MEIP City Working Paper Series

Options for Domestic Solid Waste Treatment in Beijing

A Study by the
Beijing Environmental Sanitation Administration

January 1996

Metropolitan
Environmental
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ABBREVIATIONS

BESA	Beijing Environmental Sanitation Administration
ESB	Environmental Sanitation Bureau
RMB	Chinese Yuan
kcal/kg	kilo-calorie per kilogram
kJ/kg	kilo-joule per kilogram
MPa	mega Pascal

INTRODUCTION

Urban refuse treatment is a serious problem facing many large cities. Beijing, the capital of China, is a metropolis where environmental protection and improvement are vital for it to develop into a modern international city. Since 1986, a number of improvements have been made regarding solid waste disposal. The Beijing Municipal Government has allocated funds and has acquired 400 hectares of land to build 15 domestic solid waste transfer stations and dumping sites. A World Bank loan has been obtained to construct a sanitary landfill facility. A grant from the government of Germany has been received to construct a waste transfer station, composting plant and sanitary landfill site. These projects will be finished and begin operation in 1995. Domestic solid waste treatment facilities and waste management in Beijing are being improved step by step to meet the demands of a modern city.

Based on data through 1991, this paper gives an overall introduction to domestic solid waste management and disposal in Beijing. The general goal of achieving environmental sanitation modernization is described, and analysis of the implementation plan is detailed.

Chapter 1. DESCRIPTION OF THE PLANNING AREA

Scope The area under investigation for the domestic waste management and disposal in Beijing encompasses the 18 districts and counties under the jurisdiction of the Beijing Municipal Government (see Figure 1-1). The districts and counties are classified as urban (four districts), suburban (four districts) or outlying areas (eight counties and two districts) according to their distance from the center of the city.

Urban Areas:	Dongcheng District, Xicheng District, Chongwen District and Xuanwu District;
Suburban Areas:	Chaoyang District, Haidian District, Shijingshan areas District and Fengtai District
Outlying Areas:	Mentougou District, Fangshan District, Chanping areas County, Shunyi County, Tongxian County, Daxing County, Pinggu County, Huairou County, Miyun County and Yanqing County;

Area and Population Beijing has a total area of 16,807.8 square kilometers, of which 6,390.3 square kilometers (38 percent of the total area) are flat and 10,417.5 square kilometers (62 percent of the total area) are mountainous.

The population of Beijing increases each year. In 1989, the total population was 10,858,000, of which 10,211,000 were permanent residents and 647,000 were temporary residents; these numbers grew to 11,035,000, 10,322,000 and 713,000 respectively in 1990; and to 11,157,000, 10,395,000 and 762,000 in 1991. The permanent resident population and temporary population in the urban areas has been decreased each year while the total population of Beijing increased. That is because, due to urban development, residents of old buildings in the urban areas have resettled to the suburbs. The population of the suburbs is increasing relatively rapidly. In addition, there is a large transient (non-residential) population in Beijing, approximately 800,000 in 1990.

Climate Located in a warm, semi-humid monsoon zone, Beijing is dominated by a continental monsoon climate. It has a varied topography, surrounded by mountains in the west, north and northeast and bordered by a plain in the southeast. The northwest terrain is therefore higher than the southeast plain, and the climate differs significantly between the flat and mountainous areas. Beijing has distinct seasons. The average annual precipitation of 600 millimeters is mainly concentrated in July and August; the average temperature in the summer is 26^{0}C, and that in the winter is 6^{0}C. The heating season is from November 15 to March 15.

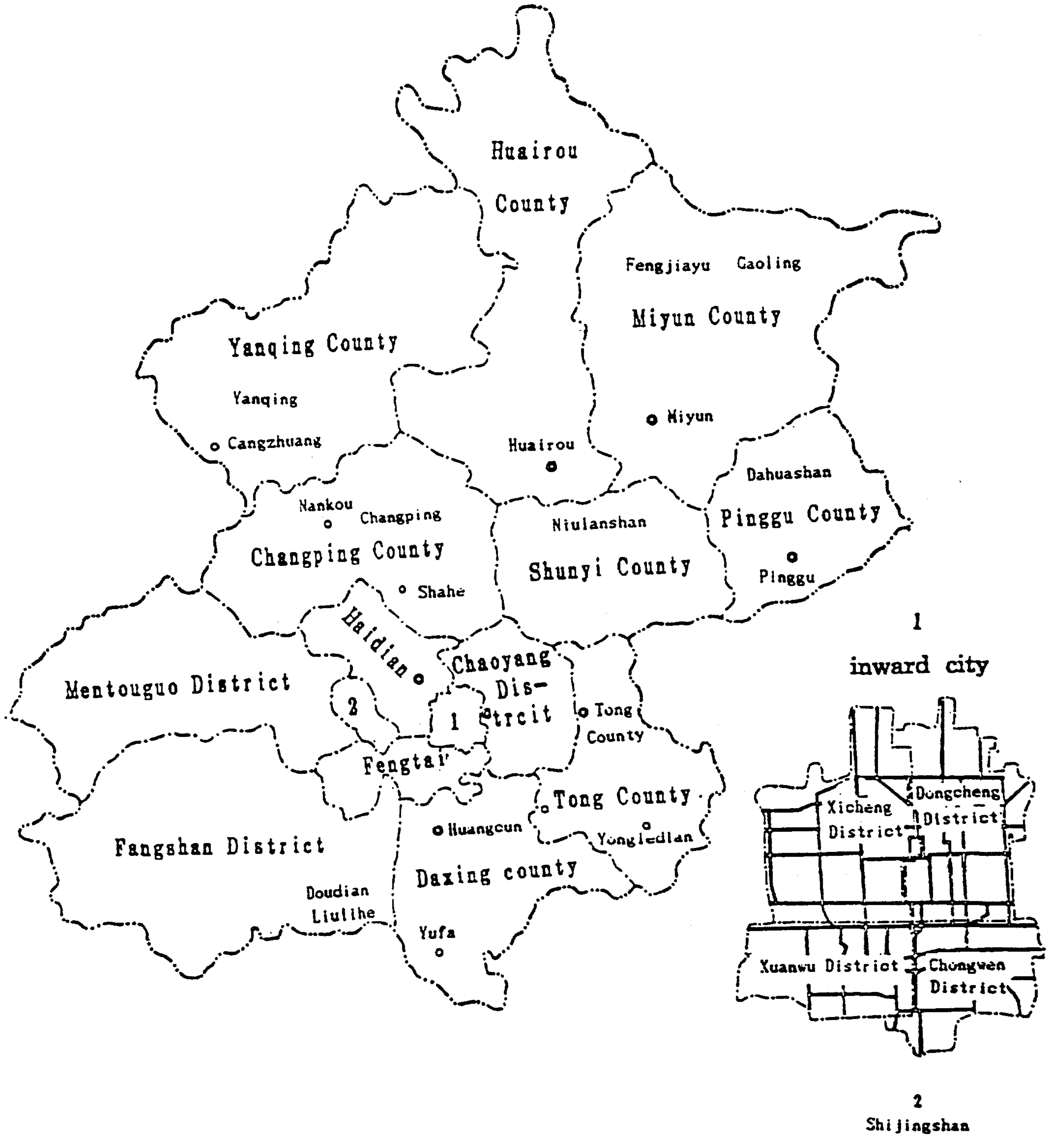

Figure 1-1 Beijing Administrative Divisions Map

Chapter 2. URBAN DOMESTIC SOLID WASTE

Urban Domestic Solid Waste Data

Generation Quantity Due to urban development, population growth, and consumption increase, the volume of urban domestic refuse generation increases every year. It increased from 2,744,000 tons in 1986 to 3,971,000 tons in 1991, an annual rate of increase of 8.2 percent (see table 2-1 and figure 2-1). From table 2-1, it is evident that refuse generation was mainly concentrated in the urban and suburban areas and that the domestic refuse generation rate in the suburban areas increased much more rapidly than in the urban areas. This is attributable to urban development, which has resulted in urban migration to the suburbs where the permanent resident and transient populations are increasing, creating a net flux to the suburbs.

Every year, there are three refuse generation peaks in Beijing. The first peak occurs during the heating season from December to April, caused by increased coal consumption for heating in single-story residences. The second peak occurs in July, when many vegetables and fruits, especially watermelon, are harvested and sold. Statistics show that in 1988, 350 million kilograms of watermelon were sold. Since watermelon rinds comprise 40 percent of total melon weight, waste from watermelon rinds was 140 million kilograms. The third peak occurs from late October to December, when leaves fall from the trees and accumulate in the urban areas and residents store a large supply of cabbage. Statistics show that from 350 million kilograms of cabbage on the market in 1988, 15 percent (or 50 million kilograms), of the cabbage became refuse.

Refuse Composition The composition of refuse varies according to location in the city, standard of living, energy source, amount of vegetation in the area, and season. Refuse in Beijing is mainly composed of food, grass and plants, brick and tile, ash and dirt, and waste materials. Table 2-2 and table 2-3 describe refuse composition in 1990 and 1991. From the tables, it is evident that refuse from single-story residential areas and from the city as a whole (as measured at refuse sites) contains more ash and dirt, which have high densities. The high ash and dirt content in the waste is from coal heating since gas heating is not widespread. Refuse in densely populated areas with gas heating contains mainly food and water, so the density is also high. Refuse in upper-class residential, hospital and institutional areas contains more paper than refuse from other areas.

Table 2-4 presents the composition of mixed refuse in waste dumping sites from 1986 to 1991. The table shows that brick, tile, ash and dirt accounted for an average of 50.42 percent of the refuse; organic waste accounted for 31.8 percent; waste materials 12.78 percent. In 1991, there was a significant decrease in the percentage of waste materials contained in refuse due to increased waste purchasing and scavenging. If proper waste collection methods were adopted to reduce the waste material content of refuse, the transportable quantity of refuse would greatly decrease.

Table 2-1 Refuse Generation in Beijing

	Refuse generated per year (Unit: 10,000 tons)						
	1986	1987	1988	1989	1990	1991	1992
Total of all areas	**274.4**	**298.3**	**319.9**	**337.0**	**384.1**	**397.7**	**430.7**
Urban areas total	**127.1**	**127.8**	**138.7**	**144.4**	**155.0**	**152.1**	
Dongcheng	33.6	34.0	35.4	38.8	40.3	35.9	
Xicheng	36.6	37.7	42.8	45.4	47.1	40.3	
Chongwen	24.6	26.0	28.2	30.4	31.8	35.8	
Xuanwu	32.3	30.1	32.8	29.8	35.8	46.1	
Suburban areas total	**106.6**	**128.9**	**144.7**	**154.2**	**175.8**	**198.1**	
Chaoyang	36.9	45.9	49.3	49.8	53.2	73.0	
Fengtai	24.7	30.7	32.8	32.8	34.5	36.3	
Shijingshan	7.1	9.2	11.0	12.1	13.2	13.6	
Haidian	37.9	44.1	51.6	59.4	14.9	75.2	
Outlying areas total	**40.7**	**41.6**	**36.5**	**38.4**	**53.3**	**46.8**	
Mentougou	8.5	9.0	9.7	9.3	12.2	12.5	
Fangshan	5.4	5.3	4.6	4.6	5.1	5.4	
Changping	1.2	1.2	1.6	1.4	1.4	1.6	
Shunyi	3.6	4.3	2.1	3.4	3.8	4.5	
Tongxian	11.2	11.0	9.5	10.6	20.0	10.7	
Daxing	1.8	2.6	1.5	1.2	2.4	3.4	
Pinggu	1.0	1.0	1.0	1.2	1.2	1.4	
Huairou	3.8	3.6	3.1	3.0	3.0	3.0	
Miyun	3.3	2.4	2.0	2.5	3.1	3.1	
Yanqing	0.9	1.2	1.4	1.1	1.1	1.3	

Figure 2-1 Diagram of annual refuse generation

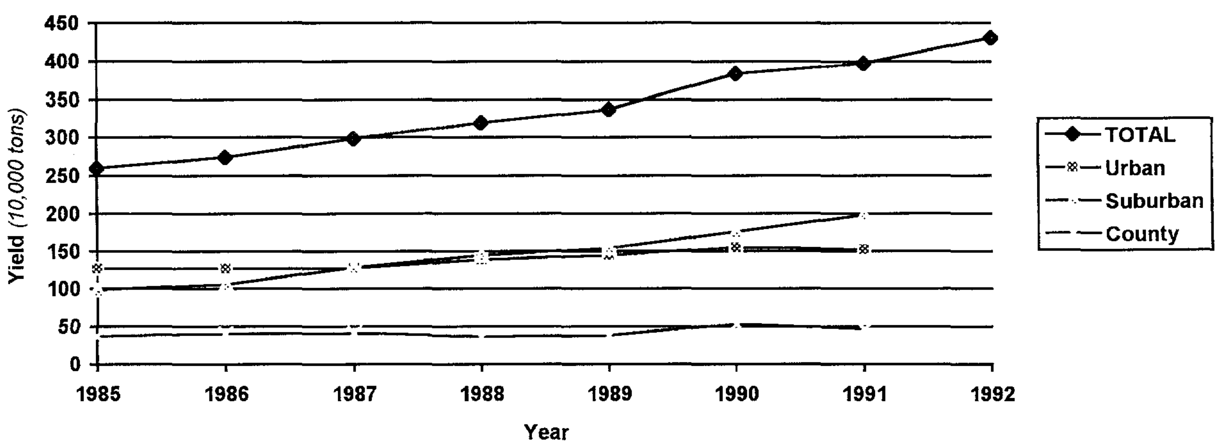

Table 2-2 Refuse Composition in 1990 (annual average) *Standard = moisture*

Constituent (%)	Refuse site	Gas-heated buildings	Upper-class residential areas	Commercial Areas	Hospitals	Institutional areas	Single-story residential areas
metal	0.09	0.64	4.64	0.94	1.98	2.18	0.92
glass	3.10	7.16	16.19	7.13	12.59	13.22	2.32
paper	4.56	5.65	36.21	18.38	34.29	32.21	4.32
plastic	4.08	4.48	10.99	9.76	8.61	9.28	3.28
fabric	1.82	0.85	2.97	4.34	4.63	3.00	0.69
food	23.79	79.00	22.46	21.07	37.49	24.76	28.23
grass and plants	4.13	0.95	2.04	29.12	0.41	11.34	7.25
ash and dirt	51.22	0	0	9.31	0	2.19	46.84
brick and tile	4.11	1.27	1.69	2.84	0	1.09	0
misc.	3.10	0	2.83	0	0	0.73	5.58
water content	30.17	64.50	30.36	40.39	44.14	35.76	39.76
density (t/m^3)	0.36	0.21	0.16	0.15	0.17	0.15	0.31

Table 2-3 Refuse Composition in 1991 (annual average) *Standard = moisture*

Constituent (%)	Refuse site	Gas-heated buildings	Upper-class residential areas	Commercial Areas	Hospitals	Institutional areas	Single-story residential areas
metal	0.08	1.41	5.20	3.16	2.09	1.59	0.21
glass	1.56	2.10	15.68	8.20	10.31	14.35	1.91
paper	3.00	6.23	30.23	19.86	27.38	39.83	3.98
plastic	4.18	5.18	18.30	10.72	9.07	7.10	4.76
fabric	1.16	1.07	1.96	2.01	2.04	3.20	0.92
food	24.52	82.27	19.92	11.05	26.23	33.56	43.26
grass and plants	7.02	0.85	7.12	38.03	15.77	0.38	4.83
ash and dirt	56.69	0	0	6.83	5.51	0	39.99
brick and tile	1.71	0.90	1.57	0.13	1.60	0	0.14
misc.	0	0	0	0	0	0	0
water content	15.96	59.25	29.55	34.31	34.31	44.65	47.27
density (t/m^3)	0.750	0.231	0.130	0.195	0.137	0.156	0.307

Table 2-4 Classification of Mixed Refuse Composition (%) *Standard = wet method*

		Percentage per year					
		1986	1987	1988	1989	1990	1991
Organic	Food	38.25	29.17	26.11	15.0	23.79	24.52
	Plants and grass	4.05	2.59	1.52	10.24	4.13	7.08
	Total	**42.3**	**31.76**	**27.63**	**25.24**	**27.92**	**31.60**
Inorganic	Brick and tile	4.11	4.59	3.25	0.94	4.11	1.71
	Ash and dirt	42.63	48.21	55.18	29.92	51.22	56.69
	Total	**46.74**	**52.80**	**58.43**	**30.84**	**55.33**	**58.40**
Waste material	Paper	5.2	7.79	5.6	5.66	4.56	3.0
	Metal	0.8	1.07	1.37	0.24	0.09	0.08
	Plastic	1.66	2.27	1.65	1.91	4.08	4.18
	Glass	2.14	2.37	4.0	3.08	3.1	1.56
	Fabric	0.59	1.38	1.32	2.46	1.82	1.16
	Total	**10.39**	**15.38**	**13.94**	**13.35**	**13.65**	**9.98**
Water ratio (%)		41.14		36.54	31.98	30.17	15.96
Density (tons/m^3)		0.476		0.539	0.23	0.36	0.75

Chemical Composition of Refuse Table 2-5 shows the percentage of some of the chemical elements contained in refuse. The carbon/nitrogen ratio in refuse can be calculated from the waste composition data, the results of which are shown table 2-6.

Table 2-5 Percentage (%) of Chemical Elements in Refuse

Refuse Items	C	H	O	N	S	Cl
Food	43.52	6.22	34.05	2.79	< 0.3	1.21
Paper	40.37	5.96	39.01	< 0.3	< 0.3	< 0.3
Plastic	82.90	13.20	0.96	< 0.3	< 0.3	< 0.3
Fabric	48.36	5.58	39.59	< 0.3	< 0.3	0.23
Plants and grass	40.54	5.85	33.34	1.66	< 0.3	0.63

Table 2-6 Average Carbon/Nitrogen Ratio in Refuse

	1989	1990	1991	Average
C : N	30.74 : 1	28.06 : 1	33.07 : 1	30.62 : 1

Calorific Value of Refuse Refuse composition varies according to standards of living and type of infrastructure; combustible compositions vary in a similar manner. Refuse from hotels and upper-class residential areas contains more plastic and paper; refuse from hospitals contains higher quantities of packing paper; refuse from institutional and commercial areas contains mainly paper and vegetation. The above types of refuse have high calorific values. Refuse from gas-heated buildings has a high water content; refuse from single-story residential areas and waste dumping sites contains more ash and dirt. The calorific value of these kinds of refuse is lower.

The Beijing Sanitation Science Research Institute tested the calorific value of refuse from May of 1991 to April of 1992 at the following sites: Tuanjiehu Residential Quarters (ordinary gas-heated building area), embassy area (upper-class residential area), Beijing Chemical Engineering University (institutional area), Chaoyang Hospital (hospital area), Beijing Department Store (commercial area), Xiaohuangzhuang Residential Quarters (single-story residential area), and The Great Wall Hotel (hotel area). From the results shown in table 2-7, it is evident that the calorific value of refuse from gas-heated buildings, single-story residential areas and waste sites is lower than that of the refuse from other areas.

Table 2-7 Average Calorific Value of Refuse

Area	kJ/kg	kcal/kg
Gas-heated building	4,534	1,083
Upper-class residential area	8,892	2,146
Cultural and educational area	9,910	2,367
Hospital area	7,557	1,805
Commercial area	8,172	1,952
Single-story residential area	2,846	682
Refuse sites	2,873	686
Hotels	10,868	2,596

Current Domestic Solid Waste Management

Institutional Management The Beijing Environmental Sanitation Administration (BESA), a bureau of the Beijing Municipal Government, is in charge of environmental sanitation management in Beijing. It carries out its work under the supervision of the Beijing Municipal Administration Committee.

BESA consists of four systems: an administrative bureau organ, a subordinate administrative system, an operations direction and management system and a city sanitation supervision system. Figure 2-2 describes the organization and function of the subordinate administrative system and the operation direction and management system.

(1) BESA directs and supervises the operation of district and county Environmental Sanitation Bureaus (ESBs). These sub-bureaus are under the leadership of the respective district or county government.

(2) The First, Second, and Fourth Cleaning Truck Plants are in charge of dispatching cleaning trucks and drivers for refuse collection in the Chongwen, Xuanwu, Dongcheng and Xicheng districts; ESBs in these districts provide sanitation workers and operators.

(3) ESBs in the suburban and outlying areas are in charge of dispatching cleaning trucks and drivers and road cleaning. The sanitation workers and operators are provided by ESBs.

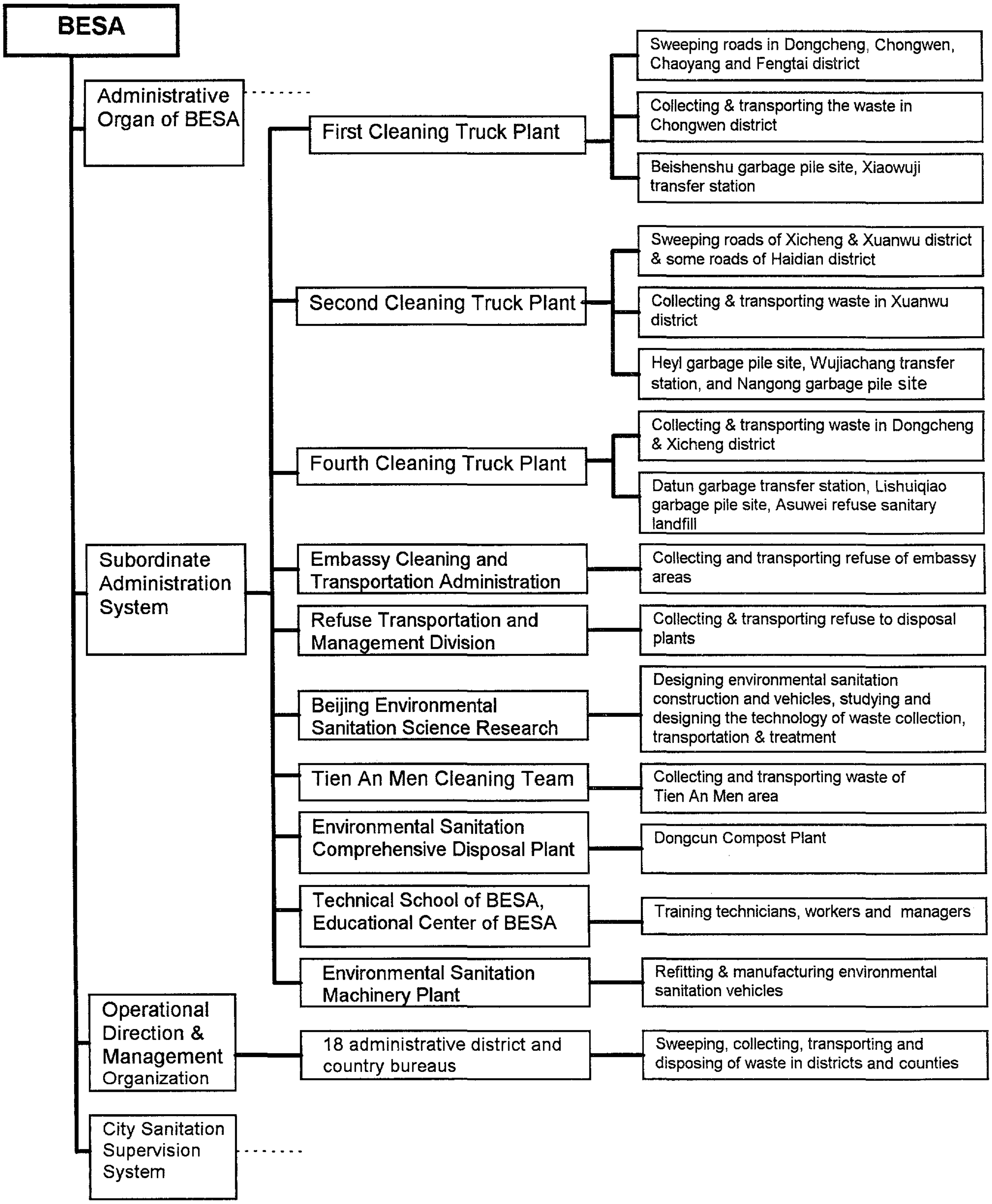

Figure 2-2 Municipal domestic solid waste management system

Road Cleaning Two methods of road cleaning employed in Beijing are mechanical (by sweeper and sprinkler) and manual.

The First and Second Cleaning Truck Plants are responsible for mechanically cleaning the roads in the urban areas and part of the suburban areas; manual cleaning in these districts is managed by the district ESBs. Road cleaning in the outlying districts and counties is carried out by the local ESBs. There is no mechanized cleaning in most of the outlying areas; all the roads are cleaned manually.

(1) In the urban and suburban areas of Beijing, the machines used to clean the roads are sweepers, Jiefang sprinklers, semi-trailer sprinkler, and vacuum cleaners. Currently, 327 roads in the urban areas (52% of the total) are swept during the night and cleaned manually during the daytime.

(2) Statistics show that in 1991, 38,268,000 square meters of pavement were cleaned, including 24,382,000 square meters of vehicle road and 13,882,000 square meters of sidewalk. Among the vehicle road, 10,559,000 square meters were cleaned by machine, and 7,415,000 square meters were washed manually.

Refuse Collection and Transportation

Organization and Management of Refuse Collection Refuse generated in urban areas is collected and transported by the First, Second and Fourth Cleaning Truck Plants and ESBs of each district. The cleaning truck plants are in charge of dispatching refuse collection trucks and drivers; the respective ESBs provide sanitation workers. ESBs in the suburban and outlying districts and counties are responsible for refuse collection and transportation in their district or county. Ordinarily, the entities which generate domestic solid waste entrust and pay the sanitation department to collect and transport the waste. However, hospitals incinerate the medical waste they generate; domestic refuse from hospitals is collected and transported by local sanitation departments.

Methods of Refuse Collection The following are common refuse collection methods. To improve the situation, refuse collection at fixed times, regulations limiting dumping to evening hours and nighttime collection have been implemented in recent years. However, sealed refuse stations (4) mark an improvement over the first three (1-3) methods.

(1) Garbage container station. This method began operation in the late 1970's. Several garbage containers are placed together near a residential area; inhabitants can throw garbage into the containers at any time. When the cleaning truck arrives, the garbage is dumped and the container is replaced.

(2) Garbage hopper station. Similar to the garbage container station, garbage hoppers are much larger. This method is used only in suburban and outlying areas.

(3) Ground garbage site. This method involves enclosing a site with a wall. Garbage dumped into the site is collected by cleaning trucks. This method is used only in suburban and outlying areas. Regarding the above three methods, although cleaning trucks collect refuse daily, residents dump garbage continually, and some inevitably spills. Some of the garbage is exposed to the air and causes environmental pollution. In addition, the containers and hoppers become seriously damaged; more than 100 RMB Yuan is spent yearly on the maintenance of each container and hopper.

(4) Sealed refuse station. This method was developed in the middle and late 1980s. According to this method, each house has two garbage containers accessible to cleaning trucks. Garbage is dumped into the containers; when the containers are full, they are hoisted onto the cleaning truck and taken away. After they are unloaded at the station, they are returned. This method avoids waste exposure to air and secondary pollution. However, the capital cost is very high. As there are no compression facilities, the loading capacity of the containers is also greatly reduced.

In 1991, 276 sealed refuse stations were in operation in Beijing; in 1992, there were a total of 548 sealed stations finished or under construction, of which 402 stations had been put into operation. Of the total domestic solid waste, 56 percent was collected and transported in this way.

(5) Rear-loading compressing cleaning trucks. Rear-loading cleaning trucks are driven to certain locations at fixed times to collect garbage. This method is still in the pilot stage.

Frequency and Time of Refuse Collection In most of the residential areas, shops, hotels, food processing plants and other areas, refuse is collected at least once a day. During peak periods and in areas with high population densities, refuse is collected twice a day or as needed. There are daytime and nighttime shifts for refuse collection; the municipal government requires that 40 percent of the refuse be collected during the night. Refuse of the 100 principal streets is collected during the night while refuse of narrow streets and lanes is collected during the day.

Transfer of Refuse Since the urban areas is far from the dumping and landfill sites, refuse is first transported to transfer stations and then transferred to the designated landfill or dumping site. Refuse generated in suburban and outlying areas is transported directly to the designated dumping site or composting plant. Currently, there are eight equipped waste transfer stations in Beijing. Collected refuse is dumped on the ground at the transfer station, loaded to the transfer vehicle by a front-end loader and then transferred to the designated destination. Table 2-8 describes the eight transfer stations. The locations of the transfer stations are shown in figure 2-3. The operational state of the transfer stations follows:

(1) Datun Transfer Station. Managed by the Fourth Cleaning Truck Plant, 1,500 tons per day of refuse from the Dongcheng and Xicheng Districts are dumped at this station, loaded into the transfer vehicles, and then transferred to the Lishuiqiao Dumping Site. The Datun Transfer Station has now begun operation and is being used as a complement to the Asuwei Sanitary Landfill Site.

(2) Dawangjing Transfer Station. Since land has not been acquired for its corresponding landfill site, this transfer station is not yet in use. The Fourth Cleaning Truck Plant currently uses it as a workshop.

(3) Gaojing Transfer Station. Managed by the First Cleaning Truck Plant, it is not currently in use.

(4) Xiaowuji Transfer Station. Managed by the First Cleaning Truck Plant, 1,000 tons of refuse from the Chongwen District are transported daily to this transfer station. About 300-400 tons of solid waste per day are transferred to the Beishenshu Landfill Site to be dumped there temporarily.

(5) Majialou Transfer Station. Managed by the Cleaning Truck Plant of Fengtai District, it is not currently in operation.

(6) Wujiachang Transfer Station. Managed by the Second Cleaning Truck Plant, 500-600 tons of refuse come into this transfer station daily. A week later, the refuse is transferred to the Nangong Dumping Site or the Anding Landfill Site to be dumped there temporarily.

(7) Wuluju Transfer Station. Managed by the ESB of the Haidian District, 1,000 tons of refuse are transported daily to this transfer station, after which it is transferred to the Sanxingzhuang Composting Plant.

(8) Houbajia Transfer Station. Managed by the ESB of the Haidian District, it is not currently in use.

The above eight transfer stations (except the Datun Transfer Station) are enclosed by walls and do not have any transfer facilities or buildings.

Table 2-8 Refuse Transfer Stations

District	Land Area *(m^2)*	Building Area *(m^2)*	Total Investment *(RMB 1000 Yuan)*	Date of Construction Start	Beginning of Operation	Location
Datun	39,000		7,390			Datun, Chaoyang District
Dawangjing	29,333	545	1,250	March 1985	December 1986	Heping, Chaoyang District
Gaojing	20,000	2,600	1,780	March 1983	June 1986	Gaobeidian, Chaoyang District
Xiaowuji	20,000	2,214	1,550	June 1984	December 1985	Shibalidian, Chaoyang District
Majialou	26,000	200	1,430	September 1983	December 1986	Huangtugang, Fengtai District
Wujiachang	25,333	310	5,110	March 1986		Yuyuantan, Haidian District
Wuluju	30,000	200	1,460	October 1984	December 1985	Yuyuantan, Haidian District
Houbajia	25,333	200	1,340	May 1985	December 1985	Dongsheng, Haidian District
Total	**214,999**	**6,269**	**21,310**			

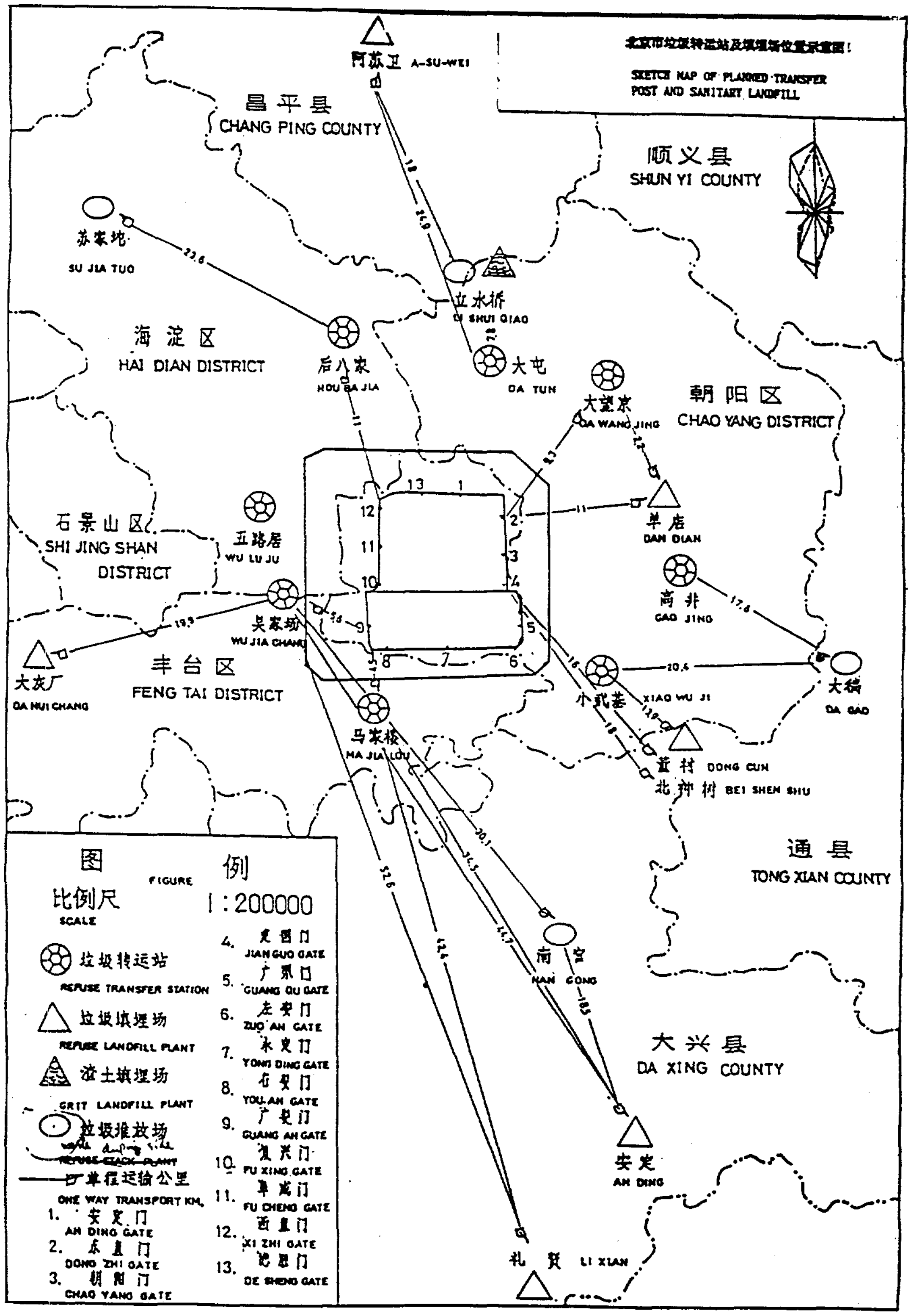

Figure 2-3 Sketch Map of Refuse Transfer Station and Sanitary Landfill Sites

Treatment and Disposal of Domestic Solid Waste Currently, Beijing has four large domestic solid waste dumping sites and five large landfill sites (see table 2-9, table 2-10, and figure 2-3) which are used principally for treating refuse from the urban areas and part of the suburban areas.

Table 2-9 Refuse Dumping Sites

Domestic Dumping Sites	Area of Land *(m^2)*	Construction Area *(m^2)*	Total Investment *(RMB 1000 Yuan)*	Date of Construction Start	Beginning of Operation	Location
Lishuiqiaqo	90,867	320	1,510	March 1982	December 1983	Dongxiao kou, Changping County
Dagao	80,000	300	1,850	July 1982	December 1984	Liyuan, Tong County
Nangong	66,581	300	1,440	June 1982	December 1984	Hongxing Farm, Daxing County
Sujiatuo	65,800	300	1,260	July 1983	December 1983	Sujiatuo, Haidian District
Total	**303,248**	**1,220**	**6,060**			

Refuse Dumping Sites

(1) Lishuiqiao Refuse Dumping Site. Managed by the Fourth Cleaning Truck Plant, 800,000 tons of solid waste have been dumped at this site.

(2) Dagao Refuse Dumping Site. Managed by the ESB of Tongxian County, it is currently used as an Anaerobic Composting Plant with an output of 290-350 tons per day.

(3) Nangong Waste Dumping Site. Managed by the Second Cleaning Truck Plant, it has received 300,000 tons of waste.

(4) Sujiatuo Refuse Dumping Site. It is not currently in use.

Table 2-10 Refuse Landfill Sites

Refuse Landfill Sites	Area of Land *(m²)*	Construction Area *(m²)*	Total Investment *(RMB 1000 Yuan)*	Date of Construction Start	Beginning of Operation	Location
Asuwei	719,007	200	10,820	May 1986	December 1994	Xiaotangshan, Changping County
Beishenshu	353,333	200	4,670	May 1986		Ciqu, Tong County
Anding	338,667	200	1,080	March 1986		Anding, Daxing County
Lixian	821,333		6,920	March 1986		Lixian, Daxing County
Dahuichang	271,528		5,150			Changxindian, Fengtai District
Total	**2,892,535**	**600**	**32,380**			

Landfill Sites

(1) Asuwei Sanitary Landfill Site. Completed in October 1994 with disposal capacity of 2,000 tons per day, it is managed by the Fourth Cleaning Truck Plant.

(2) Lishuiqiao Landfill Site. Managed by the Fourth Cleaning Truck Plant, it has received 800,000 tons of waste.

(3) Beishengshu Landfill Site. Managed by the First Cleaning Truck Plant, 1 million tons of waste have been dumped at this site.

(4) Anding Landfill Site. It has not yet begun operation.

(5) Lixian Landfill Site. It has not yet begun operation.

(6) Dahuichang Landfill Site. It has not begun operation.

Analysis of Pollution in Large Refuse Dumping Sites Open-air dumping of refuse without treatment has caused severe environmental pollution. The following is an analysis of the pollution caused by dumping at the Lishuiqiao Refuse Dumping Site:

(1) NH_3 and H_2S emitted from the site peaks from April to September and is especially high in June and August.

(2) The presence of pollutants significantly decreases 200 meters from the refuse dumping site. There is practically no presence of pollutants 500 meters from the dumping site.

Investigation of Flies, Maggots and Pupae In August 1987, the Beijing Sanitation and Anti-Epidemic Station quantified the presence of flies, maggots and pupae at the Lishuiqiao Refuse Dumping Site. To measure the number of flies, they counted the number of flies one person could catch per hour. Using insect nets, three professionals caught 319 flies (all houseflies) in half an hour. Hence, the density was 212 per person-hour. For the maggot and pupa test, they excavated 1 kg of sample refuse from an area of 0.11 square meters at the site and brought it to the laboratory. They found 120 maggots (of which 95% were houseflies), and 979 fly pupae (of which 98% were houseflies).

Refuse Treatment Methods The main methods of refuse treatment currently used in Beijing are (1) mechanized composting, (2) simple composting, (3) brick-making, (4) sanitation landfill, (5) refuse screening, and (6) comprehensive utilization.

(1) Mechanized Composting: So far, there is only one mechanized composting plant in Beijing, the Doncun Mechanized Composting Plant. This plant occupies an area of 114,000 square meters with buildings occupying 4,900 square meters. The total investment was RMB 6 million Yuan, of which equipment costs were RMB 2 million Yuan and labor costs were RMB 4 million Yuan.

The following is a brief description of the composting process: refuse → pit → grab crane → conveyer → coarse screening by drum sieve → manual selection of plastic, glass paper → metal removal by magnet separator → primary fermentation and ground sucking, deodorization to the emitted air by filtering → secondary fermentation → Monolayer flexible screening → removing hard materials with bouncing stone separator → composting product. Composition of the composting product is shown in Table 2-11

Table 2-11 Composition of Compost

Item	Dongcun Mechanized Compost Plant	Shijingshan Compost Plant	Standard value
Total nitrogen (%)	1.398	0.694	$\geq$ 0.5
Soluble nitrogen (%)	0.152	0.130	
Total phosphorus (%)	0.246	0.374	$\geq$ 0.3
Soluble phosphorus (%)	0.026	0.062	
Total potassium (%)	1.075	1.742	$\geq$1.0
Soluble potassium (%)	0.465	0.457	
Carbon content (%)	16.307	9.684	$\geq$10
Water content (%)	43.5	21.05	25 - 35
pH	8.9	7.42	6.5 - 8.5
Total large intestine bacillus	4×10^{-2}	< 0.111	10^{-1} - 10^{-2}
Death rate of ascaris ova (%)	96	100	95 - 100

The compost is sold to farmers at a price of RMB 5 Yuan per ton. The sales volume greatly depends on the season. The municipal government subsidizes the process in the amount of RMB 24 Yuan per ton of refuse.

(2) Simple Composting: The Shijingshan Composting Plant occupies an area of 33,330 square meters with buildings occupying 3,300 square meters. The treatment capacity is 100 tons per day. The total investment was RMB 2.1 million Yuan, of which equipment costs were RMB 0.3 million Yuan and labor costs were RMB 1.8 million Yuan.

The following describes the process of simple composting: static aerobic ventilation on the floor and turning by a loader → secondary fermentation → screening by a drum sieve → composting product. Composition of the composting product is shown in table 2-11.

Since the composting product is screened by a sieve, the final product contains a small quantity of small stones and broken glass, which affects the quality of the final composting product. Recently, a crusher was installed that grinds stones and broken glass into powder, which has improved the quality of the composting product.

Currently, the second process of the Shijingshan Composting Plant is undergoing renovation; the second open fermentation pool is being converted to the sealed type. After completion, the treatment capacity will be 200 tons per day.

(3) Brick-Making: In 1992, cooperating with the Nanhuqu Brick-making Plant No. 2, the ESB set up a demonstration plant to make bricks from refuse. The demonstration plant can treat 270 tons of screened refuse and produce 300,000 bricks per day.

The process for brickmaking is as follows: screening refuse (using vibrating sieve or drum sieve) → crushing the screened refuse → mixing with clay and additive agent.

Refuse comprises about 40 percent of the brick. Tests carried out by the Beijing Building Material Quality Supervision and Test Station show that brick made from refuse can meet the GB5101-85 standard for first-grade ordinary fired brick. The physical and mechanical properties of the brick are shown in table 2-12.

Table 2-12 Specifications of brick made from fired clay and refuse

		Unit	Average value	Minimum value of single brick	Grade
Mechanical performance	Compression Strength	MPa	17.30	15.90	150
	Bending Strength	MPa	4.29	3.22	
Durability	Freezing Resistance		These bricks did not break after fifteen freezing-melting cycles.		
	Weight loss after freezing	%	0.2 (maximum value of single brick)		
	Water Absorption	%	22		
	Lime Burst		no result		
	Frosting		no result		

(4) Sanitary Landfill. The Asuwei Sanitary Landfill Site occupies 71.8 hectares (1,078 square meter). The design capacity of this sanitary landfill site is 2,000 tons per day; the effective landfill area is about 42.9 hectares. The groundwater is five meters below the surface. The compacted density of refuse can reach 0.9 ton per cubic meter. This landfill site has a capacity of 7,752,600 tons, and its projected service life is 11 years.

(5) Screening. This method is used principally in simple composting plants in outlying areas. After sitting for a certain period of time, most of the organic matter in the refuse biodegrades. By screening, large particulate matter can be removed, leaving only substances smaller than 20 millimeter. They can be applied directly to fields or be used as the carrier of complex fertilizer (e.g. biological or organic complex fertilizer). The large particulate matter can be landfilled directly to reduce land use.

(6) Comprehensive Utilization. There are useful substances such as metal, glass, plastic, and paper in refuse. In recent years, much progress has been made in refuse utilization. Some projects have passed the pilot stage; plants are under construction to implement some of the larger-scale projects. Some reuses include: making glass cloth from waste glass, braiding bags from waste plastic, making coating material from waste plastic, and making building material from inorganic waste (see Appendix).

Hazardous Domestic Solid Waste Dry-cell batteries and waste paint are the main hazardous constituents of domestic solid waste. As there is no specific collection site and also no corresponding laws and regulations, these hazardous wastes are thrown into domestic solid waste without receiving any treatment. This causes serious pollution to the surrounding environment, groundwater and soil and causes great harm to people's health.

Chapter 3. GOALS OF PLAN

General Goals

The mechanized cleaning rate of urban roads, waste collection methods, and waste treatment rates can, to some degree, reflect the economic situation and development of a country. Table 3-1 presents the indices of refuse treatment in some cities in developed countries. Table 3-2 presents the waste collection methods in some US cities.

Table 3-1 Indices of Urban Refuse Treatment of Some Cities in Developed Countries

City	Mechanized cleaning rate of roads	Method of refuse collection and transportation	Refuse treatment rate
New York, United States	100%	sealed	100%
Tokyo, Japan	100%	sealed	100%
London, Britain	100%	sealed	100%
Paris, France	100%	sealed	100%
Los Angeles, United States	100%	sealed	100%

Table 3-2 Waste Collection Methods in Some US Cities

City	New York	Boston	Los Angeles
Collection method	Sorted	Sorted	Sorted (in preparation)

Tables 3-1 and 3-2 show that domestic solid waste collection, transportation and treatment have reached a high level. Beijing plans to reach the standard of developed countries for waste control and treatment within this planning period. The main targets are:

(1) To implement sorted collection of refuse;

(2) To carry out sealed refuse collection and transportation;

(3) To achieve a mechanized cleaning rate of roads of 95 percent and to implement mechanization in environmental sanitation operation to reduce the number of sanitation workers;

(4) To achieve non-polluting treatment of 100% of waste to eliminate the pollution caused by refuse;

(5) To minimize land use.

Analysis of the 1995 Environmental Targets

Road Cleaning Based on data from the "Introduction to Beijing Environmental Sanitation Management," table 3-3 presents the mechanized cleaning rate of roads in various areas in 1991 and 1992. The mechanized cleaning of roads will continue at a rate of approximately 40 percent in 1995.

Table 3-3 Mechanized Cleaning Rate of Roads

Year	Urban Areas	Suburban Areas	Outlying Areas	Average
1991	63.5%	43.1%	11.1%	43.3%
1992	61.0%	39.7%	9.9%	40.2%

Waste Collection and Transportation In order to achieve the goal of no waste exposed to air in urban and suburban areas, all open garbage container stations in the urban and suburban areas are to be eliminated. Garbage and waste collection at scheduled times and fixed locations will be expanded. There will be 250 sealed collection stations in use in the urban areas, and 450 sealed collection stations in the suburban areas.

Waste Treatment The Asuwei Sanitary Landfill Site will be put into operation before the end of 1995 with a daily treatment capacity of 2000 tons; the Dongcun Composting Plant and the Shijingshan Composting Plant each will treat 100 tons of waste a day. The daily waste treatment capacity in Beijing will reach 2200 tons per day, or 33.7 percent of the waste generated in the urban and suburban areas, and 28.5 percent of total waste generated in the city.

Environmental Target Schedule

Road Cleaning Table 3-4 presents the target mechanized cleaning rates (including washing) of roads until 2015.

Table 3-4 Target mechanized cleaning rates of roads

	1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015
Average mechanized cleaning rate (%)	70	85	95	> 95
Mechanized cleaning area (1000 m^2)	2,721	3,830	4,963	5,479

Waste Collection and Transportation From 1996 to 2000, the number of sealed refuse collection stations will be expanded to 280 in the urban areas and 500 in the suburban areas; sealed waste collection stations will also be introduced to the outlying areas. The rate of sealed waste collection will reach 90 percent city-wide. Sealed waste collection stations with compressing facilities will be constructed; the existing waste collection stations without compressing facilities will be renovated. A sorted waste collection pilot project will be launched.

From 2001 to 2005, the number of sealed waste collection stations will reach 290 in the urban areas, and 510 in the suburban areas. The sealed waste collection rate will reach 90 percent in the urban, suburban and outlying areas. Sorted waste collection will be expanded.

Waste Treatment Beijing will set the national standard of sanitation for China by the year 2000. The rate of non-polluting treatment of waste will reach 60 percent in 2000, 80 percent from 2001 to 2005, and 100 percent after 2006.

Chapter 4. WASTE TREATMENT PLAN

Waste Treatment Quantity

According to the general planning targets, the non-polluting treatment rate of waste will reach 60 percent before the year 2000, 80 percent from 2001 to 2005, and 100 percent after 2006. However, as it will not have reached 100 percent during the ten years between 1996 and 2005, there will be waste generated during this period that will be dumped without any treatment. Although part of the dumped waste can be used to make brick, 50 percent of the content needs to be incinerated or landfilled. Calculations show that, based on the goal that dumped waste should be treated before the year 2010, 1,100 tons of waste will be generated beginning in 1996. Taking into consideration the existing waste and the quantity to be dumped in the next years, table 4-1 presents the predicted waste treatment volumes through 2015.

Table 4-1 Waste treatment quantity

	1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015
Treatment capacity *(tons per day)*	6,100	7,800	8,900	9,100

Analysis Of Waste Treatment Methods

Comparison of Waste Treatment Methods We analyzed the feasibility of Beijing adopting popularized and industrialized waste treatment methods such as composting, incineration, and sanitary landfilling.

(1) *Cost.* The cost of incineration treatment is the highest, and that of sanitary landfilling is the lowest. However, by incinerating, non-polluting treatment and waste reduction can be achieved. Ash generated by incineration occupies only 10 percent of the waste volume before incineration. In addition, heat from incineration can be recovered for heating supply and power generation and considerable income can be obtained.

(2) *Land Use.* Sanitary landfill sites occupy more land than other waste treatment methods; incineration occupies the least land. For a city with limited land, land use should be taken into consideration when selecting waste treatment methods.

(3) *Transportation Distance.* In general, sanitary landfill sites are far from the urban areas. Therefore, large supporting transfer stations must be built. Composting plants and incineration

sites can be located near the urban areas. Waste can be transported directly to composting plants or incineration sites, reducing transportation costs.

The above analysis shows that each treatment method has advantages and disadvantages.

Limitations of Treatment Methods

(1) Referring back to table 2-7, we can see that the calorific value of domestic solid waste generated in single-story residential areas and gas-heated buildings is lower than 1,800 kilo-calorie per kilogram; the calorific value of waste generated by other areas is higher than 1,800 kilo-calorie per kilogram and is suitable for incineration. Table 4-2 presents the percentage of waste collected in various areas of the city. From this data, we calculated the maximum rate of waste which can be incinerated to be 39 percent.

Table 4-2 Percentage of each area's waste collection in 1992

Gas-heated buildings	Single-story residential areas	Commercial areas	Senior houses	Industrial areas	Hospitals
20.11%	40.89%	28.0%	0.65%	9.73%	0.62%

(2) Compostable waste (food and vegetation) comprises 35 percent of total waste.

(3) All constituents of waste can be landfilled.

When selecting the proportion of each treatment method, the above analysis of limitations should be taken into consideration.

Waste Treatment Plan Options

Since each treatment method is distinct, the proportion of waste treated by each method in developed countries depends on the specific country's economic situation, land utilization, environmental conditions, and other factors. Table 4-3 presents the projected waste treatment methods used in the United States. Table 4-4 presents the proportions of waste treated by three of these methods. These two tables show the overall situation of the country; each city, of course, has its own distinct waste treatment profile. For, example, in Los Angeles, landfilled waste accounts for 99 percent of total waste. This is due to the composition of waste generated (the food content is low; see table 4-5) and land utilization in the city.

Table 4-3 Projected waste treatment methods in the United States

	1990	1995	2000
Recycling	14.9%	19.6%	22.9%
Composting	2.1%	5.3%	7.1%
Incineration	16.3%	17.0%	20.8%
Landfilling	66.7%	58.0%	49.2%

Table 4-4 Projected three treatment methods in the United States

	1990	1995	2000
Composting	2.5%	6.6%	9.2%
Incineration	19.1%	21.3%	27.0%
Landfilling	78.4%	72.1%	63.8%

Table 4-5 Waste composition in Los Angeles

Constituent	Content	Constituent	Content	Constituent	Content
grass, earth, gravel	32%	metal, glass	12%	cloth, plastic, food	11%
tree branches	23%	wood	10%	newspaper, bags	12%

When determining waste treatment options for Beijing, we should not only refer to the general and specific characteristics, but should also take the economic and environmental conditions into consideration. Following are the main principles to be observed in determining waste treatment options of Beijing:

(1) The principle of least investment and cost should be observed;

(2) Chinese dietary habits have led to a high percentage of food in domestic solid waste. Meanwhile, agriculture in China lacks fertilizer; composting can be adopted to treat waste, but the proportion of composting should not be too high because compost can only be sold to surrounding farms (to minimize transportation costs).

(3) It is increasingly difficult and expensive to acquire land. Thus, by the end of the planned period, the proportion of waste incinerated should increase.

(4) The refuse treatment targets can be realized in two stages in relation to the economic development trend. During the first stage (before the year 2000), priority will first be given to developing sanitary landfill sites and composting plants, which require low investment and have short construction periods and then to constructing incineration sites so as to achieve the goals of non-polluting waste treatment and protection of the environment and people's health. During the second stage, efforts will be made to improve the waste treatment technology and equipment in order to achieve modernization of waste treatment. The service life of sanitary landfill sites in the urban and suburban areas should be prolonged, and the proportion of incinerated waste should be increased so as to minimize land use.

(5) In outlying areas, composting is the best method of waste treatment.

Based on the above principles, the following three options were proposed:

Option 1: All the refuse which can not be treated by existing composting plants and plants scheduled for construction (which have a total treatment capacity of 600 tons per day) will be landfilled. The proportion of waste to be treated by different methods during each period is shown in table 4-6. Applying the principle of investment and cost, landfilling is the most desirable method.

Table 4-6 Proportions of treatment methods for Option 1

	1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015
Composting	10%	10%	10%	10%
Landfilling	90%	90%	90%	90%
Incineration	0%	0%	0%	0%

Option 2: This option, detailed in table 4-7, separates the target into two stages. In the first stage (before the year 2000), priority is given to developing sanitary landfill sites. In the second stage (after the year 2001), waste to be incinerated will be gradually increased, waste to be landfilled will be reduced, and waste to be composted will comprise 15 percent of the total waste.

Table 4-7 Proportions of treatment methods for Option 2

	1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015
Composting	10%	15%	15%	15%
Landfilling	80%	65%	55%	55%
Incineration	10%	20%	30%	30%

Option 3: This option takes the difficulty and expense of land acquisition into consideration. Also, since there will be more combustible constituents in waste in the last years of the planning period, the proportion of waste to be incinerated will increase, that to be landfilled will decrease, and the service life of sanitary landfill sites will be prolonged in order to reduce land use. The proportion of refuse treated by different methods according to this option is shown in table 4-8.

Table 4-8 Proportions of different methods for Option 3

	1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015
Composting	10%	15%	15%	15%
Landfilling	80%	65%	55%	45%
Incineration	10%	30%	30%	40%

Waste Treatment Facilities For Each Option

When planning the construction projects of the waste treatment facilities of each option, the following principles should be observed:

(1) The proportion of waste to be treated by each method should be taken into consideration.

(2) There should be an auxiliary waste transfer station or sanitary landfill site near the composting plant and incineration site to treat the residues from these operations.

(3) Efforts should be made to use existing waste treatment facilities to minimize investment.

(4) Site selection of the waste treatment facilities should be guided by the Beijing Municipal Government Master Plan (hereafter referred to as "Master Plan").

In order to observe the above principles, it is necessary to analyze the distribution of existing facilities.

Analysis of Distribution of Existing Facility Sites Referring back to figure 2-3, this sketch presents the distribution of existing facilities in Beijing. As this distribution was planned before waste data was collected, the number of facilities is too high. In addition, some of the sites will be acquired with the implementation of the Master Plan. The following adjustments have been made:

(1) The Dawangjing Station is located in the planned construction area of the Master Plan; the site can be replaced by an appropriate site in the Wangjing Residential Quarter.

(2) The Lishuiqiao Station is located in the planned construction area of the Master Plan; it can be replaced by a proper site in the Maofang area of the Haidian District.

(3) The Wujiachang Station is located in the planned construction area of the Master Plan; it will be closed.

(4) Sujiatuo is far away from transfer stations and landfill sites and is therefore inappropriate for a composting plant. It can be adapted to become a sanitary landfill site.

Construction Plan of Refuse Treatment Facilities Tables 4-9, 4-10 and 4-11 present the scale, location, land use, construction period and service life of the facilities planned for construction in the three options mentioned above, according to the required conditions and above analysis. Figures 4-1, 4-2 and 4-3 present the waste treatment facilities planned in each option.

Table 4-9 Construction projects for refuse treatment *(Option 1)*

Project	Capacity *tons / day*	Location	Area (m^2) Available	Proposed	Construction and Operation Schedule 1996 - 2000	2001-2005	2006 - 2010	2011 - 2015
Asuwei Landfill	2,000	Xiaotangshan, Changping County	1,078					
Beishenshu Landfill	1,500	Ciqu, Tong County	530					
Anding Landfill	1,000	Anding, Daxing County	420					
Dahuichang Landfill	1000	Changxindian, Fengtai District	407					
Damushe Landfill	1,500	Damushe, Tongxian County		1,000				
Shunyi Landfill	2,000	Shunyi County		1,200				
Sujiatuo Landfill	1,500	Sujiatuo, Haidian District	98	1,000				
Lixian Landfill	1,000	Lixian, Daxing County	1,232					
Lixian Landfill	2,000	Lixian, Daxing County	1,232					
Southwest Landfill	1,100	Southwest Area of Beijing		1,000				
Shijingshan Composting Plant	100	Shijingshan District						
Nangong Composting Plant	400	Hongxing Farmland, Daxing County	100					
Dongcun Composting Plant	100	Ciqu, Tong County	[171]					
Treatment in Outer Suburbs	200	Counties and Far Suburbs						
Treatment in Outer Suburbs	300	Counties and Far Suburbs						
Treatment in Outer Suburbs	400	Counties and Far Suburbs						
Refuse Disposal Load		(tons/day)			6,100	7,800	8,900	9,100

Note: (1) Figures in brackets indicate the sum area of composting and incineration plant.
(2) Horizontal line-shading indicates construction period and solid gray shading indicates operation period

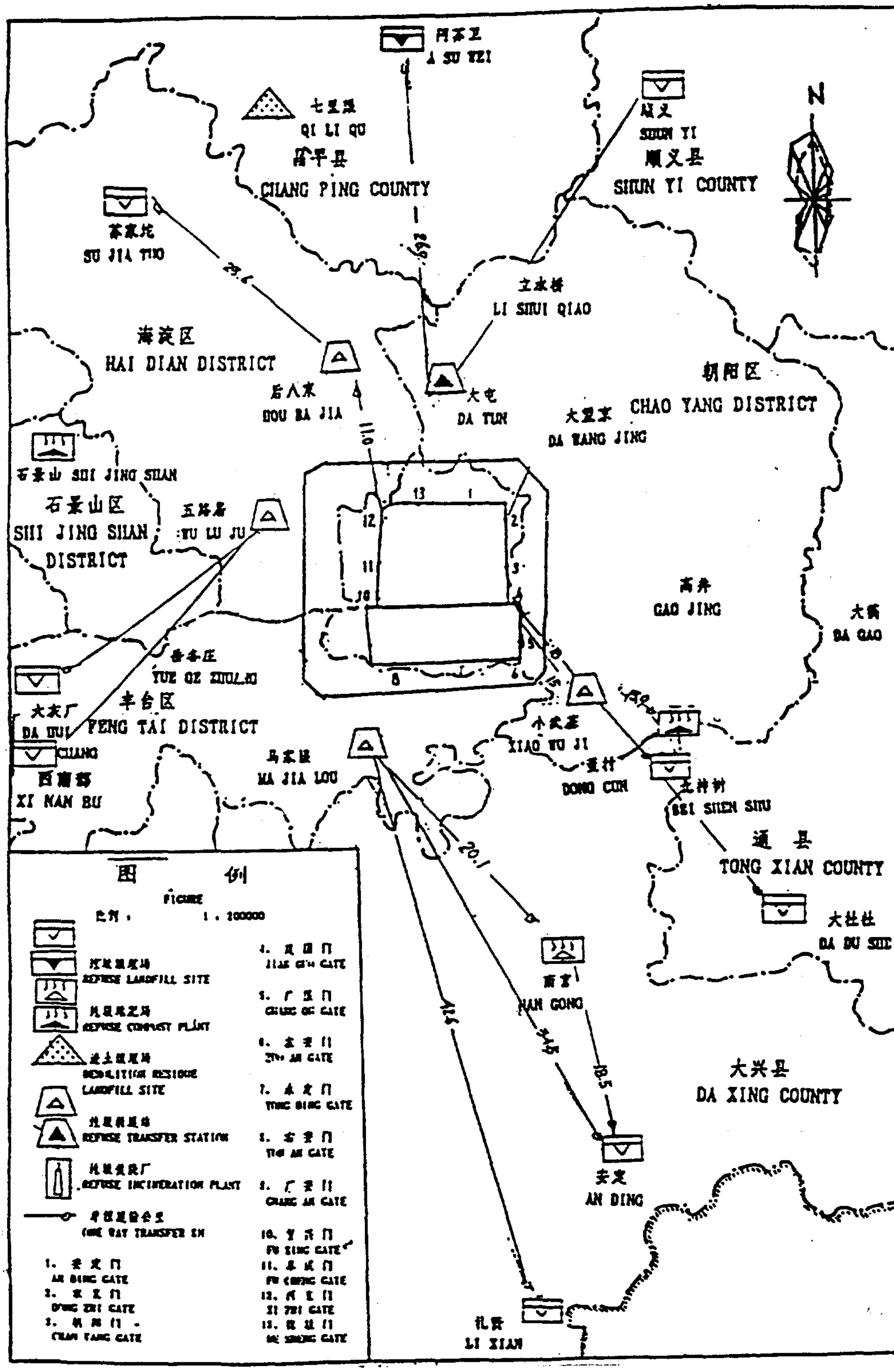

Figure 4-1 Planning Map of Refuse Treatment Facilities in Beijing (Option 1)

Table 4-10 Construction projects for refuse treatment *(Option 2)*

Project	*Capacity (tons/day)*	Location	Area *(m²)*		Construction and Operation Schedule			
			Available	Proposed	1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015
Asuwei Landfill	2,000	Xiaotangshan, Changping County	1078					
Beishenshu Landfill	1,000	Ciqu, Tong County	530					
Anding Landfill	1,000	Anding, Daxing County	420					
Dahuichang Landfill	1,000	Changxindian, Fengtai District	407					
Damushe Landfill	1,000	Damushe, Tongxian County		550				
Shunyi Landfill	1,000	Shunyi County		550				
Sujiatuo Landfill	1,000	Sujiatuo, Haidian Dist.	98					
Lixian Landfill	2,000	Lixian, Daxing Cnty	1232					
Shijingshan Composting Plant	100	Shijingshan District						
Nangong Composting Plant	400	Hongxing Farmland, Daxing County	100					
Dongcun Composting Plant	100	Ciqu, Tong County	[171]					
Dongcun Composting Plant	300	Ciqu, Tong County	[171]					
Treatment in Outer Suburbs	100	Counties and Far Suburbs						
Treatment in Outer Suburbs	200	Counties and Far Suburbs						
Treatment in Outer Suburbs	400	Counties and Far Suburbs						
Mafang Composting Plant	300	Haidian District		80				
Dongcun Incineration Plant	800	Ciqu, Tong County	[171]					
Wuluju Incineration Plant	1,000	Yuyuantan, Haidian District		60				
Wangjing Incineration Plant	1,000	Heping, Chaoyang District		60				
Yuegezhuang Incineration Plant	1,000	Yuegezhuang, Chaoyang District						
Refuse Disposal Load (tons/day)					6,200	7,800	8,900	9,100

Note: (1) Figures in brackets indicate the sum area of composting and incineration plant.
(2) Horizontal line-shading indicates construction period and solid gray shading indicates operation period

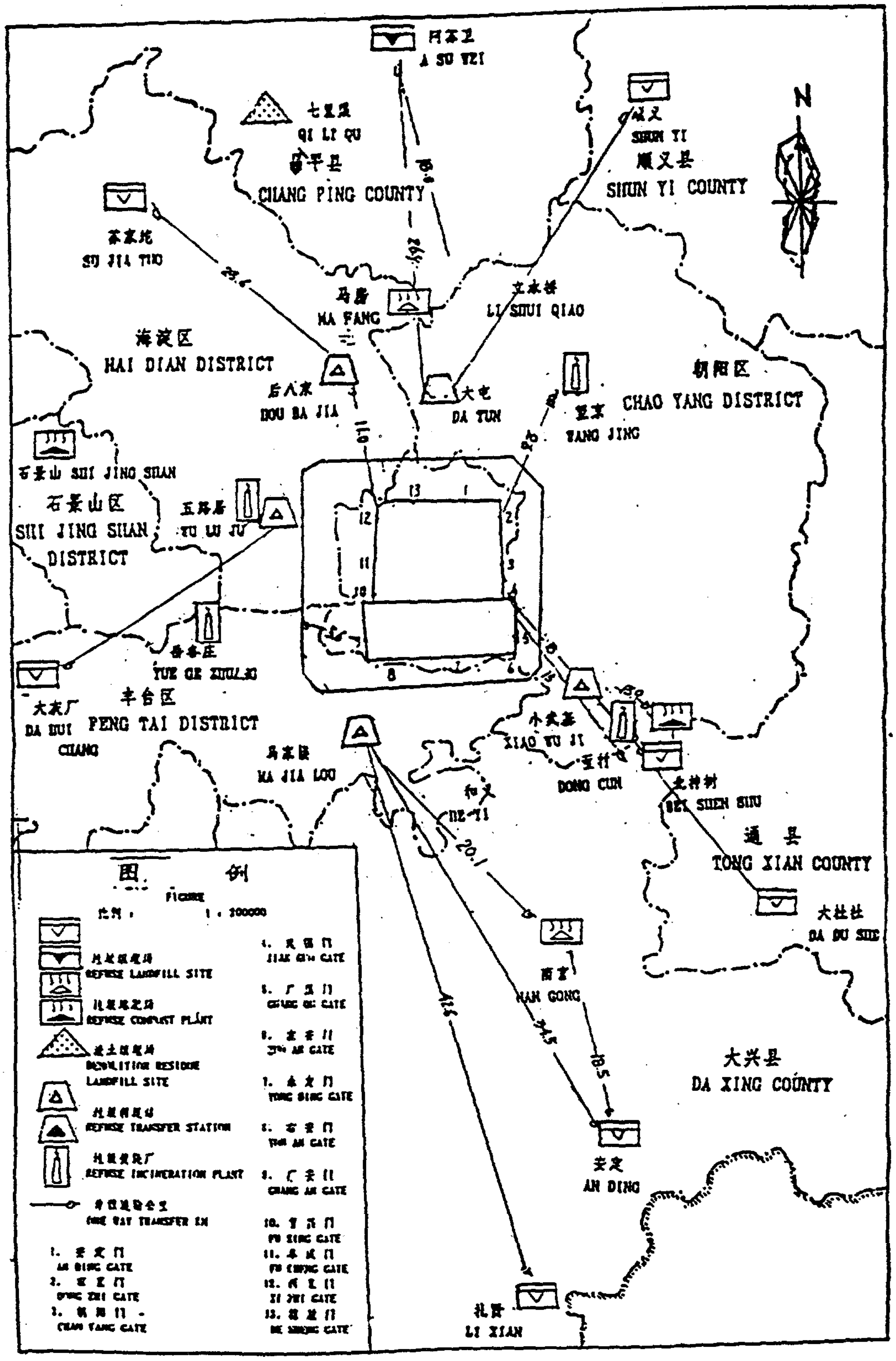

Figure 4-2 Planning Map of Refuse Treatment Facilities in Beijing (Option 2)

Table 4-11. Construction projects for refuse treatment *(Option 3)*

Project	Capacity *tons/day*	Location	Area *(m^2)*		Construction and Operation Schedule			
			Available	Proposed	1996 - 2000	2001 - 2005	2006 - 2010	2011 - 2015
Asuwei Landfill	2,000	Xiaotangshan, Changping County	1,078					
Beishenshu Landfill	1,000	Ciqu, Tong County	530					
Anding Landfill	1,000	Anding, Daxing Cnty	420					
Dahuichang Landfill	1,000	Changxindian, Fengtai District	407					
Damushe Landfill	1,000	Damushe, Tongxian County		550				
Shunyi Landfill	1,000	Shunyi County		550				
Sujiatuo Landfill	1,000	Sujiatuo, Haidian Dist.	98	500				
Lixian Landfill	1,000	Lixian, Daxing County	1,232					
Shijingshan Composting Plant	100	Shijingshan District						
Nangong Composting Plant	400	Hongxing Farmland, Daxing County	100					
Dongcun Composting Plant	100	Ciqu, Tong County	(171)					
Dongcun Composting Plant	300	Ciqu, Tong County	(171)					
Treatment in Outer Suburbs	100	Counties and Far Suburbs						
Treatment in Outer Suburbs	200	Counties and Far Suburbs						
Treatment in Outer Suburbs	200	Counties and Far Suburbs						
Mafang Composting Plant	300	Haidian District		80				
Dongcun Incineration Plant	600	Ciqu, Tong County	(171)					
Wuluju Incineration Plant	1,000	Yuyuantan, Haidian District		60				
Wangjing Incineration Plant	1,000	Heping, Chaoyang Dist.		60				
Yuegezhuang Incineration Plant	1,000	Yuegezhuang, Chaoyang District						
Mafang Incineration Plant	1,000	Haidian District		60				
Refuse Disposal Load		*tons/day*			6,200	7,800	8,900	9,100

Note: (1) Figures in brackets indicate the sum area of composting and incineration plant.
(2) Horizontal line-shading indicates construction period and solid gray shading indicates operation period

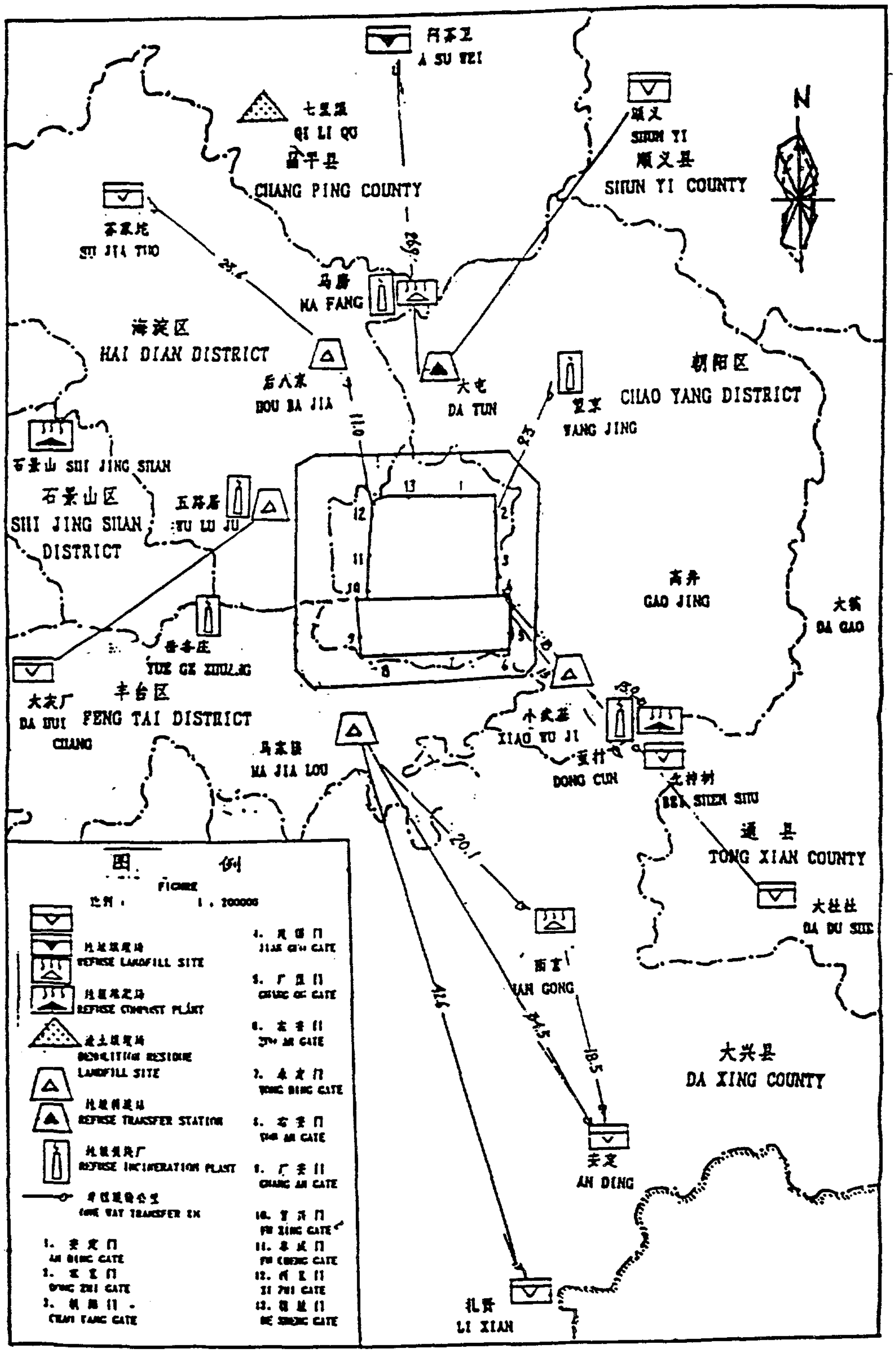

Figure 4-3 Planning Sketch Map of Refuse Treatment Facilities in Beijing (Option 3)

Investment and Operational Costs of Waste Treatment Facilities According to calculations of waste treatment costs based on 1991 costs, tables 4-12, 4-13 and 4-14 show the total capital and operational costs of waste treatment facilities planned in the three options. The distance from each waste transfer station to the nearest sanitary landfill site is shown in table 4-15. The construction investment and operational costs of waste transfer stations based on 1991 prices is shown in table 4-16.

Table 4-12 Capital (C) and Operational (O) Costs of Refuse Disposal Sites - *Option 1*

		1996 - 2000		2001- 2005		2006 - 2010		2011 - 2015		TOTAL
Disposal Sites	Capacity *tons/day*	C	O	C	O	C	O	C	O	*1,000 Yuan*
Landfills:										
Asuwei	2,000		14,345		14,345					28,690
Beishenshu	1,500	89,471	6,455		10,758					106,684
Anding	1,000	89,648	2,869		7,173		7,173			76,863
Dajhuichang	1,000	59,648	1,435		7,173		7,173		2,869	78,298
Damushe	1,500						10,758		10,758	110,987
Shunyl	2,000			89,471			14,345		14,345	147,985
Sujiatuo	1,500			119,295	6,455		10,785		10,785	117,442
Lixian	[1,000] 2,000			89,471		59,648	4,304	59,648	14,345	137,945
Southwest	1,100							65,612	4,734	70,346
Composting Plants:										
Shijingshan	100		2,471		2,471		2,371		2,471	9,884
Nangong	400	29,155	7,413		9,885		9,885		9,885	6,623
Dongcun	100		2,471		2,471		2,471		2,471	9,884
Outer Suburbs	[200] 400			14,578	2,966	7,289	6,425	7,289	8,897	47,444
Total		237,932	37,459	312,815	63,697	66,937	75,763	132,549	81,533	1,008,675

Table 4-13 Capital (C) and Operational (O) Costs of Refuse Disposal Sites - *Option 2*

		1996 - 2000		2001- 2005		2006 - 2010		2011 - 2015		TOTAL
Disposal Sites	Capacity *tons/day*	C	O	C	O	C	O	C	O	*1,000 yuan*
Landfills:										
Asuwei	2,000		14,345		14,345					28,690
Beishenshu	1,000	59,648	4,304		7,173		4,303			75,429
Anding	1,000	59,648	2,869		7,173		7,173		2,869	79,732
Dahuichang	1,000	59,648	1,435		7,173		7,173		2,869	78,298
Damushe	1,000					59,648	2,869		7,173	69,690
Shunyl	1,000			59,648			7,713		7,173	73,994
Sujiatuo	1,000			59,648			7,713		7,713	73,994
Lixian	2,000							119,295	8,607	127,902
Composting Plants:										
Shijingshan	100		2,471		2,471		2,371		2,471	9,884
Nangong	400	29,155	7,413		9,885		9,885		9,885	66,223
Dongcun	[100] 300		2,471	14,578	5,436		7,413		7,413	37,311
Outer Suburbs	[100] 400			7,289	1,483	7,289	3,954	14,578	7,908	42,501
Mafang	300			21,866	4,448		7,413		7,413	41,140
Incineration Plants:										
Dongcun	600	130,552	10,219		25,548		25,548		25,548	217,415
Wuluju	1,000			198,988	17,032		42,580		42,580	301,180
Wangjing	1,000					198,988	17,032		42,580	258,600
Yuegezhuang										
Total		338,651	45,527	362,017	102,167	265,925	152,161	133,873	181,662	1,581,983

Table 4-14 Capital (C) and Operational (O) Costs of Refuse Disposal Sites - *Option 3*

Disposal Sites	Capacity *tons/day*	1996 - 2000 C	1996 - 2000 O	2001- 2005 C	2001- 2005 O	2006 - 2010 C	2006 - 2010 O	2011 - 2015 C	2011 - 2015 O	TOTAL *1,000 Yuan*
Landfills:										
Asuwei	2,000		14,345		14,345					28,690
Beishenshu	1,000	59,648	4,304		7,173		4,303			75,429
Anding	1,000	59,648	2,869		7,173		7,173		2,869	79,732
Dahuichang	1,000	59,648	1,435		7,173		7,173		2,869	78,298
Damushe	1,000					59,648	2,869		7,173	69,690
Shunyl	1,000						7,713		7,173	73,994
Sujiatuo	1,000			59,648			7,713		7,173	73,994
Lixian	1,000			59,648				59,648	4,304	127,902
Composting Plants:										
Shijingshan	100		2,417		2,471		2,471		2,471	9,884
Nangong	400	29,155	7,413		9,885		9,885		9,885	66,223
Dongcun	[100] 300		2,471	14,578	5,436		7,413		7,413	37,311
Outer Suburbs	[100] 400			7,289	1,483	7,289	3,954	14,578	7,908	42,501
Mafang	300			21,866	4,448		7,413		7,413	41,140
Incineration Plants:										
Dongcun	600	130,552	10,219		25,548		25,548		25,548	217,415
Wuluju	1,000			198,988	17,032		42,580		42,580	301,180
Wangjing	1,000					198,988	17,032		42,580	258,600
Mafang	1,000							198,988	25,548	224,536
Yuegezhuang										
Total		338,651	45,527	362,017	102,167	265,925	152,161	273,214	202,907	1,742,569

Note for tables 4-12, 13, 14: (1) Operational costs refer to cumulative costs in the period. (2) Figures in brackets refer to the capacity at the first stage. (3) All costs are based on 1991 prices.

Table 4-15 Distances between transfer stations and treatment sites *Unit = km*

	Transfer station: Datun	Xiaowuji	Wuluju	Majialou	Houbajia
Asuwei Landfill	26.7				
Beishenshu Landfill		13.9			
Anding Landfill				34.5	
Dahuichang Landfill			18.9		
Damushe Landfill		27.0			
Shunyi Landfill	30.0				
Sujiatuo Landfill					23.6
Lixian Landfill				42.6	
Southwest Landfill			25.0		
Nangong Composting Plant				20.1	

Table 4-16 Construction (C), Operational (O) and Transportation (T) Costs for Transfer Stations *Unit = 1,000 Yuan*

	Transfer Station	Capacity *tons/day*	1996 - 2000			2001 - 2005			2006 - 2010			2011 - 2015			Total
			C	O	T	C	O	T	C	O	T	C	O	T	
Option 1	Datun	1,500		13,000	13,059		13,000	13,059		13,000	14,673		1,300	14,673	107,464
	Xiaowuji	1,500	32,100	7,800	4,079		13,000	6,798		13,000	13,206		13,000	13,206	116,189
	Majialou	(1,000) 2,000	21,400	3,467	4,500	21,400	8,667	11,249		17,333	22,499		17,333	22,499	150,347
	Wuluju	1,000	21,400	1,733	1,233		8,667	6,163		8,667	6,163		8,667	8,152	70,845
	Houbajia	1,500				32,100	7,800	9,626		13,000	11,543		13,000	11,543	98,612
	Total		74,900	26,000	22,871	53,500	51,134	46,895		65,000	68,084		65,000	70,073	543,457
Option 2	Datun	1,500		13,000	13,059		13,000	13,059		13,000	9,782		13,000	9,782	97,682
	Xiaowuji	1,000	21,400	5,200	2,029		8,667	3,382		8,667	5,551		8,667	8,805	72,368
	Majialou	(1,000) 2,000	21,400	3,466	4,500		8,667	11,249		8,667	11,249	21,400	13,866	16,673	121,137
	Wuluju	1,000	21,400	1,733	616		8,667	3,081		8,667	3,081		8,667	1,233	57,145
	Houbajia	1,000				21,400				8,667	7,695		8,667	7,695	54,124
	Total		64,200	23,399	20,204	21,400	39,001	30,771		47,668	37,358	21,400	52,867	44,188	402,456
Option 3	Datun	1,500		13,000	13,059		13,000	13,059		13,000	7,982		13,000	9,782	97,682
	Xiaowuji	1,000	21,400	5,200	2,029		8,667	3,382		8,667	5,551		8,667	8,805	72,368
	Majialou	1,000	21,400	3,466	4,500		8,667	11,249		8,667	11,249		8,667	11,249	89,114
	Wuluju	1,000	21,400	1,733	616		8,667	3,081		8,667	3,081		8,667	1,233	57,145
	Houbajia	1,000				21,400				8,667	7,695		8,667	7,695	54,124
	Total		64,200	2,339	20,204	21,400	39,001	30,771		47,668	37,358		47,668	38,764	370,433

Note: (1) Operational costs refer to cumulative costs in the period. (2) Figures in brackets refer to the capacity at the first stage. (3) All costs are based on 1991 prices.

RECOMMENDED OPTIONS

Analysis of and calculations for the three options are summarized in table 4-17. From this table, the following conclusions are made:

(1) Since each of the three options emphasizes a different treatment method, the cost for each option is different. Option 1 requires higher waste transfer costs and lower waste treatment costs; Option 3 requires lower transfer costs, but higher treatment costs; Option 2 is in between. The total investment of Option 1 is the least and that of Option 3 is the highest.

(2) Regarding income from composting and power generation by incineration, the income from Option 3 is clearly the highest. After subtracting their respective income, the total costs of the three options, based on 1991 prices, are:

Option 1: RMB 993.3 million Yuan;
Option 2: RMB 1.2371 billion Yuan;
Option 3: RMB 1.375 billion Yuan.

(3) Since Option 1 includes treating 90 percent of the waste by landfill, it requires the highest land use, about 538 hectares; Option 2 requires 378 hectares; Option 3 requires 382 hectares. Hence, Option 2 requires the least land use.

The above conclusions demonstrate that the total cost and land use of Option 3 are higher than those of Option 2; therefore, Option 2 is superior to Option 3. The total cost of Option 2 is RMB 243.8 million Yuan higher than that of Option 1, while land use of Option 2 is 160 hectares less than that of Option 1. In recent years, the cost for land acquisition has steadily increased, the current price being five to ten times the original price. If land prices increase to RMB 1.5 million Yuan per hectare, the total cost of Option 2 will equal that of Option 1. In addition, from the perspective of refuse minimization, recovery and non-polluting treatment, Option 2 is better than Option 1. Therefore, Option 2 is recommended as the waste treatment option.

Table 4-17 Comparison of the Three Options

	Options	Total	1996 - 2000 6,100 tons/day	2001 - 2005 7,800 tons/day	2006 - 2010 8,900 tons/day	2011 - 2015 9,100 tons/day
Method *Ratio* Landfilling : Composting : Incineration	1		0.90 : 0.10 : 0.00	0.90 : 0.10 : 0.00	0.90 : 0.10 : 0.00	0.90 : 0.10 : 0.00
	2		0.80 : 0.10 : 0.10	0.64 : 0.15 : 0.21	0.56 : 0.15 : 0.29	0.55 : 0.16 : 0.29
	3		0.80 : 0.10 : 0.10	0.64 : 0.15 : 0.21	0.56 : 0.15 : 0.29	0.44 : 0.16 : 0.40
Waste Transportation Costs *in RMB million Yuan* (Including construction, operational, and transportation costs)	1	543.5	123.8	151.5	133.1	135.1
	2	402.5	107.8	91.2	85	118.5
	3	370.4	107.8	91.2	85	86.4
Waste Treatment Costs *in RMB million Yuan* (including construction and operational costs)	1	1,008.7	275.4	376.5	142.7	214.1
	2	1582	384.2	464.2	418.1	315.5
	3	1,742.6	384.2	464.2	418.1	476.1
Total Costs *in RMB million Yuan*	1	1,552.2	399.2	528	275.8	349.2
	2	1,984.5	492	555.4	503.1	434
	3	2,113	492	555.4	503.1	562.5

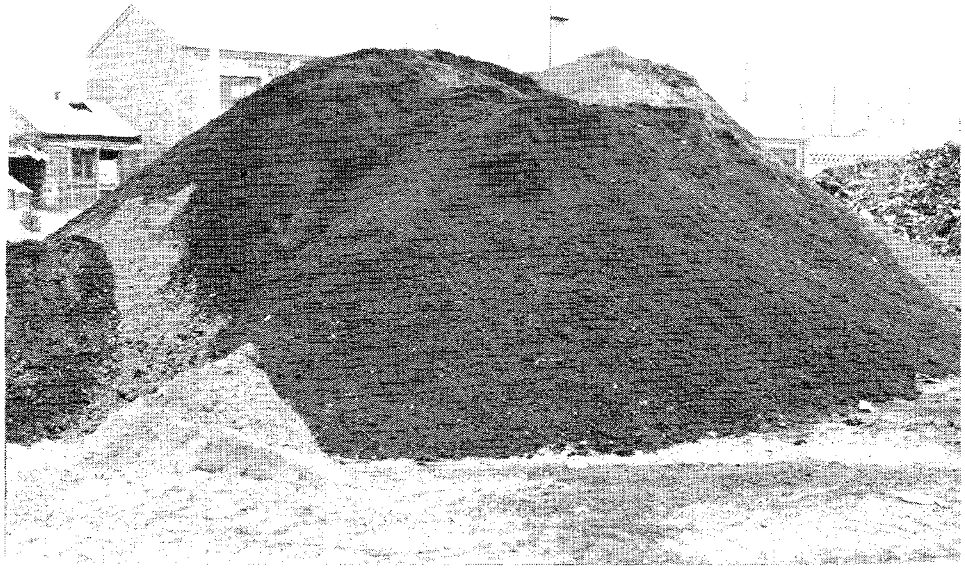

Photo 1. Inorganic portion of domestic solid waste →

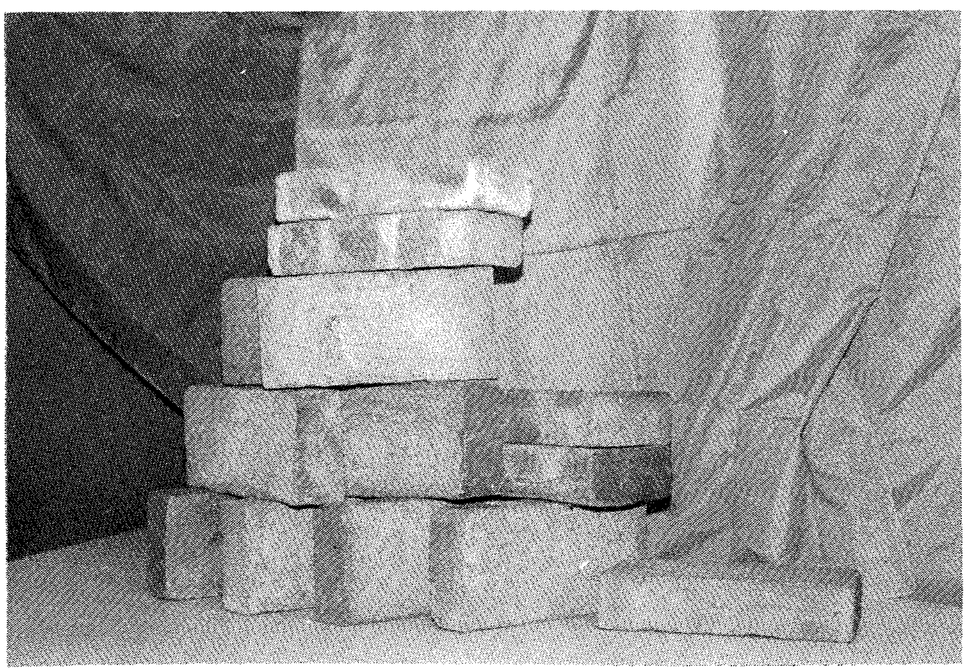

Photo 2. Product: brick →

APPENDIX: DOMESTIC SOLID WASTE COMPREHENSIVE UTILIZATION PROJECTS IN BEIJING

Brick-making

Survey. Brick can be fired from domestic solid waste, clay and auxiliary materials. The main advantages of making brick from waste are:

(1) disposal of a large amount of waste: each brick contains 60 percent waste by volume and 40 percent waste by weight;

(2) reduction of land use: each brick made with waste products saves 1,300 grams of clay; land use from waste dumping is significantly reduced;

(3) reduction of energy use: since waste has certain calorific value (averaging 4,000 joule per kilogram), the coal used for firing brick can be reduced by half.

Process. After being screened and crushed to a specified size, waste, clay and additive materials are mixed at a specific ratio; the mixture is pressed into green brick by a vacuum brick-making machine; the green brick is sent to the kiln to be fired.

Specifications. These specifications meet the GB 5101-80 standard for first-grade fired stock brick

- Compression Strength = 17.3 MPa (average)
- Bending Strength = 4.29 MPa (average)
- Grade = 150
- Water Absorption = 22%
- Freezing Resistance = not broken after 15 freezing-melting cycles
- Lime Burst = none
- Frosting = none

Investment. In order to establish a waste brick-making plant in an existing brick-making plant, it is necessary only to introduce waste treatment processes and equipment. An investment of RMB 10 million Yuan is needed to construct a waste brick-making plant with a productivity of 10 million bricks per year.

Economic Benefit. The unit production cost of waste brick is RMB 0.01 Yuan higher than that of the stock clay-fired brick. The annual income of a plant with the above-mentioned scale could reach RMB 180 million Yuan with a profit of RMB 2 million Yuan. Investment could be recovered within five years.

Environmental Benefit: Waste reduction, non-polluting treatment, and recycling would be the benefits.

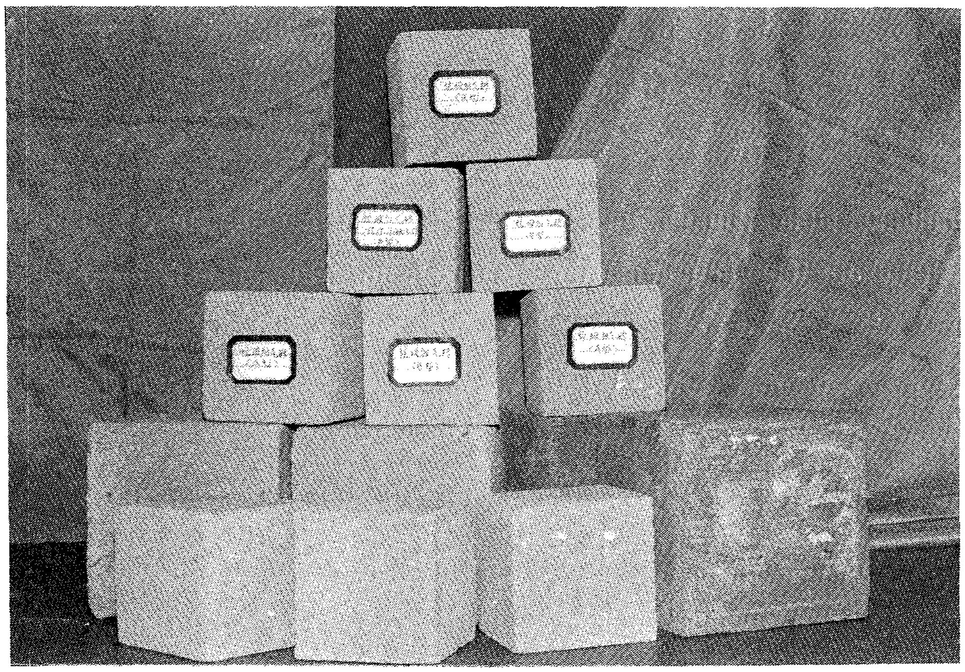

Photo 3. Product : Aeroconcrete →

Making Aeroconcrete from Waste

Survey. Aeroconcrete is a widely used, high technology light building material. The traditional aeroconcrete process was adapted, replacing sand with waste material. The action of a foaming agent completes the manufacturing process. Aeroconcrete made with waste materials meets the standards of aeroconcrete made by the traditional process. Adopting this technology can reduce waste pollution and reuse waste as an input for a high-quality building material.

Process. After being torrefied, crushed and milled to the specified granule size, the waste is mixed with sand, cement and other materials at a specified ratio. A foaming agent is added to mold the mixture, and the molded concrete is autoclaved.

Specifications.

- Compression Strength = 3.8 MPa
- Bending Strength =1.7 MPa
- Contract Ratio = 0.64 mm/m
- Density = 531 kg/m^3
- Water Content = 5.3%
- Water Absorption = 84.2%
- Freezing Resistance = The loss of weight is 0; loss of strength is 8.3% after 15 freezing-melting cycles.

Investment. The expected production rate of aeroconcrete by this project is 200,000 cubic meters per year. Advanced production lines and equipment would be imported. The total investment, including construction costs, is approximately RMB 78 million Yuan, including RMB 55 million Yuan in equipment costs. The construction period would be about one year.

Environmental and Social Benefit. When complete, the plant would produce 200,000 cubic meters of light building material per year to help meet market demands. In addition, the plant can utilize nearly 100,000 tons of waste per year without any government investment. Environmental, groundwater and atmospheric pollution caused by dumped waste would be greatly reduced.

Given the current building materials market, annual sales income could reach more than RMB 40 million Yuan while the production costs would be about RMB 20 million Yuan, bringing an annual profit of RMB 20 million. The investment could be recovered in four to five years. The project would bring significant economic benefit.

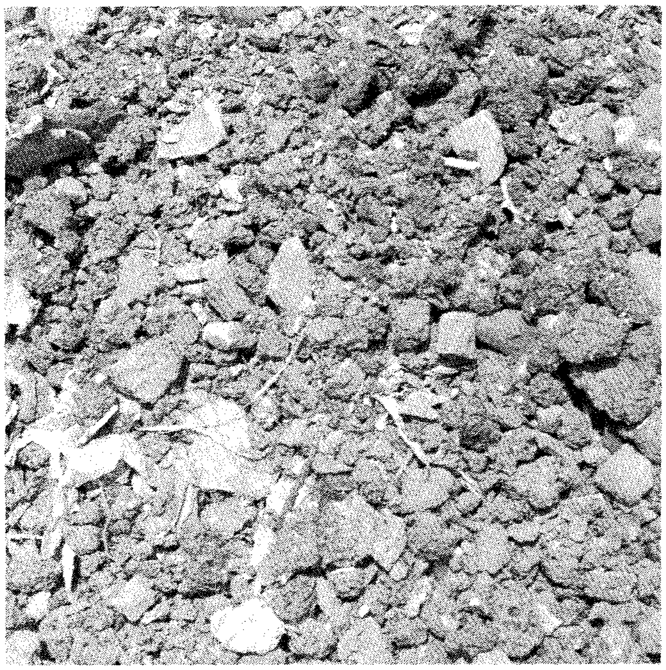

Photo 4. Ash and slag as raw material →

Photo 5. Brick kiln →

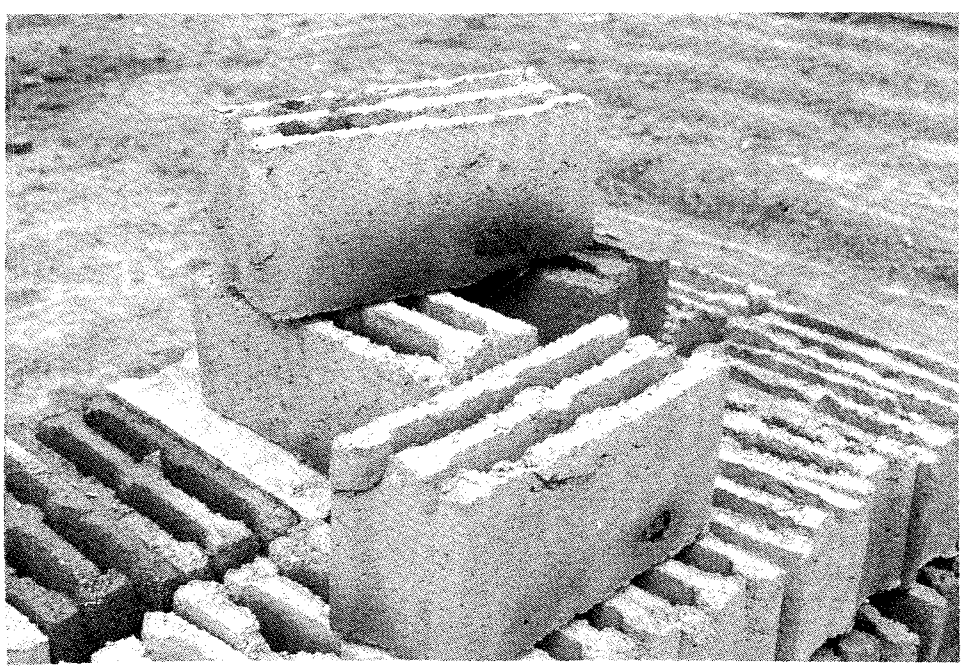

Photo 6. Product: concrete block→

Firing Concrete Block from Waste

Survey. This technology uses sludge fired from decayed waste in waste dumping sites to produce concrete. It is not necessary to fire the sludge again in the process; only curing is needed. Its main features follow:

(1) The process is simple, and only a small investment is needed. By adopting this technology, waste can be fired without screening; waste pre-treatment is not necessary. The process also requires very little equipment, and the production scale can be adjusted at any time.

(2) The waste non-polluting treatment and resource utilization rates are high. Since the waste is treated at high temperatures (800°C), all pathogenic bacteria are killed; non-polluting treatment is realized and there is no pollution from the manufacturing process. In addition, sludge from waste firing is utilized.

(3) This project has obvious social and environmental benefits. Building materials produced by this technology contain 70 percent waste, which helps reduce waste pollution and maximizes waste recycling.

(4) Concrete blocks are widely used, and since the process is simple, blocks of various sizes can be produced by changing the mold. It is also possible to adjust the waste ratio according to the standards of municipal works, bridges, or walls.

Process. waste firing → crushing → mixing (sludge and other material) → molding → curing → final product

Technical Specifications.

- Density = 923 kg/m^3
- Bending Strength = 12-17 MPa
- Compression Strength = 36-51 MPa
- Water Absorption = 23.7%
- Hollow Ratio = 33.9%
- Contraction Ratio = 0.03%

Investment. Assuming the production scale is 100,000 cubic meters per year, the total investment would be approximately RMB 8 million Yuan, and 40,000 square meters of land would be needed.

Economic Benefit. Production costs would be about RMB 100 Yuan per cubic meter; annual profits could reach RMB 2 million Yuan; the investment could be recovered in four years.

Environmental Benefit. Waste sludge can replace a large amount of cement and sand in the production of concrete blocks. This project can save resources as well as recycle waste.

Photo 7. Waste slag →

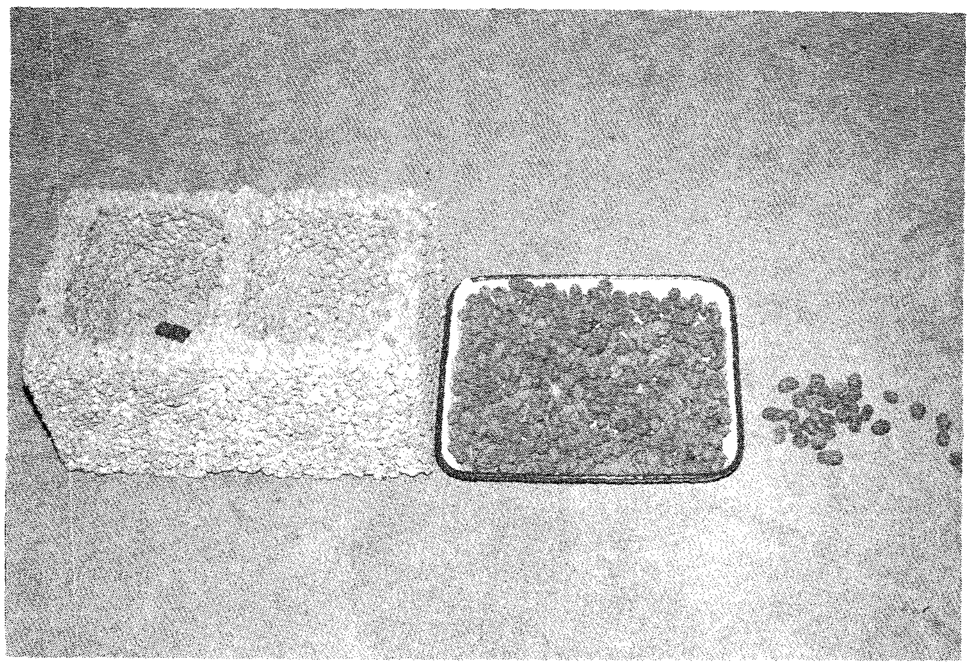

Photo 8. Product: ceramsite and ceramsite block →

Making Ceramsite from Waste

Survey. Making light aggregate from waste inorganic matter can help solve the problem of domestic solid waste treatment and disposal, and can also can provide a kind of new artificial aggregate for construction. This technology provides a new method for utilizing waste; the product contains 30 percent waste. To use waste in the production, it is only necessary to add a waste treatment process to existing aggregate production plants; after treatment, the waste can be used as a raw material. It requires low investment and will quickly generate a profit. Use of clay will be reduced, benefiting land protection. Since the treated waste is fired, a high non-polluting treatment rate can be realized.

Process. screening ash after fermentation → mixing ash with clay and other auxiliary materials, stirring → granulating → drying, firing

The final product meets the following requirements: high strength, low thermal conductivity, low energy consumption, corrosive resistance, decorative, and erosion resistance.

Technical Specifications. The product meets national standards for similar products

- Dry Loose Density = 732 kg/m^3
- Barrel-pressing Strength = 3.9 MPa
- Water Absorption = 5%
- Freezing Resistance = weight loss is 0.4% after 5 freezing-melting cycles
  - Hollow Ratio = 41.6%
  - Softness Coefficient = 0.95

Investment. Based on the production scale of 100,000 cubic meters per year, the total investment would be RMB 10 million Yuan.

Economic Benefit. The project could bring an annual profit of RMB 2.5 million Yuan. Compared with traditional waste treatment methods, this method can obtain certain economic benefit so as to reduce the government's investment in waste treatment.

Social and Environmental Benefit. This project can save land, bringing significant social and environmental benefits.

Photo 9. Polystrene processing plant →

Photo 10. Product ready for shipping →

Making Coating from Waste Polystyrene

Survey. With the development of the economy and industry, more and more disposable polystyrene products are produced and become waste. Large amounts of waste polystyrene products seriously affect the environment; this technology can change this waste into a useful resource.

Dozens of anti-corrosion coatings and paints can be made from polystyrene waste. These products have good saline and rust resistance, strong adhesive quality and tenacity, and fast drying speed. They also have excellent strong chemical and physical properties. Production can occur at low temperatures. They can match with phenolic aldehyde, ethylene and pitch very well.

Process. waste dissolving → modifying → grinding → packing

All **specifications** can meet the national standards for chlorinated polyvinyl chloride corrosion resistant coating.

Investment. Building a coating production plant with a capacity of 500 tons per year requires 3000 square meters of land. The total investment would be about RMB 2 million Yuan.

Economic Benefit. Annual sales income could reach RMB 5 million Yuan; annual profits would be RMB 600,000 Yuan.

Social and Environmental Benefit. Producing one ton of product utilizes 0.15 tons of waste polystyrene products. At the above production capacity, 75 tons of waste polystyrene can be recycled every year. Assuming a density of 0.02 kilograms per cubic meters, 3,750 cubic meters of waste can be utilized. This project can save a large amount of raw materials and help reduce pollution.

Photo 11. Waste polystyrene

Photo 12. Organic waste →

Photo 13. Compost →

Making Organic Fertilizer from Waste

Survey. Directly applying waste to agricultural lands would cause pollution; fertilizer produced by traditional composting (anaerobic or aerobic) has the disadvantage of low efficiency and contains coarse particulate. This method processes waste to produce organic high-efficiency fertilizer. This product overcomes the disadvantages of natural composting fertilizers and can meet the needs of different plants.

The processed organic biological fertilizer is different from ordinary fertilizers; it serves as a carrier for useful bacteria to soil. The action of these bacteria helps break down constituents in the soil to elemental nitrogen, phosphorous and potassium, making these and other nutrients available to the plants. Its effective time is also comparatively long.

Experiments show that crops treated with organic fertilizers are healthier and stronger than other crops. All tested indices of crops treated with this kind of fertilizer were higher than or near that of other crops.

Process. waste fermenting and sterilizing under high temperature → adding organic material → drying → crushing → adding organic bacteria → molding → packing

Investment. Assuming a production scale of 10,000 tons per year, equipment costs would be RMB 500,000 Yuan. The total investment including simple construction costs would be RMB 2 million Yuan.

Economic Benefit. Production costs of the fertilizer would be RMB 350 Yuan per ton. The current market price is RMB 400 Yuan per ton; annual profits could reach RMB 500,000 Yuan.

Economic Benefit. Each ton of fertilizer contains 90 percent waste. Every year, 10,000 tons of waste could be utilized by this method. It would also improve soil quality, protect the environment and improve plant productivity.

Photo 14. Braided bag material →

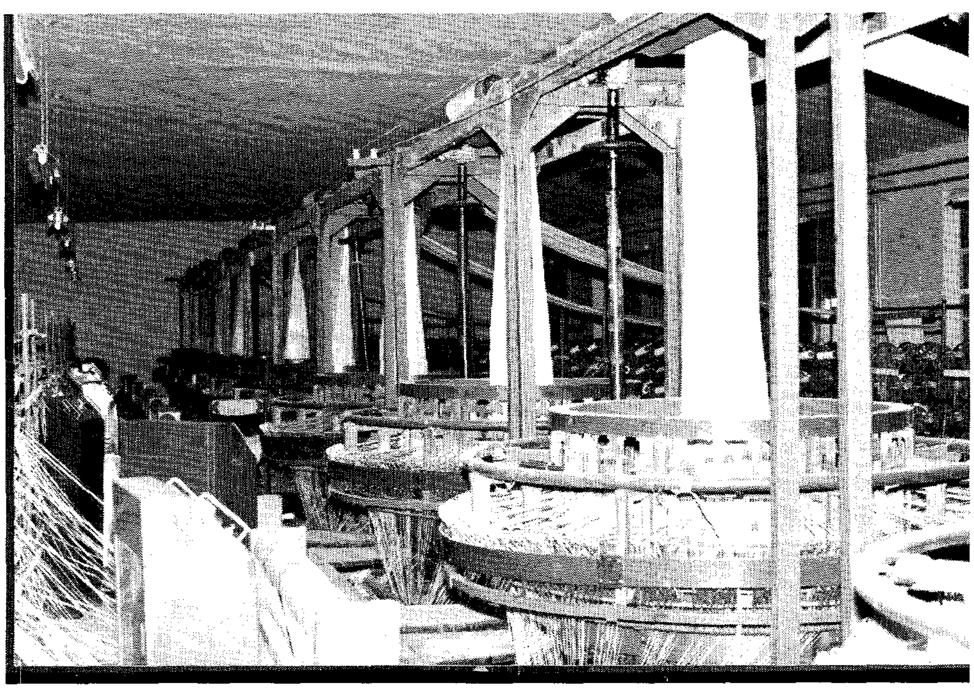

Photo 15. Weaving fibers for making braided bag →

Making Braided Bags from Waste Polyvinyl Chloride

Survey. Waste plastic has become a major constituent in waste. Currently, it accounts for approximately 3 percent of total waste. Plastic can not degrade or decay, and burning plastic would generate hazardous substances. Hence, plastic has a tremendous impact on the environment.

Plastic braided cloth is a widely used packing material. Using waste plastic as a raw material for plastic braided cloth can not only reduce resource consumption, but will also reduce environmental pollution. After extensive experimentation, the comprehensive utilization technology of using waste plastic as a raw material for braided cloth has been refined.

The waste plastic used as a production material is principally composed of polyvinyl chloride. After cleaning, drying and heating, the waste plastic is ready as a production input. Although the plastic requires waste treatment, the total material cost is lower than or equal to the price of purchased production material. In addition, a large amount of waste can be utilized. This process brings significant environmental benefit.

Process. waste cleaning and drying, adding reinforcing agent → heating → selecting particulate, mixing waste with new polypropylene → heating → extruding → drawing → cutting → oven drying → towing → braiding → packing

Specifications. The production material contains 30 percent waste polyvinyl chloride. The final product meets national standards.

Investment. Building a plant with productivity of 360 tons of braided material (equivalent to 4.5 million bags) per year requires an investment of RMB 2.5 million Yuan and 1000 square meters of land, of which buildings will occupy be 600 square meters.

Economic Benefit. At current market prices, the annual profit could reach RMB 500,000 Yuan; the total investment could be recovered in five years.

Social and Environmental Benefit. This project can help eliminate pollution caused by waste plastic.

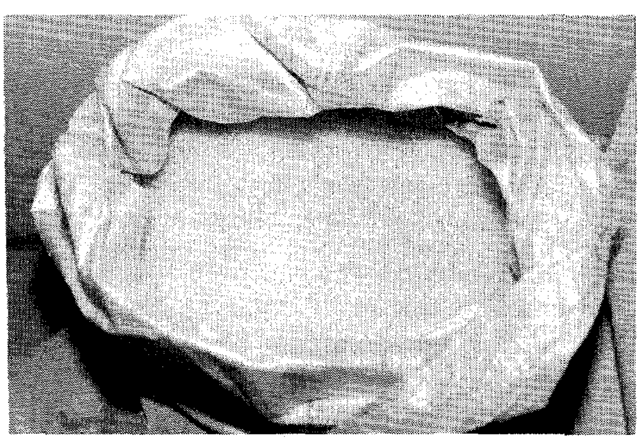

Photo 16. PUC beads made from waste PUC materials

Photo 17. Waste PUC →

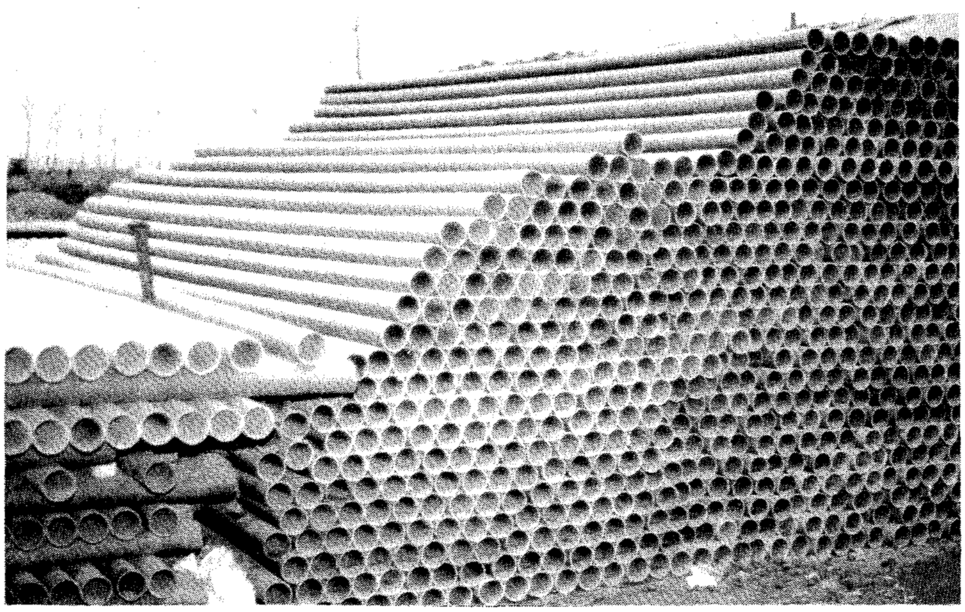

Photo 18. Product: Polyvinyl pipes

Making Hose from Waste Polyvinyl Chloride

Survey. Urban development has increased the demand for plastic hose. Using waste plastic in the production process can not only save raw materials, but can also increase environmental protection.

Waste plastic comprises 90 percent of the production materials. Most of the waste plastic is selected manually from the collected waste manually. If sorted waste collection were realized, it would reduce costs.

Process. material selection → cleaning → crushing → mixing with auxiliary materials → granulating → feeding → heating → drawing and molding

Technical Specifications. The product meets national standards.

Flattening Test . The hose can be pressed to half of its diameter without being damaged.

Falling Impact Test. When a one-kgf weight falls on the sample from a height of 0.5 meters, no damage is done 9 times out of 10.

- Longitudinal Size Change Ratio = +2.2%
- Vicat Softening Point = 85°C
- Specific Gravity = 1.56

Investment. Building a plastic hose making plant with a productivity of 150 tons of hose per year would require seven sets of equipment. Equipment costs would be about RMB 200,000 Yuan; it requires a building area of 200 square meters. Total investment will be about RMB 400,000 Yuan.

Economic Benefit. The production costs would be RMB 2000 Yuan per ton. The total unit cost is RMB 2,500 Yuan per ton; current market price is RMB 3,300-4,500 Yuan per ton. Annual profits could reach RMB 120,000-150,000 Yuan; total investment could be recovered in three to four years.

Environmental Benefit. Each year, 200 tons of waste plastic would be reused. Pollution caused by waste plastic would be significantly reduced.

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