THE REPUBLIC OF KOREA

MASTER PLAN AND FEASIBILITY STUDY ON SEOUL MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM IN THE REPUBLIC OF KOREA

FINAL REPORT

OCT. 1985

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JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

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PREFACE

In response to the request of the Government of the Republic of Korea, the Government of Japan decided to conduct a Master Plan and Feasibility Study on Seoul Municipal Solid Waste Management System Project and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA sent to Korea a preliminary survey team headed by Dr. Masao SAGO, Professor of Science University of Tokyo, from October to November, 1983.

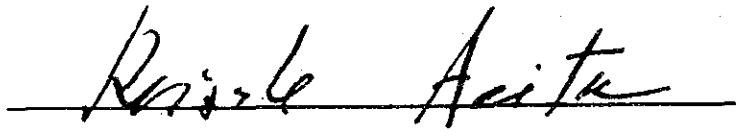
The team had a series of discussions on the Project with the officials concerned of the Government of Korea, in particular with those of the Ministry of Science and Technology (MOST), and the Korea Advanced Institute of Science and Technology (KAIST), and has agreed on the Scope of Work for the Study.

After a preliminary survey was conducted, JICA dispatched to Korea a Study team led by Mr. Fusao NODE, Nippon Jogesuido Sekkei Co., Ltd., and made full-scaled survey based upon the Scope of Work, from June 1984 to October 1985, and the present report has been prepared.

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.

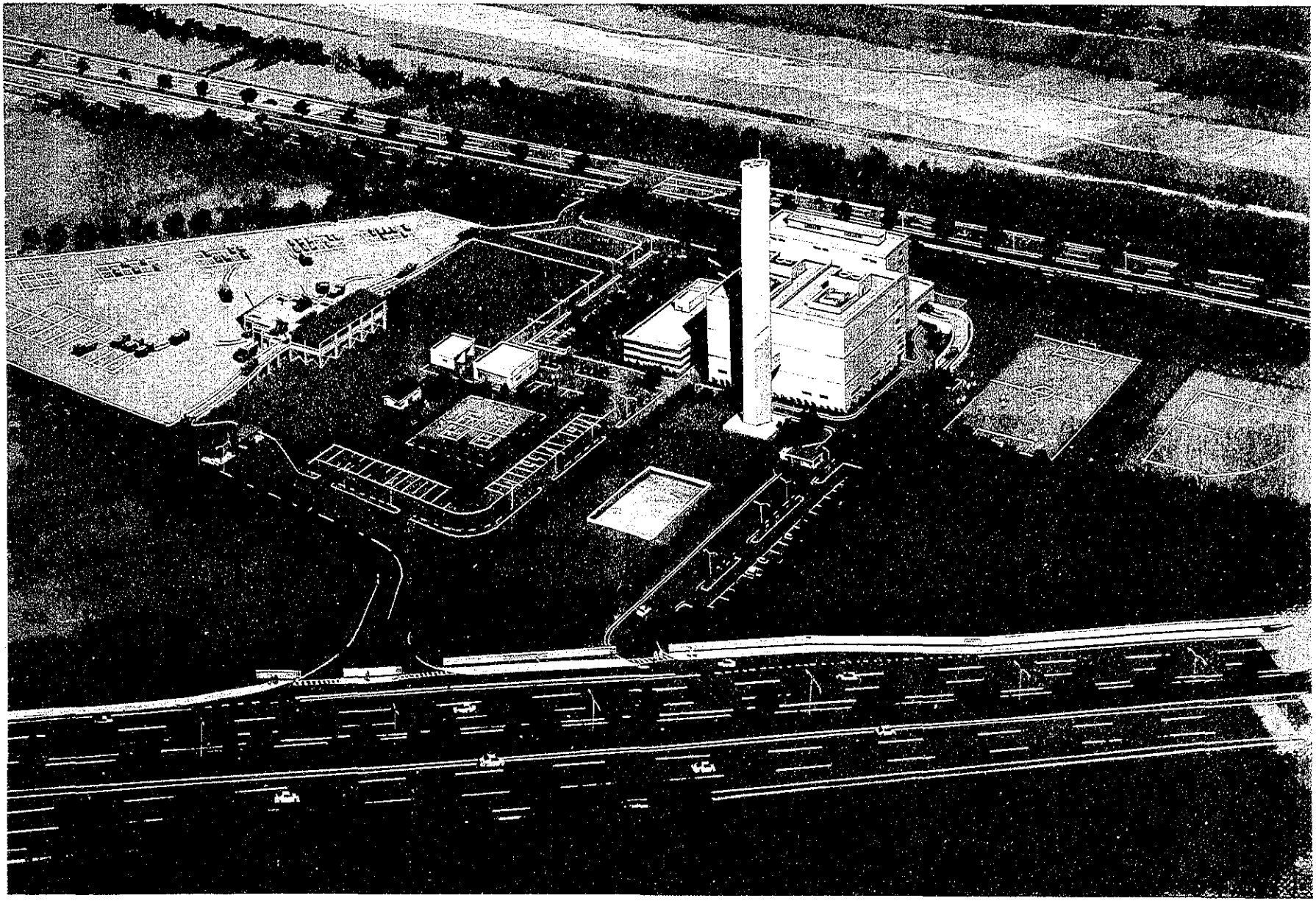
I wish to express my deep appreciation to the officials concerned of the Government of Korea for their close cooperation extended to the team.

October, 1985



Keisuke ARITA
President
Japan International Cooperation Agency

SEOUL
LOCATION MAP
S=1：200,000
0
5
10KM
서울特別市
高陽郡
仁川直轄市
富川市
光明市
安養市
城南市



PERSPECTIVE VIEW OF INTERMEDIATE PROCESSING CENTER

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LIST OF ABBREVIATIONS

Organizations and Countries

ADB	Asian Development Bank
G.F.R.	German Federal Republic
JICA	Japan International Cooperation Agency
KAIST	Korea Advanced Institute of Science and Technology
KDI	Korea Development Institute
KRIHS	Korean Research Institute for Human Settlements
MOST	Ministry of Science and Technology
NCRDBP	National Capital Region Development Plan
NLDP	National Land Development Plan
OOE	Office of Environment
R.O.K.	Republic of Korea
SMG	Seoul Metropolitan Government
TMG	Tokyo Metropolitan Government
U.N.	United Nations
U.S.A.	United States of America

Symbols

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
EP	Electrostatic Precipitator
EPL	Environmental Preservation Law
E/S	Existing System
Fig.	Figure
GNP	Gross National Product
GRP	Gross Regional Product
I/C	Incineration Plant
LNG	Liquid Natural Gas
MC	Multi-Cyclone
MPN	Most Probable Number
NO.	Number
NO_x	Nitrogen Oxides
O/M	Operation and Maintanance
Org.	Organic

p.	Page
per	Person
Ref.	Reference
SOC	Social Overhead Capital
SO_x	Sulfur Oxides
SS	Suspended Solids
T-P	Total Phosphorous
T/S	Transfer Station
TSP	Total Suspended Particulates
Vol.	Volume

Units

a	are
cm	centimeter
d	day
dB	decibel
o	degrees
^oC	degrees Centigrade
g	gram
hr	hour
ha	hectare
kcal	kilocalorie
kg	kilogram
km	kilometer
km^2	square kilometer
kw	kilowatt
kwh	kilowatt-hour
Leq	equivalent level
ℓ	liter
m	meter
m^2	square meter
m^3	cubic meter
mg	milligram
min	minute
mℓ	milliliter

mon	month
μg	microgram
Nm^3	normal cubic meter
ppm	parts per million
%	percent
‰	per-mill
sec or s	second
t or T	ton
yr	year
$	U.S. dollar
W	Korean Won
¥	Japanese Yen

SUMMARY

CONTENTS OF SUMMARY

PART I GENERAL

I-1 Background of Study

In response to the request from the Government of the Republic of Korea, the Government of Japan has decided to carry out a Master Plan and Feasibility Study on Seoul Municipal Solid Waste Management System in the Republic of Korea (hereafter referred to as "the Study"), in accordance with the laws and regulations in force in Japan. The Japan International Cooperation Agency (hereafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, performed the Study in close cooperation with the authorites concerned of the Government of the Republic of Korea, in particular with the Ministry of Science and Technology (hereafter referred to as "MOST") and the Korea Advanced Institute of Science and Technology (hereinafter referred to as "KAIST").

With the rapid increase of urban population and variation in socio-economical conditions, the establishment of an appropriate management system for the increasing output of solid waste has become an urgent need for the City of Seoul. The background to the Study is described as;

1) From the environmental and energy-saving point of view, Seoul municipality is anxious to establish an appropriate management system for solid waste which is characterized by certain properties.

2) The prevailing solid waste management system in Seoul is represented by a mixed collection system using hand carts, the transfer of collected waste and simplified landfill. This system brings inevitable problems of pollution, labor efficiency and limitation of landfill sites and, as a result, the urgent establishment of an appropriate alternative system involving the flow from waste generation to disposal is needed.

3) Under the 5th Five Year Plan for Economic and Social Development Plan (1982-1986), balanced development and utilization of national land and environmental preservation are raised as a principal policy of the Government. Under this situation, the appropriate management of the municipal solid waste in the capital city of the Republic of Korea is considered of great importance.

4) The Asian Games will be held in Seoul in 1986 and the Olympic Games in 1988. With this incentive, the establishment of the rational waste management system has become an urgent and important issue for improving the living environment and to promote the modern city planning of Seoul.

5) In Korea, various surveys and studies have been made regarding the municipal solid waste management system by governmental organizations and universities and some projects are being implemented. In the course of the Study, documents on these existing projects are consulted for planning the comprehensive solid waste management system for the future.

6) The Government of Korea desires that the execution of this project will become the model case for improvements in solid waste management systems in other municipalities.

Preliminary survey was carried out in October-November, 1983 and again in February-March, 1984 when agreement on the Scope of Works were made and confirmed between the Japanese Mission and the Steering Committee.

I-2 Scope of Study

This document contains two studies. A Phase I Study establishes a Master Plan for the year 2005, and a Phase II Study carries out a Feasibility Study on a Short Term Improvement Project.

The Master Plan phase has been performed to promote the establishment of an effective municipal solid waste management system for improved public sanitation and also resource conservation, environmental preservation and the socio-economical aspects of a total system from generation to final disposal.

Basic field surveys to supplement existing data and identify the problems of the existing system are used as basic material for the Master Plan and the Short Term Improvement Project.

The Feasibility Study is conducted on a Short Term Improvement Project targeted for the year 1988. This includes the basic design of transfer and processing facilities, and final disposal facilities, as well as economic/financial evaluation and environmental assessment.

The Study area covers, in principle, the entire Seoul municipality. However, further extensive area was considered for the transportation, disposal and landfill studies. Since this Study area is extremely wide, it has been divided into five zones according to Gu's.

The Study covers municipal solid waste of Seoul City which consists of domestic and commercial waste including sludge from public waste treatment facilities (night soil and sewage treatment facilities). The components of this waste are combustibles such as paper, plastics, textiles and wood, and non-combustibles such as metal, glass, ceramics and briquet ash.

PART II MASTER PLAN

II-1 Strategy for Implementation

The basic strategy for implementation of the Master Plan is listed below.

- Introduction of separate collection at source
- Improvement of collection and transportation

- Adoption of intermediate processing
- Establishment of landfill planning
- Cooperation of residents
- Personnel and institutional reinforcement

Each subsystem of the proposed Master Plan is described:

On-site Storage	:	Three component separation of waste into briquet ash, combustibles and non-combustibles
Collection	:	Mainly adpotion of mechanical collection, container box collection for briquet ash and station or curbside collection for the other waste
Transfer/Transportation	:	Mechanical transfer stations and large size transportation vehicles
Intermediate Processing	:	Incineration for combustibles and meterial recovery for non-combustibles
Final Disposal	:	Nanjido mounds, Incheon coastal landfill and subsidiary landfills in Seoul

II-2 Proposed Facility Allocation and Implementation Schedule

Derived from the least cost method in principle location for the incinerating facilities and mechanical transfer stations is proposed as shown in Fig. S-1. The schedule recommended for implementation of the Master Plan is shown in Fig. S-2. The investment program to attain the Master Plan is indicated in Table S-1.

II-3 Economic and Financial Evaluation

Projections of the total capital availability during the planned period in Seoul City range from W985 billion down to W530 billion. Taking into account the economic development of Korea and Japanese experience, the likely capital availability is expected to be of the order of W700 billion. This scale of investment will make it possible to incinerate 50 to 60 percent of combustibles to be generated in Seoul City in the year 2005.

Table S-1 Investment Schedule for Proposed Master Plan

(Unit: million Won)

Year	Facility					Vehicle			Landfill			Total
	Inci-nerator	Transfer Station	Material Recovery	Land Acquisition	Subtotal	Collec-tion	Transfer/ Transport	Subtotal	Nanjido	Incheon	Subtotal	
1986				1,845	1,845				3,350		3,350	5,195
1987	7,694	483			8,177				1,267		1,267	9,444
1988	15,356	371			15,727	2,893	2,495	5,388	1,267		1,267	22,382
1989		1,555		449	2,004				1,266		1,266	3,270
1990	4,796	1,845		3,780	10,421	4,694	3,535	8,229	850		850	19,500
1991	19,184	1,849		780	21,813	4,646	3,581	8,227	850		850	30,890
1992	23,980	1,849		780	26,609	4,909	3,719	8,628	400		400	35,637
1993	4,796	1,897		3,780	10,473	6,867	4,071	10,938	400	4,499	4,899	26,310
1994	19,184	1,972		780	21,936	7,679	6,091	13,770	400	15,935	16,335	52,041
1995	23,980	242	660		24,882	4,862	13,330	18,192		39,855	39,855	82,929
1996	4,796	290	660		5,746	6,658	3,895	10,553		900	900	17,199
1997	19,184	242	660		20,086	4,646	3,581	8,227		899	899	29,212
1998	23,980	242	660		24,882	4,909	3,719	8,628		2,335	2,335	35,845
1999	7,194	290	660	4,500	12,644	8,854	4,438	13,292		899	899	26,835
2000	28,776	338	660		29,774	7,679	6,091	13,770		899	899	44,443
2001	35,970	242	660		36,872	4,862	13,330	18,192		10,174	10,174	65,238
2002	7,194	290	660	4,500	12,644	9,629	4,438	14,067		899	899	27,610
2003	28,776	242	660		29,678	4,646	3,581	8,227		899	899	38,804
2004	35,970	242	660		36,872	4,909	3,719	8,628		1,126	1,126	46,626
2005		290	-		290	11,802	4,982	16,784		899	899	17,973
Total	310,810	14,771	6,600	21,194	353,375	105,144	88,596	193,740	10,050	80,218	90,268	637,383

Collection Waste Amount

Site for Facility		Collection Waste Amount t/d			
		I/C	T/S		
		C	B	N.C	Total
I/C + T/S	No.1	1,800	853	362	1,215
	No.2	2,040	966	411	1,377
	No.3	1,789	847	359	1,206
	No.4	2,009	951	403	1,354
T/S	No.5	-	1,209	3,068	4,277
	No.6	-	643	1,500	2,143
	No.7	-	1,861	3,909	5,770

Note: C : Combustibles for incineration
B : Briquet ash
N.C: Non-combustibles and non-processed combustibles
I/C: Incinerator
T/S: Transfer station

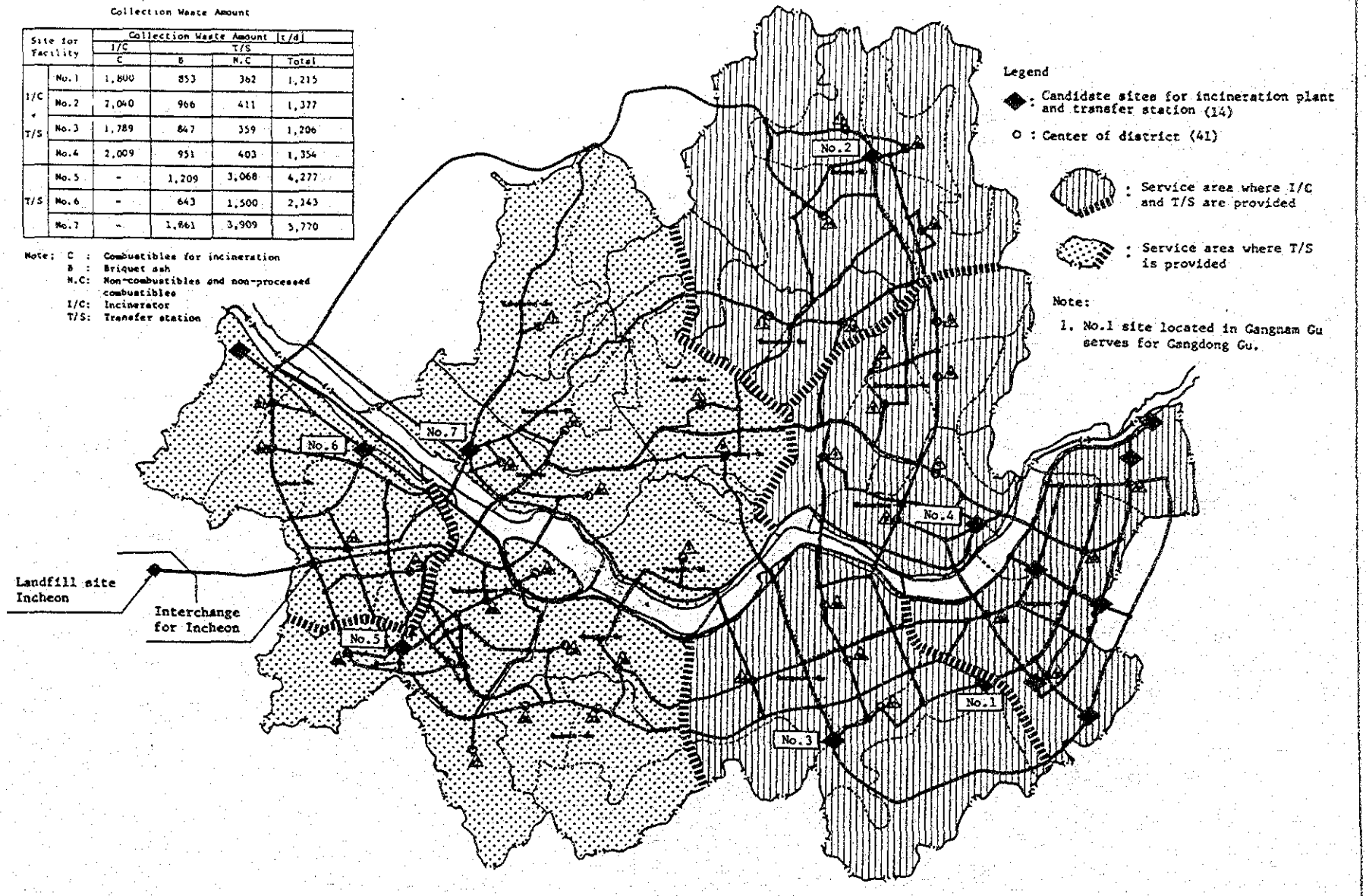


Fig. S-1 Proposed Facility Allocation and Expected Transportation Route

As shown in Fig. S-2, however, a comparison of the annual capital requirements with the 0.2 percent allocation of gross investment reveals a possible capital shortfall in seven years out of the whole period of the Master Plan. On the other hand, cumulative capital requirements will be covered by the cumulative availability of capital from 1986 till 1993, but a cumulative shortfall will occur from 1994 when the investment on Incheon landfill will start.

These capital requirements from 1994 include about W80 billion for Incheon landfill. The investment cost of the landfill will take one third and 48 percent of the total capital requirements for the Master Plan in 1994 and 1995, respectively.

The self-sustaining degree drops sharply to 27.0 percent in 1996 when the operation of the Incheon landfill starts. However, if the collection fee is raised by around 10 percent, a 30-percent self-sustaining will be attained. This raise in collection fee may not be unrealistic when considering increase of family income in the future. On the contrary, the ability of rate payers will be high enough to attain more than 30-percent self-sustaining in solid waste management under the proposed system. (Table S-2).

Table S-2 Estimated Self-Sustaining Degree

	1988	1991	1996	2001	2005
Unit Cost (W/t)	8,013	8,227	12,322	12,530	13,002
Collection Fee (W/t)	3,070	3,130	3,330	3,500	3,640
Self-Sustaining Degree(%)	38.3	37.5	27.0	27.9	28.0

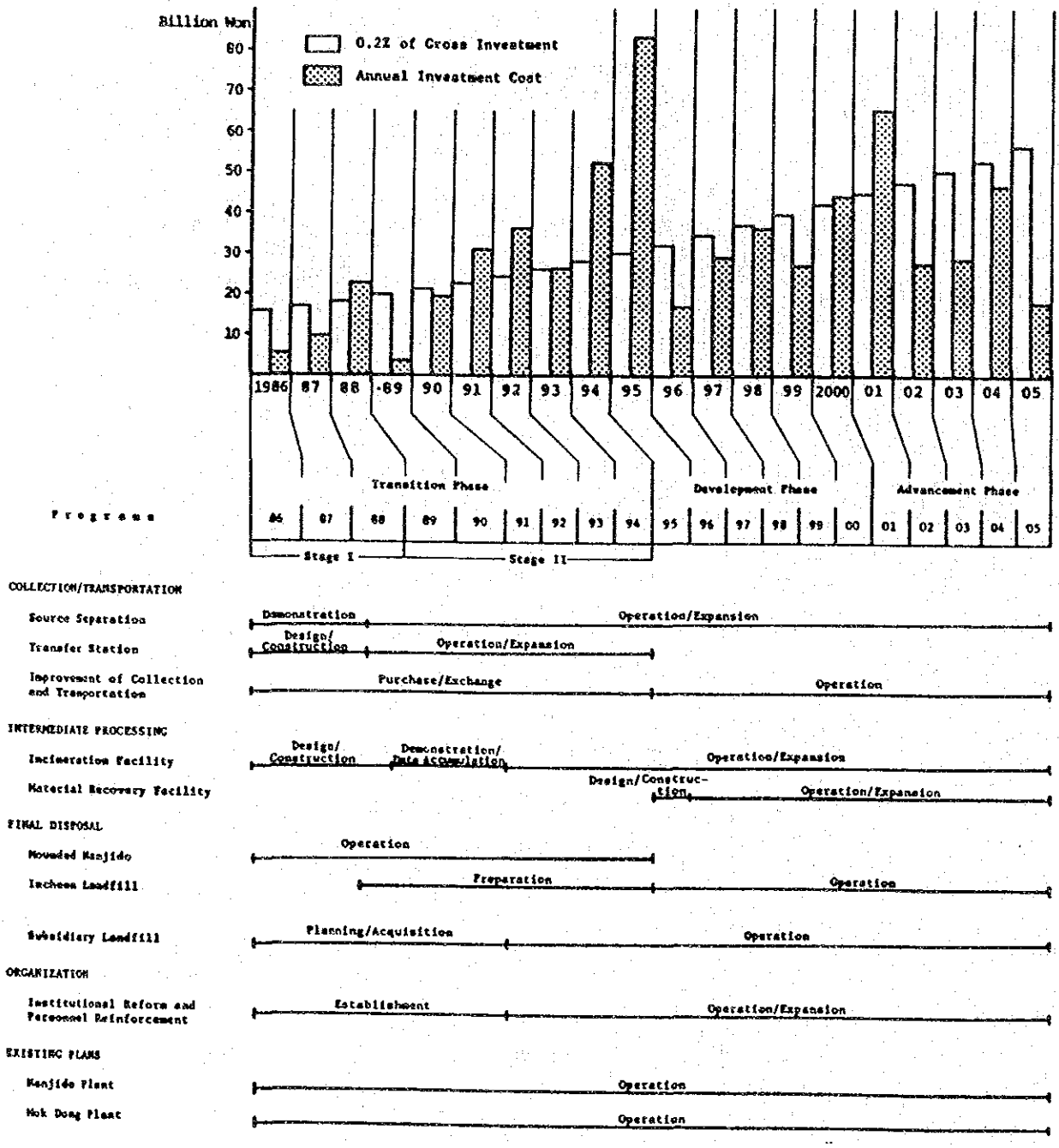


Fig. S-2 Comparison of Annual Investment Cost with Gross Investment

PART III FEASIBILITY STUDY

III-1 Project Identification

A project to improve the existing solid waste management system of Seoul, which is urgently needed in the short term by 1988, is the subject of the feasibility study. The feasibility study encompasses basic planning of facilities and evaluation of financial matters and environmental aspects.

Evaluation of the candidate sites were made with respect to transport effect regarding the indexes such as ton-km and truck-hours, and quantitative evaluation by the least cost method was made for final screening of project area before performing the comprehensive evaluation as shown in Table S-3.

Table S-3 Comparison of Cost of Each Model

Item	Cost (₩1,000/year)	
	Model-1 *	Model-2 **
Vehicle Collection	4,501,711	4,524,351
Existing Collection	5,650,928	6,639,934
Large Scale Transfer Station	240,324	224,830
Incinerating Center	2,269,490	2,269,490
Total	12,662,453	13,658,605

* Incineration plant is constructed in Gangdong Gu.
** Incineration plant is constructed in Dobong Gu.

Comparison of the total indicates that Model-1 is about one billion (w/year) less expensive than Model-2. Additionally by considering the following factors, Model-1, improvement of waste management system in Gandong Gu, is recommended for the short term project.

1. Gangdong Gu has a high potential for urbanization in the near future.
2. Gangdong Gu has excellent road condition.
3. High heating value is expected by waste from central heated apartments.
4. Intermediate processing site has been already decided by Seoul City.
5. Olympic games will be held in 1988.

III-2 Basic Planning

Basic planning on this system flow was carried out and the basic specifications are compiled in Table S-4, and the mass balance of the waste is explained in Fig. S-3.

III-3 Project Schedule for Implementation

The proposed implementation schedule for Gangdong Gu is shown in Table S-5. This proposal covers the period from 1985 up to the year 1988. This is in accordance with the implementation schedule of the master plan.

Table S-5 reveals the extremely tight schedule of the pre-construction phase. Therefore, it is necessary to take quick action based on the proposed implementation schedule.

The investment schedule is proposed to correlate to the implementation schedule. The investment schedules for Gangdong Gu are presented in Table S-6.

Table S-4 Basic Specifications for Short Term projects

Item	Specification
Specification Components	1. Combustibles 2. Non-combustibles 3. Briquet ash
On-Site Storage	- Plastic buckets with lid - Plastic and paper bags
Collection Method	- Station or curbside - Collection of briquet ash with container boxes
Collection Vehicles	2 t and 4 t trucks: - Compactor trucks for combustibles - Dump trucks for non-combustibles and briquet ash
Transfer	Mechanical transfer station for non-combustibles, briquet ash and non-incinerated combustibles with capacities of: - Gandgong Gu --- 1,250 t/day
Transportation	10 t container trucks
Processing	- Stocker type incineration of combustibles with power recovery and capacity of 600 t/day - Simple material sorting of non-combustibles at transfer station
Disposal	- Landfilling at Nanjido of residues from both incineration and recovery of non-combustibles, and of non-incinerated combustibles - Use of briquet ash as cover material for sanitary landfilling

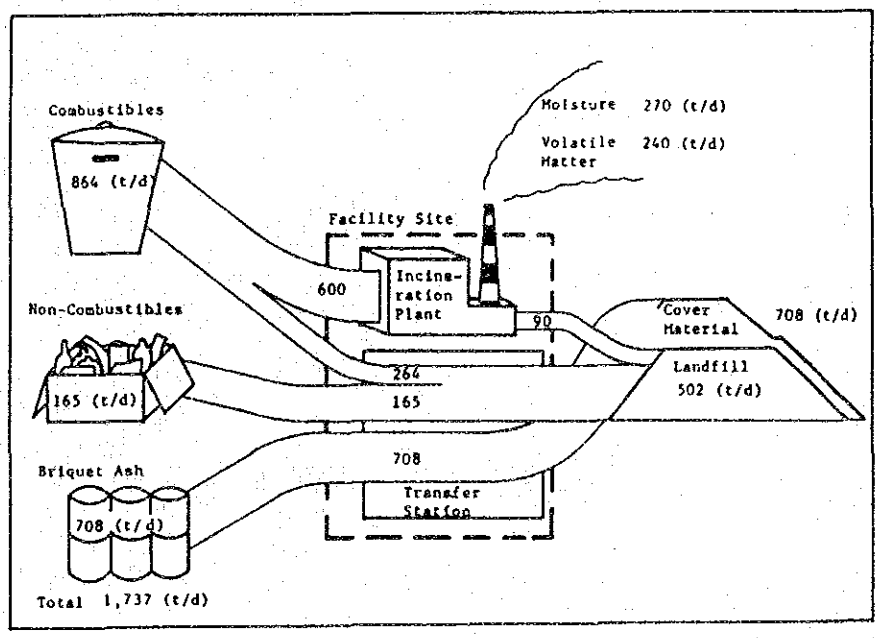


Fig. S-3 Flow of Separated Waste in Gangdong Gu (1988)

Table S-5 Implementation Schedule for Short Term Project

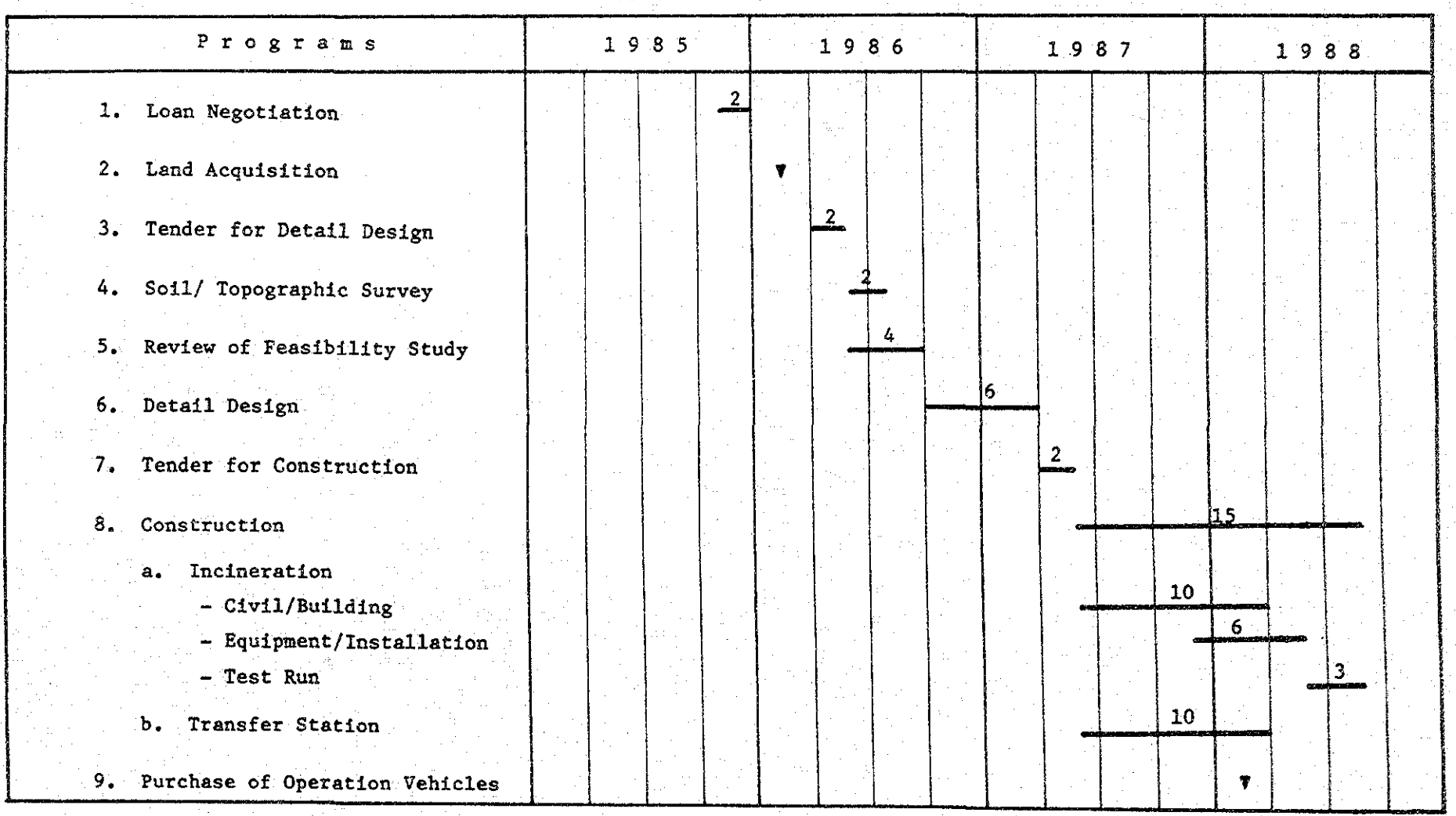


Table S-6 Investment Schedule for Short Term Project

(Unit thousand Won)

	1986			1987			1988			89	90	91	92	93	94	95	96	97	98	99	2000	01	02	03	04
	Local	Foreign	Subtotal	Local	Foreign	Subtotal	Local	Foreign	Subtotal	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Land Acquisition	1,845,000	-	1,845,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Engineering Service	119,160	447,440	566,600	116,280	271,470	387,750	45,360	185,990	231,550	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Detail Design	119,160	447,440	566,600	47,940	191,760	239,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Supervision	-	-	-	68,340	79,710	148,050	45,360	185,990	231,550	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Construction	-	-	-	5,941,750	2,234,800	8,176,550	5,176,750	10,550,200	15,726,950	-	-	-	-	-	96,600	-	-	-	205,200	-	96,600	-	-	-	-
a. Incinerator	-	-	-	5,459,350	2,234,800	7,694,150	4,805,650	10,550,200	15,355,850	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Civil and Building	-	-	-	5,229,750	-	5,229,750	1,743,250	-	1,743,250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Mechanical Equipment	-	-	-	229,600	2,234,800	2,464,400	918,400	8,939,200	9,857,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Piping	-	-	-	-	-	-	776,000	-	776,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Electrical Equipment	-	-	-	-	-	-	1,368,000	1,611,000	2,979,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
b. Transfer Station	-	-	-	482,400	-	482,400	371,100	-	371,100	-	-	-	-	-	96,600	-	-	-	205,200	-	96,600	-	-	-	-
- Civil and Building	-	-	-	441,360	-	441,360	110,340	-	110,340	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Equipment	-	-	-	41,040	-	41,040	260,760	-	260,760	-	-	-	-	-	96,600	-	-	-	205,200	-	96,600	-	-	-	-
Operation Vehicles	-	-	-	-	-	-	5,388,000	-	5,388,000	-	-	-	-	-	5,388,000	1,147,500	-	-	-	-	5,388,000	1,147,500	-	-	-
a. Collection	-	-	-	-	-	-	2,893,500	-	2,893,500	-	-	-	-	-	2,893,500	-	-	-	-	-	2,893,500	-	-	-	-
b. Transfer	-	-	-	-	-	-	2,494,500	-	2,494,500	-	-	-	-	-	2,494,500	1,147,500	-	-	-	-	2,494,500	1,147,500	-	-	-
Landfill	198,320	-	198,320	75,010	-	75,010	75,010	-	75,010	74,950	50,320	50,320	23,680	290,020	967,030	2,359,420	53,280	53,220	138,230	53,220	53,220	602,300	53,220	53,220	66,660
a. Manjido	198,320	-	198,320	75,010	-	75,010	75,010	-	75,010	74,950	50320	50,320	23,680	23,680	23,680	-	-	-	-	-	-	-	-	-	-
b. Incheon I	-	-	-	-	-	-	-	-	-	-	-	-	-	266,340	943,350	2,359,420	53,280	53,220	138,230	53,220	53,220	602,300	53,220	53,220	66,666
c. Incheon II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subtotal	2,162,480	447,440	2,609,920	6,133,040	2,506,270	8,639,310	10,685,320	10,736,190	21,421,510	74,950	50,320	50,320	23,680	290,020	6,451,630	3,506,920	53,280	53,220	343,430	53,220	5,537,820	1,749,800	53,220	53,220	66,660
Physical Contingency	216,250	44,740	260,990	613,300	250,630	863,930	1,068,530	1,073,620	2,142,150	7,500	5,030	5,030	2,370	29,000	645,160	350,690	5,330	5,320	34,340	5,320	553,780	174,980	5,320	5,320	6,670
Total	2,378,730	492,180	2,870,910	6,746,340	2,756,900	9,503,240	11,753,850	11,809,810	23,563,660	82,450	55,350	55,350	26,050	319,020	7,096,790	3,857,610	58,610	58,540	377,770	58,540	6,091,600	1,924,780	58,540	58,540	73,330

	05	06	07	08	Total		
	L	L	L	L	Local	Foreign	Total
Land Acquisition	-	-	-	-	1,845,000	-	1,845,000
Engineering Service	-	-	-	-	281,000	904,900	1,185,900
Detail Design	-	-	-	-	167,100	639,200	806,300
Supervision	-	-	-	-	113,900	265,700	379,600
Construction	-	96,600	-	-	11,613,500	12,785,000	24,398,500
a. Incinerator	-	-	-	-	10,265,000	12,785,000	23,050,000
- Civil and Building	-	-	-	-	6,973,000	-	6,973,000
- Mechanical Equipment	-	-	-	-	1,148,000	11,174,000	12,322,000
- Piping	-	-	-	-	776,000	-	776,000
- Electrical Equipment	-	-	-	-	1,368,000	1,611,000	2,979,000
b. Transfer Station	-	96,600	-	-	1,348,500	-	1,348,500
- Civil and Building	-	-	-	-	551,700	-	551,700
- Equipment	-	96,600	-	-	796,800	-	796,800
Operation Vehicles	-	5,388,000	1,147,500	-	24,994,500	-	24,994,500
a. Collection	-	2,893,500	-	-	11,574,000	-	11,574,000
b. Transfer	-	2,494,500	1,147,500	-	13,420,500	-	13,420,500
Landfill	53,220	266,340	943,350	2,359,420	8,912,980	-	8,912,980
a. Manjido	-	-	-	-	594,970	-	594,970
b. Incheon I	53,220	-	-	-	4,748,900	-	4,748,900
c. Incheon II	-	266,340	943,350	2,359,420	3,569,110	-	3,569,110
Subtotal	53,220	5,250,940	2,090,850	2,359,420	47,646,980	13,689,900	61,336,880
Physical Contingency	5,320	575,090	209,090	235,940	4,764,700	1,368,990	6,133,670
Total	58,540	6,326,030	2,299,940	2,595,360	52,411,680	15,058,890	67,470,550

- Remarks -

(1) Incinerator

1) Of the investment cost of civil and building, 75% is disbursed in 1987 and 25% in 1988.
2) Of the investment cost of mechanical equipments, 20% is disbursed in 1987 and 80% in 1988.
3) Investment cost of piping and electrical equipments are disbursed in 1988.
4) Economic life is 20 years.

(2) Transfer Station

1) Of the investment cost of civil and building, 80% is disbursed in 1987 and 20% in 1988.
2) Of the investment cost of equipments excluding wheel loader, 20% is disversed in 1987 and 80% in 1988.
3) Wheel loader is purchased in 1988 and this cost (96,000 x 10^3 Won) is involved in the cost of equipments.
4) Economic life of civil and building is 30 years. 10 years for equipment and 6 years for wheel loader.

(3) Operation Vehicles

1) Economic life is 6 years.

(4) Landfill

1) Investment costs and disbursement schedule of landfill both Manjido and Incheon complised with Seoul side studies.
2) Project cost to be invested is shared in proportion to landfill volume of the projects.

(5) Renewal costs for vehicles and equipment except incinerator are disbursed at the interval of their economic life.

(6) Operation/maintenance and depraciation cost is excluded in this Table.

III-4 Project Evaluation

4-1 Financial Evaluation

The FIRR was calculated for 7 alternative cases (Table S-7). Case 1 to Case 3 are for the cases in which the collection fee is fixed at the present level and the self-sustaining degree is varied from 27 to 34 percent. At the present level of collection fee, the project will be financially feasible when the self-sustaining degree is 34 percent. Case 4 to 7 are for raising the present level of collection fee. If the collection fee is raised by 30 percent, the self-sustaining degree rises to more than 40 percent. In order to get more than 10-percent FIRR, the self-sustaining degree drops to 35 percent.

Table S-7 FIRR for Short-term Project in Gangdong Gu

Case	Collection Fee	Self-Sustaining Degree (%)	FIRR (%)
1	At present level	30	8.0
2	- do -	34	5.1
3	- do -	27	10.8
4	30% up	35	10.9
5	- do -	45	4.7
6	1988 - 1995 30% up	45	6.2
7	1996 - 2008 50% up	45	6.2

4-2 Comprehensive Evaluation

Considering the results of financial, social and other impact evaluations, comprehensive evaluation of the Project is made here compared with the existing system as shown in Table S-8.

Table S-8 Comprehensive Evaluation of the Project

Criteria	Existing System	Proposed System
Volume Reduction	x	o
Collection Efficiency	x	o
Working Conditions	x	o
Recycle	Δ	o
Environmental Conservation	x	o

Legend: o = Superior, Δ= Acceptable, x = Inferior

The proposed project conforms to the objective of this study and is evaluated as reasonable. The Project is recommended to be implemented as soon as possible since the Study revealed that this system is most effective and meets the financial and environmental requirements.

PART IV CONCLUSION AND RECOMMENDATIONS

IV-1 General

Through this study, various problems were identified on the existing solid waste management system in Seoul. Several alterntives for the master plan were established considering the measures for these problems. Each alternative was evaluated and the optimum master plan was selected. The feasibility study was made for Gangdong Gu as the first step of the master plan. The results of this study are as follows.

IV-2 Collection and Transportation

2-1 Master Plan

Three component separation of combustibles, non-combustibles, briquet ash is required for incineration, material recovery and preparing covering material for landfill.

Hand cart collection system should be changed to vehicle collection system in whole Seoul by 1995 to improve collection efficiency, sanitary conservation, working hours and worker's status.

Transfer stations are recommended for the effective transportation of waste to the disposal site.

2-2 Feasibility Study

Improved collection and transportation system will be established in whole Gangdong Gu in 1988. Transfer station with its capacity of 1,150 t/day, is proposed to be constructed at the east end of Gangnam Gu where an incinerator is also provided.

Compactor trucks collect combustible waste and dump trucks collect briquet ash and non-combustible waste.

Container trucks are used for transportation from transfer station and incinerator to disposal site. Two tons and four tons of trucks are used for collection in accordance to road width in collection site. Gangdong Gu is proposed to be divided into 7 zones for the purpose of the uniformity of daily collection amount of waste and daily working hours in relation to collection frequency in each zone.

IV-3 Intermediate Processing

3-1 Master Plan

Construction of 13 units of incineration plants are proposed in master plan where one unit is 600 t/d. The amount of incinerated waste would amount to 2,574 thousand tons in 2005, which is 48% of estimated combustible waste. Material recovery plants are also proposed in the plan. Daily processing rate will be 300 tons in 2005, which means 99 thousand tons are treated annually by the plants. With the operation of the intermediate processing plants, 2,060,000 m^3/year of landfill volume will be reduced in 2005.

3-2 Feasibility Study

Construction of 600 ton/day incineration plant was proposed for Gangdong Gu. The plant is expected to be in operation in autumn 1988. In 1988, 100 days of operation is planned and 330 days after 1989. The reduction of landfill volume by this plant will amount to 157,000 m^3/year.

IV-4 Final Disposal

Final disposal for this project is proposed as Nanjido mounding, Incheon coastal landfilling and use of subsidiary landfills. Subsidiary landfills are significant if sufficient area can be secured within reasonable distances, and if administrative settlements can be made in the case of sites out of the administrative boundaries.

IV-5 Institutional Arrangement

The range of jurisdiction for the municipality and Gu's is recommended as described in Table S-9.

Table S-9 Recommendations on Jurisdiction

Duty	Jurisdiction	Comment
Collection	Gu	- Presently under jurisdiction of Gu - Requires close communication with residents
Haul to Transfer Station	Gu	- Presently under jurisdiction of Gu - Requires close communication with residents
Transfer Station and Transportation from Transfer Station to Landfill Site	City	- Requires a unified management of trucks serving all transfer station - One station may serve more than one Gu
Intermediate Processing Facility	City	- Requires a standardized system of operation and maintenance - Effectiveness of construction planning when administered by city - Accumulation of technological know-how
Nanjido Disposal Site	City	- Though Nanjido is presently managed by Mapo Gu, the city has responsibility for implementation of the mounding plan

PART I
GENERAL

PART I GENERAL: (1) Chap. 1 INTRODUCTION

- 1-1 Background of Study
- 1-2 Conduct of the Study
- 1-3 Organization of the Project Team
- 1-4 Objectives
- 1-5 Scope of Study

→
- -5 Preliminary Conditions
  - Study on basic design of Seoul municipal waste processing plant (RDF)
  - Incinerator construction plan in Mok-Dong area
  - Nanjido mounding plan
  - Feasibility study on large scale waste landfill siting in metropolitan area (Incheon)

↓

: (2) Chap. 2 PRESENT SITUATION

- 2-1 Existing System
  - -1 Administration
  - -2 Collection and transportation
  - -3 Final disposal
  - -4 Recycling system

→
- -1 Administrative organization of Seoul City, Gu's, Bureau of Parks and Environment
- -2 Collection /transportation cost was 6,059 W/ton
- -3 Final disposal in Nanjido
- -4 Self-support work corps, recovery rates and prices of materials

↓

- 2-2 Summary of Basic Field Survey
  - -1 Waste generation
  - -2 Collection and transportation
  - -3 Recycling
  - -4 Final disposal

→
- -1 1,469 kg/cap/day of waste generation from residences, waste components from various sources
- -2 Time motion of collection/transportation vehicles
- -3 Recoverable market survey, recycling amount
- -4 Truck loading rate was 78% in average

↓

- 2-3 Problem Identification

→
- Problems in existing system and their countermeasures

↓

: (3) Chap. 3 FRAMEWORK FOR PLANNING

- 3-1 Projected Populations

→
- Population in Seoul City will be 10.3 and 12.5 million in 1988 and in 2005, respectively

↓

- 3-2 Future Economic Conditions
  - -1 Fifth five year development plan
  - -2 Korea in the Year 2000
  - -3 GNP projections
  - -4 Future Seoul economy

→
- -1 GNP of 65.5 trillion W in 1988 by 1980 value is expected by R.O.K.
- -2 GNP of 147.1 trillion W in 2000 by 1980 value is expected by R.O.K.
- -3 GNP is projected to be 65.6 and 185.4 trillion W by 1980 value in 1988 and in 2005 with the annual growth rate of 6.6%, respectively in this study
- -4 Seoul GRP is projected to be 9.1 and 28.0 trillion W by 1984 value in 1988 and 2005 with the annual growth rate of 7.6%, respectively

↓

- 3-3 Waste Characteristics and Generation Rates
  - -1 Present status of waste generation
  - -2 Waste generation forecasts
  - -3 Waste characteristics
  - -4 Considerations from economic aspects

→
- -1 8,520,591 ton of waste generation in nominal ton in 1984
- -2 Per capita generation rate of 2.042 kg/cap.d and 2.107 kg/cap.d in 1988 and 2005, respectively
- -3 Physical component, bulky waste
- -4 Relationship between waste generation rate and GRP

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1-1 Background of Study

In response to the request from the Government of the Republic of Korea, the Government of Japan has decided to carry out a Master Plan and Feasibility Study on Seoul Municipal Solid Waste Management System in the Republic of Korea (hereinafter referred to as "the Study"), in accordance with the laws and regulations in force in Japan. The Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, performed the Study in close cooperation with the authorities concerned of the Government of the Republic of Korea, in particular with the Ministry of Science and Technology (hereinafter referred to as "MOST") and the Korea Advanced Institute of Science and Technology (hereinafter referred to as "KAIST").

With the rapid increase of urban population and variation in socio-economical conditions, the establishment of an appropriate management system for the increasing output of solid waste has become an urgent need for the City of Seoul. The background to the Study is described as;

1) From the environmental and energy-saving point of view, Seoul municipality is anxious to establish an appropriate management system for solid waste which is characterized by certain properties.

2) The prevailing solid waste management system in Seoul is represented by a mixed collection system using hand carts, the transfer of collected waste and simplified landfill. This system brings inevitable problems of pollution, labor efficiency and limitation of landfill sites and, as a result, the urgent establishment of an appropriate alternative system involving the flow from waste generation to disposal is needed.

3) Under the 5th Five Year Plan for Economic and Social Development Plan (1982-1986), balanced development and utilization of national land and environmental preservation are raised as a principal policy of the Government. Under this situation, the appropriate management of the municipal solid waste in the capital city of the Republic of Korea is considered of great importance.

4) The Asian Games will be held in Seoul in 1986 and the Olympic Games in 1988. With this incentive, the establishment of the rational waste management system has become an urgent and important issue for improving the living environment and to promote the modern city planning of Seoul.

5) In Korea, various surveys and studies have been made regarding the municipal solid waste management system by governmental organizations and universities and some projects are being implemented. In the course of the Study, documents on these existing projects are consulted for planning the comprehensive solid waste management system for the future.

6) The Government of Korea desires that the execution of this project will become the model case for improvements in solid waste management systems in other municipalities.

Preliminary survey was carried out in October-November, 1983 and again in February-March, 1984 when agreement on the Scope of Works were made and confirmed between the Japanese Mission and the Steering Committee.

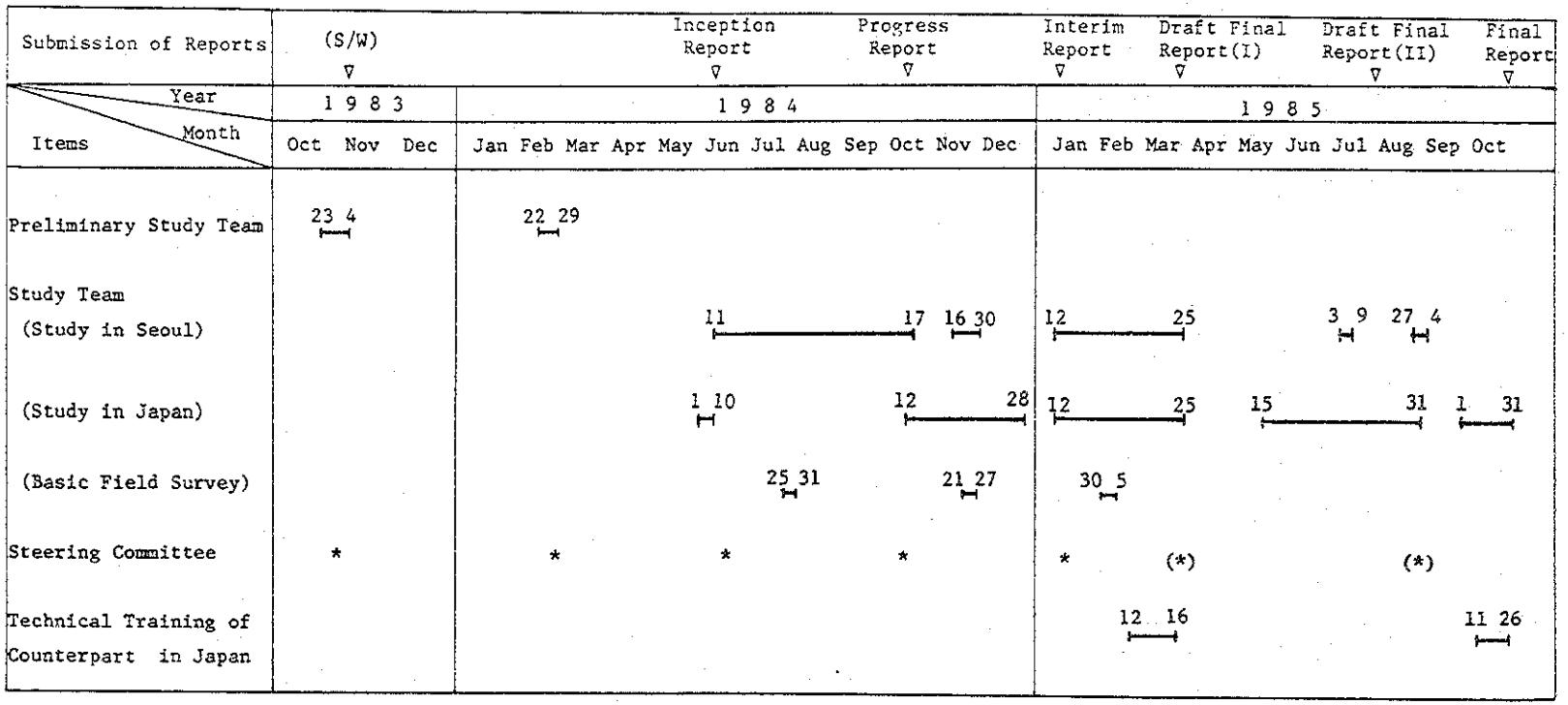
1-2 Conduct of the Study

On the basis of the preliminary survey, JICA organized a study team and dispatched them to Seoul, in June 1984, for the full-scale study. The Study has been accomplished by JICA team in close cooperation with Korean counterparts from KAIST. The Japanese consultants were assigned by JICA, and commenced activities in June, 1984 with the preparation of the Inception Report. The time scale of study

activities and report submissions are indicated in Fig. 1-2-1. This Study was completed at the end of October, 1985 with the submission of the Final Report.

The Advisory Committee (members of the Japanese Government), also organized by JICA, held meetings in Tokyo as the need arose, observing the Study's progress and providing technical advice. A member of the Advisory Committee stayed in Seoul with the Team, while the other representative members of Committee made 5 separate visits to Seoul and discussed the essential points with the Korean Steering Committee.

Fig. 1-2-1 Study Schedule



1-3 Organization of the Project Team

The Study was carried out jointly by JICA and MOST. The Advisory Committee and the Study Team were organized by JICA, while the Steering Committee and the KAIST Counterpart Team were organized by MOST.

The organization showing the interrelationship between the Korean and Japanese sides is shown in Fig. 1-3-1.

The list of members concerned with this Study is given on the following pages.

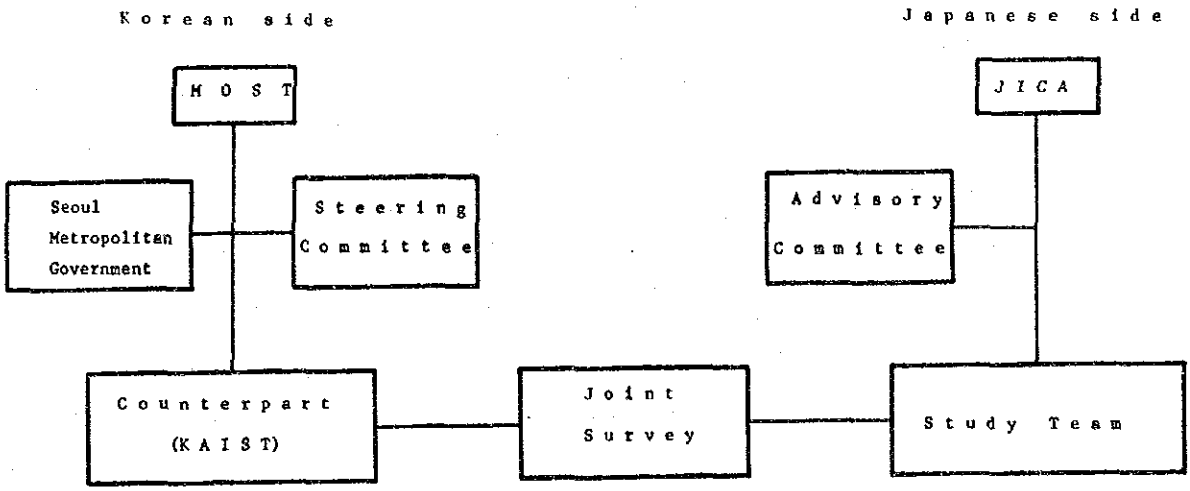


Fig. 1-3-1 Organization for Study Implementation

1-4 Objectives

The objectives of the Study are: i) to analyze and evaluate the technical and economic feasibilities of an effective and rational solid waste management system for the future, based upon the local conditions of Seoul City, and ii) to ensure a "clean" municipality that is acceptable socially, economically and environmentally.

(1) ORGANIZATION OF JAPANESE SIDE

1) Advisory Committee Members

1.	Dr. Masao Sago	Chairman of Committee Science University of Tokyo
2.	Mr. Hiroshi Miyazawa	Solid Waste Management System Japan Waste Management Association
3.	Dr. Masaru Tanaka	Sanitary Engineering The Institute of Public Health, Ministry of Health and Welfare
4.	Mr. Hideaki Unno (Predecessor: Mr. Osamu Ikeda)	Facilities Planning Ministry of Health and Welfare
5.	Mr. Hiroshi Kitagawa	Basic Field Survey Hiroshima City Office
6.	Mr. Junji Ishizuka	Coordination Japan International Cooperation Agency (JICA)

2) Study Team Members

1.	Mr. Fusao Node	Team Leader Legislation/Organization (NJS)
2.	Mr. Norio Kanno	Solid Waste Analysis (NJS)
3.	Mr. Kazuhiko Denda	Economic and Financial Analysis (PCI)
4.	Mr. Tatsuyuki Negishi	City Planning (PCI)
5.	Mr. Shoji Fujii	Recovery System Planning (PCI)
6.	Mr. Torao Tokozumi	Collection/Transportation System Planning (PCI)
7.	Dr. Hidetoshi Kitawaki	Intermediate Processing System Planning (NJS)
8.	Mr. Shigehisa Tazaki	Final Disposal System Planning (NJS)
9.	Mr. Masashi Hattori	Environmental Assessment (PCI)
10.	Mr. Kiyoshi Miyakura	System Planning (PCI)

11.	Mr. Yoshijiro Shimomura	Facility Design (PCI)
12.	Mr. Hidesumi Arai	Collection/Transportation Simulation Analysis (PCI)
13.	Mr. Makoto Hasegawa	Final Disposal Design (PCI)

Note: NJS = Nippon Jogesuido Sekkei Co., Ltd.
PCI = Pacific Consultants International

(2) ORGANIZATION OF KOREAN SIDE

1) Steering Committee Members

1.	Dr. Hoagy Kim	Chairman of Committee Chemical Research Coordinator, MOST
2.	Mr. Hee Woon Choi	Secretary of Committee Principal Investigator, KAIST
3.	Dr. Sook Pyo Kwon	Director of Institute for Environmental Reserach, Yonsei University
4.	Dr. Sung Moo Lee	Professor of Chemical Engineering, Yonsei University
5.	Dr. Dong Min Kim	Professor of Environmental Engineering, Seoul City University
6.	Dr. Jung Wook Kim	Professor, Graduate School of Environmental Studies, Seoul National University
7.	Mr. Jong Keon Perk	Chief, Division of Solid Waste Management, Office of the Environment
8.	Mr. Jong Kwan Ahn	Chief, Division of Solid Waste Management, Seoul Metropolitan Government

2) Participate in Steering Committee Meetings

1.	Mr. Sun Yong Lee	Office of the Environment
2.	Mr. Jong Sik Ro	Chief, Sanitary Facilities Section Waste Management Division Bureau of Parks and Environment Seoul Metropolitan Government

3.	Mr. In Yong Choi	Chief, Division of Environment Kurogu, Seoul Metropolitan Government
4.	Mr. Seoung Koo Ahn	Associate Professor Dept. of Environmental Engineering Seoul City University
5.	Dr. Myoung Jin Yu	Associate Professor Dept. of Environmental Engineering Seoul City University
6.	Dr. Dok Chan Kim	Associate Professor Dept. of Chemical Engineering Seoul City University

3) Counterparts

1.	Mr. Hee Woon Choi	Principal Investigator, KAIST
2.	Mr. Young Myoung Kim	Senior Engineer, KAIST
3.	Mr. Soo Yeol Kim	Investigator, KAIST

4) Principal Collaborators

1.	Dr. Hakze Chon	President, KAIST
2.	Dr. Won Hee Park	Director, Research Coordination, KAIST
3.	Dr. Sekwon Kim	Former Chemical Research Coordinator, MOST
4.	Mr. Jong Ok Lee	Principal Investigator, KAIST

5) Collaborating Institutions and Organizations

- Korea Advanced Institute of Science and Technology
- Seoul Metropolitan Government
- Office of Environment
- NEPI
- Local Consultant

1-5 Scope of Study

This document contains two studies. A Phase I Study establishes a Master Plan for the year 2005, and a Phase II Study carries out a Feasibility Study on a Short Term Improvement Project.

The Master Plan phase has been performed to promote the establishment of an effective municipal solid waste management system for improved public sanitation and also resource conservation, environmental preservation and the socio-economical aspects of a total system from generation to final disposal.

Basic field surveys to supplement existing data and identify the problems of the existing system are used as basic material for the Master Plan and the Short Term Improvement Project.

The Feasibility Study is conducted on a Short Term Improvement Project targeted for the year 1988. This includes the basic design of transfer and processing facilities, and final disposal facilities, as well as economic/financial evaluation and environmental assessment.

The Study area covers, in principle, the entire Seoul municipality. However, further extensive area was considered for the transportation, disposal and landfill studies. Since this Study area is extremely wide, it has been divided into five zones according to Gu's as illustrated in Fig. 1-5-1.

The Study covers municipal solid waste of Seoul City which consists of domestic and commercial waste including sludge from public waste treatment facilities (night soil and sewage treatment facilities). The components of this waste are combustibles such as paper, plastics, textiles and wood, and non-combustibles such as metal, glass, ceramics and briquet ash.

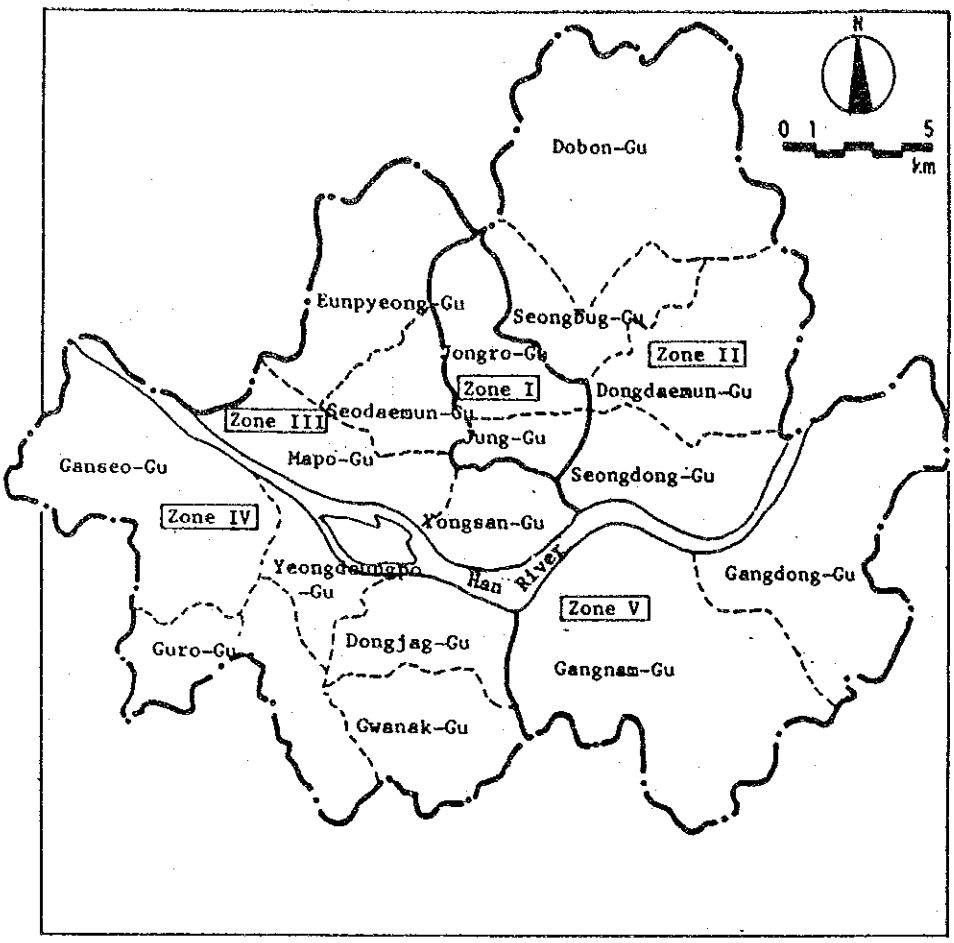


Fig. 1-5-1 Five Zones of Study Area

The subjects listed below are assumed as the preliminary conditions for implementation of this project and are not considered as study subjects.

1. From 1988 to 1994, the final disposal site will be Najido, and from 1995 on, Incheon.

2. The refuse derived fuel (RDF) and compost plant under construction and the Mok Dong incineration plant to be constructed in Seoul City.

3. Both the Nanjido mounding and Incheon coastal landfilling.

CHAPTER 2

PRESENT SITUATION

CHAPTER 2 PRESENT SITUATION

2-1 Existing System

2-1-1 General

Solid waste management in Seoul in relation to administrative aspects, waste generation mechanism, collection and transportation system, final disposal system and recycling system is presented here to identify existing problems.

The existing solid waste management system in Seoul is illustrated in Fig. 2-1-1.

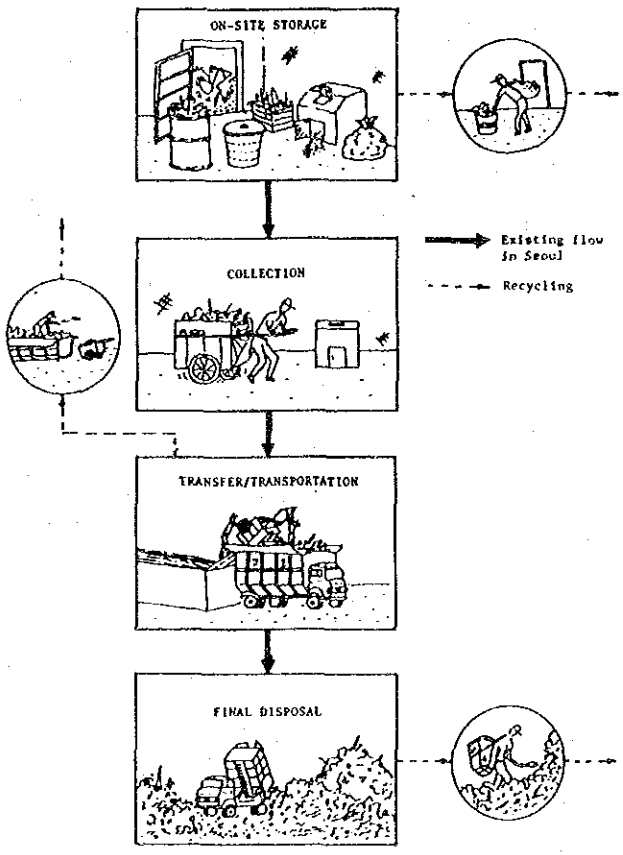


Fig. 2-1-1 Flow Diagram of the Existing Solid Waste Management

2-1-2 Administration

Seoul covers an area of about 627 km^2. The municipality is divided into the administrative units listed below.

Table 2-1-1 Administrative Levels of Seoul City

Unit		Number	Governing System
City		1	Administrative
Gu		17	Administrative
Dong	Legal	474	Administrative
	Administrative	417	
Tong		12,361	Autonomous
Ban		95,439	Autonomous

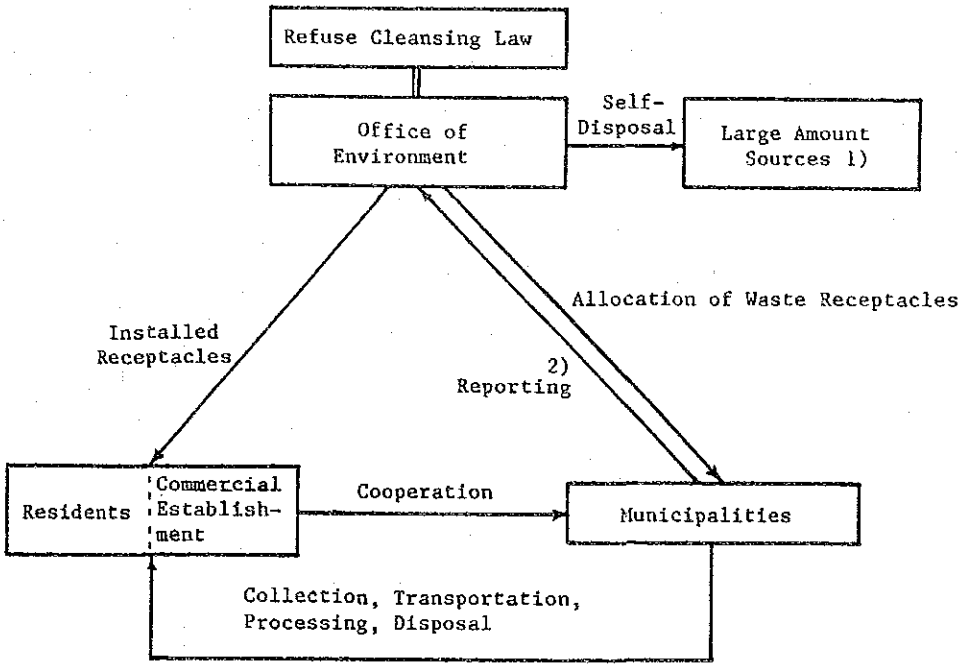
The legislation most relevant to this Study is the Refuse Cleansing Law. The objectives of the present Refuse Cleansing Law, revised in 1983, are specified in Article 1 as follows: "This Law aims at contributing to improve national health and environmental preservation through maintenance of the natural and living environment and cleanliness, by means of processing waste in a sanitary manner."

Urban areas where population and industries concentrate are specified as special cleansing areas, and therefore, appropriate cleansing operations should be carried out. In case of Seoul, the entire administrative area is considered as a special cleansing area, but the mayor has authority to exclude the following areas from its designation.

1. Dongs where the population density is less than 1,000 persons per square kilometer.

2. Dongs surrounded by mountains, hills and fields.

The administrative structure in the special cleansing area is shown in Fig. 2-1-2. The installation and maintenance of refuse receptacles at the waste sources along with the operation criteria of solid waste management for municipalities are defined in the regulation.



Note: 1) A large amount source is defined as a single source generating over 300 kg per day and must comply with specified criteria.

2) Municipalities should report to O.O.E. on the following matters.

1. Projected collection and disposal rate
2. Landfill situation
3. Personnel, facilities and equipment
4. Expansion plan for facilities
5. Problems and countermeasures

Fig. 2-1-2 Schematic Administrative Structure

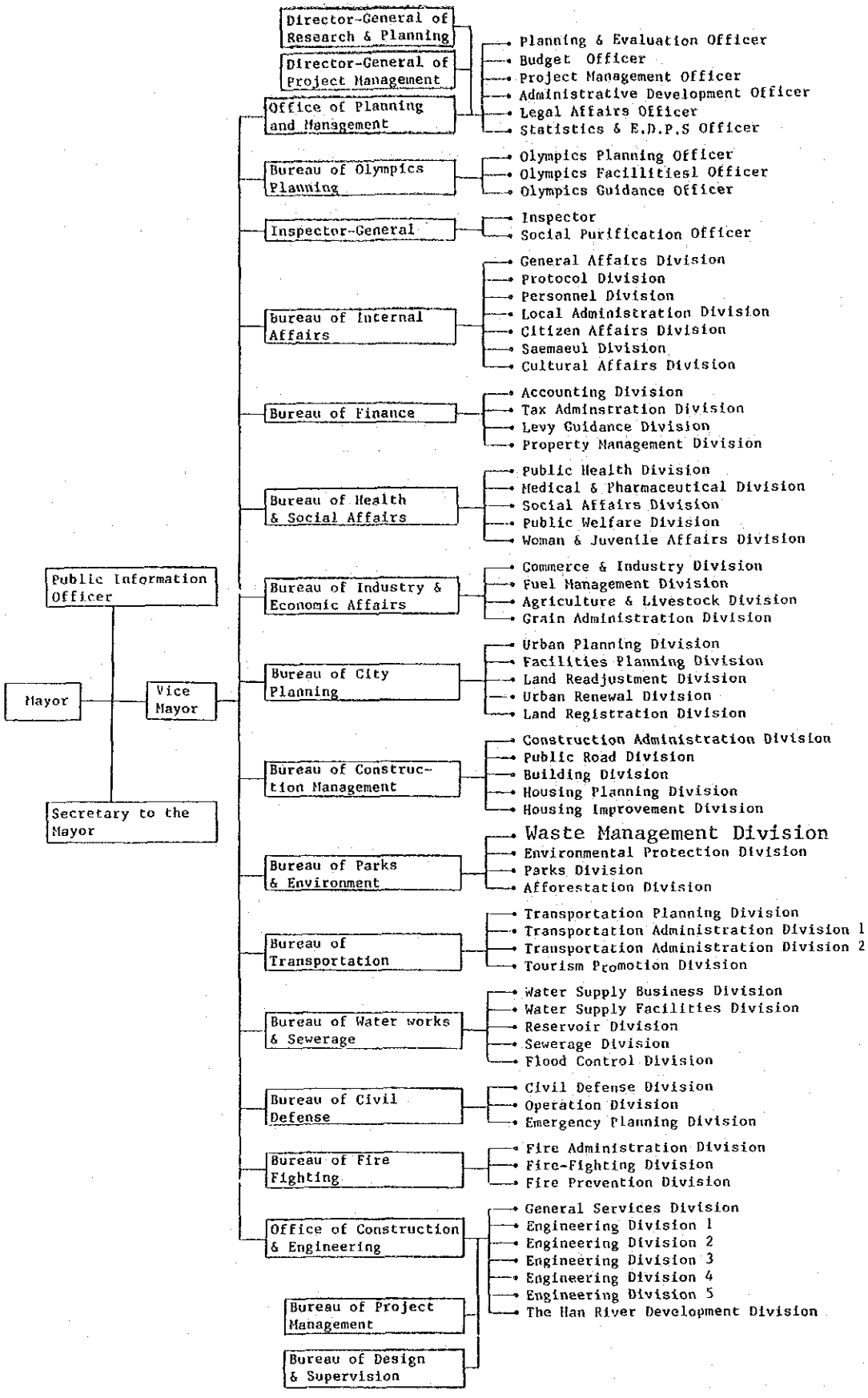


Fig. 2-1-3 Organization Chart of Seoul Metropolitan Government

Cleansing operations such as collection, transportation and disposal are carried out not only by municipalities, but private companies as well. Private companies collect solid wastes in the designated areas based on the contract with the city mayor and under the jurisdiction of the Cleansing Division of Gu. They use vehicles and facilities in compliance with the regulations associated with solid waste cleansing law. According to the regulations, private companies report the collected amount of waste and charges to the city government. The organization of Seoul Metropolitan Government is shown in Fig. 2-1-3. Under the Bureau of Parks and Environment, the Cleansing Division has administrative responsibilities for management of domestic solid waste. The organization of the Bureau of Parks and Environment is depicted in Fig. 2-1-4. The Cleansing Division of the city comprises of four sections, responsibilities of which are given in Appendix.

Collection and transportation of wastes are conducted by the Cleansing Division of Gu. The organization of a Gu is shown in Fig. 2-1-5 and responsibilities of the Cleansing Division in the Bureau of Citizens are given in Appendix.

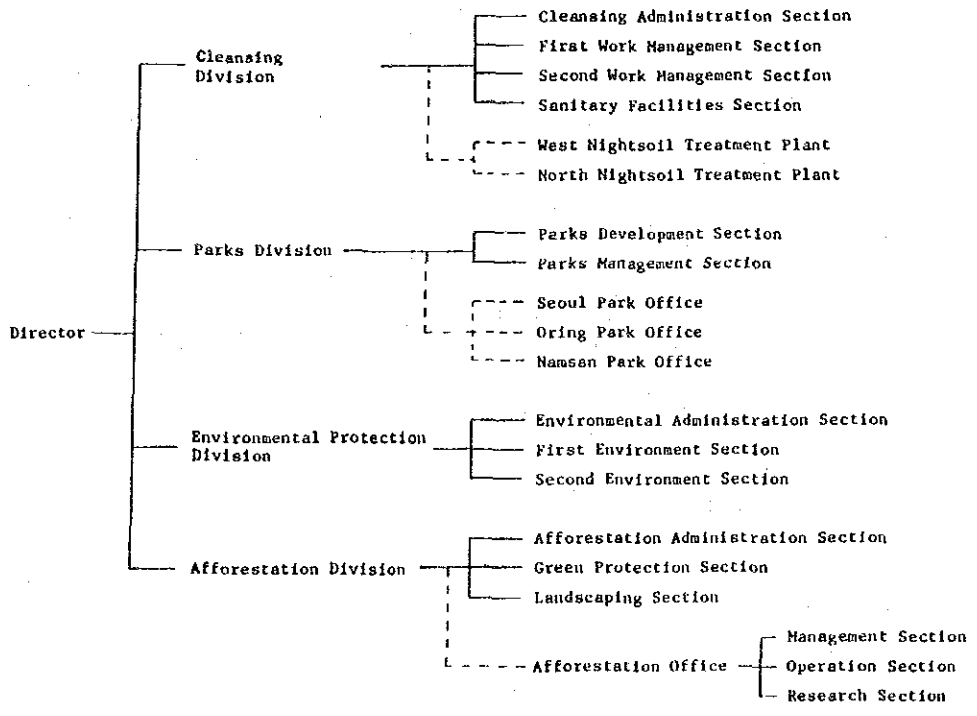


Fig. 2-1-4 Organization Chart of Bureau of Parks and Environment

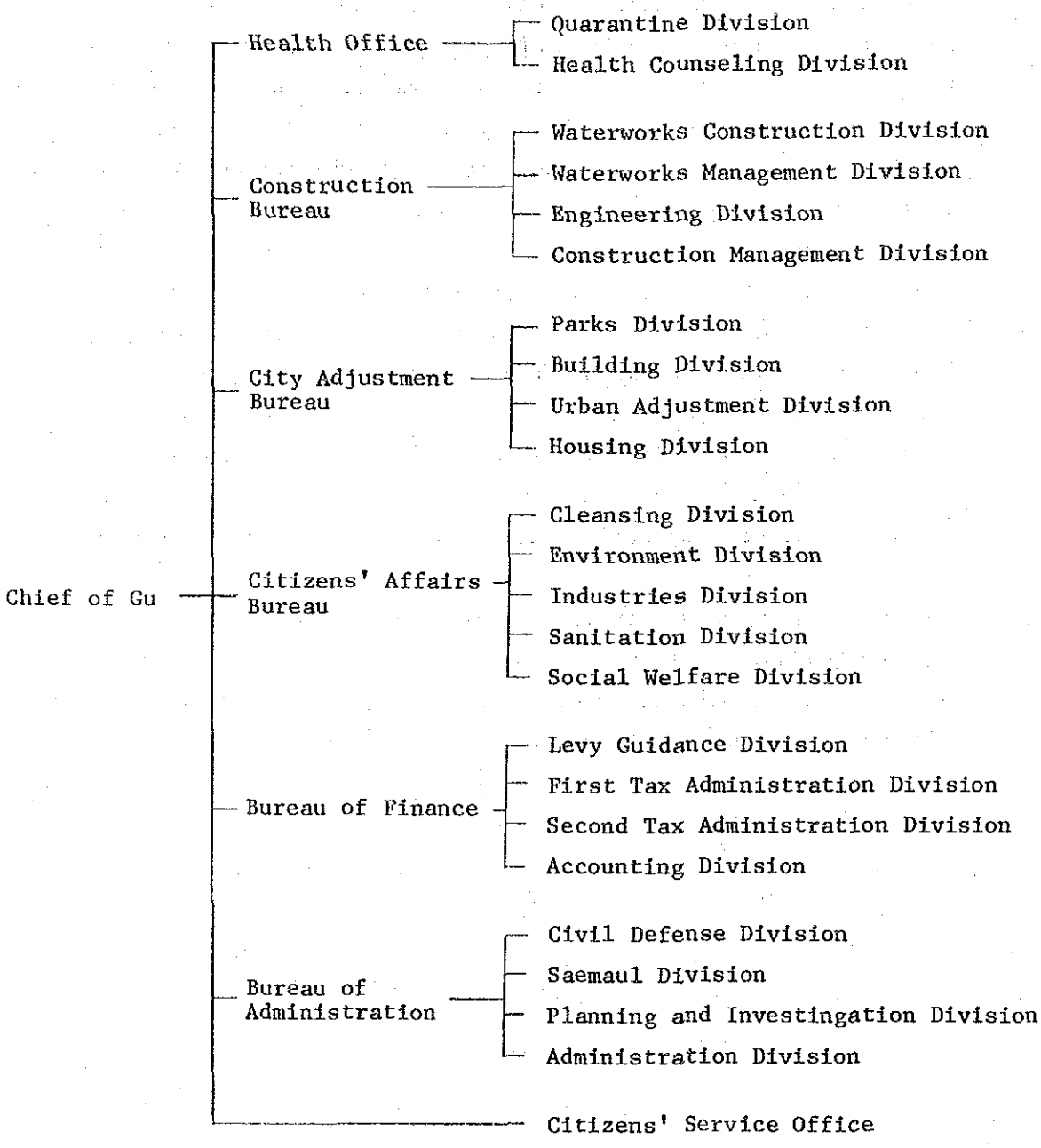


Fig. 2-1-5 Organization Chart of Gu

2-1-3 Collection and Transportation

(1) General Situation

The flow of the existing waste collection and transportation system taken by Seoul City is indicated in Fig. 2-1-6. Collection is carried out manually mainly by two methods: 1. placing collected waste into hand carts and transferring onto trucks, and 2. transferring directly onto trucks. Then the loaded trucks are hauled to the disposal site.

The total cost of collection and transportation is estimated by Seoul City Authority about five to six thousand won per ton.

Although this value is very low compared with that of foreign municipalities, it is expected to increase in proportion to the escalation of personnel expenses in future, because a large portion of this cost consits of personnel expense for a present hand cart system.

(2) Collection Situation

In 1983, of the total collected rate of about eight million tons of waste, about 62% was by Seoul City personnel and the remainder 38% was commissioned to private firms. The main served sources of the public collectors are independent houses, while the private companies collect from commercial establishments and apartments. Though sources generating more than 300 kg/day are to self-dispose of their own waste, these are primarily contracted to private firms. The non-collected population is less than 0.1% of the total.

The number of city workers in 1983 in Seoul was 7,633, of which 5,156 were collection workers and the remainder were road sweepers. Private companies employed 2,180. The city owned 8,390 hand carts in 1983 and private firms owned 1,819 carts. The duty area of the collection workers covers from 110 to 140 houses. The average amount of waste collected by the workers is 2,600 kg per person per day for public workers and 4,700 kg/per/day for private collectors.

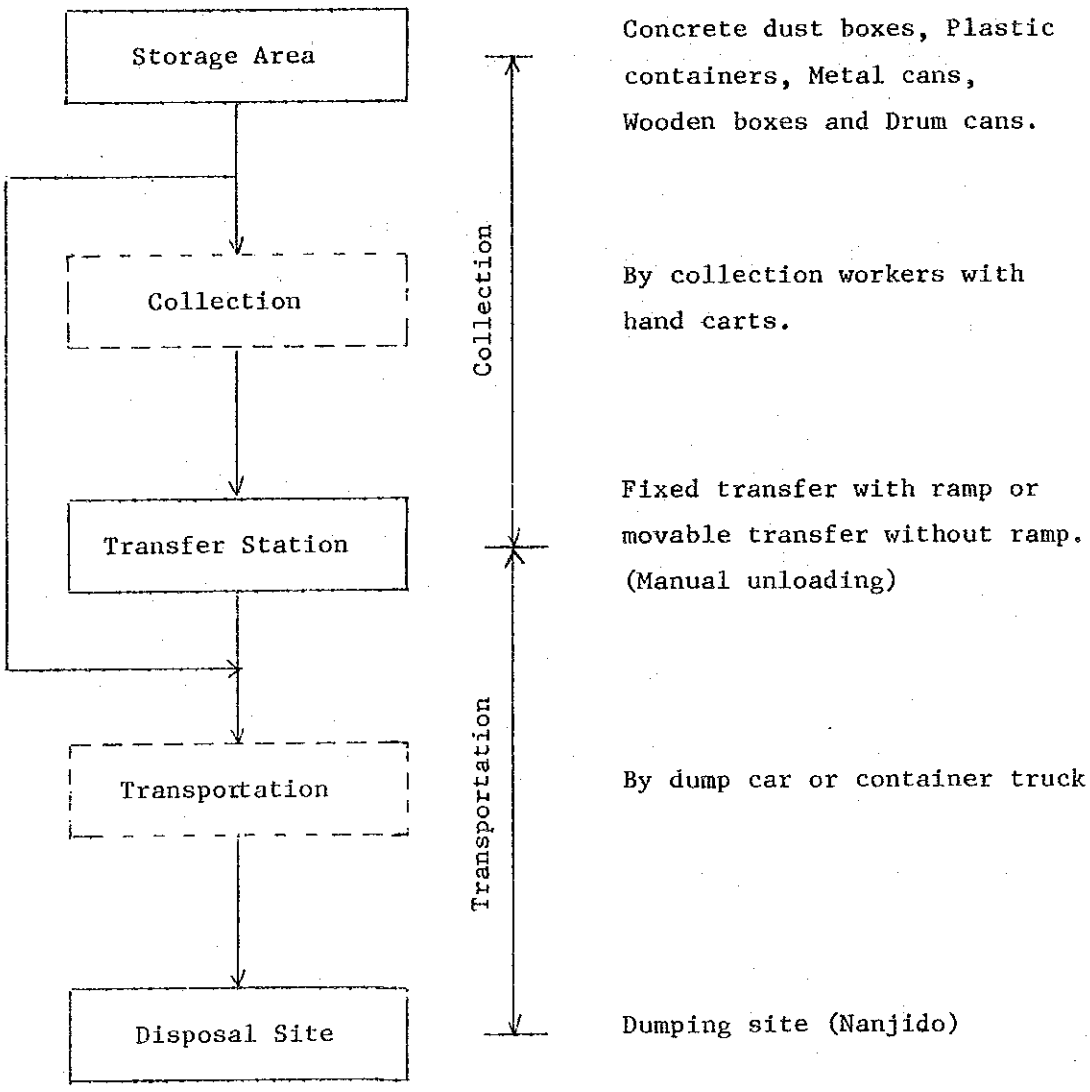


Fig. 2-1-6 Flow of Waste Collection and Transportation

At the present times, three kinds of collection methods are applied (Fig. 2-1-7).

- Door-to-door collection by hand carts
  (for independent houses)

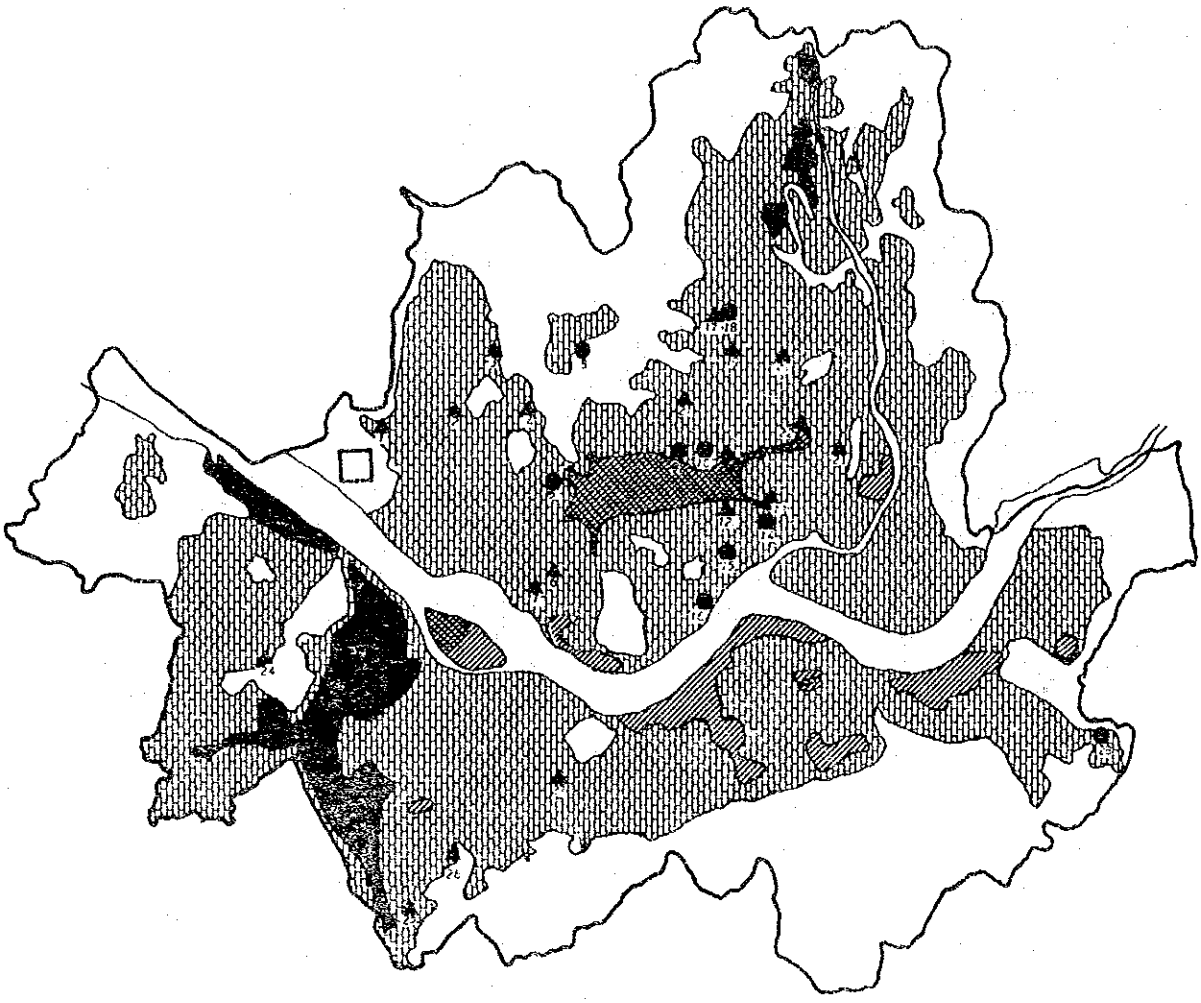
- Bell ringing collection by hand carts
  (for independent houses in weak collection areas which have very steep topography or very narrow alleys)

- Truck collection
  (for apartment houses, office, hotels and markets)

The on-site storage methods used by independent houses include the traditional concrete dust boxes, plastic containers, wooden crates, metal cans, drum cans and bags. Almost all of the apartments possess dust chutes for waste storage, and in a few cases, waste is brought directly to refuse containers stationed along streets.

The waste storage rooms (dust chute pits) used by apartments are generally located below the ground level without considering the method of collection. Therefore, the storage area becomes unsanitary due to leachate formation propelled by rain water and the odors generated. Furthermore storage rooms become nesting places for rats and insects. Collection workers have to transfer these wastes from these small outlets into baskets and carry them to hand carts and collection trucks; hence operation efficiency is very low.

In principle, collections should take place everyday, but actually, over 50% of the collections are performed three times a week.



Industrial area

Commercial area

Apartment house

Door to door Collection

No collection area

Pannier collection

Bell ringing collection) weak collection site

Disposal site (Nanjido)

Fig. 2-1-7 Collection Area

(3) Transportation Situation

There are 696 small scale transfer stations for unloading solid waste from hand carts into dump trucks or containers. These transfer stations are located along streets, rivers and open areas, and are enclosed with simple metal fences. However citizens complain about the dust and odors generated, and unaesthetic appearances and unsanitary conditions.

Manual unloading methods are used in most cases. Stations without ramps are especially dangerous when collection workers unload solid waste from hand carts into dump trucks using two wooden planks.

Seoul authorities use only 9 loaders for the unloading operation at a few transfer stations. In April, 1984, the municipality owned 512 transportation vehicles. The average round-trip distance travelled by these vehicles was 32 km.

(4) Collection Fee and Tips

The collection fee paid by waste generators depends on the house type and floor area. The fees based on source types are listed below.

Table 2-1-2 Base Collection Fee

Source Type	Floor Space (m2)	Fee (₩/mon)
Independent House	33	130
Apartment	33	400
Commercial Establishment	16.5	800
Large Amount Generator	1	4,000

According to results of a questionnaire survey, tips received by collection workers from waste generators ranged from 500 to 5,000 wons per month with an average of ₩2,000/mon. The survey also indicated that almost 60% of the residents thought that the tip they pay was reasonable.

2-1-4 Final Disposal

(1) Background of Landfilling

Landfilling is defined as a final disposal method and is treated in a similar manner as incineration, recycling and composting in the Refuse Cleansing Law. A legal landfill site is specified to be an area of over 3,300 m^2 with a landfilling volume of over 10,000 m^3. In addition, the Seoul refuse cleansing regulation states that the mayor has the power to give permission for landfilling when owners intend to fill refuse into their land only for the following reasons.

1. Ground levelling for residential use.
2. Conversion of wasteland into cultivated land.
3. Refilling of gravel borrow pits and other excavated areas.
4. Soil conditioning of cultivated land.

However, since most landfillings in the past were carried out by filling open trenches and swamplands, insufficient records and data on disposal were kept. Furthermore, these were not recognized as final disposal methods, but rather as land reclamation measures.

(2) Nanjido Landfill Site

Nanjido disposal site is located at the western side of Seoul in Mapo Gu. The filling operation started in 1974 and was legally authorized by the City Planning Law in 1978. With an area of 294.1 ha, this is recognized as the only major disposal site for Seoul. However, in 1984, about 90% of the site was filled.

The dumping site at Nanjido is divided into four sections, of which three are for public trucks and one for private vehicles. The disposal rates in 1983 are presented in Table 2-1-3. The average truck loading density is about 0.5 t/m^3, which implies a loading rate of about 70% to nominal capacity.

Table 2-1-3 Disposal Rate at Nanjido (1983)

Category	No. of Trucks		Disposal Rate		Area
	Daily Average	Annual Total	Daily Average (ton)	Annual Total (1,000 ton)	
Public	1,359	495,974	9,500	3,467	Annual 6,079 ha
Private	931	339,749	4,542	1,658	
Industrial Waste	35	13,086	194	71	
Others	300	109,500	1,350	493	
Total	2,625	958,309	15,586	5,689	

The landfill method is an open dump system with final cover. Whenever a solid waste layer becomes approximately 7 m, a 60 cm layer of soil is covered. Then, the filling procedure is repeated at the next fill area. Consequently, the interior of the fill becomes anaerobic, resulting in production of methane gas, highly organic leachate, offensive odor and other environmentally unacceptable matter. The water quality of samples taken around Nanjido is indicated in Table 2-1-4.

Table 2-1-4 Annual Average Water Quality

Indicator	Leachate Taken at Nanjido	Water Sample from nearby Stream
pH	7.7	7.7
BOD (mg/ℓ)	10,000	46
COD (mg/ℓ)	2,100	23
SS (mg/ℓ)	230	60
T-P (mg/ℓ)	20	7
NH_3-N (mg/ℓ)	1,400	30
NO_2-N (mg/ℓ)	0.1	0.5
NO_3-N (mg/ℓ)	3.2	0.5