

MINISTRY OF PHYSICAL PLANNING AND CONSTRUCTION
THE REPUBLIC OF POLAND

**THE STUDY
ON
THE SOLID WASTE MANAGEMENT
FOR
POZNAN CITY**

**FINAL REPORT
CASE STUDY OF MSWM
MASTER PLAN MANUAL FOR LUBLIN**

MAY 1993

**KOKUSAI KOGYO Co.Ltd.,
PACIFIC CONSULTANTS INTERNATIONAL**

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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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In this report, project cost is estimated at January 1993 price and at an exchange rate of 1 US\$ = ¥ 125 = 15,700 Zl.

**THE STUDY
ON
THE SOLID WASTE MANAGEMENT
FOR
POZNAN CITY**

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- H. Examination of Technical System Alternative Plan
- I. The Master Plan
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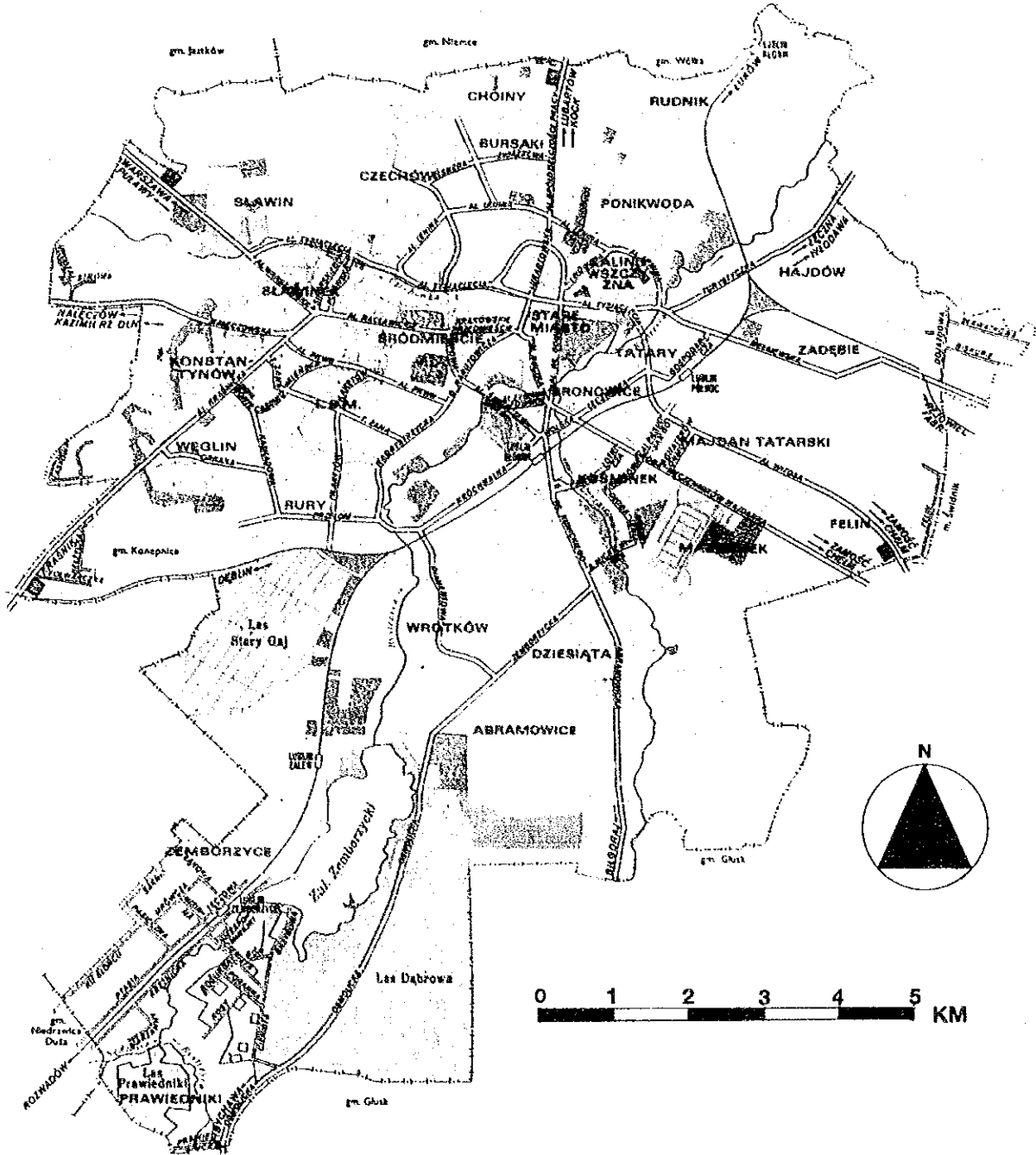
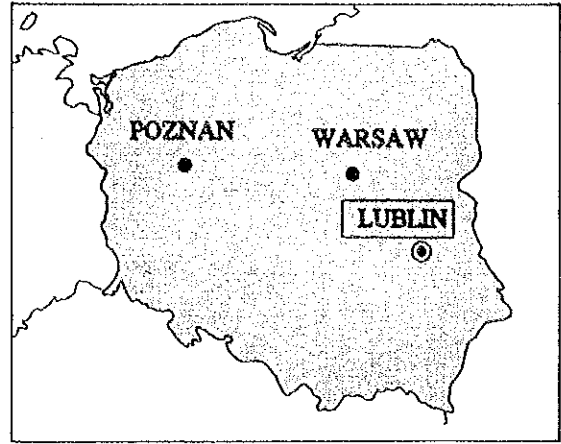
VOLUME IV : DATA BOOK

MANUAL FOR FORMULATION AND IMPLEMENTATION OF MSWM MASTER PLAN (English Version)

MANUAL FOR FORMULATION AND IMPLEMENTATION OF MSWM MASTER PLAN (Polish Version)

CASE STUDY OF MSWM MASTER PLAN MANUAL FOR LUBLIN

***This is CASE STUDY OF MSWM MASTER PLAN
MANUAL FOR LUBLIN.***



LOCATION MAP

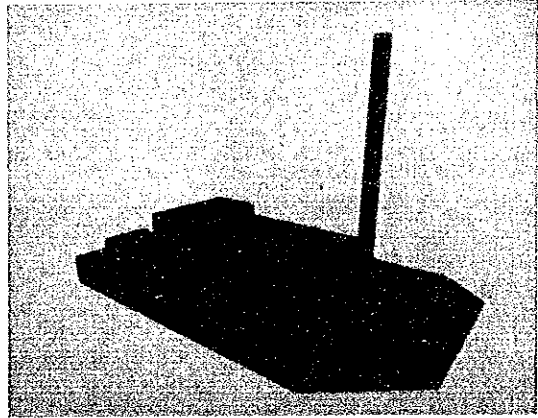
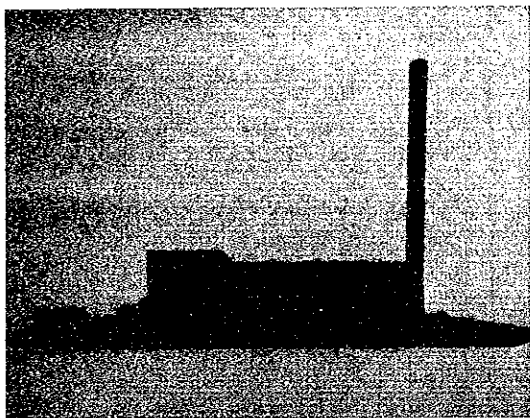
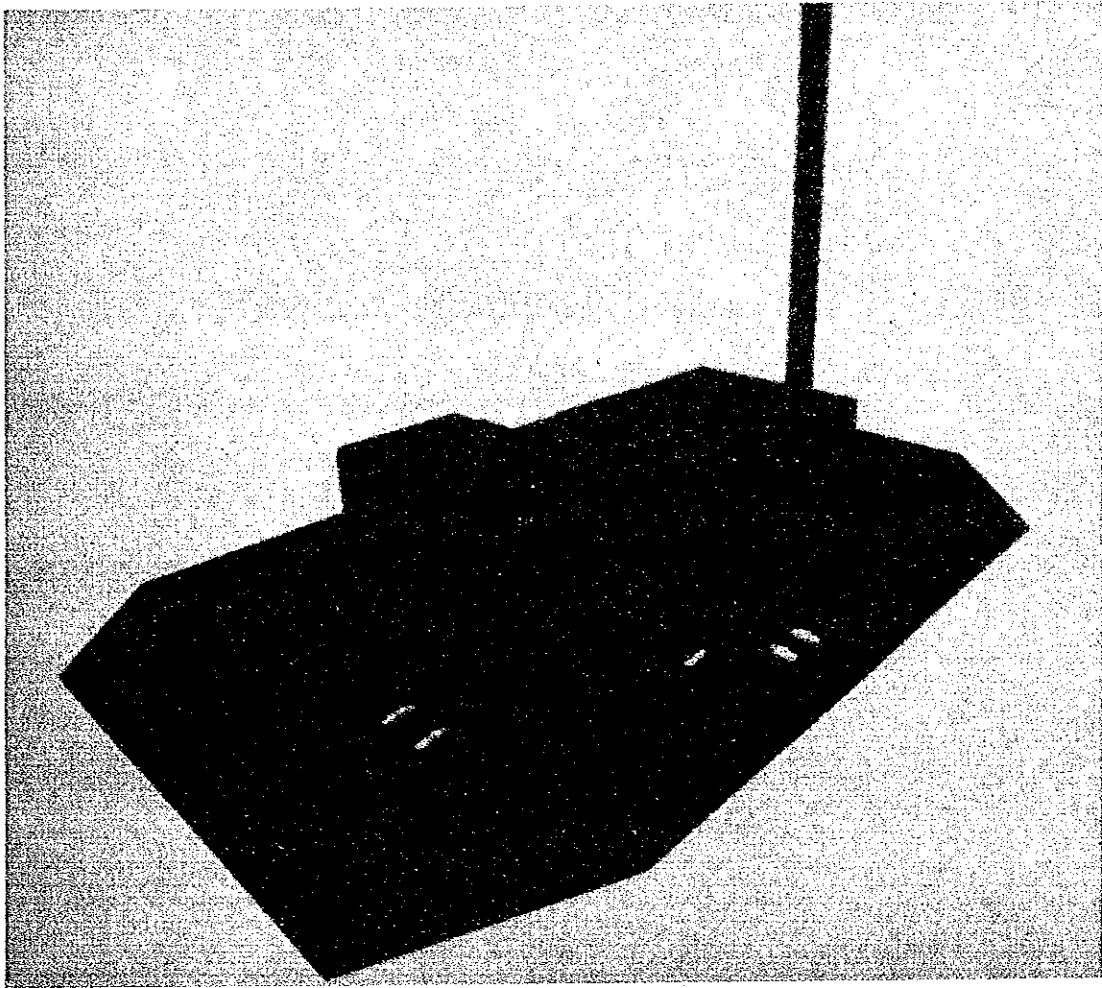


Plate 1 Image of Incineration Plant

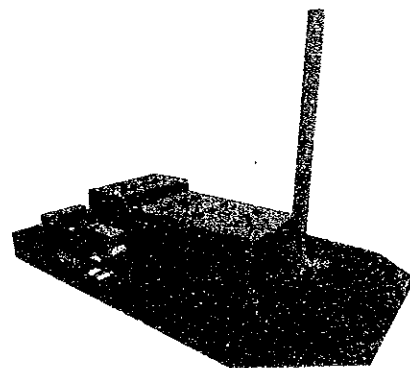
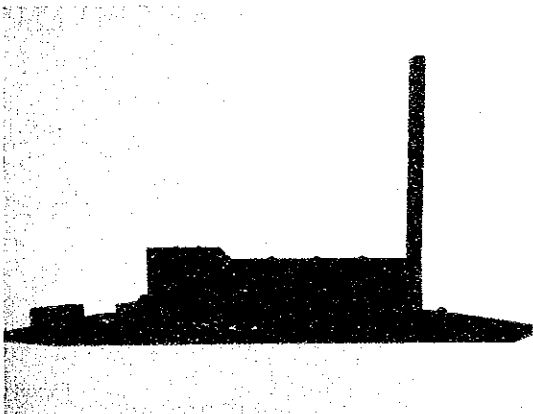
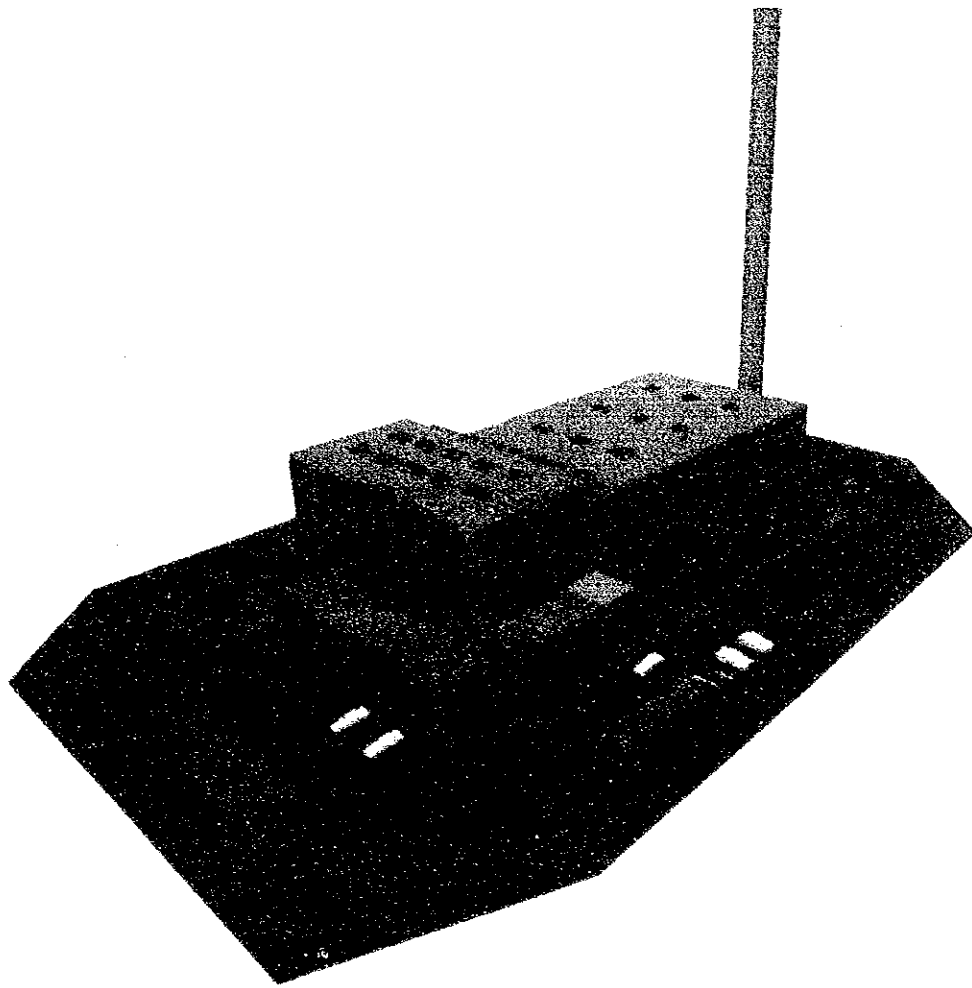


Plate 1 Image of Incineration Plant



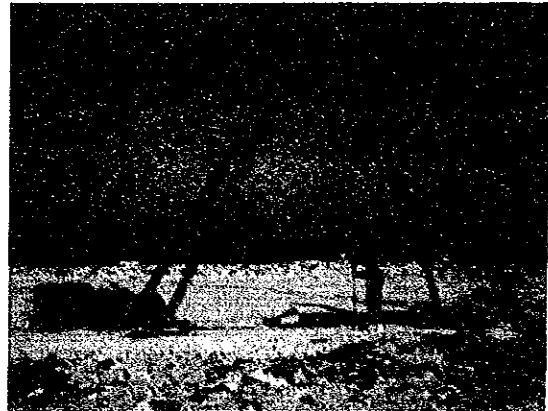
Collection in the City of Lublin



Present Landfill at Jawidz



Waste Amount and Composition Survey



Biogas Project at Jawidz Landfill



Construction of Future Landfill at Rokitno



Promotion Event of Public Cooperation
(Japanese Day in Lublin)

Plate 2 Present MSWM in Lublin



Collection in the City of Lublin



Present Landfill at Jawidz



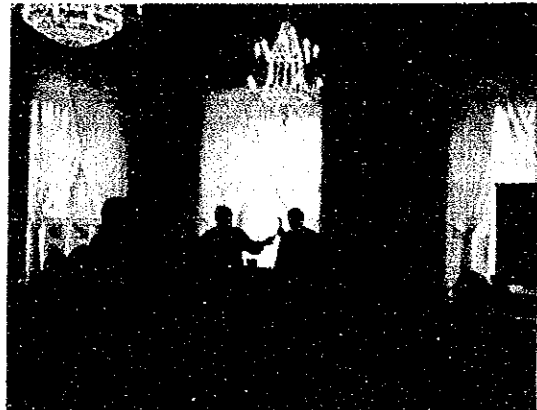
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**Promotion Event of Public Cooperation
(Japanese Day in Lublin)**

CASE STUDY OF MASTER PLAN MANUAL FOR LUBLIN

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ABBREVIATIONS

ORGANIZATIONS

DIA	Department for Investment Affairs, Poznan Municipality
DCRA	Department for Communal and Residential Affairs, Poznan Municipality
EBRD	European Bank for Reconstruction and Development
EC	European Communities
JICA	Japan International Cooperation Agency
LPEC	Lublin Heat Energy Company
MOPPC	Ministry of Physical Planning and Construction
MPO	Municipal Cleansing Company
PEC	Heat Supply Company
SANEPID	Sanitary Epidemiological Institute
SANITECH	Sanitary Technology Company

REPORT and STUDY

ASG	Apparent Specific Gravity
CV	Calorific Value
DF/R	Draft Final Report
F/R	Final Report
IC/R	Inception Report
ISW	Industrial Solid Waste
ISWM	Industrial Solid Waste Management
IT/R	Interim Report
LCV	Lower Calorific Value
M/M	Minutes of Meeting
MSWM	Municipal Solid Waste Management
O & M	Operation and Maintenance
PR/R	Progress Report
S/W	Scope of Work
SWM	Solid Waste Management
WACS	Waste Amount and Composition Survey
EC PHARE Report	Municipal Waste-Strategy for Waste Management and Applicable Methods for Collection and Treatment in 1992

SOCIO-ECONOMY

EIRR	Economic Internal Rate of Return
FIRR	Financial Rate of Return
GDP	Gross Domestic Product

GNP	Gross National Product
GRDP	Gross Regional Domestic Product
USD	U.S. dollar
zl	Zlotych
p.a.	per annually
mill.	million
bill.	billion

UNIT

mm	millimetre
cm	centimetre
m	meter
km	kilometre
m ²	square meter
km ²	square kilometre
ha	hectare
m ³	cubic meter
mg	milligram
lit.	litre
kg	kilogram
ton	ton
sec.	second
min.	minutes
hr	hour
d	day
%	percent
no.	number
nos.	numbers
kw	kilowatt
kj	kilojoule
kcal	kilocalorie

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

1) M/M on November 25, 1991

Minutes of Meeting for The Study on the Solid Waste Management for City Poznan in the Republic of Poland signed on November 25, 1991 (hereinafter referred to as "M/M on November 25,1991") by both Polish and Japanese governments, which defines the scope of the Study, stated as follows:

"In Poland, there are several cities with more than half million population where the improvement of Municipal Solid Waste Management is an urgent task. As such the Ministry of Construction hopes to use Poznan City as a model for such cities. Therefore, a manual should be prepared in English, as the result of the Study, on formulation and implementation of the municipal solid waste management master plans taking into account the local conditions which differ from city to city. The draft manual must be ready by the time of submission of Interim Report. When it is ready, its applicability to other Polish cities will be checked using the City of Lublin as a test case during the second work in Poland. Then necessary modifications will be made to the manual. As the result of this testing, recommendations for the improvement of municipal solid waste management in the City of Lublin will be prepared and presented to the Municipality of Lublin".

2) Case Study in the City of Lublin

As described in the above-mentioned M/M on November 25, 1991, a draft manual for formulation and implementation of MSWM master plan was prepared in the Interim Report submitted in mid-October 1992. Based on the draft manual, this case study was carried out in order to:

- check the applicability of the draft manual to other Polish cities;
- make necessary modifications on it; and
- to prepare recommendations for the improvement of municipal solid waste management in the City of Lublin including a concept of her MSWM master plan.

3) Study Waste

Like Poznan study the wastes studied were household wastes, market wastes, commercial wastes, road sweeping and institutional wastes. Medical and industrial wastes, however were excluded.

1.2 Key Assumptions

Key assumptions used in this study area (Lublin Agglomeration) are as follows:

1) Socio-economic Conditions

Items	Unit	Descriptions
1. Population		
- Projected Population	persons	1992 2001 2010 492,500 574,000 669,500
- Annual Growth Rate	%	1.72%/year
2. Economy		
- GDP	bill.USD	73.7 in 2000 132.0 in 2010
- Annual Increase Rate of GDP in Real Term	%	1993 - 1994 0% 1995 - 2000 3% 2001 - 2010 6%
- *Future Budget Scale of the Lublin Agglomeration	bill.ZI	The budget in 1993 will increase in accordance with GDP increase in real term. 962 in 2000 1,729 in 2010
- Income Level of the Citizens (per household)	ZI/month	The income will increase according to the GDP increase in real term+population growth. 3,483,000 in 2000 5,260,000 in 2010
- Currency Exchange Rate		1 USD = 15,700 Zloty = 125 Yen
- Inflation Rate	%	70% in 1991 40 - 45% in 1992 0% from 1993 to 2010 for the economic and financial analysis of the Study

(Note) *The figure is estimated by simply multiplying the budget of Lublin Municipality in 1993 (596 billion ZI) by the ratio of 1.397 (the ratio of the population of Lublin Agglomeration by it of Lublin City) due to the lack of information.

2) Waste Amount and Composition

Items	Unit	Descriptions		
1. Waste Amount				
1-1 Waste Discharge Ratio		1992	2001	2010
- MSW	g/person/day	508(92)	549(115)	697(170)
- MSW excluding Road Sweeping and Bulky Wastes with Ashes	(1,000 ton/year)	454(82)	488(102)	618(151)
- MSW excluding Road Sweeping and Bulky Wastes without Ashes		424(76)	488(102)	618(151)
1-2 Collection Ratio of Household Waste	%	?	100	100
1-3 Annual Increase Rate of Waste Discharge		1992 - 2000	2001 - 2010	
- MSW with Ash	%	- 0.87	2.70	
- MSW without Ash	%	1.40	2.70	
Note: Ash discharge from households will be ended by 2001.				
2. Waste Composition				
2-1 Forecast for Waste Composition				
<p>The chart displays the forecasted composition of waste from 1992 to 2010. The Y-axis is labeled 'Composition' and ranges from 0% to 100% in 10% increments. The X-axis is labeled 'Year' and lists years from 1992 to 2010. The legend identifies the following components: Garbage (black), Paper (white), Textile (dark grey), Plastics (medium grey), Grass & Wood (light grey), Leather & Rubber (white with horizontal lines), Metal (dark grey with diagonal lines), Glass (medium grey with diagonal lines), Ceramic & Soil (light grey with diagonal lines), and Others (black with diagonal lines). The chart shows a general increase in the proportion of Garbage and Paper over time, while other components like Textile and Plastics remain relatively stable.</p>				
2-2 Lower Calorific Value		1992	2001	2010
- MSW for Incineration (MSW excluding Road Sweeping and Bulky Wastes with Ashes)	kcal/kg	1,146	1,419	1,628
- MSW without Ashes for Incineration	kcal/kg	1,213	1,419	1,628
- Separately Collected MSW for Incineration	kcal/kg	1,320	1,716	2,217
- Sewage Sludge and Separately Collected MSW for Incineration	kcal/kg	1,229	1,580	2,022

3) Life Span of Equipment and Facilities

	Life Span (years)	Salvage value (%)
Container	5	0
Vehicle and Heavy Equipment	7	10
Machinery	15	0
Building and Civil Works	30	0

Note: The life span of other facilities for the disposal site depends on the period of its operation.

4) Loan Conditions

	Repayment Schedule and Interest Rate in Real Term
- Long Term Loans	Repayment over 10 years with a 3 years grace period, 7.5%
- Short Term Loans	Repayment in the Following Years, 13.5%

CHAPTER 2

FIELD SURVEY

CHAPTER 2 FIELD SURVEY

2.1 Field Survey

Basic information such as the quantity and quality of solid waste generated in the study area, the population covered by the collection services, maps showing the collection area, etc., is the principal and the key factor for a successful and workable municipal solid waste management plan.

According to the manual, in order to clearly know the present MSWM, the following field surveys are to be conducted if necessary:

- study on waste amount and composition both in summer and winter;
- public opinion survey;
- time and motion study for waste collection and cleansing works;
- survey on scavengers;
- survey on the recycling system and the market for reusable materials; and
- investigation of present and future sites for intermediate treatment facilities and final disposal.

Although the existing EC PHARE report, elaborated the two scenarios for the MSWM in Lublin, it did not identify the waste amount and composition in Lublin. Due to the study time limitation and the degree of importance for the preparation of a MSWM master plan, only waste amount and composition survey in winter and public opinion survey were conducted in cooperation with the Lublin Foundation for Environmental Protection. The results are described bellow.

2.2 Waste Amount and Composition Survey

1) Objective of the Survey

The amount of the composition of waste are very fundamental data for planning technical systems for collection, haulage, treatment and disposal. Since waste amount and composition at generation sources differ from ones at a disposal site, the study should be done at both places.

A WACS (Waste Amount and Composition Survey) was carried out in order to obtain the basic information such as waste generation ratio, discharge amount,

amount of self-disposal and collection, and to finally clarify the waste stream in the study area.

Survey of waste amount and composition is to be conducted at least twice (once in summer and once in winter). However, due to the time limitation, it was conducted only in winter. The averages of them were estimated based on the results obtained by the Study of Poznan.

2) Definitions of Waste

In order to make the contents of the WACS and the waste stream clearly understood, the words used in the study are defined as follows;

a. Household waste

Waste generated in or discharged from each household including waste in shops. Those generated through commercial activities are excluded.

b. Commercial waste

Wastes generated in or discharged from shops, excluding household waste of them. Shops include restaurants, hotels, drug stores, grocery shops, printing shops, private offices, etc.

c. Market waste

Waste generated in or discharged from markets both for wholesale and retailing.

d. Institutional waste

As for the institutional waste, government offices and schools waste is examined in the Study.

e. Road sweeping waste

Road sweeping waste include all wastes generated by the following cleansing services;

- road sweeping waste; and
- public area cleansing waste.

f. Bulky waste

Abandoned bulky items (such as furniture and vehicles), which are discharged from the above-mentioned categories of sources, is considered as bulky waste in the Study.

g. Other wastes

Other wastes in the Study are the wastes which are disposed of at the present Jawidz disposal site and are not considered as the MSW (item a. to f.).

3) Method of Waste Amount Survey

Waste amount survey applied in this study was divided into the following two methods:

- discharge ratio survey at generation sources; and
- interview survey to MPO.

In addition, the results of the POS were referred for the final determination of the amount. The method applied to the WACS is tabulated in Table 2.2-1.

Table 2.2-1 Method of Waste Amount Survey

Category	Discharge Ratio Survey	Interview Survey to MPO
MSW (Total)		x
Household Waste	x	
Market Waste	x	
Commercial Waste	x	
Institutional Waste	x	
Road Sweeping Waste		x
Bulky Waste		x
Others (Total)		x

Note: The item given "x" was surveyed in the Study.

4) Selection of Sampling Point for Discharge Ratio Survey

As the result of reconnaissance and hearing from the relevant persons, the types of municipal wastes to be studied were categorized as shown below and then classified into smaller categories depending on the composition of waste in each category.

- household waste (from residences);
- commercial waste (from restaurants and shops);
- institutional waste (from offices and schools);
- market waste (from markets); and
- road sweeping waste (from road and public area)

a. Household waste

The ash discharged from the stove in the residents was deemed to be an important factor for the composition of waste. Therefore, household waste was classified into the six categories as shown below.

- apartment buildings with municipal heat supply (LPEC)
- apartment buildings without municipal heat supply (Non LPEC)
- detached or semi-detached houses with municipal heat supply (LPEC)
- detached or semi-detached houses without municipal heat supply (Non LPEC)

b. Commercial waste

Commercial waste was classified into two categories which consist of food suppliers like restaurants and ordinary shops.

The amount of waste discharged from both categories was measured. The composition analysis, however, was carried out concerning the mixed waste.

c. Market waste

Lublin City is dotted with some markets of middle and small scale. As the result of the reconnaissance, the two representative markets were selected (one from wholesale and the other from retail) in consideration of kinds of commodities and scale of selling. As waste composition between two sampling points was not different apparently, waste amount survey was carried out at the two points and waste composition survey was done for the waste from the market for retailers.

d. Institutional waste

Amount and composition survey of institutional waste was carried out at the municipality office and an elementary school. Waste amount was measured at the both offices and waste composition was analyzed for mixed waste from the two offices.

e. Road sweeping and bulky wastes

The amount of road sweeping waste and public area cleansing waste was estimated based on the answer made by MPO.

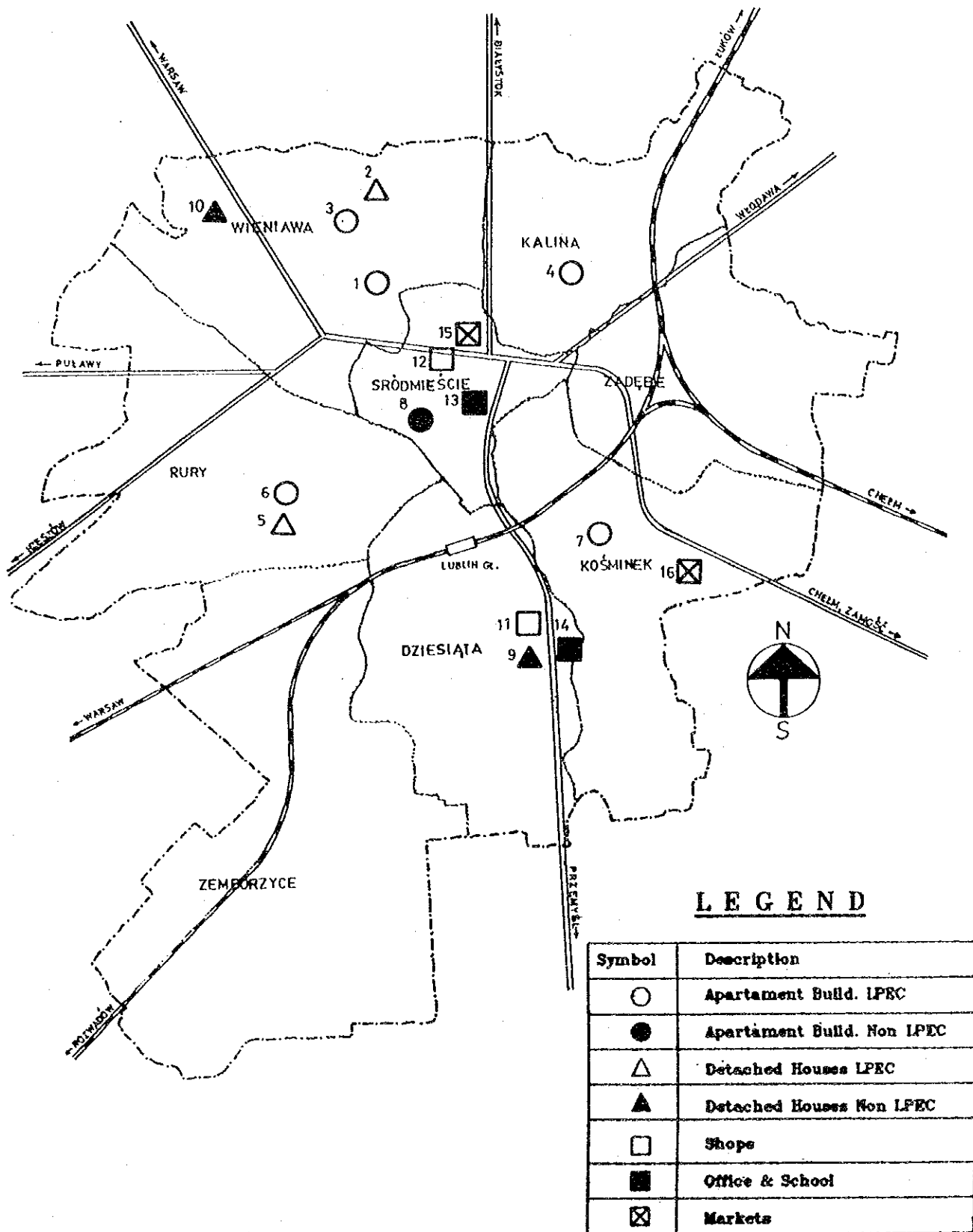
The number of samples in accordance with the category of generation sources is tabulated in Table 2.2-2. The sample points for WACS is tabulated in Table 2.2-3 and shown in Fig.2.2-1.

Table 2.2-2 Number of Samples for WACS

Category of Generation Sources	Number of Samples for Waste Amount Survey	Number of Samples for Waste Composition Analysis
1. Household Waste LPEC Area	35	1
2. Household Waste Non-LPEC Area	25	1
3. Commercial Waste - from catering - from other shops	5 5	1
4. Office Waste	2	1
5. Market Waste	2	1
Total	74	5

Table 2.2-3 Sample Points for WACS

NO	Category	Heat	Sampling NO.	Location
1	Apartment Buildings	LPEC	5	Wieniawa Czechow
2	Detached Houses	LPEC	5	ditto
3	Apartment Buildings	LPEC	5	ditto
4	ditto	LPEC	5	Kalina Kalinowska
5	Detached Houses	LPEC	5	Rury Czuby
6	Apartment Buildings	LPEC	5	ditto
7	ditto	LPEC	5	Kosminck Maki
8	ditto	Non LPEC	15	Srodmiescie
9	Detached Houses	Non LPEC	5	Dziesiata
10	ditto	Non LPEC	5	Wieniawa Slawin
11	Shops	-	5	Dziesiata
12	Shops	-	5	Srodmiescie
13	Office	-	1	City Hall (Ra-tusz), Plac Lokietka 1 SP nr 1, ul.
14	School	-	1	Kunickiego 116 Nowy Plac Targowy, Aleja
15	Market	-	1	Tysiaclecia Plac Targowy
16	Market	-	1	ul.Grenadierow



Note : The figure shown is the same as NO shown in Table 2.2-3

Fig.2.2-1 Sample Points of WACS

5) Survey Period

The survey was conducted in the following periods;

Table 2.2-4 Survey Period of WACS

Items	Survey Period
Delivery of Plastic Bags and Instruction Papers	Nov. 30th to Dec. 1st
Waste Collection From Each Generation Sources	Dec. 3rd to Dec. 10th
Waste Amount Measurement	Dec. 3rd to Dec. 10th
Trial of Waste Composition Analysis	Dec. 3rd
Waste Composition Analysis	Dec. 4th to Dec. 12th

6) Method of the Survey

Method of the survey is tabulated in Table 2.2-5. Upon consideration of daily fluctuation of discharged waste amount, the survey was conducted for continuous 8 days. The data obtained at the first day (Dec. 3rd) was not used for the analysis, only for the reference.

a. Collection of sample

Before the execution of the WACS, required numbers of plastic bags were distributed to residences, shops and offices which were selected as sampling points. Then, when a sample was collected by the Study Team, a sticker was given to the sample in order to classify the sample.

The sample discharged from the market was collected by containers.

b. Waste amount survey

Collection of waste from each generation source was carried out after 7:00 AM. After collection, each waste was measured at the garage of the Lublin Foundation for Environmental Protection. Totally 74 samples were to be measured everyday. All wastes were measured by two weighing plates except for waste from the wholesale market which was measured by a weighbridge due to the large waste amount.

The waste to be collected was the one which was generated from 7:00 AM of the previous day to 7:00 AM the day of the collection. Therefore, the sampling houses were requested to put their waste into the plastic bags supplied for the survey in accordance with this rule. The sampling houses were also requested to put their plastic bags at the designated places for the collection.

c. Waste composition survey

After the measurement of weight, wastes were mixed in accordance with the 5 categories described in the Table 2.2-2. Then the waste of each category was reduced up to 30 to 40 litres by the designated reduction method described in the WACS in the City of Poznan.

Then each ASG (Apparent Specific Gravity) of 5 categories of the waste was measured. After the measurement of the APGs, each category of the waste was classified into 10 items as described below:

- garbage (food waste)
- paper
- textile
- plastic
- grass and wood
- leather and rubber
- metals
- glasses
- ceramic and soil (including ash)
- others

In order to get ASG the plastic bucket containing waste was tapped on the ground several times, the waste volume was measured with eye and the weight by the platform balance.

ASG (Apparent Specific Gravity) was calculated by following formula.

$$\text{ASG} = \text{Weight of Waste (kg)} / \text{Volume of Waste (litres)}$$

After ASG was measured, waste was applied to the composition survey. Items of waste composition survey were shown in Table 2.2-5.

Table 2.2-5 Method of Survey

Discharge Sources	Collection of Sample	Waste Amount Survey	Waste Composition Survey
Residential Area (LPEC)	by plastic bag	by weighing plate	Analysis Items - ASG (Apparent Specific Gravity) - Physical composition .. wet base (garbage, paper, textile, plastic, glasses, grass and wood, leather and rubber, metals, ceramic and soil, others)
Residential Area (Non LPEC)	by plastic bag	by weighing plate	
Commercial Area	by plastic bag	by weighing plate	
Market	by container	by weighing plate for the retailing market and weighbridge for the wholesale market	
Institutional	by plastic bag	by spring balance	

- Physical composition (wet base)

The physical composition was measured in wet base. After the segregation the samples were dried in the dryer (100°C, 3 days). Due to small capacity of the available dryer, the sample for drying was reduced again up to around 10 % to 20 % of segregated volume. Therefore, it must be noted that the physical composition in wet base is reliable, but it in dry base shall be carefully used.

7) Results of the Survey

a. Waste amount

i. Household waste

The result of waste amount survey is tabulated in Table 2.2-6 and 2.2-7. Amount of waste discharged from residences per unit per day was different in LPEC and Non LPEC. Discharged amount of waste from a residence was **336 g/day/person** in LPEC and **542 g/day/ person with ash** and **447 g/day/person** without ash in Non LPEC. Average discharged amount of waste in the city was **400 g/day/ person with ash** and **370 g/day/person** without ash based on the population ratio of LPEC (69 %) and Non LPEC area (31 %).

Table 2.2-6 Waste Amount of Household

Category	Number of Residence	Total Number of Family Members	Average Discharge Amount (g/d)	Average Discharge Amount (g/d/per)
Household (LPEC)	34	122	40,950	336
Household (Non LPEC)	25	91	49,286	542 (447)
Average	-	-	-	400 (370)

Note:

- *1. Average figure was obtained by the figures from Dec. 4th to Dec. 10th.
- *2. The figure of the parentheses was the average excluding ash amount.

ii. Commercial, Market and Institutional wastes

The result of waste amount survey is tabulated in Table 2.2-7.

Table 2.2-7 Waste Amount of Commercial, Market and Institutional

Category	Number of Samples	1. Basic Indexes	Average Discharge Amount (g/d)	2. Average Discharge Amount
Commercial (1) ^{*1}	5	447	9,330	21
Commercial (2) ^{*2}	5	260	44,440	171
Market ^{*3}	2	380	826,500	2,172
Institution (1) ^{*4}	1	172	14,070	82
Institution (2) ^{*5}	1	1000	26,990	27

Note:

- *1 commercial (1); Shops other than catering. 1. area of shops (m²), 2. g/day/m².
- *2 commercial (2); Catering. 1. number of seats, 2. g/day/seat.
- *3 Market; 1. number of shops, 2. g/day/shop.
- *4 Institutional (1); Government office. 1. number of employees, 2. g/day/employee
- *5 Institutional (2); School. 1. number of students, 2. g/day/student.

b. Waste composition

i. Results

The result of waste composition survey is tabulated in the Tables 2.2-8 to 2.2-14.

In order to use the tables, it should be noted that the composition survey of markets was done only for the waste from the retailing market. Due to the renovation of the market, the waste containers (1.1 m³) of the market did have any shelters for protection from rain and 5 days among 7 days of the WACS were rain. Therefore, the actual water content may be less than the result.

The following characteristics are observed by the tables:

- The ASGs are less than **0.2 ton/m³** considering the inclusion of ash in household waste of Non LPEC and the rain water intrusion of the market waste.
- Garbage shares more than **65 %** in household waste of LPEC.
- The ratio of ceramic and soil in Non LPEC is **21.74 %** due to the high inclusion of ash. Without ash its ratio would be the same as it of LPEC.
- It is observed in the commercial waste that the ratio of paper is the second highest, i.e. **25.33 %**, due to the discharge of paper containers from the first food shops and cardboard, etc., and that the ratio of glasses is the highest, i.e. **24.28 %**.
- The reason why the garbage ratio of institutional waste is the highest, i.e. **70.9 %**, is due to the food waste from the school of which weight was heavy and was not recycled for the animals. Except for food waste of the lunch in the school, the contents of paper is remarkable.
- As for the market waste, the ratio of paper such as cardboard for packing is the highest, i.e. **32.56 %**.

Table 2.2-8 Apparent Specific Gravity

Date		Household Waste (LPEC)	Household Waste (Non LPEC)	Commercial Waste	Institutional Waste	Market Waste
3rd	Sample Volume (l)	40	40	40	40	40
Dec.	Sample Weight (kg)	8.155	7.461	4.650	2.060	9.220
1992	ASG (kg/l)	0.204	0.187	0.116	0.052	0.231
4th	Sample Volume (l)	40	40	40	40	40
Dec.	Sample Weight (kg)	5.445	5.697	4.010	7.120	6.660
1992	ASG (kg/l)	0.136	0.142	0.100	0.178	0.167
5th	Sample Volume (l)	40	40	40	40	40
Dec.	Sample Weight (kg)	7.300	6.835	2.390	2.190	9.500
1992	ASG (kg/l)	0.183	0.171	0.060	0.055	0.238
6th	Sample Volume (l)	40	40	40	40	40
Dec.	Sample Weight (kg)	7.410	10.800	8.460	3.910	11.680
1992	ASG (kg/l)	0.185	0.270	0.212	0.098	0.292
7th	Sample Volume (l)	40	40	40	40	40
Dec.	Sample Weight (kg)	7.986	9.350	4.776	13.590	11.320
1992	ASG (kg/l)	0.200	0.234	0.119	0.340	0.283
8th	Sample Volume (l)	40	40	40	40	40
Dec.	Sample Weight (kg)	7.634	7.259	5.002	7.620	8.108
1992	ASG (kg/l)	0.191	0.181	0.125	0.191	0.203
9th	Sample Volume (l)	40	40	40	40	40
Dec.	Sample Weight (kg)	8.492	8.762	3.254	2.866	7.462
1992	ASG (kg/l)	0.212	0.219	0.081	0.072	0.187
10th	Sample Volume (l)	40	40	40	40	40
Dec.	Sample Weight (kg)	6.258	11.550	6.990	5.834	7.732
1992	ASG (kg/l)	0.156	0.289	0.175	0.146	0.193
	Sample Volume (l)	40	40	40	40	40
Average	Sample Weight (kg)	7.218	8.608	4.983	6.161	8.923
	ASG (kg/l)	0.180	0.215	0.125	0.154	0.223

Table 2.2-9 Summary of Waste Composition Survey

Classification			Residential (LPEC)	Residential (Non LPEC)	Commercial	Institutional	Market
Wet Weight	combustibles	garbage	(g) 4,711	3,896	1,547	4,369	2,522
			(%) 65.26	45.25	30.17	70.90	28.27
		paper	(g) 802	1,177	1,299	920	2,905
			(%) 11.11	13.67	25.33	14.93	32.56
		textile	(g) 272	181	39	88	220
			(%) 3.77	2.10	0.76	1.43	2.47
		plastic	(g) 274	379	379	192	393
			(%) 3.80	4.40	7.39	3.12	4.40
		grass and wood	(g) 166	139	219	48	1,034
			(%) 2.30	1.61	4.27	0.78	11.59
	leather and rubber	(g) 132	230	-	-	37	
		(%) 1.83	2.67	-	-	0.41	
	Sub-total	(g) 6,357	6,002	3,483	5,617	7,111	
		(%) 88.06	69.72	67.92	91.16	79.70	
	incombustibles	metals	(g) 220	285	307	61	110
			(%) 3.05	3.31	5.99	0.99	1.23
		glasses	(g) 470	450	1,245	134	668
			(%) 6.51	5.23	24.28	2.17	7.49
		ceramic and soil	(g) 172	1,872	93	350	1,033
			(%) 2.38	21.74	1.81	5.68	11.58
others	(g) -	-	-	-	-		
	(%) -	-	-	-	-		
Sub-total	(g) 862	2,607	1,645	545	1,811		
	(%) 11.94	30.28	32.08	8.84	20.30		
Total	(g) 7,219	8,609	5,128	6,162	8,922		
	(%) 100.00	100.00	100.00	100.00	100.00		
Moisture Content			(g) 3,790	3,176	1,583	3,497	4,066
	(%) 52.50	36.89	30.87	56.75	45.57		
Dry Weight	combustibles	garbage	(g) 1,391	1,309	530	1,239	656
			(%) 19.27	15.21	10.34	20.11	7.35
		paper	(g) 543	834	973	659	1,686
			(%) 7.52	9.69	18.97	10.69	18.90
		textile	(g) 233	158	17	72	96
			(%) 3.23	1.84	0.33	1.17	1.08
		plastic	(g) 251	336	335	161	283
			(%) 3.48	3.90	6.53	2.61	3.17
		grass and wood	(g) 98	51	73	32	493
			(%) 1.36	0.59	1.42	0.52	5.53
	leather and rubber	(g) 125	206	-	-	32	
		(%) 1.73	2.39	-	-	0.36	
	Sub-total	(g) 2,641	2,894	1,928	2,163	3,246	
		(%) 36.58	33.62	37.60	35.10	36.38	
	incombustibles	metals	(g) 220	285	307	61	110
			(%) 3.05	3.31	5.99	0.99	1.23
		glasses	(g) 470	450	1,245	134	668
			(%) 6.51	5.23	24.28	2.17	7.49
		ceramic and soil	(g) 98	1,804	65	307	832
			(%) 1.36	20.95	1.27	4.98	9.33
others	(g) -	-	-	-	-		
	(%) -	-	-	-	-		
Sub-total	(g) 788	2,539	1,617	502	1,610		
	(%) 10.92	29.49	31.53	8.15	18.05		
Total	(g) 3,429	5,433	3,545	2,665	4,856		
	(%) 47.50	63.11	69.13	43.25	54.43		

Table 2.2-10 Composition of Household Waste (LPEC)

Classification			3 Dec 1992	4 Dec 1992	5 Dec 1992	6 Dec 1992	7 Dec 1992	8 Dec 1992	9 Dec 1992	10 Dec 1992	Average
Wet Weight	combustibles	garbage	(g) 6,650	2,820	5,390	3,770	5,900	4,940	6,400	3,758	4,711
			(%) 81.55	51.79	73.84	50.88	73.88	64.71	75.37	60.05	65.26
		paper	(g) 770	725	800	820	800	812	934	722	802
			(%) 9.44	13.31	10.96	11.07	10.02	10.64	11.00	11.54	11.11
		textile	(g) 120	450	210	200	140	244	406	252	272
			(%) 1.47	8.26	2.88	2.70	1.75	3.20	4.78	4.03	3.77
		plastic	(g) 270	180	270	430	440	286	134	180	274
			(%) 3.31	3.31	3.70	5.80	5.51	3.75	1.58	2.88	3.80
	grass and wood	(g) 10	50	20	100	16	346	118	512	166	
		(%) 0.12	0.92	0.27	1.35	0.20	4.53	1.39	8.18	2.30	
	leather and rubber	(g) -	-	-	670	-	18	234	-	132	
		(%) -	-	-	9.04	-	0.24	2.76	-	1.83	
	Sub-total	(g) 7,820	4,225	6,690	5,990	7,296	6,646	8,226	5,424	6,357	
		(%) 95.89	77.59	91.64	80.84	91.36	87.06	96.87	86.67	88.06	
	incombustibles	metal	(g) 10	300	200	170	230	252	140	246	220
			(%) 0.12	5.51	2.74	2.29	2.88	3.30	1.65	3.93	3.05
		glass	(g) 250	730	260	950	460	300	-	588	470
			(%) 3.07	13.41	3.56	12.82	5.76	3.93	-	9.40	6.51
		ceramic and soil	(g) 75	190	150	300	-	436	126	-	172
		(%) 0.92	3.49	2.05	4.05	-	5.71	1.48	-	2.38	
other	(g) -	-	-	-	-	-	-	-	-		
	(%) -	-	-	-	-	-	-	-	-		
Sub-total	(g) 335	1,220	610	1,420	690	988	266	834	862		
	(%) 4.11	22.41	8.36	19.16	8.64	12.94	3.13	13.33	11.94		
Total	(g) 8,155	5,445	7,300	7,410	7,986	7,634	8,492	6,258	7,219		
	(%) 100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Moisture Content			(g) 2,251	1,972	4,288	3,307	4,617	4,263	5,209	2,876	3,790
			(%) 27.60	36.22	58.74	44.63	57.81	55.84	61.34	45.96	52.50
Dry Weight	combustibles	garbage	(g) 4,600	1,140	1,454	1,299	1,530	1,203	1,815	1,297	1,391
			(%) 56.41	20.94	19.92	17.53	19.16	15.76	21.37	20.73	19.27
		paper	(g) 674	544	518	469	600	625	503	542	543
			(%) 8.26	9.99	7.10	6.33	7.51	8.19	5.92	8.66	7.52
		textile	(g) 102	431	192	98	126	200	348	233	233
			(%) 1.25	7.92	2.63	1.32	1.58	2.62	4.10	3.72	3.23
		plastic	(g) 240	178	270	344	411	260	134	162	251
			(%) 2.94	3.27	3.70	4.64	5.15	3.41	1.58	2.59	3.48
	grass and wood	(g) 8	36	15	29	12	222	55	314	98	
		(%) 0.10	0.66	0.21	0.39	0.15	2.91	0.65	5.02	1.36	
	leather and rubber	(g) -	-	-	625	-	16	232	-	125	
		(%) -	-	-	8.43	-	0.21	2.73	-	1.73	
	Sub-total	(g) 5,624	2,329	2,449	2,864	2,679	2,526	3,087	2,548	2,641	
		(%) 68.96	42.77	33.55	38.65	33.55	33.09	36.35	40.72	36.58	
	incombustibles	metal	(g) 10	300	200	170	230	252	140	246	220
			(%) 0.12	5.51	2.74	2.29	2.88	3.30	1.65	3.93	3.05
		glass	(g) 250	730	260	950	460	300	-	588	470
			(%) 3.07	13.41	3.56	12.82	5.76	3.93	-	9.40	6.51
		ceramic and soil	(g) 20	114	103	119	-	293	56	-	98
		(%) 0.25	2.09	1.41	1.61	-	3.84	0.66	-	1.36	
other	(g) -	-	-	-	-	-	-	-	-		
	(%) -	-	-	-	-	-	-	-	-		
Sub-total	(g) 280	1,144	563	1,239	690	845	196	834	788		
	(%) 3.43	21.01	7.71	16.72	8.64	11.07	2.31	13.33	10.92		
Total	(g) 5,904	3,473	3,012	4,103	3,369	3,371	3,283	3,382	3,429		
	(%) 72.40	63.78	41.26	55.37	42.19	44.16	38.66	54.04	47.50		

Table 2.2-11 Composition of Household Waste (Non LPEC)

Classification			3rd Dec. 1992	4th Dec. 1992	5th Dec. 1992	6th Dec. 1992	7th Dec. 1992	8th Dec. 1992	9th Dec. 1992	10th Dec. 1992	Average
Wet Weight	combustibles	garbage	(g) 2,940	3,080	2,410	4,280	4,200	3,228	5,224	4,850	3,896
			(%) 39.40	54.06	35.26	39.63	44.92	44.47	59.82	41.99	45.25
		paper	(g) 1,345	1,120	950	1,870	1,310	698	1,020	1,272	1,177
			(%) 18.03	19.66	13.90	17.31	14.01	9.62	11.64	11.01	13.67
		textile	(g) -	40	640	100	120	116	166	86	181
			(%) -	0.70	9.36	0.93	1.28	1.60	1.89	0.74	2.10
		plastic	(g) 390	450	210	480	340	406	246	518	379
			(%) 5.23	7.90	3.07	4.44	3.64	5.59	2.81	4.48	4.40
		grass and wood	(g) 150	-	70	175	670	38	10	8	139
			(%) 2.01	-	1.02	1.62	7.17	0.52	0.11	0.07	1.61
	leather and rubber	(g) 120	20	670	200	22	24	672	-	230	
		(%) 1.61	0.35	9.80	1.85	0.24	0.33	7.67	-	2.67	
	Sub-total	(g) 4,945	4,710	4,950	7,105	6,662	4,510	7,338	6,734	6,002	
		(%) 66.28	82.68	72.42	65.79	71.25	62.13	83.75	58.30	69.72	
	incombustibles	metals	(g) 250	120	430	130	480	386	146	302	285
			(%) 3.35	2.11	6.29	1.20	5.13	5.32	1.67	2.61	3.31
		glasses	(g) 1,010	130	150	705	1,290	542	70	260	450
			(%) 13.54	2.28	2.19	6.53	13.80	7.47	0.80	2.25	5.23
		ceramic and soil	(g) 1,256	737	1,305	2,860	918	1,821	1,208	4,254	1,872
			(%) 16.83	12.94	19.09	26.48	9.82	25.09	13.79	36.83	21.74
others	(g) -	-	-	-	-	-	-	-	-		
	(%) -	-	-	-	-	-	-	-	-		
Sub-total	(g) 2,516	987	1,885	3,695	2,688	2,749	1,424	4,816	2,607		
	(%) 33.72	17.32	27.58	34.21	28.75	37.87	16.25	41.70	30.28		
Total	(g) 7,461	5,697	6,835	10,800	9,350	7,259	8,762	11,550	8,609		
	(%) 100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Moisture Content			(g) 2,210	2,328	1,485	3,969	3,822	2,685	3,659	4,288	3,176
	(%) 29.62	40.86	21.73	36.75	40.88	36.99	41.76	37.13	36.89		
Dry Weight	combustibles	garbage	(g) 1,240	965	1,382	927	1,347	933	1,972	1,636	1,309
			(%) 16.62	16.94	20.22	8.58	14.41	12.85	22.51	14.16	15.21
		paper	(g) 1,076	980	679	1,603	819	499	835	424	834
			(%) 14.42	17.20	9.93	14.84	8.76	6.87	9.53	3.67	9.69
		textile	(g) -	32	608	82	98	108	115	60	158
			(%) -	0.56	8.90	0.76	1.05	1.49	1.31	0.52	1.84
		plastic	(g) 322	432	194	411	291	325	219	478	336
			(%) 4.32	7.58	2.84	3.81	3.11	4.48	2.50	4.14	3.90
		grass and wood	(g) 23	-	25	32	263	30	2	2	51
			(%) 0.31	-	0.37	0.30	2.81	0.41	0.02	0.02	0.59
	leather and rubber	(g) 74	18	591	185	22	23	602	-	206	
		(%) 0.99	0.32	8.65	1.71	0.24	0.32	6.87	-	2.39	
	Sub-total	(g) 2,735	2,427	3,479	3,240	2,840	1,918	3,745	2,600	2,894	
		(%) 36.66	42.60	50.90	30.00	30.37	26.42	42.74	22.51	33.62	
	incombustibles	metals	(g) 250	120	430	130	480	386	146	302	285
			(%) 3.35	2.11	6.29	1.20	5.13	5.32	1.67	2.61	3.31
		glasses	(g) 1,010	130	150	705	1,290	542	70	260	450
			(%) 13.54	2.28	2.19	6.53	13.80	7.47	0.80	2.25	5.23
		ceramic and soil	(g) 1,256	692	1,291	2,756	918	1,728	1,142	4,100	1,804
			(%) 16.83	12.15	18.89	25.52	9.82	23.80	13.03	35.50	20.95
others	(g) -	-	-	-	-	-	-	-	-		
	(%) -	-	-	-	-	-	-	-	-		
Sub-total	(g) 2,516	942	1,871	3,591	2,688	2,656	1,358	4,662	2,539		
	(%) 33.72	16.54	27.37	33.25	28.75	36.59	15.50	40.36	29.49		
Total	(g) 5,251	3,369	5,350	6,831	5,528	4,574	5,103	7,262	5,433		
	(%) 70.38	59.14	78.27	63.25	59.12	63.01	58.24	62.87	63.11		

Table 2.2-12 Composition of Market Waste

Classification			3rd Dec. 1992	4th Dec. 1992	5th Dec. 1992	6th Dec. 1992	7th Dec. 1992	8th Dec. 1992	9th Dec. 1992	10th Dec. 1992	Average
Wet Weight	combustibles	garbage	(g) 1,610	900	3,500	2,650	4,600	1,606	1,624	2,776	2,522
			(%) 17.46	13.51	36.84	22.69	40.64	19.81	21.76	35.90	28.27
		paper	(g) 2,160	1,560	1,820	2,500	4,600	3,698	3,466	2,690	2,905
			(%) 23.43	23.42	19.16	21.40	40.64	45.61	46.45	34.79	32.56
		textile	(g) 180	60			190	1,068	142	80	220
			(%) 1.95	0.90	-	-	1.68	13.17	1.90	1.03	2.47
		plastic	(g) 350	190	500	380	600	456	300	328	393
			(%) 3.80	2.85	5.26	3.25	5.30	5.62	4.02	4.24	4.40
		grass and wood	(g) 1,620	900	370	3,400	470	722	626	752	1,034
			(%) 17.57	13.51	3.89	29.11	4.15	8.90	8.39	9.73	11.59
	leather and rubber	(g)			100			158		37	
		(%)	-	-	-	0.86	-	-	2.12	-	0.41
	Sub-total	(g) 5,920	3,610	6,190	9,030	10,460	7,550	6,316	6,626	7,111	
		(%) 64.21	54.20	65.16	77.31	92.40	93.12	84.64	85.70	79.70	
	incombustibles	metals	(g) 150	100	210	150	170		58	84	110
			(%) 1.63	1.50	2.21	1.28	1.50	-	0.78	1.09	1.23
		glasses	(g) 890	950	1,200	1,350	400	432	6	340	668
			(%) 9.65	14.26	12.63	11.56	3.53	5.33	0.08	4.40	7.49
		ceramic and soil	(g) 1,220	2,000	1,900	1,150	290	126	1,082	682	1,033
			(%) 13.23	30.03	20.00	9.85	2.56	1.55	14.50	8.82	11.58
others		(g) 1,040									
	(%) 11.28										
Sub-total	(g) 3,300	3,050	3,310	2,650	860	558	1,146	1,106	1,811		
	(%) 35.79	45.80	34.84	22.69	7.60	6.88	15.36	14.30	20.30		
Total	(g) 9,220	6,660	9,500	11,680	11,320	8,108	7,462	7,732	8,922		
	(%) 100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Moisture Content			(g) 1,995	1,470	3,199	6,107	5,598	4,597	3,393	4,100	4,066
			(%) 21.64	22.07	33.67	52.29	49.45	56.70	45.47	53.03	45.57
Dry Weight	combustibles	garbage	(g) 696	233	1,544	642	961	317	295	599	656
			(%) 7.55	3.50	16.25	5.50	8.49	3.91	3.95	7.75	7.35
		paper	(g) 1,697	1,326	1,310	985	3,450	1,499	1,835	1,395	1,686
			(%) 18.41	19.91	13.79	8.43	30.48	18.49	24.59	18.04	18.90
		textile	(g) 146	54			72	403	97	44	96
			(%) 1.58	0.81	-	-	0.64	4.97	1.30	0.57	1.08
		plastic	(g) 256	106	440	228	300	304	300	305	283
			(%) 2.78	1.59	4.63	1.95	2.65	3.75	4.02	3.94	3.17
		grass and wood	(g) 1,256	588	106	1,395	207	478	362	318	493
			(%) 13.62	8.83	1.12	11.94	1.83	5.90	4.85	4.11	5.53
	leather and rubber	(g)			75			152		32	
		(%)	-	-	-	0.64	-	-	2.04	-	0.36
	Sub-total	(g) 4,051	2,307	3,400	3,325	4,990	3,001	3,041	2,661	3,246	
		(%) 43.94	34.64	35.79	28.47	44.08	37.01	40.75	34.42	36.38	
	incombustibles	metals	(g) 150	100	210	150	170		58	84	110
			(%) 1.63	1.50	2.21	1.28	1.50	-	0.78	1.09	1.23
		glasses	(g) 890	950	1,200	1,350	400	432	6	340	668
			(%) 9.65	14.26	12.63	11.56	3.53	5.33	0.08	4.40	7.49
		ceramic and soil	(g) 1,182	1,833	1,491	748	162	78	964	547	832
			(%) 12.82	27.52	15.69	6.40	1.43	0.96	12.92	7.07	9.33
others		(g) 952									
	(%) 10.33										
Sub-total	(g) 3,174	2,883	2,901	2,248	732	510	1,028	971	1,610		
	(%) 34.43	43.29	30.54	19.25	6.47	6.29	13.78	12.56	18.05		
Total	(g) 7,225	5,190	6,301	5,573	5,722	3,511	4,069	3,632	4,856		
	(%) 78.36	77.93	66.33	47.71	50.55	43.30	54.53	46.97	54.43		

Table 2.2-13 Composition of Commercial Waste

Classification			3rd Dec. 1992	4th Dec. 1992	5th Dec. 1992	6th Dec. 1992	7th Dec. 1992	8th Dec. 1992	9th Dec. 1992	10th Dec. 1992	Average	
Wet Weight	combustibles	garbage	(g) 500	700	490	3,600	450	1,592	1,176	2,820	1,547	
			(%) 10.75	17.46	14.45	42.55	9.42	31.83	36.14	40.34	30.17	
		paper	(g) 1,000	1,460	1,110	1,270	1,520	1,074	600	2,060	1,299	
			(%) 21.51	36.41	32.74	15.01	31.83	21.47	18.44	29.47	25.33	
		textile	(g) -	-	-	270	-	-	-	-	-	39
			(%) -	-	-	3.19	-	-	-	-	-	0.76
		plastic	(g) 500	260	500	320	170	648	302	450	379	
			(%) 10.75	6.48	14.75	3.78	3.56	12.95	9.28	6.44	7.39	
		grass and wood	(g) 150	-	170	240	100	654	338	30	219	
			(%) 3.23	-	5.01	2.84	2.09	13.07	10.39	0.43	4.27	
	leather and rubber	(g) -	-	-	-	-	-	-	-	-	-	
		(%) -	-	-	-	-	-	-	-	-	-	
	Sub-total	(g) 2,150	2,420	2,270	5,700	2,240	3,968	2,416	5,360	3,483		
		(%) 46.24	60.35	66.96	67.38	46.90	79.33	74.25	76.68	67.92		
	incombustibles	metals	(g) 250	270	250	480	170	330	268	380	307	
			(%) 5.38	6.73	7.37	5.67	3.56	6.60	8.24	5.44	5.99	
		glasses	(g) 2,250	1,140	720	2,280	2,270	626	516	1,160	1,245	
			(%) 48.39	28.43	21.24	26.95	47.53	12.51	15.86	16.60	24.28	
		ceramic and soil	(g) -	180	150	-	96	78	54	90	93	
			(%) -	4.49	4.42	-	2.01	1.56	1.66	1.29	1.81	
others	(g) -	-	-	-	-	-	-	-	-			
	(%) -	-	-	-	-	-	-	-	-			
Sub-total	(g) 2,500	1,590	1,120	2,760	2,536	1,034	838	1,630	1,645			
	(%) 53.76	39.65	33.04	32.62	53.10	20.67	25.75	23.32	32.08			
Total	(g) 4,650	4,010	3,390	8,460	4,776	5,002	3,254	6,990	5,128			
	(%) 100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00			
Moisture Content			(g) 704	1,091	898	3,699	886	1,789	1,107	1,605	1,583	
		(%) 15.14	27.21	26.49	43.72	18.55	35.77	34.02	22.96	30.87		
Dry Weight	combustibles	garbage	(g) 233	184	111	708	132	478	316	1,784	530	
			(%) 5.01	4.59	3.27	8.37	2.76	9.56	9.71	25.52	10.34	
		paper	(g) 769	973	894	822	1,086	955	533	1,545	973	
			(%) 16.54	24.26	26.37	9.72	22.74	19.09	16.38	22.10	18.97	
		textile	(g) -	-	-	116	-	-	-	-	-	17
			(%) -	-	-	1.37	-	-	-	-	-	0.33
		plastic	(g) 414	208	344	295	170	598	283	450	335	
			(%) 8.90	5.19	10.15	3.49	3.56	11.96	8.70	6.44	6.53	
		grass and wood	(g) 30	-	43	60	10	190	203	3	73	
			(%) 0.65	-	1.27	0.71	0.21	3.80	6.24	0.04	1.42	
	leather and rubber	(g) -	-	-	-	-	-	-	-	-		
		(%) -	-	-	-	-	-	-	-	-		
	Sub-total	(g) 1,446	1,365	1,392	2,001	1,398	2,221	1,335	3,782	1,928		
		(%) 31.10	34.04	41.06	23.65	29.27	44.40	41.03	54.11	37.60		
	incombustibles	metals	(g) 250	270	250	480	170	330	268	380	307	
			(%) 5.38	6.73	7.37	5.67	3.56	6.60	8.24	5.44	5.99	
		glasses	(g) 2,250	1,140	720	2,280	2,270	626	516	1,160	1,245	
			(%) 48.39	28.43	21.24	26.95	47.53	12.51	15.86	16.60	24.28	
		ceramic and soil	(g) -	144	130	-	52	36	28	63	65	
			(%) -	3.59	3.83	-	1.09	0.72	0.86	0.90	1.27	
others	(g) -	-	-	-	-	-	-	-	-			
	(%) -	-	-	-	-	-	-	-	-			
Sub-total	(g) 2,500	1,554	1,100	2,760	2,492	992	812	1,603	1,617			
	(%) 53.76	38.75	32.45	32.62	52.18	19.83	24.95	22.93	31.53			
Total	(g) 3,946	2,919	2,492	4,761	3,890	3,213	2,147	5,385	3,545			
	(%) 84.86	72.79	73.51	56.28	81.45	64.23	65.98	77.04	69.13			

Table 2.2-14 Composition of Institutional Waste

Classification			3rd Dec. 1992	4th Dec. 1992	5th Dec. 1992	6th Dec. 1992	7th Dec. 1992	8th Dec. 1992	9th Dec. 1992	10th Dec. 1992	Average
Wet Weight	combustibles	garbage	(g) 300	4,700	320	760	13,000	6,140	1,538	4,126	4,369
			(%) 14.56	66.01	14.61	19.44	95.66	80.58	53.66	70.72	70.90
		paper	(g) 1,010	1,000	1,330	1,550	120	938	702	798	920
			(%) 49.03	14.04	60.73	39.64	0.88	12.31	24.49	13.68	14.93
		textile	(g) 80	100	20	100		102	94	198	88
			(%) 3.88	1.40	0.91	2.56	-	1.34	3.28	3.39	1.43
		plastic	(g) 70	100	80	250	470	208	170	68	192
			(%) 3.40	1.40	3.65	6.39	3.46	2.73	5.93	1.17	3.12
	grass and wood	(g) 60	100	80			54	78	22	48	
		(%) 2.91	1.40	3.65	-	-	0.71	2.72	0.38	0.78	
	leather and rubber	(g)									
		(%)									
	Sub-total	(g) 1,520	6,000	1,830	2,660	13,590	7,442	2,582	5,212	5,617	
		(%) 73.79	84.27	83.56	68.03	100.00	97.66	90.09	89.34	91.16	
	incombustibles	metals	(g) 90	70	80	80		56	16	124	61
			(%) 4.37	0.98	3.65	2.05	-	0.73	0.56	2.13	0.99
		glasses	(g) 120		230	670		36			134
			(%) 5.83	-	10.50	17.14	-	0.47	-	-	2.17
		ceramic and soil	(g) 330	1,050	50	500		86	268	498	350
			(%) 16.02	14.75	2.28	12.79	-	1.13	9.35	8.54	5.68
others	(g)										
	(%)										
Sub-total	(g) 540	1,120	360	1,250	-	178	284	622	545		
	(%) 26.21	15.73	16.44	31.97	-	2.34	9.91	10.66	8.84		
Total	(g) 2,060	7,120	2,190	3,910	13,590	7,620	2,866	5,834	6,162		
	(%) 100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		
Moisture Content			(g) 434	3,765	527	1,175	10,171	4,857	998	2,982	3,497
	(%) 21.07	52.88	24.06	30.05	74.84	63.74	34.82	51.11	56.75		
Dry Weight	combustibles	garbage	(g) 164	1,257	93	280	2,982	1,706	790	1,565	1,239
			(%) 7.96	17.65	4.25	7.16	21.94	22.39	27.56	26.83	20.11
		paper	(g) 842	833	1,045	969	108	586	501	570	659
			(%) 40.87	11.70	47.72	24.78	0.79	7.69	17.48	9.77	10.69
		textile	(g) 71	92	20	82		87	88	136	72
			(%) 3.45	1.29	0.91	2.10	-	1.14	3.07	2.33	1.17
		plastic	(g) 30	94	78	225	329	189	170	45	161
			(%) 1.46	1.32	3.56	5.75	2.42	2.48	5.93	0.77	2.61
	grass and wood	(g) 15	50	72			37	60	2	32	
		(%) 0.73	0.70	3.29	-	-	0.49	2.09	0.03	0.52	
	leather and rubber	(g)									
		(%)									
	Sub-total	(g) 1,122	2,326	1,308	1,556	3,419	2,605	1,609	2,318	2,163	
		(%) 54.47	32.67	59.73	39.80	25.16	34.19	56.14	39.73	35.10	
	incombustibles	metals	(g) 90	70	80	80		56	16	124	61
			(%) 4.37	0.98	3.65	2.05	-	0.73	0.56	2.13	0.99
		glasses	(g) 120		230	670		36			134
			(%) 5.83	-	10.50	17.14	-	0.47	-	-	2.17
		ceramic and soil	(g) 294	959	45	429		66	243	410	307
			(%) 14.27	13.47	2.05	10.97	-	0.87	8.48	7.03	4.98
others	(g)										
	(%)										
Sub-total	(g) 504	1,029	355	1,179	-	158	259	534	502		
	(%) 24.47	14.45	16.21	30.15	-	2.07	9.04	9.15	8.15		
Total	(g) 1,626	3,355	1,663	2,735	3,419	2,763	1,868	2,852	2,665		
	(%) 78.93	47.12	75.94	69.95	25.16	36.26	65.18	48.89	43.25		

ii. Estimation of the lower calorific value

The lower calorific value (LCV) of waste was not actually measured in this study due to the limitation of both time and budget. It is, however, estimated by the following formula based on the result of the study in Poznan and data obtained in the Japan. (Calorific value differences of wastes in Lublin and Poznan are due to the moisture contents differences).

$$LCV = (RGa^{*1} * 810 + RPa^{*2} * 2,400 + RT^{*3} * 3,000 + RPl^{*4} * 8,600 + RGr^{*5} * 1,700 + RL^{*6} * 4,500) / 100$$

RGa^{*1} ; Ratio of garbage in wet weight (%)

RPa^{*2} ; Ratio of paper in wet weight (%)

RT^{*3} ; Ratio of textile in wet weight(%)

RPl^{*4} ; Ratio of plastic in wet weight (%)

RGr^{*5} ; Ratio of grass and wood in wet weight (%)

RL^{*6} ; Ratio of leather and rubber in wet weight (%)

Table 2.2-15 Three Contents and Lower Calorific Value of the Waste

Category	Contents (%)				Lower Calorific Value (kcal/kg)
	Moisture	Combustibles	Incombustible	Total	
Household (LPEC)	52.50	36.58	10.92	100	1,357
Household (Non LPEC)	36.89	33.62	29.49	100	1,602
Markets	45.57	36.38	18.05	100	1,678
Commercial	30.87	37.60	31.53	100	1,583
Institutional	56.75	35.10	8.15	100	1,257

Note: Incombustible in this table do not include ash of combustibles after combustion.

8) Findings on Waste Amount

a. Discharge ratio

The discharge ratio of following wastes were investigated by the WACS.

- Household waste
 - . from LPEC area
 - . from Non LPEC area
- Commercial waste

- . from catering shops
 - . from shops other than catering
- Market waste
- . Institutional waste
 - . from government offices
 - . from schools

i. Household waste

Heat supply for household

Hot water supply and heating supply are very important for people living in Poland. The system of heat and hot water supply is divided into two; one is the district central heating system and the other is individual heating.

Part of Houses and apartments, which are generating heat by using coal fuel boilers, discharge ash as the household waste.

The houses surveyed for the WACS were thereby selected based on the classification of heat supply and structure of buildings.

According to the City Master Plan, the heat supply for household in 1988 is tabulated in Table 2.2-16.

Table 2.2-16 Heat Supply for Household in 1988

District	Apartment Buildings				Detached House			
	Number of Residents	Ratio (%)			Number of Residents	Ratio (%)		
		LPEC	Gas	I.H.S.*		LPEC	Gas	I.H.S.
Srodmiestcie	48,817	33.0	1.8	65.2	1,431	-	58.0	42.0
Rury	79,043	100.0	-	-	9,542	-	63.0	37.0
Wieniawa	68,040	100.0	-	-	6,928	20.3	66.5	13.2
Kalina	29,147	100.0	-	-	6,435	-	42.6	57.4
Zadobie	13,515	100.0	-	-	2,600	-	-	100.0
Kosminek	19,262	90.0	0.1	9.9	21,258	-	32.7	67.3
Dziesiata	22,973	70.0	0.2	29.8	17,052	-	55.6	44.4
Zemborzyce	109	-	-	100.0	2,545	-	-	100.0
Total	280,906	85.0	0.3	14.7	67,791	2.1	45.2	52.7

Note: *I.H.S. = Individual Heat Supply (by coal, wood, etc.).

Waste discharge

Supposing the ratio of LPEC and Non LPEC were not changed, based on the Table 2.2-16 population of 1988 and 1991 in accordance with LPEC and Non LPEC is calculated as follow;

	Ratio	Population in 1988	Population in 1991
LPEC	69%	240,601	243,225
Non LPEC	31%	108,096	109,275
Total	100%	348,697	352,500

The unit discharge ratios were obtained by the WACS as follows;

LPEC : 336 g/person/day
Non LPEC (including ash) : 542 g/person/day

Hence, the amount of wastes discharged in 1991 are as follows;

LPEC : 81.7 tons/day
Non LPEC : 59.2 tons/day
waste other than ash : (48.8)
ash : (10.4)

Total :140.9 tons/day

ii. Commercial waste

The waste amount and composition depend on the categories of business. The shops were classified into the following two categories and the waste generation ratios were calculated based on the survey result, as follows;

- catering shops : 171 g/seat/day
- other shops than catering : 21 g/m²/day

According to the City Master Plan, the number of seats in catering shops and the floor areas in other shops than catering are available for those in 1980. They are supposed to increase in accordance with the population increase as follows;

	1980	1991	Increase ratio
Population	304,423	352,500	1.16
Number of Seats in Catering Shops (m2)	9,458	10,970	1.16
Floor Area of Other Shops than Catering (Seats)	94,600	109,740	1.16

Hence, the amount of wastes discharged in 1991 were estimated as follows:

- catering shops : 1.9 tons/day
- other shops : 2.3 tons/day

Total : **4.2 tons/day**

iii. Market waste

The unit waste generation ratio of a shop was surveyed at the two markets in the city. The result is as follows;

- unit waste discharged ratio : 2,172 g/shop/day

The number of shops in markets given were 1,400 shops in 1992.

- amount of waste discharged : **3 tons/day**

iv. Institutional waste

Government offices

A government office in the city was surveyed. The result is as follows;

- unit waste discharge ratio : 82 g/employee/day

The total number of government employees in the city was of 119,832 persons according to the Voivodship Statistic Office in Lublin data, hence;

- amount of waste discharged : **9.8 tons/day**

Schools

A primary school in the city was surveyed and the unit discharge ratio is as follows;

- unit waste discharge ratio : 27 g/student/day

The number of students in 1980 is only available data from City Master Plan. Supposing it were increased in accordance with population, the number of students is estimated as follows;

	1980	1991
Population	304,423	352,500
Number of Students in Primary Schools	31,956	-
Number of Students in Secondary Schools	5,971	-
Number of Students in Universities and Other Schools	24,613	-
Total Number	62,540	72,550

Hence, the amount of waste discharged from schools is **2.0 tons/day**.

v. Road sweeping waste

According to the MPO, the disposal amount of the road sweeping waste was 24,300 m³ in 1991. Our study concluded average apparent specific gravity (ASG) were less than 0.2 ton/m³. Supposing ASG of the road sweeping waste were 0.2 ton/m³, the disposal amount is 4,860 ton/year and **13.3 tons/day**.

vi. Bulky waste

The MPO did not have any data on the bulky waste. According to the POS (Public Opinion Survey) Q-16, some of the bulky waste were collected by the MPO. Consequently, supposing the discharge ratio of the bulky waste were in proportion to the ratio of the household waste, it would be **5.7 tons/day** according to the result of Poznan study, i.e. the bulky waste 15.7 tons/day against household waste 386.0 tons/day.

vii. **Other wastes**

According to the MPO, the Jawidz landfill received other wastes than MSW such as sewage sludge, moulding sand, etc. and their disposal amount in 1992 was 75,154 m³/year. Supposing ASG of other wastes were also 0.2 ton/m³, the disposal amount is 15,000 ton/year and **41.1 tons/day**.

The above-mentioned results are summarized in Table 2.2-17.

Table 2.2-17 Waste Discharge Ratio and Amount

Item		Discharge Ratio	Number of Units	Waste Amount	
1. MSW	Household Waste (LPEC)	Lublin	336 g/person/day	243,225 person	81.7 t/day
		Poznan	480 g/person/day	354,300 person	170.0 t/day
	Household Waste (Non LPEC)	Lublin	542 g/person/day	109,275 person	59.2 t/day
		Poznan	915 g/person/day	236,200 person	216.0 t/day
Commercial Waste (other shops)	Lublin	21 g/m ² /day	109,740 m ²	2.3 t/day	
	Poznan	24 g/m ² /day	202,966 m ²	4.9 t/day	
Commercial Waste (catering shops)	Lublin	171 g/seat/day	10,970 m ²	1.9 t/day	
	Poznan	160 g/m ² /day	172,725 m ²	27.6 t/day	
Market Waste	Lublin	2,172 g/shop/day	1,400 shops	3.0 t/day	
	Poznan	3,040 g/shop/day	1,970 shops	6.0 t/day	
Institutional Waste - offices - schools	Lublin	82 g/employee/day	119,832 employees	9.8 t/day	
	Poznan	27 g/student/day	72,500 students	2.0 t/day	
		65 g/employee/day	161,885 employees	9.3 t/day	
Road sweeping Waste	Lublin	-	-	13.3 t/day	
	Poznan	-	-	4.0 t/day	
Bulky Waste	Lublin	-	-	5.7 t/day	
	Poznan	-	-	15.7 t/day	
MSW Total	Lublin	-	-	178.9 t/day	
	Poznan	-	-	453.5 t/day	
2. Other Wastes	Lublin	-	-	41.1 t/day	
	Poznan	-	-	82.4 t/day	
Total	Lublin	-	-	220.0 t/day	
	Poznan	-	-	555.9 t/day	

Note: Big difference between Lublin and Poznan of commercial waste from catering shops is due to the recycling described in the next section.

Accordingly, the following major figures on waste discharge ratio are deduced:

- MSW discharge amount : **178.9 tons/day**
- MSW discharge ratio per capita : **508 g/person/day**
(in Poznan **769 g/person/day**)
- Annual NSW discharge : **65,300 ton/year**

b. **Disposal Amount**

The wastes disposed of at present Jawidz landfill were classified as follows;

- MSW : household waste, commercial waste, market waste, institutional waste, road sweeping waste and bulky waste.
- others : sewage sludge, moulding sand, construction waste, etc.

Based on information obtained from MPO, the disposal amount in 1992 is estimated and shown in Table 2.2-18.

Table 2.2-18 Disposal Amount Estimated by the Information from MPO

Item	Yearly Volume (m ³ /day)	Yearly Amount (t/year)*	Daily Amount (t/day) *
MSW by MPO	640,275	128,000	350.6
Other Wastes	75,154	15,000	41.1
Total	715,429	143,000	391.7

Note:

* Amount is calculated assuming the ASG were 0.2 ton/m³.

c. Conclusion

The EC PHARE report concluded regarding the waste amount in Lublin as follows:

The reported quantities of waste have been evaluated. some variation in the quantities are observed:-

- Theoretical quantity 471 tons/day (172,000 tonnes/year)
- Collection vehicles 274 tons/day (100,000 tonnes/year)
- Max. collection capacity 252 tons/day (92,000 tonnes/year)
- Chosen quantity 321 tons/day (117,000 tonnes/year)

The theoretical specific quantities were reported to be an average of 0.50 tonnes/year/inhabitant (Variation 0.3 - 0.9). However, this was not consistent with the quantities reported to be collected or the quantities reported as maximum collection capacity. For this reason, a specific quantity of 0.3 has been selected. This figure appears to be more consistent with the actual quantities.

Although the EC report concluded 321 tons/day and the disposal amount from MPO was 391.7 tons/day regarding the waste quantity in Lublin, we concluded the waste amount in Lublin as shown in Table 2.2-19.

Table 2.2-19 Waste Amount

Unit: tons/day

Category of Waste	Waste Discharge in Lublin	Estimated Disposal Amount at Jawidz Landfill	Waste Amount in Poznan
1. MSW			
Household Waste	140.9	196.9	386.0
(Household Waste)	(130.4)	-	(283.2)
(Domestic Ash)	(10.5)	-	(102.8)
Commercial Waste	4.2	5.9	32.5
(Shops)	(2.3)	-	(4.9)
(Catering)	(1.9)	-	(27.6)
Market Waste	3.0	4.2	6.0
Institutional Waste	11.8	16.5	9.3
Road Sweeping Waste	* 13.3	18.6	4.0
Bulky Waste	*5.75	8.0	*15.7
Sub-total	178.9	** 250.1	453.5
2. Other Wastes	-	* 41.1	* 82.4
Total	-	291.2	535.9

Note: * The figure is disposal amount.

** The figure is deduced by multiplying 178.9 by 492,500 (the population including other local authorities)/352,500 (the population of the City of Lublin)

Regarding the disposal amount in the present Jawidz landfill, the estimation was done based on the following assumptions:

- Waste discharged from each generation source was collected and disposed of at the landfill.
- The present landfill was used not only by the City of Lublin but also by Swidnik, Leczna and other small Guminas (communities).
- Total population in 1992 of those local authorities is 140 thousand.
- Waste discharge ratio in those local authorities is the same as it in the City of Lublin.
- Waste discharge in those local authorities is also 100% collected and disposed of at the landfill.

As clearly understand with these assumptions, the estimated disposal amount at the present landfill in Table 2.2-19 is much more than the actual disposal amount. However, as for the design purpose for landfills and processing facilities, this figure could be used. Because the collection ratio in future may be or should be 100% of the discharge ratio,. It must be noted that even the maximum possible disposal amount (estimated at 291.2 tons/day) is still much less than the disposal amount reported by MPO (391.7 ton/m³). It is, therefore, recommended that the existing weighbridge at the present landfill should be used to generate reliable data.

d. Recycling

It is quite difficult to get the amount of waste recycled, self-disposed or illegal dumped. During the WACS, however, the following recycling activities at the waste generation sources were observed:

- Large amount of food waste generated in a restaurant and the school was collected by a private recycle in order to feed it for livestock farming specially for pigs.
- Large amount of recyclable wastes such as cardboard boxes, etc. generated in two shops was collected by private recyclers for sale.
- Ash generated in some shops and the school was used for spreading frozen and slippery roads and construction of temporary roads.

Based on the WACS, the amount of recycled waste is estimated and tabulated in Table 2.2-20.

Table 2.2-20 Recycled Amount from the WACS

Items	Amount by WACS	Number of Units	Recycled Amount (tons/day)
1. Food waste			
- from commercial	0.16 l/seat/day	10,970 seats	1.41*
- from school	0.02 l/student/day	72,550 students	1.16*
Sub-total	-	-	2.57
2. Recyclables Other than Food Waste			
- from commercial	0.01 kg/m ² /day	109,740 m ²	1.10
Sub-total	-	-	1.10
3. Ash			
- from catering	0.087 kg/seat/day	10,970 seats	0.95
- from other shops	0.012 kg/m ² /day	109,740 m ²	1.32
- from school	0.004 kg/student/day	72,550 students	0.29
Sub-total	-	-	2.56
Total	-	-	6.23

Note: Unit weight of food waste is supposed at 0.8 kg/litre.

As shown in Table 2.2-20, the recycled amount obtained from the WACS was 6.2 tons/day. The recycling at residences, however, was not observed in the WACS. The reasons may be as follows;

- Amount of waste to be recycled is less.
- Recycling at the residences is done mainly by means of selling recyclable materials such as bottles to the shops by each residents as shown in the result of the POS Q 5-8.
- Food waste of the residences is fed to their animals as shown in the result of the POS Q 5-10.

Upon consideration of the above-mentioned reasons and the proportion of the discharged waste amount (household 140.9 tons/day, other 19 tons/day) recycled amount at households may be at least 3 times more than the amount of 6.2 tons/day.

9) Findings On Waste Composition

Upon consideration of the ratio of waste discharge amount regarding each category of waste, the composition of MSW except for domestic ash, road sweeping and bulky waste is estimated and tabulated in Table 2.2-21 and 2.2-22: i.e. a weighing average waste composition of household waste excluding ash, commercial, market and institutional waste is calculated.

Table 2.2-21 Physical Composition of MSW (Wet Base)

Category	Item	Ratio (%) of Lublin	Ratio (%) of Poznan
Combustible	Garbage	61.11	33.95
	Paper	14.18	19.33
	Textile	3.10	7.27
	Plastics	4.41	7.89
	Grass & Wood	2.33	5.90
	Leather & Rubber	2.09	2.26
	Sub-total	87.22	76.60
Noncombustible	Metal	3.29	3.76
	Glass	6.69	15.16
	Ceramic & Soil	2.81	1.53
	Others	0	2.93
	Sub-total	12.79	23.38
	Total	100	100

Note: MSW here excludes domestic ash and road sweeping and bulky waste.

Table 2.2-22 Chemical Composition of MSW

Category	Item	Ratio (%) of Lublin	1984/85 Waste Study in Poznan	Ratio (%) of Poznan
Three contents	Moisture	49.64	41.84	35.74
	Combustible	33.12	24.08	38.04
	Ash	*17.24	34.34	26.23
Chemical Contents of Combustible	Carbon	NA	13.84	19.03
	Hydrogen	NA	1.46	4.21
	Nitrogen	NA	0.19	0.71
	Sulphur	NA	0.02	0.05
	Chlorine	NA	0.50	0.40
	Oxygen	NA	8.08	13.63
C/N Ratio		NA	72.84	26.8
Lower Calorific Value (All Waste and Measured)		NA	856	1,854 kcal/kg
		NA	3,583	7,762 kj/kg
Lower Calorific Value (Combustible Matter)		NA	2,134	5,442 kcal/kg
		NA	8,935	22,785 kj/kg

Note: MSW here excludes domestic ash and road sweeping and bulky waste. However, 1984/85 Waste Study included domestic ash.

* Since the ash of combustibles was not actually measured, the ash content of combustibles after combustion obtained by the Poznan Study, i.e. 5.1% was added to the incombustible matter content, i.e. 12.12%.

In order to clearly understand the lower calorific value (all waste) of MSW other than road sweeping and bulky waste, the following figures are calculated by the formula described in the section 7), a,ii, Estimation of the LCV.

Table 2.2-23 Lower Calorific Values

Waste Category	LCV of Lublin (kcal/kg)	LCV of Poznan (kcal/kg)
MSW ^{*1} without Ash (Measured)	NA	1,854
MSW without Ash (Estimated)	1,213	1,805
MSW with Ash (Estimated)	1,146	1,437
Household Waste without Ash (Estimated)	1,220	1,792
Household Waste with Ash (Estimated)	1,142	1,384
Household Waste (Coal-heat household) with Ash (Estimated)	NA	806
Household Waste (1984/85 Waste Study) ^{*2}	-	855

Note: *1 MSW here excludes domestic ash and road sweeping and bulky waste.

*2 1984/85 Waste Study means "Research on Technological Properties of Poznan Municipal Waste" done by Engineering College of Warsaw.

For the elaboration of Table 2.2-23, upon consideration of the 1984/85 Waste Study, the three contents of the coal ash were supposed as follows: i.e., coal ash has still a certain energy.

- Moisture : 45 %
- Combustibles : 10 %
- Ash : 45 %

According to Table 2.2-23, the estimated LCV of household waste with ash from coal-heat house is calculated at 806 kcal/kg. This is very similar to the figure (855 kcal/kg) of the 1984/85 Waste Study.

The comparison of waste composition between Lublin, Poznan and Japan is presented in Table 2.2-24.

For reference, a previous waste composition data in Lublin is tabulated in Table 2.2.1-25 and -26. The data is shown in the EC PHARE Final Report Volume II and it was done by "Biuro Projektow Budownictwa Komunalnego Stolica" (Commune Building Planning Office "Stolica") in 1989 (?). There is a big difference on LCV between our data (1,209 kcal/kg) and it (683 kcal/kg). there is no description on the method of the analysis. It is highly desirable to carry out the waste amount and composition study again in order to clearly know the actual waste amount and composition.

Table 2.2-24 Compare of Waste Composition Lublin, Poznan and Japan

	Lublin (1992)	Poznan(1992)	JAPAN(1972)
Moisture Contents (%)	49.66	35.74	54.10
Combustible Contents (%)	33.12	38.04	31.43
Carbon (%)	NA	19.03	15.44
Hydrogen (%)	NA	4.21	2.40
Nitrogen (%)	NA	0.71	0.39
Sulphur (%)	NA	0.05	0.05
Chloride (%)	NA	0.40	0.32
Oxygen (%)	NA	13.63	12.83
Ash Contents (%)	*17.22	26.23	14.47
Combustible Matter (%)	87.22	76.60	89.04
Garbage (%)	61.11	33.95	25.90
Paper (%)	14.18	19.33	35.60
Textile (%)	3.10	7.27	3.20
Plastics (%)	4.41	7.89	6.93
Grass & Wood (%)	2.33	5.90	-
Lather & Rubber (%)	2.09	2.26	0.82
Others (%)	-	-	16.59
In-combustible Matter (%)	12.79	23.38	10.96
Metal (%)	3.29	3.76	3.66
Glass (%)	6.69	15.16	7.30
Ceramic & Stone (%)	2.81	1.53	-
Others (%)	0	2.93	-
Lower Calorific Value(kcal/kg) (Combustible Matter) (kj/kg)	**4,547 **19,037	5,442 22,785	4,739 19,841
Lower Calorific Value(kcal/kg) (All waste) (kj/kg)	**1,209 **6,033	1,854 7,762	1,165 4,878

Note: Lublin, Poznan (1992) :JICA Study Team
Japan (1972) :Tokyo

* Since the ash of combustibles was not actually measured, the ash content of combustibles after combustion obtained by the Poznan Study, i.e. 5.1% was added to the in-combustible matter content, i.e. 12.12%.

** The figures are estimated by the estimation formula.

Table 2.2-25 Waste Composition in Lublin (in Dry Base)

	Average Annual Values			Average for City
	New Buildings	Old buildings	Single-family Houses	
Fraction Division				
fraction 0-10 mm	14.7	22.0	16.6	18.9
fraction 10-40 mm	48.6	33.5	35.8	39.2
fraction 40-100 mm	20.9	20.5	23.8	21.2
fraction above 100 mm	15.8	23.8	21.7	20.7
Physical Composition				
fraction 0-10 mm	19.7	16.8	23.2	23.7
paper	17.3	15.3	16.1	16.1
textiles	4.5	4.2	3.9	4.2
plastics	3.4	4.0	3.7	3.7
glass	10.0	7.4	7.7	8.3
metals	3.1	3.3	5.2	3.4
vegetable catering	33.8	21.3	22.7	25.9
animal catering	3.5	2.5	2.9	2.7
other organic	1.9	3.7	7.6	3.7
other inorganic	2.6	10.5	8.2	7.3
Moisture Content	53.6	40.4	44.9	45.8

Table 2.2-26 Chemical Composition of MSWM in Lublin

	Unit	Average Annual Values			Average for City
		New Buildings	Old Buildings	Single-family Houses	
Contents of Organic Matter	%	43.9	33.2	39.3	37.9
Contents C Organic	%	21.9	16.4	18.8	18.7
Contents N Organic	%	1.0	0.78	0.95	0.94
Contents P Total	% P ₂ O ₅	0.55	0.50	0.57	0.53
Contents K Total	% P ₂ O ₅ % K ₂ O	0.55	0.36	0.38	0.46
Moisture Content	%	53.6	40.4	44.9	45.8
Combustibles Elements	%	21.3	20.7	22.7	21.0
Incombustible Elements	%	25.5	38.8	33.4	32.9
Volatile Elements	%	76.4	65.5	72.0	70.0
LCV for Combustibles	kj/kg kcal/kg	9,760	8,043	7,655	8,585
		2,331	1,921	1,828	2,050
LCV for All Wastes	kj/kg kcal/kg	2,510	3245	2,460	2,860
		599	775	588	683

1) General

A waste stream of Lublin city has been drawn up based on the following surveys. WACS, however, was conducted only in winter. It is, therefore, recommended to carry out WACS in summer, preferably in spring and autumn in order to make presented waste stream more clear and accurate.

- WACS (Waste Amount and Composition Survey);
- POS (Public Opinion Survey); and
- information on disposal amount obtained from MPO.

A concept of the waste stream is illustrated and shown in Fig. 2.3-1.

Solid waste generated in each generation source is classified into the three categories; i.e. recycled, discharged and self-disposed waste. The discharged waste is divided into waste collected by each collection service and waste illegally dumped.

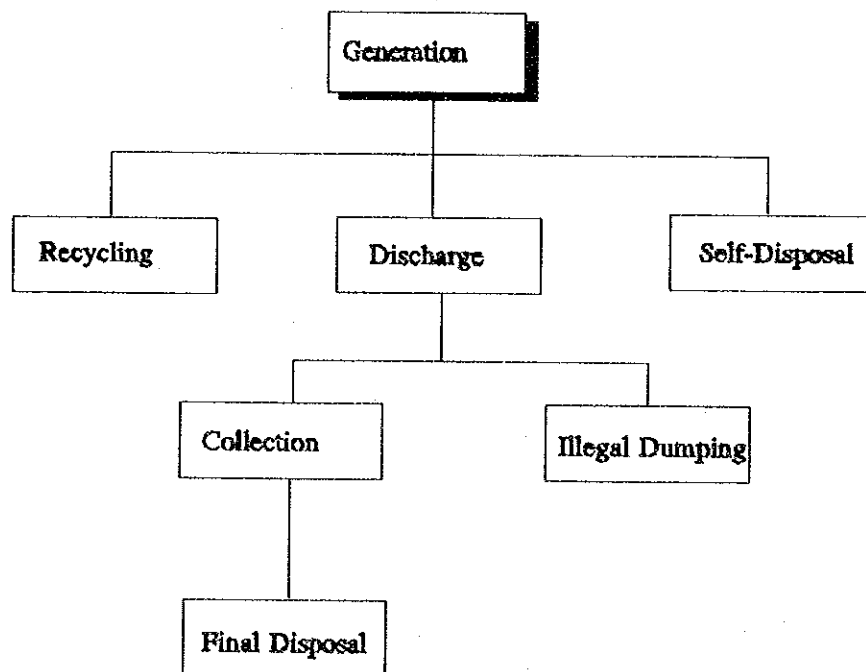


Fig.2.3-1 Concept of Waste Stream

2) Waste Stream

a. Classification of waste

The following sorts of wastes are hauled to the disposal site at present.

i. MSW

- Household waste
 - . household waste (excluding ash)
 - . domestic ash
- Commercial waste
- Market waste
- Institutional waste (Office waste)
- Road sweeping waste
- Bulky waste

ii. Other wastes

- Moulding sand
- Sewage sludge
- Others (construction waste, etc.)

b. Waste stream

Regarding MSW other than bulky waste, discharge ratio was surveyed by WACS. However, total disposal amount was not measured at the Jawidz landfill and discharge ratios of other wastes and bulky waste were not surveyed. It is also noted that the amount of recycling and self-disposal is hard to survey and it requires a considerable effort. Due to this reason, although the waste stream for Lublin Agglomeration, i.e. Lublin, Swidnik, Leczna and other small Guminas, could not be complete, it was prepared as a draft for the future study and shown in Fig. 2.3-2.

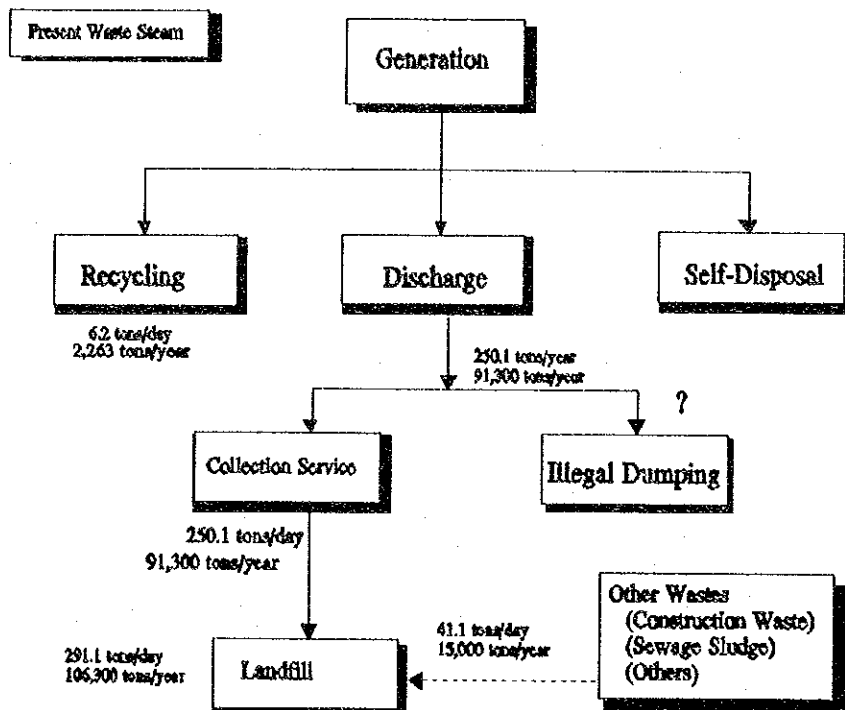


Fig.2.3-2 Present Waste Stream of MSW in Lublin Agglomeration

2.4 Public Opinion Survey

1) Objectives of the Study

The public opinion survey (POS) was carried out in order to understand the majority of the public opinions on MSWM, so that the citizen's opinion would be able to be taken into account for the formulation of the MSWM Master Plan. The main objectives are summarized below;

- a. to collect the basic information concerning MSWM
- b. to understand the present MSWM problems
- c. to understand the present waste discharge, storage and collection system
- d. to understand the ratio of the family discharging ash
- e. to know the citizen's understanding level to MSWM
- f. to grasp the public cooperation possibility of waste segregation at the generation source
- g. to understand the allowable waste collection fee for citizens
- h. to understand the satisfactory level of the citizen to the present MSWM

2) Selection of Sample Points

In order to obtain the public opinion and the basic information which represent the majority of citizens in the City of Lublin, the sample residences and shops were selected by the following manners;

- a. As clearly described in the Manual, the POS shall be conducted prior to the WACS. This time, however, could not follow the Manual due to the time limitation. Therefore, the sample points of the WACS were selected as those for the POS as well.
- b. The residential area was classified into the two categories as shown below and the interviewees should be selected in each categories in the proportion with the actual population of residential structure. The proportion was not however, available at the time of the commencement of the POS. Therefore, about 70 % of the interviewees were selected from apartment buildings. (It was identified 80 % later on.)
 - apartment buildings
 - detached or semi-detached houses

- c. It is deemed to be an important factor for the composition of waste whether the ash discharged from the stove in the residents is discharged into the waste container or not. Forty percent of interviewees in residential areas were selected in the area which is not supplied with heat by the municipal heat supply company, LPEC, according to the heat supply ratio of Poznan City. However, the ratio was found out about 70 % later on.
- d. Regarding the sampling area of shops and restaurants, the areas where various kind of shops were existing were selected so that the composition of waste represents average.

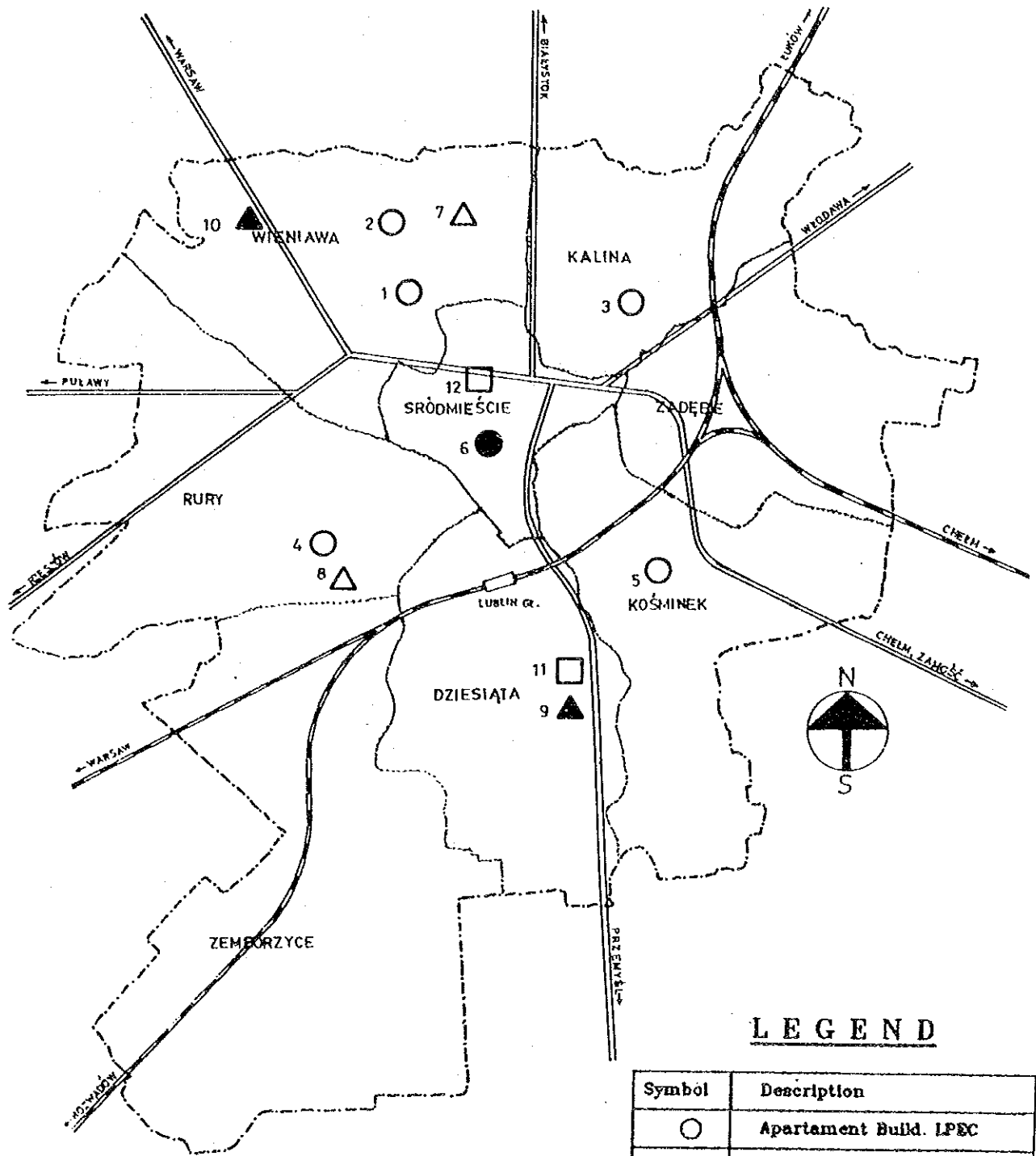
The sample points of POS are tabulated in Table 2.4-1 and shown in Fig.2.4-1.

Table 2.4-1 Sample Points of Public Opinion Survey

No	Category	Heat	Sample No	Location
1	Apartment Buildings	LPEC*	11	Wieniawa Czechow
2			11	Wieniawa Czechow
3			11	Kalina Kalinowszczyzna
4			10	Rury Czuby
5			10	Kosminek Maki
6		Non LPEC	33	Srodmiescie
7	Detached or Semi-detached House	LPEC	11	Wieniawa Czechow
8			10	Rury Czuby
9		Non LPEC	11	Dziesiata
10			10	Wieniawa Slawin
11	Shops, Restaurants, etc.		11	Dziesiata
12			11	Srodmiescie
Total			150	

Note: * LPEC (Lubelskie Przedsiębiorstwo Energetyki Ciepłej) means municipal heat supply distributed area.

Fig.2.4-1 Sample Points of POS



LEGEND

Symbol	Description
○	Apartment Build. LPEC
●	Apartment Build. Non LPEC
△	Detached Houses LPEC
▲	Detached Houses Non LPEC
□	Shop, Restaurant, etc.

Note : The figure shown is the same as NO shown in Table 2.4.-1

3) Method of the Survey

Upon consideration of the time limitation and comparison with the Study of Poznan, the questionnaire used in the Poznan study was adopted after several revisions.

Before the execution of the survey, the Study Team made the lecture to the interviewers in order to let them understand the objectives and the contents of the survey.

POS was conducted by means of the interview to each resident, shop's and restaurant's owner or employee from December 8th to 15th, 1992. The interviewer visited each interviewee and collect answers from them at the same time. All answers were input to the computer for analyzing.




4) Results of the Survey

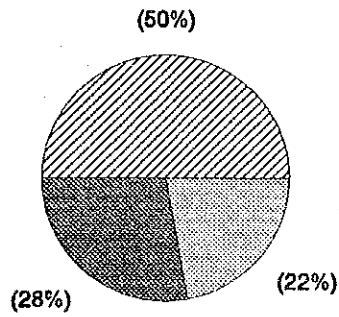
I Items Filled by Interviewer

Q1-3 Category of House

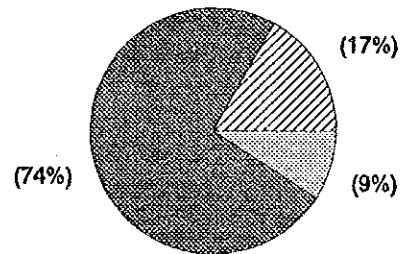
	Residential Area	Commercial Area
New Apartment Building (after 1945)	50 %	17 %
Old Apartment Building (before 1945)	28 %	74 %
Detached or Semi-Detached House	22 %	9 %

Legend

-  New Building
-  Old Building
-  Detached Houses



Residential Area









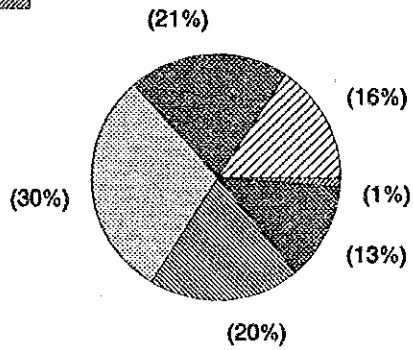
Commercial Area

Q1-4 Distance from the house to communal container of discharge point

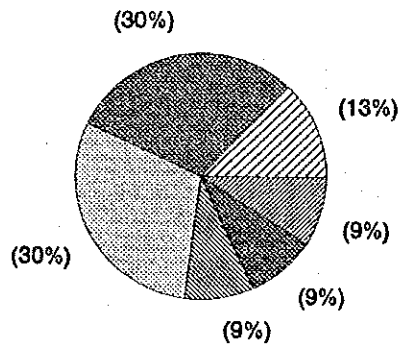
	Residential Area	Commercial Area
In front of the premises	16 %	13 %
Less than 10 m	21 %	30 %
10 - 29 m	30 %	30 %
30 - 49 m	20 %	9 %
50 m or more	13 %	9 %
There is no communal container or discharge point in this area.	1 %	9 %

Legend

-  In front
-  Less than 10 m
-  10-29 m
-  30-49 m
-  50 m or more
-  No container



Residential Area



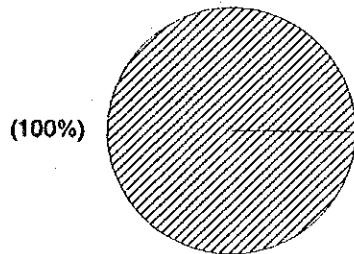
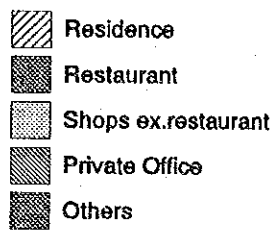
Commercial Area

II General Questions

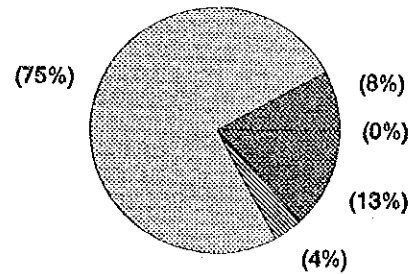
Q2-1 Business Category of the House

	Residential Area	Commercial Area
Residence	100 %	0 %
Restaurant	0 %	8 %
Shops except restaurant	0 %	75 %
Private Office	0 %	4 %
Others	0 %	13 %

Legend



Residential Area

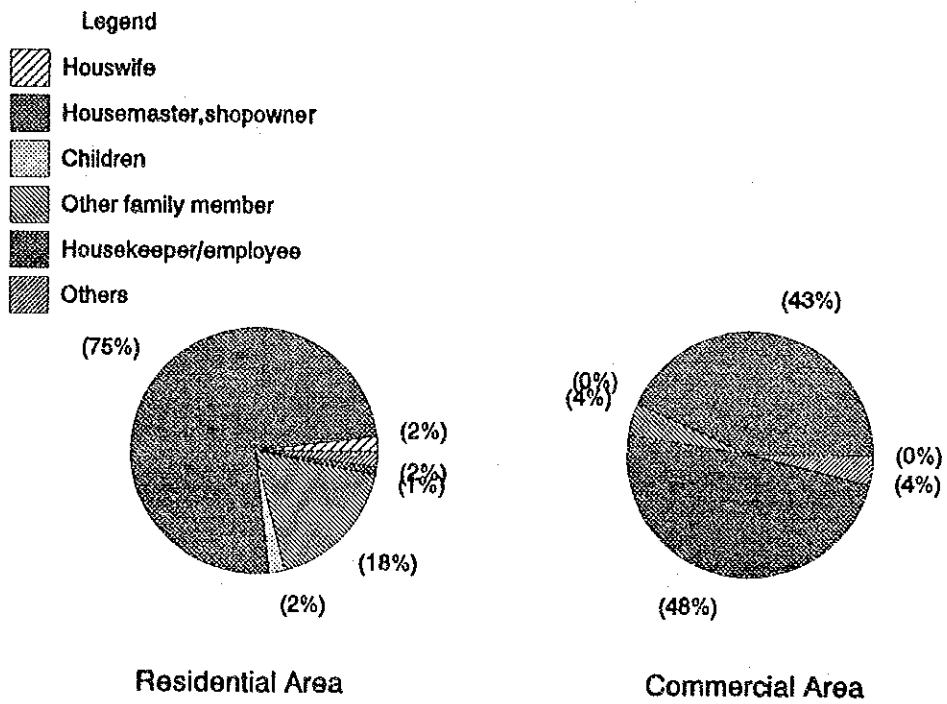


Commercial Area

Q2-2 Type of Interviewee

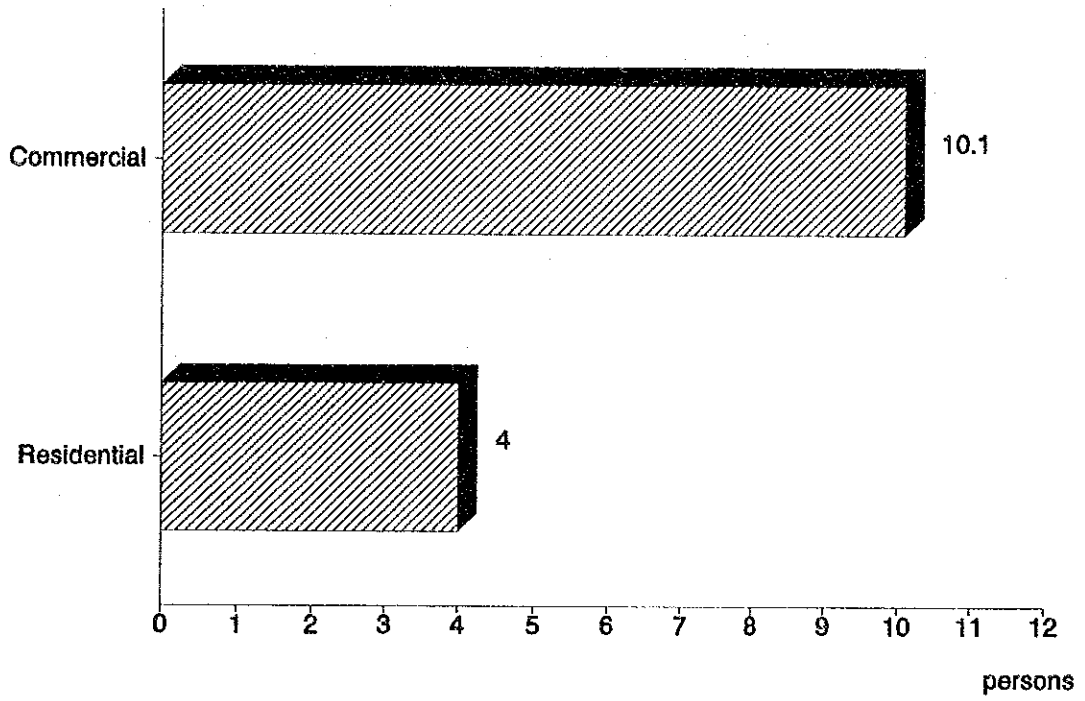
	Residential Area	Commercial Area
Housewife	2 %	0 %
The master of house or owner of shop	75 %	43 %
Children	2 %	0 %
Other family member	18 %	4 %
Housekeeper or employee	1 %	48 %
Others	2 %	4 %

Note: One of "others" in residential area was temporary stay and one in commercial was the manager of the shop.



Q2-4 Number of persons staying in the house/shop/office.

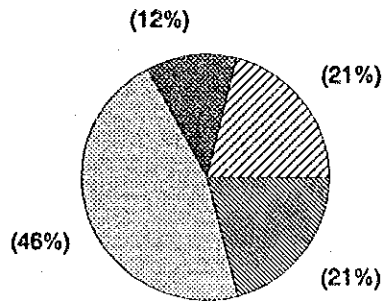
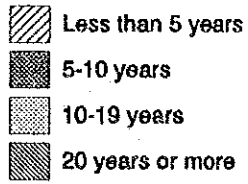
	Residential Area	Commercial Area
Number of persons staying	4.0 persons	10.1 persons



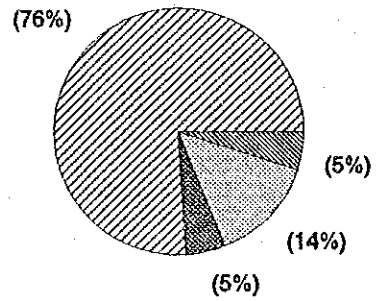
Q2-5 Number of dwelling years at this place

	Residential Area	Commercial Area
Less than 5 years	21 %	76 %
5 - 10 years	12 %	5 %
10 - 19 years	46 %	14 %
20 years or more	21 %	5 %

Legend



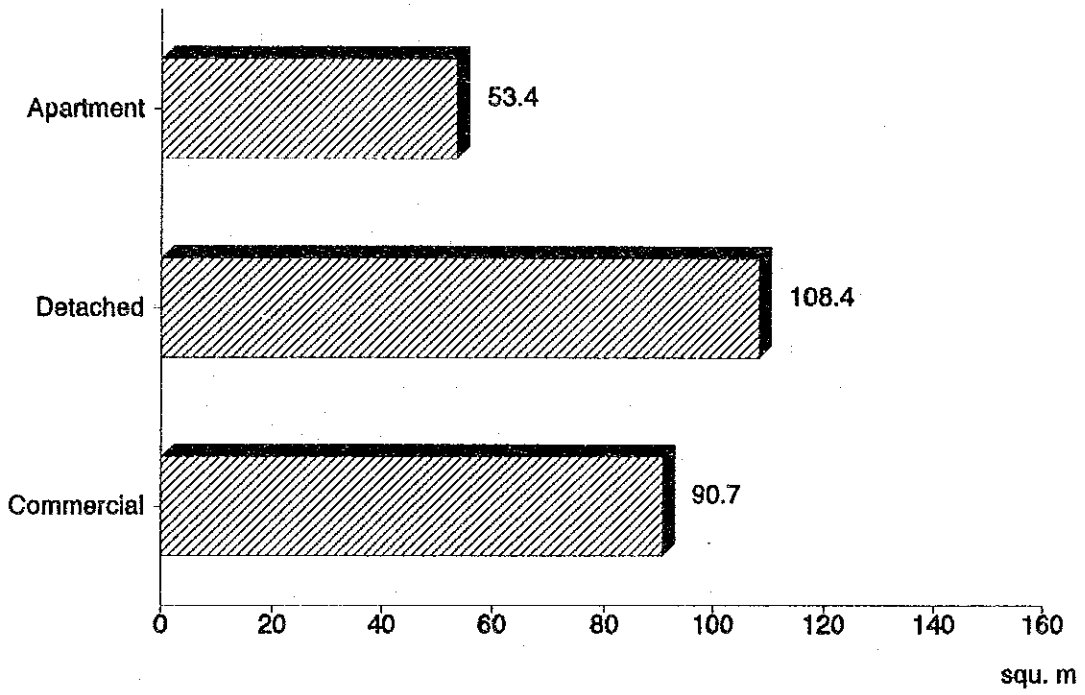
Residential Area



Commercial Area

Q2-6 Area of the house/shop/office

	Residential Area		Commercial Area
	Apartment	Detached	
Area of the house/shop/office	53.4 m ²	108.4 m ²	90.7 m ²

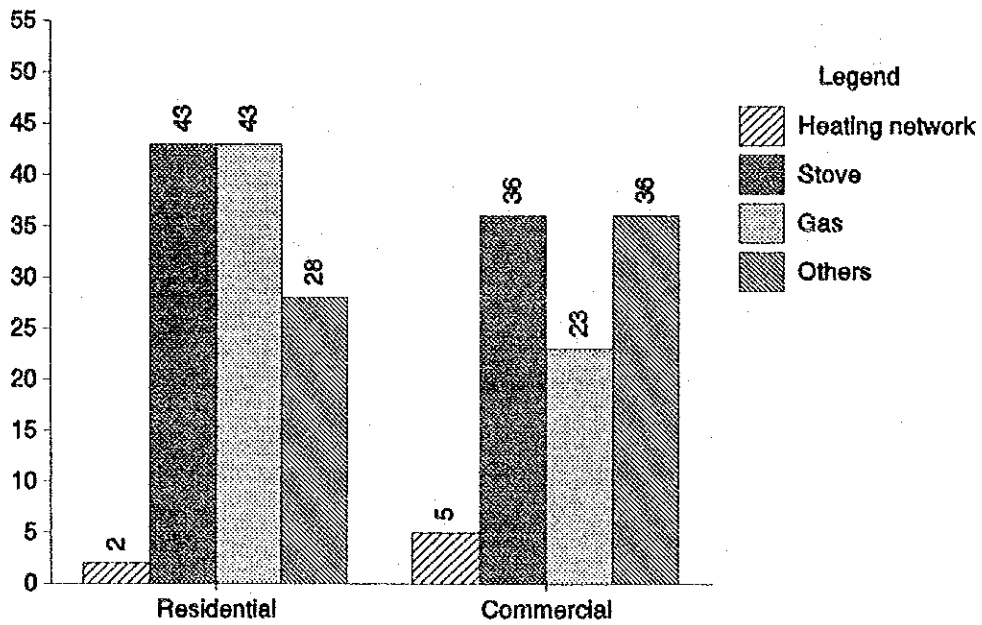


Q2--7 Heat Supply System (Plural answer)

	Residential Area (Non LPEC)	Commercial Area
Municipal Heating Network	2 %	5 %
Stove	43 %	36 %
Gas	43 %	23 %
Others	28 %	36 %

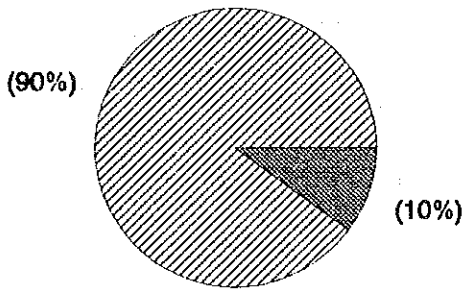
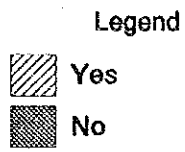
Note: All of "others" were electric heaters.

All LPEC areas are covered by municipal heating network.

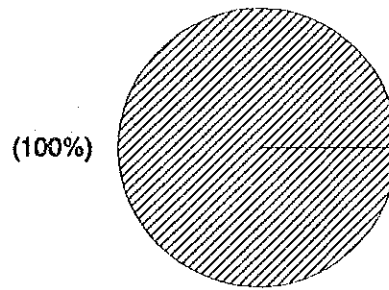


Q2-8 Does the central heating system of stove produce ash?

	Residential Area	Commercial Area	Total
Yes	90 %	100 %	93 %
No	10 %	0 %	7 %



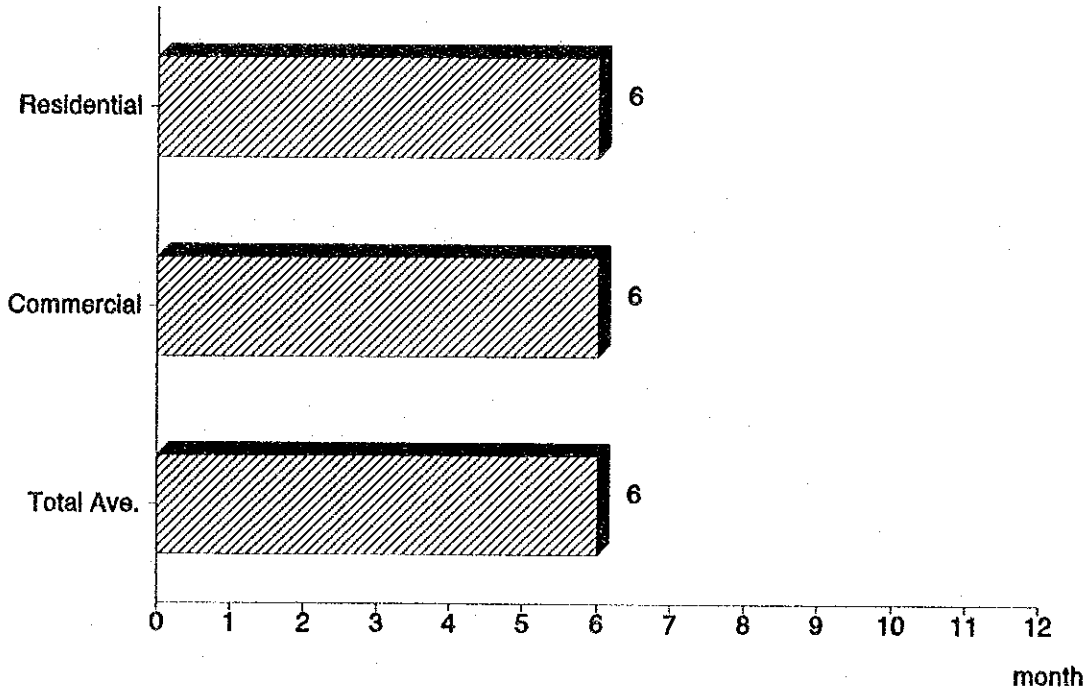
Residential Area



Commercial Area

Q2-9 How many months per year the ash is discharged?

	Residential Area	Commercial Area	Total Average
Discharge month per year	6	6	6







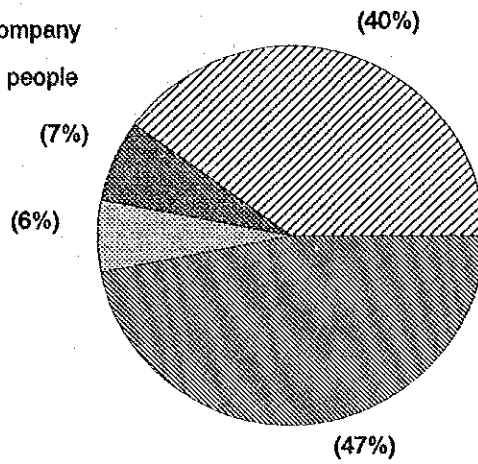
Q2-10

Employment of The Master

	Residential Area
Public Servant	40 %
Employee of Private Company	7 %
Owner of company, shop, etc.	6 %
No working people	47 %

Legend

-  Public Servant
-  Private Company
-  Owner of company
-  No working people









Residential Area

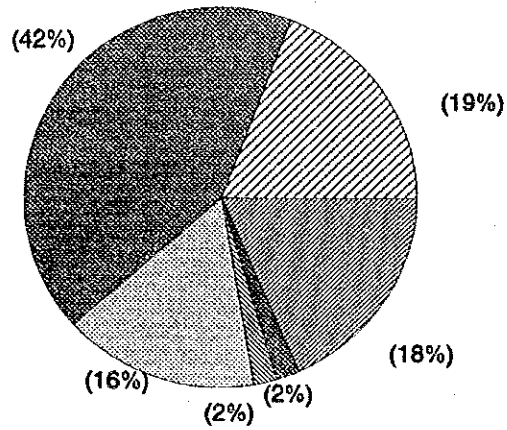
Q2-11

Total expenditure of your family per month

	Residential Area
Less than 2 million zlotych/month	19 %
2 - 4 million zlotych/month	42 %
4 - 6 million zlotych/month	16 %
6 - 8 million zlotych/month	2 %
More than 8 million zlotych/month	2 %
I don't know.	18 %

Legend

-  Less than 2m.zl/month
-  2-4 m. zl/month
-  4-6 m. zl/month
-  6-8 m. zl/month
-  More than 8m.zl/month
-  I do not know



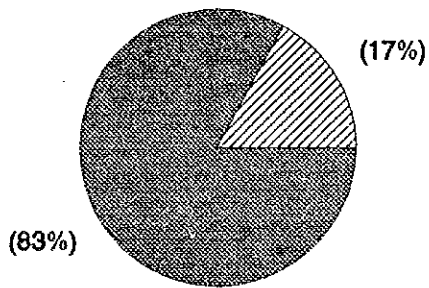
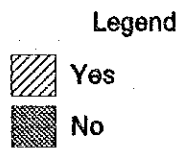
Residential Area

III Questions on Discharge of Waste from Your House

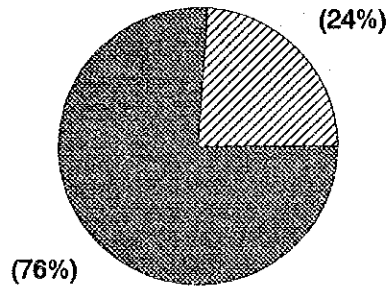
Q3-1 Do you discharge ash from your heating equipment?

	Residential Area	Commercial Area
Yes	17 %	24 %
No	83 %	76 %

If yes, please answer 3-2 and 3-3.



Residential Area

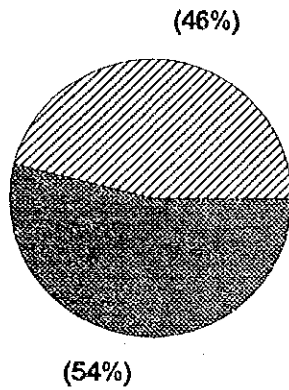
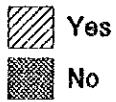


Commercial Area

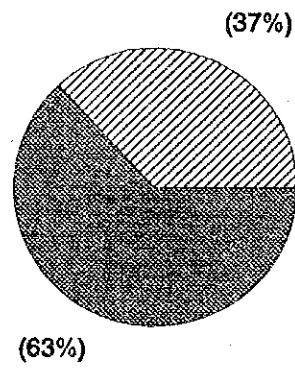
Q3-2 Do you discharge ash with other mode of wastes?

	Residential Area	Commercial Area
Yes	46 %	37 %
No	54 %	63 %

Legend



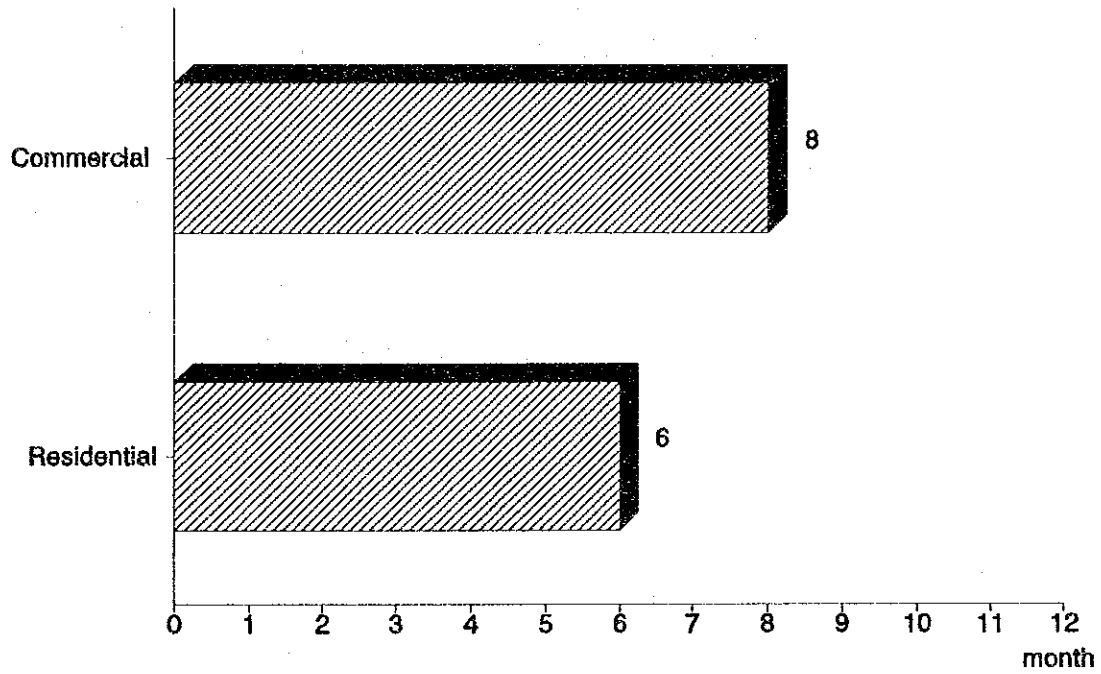
Residential Area



Commercial Area

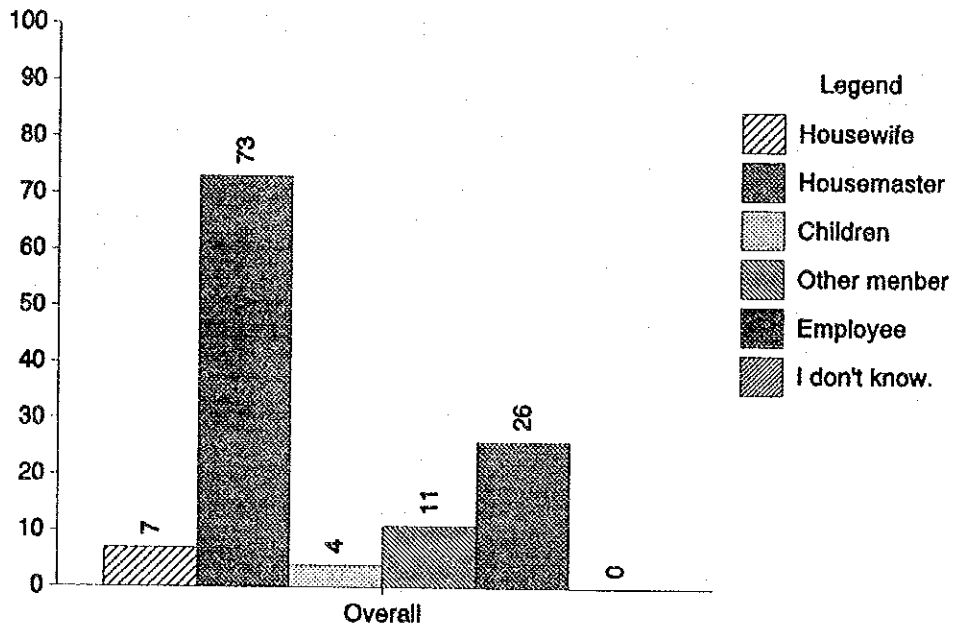
Q3-3 How many months per year do you discharge ash?

	Residential Area	Commercial Area
Month per year	6	8



Q3-4 Who discharge ash from your house? (Plural answer)

	Overall
Housewife	7 %
The master	73 %
Children	4 %
Other family member	11 %
Guardian or employee	26 %
Others	0 %
I don't know	4 %








Q3-5 Where do you discharge waste from your house?

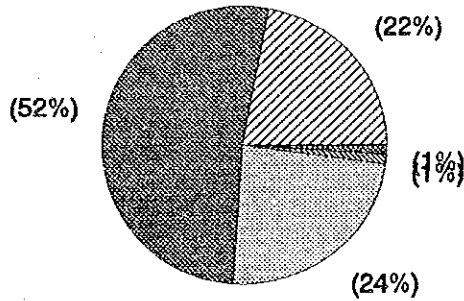
	Residential Area	Commercial Area
Individual container	22 %	32 %
Communal container	52 %	59 %
Dust chute	24 %	0 %
Others	1 %	5 %
I don't know	1 %	5 %

Note: Contents of "others";

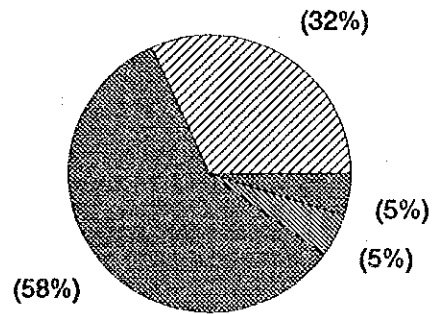
one - dust chute, two - take out it to the other places where they lived in.

Legend

-  Individual container
-  Communal container
-  Dust chute
-  Others
-  I don't know



Residential Area



Commercial Area





Q3-6 What type of container do you use for carrying waste to discharge point in question No.3-5?

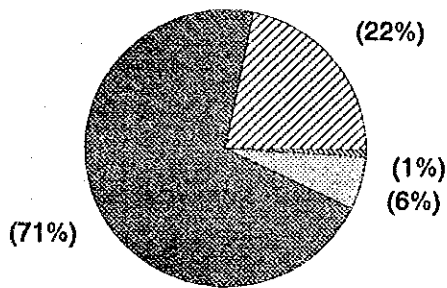
	Residential Area	Commercial Area
Plastic bag	22 %	35 %
Plastic bucket	71 %	30 %
Metal bucket	6 %	9 %
Others	1 %	26 %
I don't know	0 %	0 %

Note: Contents of "others";

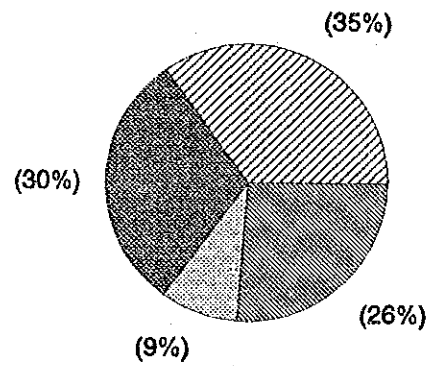
6 persons use cardboard boxes and one uses a paper bag.

Legend

-  Plastic bag
-  Plastic bucket
-  Metal bucket
-  Others



Residential Area



Commercial Area

Q3-7 Why do you use it? (Plural answers were made by interviewee).

	Residential Area	Commercial Area
It is clean after collection work.	23 %	18 %
It prevents foul odor.	8 %	9 %
It is easy handling.	69 %	91 %
Keep away pest such as flies.	5 %	9 %
Others	20 %	5 %

Note: Contents of "others";

- we have this kind of bucket - 15 answers
- we used to it - 2 answers
- looks good - 1 answer
- does not get rusty - 1 answer
- it is Sanepid's demand - 1 answer
- practical - 1 answer
- protect agains fire and keeps tidy - 1 answer
- I don't know - 1 answer

