

3. Transfer station cost of Model-1 is expensive compared with Model-2 due to capacity difference.

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

The short term improvement project is the first stage of the master plan, and therefore the concepts proposed in the master plan are applicable. The simplified system flow of solid waste for this project is depicted in Fig. S-8. Basic planning on this system flow was carried out and the basic specifications are compiled in Table S-15, and the mass balance of the waste is explained in Fig. S-9.

III-3 Project Schedule for Implementation

The proposed implementation schedule for Gangdong Gu is shown in Table S-16. This proposal covers the period from 1985 up to the year 1988. This is in accordance with the implementation schedule of the master plan.

Three major items are required in the pre-construction phase following this Study, namely detail design, land acquisition and tendering in addition to finance negotiations unless the project is financed from Korean sources. Table S-16 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-17.

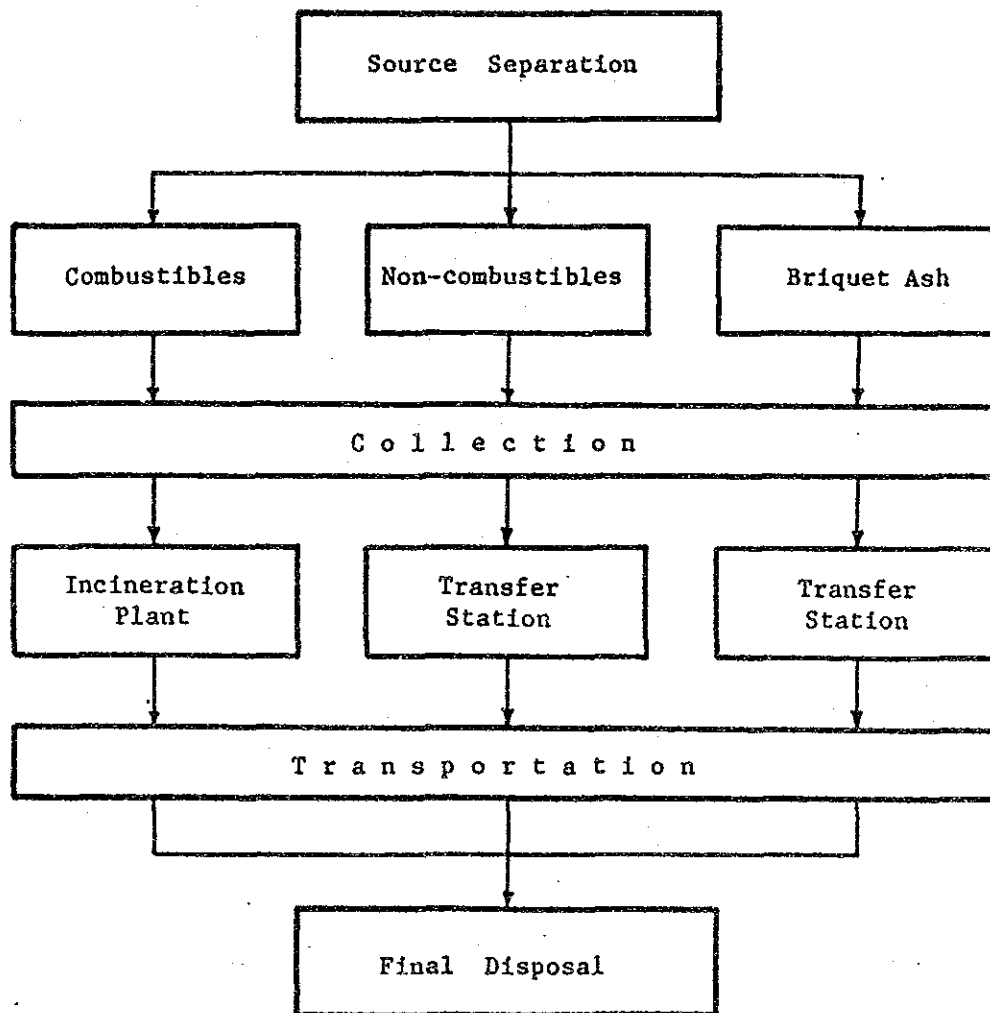


Fig. S-8 Project System Flow

Table S-15 Basic Specifications for Short Term projects

Item	Specification
Specification Components	<ol style="list-style-type: none"> 1. Combustibles 2. Non-combustibles 3. Briquet ash
On-Site Storage	<ul style="list-style-type: none"> - Plastic buckets with lid - Plastic and paper bags
Collection Method	<ul style="list-style-type: none"> - Station or curbside - Collection of briquet ash with container boxes
Collection Vehicles	<p>2 t and 4 t trucks:</p> <ul style="list-style-type: none"> - Compactor trucks for combustibles - Dump trucks for non-combustibles and briquet ash
Transfer	<p>Mechanical transfer station for non-combustibles, briquet ash and non-incinerated combustibles with capacities of:</p> <ul style="list-style-type: none"> - Gandgong Gu --- 1,250 t/day
Transportation	10 t container trucks
Processing	<ul style="list-style-type: none"> - Stocker type incineration of combustibles with power recovery and capacity of 600 t/day - Simple material sorting of non-combustibles at transfer station
Disposal	<ul style="list-style-type: none"> - 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

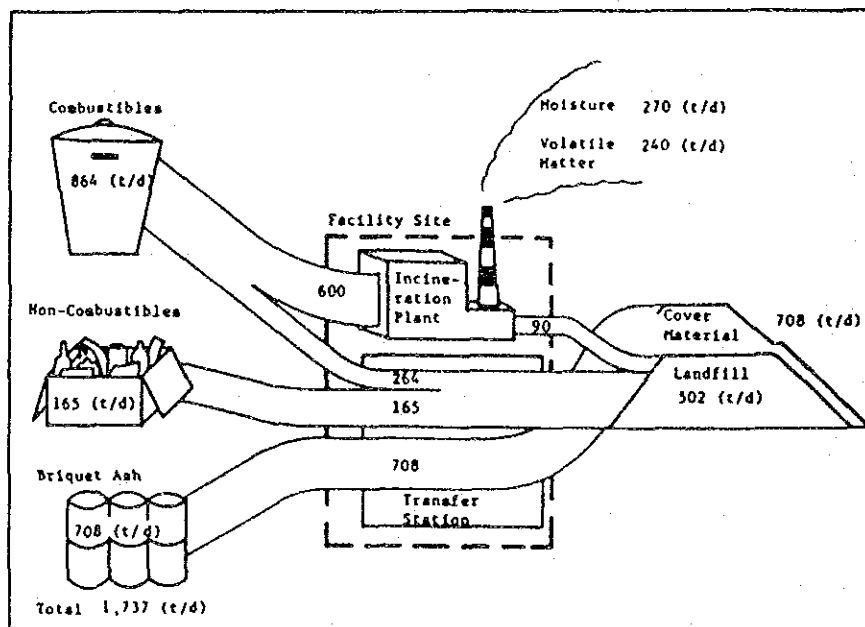


Fig. S-9 Flow of Separated Waste in Gandgong Gu (1988)

Table S-16 Implementation Schedule for Short Term Projects

Programs	1985	1986	1987	1988
1. Loan Negotiation	2			
2. Land Acquisition				
3. Tender for Detail Design		2		
4. Soil/ Topographic Survey		2		
5. Review of Feasibility Study		4		
6. Detail Design			6	
7. Tender for Construction			2	
8. Construction				15
a. Incineration				
- Civil/Building				10
- Equipment/Installation				6
- Test Run				3
b. Transfer Station				10
9. Purchase of Operation Vehicles				7

Table S-17 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	
Land Acquisition	1,845,000	-	1,845,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Engineering Service	119,160	447,440	566,600	116,280	271,470	387,750	45,560	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	45,560	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. Nanjido	198,320	-	198,320	75,010	-	75,010	75,010	-	75,010	74,950	50,320	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
Land Acquisition	-	-	-	-	1,845,000	-
Engineering Service	-	-	-	-	281,000	904,900
Detail Design	-	-	-	-	167,100	639,200
Supervision	-	-	-	-	113,900	265,700
Construction	-	96,600	-	-	11,613,500	12,785,000
a. Incinerator	-	-	-	-	10,265,000	12,785,000
- Civil and Building	-	-	-	-	6,973,000	-
- Mechanical Equipment	-	-	-	-	1,148,000	11,174,000
- Piping	-	-	-	-	776,000	-
- Electrical Equipment	-	-	-	-	1,368,000	1,611,000
b. Transfer Station	-	96,600	-	-	1,348,500	-
- Civil and Building	-	-	-	-	551,700	-
- Equipment	-	96,600	-	-	796,800	-
Operation Vehicles	-	5,388,000	1,147,500	-	24,994,500	-
a. Collection	-	2,893,500	-	-	11,574,000	-
b. Transfer	-	2,494,500	1,147,500	-	13,420,500	-
Landfill	53,220	266,340	943,350	2,359,420	8,912,980	-
a. Nanjido	-	-	-	-	594,970	-
b. Incheon I	53,220	-	-	-	4,748,900	-
c. Incheon II	-	266,340	943,350	2,359,420	3,569,110	-
Subtotal	53,220	5,250,940	2,090,850	2,359,420	47,646,980	13,689,900
Physical Contingency	5,320	575,090	209,090	235,940	4,764,700	1,368,990
Total	58,540	6,326,030	2,299,940	2,595,360	52,411,680	15,058,890

- 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 disbursed in 1987 and 80% in 1988.
- 3) Wheel loader is purchased in 1988 and this cost (96,000 x 10³ 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 Nanjido and Incheon complied 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 depreciation cost is excluded in this Table.

III-4 Project Evaluation

4-1 Financial Evaluation

The financial internal rate of return (FIRR) was calculated for the purpose of evaluating the financial feasibility of the project. The FIRR is computed for several cases by varying the "self-sustaining degree" (ratio of total direct revenue to the total cost of waste management) of solid waste management as well as the level of collection fee.

The rationale of the FIRR calculation is outlined as follows. The solid waste management project is not implemented for profit-making but for the indispensable needs of society. This kind of project produces high socio-economic benefits to society even if its financial return is low. It is, therefore, financially feasible if the FIRR is higher than the interest rate of financial sources available to the project. A 5-percent FIRR is adopted as the selection criteria for the project in consideration of the present interest rate on loans for the Government in Korea as well as that of bilateral loans.

The FIRR was calculated for 7 alternative cases (Table S-18). 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-18 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 Social and Other Impact Evaluation

Project evaluation should be made from two aspects.

- If the objective of the Project is reasonable, and
- If the implementation plan fits the objective, and is the most effective.

The basic concepts of the Project are the same as those of the Master Plan, which aim to ensure the effective and sanitary management of waste from generation to final disposal.

Social and other impact evaluation is made on each subsystem considering the above concepts.

(1) Incineration Plant

The main impacts due to the plant are:

- Contribution to the local community by district heating
- Improvement of roads around the plant

- Lower values of adjacent land
- Air pollution by emission gas if the proper measures are not provided

Although the cost needed for construction and operation of the plant is not small, the Project should be implemented as soon as possible, because land acquisition is becoming more difficult in Seoul. Incineration of all the combustible waste should be set as a target as it is the most effective method of volume reduction. The devices to prevent air pollution by emission gas and the wastewater treatment facilities should be provided.

(2) Collection and Transportation

Effectiveness of solid waste management depends on establishment of effective collection and transportation system.

Advantage and disadvantage of the Project are shown in Table S-19.

Table S-19 Advantage and Disadvantage of Project

	Advantage	Disadvantage
Separate Collection	<ul style="list-style-type: none"> . Fitness for incineration and material recovery 	<ul style="list-style-type: none"> . High cooperation of citizens is required
Vehicle Collection	<ul style="list-style-type: none"> . High collection efficiency . Decrease in traffic accidents to workers . Sanitary collection . Improvement of working conditions . Saving the operation cost . Improving the status of workers 	<ul style="list-style-type: none"> . Concentration of vehicles . High truck purchase cost

As shown in Table 4-2-18, cost of the proposed system does not differ a lot from the existing system. As the share of personnel expenses in the existing system is high, the proposed system is expected to be more economic in the future as the personnel expenses would rise rapidly.

(3) Material Recovery

Material recovery is an excellent method of intermediate processing, because it has the following advantages:

- It enables effective use of resources
- It reduces the disposal volume of waste

Besides these advantages, the material recovery system would promote enhancement of recognition about limited amount of natural resources. Thus, it works to spread consideration of resource saving, and consequently reduces the generation of waste.

4-3 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-20.

Table S-20 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

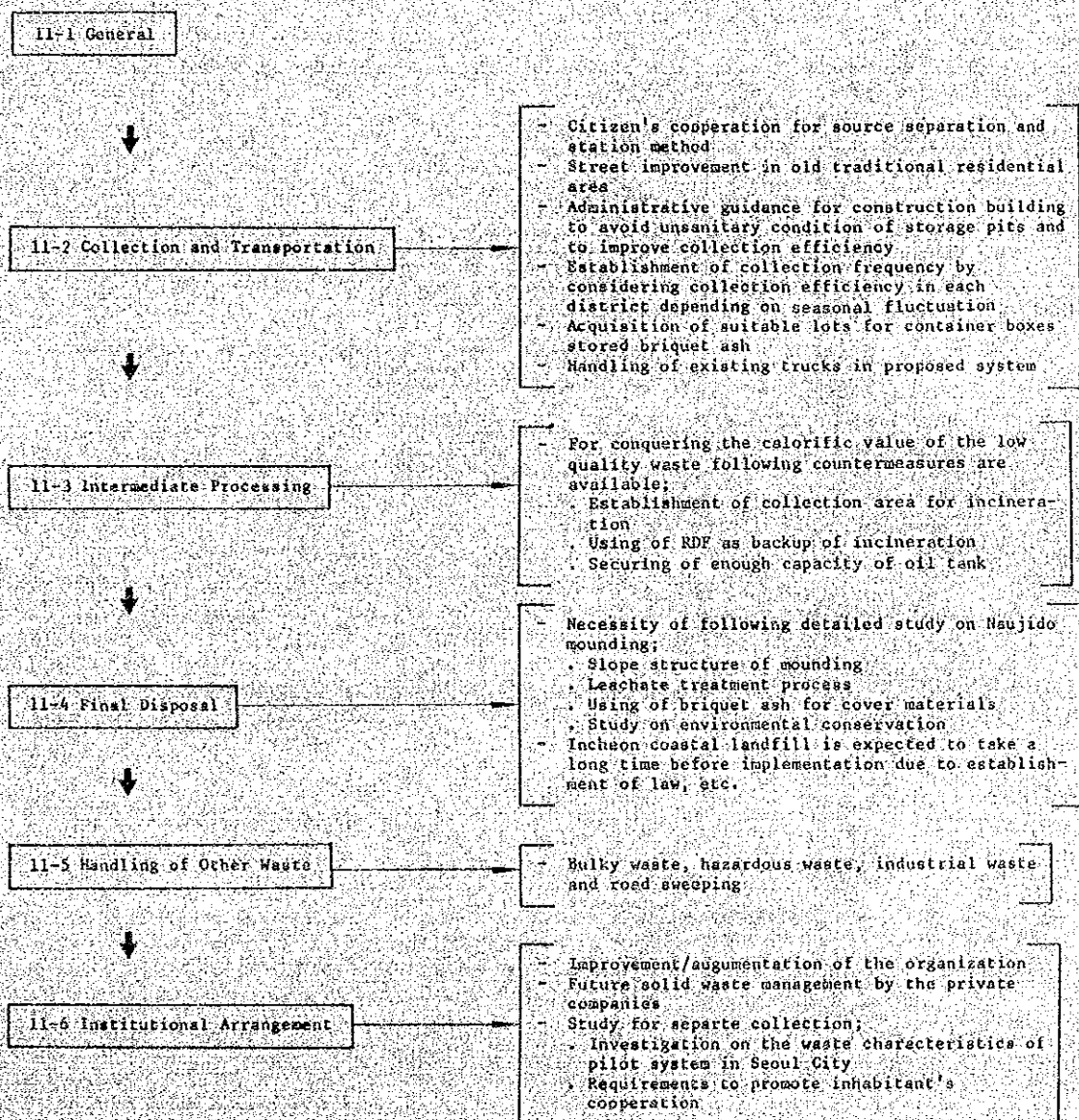
Legend: o = Superior, Δ = Acceptable, x = Inferior

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

PART IV CONCLUSION AND RECOMMENDATIONS:

(1) Chap. 11 CONCLUSION AND RECOMMENDATIONS



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 alternatives 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 m³/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 m³/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-21.

Table S-21 Recommendations on Jurisdiction

Duty	Jurisdiction	Comment
Collection	Gu	<ul style="list-style-type: none"> - Presently under jurisdiction of Gu - Requires close communication with residents
Haul to Transfer Station	Gu	<ul style="list-style-type: none"> - Presently under jurisdiction of Gu - Requires close communication with residents
Transfer Station and Transportation from Transfer Station to Landfill Site	City	<ul style="list-style-type: none"> - Requires a unified management of trucks serving all transfer station - One station may serve more than one Gu
Intermediate Processing Facility	City	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Though Nanjido is presently managed by Mapo Gu, the city has responsibility for implementation of the mounding plan

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