aims at clarifying the present conditions on the s.w.m. in Alexandria and at preparing a Master Plan (Phrase I & Phase II), as well as execution of a feasibility study on the s.w.m. in the Middle District (Phase III).

In this study, the following was taken into consideration.

a. In phase I, the current situation of the s.w.m. throughtout Alexandria was studied in details as much as possible and its relevance to the administrative organization was examined. As a result, what called for techinical, economic and social countermeaures was pointed out. Also this information was utilized as basic data for the study.

b. In Phase II, the possible sub-systems for the s.w.m. are proposed and evaluated mainly from technical viewpoints. Then alternatives of the s.w.m. combined with selected sub-systems in above are evaluated on the advantages and disadvantages through discussion from technical, economic and social viewpoints.

c. In Phase III, feasibility study on the s.w.m. system limited to the Middle District. It is neccessary to thoroughly understand that it is only a part of the whole program and that it is to serve as a standard for the s.w.m. system on other districts.

In the latter half of Phase II, under open deliberation with Egyptian counterparts, Middle District was selected as the qualified district where the priority project shall be carried out.

1.2 Proceeding

The field survey was started on August 6th, 1984 in accordance with the Scope of Work (Attachment 1) concluded by and between the Governorate of Alexandria and the Japan International Cooperation Agency (JICA) on March 29th, 1984.

The achieved results of the field survey and subsequent analysis conducted in Japan during the next five months are compiled into the Final Report submitted herewith. The works proceeded as follows;

(1) Phase I (August 1984 - December 1984)

* An Inception Report which explains the overall plan of this study was approved during the first local supervisory committee meeting.
* Existing local data were collected.
* Fact finding survey was conducted on wastes generation and disposal.
* Current socio-economic environment was analyzed.
* Assumed preconditions for the framework of city planning were reviewed.
* The amount of wastes generated and their composition were investigated.
* Problems were sorted out and preconditions for formulating the Master Plan were confirmed.
* Questionnaire surveys and interviews with inhabitants were conducted on the current wastes collection system.
* Alternatives were presented to and discussed with the Egyptian counterparts.
* A Progress Report was submitted and explained to the Egyptian counterparts.
* The second local supervisory committee meeting was held.

(2) Phase II (January 1985 - March 1985)

* The framework for city planning was laid down.
* The amount of wastes to be generated and waste composition in future were forecast.
* The basic measures for formulating the Master Plan were laid down.

* Alternatives were evaluated and an optimum plan was selected.
* The Master Plan was drawn up and the Middle District was selected as the specified area.
* Interim Report was submitted and explained to the Egyptian counterparts.
* The third local supervisory committee meeting was held.

(3) Phase III (May 1985 - March 1986)

* Present situation of the Middle District was surveyed.
* Questionnaire surveys and interviews with inhabitants were conducted on the waste collection services.
* Collection experiments were performed.
* Actual operating condition of the existing compost plant was investigated.
* Marketability of compost was surveyed.
* Topographical and geological survey of sites for final disposal and compost plant was carried out.
* Consultation with the Egyptian counterparts was held on the basic measures for formulating plans for waste collection and street sweeping.
* The basic policies for formulating the organization and administration plans were confirmed.
* Progress Report II was submitted.
* The fourth local supervisory committee meeting was held.
* Draft Final Report was submitted.
* The fifth local supervisory committee meeting was held.
* Final Report is submitted as scheduled.

This study was conducted under the cooperation of the Egyptian counterparts from the General Manager of Alexandria and the Middle District represented by General Manager Mr. Saad Rafael and the guidance of the JICA Supervisory Committee chaired by Dr. Sachiho Naito. Names of the participants concerned are listed in Attachment 2, and minutes of major meetings are presented in Attachment 3.

CHAPTER 2. OUTLINE AND PROBLEM OF SOLID WASTE MANAGEMENT IN ALEXANDRIA

CHAPTER 2. OUTLINE AND PROBLEMS OF S.W.M. IN ALEXANDRIA

2.1 Actual Amount and Composition of Solid Waste

2.1.1 Administrative Division and Population

Fig. 2-1-1 shows the administrative division within the area around the Green Belt indicated in the Plan 2005.

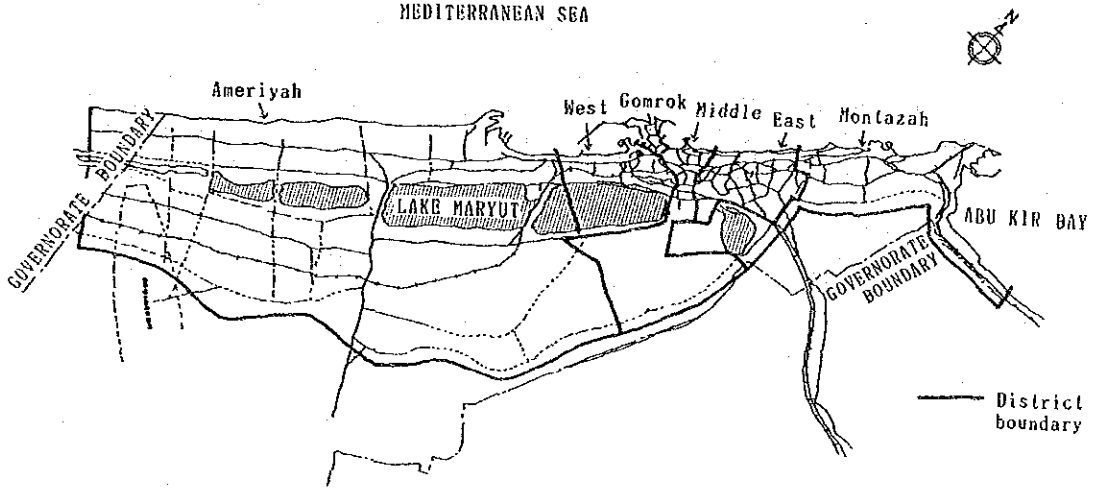

Fig. 2-1-1 ADMINISTRATIVE DIVISION OF ALEXANDRIA

Fig. 2-1-2 shows the area currently used for residential and commercial/business purposes. Fig. 2-1-3 shows the population distribution. The total population in 1984 was 2,884,000, consisting of 755,000 in Middle, 723,000 in East, 731,000 in West, 441,000 in Montazah, 321,000 in Gomrok, and 113,000 in Ameriyah District.

During the summer season between June and August, the population swells with summer vacationers. The the number of vacationers' population is estimated to be about one million.

The number of dwelling units is 466,000 and the average family size is five persons per family.

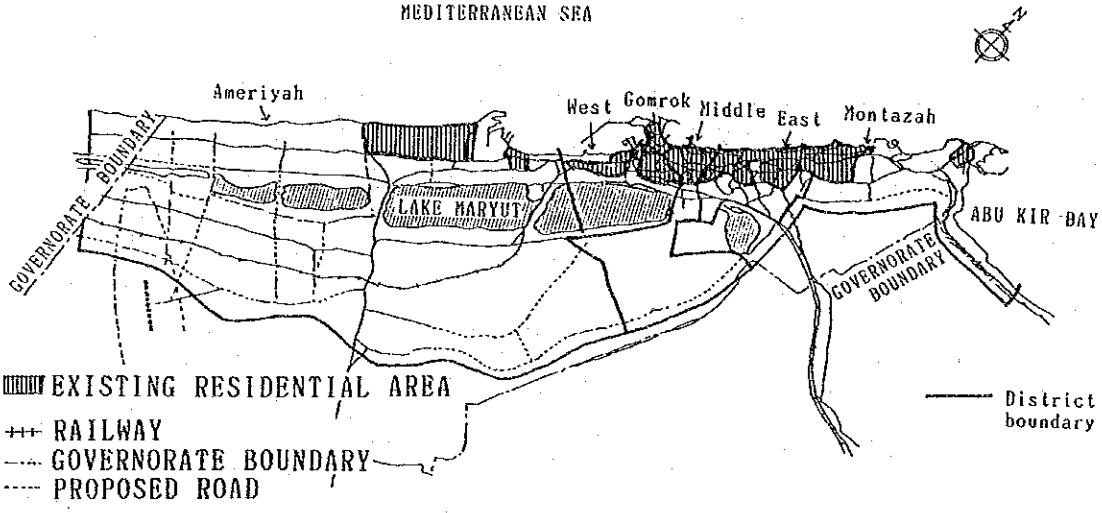

Fig. 2-1-2 THE AREA CURRENTLY USED FOR RESIDENTIAL AND COMMERCIAL PURPOSES

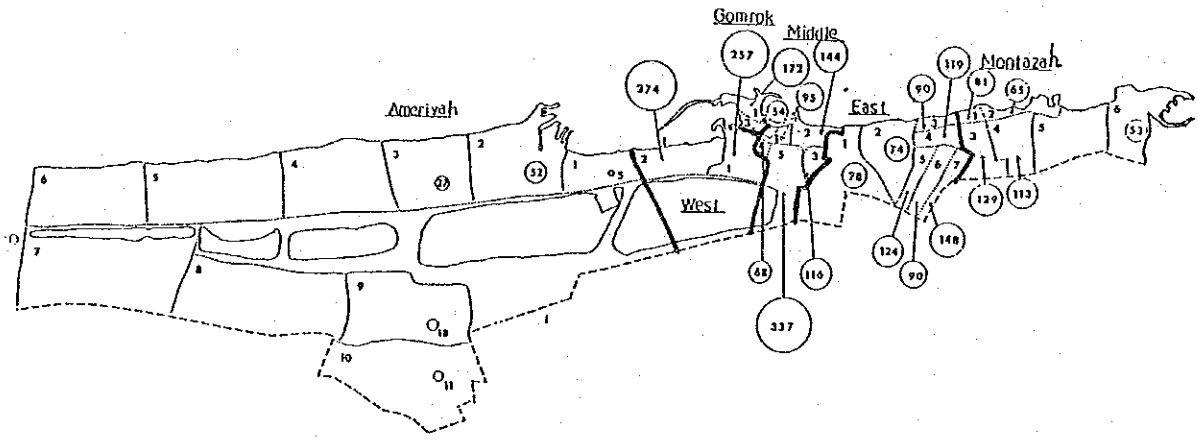

Fig. 2-1-3 POPULATION DISTRIBUTION IN 1984 (1,000 person)

2.1.2 Actual Amount and Composition of Solid Waste

1) Waste amount

(1) Types of waste

Wastes generated in the city area of Alexandria consist of domestic waste, commercial waste, vacationer waste, street waste, factory and port waste and sewerage sludge. The wastes which the city authority collects and disposes of are domestic waste, commercial waste, vacationers' waste and street waste.

(2) Domestic waste

The generation rate of domestic waste by income class is as shown in Table 2-1-1. The average generation rate is 284g/person/d. The waste amount generated in each district was calculated on the basis of this generation rate with respect to the population distribution by income class in each district. It resulted in 822 t/d for whole Alexandria in 1984. The waste amount generated in each District is as shown in Table 2-1-2.

(3) Commercial waste

The amount of commercial waste was estimated from the relationship between the amount of domestic waste and the actually hauled amount into final disposal sites. It resulted in 430 t/d for whole Alexandria as shown in Table 2-1-2.

(4) Summer vacationers' waste

About one million vacationers visit Alexandria every summer. The waste generation rate of vacationers was assumed to be the same as the domestic waste generation rate of the high income level family. Amount of vacationers' waste resulted in 360 t/d for whole Alexandria.

(5) Street waste

Most of the wastes littered on the streets in Alexandria result from throwing of domestic waste. Then the amount of such waste is included in the amount of domestic waste. Only the waste on main streets and secondary streets which can properly be called genuine street waste were estimated. The length of the main streets is 400km and that of secondary streets is 900 km respectively, and the amount of waste generated on those streets is estimated to be approximately 15 t/d.

Table. 2-1-1 DOMESTIC WASTE GENERATION BY INCOME CLASS

Income Class	Low	Middle	High	Average
Generation Rate (g/person/d)	221	344	362	284
Density (kg/m^3)	254	224	192	236

Table 2-1-2 WASTE AMOUNT IN 1984

(t/d)

	Domestic Waste	Commercial Waste	Sub-Total	Summer Vacationer' Waste	Street Waste
Montazah	114	30	154	180	-
East	204	102	306	126	-
Middle	229	160	389	18	-
Gomrok	99	93	192	0	-
West	145	29	174	0	-
Ameriyah	31	6	37	36	-
Total	822	430	1,252	360	15

2) Waste composition

Table 2-1-3 shows the results of analysis of composition of domestic waste, commercial waste and street waste. There is a clear distinction in the composition of domestic waste of the low income class and that of the middle/high income class. The low income class waste in comparison shows a higher ratio of garbage/grass and lower ratio of papers comparing with that of the middle/high income class.

Commercial waste is characterized by the lower ratio of garbage/grass and higher ratios of textiles and plastics compared with domestic waste. Street waste is apparently different in composition from domestic waste and commercial waste. Sand accounts for the largest portion at 50%, followed by papers and plastics.

Table 2-1-3 ASSUMED VALUES OF COMPOSITION IN 1984

(% in wet base)

Classification	Domestic Waste		Commercial Waste	Street Waste (Main Street)
	Low Income	Middle.High Income		
Garbage/Grass	73	61	55	14
Paper	14	23	20	22
Textile	4	3	9	-
Plastics	4	4	10	8
Metals	2	3	3	2
Glass	2	3	2	-
Sand	-	-	-	50
Others	1	3	1	4
Total	100	100	100	100

2.2 Collection and Street Sweeping

2.2.1 General

At present, three sectors are involved in the municipal waste collection in Alexandria. One is the private sector, the Zabbaleen, who have been providing door-to-door waste collection service for many years. The next is the public sector, the District, and the last is the extra-governmental body of the District, called the Association for Development of Society (ADS). The modes of collection of these three parties are as summarized below.

a. Zabbaleen collect waste directly from each household with a donkey cart of about 2 m^3 in loading capacity. The waste, after being hauled to the sorting site, from which bones, textiles, glasses and metals are salvaged and the residual is sold to farmers, etc.

b. The District uses collection vehicles to collect waste at collection stations in the morning and hauls it to the final disposal site for disposal. Other than the 2% cleansing tax levied on dwelling units, basically, this service is free of charge.

c. ADS uses the District's collection vehicles to collect and haul waste from each shop and household by charging a fee to supplement the District's collection service. The scale and the system of collection of each ADS's activity, however, vary by each District.

d. Street waste is swept by the District and hauled to the disposal site.

The flow of municipal waste from its generation to disposal is as illustrated in Fig. 2-2-1, in which 5. shows uncollected waste, 2. shows that some of the municipal waste turns into street waste and A and 3. show that wastes are sorted by Zabbaleen on the streets and that the residual is thrown away on the streets or at the waste collection point.

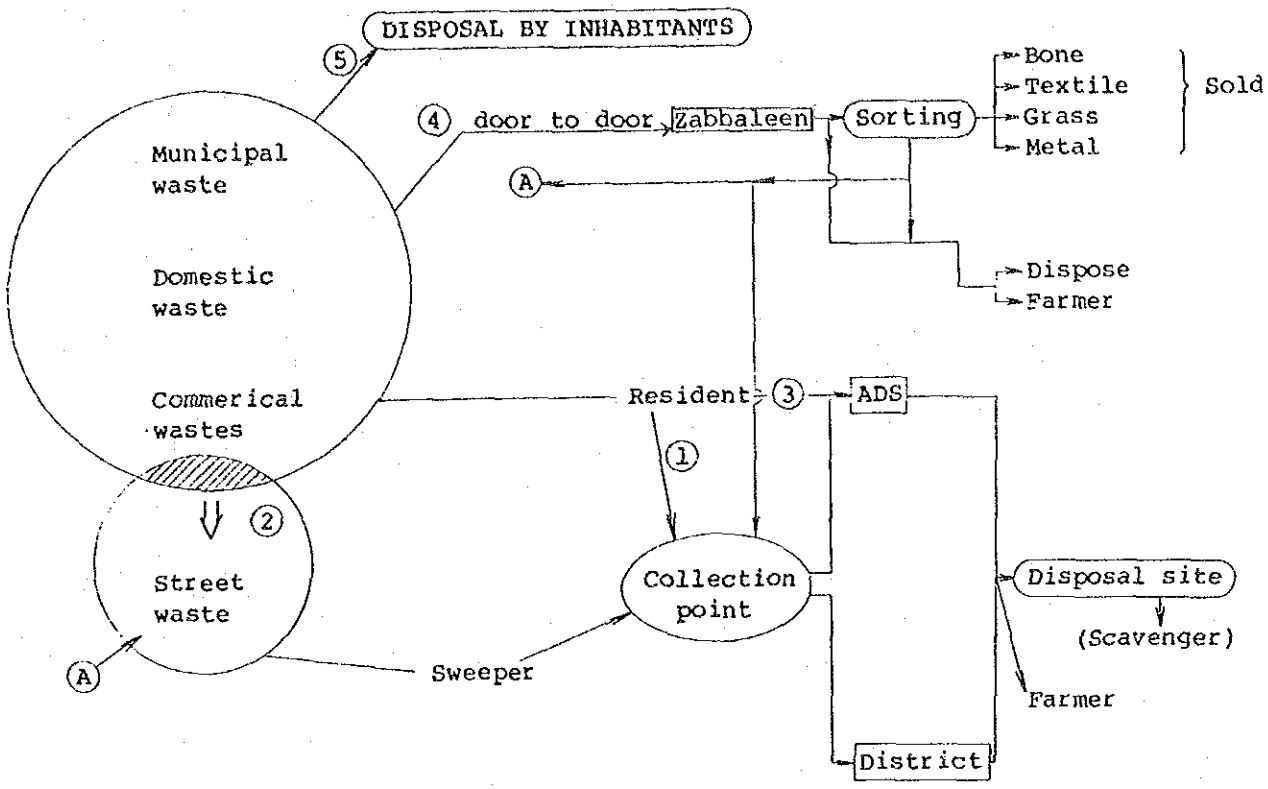

Fig. 2-2-1 FLOW CHART OF SOLID WASTE

The salient features of waste collection in Alexandria today may be epitomized into the following four points.

- Most of domestic waste is collected by street sweepers.

- As three sectors are involved in collection of wastes, the flow of wastes from discharge to disposal is complicated.

- The service level of each sector is not uniform. Also, while one charges a fee, the other does not.

- The scope of responsibility of each sector is ambiguous.

A review of the history of waste collection in Alexandria up to the present way would be helpful in determining the direction in which improvements should be made. Until ten years ago, collection of municipal waste had been performed by Zabbaleen, while District administration had been responsible for sweeping of streets and collection and haulage of street waste. In other words, the District administration was not involved in domestic waste collection. Also, until then, waste disposing of was relatively easy using a part of Lake Maryut which is very close to the city as a disposal site. The following may be cited as the causes which brought about changes in the foregoing waste collection mode.

a. Contrary to the increase in waste amount accompanying population growth, the number of Zabbaleen decreased sharply.

b. As the disposal sites were moved farther away, the cases of Zabbaleen throwing the wastes away on the streets instead of hauling them to the disposal sites increased.

The above led to undermine the system of waste collection by Zabbaleen resulting in frequent occurrences of littering of domestic waste on the streets.

The Governorate has tried to cope with such a situation by strengthening the District's collection system for littered wastes, introducing ADS and strengthening the penal regulations against unlawful dumping of wastes by the inhabitants, business proprietors and Zabbaleen. However, as one of those actions is a temporary, emergency measure in nature, lacking any comprehensive plan for the middle or long range based on a future perspective, the Governorate has been unable to establish a technically and financially satisfactory system.

The problems in waste collection of Alexandria, for example the lack of managerial system over the Districts' waste collection, the commingling of municipal waste and street waste, and coexistence of the fee charging systems and the non-charging system for waste collection, cannot be discussed without an understanding of such historical facts.

2.2.2 Waste Collection System

As described previously, waste collection in Alexandria is performed by three sectors. The public waste collection services are operated by six districts. ADS, which is an extra-governmental organ of each district, carries out social welfare activities. The ones in Middle, East and West District were established in 1970, the one in Ameriyah in 1973, in Gomrok in 1982 and in Montazah in 1983. The direct causes which led these organizations to engage in waste collection by charging fees are the decrease in the number of Zabbaleens and the fact that the district is not obligated to collect commercial wastes on free of charge.

Also, the shortage of funds for incentive payments to workers can be enumerated as another cause. Activities of ADS in waste collection commenced in 1982 in Middle District, 1983 in East, 1981 in West, 1983 in Gomrok, 1982 in Ameriyah and 1984 in Montazah. Collection of household waste is included in the field of ADS's activities only in Middle and West Districts. In the other districts, ADS collects the waste mainly from shops.

According to the past records, Zabbaleen had been collecting about 70% of wastes in Alexandria, but they have phased out almost completely today.

2.2.3 Present Situation of Collection

1) Service area

In the south of Mahmoudiyah Canal, in Ghebrial and El Seyof of East District and in Montazah No. 4 Block of Montazah District, wastes are dumped in vacant lots in and around the blocks. The collection service in these blocks is therefore considered inadequate. The accurate population in these areas is unknown due to lack of statistical data, but is roughly estimated to be around 600,000. Thus, the current collection service coverage rate is estimated to be about 80% of the total population.

2) Waste amount collected

The total waste amount collected was estimated from the results of the field fact-finding survey at final disposal sites as shown in Table 2-2-1. The waste amount collected and disposed of is about 80% of the waste amount generated in all of Alexandria. Montazah and East Districts have a large gap between the waste amounts generated and collected. The gap of each district is 73% and 74%, respectively.

The share of districts' collection is 72 %, that of ADS 21 % and that of Zabbaleen a very low 7 % of the total waste collected amount.

Table 2-2-1 AMOUNT OF COLLECTED SOLID WASTE BY THE SECTORS

(t/d)

District	1) District	1) ADS	2) Zabbaleen	Total	Waste Amount 3) Generated in ALEX in 1984
Montazah	81	5	26	112	154
East	114	58	45	217	306
Middle	270	102	0	372	389
Gomrok	151	32	0	183	192
West	125	22	0	147	174
Ameriyah	39	8	0	47	37
Total	780	227	73	1,078	1,252

Notes 1) Estimates based on the records at disposal sites during Sept. 16 and Sept. 22, 1984. These estimates include vacationers' waste.
2) Estimates based on the number of donkey-driven carts.
3) Refer to Table 2-1-2.

3) Collection frequency

Basically, waste is collected once a day by all three sectors, namely district, ADS and Zabbaleen. In commercial areas or markets, waste is collected two or three times a day depending on the condition of waste generation. South of Mahmoudiyah Canal, ADS collects the waste only two or three times a week.

4) Waste collection stations (waste station)

Clearly designated waste stations are only those where the communal containers of capacity about 2 m^3 are located at about 1,300 places throughout Alexandria. There are many other waste stations, with no facility as waste stations (which are referred to as open stations hereinafter). They are not designated by the districts but spontaneously formed. As there is no regulation that waste should be discharged to these stations, actually the inhabitants who use plastic bags or other containers discharge waste at the entrance of each building, while those who do not use any container discharge waste at the open station. Thus, it is reasonable to conclude that there is no clearly designated collection point except the communal containers.

In the case of collection by ADS, although it differs depending on each district, the general method in the residential area is to herald the arrival of collection vehicle by whistle sounding, whereupon the inhabitants carry waste and discharge to the collection vehicle. Waste from shops is collected by door-to-door method.

2.2.4 Actual State of Waste Discharge

The waste discharge varies by the container of waste, the collection method and the person who discharges it. As the discharge is the point of contact between inhabitants who receive collection service and the collection sectors, it is indispensable extremely important to grasp actual state in order to improve the collection service.

1) Household

Household generally discharges waste in the following manner. In the case of high/middle income residences, waste is discharged by servants or directly collected by Zabbaleen at the door. It is rare that waste is discharged to the waste station personally by any member of the family. Plastic bags are generally used to discharge waste. Plastic bins or tin cans are also used frequently. Paticularly in the city center where there are not many waste stations, waste is rarely discharged to the station.

In the case of the low income households, waste is mostly discharged by the family members themselves, directly to the street, the collection vehicle, or the waste station. Plastic bags for discharge are rarely used there. Instead, tin cans and plastic bins are mainly used.

Generally inhabitants who do not use plastic bags tend to carry waste to the waste station, while those who use plastic bags tend to discharge waste at the entrance of buildings. The worst possible discharge case is the people who throw waste from window of buildings onto the street. Improvement of these discharge manners is urgently desired. The discharging time at waste stations is from 8 o'clock in the evening to midnight or early in the next morning.

2) Shops and offices

Restaurants, hotels and small factories discharge a large amount of waste. Wastes discharged from these establishments are usually carried to the station by the employees or collected by ADS by door-to-door collection. In the case of offices and ordinary shops the discharged waste amount is relatively small, and the employees discharge it, or Zabbaleen or sweepers collect it by door-to-door.

Meanwhile, plastic bags are hardly used in carrying out commercial waste. Thus, commercial waste is generally discharged at waste stations in the open state.

3) Special institutions

Penitentiaries, large hospitals, zoos and other institutions which discharge a large amount of waste are provided with communal containers.

A part of waste generated in hospital is injurious to health and it is incinerated at some of the larger hospitals, but generally this waste is discharged together with ordinary waste.

4) Market

Markets in Alexandria are clearly separated from residential areas. They do not have ample space to discharge waste. Their waste is discharged at open stations on the street. According to the market activities, waste is discharged in the afternoon and in the evening .

2.2.5 Waste Collection Vehicles and Garages

1) Collection vehicle

The number of waste collection vehicles and their operation rate are shown in Table 2-2-2. According to this table, the total number of vehicles is 188, the number of vehicles in working condition is 137 and the average number of actual working vehicles is about 80 per day, indicating a very low operating rate of 42%.

Table 2-2-2 NUMBER OF COLLECTION VEHICLES AND NUMBER OF WORKING VEHICLES

(Unit)

	Fit	Unfit	Total	1) Working	Working Ratio(%)
Montazah	17	12	29	9.4	32.4
East	30	6	36	20.0	55.5
Miaale	35	12	47	23.6	50.2
Gomrok	23	11	34	12.2	35.9
West	21	6	27	9.2	34.1
Ameriyah	11	4	15	5.0	33.3
	137	51	188	79.4	42.2

Note: 1) The number of average daily working vehicles during August 22-31, 1984

The number of vehicles by type is as shown in Table 2-2-3. There are five types of vehicle, container vehicle, compactor vehicle, rotary compactor vehicle, large dump truck, and small dump truck. Most of them are made in U.S.A., Italy or Japan. All of the container vehicles, compactor vehicles, rotary compactor vehicles are obatined by foreign grants, while dump trucks were purchased out of the governorate's own budget. Thus, about 50% of the vehicles held were procured through foreign grants. The number of drivers in the summer of 1984 was 122, which is less than the number of vehicles in working condition but larger than the number of vehicles actually working.

Table 2-2-3 NUMBER OF COLLECTION VEHICLES

(Units)

Type	Loading Capacity (m^3)	Total	Fit	Unfit
Container Collection Vehicle (Truxmore)	16	42	33	9
Compactor Vehicle (Fiat Leach)	11 (Fiat) 9 (Leach)	51	42	9
Rotary Compactor Vehicle (Fiat Mince)		6	2	4
Large Dump truck (Isuzu, Fuso, Mitsubishi, Nissan)		45	39	6
Small Dump truck (Mazda, Daihatsu)	3.5	44	21	23
Total		188	137	51

The number of vehicles used in ADS collection work is shown in Table 2-2-4.

Table 2-2-4 NUMBER OF WORKING VEHICLES IN ADS COLLECTION

(Units)

Montazah	2.9
East	13.9
Middle	20.0
Gomrok	(10.0)
West	6.0
Ameriyah	3.0

Note: Mean value of the data obtained. Estimated value for Gomrok.

2) Garage

Every District has one garage which performs middle-class maintenance for vehicles. All garages are located in urban areas. Generally, each garage has only a small parking space. The garage of West District has no parking space at all so that vehicles must be parked on the streets. All parking space is occupied by vehicles that are not in use. Particularly in Gomrok and Middle District garages, the entrance which also serves as the exit and parking space is small either so that it takes time for the vehicles to leave the garage or to enter it after finishing work. On the top of the problem a fuel station is not provided in any of the garages so that vehicles are compelled to go to the Central Workshop for fueling every two or three days. Furthermore, fueling takes long time due to limited fueling space.

2.2.6 Waste Collection Process

1) Preparatory work

Vehicles depart from the garage between 7:00 and 8:00 in the morning for District collection and between 14:00 and 15:00 for ADS work. At that time the driver leave the garage of himself, and picks up the collection assistants at the sub-cleansing office, then heads for the collection area. The average distance from the garage to each collection area is generally below 5 km as shown in Table 2-2-5. According to the results of the field survey, the average speed is 25 km/h and the necessary driving time to the collection area is around 10 minutes.

Table 2-2-5 DISTANCE BETWEEN DISTRICT GARAGE AND COLLECTION AREA

	(km)
Montazah	2.7
East	5.0
Middle	2.0
Gomrok	5.0
West	1.4
Ameriyah	4.6

2) Collection

The collection work after arriving at the collection area varies according to the type of vehicle and whether it is for District or ADS collection.

(1) Container vehicle

The container vehicle equipped with a side lift stops alongside the container to load waste from it. Attaching and detaching of container is performed by two assistants, while another collects waste scattered around the container. In cases of loading from open stations, the collection assistants load the discharged waste using green baskets. In this case, loading takes considerable time since the waste hopper is narrow and too high.

(2) Compactor vehicle

Upon the arrival of the compactor vehicle at the waste stations, four or five collection assistants gather the waste and load it onto the vehicle using green baskets. As waste is generally in loose state, loading requires much manpower and time.

(3) Open dump truck

To increase loading capacity, the sideboards of the loading deck of dump trucks are raised. Because of this, waste must be thrown up more than two meters high for loading. As waste is generally discharged in loose bulk, the time required for loading waste becomes longer. Normal number of collection assistants is four for a large dump truck, and two for a small dump truck.

In the case of ADS waste collection from residences, the arrival of the vehicle is heralded with by a whistle blowing so that the residents can carry out waste to the vehicle.

The results of the investigation on the required time for collection are shown in Table 2-2-6. The time for collection work is about 45 minutes for container vehicles and small dump truck, and about 75 minutes for compactor vehicle and large dump truck. Container vehicle is the highest in collection efficiency, while the large dump truck is the lowest. Since these figures are calculated excluding the assistance of street sweepers, the actual efficiency is lower than the values shown in the Table 2-2-6.

Table 2-2-6 COLLECTION WORK TIME AND EFFICIENCY

	Collection work time (A)	Pay load (B)	Number of worker (C)	$\frac{A \times C}{B}$
Container Vehicle	44 minute	6.5 t	34 person	27.0
Compactor Vehicle	74	4.0	45	92.5
Large Dump truck	76	2.5	45	152.0
Small Dump truck	46	1.2	3	115.0

Note: The result of collection efficiency survey by JICA study team in 1984.

3) Haulage

When the vehicle is filled with waste, collection assistants are left in the collection area, and the vehicle hauls the waste to the disposal site. The distance from each collection area to the present disposal site is in the range of 4 to 5 km except in Montazah District. Accordingly, haulage requires 10 to 20 minutes. The required time at the disposal site for unloading is around 10 minutes.

The number of trips which each collection vehicle makes during the District work varies according to vehicle type and to each District. In the Middle District, the number of trips is normally three for container vehicle, compactor vehicle and large dump truck, and five for small dump truck.

The number of trips per day and that per vehicle in ADS work are shown in Table 2-2-7.

Table 2-2-7 NUMBER OF TRIPS OF COLLECTION VEHICLES
(For ADS work)

(times)

District	Average No. of trips per day	No. of trips per vehicle
Montazah	3.3	1.1
East	22.6	1.6
Middle	48.0	2.4
Gomrok	17.0	1.7
West	11.2	1.9
Ameriyah	3.0	1.0

2.2.7 Collection Management

1) Work standard

The collection work standard is determined in terms of number of trips of collection vehicle. Neither the system based on the standard collection amount nor that based on the completion of collection of waste in assigned areas is adopted. Hence, it is often the case that all of the waste in an area cannot be completely collected in the specified number of trips due to fluctuations in the amount of waste generated in the area.

The trip system differs in each district, but in Middle district, the standards are four trips for container vehicle, as aforementioned. The necessary work time per day based on the foregoing standards is about equal for all vehicles except the dump truck as shown in Table 2-2-8.

Table 2-2-8 NECESSARY WORK TIME FOR COLLECTION IN MIDDLE DISTRICT

(Minutes)

	Collection Work time	Haulage time	Work time per 1 trip	Necessary work time per day
Container Vehicle	44	40	84	336
Compactor Vehicle	74	40	114	342
Large Dump truck	76	40	116	348
Small Dump truck	46	40	86	430

2) Collection zone

The collection service for each district is divided into cleansing zones which are under the control of sub-cleansing offices. These sub-cleansing offices are also in charge of street sweeping. In West and Ameriyah District, the collection zones and street cleansing zones overlap, but in the other districts, collection zones are more clearly divided. For instance, there are 14 and 22 collection zones in Gomrok and Middle District respectively, and the average solid waste in each zone is 13.6 t/d and 17.6 t/d respectively which require about two collection vehicles for each.

The number of cleansing zones and the amount of solid waste for each district are shown in Table 2-2-9.

Table 2-2-9 NUMBER OF CLEANSING ZONE

District	Number of Cleansing Zone (A)	Solid Waste Amount (t/d) (B)	(B)/(A) t/d/zone
Montazah	6	154	25.7
East	7	306	43.7
Middle	5	389	77.8
Gomrok	3	192	64.0
West	9	174	19.3
Ameriyah	7	37	5.3
Total	37	1,252	33.8

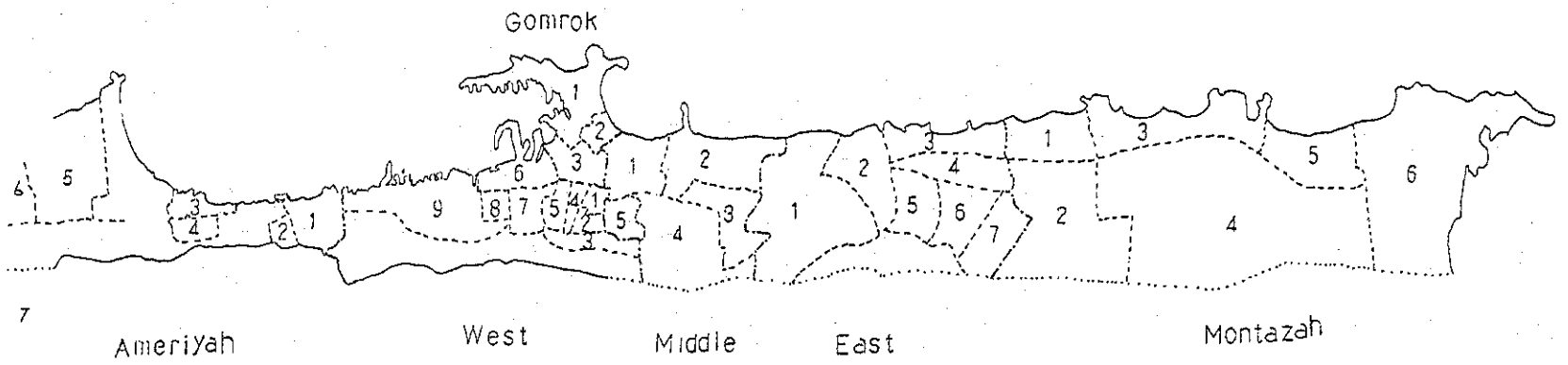

Fig. 2-2-2 CLEANSING ZONE

The collection zones are not rationally divided on the basis of the waste amount generated in each zone and the capacity of collection vehicle. There are cases where one collection vehicle collects in a few zones.

3) Collection route

The driver and the collection vehicle are assigned to fixed area. Because the collection are made everyday, scheduled allocation of collection areas is not necessary and the assignment is simple. However, due to frequent breakdown of vehicles and absence of drivers, dispatching adjustments have to be made early in the morning which often causes problems, because there are many vehicle types with different loading capacities.

The route is generally determined, but the way to make a round of that route is left to the discretion of each driver. Generally a route which covers the key points and which makes the initial trip short is selected.

4) Crew

The number of collection workers is determined in accordance with the type of collection vehicle. The waste amount loaded per collection worker is the largest for a container vehicle and smallest for a large dump truck. Although simple comparison is impossible due to the difference in the severity of the work of loading waste into vehicle, the workload of the small dump truck seems the heaviest. Table 2-2-10 shows the number of collection workers by vehicle type and the loading amount per worker.

Table 2-2-10 NUMBER OF COLLECTION WORKERS PER VEHICLE AND PAYLOAD PER WORKER

	Number of Workers per Vehicle	Loading Amount per Vehicle	Loading Amount per Worker
Container Vehicle	3 person	26 t/d	8.7 t/d
Compactor Vehicle	4	12	3.0
Large Dump truck	4	7.5	1.9
Small Dump tuck	2	6.0	3.0

The number of collection workers per working vehicle differs by district as shown in Table 2-2-11. The waste amount collected per worker for district work is also considerably different among district. It is 2.0 t/d/worker for Alexandria as a whole, which is low compared to 2.4 t/d/worker in Tokyo. (However, the workload cannot be simply compared as the conditions are different from one another.)

Meanwhile, with regard to actual working condition of workers in ADS work about half of the drivers and workers throughout Alexandria are engaged in ADS work every day, as shown in Table 2-2-12.

Table 2-2-11 REQUIRED NUMBER OF WORKERS

	No. of working vehicle (A)	No. of Worker (B)	(B)/(A)	Waste Amount Collected (C)	(C)/(B)
Montazah	9.4 unit	39 person	4.1	81 t/d	2.1
East	20.0	83	4.2	114	1.4
Middle	23.6	117	5.0	270	2.3
Gomrok	12.2	76	6.2	151	2.0
West	9.2	60	6.5	125	2.1
Ameriyah	5.0	25	5.0	39	1.6
Total	79.4	400	5.0	780	2.0

Table 2-2-12 DRIVERS AND WORKERS ENGAGED IN ADS COLLECTION WORK DAILY

(persons)

	Driver	Worker
Montazah	3	12
East	14	56
Middle	20	80
Gomrok	10	40
West	6	24
Ameriyah	3	12
Total	56	224

Note: The number of workers were estimated by assuming four workers per vehicle.

5) Working hours

The working hours for collection is between 6:00 and 14:00 for district work and between 14:00 and 20:00 for ADS work. As for the actual operating condition of collection vehicles in Middle District, the total extended working time ranges between 390 minutes and 420 minutes per vehicle when the assigned number of trips is observed.

Fig. 2-2-3 shows an example of time schedules for collection vehicles in Middle District.

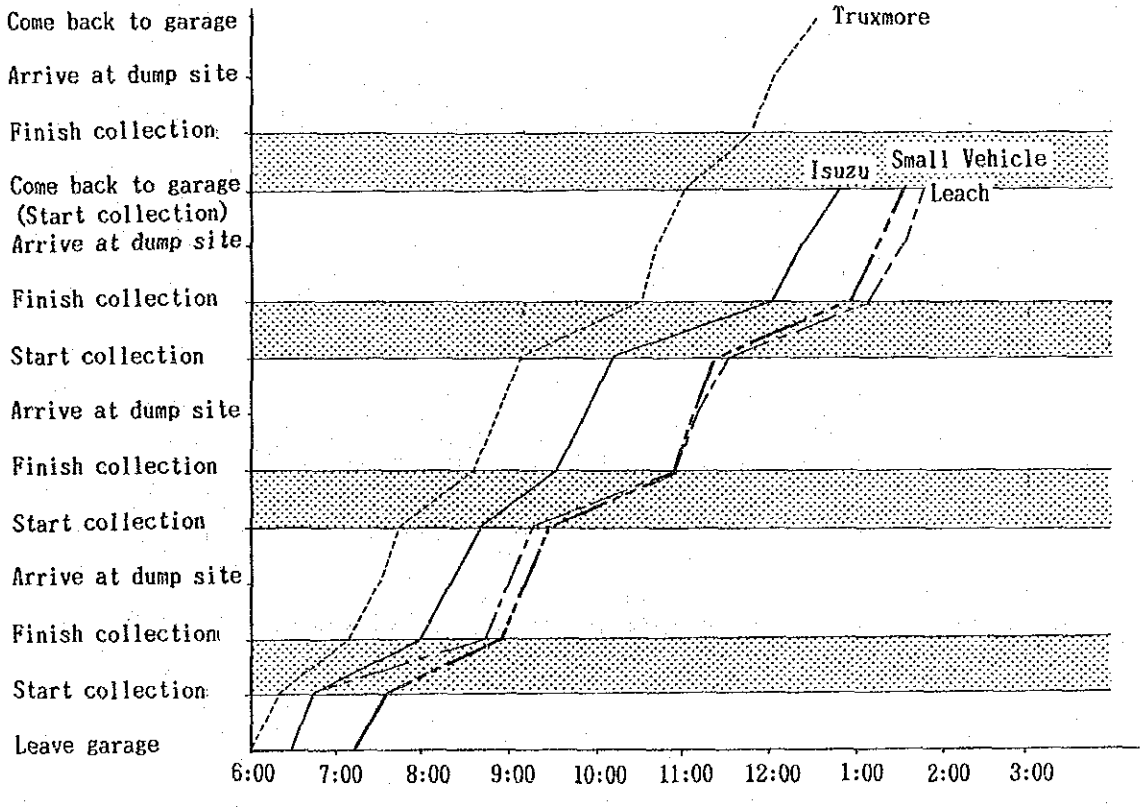

Fig. 2-2-3 AN EXAMPLE OF TIME SCHEDULES FOR COLLECTION VEHICLES IN MIDDLE DISTRICT

6) Work management

The collection work is managed by the inspectors and work masters. The work master is required to report to the inspector the condition of waste uncollected by each collection vehicle. The inspector may take disciplinary action on drivers and workers or make emergency dispatching of some other vehicle, and reports such action to his supervisor.

Meanwhile, management on the amount of waste collected is exercised by checking whether the collection vehicle is full or not and by the counting times of its arrival at the dump site. Quantitative control by means of a truck scale is not practiced.

7) Education

In order to operate the collection work stably and efficiently, it is necessary to set administrative goals in the management function and work targets in the field work function and to educate the staff to attain these goals and targets, but such attempts have not been made in Alexandria at present.

8) Wages and promotion

Most of the collection assistants have received only the elementary education or a lower one, which places them between 4th to 6th in the governmental wage schedule which is divided into 7 ranks. The basic wage of a collection assistant is around 50 LE/month. In addition to the above, an incentive payment is made for District work, and also for ADS work. In the case of District work, the amount of incentive varies according to the type of vehicle. The types are arranged in descending order as follows; Truxmore, Fiat, Leach, large dump truck and small dump truck.

The current typical pay of a collection worker is around 100 LE/month including incentives.

Basic Wage	50 LE/month
Incentive by District	20
Incentive by ADS	30
Total	100

Most of the drivers, on the other hand, have received secondary or higher education, and their basic wage is slightly higher than collection assistants at 60 to 70 LE/month but they are favorably treated in incentive payments. Drivers are ranked in three classes, the first class for the drivers of Truxmore, the second class for the ones of compactor vehicle, the third class for other drivers. The incentive is determined for each class. The first class drivers receive the following pay.

Basic Wage	60 - 70 LE/month
Incentive by District	100 - 120
Incentive by ADS	50
Total	210 - 240

The incentive paid by the district varies according to the type of vehicle, but higher incentives are paid for vehicles that entail lighter working load, and lower incentives for vehicles that entail heavier working load. This is due to an expedient to give preferential treatment to the excellent drivers and assistants by distinguishing them from others who are not, by the assignment of the types of vehicle. Accordingly, it must be kept in mind that when the type of vehicle is standardized, such an order would eventually collapse. Performance of each assistant and driver is appraised by the General Supervisor.

Promotion is based on the length of service, but also has difference by the performance appraisal of the General Supervisor. Collection assistants usually remain in the status of collection assistant throughout their entire career, and only those who have received outstanding appraisal are promoted to the rank of work master. It is said that promotion from the driver's rank to a supervisory and managerial position is very rare.

9) Guidance to citizens

Cooperation of the citizens in waste discharge is one of the most crucial factors for attaining efficient waste collection, but in Alexandria, hardly any efforts have been made to secure such cooperation. The only effort which has been made so far is to impose a fine on illegal waste discharge to streets, and actually this effort does not produce satisfactory results because the fine can only be imposed by a limited number of personnel of status higher than Inspector. Also it is difficult to fairly catch such illegal acts (they usually occur around midnight or dawn).

The most important problem regarding securing the cooperation of the citizens is that very few instructions have been made by cleansing sections to citizens on the manner of waste discharge.

2.2.8 Maintenance and Purchase of Vehicles

1) Maintenance work allotment

The maintenance of the vehicles is discharged by Central Workshop and six District Garages. Central Workshop is assigned the following duties.

a. overhaul and complicated repair of vehicles
b. purchase of vehicles and spare parts
c. custody of spare parts and control of their stocks
d. supply of vehicles, spare parts, fuel, lubricant and other necessities to District Garages

While District Garages are alloted the following.

a. periodical inspection and maintenance of vehicles
b. replacement of damaged or worn-out parts
c. repair of damaged parts (except complicated repair work)

The main portion of the maintenance work of waste collection vehicles is carried out by District Garages. Each District Garage is manned by a Chief Engineer and several technicians and is not under the direct control of the District's Cleansing Section. Although Central Workshop, as a supplier of vehicles, spare parts and other items to District Garages, should have close connections with District Garages, such close connections have not been established in every district, mainly because they are independent organization-wise from each other.

Since Central Workshop does not always have detailed and up-to-date information on maintenance of vehicles and on needs, consumption, and storage of spare parts at District Garages, consequently the Central Workshop's supply of vehicles and spare parts does not always meet with District Garages' actual needs.

2) Maintenance

Timely and adequate maintenance is indispensable to avoid unnecessary breakdown of vehicles, to prolong their life time and consequently to make full use of expensive vehicles.

Maintenance work should be divided into preventive maintenance, which is programmed in accordance with wear and tear of vehicles' parts and components, and daily maintenance. The work standard of preventive maintenance now effective in Alexandria only requires change of lubricant every 1,500 km run and no other work is ordered therein.

Although the preventive maintenance program shall, in general, be worked out based upon the specific driving conditions in the region, the program in Alexandria has paid no attention to the use of high-sulfur gasolene in Egypt.

Our survey reveals that the necessary periodical changes of lubricant are not always observed, that no person is appointed for periodical inspections of vehicles according to the manuals by each type of vehicles, and furthermore that no inspection program stipulates the monthly inspection items and the interval for each type of vehicles.

Replacement of parts have, therefore, been made based upon drivers' own decision from their experience. Since no decision-making process on parts replacement is established, the replacement is usually made for the repairs of damages rather than for the preventive maintenance work.

It is also evident that daily maintenance work by drivers, as one of their duties, is frequently neglected. Daily vehicle washing is neglected either.

3) Management of spare parts

In general, Egypt has to import most of the vehicles' spare parts and furthermore these imported spare parts are not always interchangeable among the various types of vehicle according to the different manufacturer. This is also true in Alexandria.

The purchasing program of the spare parts is designed by Central Workshop and usually the purchase is made once in two or three years together with vehicles as a package deal. It is obvious that the compatibility of spare parts can be maintained if vehicles are purchased from a single manufacturer. However, the actual situation is quite different and some types of vehicles occasionally suffer from a serious shortage of spare parts.

It shall be stressed that since District Garages do not estimate the number and the types of spare parts required in each year, Central Workshop does not grasp the demanded amount of spare parts for all districts.

Although spare parts should be supplied by Central Workshop as requested by respective District Garage, because of the shortage in the absolute quantity, some coordination has become inevitable among the districts. The arrangement often takes much time, and delays the delivery of spare parts to each District Garage, and consequently a large number of vehicles remain out-of-order in the garage wanting of spare parts.

4) Equipments and tools for repair

Although every District Garage has its own repair workshop, all of the workshops are very limited in space and do not have satisfactory equipments and tools. Especially, welding machines, measuring equipment, car-washing equipment and general-use tools suffer a serious shortage.

5) Purchasing and replacement of vehicles

The purchasing program of vehicles is formulated by Transportation Supervision Administration of Central Workshop. The actual numbers of vehicles purchased since 1979 are shown in Table 2-2-13, and it can be seen that approximately 35 units of vehicle on the average have been purchased every year for the period of the survey. Since the existing number of vehicles in 1984 is 188 units, the average life time of vehicles can be judged to be about 5 years.

The machinery-mounted vehicles such as Truxmor, Fiat and Leach have been purchased in block every four to five years, while dump trucks have been purchased every year.

Table 2-2-13 ACTUAL NUMBER OF VEHICLES PURCHASED

(Units)

	Truxmor	Fiat	Leach	Large Dump Truck	Small Dump Truck	Total
1979	3	-	-	-	-	3
1980	45	8	-	-	15	68
1981	-	-	-	21	9	30
1982	-	-	3	11	2	16
1983	-	-	-	24	10	34
1984	-	15	34	6	4	59
1985	35	-	-	-	-	-

The investment for cleansing servies is budgeted at 10,364,000 LE under the current 5-year plan (1983-87) and 6,231,000 LE or about 65% of the budget is allotted to the purchase of waste collection vehicles.

2.2.9 Street Sweeping Service

1) General

The street sweeping in Alexandria has a long traditio and has been carried out since the time of the British occupation and the basic manner of sweeping work still remains unchanged.

2) Streets to be swept and frequency of the services

Middle, Gomrok and West District are carrying out the sweeping service on all the streets of urban area in each district, while the percentage of streets being swept is comparatively low in East, Montazah and Ameriyah District because most of the streets therein remain unpaved. (Refer to Table 2-2-14.)

The street sweeping service is usually conducted twice a day on the main streets and once a day on other streets. Night time sweeping service is sometimes made in heavy traffic commercial area. But, due to the shortage of sweepers, once-a-day sweeping principle is not always observed on streets other than the main streets.

Table 2-2-14 PERCENTAGE OF STREETS TO BE SWEPT

District	Percentage of coverage
Montazah	30 %
East	70
Middle	99
Gomrok	95
West	100
Ameriyah	35

2.2.10 Method and Process of Street Sweeping

1) Method of street sweeping

Most of the streets are swept manually, except mechanical sweepers which were supplied under USAID in 1980 and are utilized on some of the main streets. Each sweeper is alloted his own sweeping area or streets and no team-work system is adopted. Every sweeper is given a broom and a basket and some of them are given a hand cart.

2) Process of street sweeping

Sweepers go to their Sub Cleansing Office by 6:00 in the morning. After the inspector's roll call, they head for their own sweeping area on foot. Their broom, basket and push cart are generally kept within allotted area respectively.

The manner of sweeping is different between main streets and the other streets. On main streets, sweepers sweep waste of the sidewalks and make piles at edge of the streets. Then they collect the piles and put them in the hand carts and carry the waste to each collection stations.

While, on the other streets, most of the sweepers' work force are concentrated on collecting the domestic waste discharged on the streets and carrying it to the collection station. Therefore, the street sweeping of the other streets is not performed satisfactorily.

The collected waste in hand carts and green baskets is discharged at the waste collection stations, piled up and is again collected by collection workers. This system generates a great deal of loss of labor.

The manpower misuse in this is avoided where communal waste container is installed, but sometimes wastes are not discharged into the communal containers.

The transportation of the street waste is made through the collection and haulage system and no vehicles specialized for street waste are deployed.

2.2.11 Situation of the Street Sweeping

1) Street sweeping work

Cleanliness of the main streets is usually high mainly because domestic waste and waste from commercial or business facilities are not discharged therein. Sweeping thereof is rather frequent (twice to three times a day), while the other streets are usually littered with wastes.

Especially in the low income area, the streets are heavily littered with waste because the street sweeping is not necessarily done everyday and a large quantity of waste is illegally dumped onto the streets.

2) Obstacles of street sweeping

The main streets, where pavement is in fairly good condition and parked cars are scarcely found, offer very good working conditions for street sweeping. On the other hand, since the other streets are usually filled with parked cars and have a large amount of piled sand and are poorly paved, a thorough street sweeping is almost impossible.

3) Amount of street waste to be swept

Our study reveals that the amount of street waste to be swept are 1 kg/km/d on the main streets and 2.9 kg/km/d on the other streets. The latter figure, however, may include some portion of domestic waste, and the amount of the pure street waste is difficult to be estimated.

2.2.12 Machinery and Equipments for Street Sweeping and Depots

1) Hand cart and mechanical sweeper

The hand carts used in Alexandria are of the following three types:

2-barrel hand cart: 0.11 m^3 capacity
Metal hand cart : 0.3 m^3 capacity
Wooden hand cart : 1.0 m^3 capacity

The wooden hand carts are especially applied in the market place or other area where a large amount of wastes is discharged everyday. The numbers of hand carts by type and by district are shown in Table 2-2-15 and a total of 1,010 units of hand carts are used in Alexandria at the time of this survey. Although all of the street sweepers in some districts are furnished with hand carts, the number of hand carts in Montazah, East, Middle, and West Districts are substantially smaller than the numbers of sweepers.

The 2-barrel hand cart is equipped with two barrels of respective 55-liter capacity and the collected wastes therein can be directly dumped into the waste collection vehicles by two workers, but the waste collected in the metal hand cart and wooden hand cart has to be discharged first on the ground. These two types of hand carts do not adopt ball bearing shaft system and, therefore easily breakdown and are hard to move.

Table 2-2-15 NUMBERS OF HAND CART

(units)

District	2-Barrel carts	Metal carts	Wooden carts	Total	Number of Sweeper
Montazah	40	35	0	75	130
East	100	50	20	170	436
Middle	183	25	59	267	586
Gomork	0	120	60	180	175
West	24	20	40	84	267
Ameriyah	146	25	63	234	74
Total	493	275	242	1,010	1,668

The average life time of the hand carts is generally estimated to be about three years. The 2-barrel hand carts and metal hand carts are manufactured at Central Workshop.

Four units of mechanical sweepers were first introduced in 1980. These are of vacuum type sweeper with running speed of 5 to 30 km/h and storage capacity of around 3 m^3.

The brooms for sweepers are procured in Egypt.

2) Depot

A depot is generally installed every 3 km^2 area and the average distance from the depot to the sweepers' allotted area does not exceed 1 km. A street sweeping depot is provided for each of 37 collection zones. These depots are not provided with a rest room, dressing room, shower room and other facilities for convenience, but only with an administration office for personnel management of sweepers.

3) Litter bin

Litter bins of 5-liter capacity are installed on the street lamp poles on the high traffic main streets. These litter bins were provided by a women's society as one of its volunteer activities. There remain problems about the maintenance of these litter bins due to insufficient numbers installed and difference between installing and sweeping authorities.

2.2.13 Management of Street Sweeping Service

1) Work volume and beat

The length of street to be allotted to a sweeper varies depending upon the districts and no uniform standard for such allotment has so far been established.

Our study in Middle District indicates that the total length of allotted street varies 1,000 to 1,500 m in the main streets and 600 to 800 m in the residential areas.

2) Allotment of personnel

The number of sweepers deployed varies substantially in the residential area. The high and middle income class residential areas are manned with a larger number of sweepers, while the low income residential areas and newly developed areas are not satisfactorily manned. Reshuffling of sweepers' beat has seldom been made and some of the old-timer sweepers have been stationed at the same beat for over 10 years.

3) Working time

The working time for sweepers is from 6:00 to 14:00, but the actual working time is generally 6:30 to 11:30.

The sweeper's duty is to sweep the assigned streets once or twice within the working time and no work standard stipulates the time schedule or allotment.

4) Supervision of sweeping work

Supervision of sweeping work is mainly undertaken by Work Masters. A Work Master is in charge of supervising 10 to 20 sweepers. The supervision is not always completely done, since his duty includes checking all the streets swept by his sweepers.

5) Education and training

No standards for education and training concerning sweeping work management have been given to Inspectors or Work Masters, nor any training for sweepers, which suggests the way and the location to carry the collected waste, attitude towards the citizens, etc.

6) Recruitment and wage of street sweepers

The recruitment of street sweepers is carried out by the districts respectively. The wage level of the street sweepers is generally equal to that of the 6th or 5th class and the average basic salary is approximately 50 LE/month. Recruitment is rather difficult due to the low wage level and the current number of sweepers is smaller than the number provided for under the budget. As shown in Table 2-2-16, the percentage of workers leaving the job is very high. The street sweepers have rarely been promoted to the upper positions.

Table 2-2-16 LEAVING RATE OF SWEEPER

Montazah	50 %
East	7
Middle	30
Gomrok	23-28
West	30
Ameriyah	16

7) Public education and fine

Although publicity cars are announcing the authority's request not to litter waste on the streets in all the districts satisfactory result has not occurred so far because the announcement is usually made in the morning and its frequency is rather low. No specific instructions to primary school pupils or information to citizens on keeping cleanness of streets are made.

District's Supervisors and Inspectors are authorized to fine citizens 10 LE for illegal discharge of waste but it is considerably difficult for the limited number of Supervisors and Inspectors to discover all violations, and most of the discovered cases have been for shops.

2.2.14 Organization and Personnel

1) Organization

The organization for street sweeping and collection of wastes on the streets is diagrammed in Fig. 2-2-4. Various functions of cleansing service are separately and independently controlled by each department of each district; daily operation of work to be administered by Cleansing Section, recruitment of sweepers and assistant workers by Administrative Dept., procurement of equipment and the parts by Financial Supervisor, and personnel administration of managerial staff of the district by Governorate.

Therefore, the cleansing service is performed out as a whole system. In addition, although Cleansing Section has and controls a great number of staff and workers, Supervisor of the department is not highly positioned in the district's organization.

The operational control of waste collection and street sweeping is performed by the vertical line of General Supervisor - Assistant Supervisor - Inspector (at Sub-Cleansing Office) - Work Master.

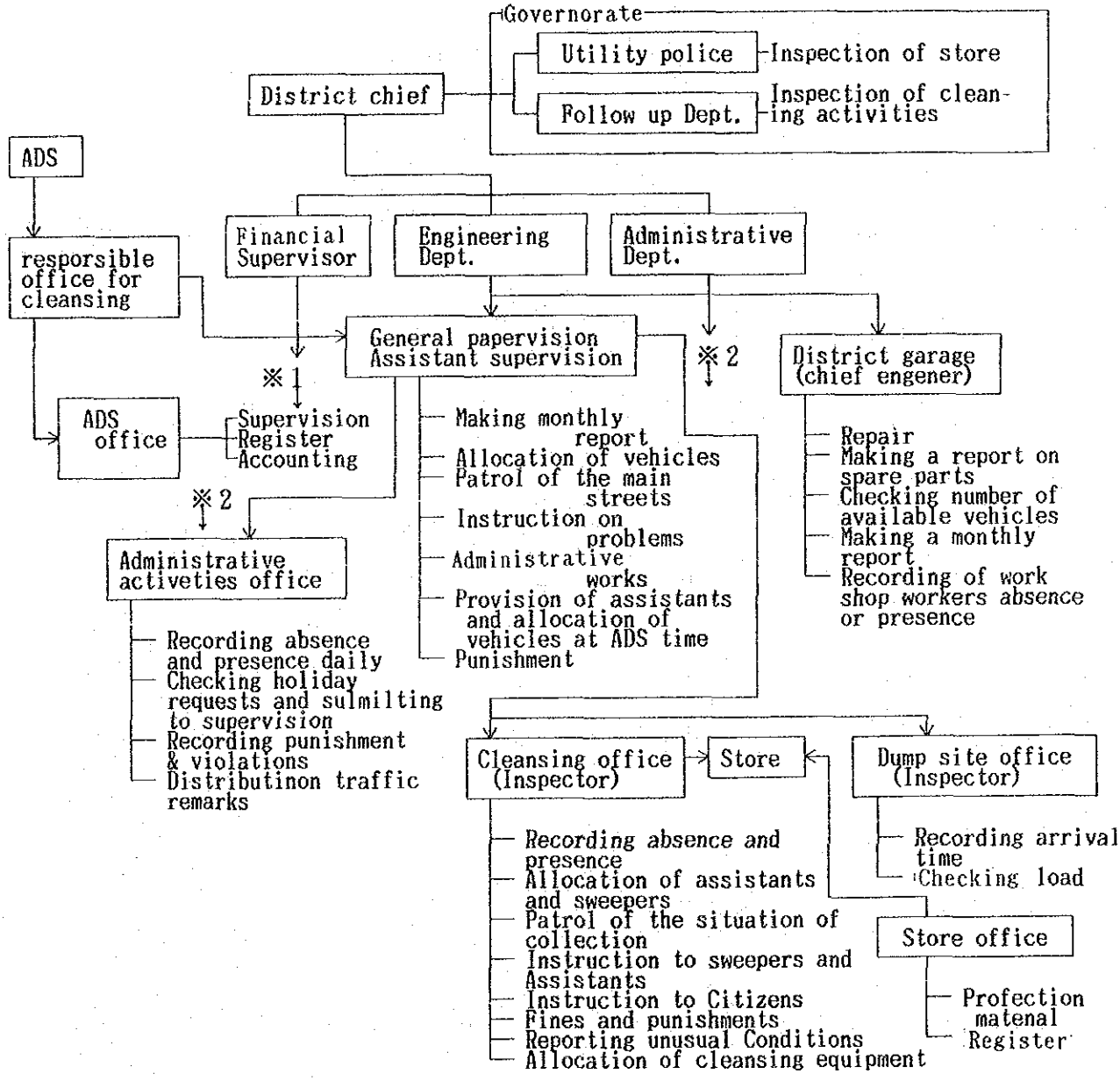

Fig. 2-2-4 STRUCTURE CONCERNING CLEANSING MANAGEMENT

The organization of the Central Workshop consists of many branches as shown in Table 2-2-17, and as a typical case of District Garages, the organization of Middle District Garage is shown in Fig. 2-2-5.

Table 2-2-17 ORGANIZATION OF CENTRAL WORKSHOP

(persons)

1.	Engineers. (EA)	8
2.	Employees affairs. (AA)	19
3.	Administrative affairs. (AA)	14
4.	Investigation administration.	8
5.	Final administration.	9
6.	Gate-signals.	7
7.	Stores.	17
8.	Security office. (SO)	15
9.	Follow-up Dept.	8
10.	Ironbar men.	7
11.	Workshop of repairing petrol engines.	15
12.	Painting section.	15
13.	Office of the mechanical specifications.	5
14.	Office of civil specifications.	8
15.	Electricity workshop.	14
16.	Battery workshop.	4
17.	Welding workshop.	16
18.	Balcksmith workshop.	22
19.	Cars' plubery workshop.	10
20.	Motorcycles' workshop.	14
21.	Bicycles' workshop.	6
22.	Mechanics' workshop. (Petrol section)	5
23.	Riddion workshop. (Petrol)	12
24.	Workshop of overhauling. (Diesel)	14
25.	Workshop of loader & cranes. (Equipment diesel)	6
26.	The mechanics' workshop. (Reparations out of the workshop)	10
27.	Crushing mechanics. (Workshop)	6
28.	Bulldozers.	9
29.	Turnery workshop.	12
30.	Metals' Plumbery workshop.	18
31.	Filing workshop.	17
32.	Seat-covering workshop.	11
33.	Tires workshop.	8
34.	Greasing working.	4
35.	Benzine pump in El Hadara.	9
36.	Carpentry workshop.	46
37.	Metals' plumbery (Casting) section.	4
38.	Cars' drivers in El Hadara garage.	99
39.	Motorcycles' drivers in El Hadara garage.	20
	TOTAL	551

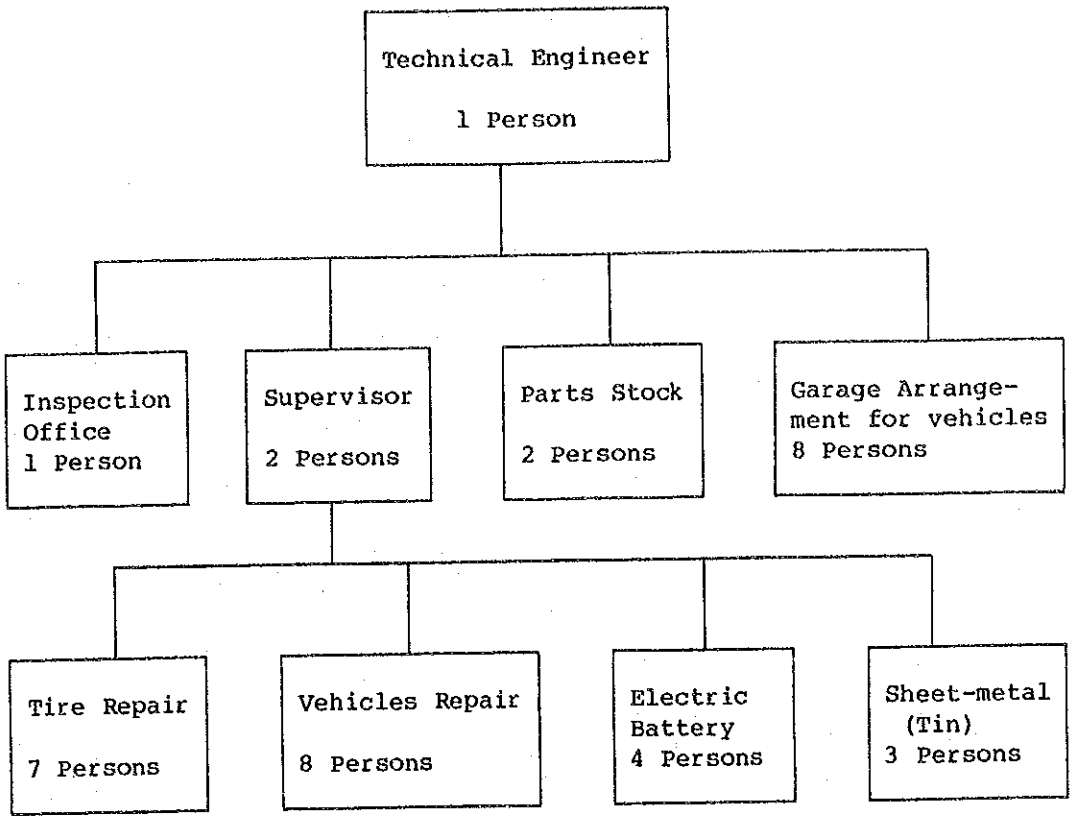

Fig. 2-2-5 ORGANIZATION OF MIDDLE DISTRICT GARAGE

2) Personnel

The numbers of staff and workers in District Cleansing Section are summed up in Table 2-2-18 by job category. Actual operations of street sweeping and waste collection are conducted by these people.

Table 2-2-18 NUMBER OF PERSONNEL IN DISTRICT CLEANSING SECTION

(persons)

District	Budget in the Governorate	General Supervision	Inspector	Work master	Second work master	Sweeper	Assistant	Other	Total
Montazah		1	6	17	17	144	39	14	238
East		1	9	27	20	351	83	14	505
Middle		1	8	33	20	560	117	45	784
Gomrok		1	3	18	15	251	76	23	387
West		1	10	22	20	248	60	25	386
Ameriyah		1	9	10	16	74	25	15	150
Total	7,170	6	45	127	108	1,678	400	136	2,450

District	Driver (persons)	Vehicle (unit)	Assistant/ vehicle	Assistant/ 1,000 citizens	Waste amount/ Assistant	Assistant/ 1,000 citizens
Montazah	11	9.4	4.1	0.110	1.9	2.74
East	23	20.0	4.2	0.125	1.38	1.53
Middle	33	23.6	5.0	0.163	2.31	1.23
Gomrok	24	12.2	6.2	0.248	1.99	1.75
West	21	9.2	6.5	0.119	2.09	1.90
Ameriyah	10	5.0	5.0	0.233	1.56	1.45
Total	122	79.4	3.2	0.152	1.95	1.59

Note: Collected by District Cleansing Section in September 1984.

A total of 400 assistants and 1,678 sweepers are employed. For total population of the city, they amount 0.152 person per 1,000 citizens and 1.59 person per 1,000 citizens, respectively. The amount of waste collected per assistant as district work is 1.95 tons per head. The number of assistants and sweepers substantially varies depending on the district. There are more drivers than vehicles in daily operation, and the ratio of number of drivers to the vehicles in operation ranges from 1.15 to 1.50. The personnel working at District Garages are estimated at about 120 persons.

2.2.15 Labor Conditions

Collection assistants and street sweepers are not supplied with uniforms, shoes, gloves, etc. They collect wastes with bare hands and are often exposed to virus and dangerous objects such as broken glass. Thus, there has been no sufficient consideration to sanitary requirements for workers.

Particularly, in case of collection of waste with dump trucks, the collector will be covered all over the body with dust and will breath in the dust when loading wastes onto trucks. Loading work is a very hard work and the personnel are placed in an extremely unhealthy working condition.

Meanwhile, low wage forces them to work for ADS in addition to the district or to work elsewhere in order to attain a satisfactory income level. Their status is at least guaranteed as Governorate's employee and they enjoy better conditions than workers in private sector in terms of social security.

2.2.16 Planning, Management and Supervisory Systems

1) Planning

Although no long-range plans on collection or street sweeping exist, there is an improvement plan formulated by the General Office of the Governorate. No particular improvement plans have yet been drawn up onto an operational level. Nor are there any specific implementation plan, organizational plan or financial plan of any sort. However, similar functions to these planning are executed by Secretary General's Office. Phased implementation plans and data collecting system plans are still the subjects for the future study. Planning at the district level where responsibility for collection, street sweeping and maintenance lies is still limited to allocation of vehicles and allotment of manpower. For the other areas, the Governorate makes plans and decision.

2) Management and supervision

The Follow-up Dept. of the Governorate supervises collection and street sweeping for the whole of Alexandria, and daily activities of collection personnel and vehicles. A monthly report on results of supervision and control is submitted to District Chief and General Secretary. This report shows the number of vehicles owned, the number of vehicles in operation, the total number of trips, the collected amount, the number of collectors and sweepers, the number of absentees of them, emergency deployment of vehicles and the assigned personnel street sweeping situation in each district, and the recommendation.

The rules and the regulations on collection are formulated by the Governorate while assignment for personnel is controlled by its Social Affairs Dept. and the various costs and the expenses for collection, by its Financial Dept. No particular efforts have been made toward the education of public on collection.

At district level, the supervisiion of the workers' behavior is the major subject, and their performance in the allotted area assessed by each Inspector is daily reported to General Supervisor. In some districts, Cleaning Section issues a weekly or monthly report. However, this practice is not generally followed.

General Supervisor cannot exercise control over District Garage. Furthermore, General Supervisor has no authority over parts control, procurement, or securing of vehicles and personnel. Permission on leaves of absence, etc. of personnel is the responsibility of Administrative Section.

2.2.17 Public Consciousness

The most important fact found as a result of interviews with residents was that ordinary citizens have little knowledge of difficulty with which the cleansing service personnel in Alexandria are performing collection and street sweeping work. They are hardly or not at all conscious of the responsibility because provisions on their obligations to cooperate with waste collection or other cleansing service have not clearly been defined.

Of the households interviewed, 67% were not satisfied with waste collection. Those dissatisfied with the environmental condition of their neighborhood streets and waste stations along streets reached to 79% and 73%, respectively. About 80% answered that there are problems in communal containers.

Meanwhile, up to 97% of the intervieweees believe citizens' participation in improvement of street beautification is necessary, and are willing to cooperate in this regard through payment of special fees or efforts for not throwing away wastes on streets.

Those respondents who said they are paying fees for their waste discharge to ADS, Zabbaleen, servant account for 71%. Particularly, those who are making payment to ADS and Zabbaleen reach to a considerable number. Households which pay 0.25 to 0.5 LE/month amount to 41%, and those with 0.5 to 1.0 LE/month, 31%. In answer to the question how much they are willing to pay, 35% of the respondents gave 0.5 to 1.0 LE/month, 42%, 1.0 to 2.0 LE/month, and 10%, 2.0 to 3.0 LE/month. However, in the low income area, 68% of the respondents gave less than 1.0 LE/month.

2.2.18 Present Problems

1) General problems

The following can be listed as general problems related to waste collection:

a. In some place, no collection service is available so that waste is disposed of within residential area or its vicinities.

b. Waste stations are open so that waste is scattered by wind. This is not desirable for the appearance and sanitation.

c. Waste is always left spilt over from communal containers, presenting unsightly views and sanitation problems.

d. Unsightly views caused by wastes scattered on the streets of residential areas.

2) Problems on the management of collection service

Problems on the management of waste collection service that require improvements can be cited as follows:

a. Rendering of the service and expansion of the area covered
some of newly developed urban areas and suburban areas are not fully served although it is necessary for adequate collection services to reach these areas.

b. Improvement in the collection efficiency
The amount of collected waste per vehicle is large but the amount of collected waste by collection personnel per working hour is not so large. In other words, the collection efficiency is low.

c. Improvement in the level of cooperation by residents and commercial establishments
The improved manner of discharge of waste is much to be desired. This is because there are no regulations on the method for discharge of waste and because the collection service is not reliable or stable.

d. Improvement in the efficiency of vehicle operation
The opereating efficiency of the vehicles is very low, being less than 50%.

e. Standardization of the collection vehicles
Because a great variety of vehicle types are used, problems occur in the operation, maintenance, purchase of spare parts, the standard level of workload, and the allocation of vehicles.

f. Upgrading of the maintenance system
No maintenance systems have been established based on maintenance standards, including daily maintenance and periodical preventive maintenance.

g. Control of spare parts

The systems for spare parts purchase and storage control have not been structured.

h. Protection of workers' health

Collection assistants are working under unhealthy conditions. They handle waste with bare hands and breathe in dust.

i. Establishment of work standards for collection

Standards for collection work have not clearly been established. It is necessary to decide a fair number of trips based on work hours, collection amount and relative difficulty of work. It is also essential to make a rational allotment of collection areas so that waste can be thoroughly collected under the trip system.

j. Full-time and part-time system

At present many workers for waste collection are forced to hold two jobs; as full-time jobs for the district in the morning and as part-time jobs for ADS in the afternoon. A system should be established for the works to finish collection works by noon, because ADS work is considerably hard as an overtime job, and because in the present system the life times of the vehicles are shortened.

k. Improvement in the wages

Very low levels of the wages for collection assistants depress their will to work.

l. More rigid control of waste from hospitals

m. Improvement of the equipments in District Garage

Measuring instruments for maintenance, equipment for washing vehicles, etc. are inadequate.

n. Introduction of definite regulations on the method for leaving waste at the collection points

o. Prohibition of open stations

p. Allotment of personnel and allocation of vehicles

There are substantial variations depending on districts in the number of personnel assigned and the number of vehicles allocated. It is recommended that personnel and vehicles be evenly distributed as much as practicable.

q. Work control by weighing amount of waste with a truck scale

It is necessary to control work volume by measuring the actual amount waste collected rather than only by the trip count.

r. Watch over scavengers

Scavengers are seen scattering rubbish at waste stations early in the morning. Such behavior should be strictly regulated.

s. Introduction of a fair charge for collection service

Unfairness concerning the charge for collection service should be corrected.

t. Application of special fees to establishments which discharge large amount of waste

It is necessary to introduce a special fee collection system, different from the collection of charges for ordinary houseolds, for those establishments which discharge a large amount of waste (markets, railway stations, hospitals, hotels, and other commercial establishments that discharge more than a certain level of the amount, for example, shops, sugar cane juice stands).

u. Optimum location of collection points

Collection points are not located in the points that will facilitate the cooperation of residents in discharge of waste.

v. Establishment of rational collection routes

It is necessary to establish rational collection routes which will result in the shortest mileage for collection, and to produce a map showing these routes.

w. Increase in supply of baskets

Because baskets are apt to break in winter, it is necessary to provide an adequate supply of baskets.

3) Problems on the management of street sweeping service

Problems on the management of street sweeping service that will require improvements are as follows:

a. Expansion of street sweeping areas
Street sweeping service is generally not sufficient in newly developed urban areas and low income residential areas. It is desirable that the service should be extended to these areas as well, considering the pavement condition of streets.

b. A system for complete separation of collection service from street sweeping
It is necessary to cearly establish the allotment for collection service and street sweeping and recover the original functions of street sweeping.

c. Establishment of rational sweeping frequency
Rational sweeping frequency should be established for full coverage of sweeping with the limited number of sweepers. At present, residential areas are swept every day but the frequency is considered excessive for these areas. It is necessary to decide on the sweeping frequency depending on its local condition.

d. Securing of cooperations of citizens
Citizens' cooperations are indispensable to maintaining the cleanliness of streets. Needs for their cooperation should be stressed more than ever.

e. Revision of the work standards for sweepers
It is necessary to allot responsible work areas to each sweeper by clearly defining standards for the extension of the street to be swept, taking into consideration of each street condition (such as sidewalk and pavement condition).

f. Request to the Road Section for removal of sand on streets

It is desirable that a request should be made to the Road Section to remove sand piles on streets which prevent complete street sweeping.

g. Introduction of no-parking days

Parking on streets is a major cause of incomplete sweeping. It is recommended that a few no-parking days a month should be set by designating areas for such ristriction, in cooperation with the Traffic Police.

h. Review of the waste transshipment system

At present, the waste collected by street sweepers is unloaded at the waste station for transshipment. It is desirable that this transshipment system be abolished and that a system for directly loading the collected waste onto the vehicles should be introduced instead.

i. Increase in supply of hand carts

The number of hand carts supplied to sweepers is insufficient. It is necessary either to supply one push cart to each sweeper as possible or to form a two-men crew system sharing one cart.

j. Standardization of hand carts

It is recommended that hand carts should be standardized into the two-barrel type for easy loading and unloading. (No domestic waste will be collected as a rule in street sweeping.)

k. Use of ball bearing for the shafts of hand carts

Most troubles in hand carts occur on the shafts which do not have ball bearing.

l. Standardization of the sweeping method

It is necessary to improve work efficiency by standardizing the sweeping method.

m. Establishment of sweeping routes

It is necessary to establish predetermined rational sweeping routes.

n. Preparation of time schedules

It is necessary to prepare a time schedule for each sweeper that will show when and where each sweeper should work.

o. Increased distribution of litter bins

It is desirable to increase the number and the distribution of litter bins in central areas.

4) Problems on organization and management

Following problems can be raised as those relating to the organization system and others managerial matters on the collection and street sweeping:

a. Reorganization on the collection and street sweeping service

To perform the collection and the street sweeping under an unitary management, it is desirable to strengthen the office for cleansing service district level and to increase functions of the branch sections.

b. Preparation of reports on the operational affairs

It is desirable that weekly, monthly and annual reports should be prepared at a district level on the operational affairs conserning to equipment, troubles, parts replacement, parts supply and storage, amount of collected waste, attendance of workers, complaints of citizens and settlements of grievances, etc.

c. Increased staff trainings

It is necessary to increase staff trainings for each of top, middle and low level managers, as well as trainings of engineers and technicians responsible for the maintenance. It is also required to give trainings to collection personnel on their attitude toward residents and prevention of labor accidents.

d. Rigid enforcement of a system for collection of fines
To reduce illegal discharge of waste on streets, it is important to raise fines and collect fines for illegal actions without fail.

e. Establishment of regulation and their notification to citizens
It is necessary to establish provisions clearly defining the role of each administrative authority responsible for cleansing service, the method for discharge of waste, prohibited actions, etc., and to inform residents that the cleeansing service is being performed in accordance with these provisions. It is also required to have residents fully understand the regulations that they should observe themselves.

f. Increased public relations activities and public education
Most citizens have little or no knowledge about how the cleansing service is being performed. Their knowledge of waste is extremely limited. To obtain their cooperation, it is desirable to have them fully understand the importance of cleansing and also to step up the education particularly to primary school pupils.

g. Improvement in the labor conditions
It is desirable to supply uniforms, shoes, etc., to collectors and provide shower facilities at sub-cleansing offices.

2.3 Intermediate Treatment Facilities

2.3.1 General

Of the solid waste generated in Alexandria, most of the waste collected by the District and ADS is hauled to disposal sites where it is dumped as landfill, while a part of collected waste is hauled to Existing Abis Compost Plant. The solid waste collected by Zabbaleen is mostly hauled to Zabbaleen waste stations where reusable materials are sorted out for selling.

The processing facilities are, therefore, the Existing Abis Compost Plant and the Zabbaleen waste stations where manual sorting is carried out.

2.3.2 Abis Compost Plant

1) Outline of the Abis Compost Plant

a. Name : Abis Compost Plant
b. Plant capacity : 10 t/hr
c. Process flow : Windrow type
d. Planned operation hour : 16 hr/d
   Work time 1st shift 7:30 - 9:30
   2nd shift 14:30 - 22:30
e. Personnel and organization:
   Number of personnel 74 persons
f. Budget
   It has the deficit of 200,000 LE in 1985.

2) Present Situation of the Plant Operation

(1) Operation time in days and hours

During January to June 1985, the total operation days were 91 days showing 50% of the total days of the same period. Also the total operation hours were 612.9 hours showing only 21.2% of the planned operation hours (2,869 hours).

3) Sales of Compost

Six customers among 22 customers has contracted to buy compost more than 200 t/year, and the amounts are contracted to be sold 4,200 t/year of coarse compost and 1,400 t/year of fine compost in all. This amount can be equivalent to fine compost of 4,130 t/year. This amount is 2.7 times the total production of this plant during January to June and equals to 3.5 months of the planned production amount. At present, the contracted amount of compost sale exceeds the produced amount taking into account other small amount customers and the fact that the plant is not operating as scheduled.

Price of the compost differs according to the kind and contract amount. As of 27th of July 1985, coarse compost contracted for more than 1,000 t/year is 5.5 LE/t and 7.25 LE/t for fine compost.

These prices were decided at a meeting held between the Compost Plant and the Ministry of Agriculture. Sale of compost produced in this plant shows activity, and is delivered in bulk at the plant. Sales revenue of compost is estimated at about 10,000 LE by June.

Regarding sale of reusable materials, the Plant has contracted with some dealers. Sales revenue is estimated at about 4,800 LE during this period.

4) Operation and Maintenance Cost

The operation and maintenance cost of this plant during this period is approximately 53,000 LE. Some 80% is for personnel expenses. Although this plant did not operate continuously, the treatment cost per one ton of waste is estimated to be about 6.0 LE as based upon the following calculation.

$$\frac{\text{Cost - Sales revenue}}{\text{Treated amount of waste}} = \frac{53{,}000\ \text{LE} - (10{,}000\ \text{LE} + 4{,}800\ \text{LE})}{6{,}360\ \text{t}}$$

$$= 6.0\ \text{LE/t}$$

The production cost of the fine compost is about 31 LE/t as can be seen from the following calculation.

$$\frac{\text{Cost - Sales revenue of reusable material}}{\text{Produced amount of fine compost}}$$

$$= \frac{53{,}000 \text{ LE} - 4{,}800 \text{ LE}}{1{,}538 \text{ t}} = 31 \text{ LE/t}$$

5) Quality of Compost

According to the analysis result of compost, quality of compost produced in this plant satisfied the specifications stipulated by the law No. 100/1967.

2.3.3 Recycling Flow

Fig. 2-3-1 shows the flow of recycling. Glass bottles, newspapers, books, clothes and plastic bins, etc. are recovered at households as valuable items.

Sorting and recovery from solid waste are carried out at Abis Compost Plant at, the waste stations by Zabbaleen and at dump sites by scavengers. Metals, paper, plastic, glass, bone, textiles and vegetables are recovered.

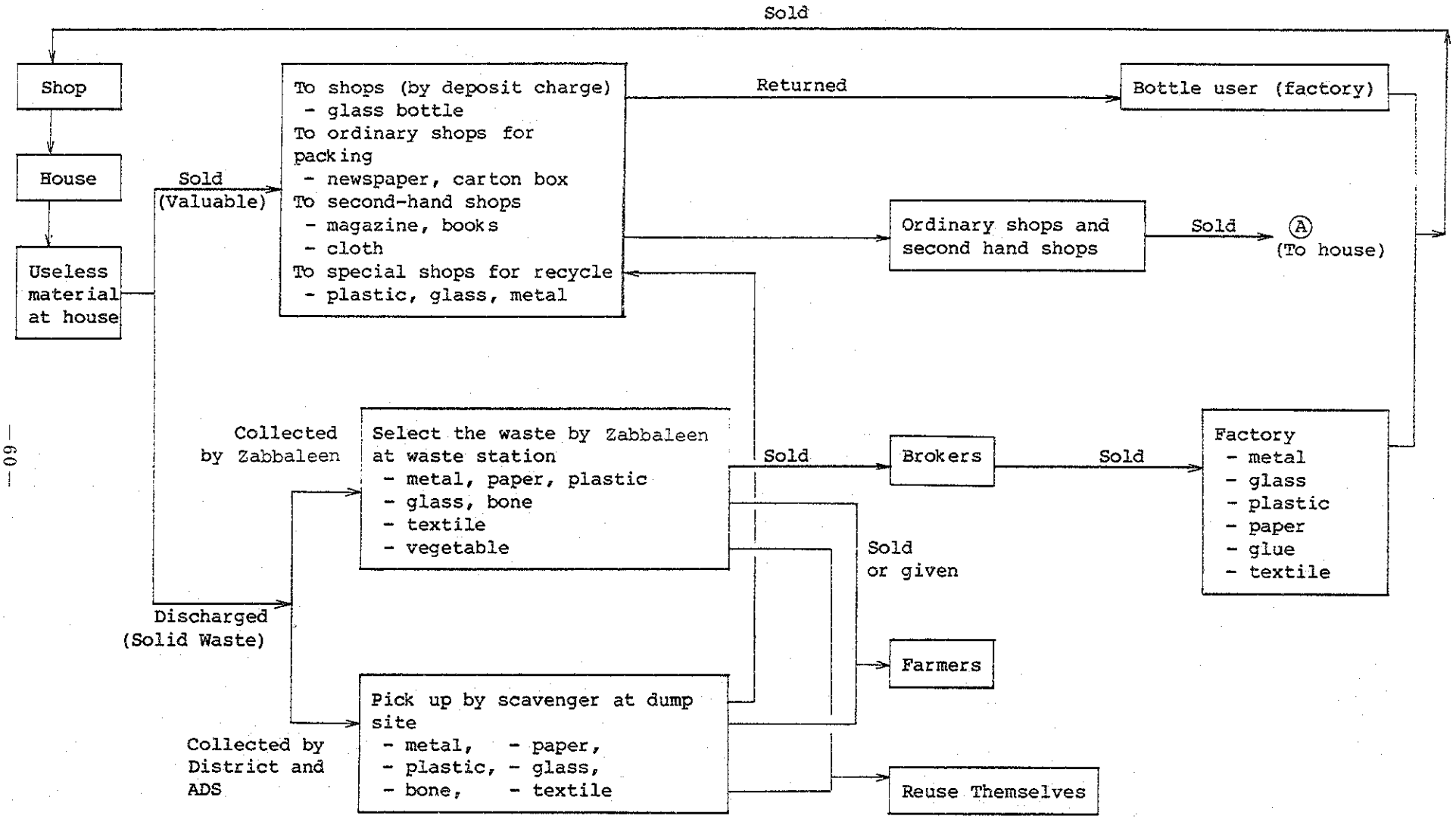

Fig. 2-3-1 RECYCLING FLOW

2.4 Final Disposal

2.4.1 General

Three dump sites, Awayed, Moharam Bey Square and Gate No. 8, are being used in Alexandria as of September 1985.
Open dumping is being carried out in the above dump sites, and environmental pollution such as fire caused by spontaneous combustion, scattering of wastes, diffusion of offensive odor, etc., are outbreaking as a result.
Approximately 1,000 ton of solid wastes, which accounts for the most of the 1,200 t/d generated in Alexandria, are collected by the districts and ADS and are disposed of at the dump sites.
It is observed that the solid wastes hauled into the dump sites consist of sewage sludge, construction and demolition wastes and other industrial wastes, in addition to the municipal solid wastes.

2.4.2 Dump Site Inventory

The present and past dump site inventory survey in whole Alexandria was carried out in November 1984 and September 1985. The outline of the results is mentioned as below and the location of each site is shown in Fig. 2-4-1.

1) Present dump site

The undermentioned dump sites are being used in Alexandria at the present time.

a. Awayed
This site is being used since July 1985, by East and Montazah Districts.

b. Moharam Bey Square Dump Site (hereinafter referred to as MBSDS)
Being used since November 1984, by Middle, Gomrok and part of the West Districts.

c. Gate No. 8

Being used since 1982, by Ameriyah and part of the West District.

Furthermore, the undermentioned sites are being used in emergency cases, and their use has been suspended for the time being.

a. El Mahraqah

This site is used exclusively by the Montazah District, but in reality its use has been suspended for the time being due to the opposition of neighboring farmers.

b. Islah

This is another site used exclusively by the Montazah District, but it is used only in case of emergency.

c. Abis

This site is located in the Middle District, and it is used by all districts in case of emergency.

2) Previous land use of the landfill sites

Imformation regarding previous land use of the sites for landfilling are summarized in the followings.

a. Montazah and East District

Mainly depressions located along canals and unreclaimed agricultural land have been used as dump sites.

b. Gomrok, Middle and West Districts

The dump sites of these districts has been provided mainly by the reclamation of the Lake Maryut.

c. Ameriyah District

Quarry sites have been used as dump sites.

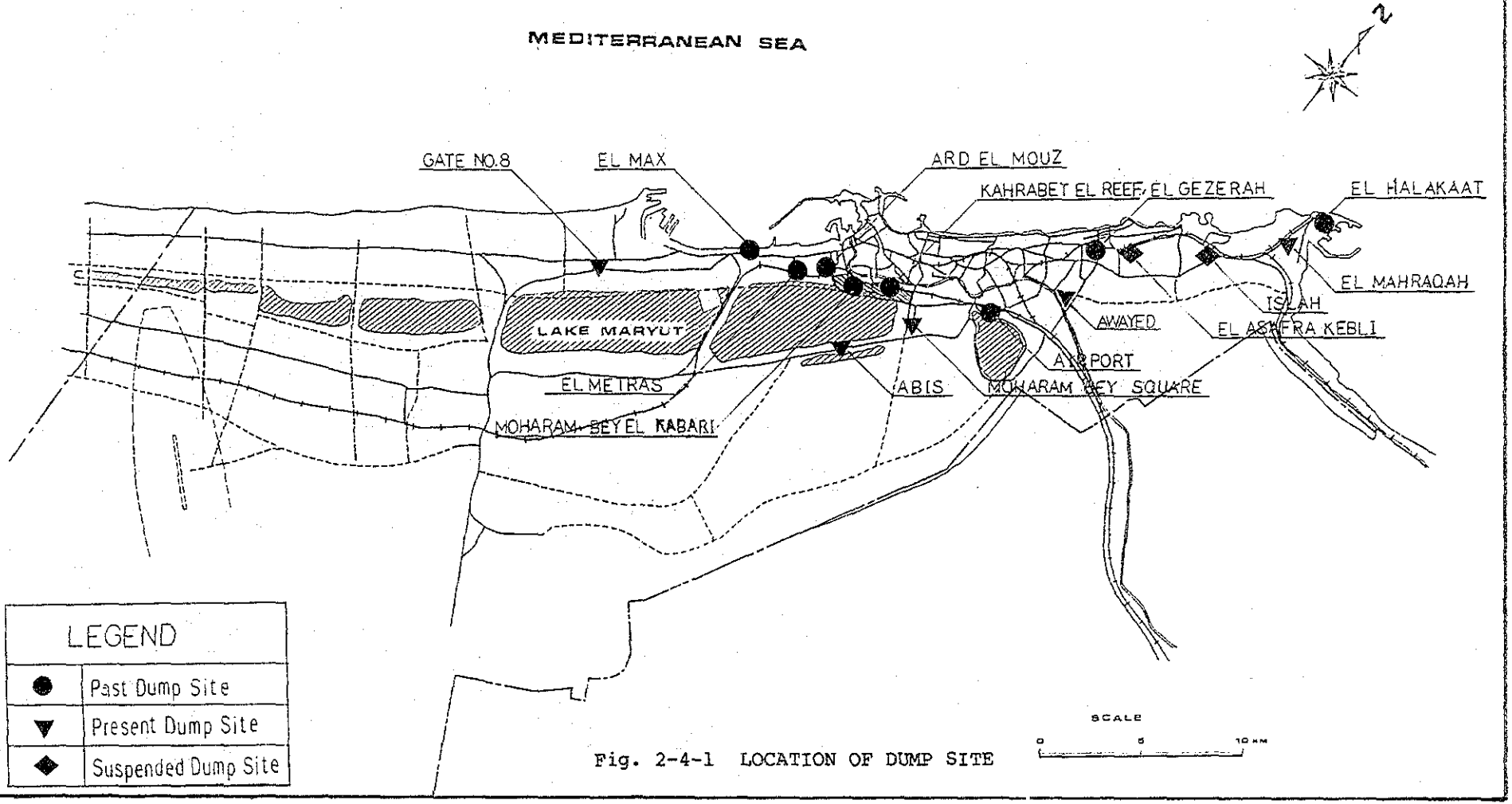

Fig. 2-4-1 LOCATION OF DUMP SITE

3) Landfill capacity and life expectancy of the present sites

The landfill capacity of the sites presently in use, including sites whose use is suspended, amounts to approximately 2,000,000 m^3 as of 1985.

The results of calculation of the life expectancy of these dump sites are as following:

a. Life expectancy excluding the sites that have been suspended:
2.03 years

b. Life expectancy including the sites that have been suspended:
2.92 years

These life expectancies are calculated on the premise of the sanitary landfilling with the waste generation rate of 1,200 t/d as of 1985.

2.4.3 Selection and Acquisition of Landfill Sites

Selection of appropriate sites is one of the most important factors for securing a stable solid waste disposal system. As things now stand, the executive agency of s.w.m. in Alexandria does not have an organization responsible for selecting and acquiring the necessary landfill sites and the selection and the acquisition work commences only when the dump site in use is running out of its capacity.

In this case the authorities in charge of the matter of the districts concerned and the Follow-up Dept. select a site regarded as appropriate for the use, and put forward the relevant application to the Secretary General.

The Secretary General examines the said application, and presents the application for the use to the landowner or to the holder of the right of use of the land. These procedures, however, take distinct periods of time

depending on the site to be secured, and in many cases it is not finished until the desired deadline, and in the worst case it is unavoidable to abandon the use of the site in question.

No cost is required for acquiring the dump site as long as it is possessed by the Central Government or by the Governorate.

2.4.4 Operation of the Dump Site

1) Disposal amount of wastes

The total amount of wastes disposed of at the dump sites in the whole city of Alexandria amounts to 967 t/d as of September 1984.
According to the trip records of collection vehicles, waste amount disposed of at MBSDS from December 1984 to August 1985 is estimated as 665 t/d. This amount can be regarded as approximately equal to the amount of wastes generated in the Middle, Gomrok and part of the West District (696 t/d), calculated in section 2.1 aforementioned, by taking into consideration the amount of wastes treated at the Abis Compost Plant.

2) Landfilling operation

The landfilling operation in the three dump sites is the so-called open dumping by merely throwing away and levelling the wastes by bulldozers. Under the circumstances, the current landfilling operation is causing a conspicuous damage in the surrounding environmental conditions, due to fire caused by spontaneous combustion and other harmful occurrence like the massive generation of rodents, insects and dispersion of offensive odor.
In particular, the MBSDS requires urgent environmental conservation measures, because it is adjacent to the drinking water canal, which accounts for supplying of 2/3rds of the city water as a whole, and furthermore it is located in the runway approach zone of the El Nozha Airport.

This dump site is furnished with the following equipment and facilities.

- Bulldozers 6 units (including 3 units out of order)
- Fire-fighting pump 1 unit
- Site offices 3 offices

Each office is sized 2.5m X 2.0m = 5.0 m^2, without shower and other sanitary facilities.

Awayed and Gate No.8 dump site are equipped only with bulldozers, and the inspection of the wastes hauled into the dump site is carried out outdoors. No fire-fighting work is carried out in these dump sites, and as a matter of fact, there was spontaneous combustion of wastes at Gate No. 8.

3) Managament

The MBSDS is operated by personnel belonging to 8 different organizations mentioned below. The implementation of unified regulations and management is difficult because these organizations have distinct administrations regarding the matter. Therefore, the operation is not satisfactory in spite of the relatively large number of personnel involved in it. Furthermore, the job-quitting rate of the workers is high because of poor working conditions.

-	General Follow-up Dept.	3 (persons)
-	Middle District	15
-	Gomrok District	3
-	West District	1
-	Central Workshop	11
-	Utility Police	4
-	Fire Police	6
-	Health Dept.	1
	TOTAL	44

4) Fund

There is no independent funds for the landfilling operation. The wages of the workers and the incentives are covered by the Governorate budget and by the Cleansing Fund, respectively. The investment cost for facility construction, equipment purchase and operation/maintenance are covered by the budgets of the organizations in charge of each item concerned. Furthermore, no fund has been appropriated so far for the sake of acquisition of disposal sites.

2.4.5 Present Problems and Subjects to be Improved

1) Present problems

The problems related to the final disposal system in the s.w.m. of Alexandria are summarized in the followings.

a. Environmental pollution

Open dumping landfill without cover material is bringing about serious environmental pollution at the vicinity of the present dump sites.

b. Difficulties for securing disposal sites

The population growth in the Governorate of Alexandria has been accelerated in the recent years, and the urbanization is proceeding rapidly as a consequence. That being so, it is becoming increasingly difficult to secure appropriate disposal sites at the outskirts and environs of the city. Furthermore, the conversion of farmland into other purposes is becoming difficult, in view of agricultural development being implemented by Egyptian Government as a national policy.

c. Lack of middle- and long-term plans for securing disposal sites

In the past the amount of wastes to be disposed of was small, and it was relatively easy to secure the dump sites.

Hereafter however, the definite plan based on middle- and long-term visions will be indispensable for securing final disposal sites in a systematic way so as to cope with the increasing generation of the wastes accompanying urban activities.

d. Proximity of the dump sites to residential areas

Most of the dump sites in Alexandria are located at the vicinity of residential areas. That being so, they bring about noxious influences on the living environment of the nearby residents, and furthermore they are not desirable from the standpoint of impairment of the urban view.

2) Subjects to be improved

Improvement for coping with the aforementioned problems is described in the followings.

a. Switching to the sanitary landfill system

It is necessary to switch from the present open dumping to the sanitary landfilling. In this connection it is indispensable to secure financial background for coping with the increasing cost, and take steps for securing new disposal sites.

b. Measures for securing disposal sites in a systematic way.

- A long-range plan should be drawn up for securing landfill appropriate site investigating vacant lands through Alexandria.
- Examination of the possibility of using idle farmlands as temporary landfill sites.
- Reduction of the waste amount through the cooperation of the citizenry and salvage of reusable materials.

c. Strengthening of the planning section regarding sanitary landfilling.

A section in charge of planning should be established within the cleansing organization, so as to deal with the following matters:

- Planning of securing disposal sites
- Planning of the facilities of disposal site
- Planning of landfilling operation
- Planning of the ultimate use of the completed site

d. Separation of disposal sites from residential areas

The disposal site should be secured as far as possible from residential areas, and measures should be considered, so as to prevent the intrusion of squatterers in the disposal sites or its environs. Furthermore, the disposal sites should be surrounded with fences, so as to shut off access of scavengers and animals.