Denmark was chosen for its reliable waste data and its geographical and demographic features which is similar to Poland.

The fraction papers necessitate considerations on the carrying out of estimations. Development on the other hand will only be considered as a minor change.

Paper

The difference in the amount of paper is probably smaller than the figures indicate as recycling activities were not yet fully implemented in Denmark in 1985 contrary to Poznan where it is well implemented due to economic incitement.

A level lower than Denmark but higher than the present is expected in the planning period.

Table I.1.3-5 shows the forecast on waste composition.

Table I.1.3-5 Forecast for Composition of MSW without Ash, Poznan

Composition	1992	1994	1998	2001	2003	2007	2010
Garbage	33.9	33.9	33.9	34.0	34.0	34.0	34.0
Paper	19.3	20.3	22.2	23.6	24.6	26.5	28.0
Textile	7.3	7.0	6.5	6.1	5.9	5.4	5.0
Plastic	7.9	7.9	7.9	8.0	8.0	8.0	8.0
Grass and Wood	5.9	5.7	5.3	4.9	4.7	4.3	4.0
Leather and Rubber	2.3	2.2	1.9	1.7	1.5	1.2	1.0
Metal	3.8	3.9	4.2	4.4	4.5	4.8	5.0
Glass	15.2	14.6	13.5	12.6	12.0	10.9	10.0
Ceramic and Soil	1.5	1.8	2.3	2.8	3.0	3.6	4.0
Others (Non-combustible)	2.9	2.7	2.3	1.9	1.7	1.3	1.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: MSW here excludes road sweeping and bulky waste.

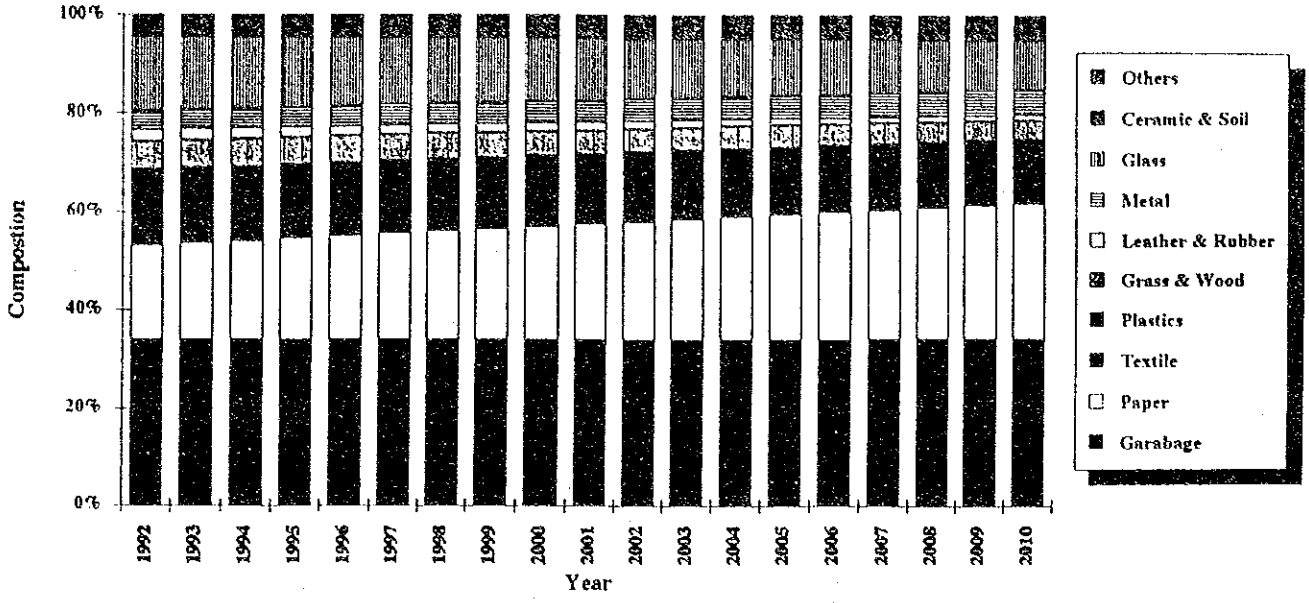


Fig.I.1.3-1 Forecast for Waste Composition

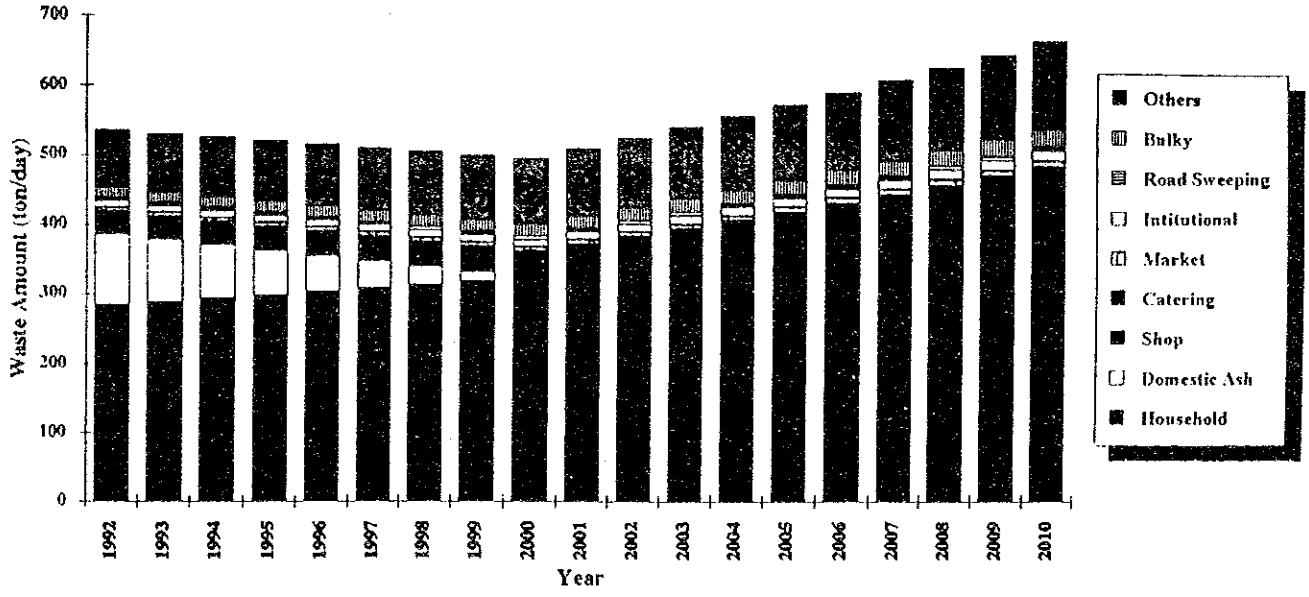


Fig.I.1.3-2 Forecast for Waste Amount

6) Forecast for Calorific Value

The calorific value of waste differs according to physical composition and three content, moisture content, combustible waste and ash. The ratio of combustible waste and ash depends on the change in physical composition. Table I.1.3-6 shows our survey data and the data in 1984/85.

Table I.1.3-6 Comparison of Three Contents and LCV, Poznan

		1992 JICA			1984/85 Waste Study
		MSW Without Ash	MSW With Ash	Coal Heat Household With Ash	
Moisture content	%	35.7	37.9	41.9	41.8
Combustible	%	38.0	31.4	20.0	24.1
Ash	%	26.2	30.7	38.1	34.1
Lower calorific value	(kcal/kg)				
Measured		1,854	-	-	856
Estimated		1,805	1,437	806	-

Note: MSW excludes road sweeping and bulky waste.

The above 1992 data by the JICA Study Team are weighing average figures, taking the waste discharge amount by each generation category into account. The moisture content of each data ranges between 30% and 50 %, and this result is quite close to the data in 1984/85. Consequently, the lower calorific value was determined only taking into account the possibility that the physical composition may vary, because the moisture content is forecast to remain constant.

Actually, the lower calorific value of each waste composition item is estimated based on the data obtained by the JICA Study Team. These lower calorific values were multiplied by the waste composition forecast result for future lower calorific values.

a. Lower calorific value of each physical composition item

Each combustible component of MSW has a calorific value in dry base. The dry base calorific value of each combustible waste obtained in Japan is shown as follows:

- Garbage 4,000 kcal/kg
- Paper 3,800 kcal/kg
- Textile 3,700 kcal/kg
- Plastic 9,800 kcal/kg

- Grass & Wood 4,000 kcal/kg
- Leather & Rubber 5,000 kcal/kg

Examining the above-mentioned calorific values and waste composition data obtained by this study, the LCV of combustible wastes in the wet base are calculated as shown in Table I.1.3-7.

Table I.1.3-7 Lower Calorific Value of Each Item

Item	Lower Calorific Value (kcal/kg)
Garbage	1,400
Paper	2,550
Textile	2,450
Plastic	6,900
Grass and Wood	630
Leather and Rubber	3,400

b. Lower Calorific Value Forecast

The future LCV of MSW is estimated by multiplying the LCV in Table I.1.3-7 by the ratio of the future physical composition shown in Table I.1.3-5, as described in B.5.1, 2 Waste Composition, iii. Estimation of the LCV.

The introduction of a separate collection system will, if not thoroughly, partly stop the inclusion of non-combustibles in combustibles. Consequently, based on the experience in Japan, the LCV of separated waste is estimated in Table I.1.3-8, assuming a 10% inclusion of non-combustibles into combustible waste.

Table I.1.3-8 Forecast for Lower Calorific Value

Year	Lower Calorific Value (kcal/kg)	
	Mixed	Separate
1992	1,805	2,199
1994	1,820	2,214
1998	1,844	2,244
2001	1,865	2,270
2003	1,877	2,284
2007	1,904	2,315
2010	1,924	2,338

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

I.1.4 Future Waste Stream

The waste streams for the year 1998, 2003, 2007 and 2010 were forecasted.

1) Condition for Forecast

- The coverage rate of household waste and domestic ash is 90 % in 1992.
- The coverage rate of household waste and domestic ash will be 100 % in 2001.
- Discharge of ash from the households will be terminated in the year 2001.
- The waste amount received at public recycling centres is 15 % of total discharge amount with reference to the actual data in Denmark.
- The sort of wastes received at the public recycling centres are some paper, textile, plastic, leather & rubber, metal, glass, ceramic, soil and all kinds of bulky wastes.
- The recycled amount of material in public recycling centres is 10 % of the received amount with reference to the actual data in Denmark.
- The sort of wastes recycled at public recycling centres are some paper, textile, metal, glass and bulky wastes.
- Eight public recycling centres start operation in:
  3 sites: in 1996
  3 sites: in 1997
  2 sites: in 1998
  The amount of wastes received and recycled at public recycling centres increase in proportion to the number of operating public recycling centres.
- Residues from incineration plants amount to 34 % with reference to the actual data in Denmark.
- The incineration plant is 80% efficient in producing heat from waste with reference to the actual data in Denmark.
- The incineration plant starts operation in:
  1st incinerator in 2001: 1/3 of the combustibles is treated.
  2nd incinerator in 2006: 2/3 of the combustibles is treated.
  3rd incinerator in 2010: all combustible wastes are treated.
- Apparent specific gravity of waste after compaction at the final disposal site is:
  . Residue of incineration: 1.1
  . Domestic ash: 1.1
  . Others: 0.8

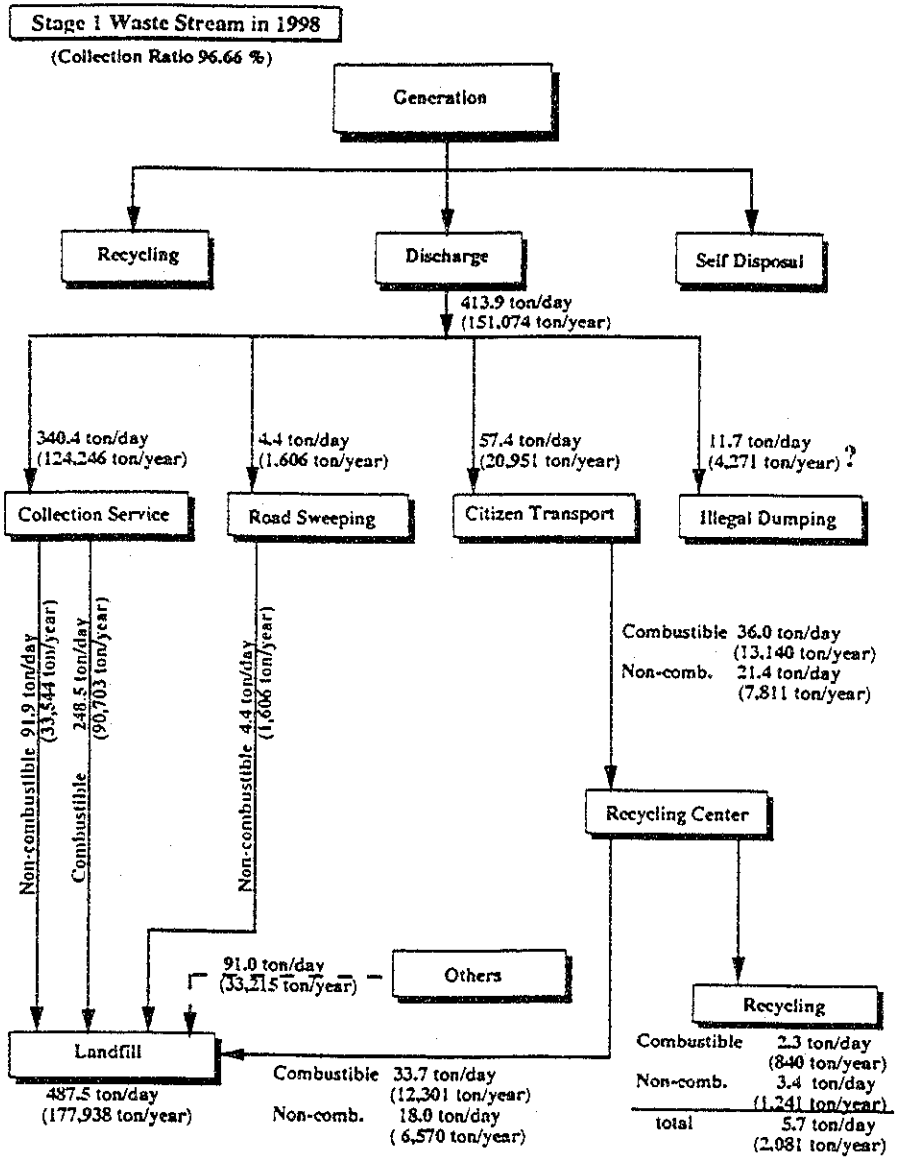


Fig.7.1.3-3 Stage 1 Waste Stream in 1998

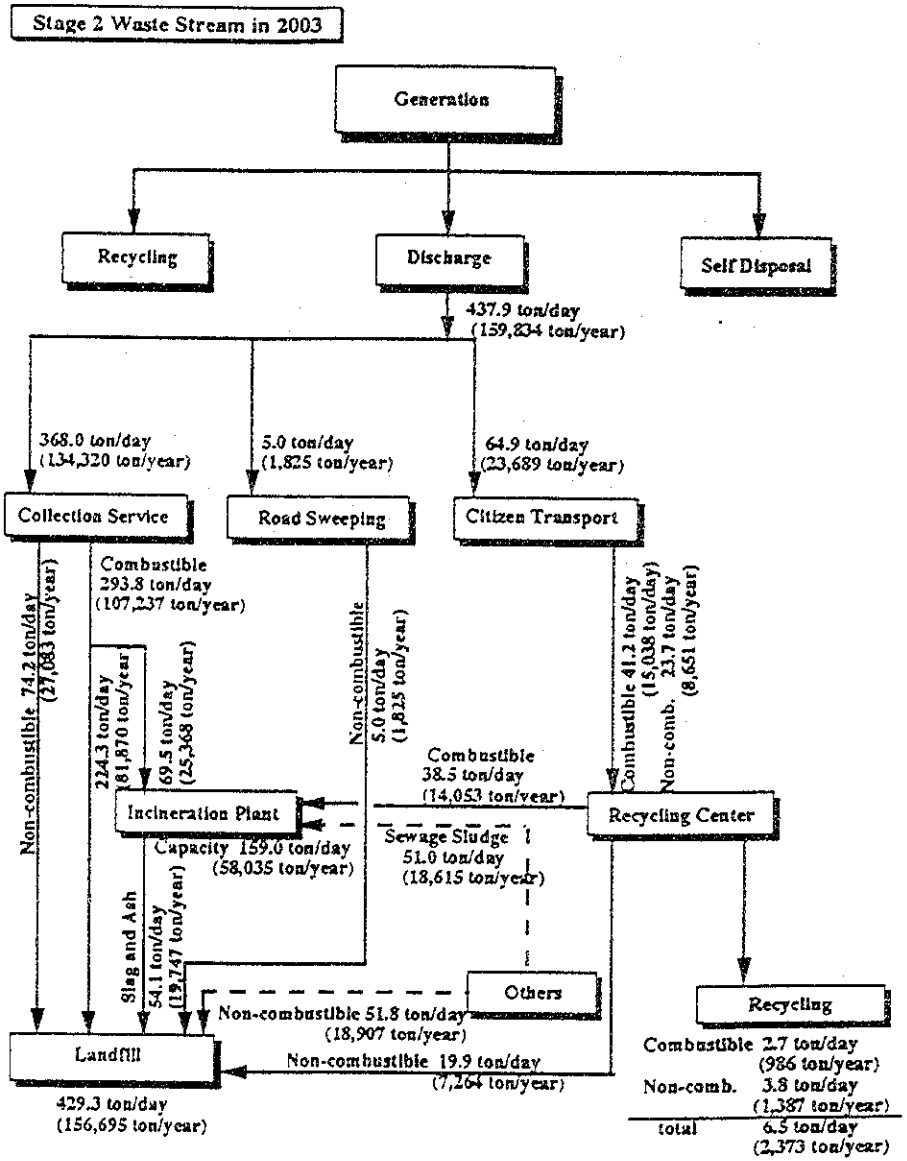


Fig.7.1.3-4 Stage 2 Waste Stream in 2003

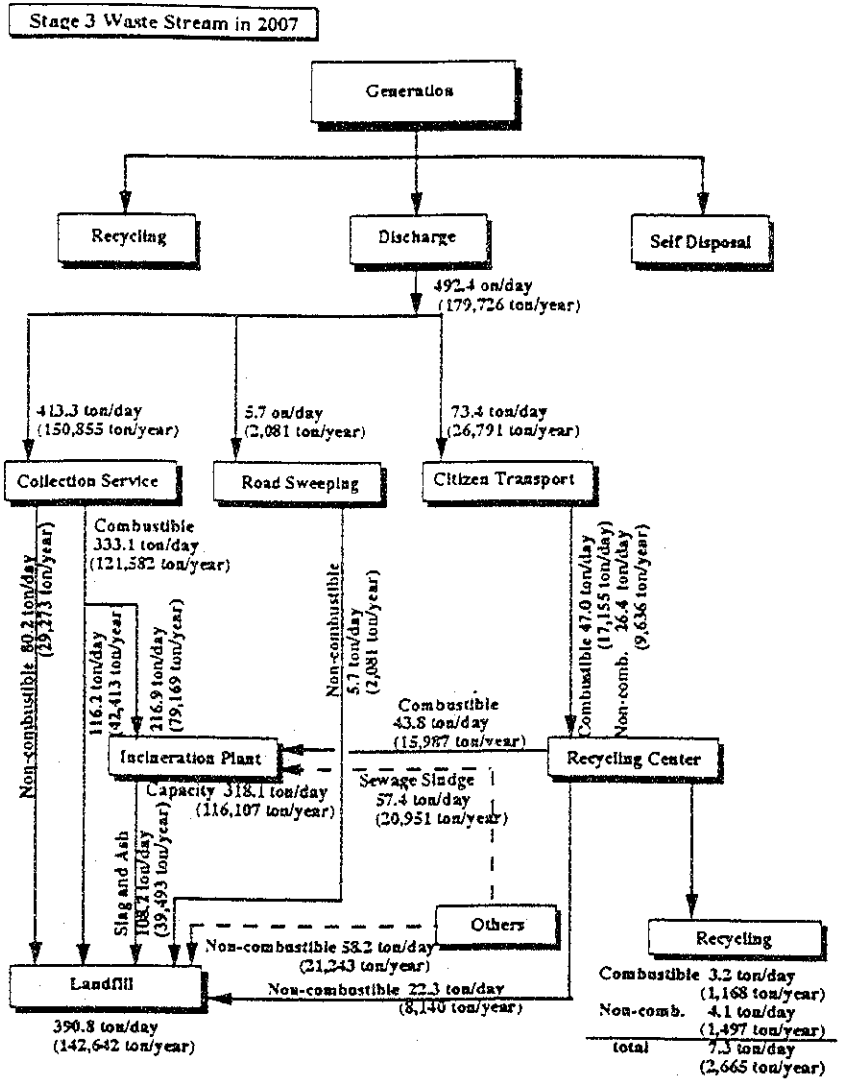


Fig.7.1.3–5 Stage 3 Waste Stream in 2007

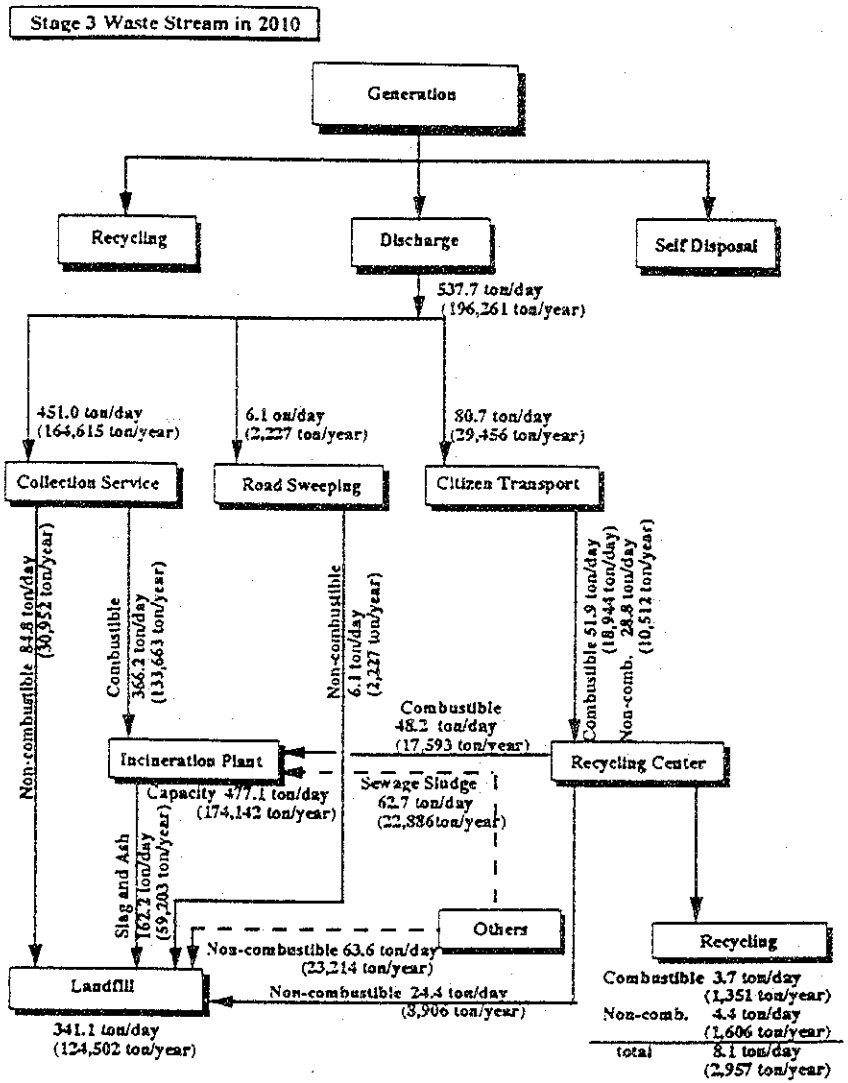


Fig. 7.1.3–6 Stage 3 Waste Stream in 2010

I.1.5 Economic and Financial Condition

The economy of Poland is being restructured at present. The economic growth rate for the past several years showed a downward trend due to the collapse of the former economic system although rapid growth can be expected if the social economic condition becomes stable after the socio-economic structure is successfully reconstructed.

1) Forecast of Economic Growth

The following two cases of economic growth rate were projected:

- case A: 1995 same as 1990 level
  1996 - 2000 3 % increase/year
  2001 - 2010 6 % increase/year

- case B 1995 same as 1990 level
  1996 - 2000 3 % increase/year
  2001 - 2010 4.5 % increase/year

The income level of Poznan is higher than the national average, and its GRDP is expected to increase more than the GDP due to the higher development potentials of regional economies which may be attributed to a border-less and free market system. Nevertheless, the ratio of the GRDP and the financial capability of the municipality is in proportion to the GDP, although population growth rate is lower than the overall population growth rate of the country.

The changes of income level estimated from GDP per capita are shown in Table I.1.5-1.

Table I.1.5-1 Changes of Income Level

		1985	1986	1987	1988	1989	1990
GDP	(trillion zl)	8.7	10.7	14.0	25.0	105.0	506.3
Exchange rate	(Zl/USD)	147.2	175.2	265.2	430.6	1446	9500
Population	(million)	37.3	37.6	37.8	37.9	38.0	38.2
GDP per capita	(USD)	1,577	1,624	1,398	1,531	1,910	1,395
Reference: GNP per capita WEIS*	(USD)	(6,470)		(6,883)	1,860 (7,270)	1,790 (1,560)	1,690

Sources : Rocznik Statystyczny 1991
World Development Report
* mark WEIS ARC report (CIA,Economic Statistics 1990)

The calculation results are shown in Table I.1.5-2.

Table I.1.5-2 GDP Estimated in 1990 Constant Price (million USD)

	1990	1992	1995	2000	2005	2010
GDP (bill.USD)						
Case A	63.6	63.6	63.6	73.7	98.7	132.0
Case B	63.6	63.6	63.6	73.7	91.9	114.5
Financial affordability of the municipality (bill.zl)						
Case A		916	916	1,062	1,421	1,902
Case B		916	916	1,062	1,323	1,649

The income level (GRDP per capita) will be between 3,339 USD(case A) and 2,896 USD (case B) in 2010.

A shift to a post-industrial society will take place in which trade and services will take the lead. The composition of industries in 2010 will be calculated by extension of change in the term from 1970 to 1989, as shown in Table I.1.5-3.

Table I.1.5-3 Change of GDP (%)

Business category	1970	1980	1989	2010
Industry	54.6	52.1	47.9	36.5
Agriculture	17.3	15.8	12.7	9.1
Trade	9.9	12.8	18.5	31.2
Other Industry	18.2	19.3	20.9	23.3

The number of employees in each business category will increase in proportion to the share of GDP, although the ratio of total number of employees to the total population keeps present level (about 43%).

I.1.6 Conditions for Cost Estimation

All design and cost estimates presented are based on the assumption that new facilities for Poznan will be designed and constructed to meet prevailing EC standards. However, one must bear in mind that the present economy of Poland cannot realistically afford overnight steps to change the level and standard of the facilities. Improvements can only be obtained gradually.

All cost estimates were conducted based on the following:

- The prices were based on the January 1993 prices.
- Labour costs and investments for constructions and equipment available in Poland reflect Polish price level. These prices are presented in Zloty (Zl). Table I.1.6-1 presents information on the January 1993 unit prices in Poznan.
- Prices for equipment not available in Poland reflects price level available in Western Europe. These are presented in CIF prices of USD (1 USD = 15,700 Zl, January 1993).
- Costs for the acquisition of lands as well as for connection fees (electricity, water and sewerage) are not included.
- Costs for preliminary studies and design works to be conducted to gain the approval of the authorities for the construction of facilities is not included.
- All salaries are net salaries, including 20 % tax and 45 % social security services.
- The inflation rate is not taken into account.

In order to obtain information on price levels available in Poznan, information on typical unit prices for earthworks, concrete works, buildings, etc., were obtained from the following companies:

- AKO-consulting is an engineering company in Poznan specializing in provision of services for construction works.
- Eud-Eko, a contractor in Poznan, is mainly involved in earthworks.

Table I.1.6-1 presents information on unit prices available in Poznan January in 1993.

Table I.1.6-1 Information on Unit Prices Available in Poznan

DESCRIPTION	UNIT PRICE INCL. ALL MATERIALS AND WORKS POZNAN, JUNE 1992
Salary within construction works including 20 % tax and 45 % social security charge:	
- manager	23.2 mill. Zl/month
- engineer and mechanic	22.6 mill. Zl/month
- driver and operator	11.6 mill. Zl/month
- worker	6.4 mill. Zl/month
- clerk	4.1 mill. Zl/month
Earthworks	
- Excavation of soil and 50 m transport to storage heap	20,000 Zl/m^3
- Excavation of soil and 500 m transport to storage heap	58,000 Zl/m^3
- Excavation of soil, 50 m transport and compaction in an embankment	35,000 Zl/m^3
- Supply of gravel for drainage including laying in a 0.3 m thick layer	58,000 Zl/m^2
- D 110 PVC laid in a 1 to 1.5 m deep trench	348,000 Zl/m.
- Supply and laying of stones for a stone drain (1m^3/m)	551,000 Zl/m.
Pavements	
Consisting of:	406,000 Zl/m^2
- 3 cm asphalt top layer	
- 7 cm asphalt bottom layer	
- 15 cm mechanical stable gravel	
- 30 cm course gravel	
Consisting of 30 cm layer of mechanical stable gravel	81,000 Zl/m^2
Concrete works:	
Formwork, reinforcement, concrete and all works for the following:	
- wall	3,944,000 Zl/m^3
- slab	3,132,000 Zl/m^3
- column	3,596,000 Zl/m^3
- continuous footing foundation	1,856,000 Zl/m^3
Buildings	
- Garage from a steel structure with steel cladding, including foundation and concrete floor	2,668,000 Zl/m^2
- Office building of brickwork, including all works	4,292,000 Zl/m^2
Fences	
- 2 m high galvanized wire mesh erected on galvanized steel posts each 2.5 m	383,000 Zl/m
- Gate (8 m wide)	8,120,000 Zl
Electrical works	
- 4 x 95 m^2 (aluminium) including earthwork for trench	232,000 Zl/m
Purchase of Polish equipment	
- Dump truck, 3 axle	446,600,000 Zl
- Dump truck, 2 axle	371,200,000 Zl
- Tractor (type)	145,000,000 Zl
Materials	
- Diesel oil	4,900 Zl/l
- Cement	34,000 Zl/50kg
- Steel beams	17,000 Zl/kg
- Energy	760 Zl/kWh

I.2 Outline of MSWM System

I.2.1 Outline of Technical System

1) Proposed Technical System

The combination of the following systems are proposed for the technical system of the MSWM Master Plan.

- **Separate Collection**
- **Recycling Centres (2-large and 6-small)**
- **Incineration Plant**
- **Sanitary Landfill**

The proposed technical system for the MSWM Master Plan is summarized and tabulated in Table I.2.1-1.

Table I.2.1-1 Outline of Technical System in 2010

Technical Sub-Systems	Contents
1. Discharge and Storage a. Amount of discharge b. Type of Refuse Bins	 196,261 ton/year (537,7 ton/day) In addition to the present system, paper bags will be used for detached houses.
2. Collection and Haulage a. Coverage Ratio b. Collection System Provided c. Amount of Waste Collected (304 days of work a year)	 100% - Regular separate collection of combustibles and non-combustibles - Bulky waste collection - Recycling centre collection - Regular collection of combustibles : 439.7 ton/day - Regular collection of Non-combustibles : 101.8 ton/day - Bulky waste collection : 29.0 ton/day - Recycling centre collection : 67.8 ton/day Total : 638.4 ton/day
3. Public Recycling Centres a. Number of Centres b. Waste Amount (304 day/year)	 8 places in total, 2 for large (3,000 m2) and 6 for small (2,000 m2) Input: from bulky waste collection : 29.0 ton/day from recycling centre collection : 67.8 ton/day Output: to incineration plant : 57.8 ton/day to recycling : 9.7 ton/day to final disposal : 29.3 ton/day
4. Road Sweeping and Public Area Cleansing	The same as the present system
5. Intermediate Treatment a. Proposed Site b. Received Waste c. Capacity d. Working Hours e. Heat Recovery	 Franowo-Michalowo, Area 5.0 ha MSW excluding road sweeping and non-combustible wastes, and sewage sludge and hospital wastes 10 ton/hour/line x 3 lines and 720 ton/day 24 hour/day and 7,000 hour/year Hot water supply 1,215 Tj/year
6. Final Disposal a. Proposed Site b. Daily Disposal c. Cumulative Disposal Amount d. Landfill Method e. Landfill Area	 Franowo-Michalowo and site area 47.4 ha 369 cu.m/day and 341.1 ton/day 3,100,000 cu.m from 1995 to 2010 Sanitary landfill and leachate is carried to sewage treatment facility 24.8 ha from 1995 to 2010
7. Recycling a. Recycling Facility b. Others	 Non specific facility will be provided except for those in the private sector. Administrative support to private recycling business and introduction of on-site composting.

2) Location of MSW Treatment Facilities

The location of MSW treatment facilities proposed in the Master Plan are presented in Fig.I.2.1-1.

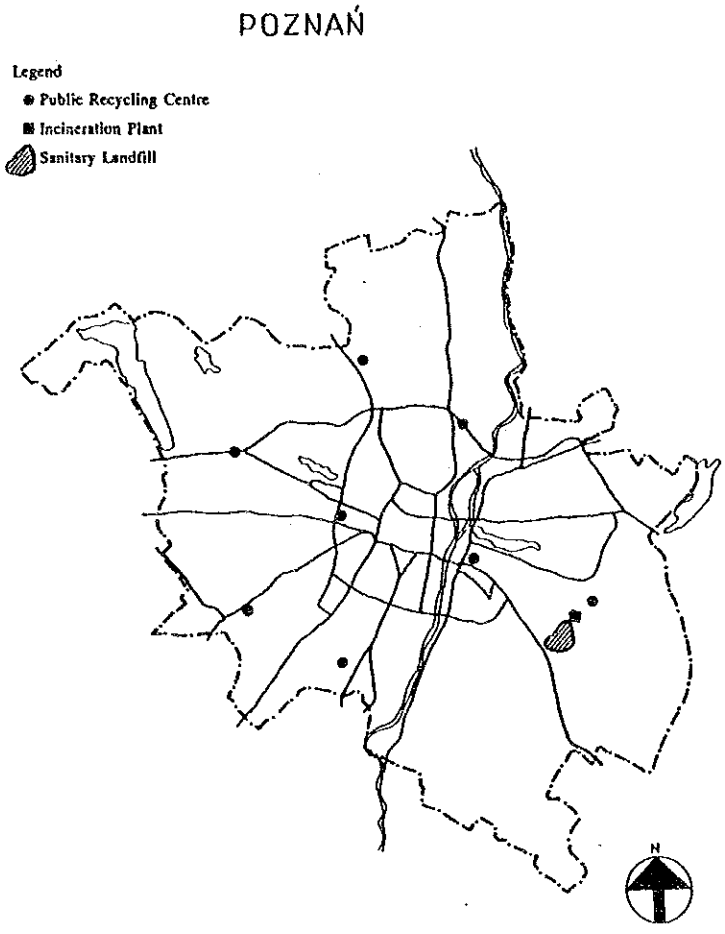


Fig.I.2.1-1 Location of MSW Treatment Facilities

3) Franowo-Michalowo Site Development Plan

The site development plan for Franowo-Michalowo sanitary landfill and incineration plant up to the year 2010 is elaborated, as shown in Fig.I.2.1-2. Although it could not tell when Franowo-Michalowo sanitary landfill will be completed, the site completion plan is prepared as shown in Fig. I.2.1-3.

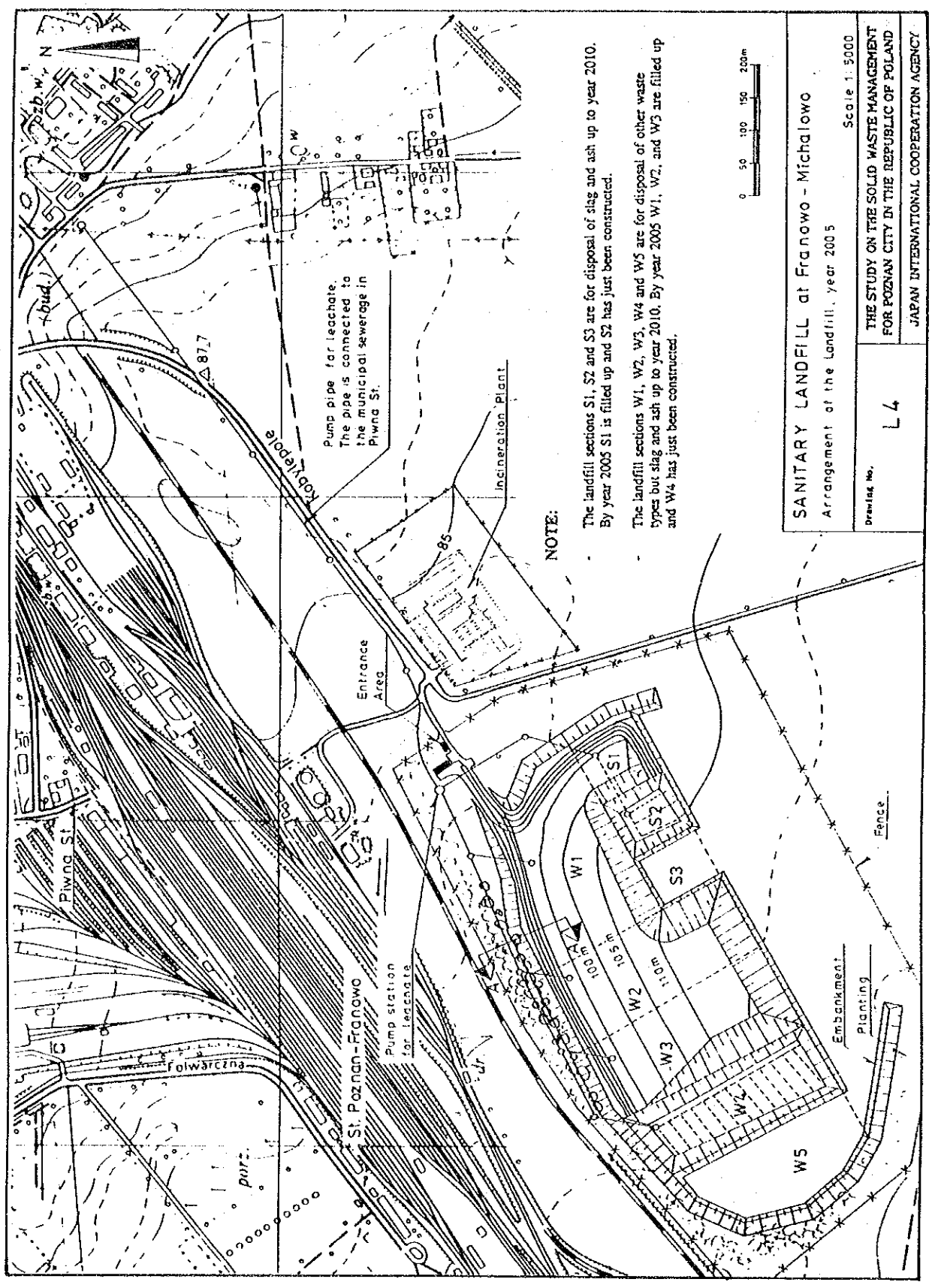


Fig. I.2.1-2 Franowo-Michalowo Site Development Plant up to 2010

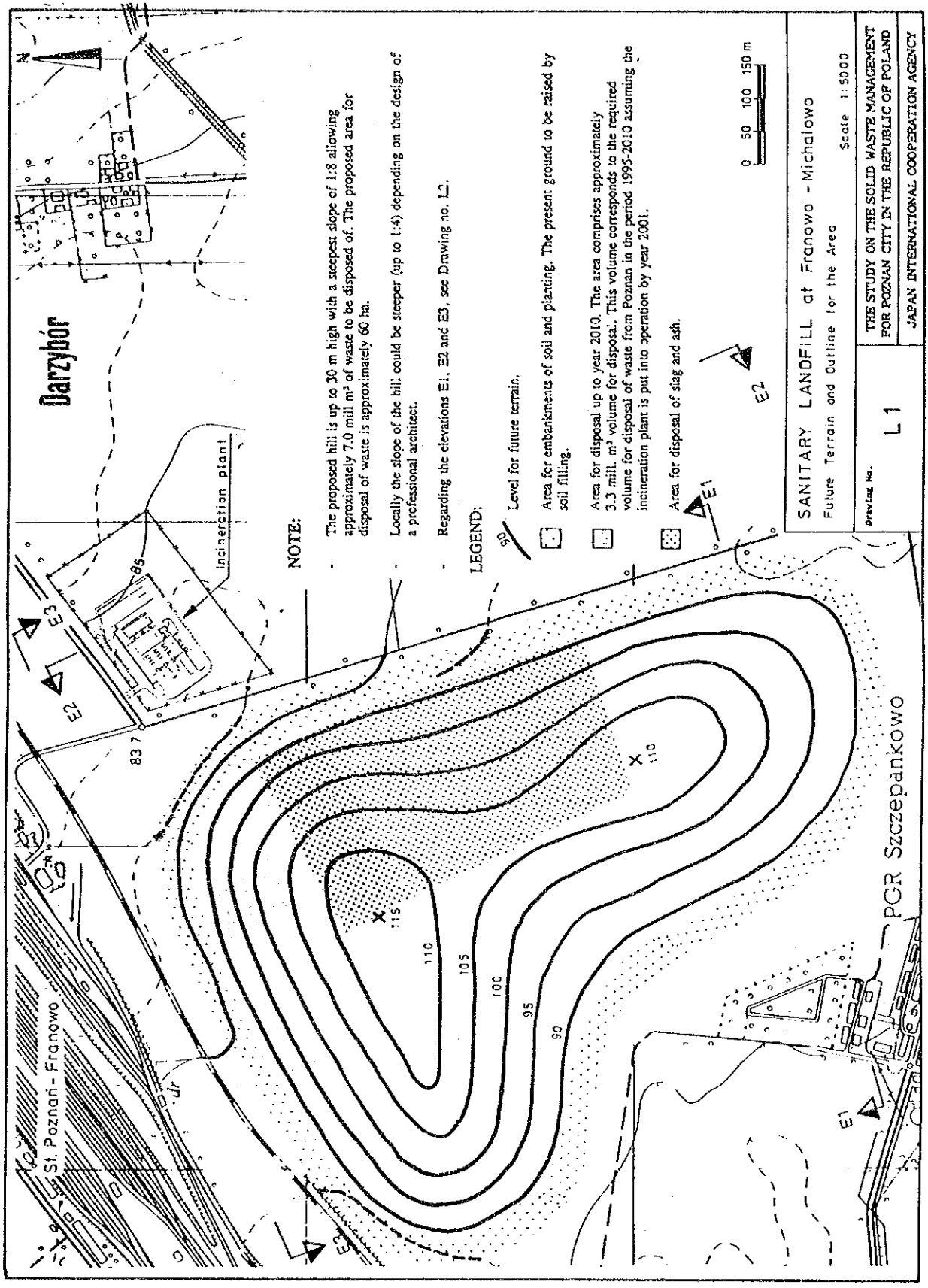


Fig. I.2.1–3 Franowo–Michalowo Site Completion Plan

4) Planned Waste Flow of MSWM Master Plan

The MSW Master Plan wasre flow is presented in Fig.I.2.1-4.

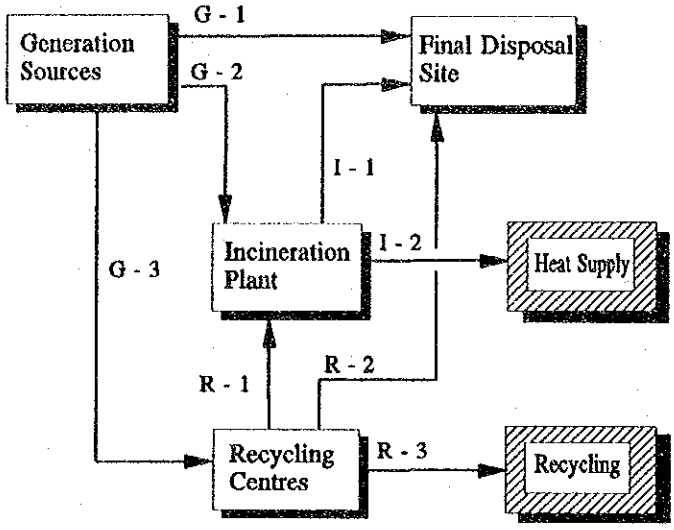


Fig.I.2.1-4 Planned Waste Flow

The explanation of waste flows shown in Fig.I.2.1-4 follows hereafter.

From Generation Source:

The householder discharges categorized wastes and disposes them separately to G1, G2 and G3 flows. Flow G-1 and G-2 are obligatory but Flow G-3 is a non-obligatory activity.

Flow G-1: Non-combustible wastes are carried to the final disposal site.
Flow G-2: Combustible wastes are carried to the incineration plant.
Flow G-3: Unsuitable wastes for regular collection and recyclable wastes are carried to recycling centres.

From Incineration Plant:

Flow I-1: The residues from the incineration plant are carried to the final disposal site.
Flow I-2: Heat generated by waste incineration is delivered to users.

From Recycling Centres:

Flow R-1: Some of the combustible wastes are carried to the incineration plant.
Flow R-2: Some of the non-combustible wastes are carried to the final disposal site.
Flow R-3: Some of the recyclable wastes are recycled.

I.3 Phased Implementation Plan

I.3.1 Examination of Implementation Schedule

1) Target Schedule

The targets of the solid Waste Management for Poznan City are as follows:

- To attain 100% collection service in the year 2000.
- To incinerate 100 combustible waste in the year 2010.
- To start operation of the sanitary disposal site in the year 1995.
- To terminate the illegal dumping by the year 2001.

The proposed target schedule is shown in Table I.3.1-1.

Table I.3.1-1 Target Schedule

Unit:%

Target	1992	1995	2001	2006	2010
Collection Service	90	93	100	100	100
Incineration	0	0	33	66	100
Sanitary Landfill		100	100	100	100
Illegal Dumping	10	7	0	0	0

2) Countermeasures to attain Targets

Targets and their countermeasures are shown in Table I.3.1-2.

Table I.3.1-2 Target and Countermeasures

Target	Countermeasures
To attain 100% collection service rate in 2000.	- Compulsory collection service - Improvement of collection system
To incinerate 100% combustible waste in 2010.	- An incineration plant - Separate collection
To start operation of the sanitary disposal site in 1995.	- Sanitary landfill
To terminate the illegal dumping by 2001.	Recycling centres

a. To attain 100% collection service in 2000.

This target will be attained by improvement of collection service, provided that the compulsory collection were introduced.

b. To incinerate 100% combustible wastes in 2010.

The whole incineration plant, which has sufficient incineration capacity for the total combustible amount in Poznan in 2010, shall be constructed by 2009 and its operation shall be commenced in full capacity in 2010.

c. To start operation of the sanitary disposal site in 1995.

The new sanitary disposal site will start to operate and receive all final disposal wastes in 1995.

d. To terminate the MSW illegal dumping by 2001.

8 public recycling centres will be constructed and they will act to terminate MSW illegal dumping.

3) Examination of Stage Plan

The introduction of stage plan, especially concerning the incineration plant, leads to the following advantages and disadvantages.

Advantage of Stage Construction

- The stage construction leads to release the financial load.
- The latest incineration technology can be introduced.
- The know-how obtained through in initial operation can be fed back to the next investment.
- The future change of waste amount and composition can be fed back to the design of the facility.

Disadvantage of Stage Construction

- The reduction of volume by the stage construction is lower than the whole package construction.
- The amount of heat recovered by the stage construction is lower than the whole package construction.

Considering advantages and disadvantages said above, the stage plan consisting of 3 phases was adopted for the MSWM implementation schedule, as shown in Table I.3.1-3.

Table I.3.1-3 Target Schedule

Plan	Implementation Period
Stage 1: Short Term Plan - Construction and operation of phase 1 & 2 landfill site - Construction and operation of 8 recycling centres - Preparation work such as investigation, basic design, detailed design and tender document - commencement of construction of the incineration plant	1994 to 1998
Stage 2: Medium Term Plan - Start separate collection in 1/3 area of Poznan City - Incinerate 1/3 of combustible waste in 2001 - Start heat supply recovered by waste incineration - Construction of phase 3 & 4 landfill site	1999 to 2003
Stage 3: Long Term Plan - Separate collection in whole Poznan City - Phase 3 incineration plants start operation - All combustible wastes are incinerated.	2004 to 2010

I.3.2 Phased Implementation Plan

1) Basic Conditions

The designed basic conditions to formulate the phased implementation schedule of MSWM Master Plan are as follows.

- The Master Plan period is from 1994 until 2000.
- All municipal solid waste in Poznan will be carried into the Franowo-Michalowo site after the year 1994.
- The master plan is implemented by in three stages.
- The phased implementation schedule of the incineration plant will be given more importance than the rest.
- The incineration plant consisting of 3 lines will be constructed line by line.

- Separate collection will be implemented on a gradual basis in accordance with the capacity of the line of the incinerator plant which will be constructed.

- 2 years of training will be conducted for separate collection.

- construction of public recycling centres will start in 1995 to control illegal dumping cases as soon as possible.

2) Phased Implementation Plan

Based on the above-mentioned conditions, a phased implementation plan of the MSWM Master Plan is elaborated as shown in Fig.I.3.2-1 and Fig.I.3.2-2. For the better understanding, an activity schedule of MSWM Master Plan is tabulated in Table I.3.2-1.

Fig.I.3.2-1 Phased Implementation Plan of MSWM Master Plan for Technical System

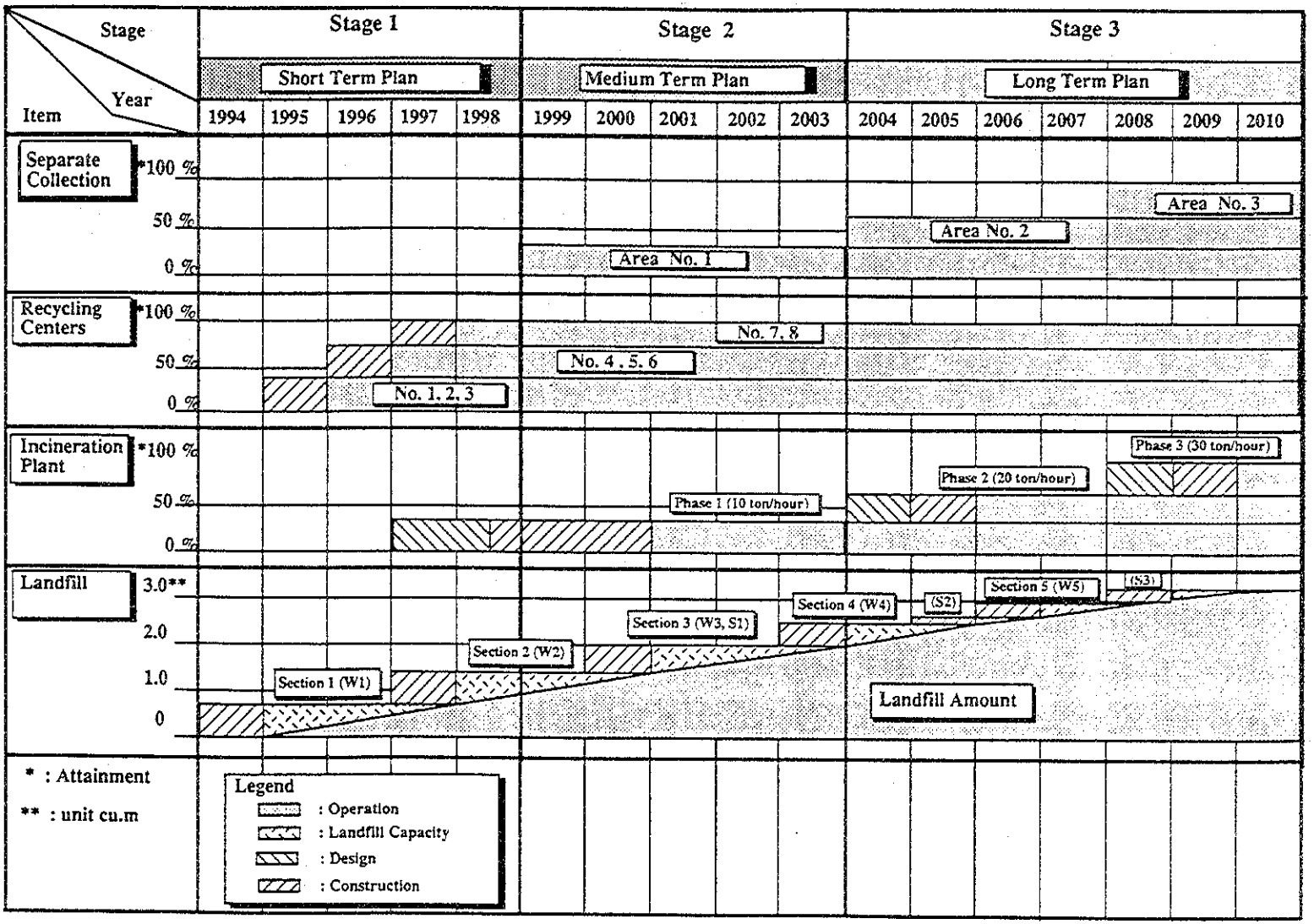


Fig.I.3.2-2 Implementation Schedule of Technical System for MSWM Master Plan

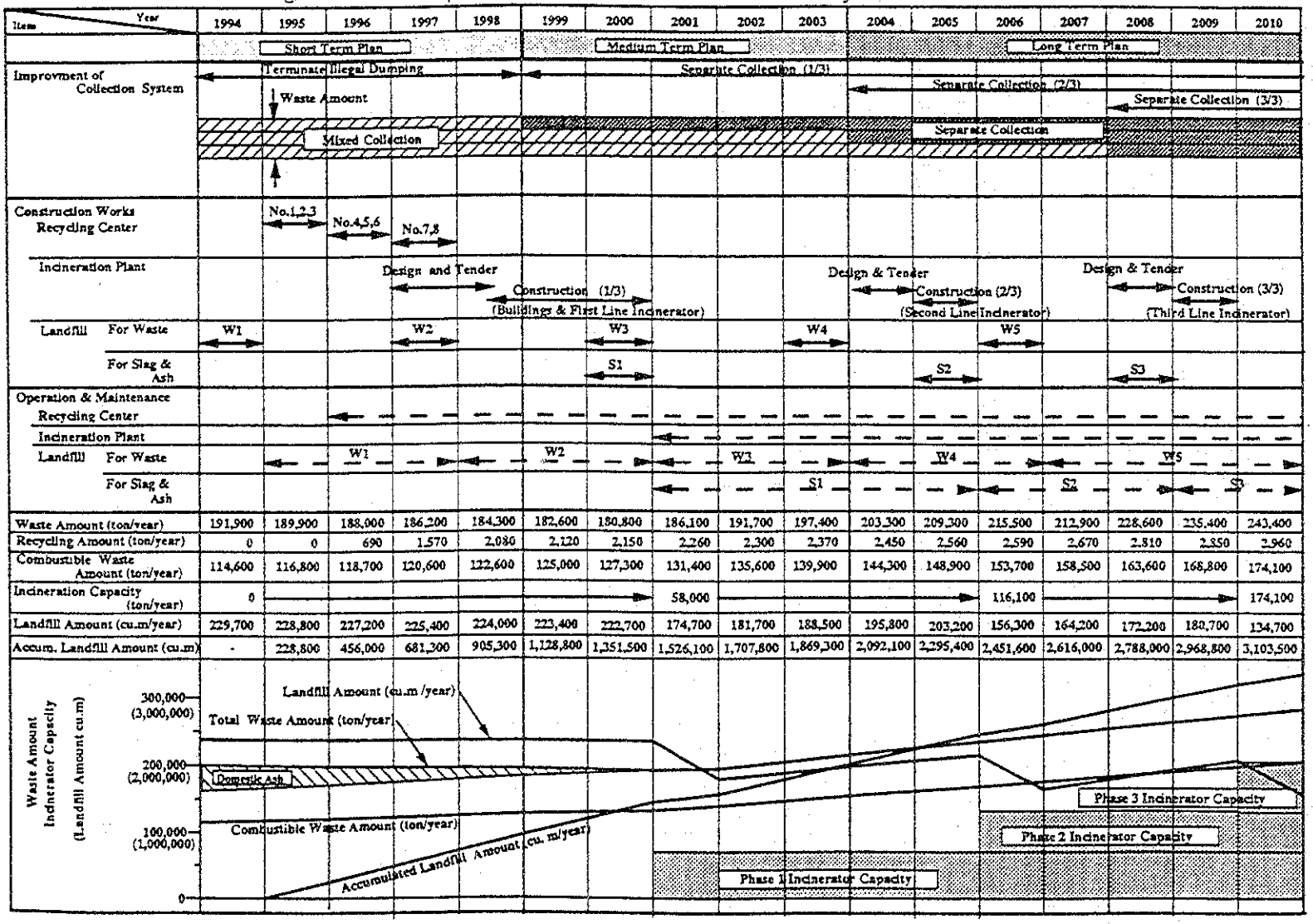


Table I.3.2-1 Activity Schedule of MSWM Master Plan

Year	Category	Activities
1993	Organization	-Collection company founded by Poznan Municipality and Rethman Recycling GmbH starts operation.
	Organization	-Strengthening of municipal organization with formation of Department for MSW.
1994	Organization	-Formation of municipal company responsible for sanitary landfill and later incineration plant (Poznan Waste Treatment and Disposal Company).
	Organization	-Intensive training of personnel at all levels to bring skills to an update level.
	Organization	-Revision of local regulations for municipal waste services.
1995	Collection	-Introduction of compulsory household waste collection.
	Financing	-Introduction of municipal collection of fee for municipal waste services.
	Landfill	-Shift landfill from Suchy Las to Franowo-Michalowo.
	Landfill	-W1 section of landfill operational.
	Collection	-Bulky waste collection operational.
1996	Public Recycling Centre	-No. 1.2.3 public recycling centres operational.
1997	Incineration	-Detailed design on Incinerator.
	Public Recycling Centre	-No. 4.5.6 public recycling centres operational.
1998	Landfill	-W2 section of landfill operational.
	Incineration	-Tender and construction of Incinerator Phase 1.
	Landfill	-No. 7.8 public recycling centres operational.
1999	Collection	-Operation of separate collection for 1/3 area of Poznan.
2001	Incineration	-Incinerator Phase I operational.
	Landfill	-W3 and S1 section of landfill operational.
2002		
2003		
2004	Collection	-Operation of separate collection for 2/3 area of Poznan.
	Landfill	-W4 section of landfill operational.
2005	Incineration	-Incinerator Phase 2 operational.
2006	Landfill	-S2 section of landfill operational.
2007	Landfill	-W5 section of landfill operational.
2008	Collection	-Operation of separate collection for whole Poznan.
2009	Landfill	-S3 section of landfill operational.
2010	Incineration	-Incinerator Phase 3 operational.

I.4 Technical System

I.4.1 Discharge, Storage, Collection and Haulage

Table I.4.1-1 Proposed Waste Flow from New Apartment Buildings Areas to Reception

Collection system		Discharge	Storage	Collection	Haulage	Reception
Regular	Combustibles	Manual carry	6-10 m^3	Curb	Hoist truck	Incinerator
	Non-combustibles	Manual carry	6-10 m^3	Curb	Hoist truck	Landfill
Bulky waste		nil	in house	Door to door	Flat-bed truck	Landfill
Recycling centre		nil	in house	Self service	Self carry	P.R.C

Table I.4.1-2 Proposed Waste Flow from Old Buildings Areas to Reception

Collection system		Discharge	Storage	Collection	Haulage	Reception
Regular	Combustibles	Manual carry	110 l 1.1 m^3	Curb	Compaction truck	Incinerator
	Non-combustibles	Manual carry	110 l 1.1 m^3	Curb	Side loading truck	Landfill
Bulky waste		nil	in house	Door to door	Flat-bed truck	Landfill
Recycling centre		nil	in house	Self service	Self carry	P.R.C

Table I.4.1-3 Proposed Waste Flow from Detached Houses to Reception

Collection system		Discharge	Storage	Collection	Haulage	Reception
Regular	Combustibles	Manual carry	Paper bag	Curb	Compaction truck	Incinerator
	Non-combustibles	Manual carry	110 l	Curb	Side loading truck	Landfill
Bulky waste		nil	in house	Door to door	Flat-bed truck	Landfill
Recycling centre		nil	in house	Self service	Self carry	P.R.C

Table I.4.1-4 Public Recycling Centres

Item	Plan
a. Number of Centres	8 places in total, 2 for large and 6 for small
b. Location	1. between Naramowicka St. and Lechicka St. 2. in Marysienki Resydential Area 3. in Sytkowo near Dabrowskiego St. 4. at the crossing of Grunwaldzka St. and Malwowa St. 5. in Swierczewo near Opolska St. 6. at the river Cybina near Zamenhofa St. 7. in Polna st. near Dabrowskiego St. 8. beside the incineration plant in Franowo
c. Waste amount through recycling centres (304 day/year)	Input: from Bulky waste collection :29.0 ton/day from Recycling centre collection :67.8 ton/day Output: to Incineration plant :57.8 ton/day to recycling : 9.7 ton/day to final disposal :29.3 ton/day
d. Proposed Area	Large centres : 3000 m^2 x 2 sites = 6000 m^2 Small centres : 2000 m^2 x 6 sites = 12000 m^2
e. Equipment	Large centres : 5 small and 16 large containers Small centres : 3 small and 10 large containers
f. Personnel	Large centres : 3 workers Small centres : 2 workers

I.4.2 Intermediate Treatment: Incineration Plant

Table I.4.2-1 Outline of Incineration Plant in 2010

Items	Contents	Remarks
a. Proposed Site	Franowo-Michalowo	Site area 5.0 ha
b. Received Waste	Combustible Waste - Household Waste - Commercial Waste - Market Waste - Institutional Waste - Bulky Waste - Sewage Sludge	Calorific value Low 1,400 kcal/kg STD 2,100 kcal/kg High 2,500 kcal/kg
c. Capacity	10 ton/hour/line x 3 lines	720 ton/day
d. Working Hours	24 hour/day	7,000 hour/year
e. Facilities Outline	Reception Facilities - Access road - Weigh bridge - Building for waste reception Waste pit Waste cranes Incineration Lines Boiler Bottom and Fly Ash Handling System Flue Gas Cleaning System Auxiliary Equipment	 Movable grate system Water tube boiler (Natural water circulation) Semi-dry system Emission Gas Quality Dust: 15 mg/Nm^3 HCl: 100 mg/Nm^3 SO2: 200 mg/Nm^3
f. Heat Recovery	Hot water supply	1,215 Tj/year
g. Personnel	80 persons	

I.4.3 Final Disposal

Table I.4.3-1 Outline of Final Disposal System in 2010

Items	Contents	Remarks
a. Proposed Site	Franowo-Michalowo	Site area 47.4 ha
b. Waste to be Disposed	Slag and Ash - Household Waste - Commercial Waste - Market Waste - Institutional Waste - Bulky Waste - Road Sweeping Waste - Other Wastes	from Incineration Plan excluding Sewage Sludge
c. Daily Disposal Amount	369 cu.m/day	341.1 ton\day
d. Cumulative Disposal Amount	3,100,000 cu.m	From 1995 to 2010
e. Landfill Method	Sanitary landfill	Leachate is carried to sewage treatment facility
f. Landfill Area	24.8 ha	From 1995 to 2010
g. Facilities Outline - Main Facilities	Enclosing structure, drain system	
- Environmental Protection Facilities	Buffer zone, gas removal, leachate collection and monitoring facilities.	
- Building and Accessories	Office and weighbridge, garage and workshop	
h. Equipment	Compactors, excavator, dump truck and tractor	
i. Personnel	18 persons	

I.4.4 Road Sweeping and Public Area Cleansing

The present road sweeping work and the public area cleansing which are performed in Poznan City are sufficiently functioning, because the results of performance are observed to be satisfactory. Therefore the special improvement is not required immediately. Some suggestion on those works are described.

1) Road Sweeping

The most of this work is executed by the authority for the provincial road. In order to cope with the financial problem this authority introduced tendering to select a contractor in 1992. As a result of tendering, four contractors were involved for road sweeping work for Poznan in 1992, although SANITECH was a monopolist in 1991. The tender system should be continued to minimize cost, however it might lead the level down of work quality. The authority of road should complete supervision capability to let the contractor fulfil the specified work quality and also watch corruption.

The targets of road sweeping work are, thereby, set for as follows;

- The performance level of the year 1991 should be maintained until the year 2010, because its level of 1992 is not sufficient already.
- gauged tendering.
- gauged supervision capability.

2) Public Area Cleansing

The system of the public area cleansing work has been also established and functioning nicely in Poznan City. Because the public space is maintained in very clean always.

The authority of green area is in charge of this work in Poznan. The most works are being carried out by the direct force. This authority is also expected to introduce more tendering in future. The introduction of tendering is unavoidable and desirable to minimize cost. However it might lead the level down of work quality. The authority of green area should complete supervision capability to let the contractor fulfil the specified work quality and also watch corruption.

The targets of public area cleansing are, thereby, set for as follows;

- The performance level of the year 1991 is maintained until the year 2010.
- gauged tendering.
- gauged supervision capability.

I.4.5 Recycling

1) Policies

- To utilize the maximum amount of waste practically.
- To develop and to stabilize the market for recycled materials in the Polish industry.
- To support organizations involved in recycling to cut collection and disposal cost.
- To regulate increase of one way containers.

2) Strategies

a. Heat recovery through incinerating combustible wastes

Combustible wastes which occupy 71 % of the total is planned to be utilized as a source of heat energy.

b. Administrative support to private recycling businesses

The Municipality try to control and to maintain the selling price of recyclable material, since they are the main opposition of the private recycling businesses.

c. Promotion of public cooperation initiated by the administration

The Municipality initiate, motivate and increase public cooperation on matters concerning recyclable material collection.

d. Introduction of on-site composting of household waste

On-site composting method is advocated to be introduced to the detached and semi-detached houses for the purpose of kitchen waste reduction.

I.5 Institutional System

This section will provide recommendations for institutional development fro the optimum MSWM for Poznan Municipality defined in the Master Plan. Recommendations were made on two levels: the national and regional levels addressed to the responsible ministries and to the local level of Poznan Municipality.

I.5.1 Institutional Development at National and Regional Levels

The efforts at national and regional level are made into a proper operational frame for the municipalities (local governments) as executing administrative level in MSWM.

National policies, legislation, and national financial actions (taxes and subsidizes) must be fixed as soon as possible and settled for a period of time in order to provide the necessary foundation for local planning. Periods of 4–6 years would allow for proper implementation.

The following recommendations should be observed for national and regional levels:

- As municipalities are a rigid organization executing bodies should provide s more flexible service

- Determination of a national (minimum) standard for waste collection could could also consider suitable ranges for fees and charges.

- Today, the municipalities cannot enforce a compulsory participation in municipal waste services. It is impossible to ensure a proper cleansing level without efforts from the municipal police and other institutions involved in the inspection of the sanitary conditions. Also, the municipalities cannot assign just one contractor for cleaning one district and, therefore, it is difficult to maximize the collection and it hinders the tendering of collection services.

- The present procedure for the acquisition of land makes it more difficult to localize waste treatment facilities. Compulsory purchase of sites for activities benefiting the community as a whole (eg. waste treatment facilities) should be introduced in the legislation.

- The present procedure encouraging compensations to a municipality for localization of waste treatment and disposal facilities serving other municipalities, in combination with the present poor financial situation for many municipalities, includes a risk for "deals" on localization of waste facilities based on economic and not environmental considerations.

- For new landfills we recommend a demand for an obligatory performance security to ensure proper closing of the landfill. The performance security, which shall be provided by the owner before the start of the operation, will serve to secure funds for its closure.

- A regional based licensing of waste treatment and disposal may ensure better operation of these facilities. The authority shall issue permissions for operation (not to be mixed with the present appropriate approval system for new facilities) and the permissions shall be given for a limited period of time.

  The authority shall collect information from inspecting authorities and also carry out additional inspection when required for issuing renewed licenses.

I.5.2 Institutional Development for Poznan Municipality

Based on the optimum technical system for Poznan Municipality, it is possible to propose the optimum institutional system.

The activities to be considered in the institutional development are:

Administration

- Planning.
- Administration.
- Financing/cost recovery.
- Control and supervision.

Technical systems

- Collection systems.
- Recycling centres.
- Incineration Plant.
- Sanitary Landfill.
- Road sweeping and public area cleansing.

In upgrading of the institutional system, also the implementation of the technical system and administration must also be considered as an early modification of the institutional system may ease the implementation (or even be decisive for implementation) of the technical system.

I.5.3 Strategy for Institutional and Organizational Development in Poznan Municipality

The general modernization of MSWM in Poznan Municipality and the increase in activities to be carried out make it appropriate to determine some general guidelines for the institutional and organizational development.

The basic philosophy is that MSWM is a public task and, thus, should be operated under public control. It is, however, recommended that subordinate municipal companies, business-like in structure and orientation, should be formed to smoothen he daily operation. Aside from recommending the introduction of competitive bidding the following guidelines were also recommended:

- Services of MSWM will be executed by sub-ordinate independent companies under municipal control in a business-like manner to facilitate decision-making and administration.

- Competitive bidding must be introduced to secure the best service for least costs.

- Facilities that will contribute to the pollution of the environment after their primary operation shall be owned 100% by the Municipality (eg. a sanitary landfill).

- If compulsory municipal waste services are performed parallel to commercial waste services, a division of these group of activities must be done in order to control costs.

- In case a private investor becomes a shareholder of municipal company, the Municipality must secure ultimate public control for services related to compulsory waste services.

- Fees and charges will be imposed and collected by the Municipality for public services determined by the Law or by municipal regulation.

- Activities related to overall planning and administration will remain in the municipal organization under strengthened power.

- The Municipality will exercise independent control over the activities (municipal control).

I.5.4 Overall Institutional System for Poznan Municipality

Based on the defined activities, we recommend an overall institutional system ilustrated below for Poznan Municipality.

BODY	TASKS
Department for Municipal Solid Waste Management in Poznan Municipality as overall responsible body for MSWM	- Planning - Administration - Collection of fees - Control and supervision
Subordinated municipal companies under municipal control as executive bodies (or through direct tendering from responsible body)	- Operation of collection services - Operation of recycling centres - Operation of incineration plant - Operation of sanitary landfill - Execution of road sweeping - Execution of public area cleansing

Fig.I.5.4-1 Proposed overall Institutional System for Poznan Municipality

The proposed structure necessitates a strengthening of the municipal administration and supervision of MSWM. Today, these duties (among other duties) are carried out by the Department for Communal and Residential Affairs and to some extent the Department for Environmental Protection.

The future organizational structure is expected to strengthen the administration and supervision of MSWM by joining the duties and responsibilities in one department by either strengthening the present organization in the Department for Communal and Residential Affairs or establishing a new department under the auspices of the Vice-Mayor of Technical Affairs.

We consider both alternatives to be appropriate, but for comprehension we will use the name "Department for Municipal Solid Waste Management" in the subsequent text. A change in organization as recommended here is under consideration in Poznan Municipality at present.

For executive tasks, we recommend a combination of direct tendering and formation of municipal companies business-like in orientation with smooth decision-making processes and who are financially independent of the municipality.

The above structure will enable the introduction and implementation of a business-orientated MSWM and will make municipal control over the duties through the Department for Municipal Solid Waste Management. Tendering will also bring about cost minimization and well defined services.

I.5.5 Department for Municipal Solid Waste Management

The strengthened Department for Municipal Solid Waste Management shall carry out the following main duties:

- Overall planning of MSWM.
- Implementation of competitive bidding and tender of services.
- Collection of fees for municipal services.
- Control and supervision, including handling of complaints.
- Administration.

1) Overall Planning of MSWM

The Department will be responsible for overall planning of MSWM, including definition of standards and guidelines for the performance of services.

The Department will take care of all major matters in relation to MSWM, but main executing activities are placed within the municipal companies.

The Department will formulate the current waste strategy and describe the necessary actions for implementation.

2) Competitive Bidding

In accordance with privatization and in order to ensure best services for least costs, competitive bidding must be implemented.

The Department will be responsible for the definition of appropriate areas for competitive bidding and for the bidding procedure.

Generally, areas which are not delegated to municipal companies must be subject to competitive bidding.

3) Collection of fees and charges

An important new role to be added to the Department will be collection of fees and charges for municipal waste services. At, present SANITECH and other private contractors who offer waste collection services to the citizens, who are given the freedom of choice, carry out collection themselves.

The idea behind municipal collection of fees and charges is to make municipal services compulsory and to provide the municipality with the best tool to control the fees. Thus, the implementation of the recommended municipal collection of fees and charges depends on the legal possibility for the Municipality to decide on the contractor for the household waste collection.

Collection of fees and charges necessitates the forming of a register and introduction of a payment procedure. The payment procedure could be combined with collection of municipal taxes including property tax or other municipal services (water and sewage).

To ease the administration, the fee system must be simplified and generalized.

Fees and charges for waste services, which are not part of the compulsory municipal services, will be collected directly by the contractor based on individual contracts.

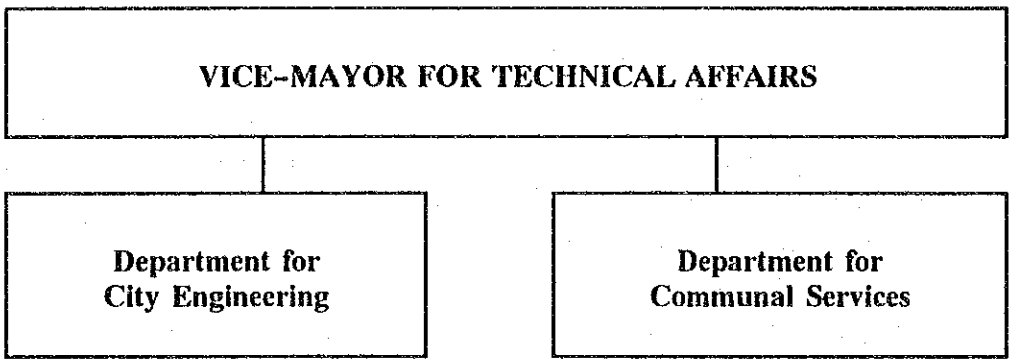
With the proposed fee collection system, it is possible for the Municipality to engage a contractor for municipal services and, thus, apply competitive bidding.

4) Control and Supervision

By delegating main executive activities to the municipal companies, the Department for Municipal Solid Waste Management can exercise supervision and control over the activities. Also, it is recommended that complaints from citizens over municipal services are handled, investigated and solved by the Department.

5) Considerations on Changes in Municipal Organization in Poznan Municipality

As mentioned before, Poznan Municipality already consider changes in the municipal organization. Below, a proposed organization chart for the area under the Vice-Mayor for Technical Affairs is presented. The proposal is at an early stage, however, it indicates that the considerations are comply with the recommendations given by the JICA-Study Team.



Subordinate Departments:

- Roads and Bridges
- Traffic Engineering
- Water and Sewage
- Green Areas
- Municipal Forest
- Heat, Power and Gas
- Social Infrastructure
- Local Investments

Subordinate Departments:

- Municipal Transportation
- City Cleansing
- Municipal Residential Buildings
- Communal Service

Fig.I.5.5-1 Proposal for New Organization under Vice-Mayor for Technical Affairs

The proposed new structure will be developed in two stages as above. The structure will strengthen the management of the area and relive the work load of the Vice-Mayor. Whether, the change will be made into one or two portions is under discussion. The appointment of technical chief(s) (City Engineer) under the Vice-Mayor will also strengthen the technical management of the City.

6) Organization of Department for Municipal Solid Waste Management

The Department for Municipal Solid Waste Management is proposed to consist of the following three sections supported by a general office:

- SECTION FOR PLANNING AND TENDERING responsible for elaboration of waste management plans, regulation, budgets and preparation of tenders of municipal waste services. This section will also participate in localization of waste facilities and be responsible for assistance to and control of municipal companies.

- SECTION FOR MUNICIPAL WASTE SERVICE responsible for municipal waste services including registration of participants in compulsory municipal waste services and collection of fees.

- SECTION FOR PUBLIC CLEANSING MONITORING responsible for control and monitoring of the public cleansing including of illegal dumping, removal of wrecked cars, cleaning of illegal dumping sites etc. This section could operate a "hot line" for citizen's complaints/information.

The present district offices should be maintained connected to the section for Public \cleansing Monitoring.

For duties related to municipal waste services there may be an initial heavy working load building up the computerized registration and fee system. Also when tender documents are prepared it may be necessary to assign consulting companies for assistance.

We consider the following staff appropriate for the Department for Municipal Solid Waste Management:

- General Office
  - . head of Department
  - . Assisting Head of Department
  - . Secretaries

- Planning and Tendering
  - . Head of Section
  - . Planners
  - . Engineers responsible for tendering and control of municipal companies
  - . Draughtsmen
  - . Secretaries

- Municipal Waste Services
  - . Head of Section
  - . Accounts
  - . Clerks
  - . Secretaries

- Public Cleansing Monitoring
  - . Head of Section
  - . Engineers
  - . Secretaries

I.5.6 Finance

1) Targets

In accordance with the Master Plan targets, the following targets were set up for the formulation of the financial system.

- To establish independence of financial source
- To establish the fair fee collection system
- To promote more privatization

In order to promote the above mentioned targets, the following measures should be taken.

- To improve the municipality's MSW managerial and supervising capabilities.
- To establish a rate the citizens can afford.
- To make the collection of the municipality's responsibility.

2) Allocation of Cost

a. Principle of cost allocation

In accordance with the "Polluter Pay Principle", the fee system based on the weight of waste amount discharged will be introduced by 2010. The allocation of MSWM cost is shown in Table I.5.6-1.

Table I.5.6-1 Allocation of MSWM Cost

Payer	Costs to be shouldered
Citizens	Collection, haulage, treatment and disposal of wastes discharged from households.
Enterprises	Collection, haulage, treatment and disposal of wastes discharged from enterprises.
Public authorities	Collection, haulage, treatment and disposal of wastes discharged from public areas such as roads, parks, squares, and public recycling centres.

b. Criteria of Affordability

The affordability of citizens and the municipality was estimated and the following guideline was set up for the formulation of the financial plan.

Table I.5.6-2 Affordability

Payer	Payable Amount
Citizen	less than 1 % of the total income
Municipality	less than 5 % of the total budget

In case their allotments exceed the above criteria, some modifications on the Master Plan such as postponement of implementation are required.

c. Items to be paid by Citizens

Citizens shall bear the following costs:

- collection fee
- solid waste tax
- bulky waste collection fee
- purchase of 110 l dustbins

*1 Collection fee is calculated based on collection cost.
*2 Solid waste tax is calculated based on treatment and disposal costs.

d. Items to be paid by Municipality

The Municipality shall bear the following costs:

- Investment costs of public recycling centres
- O & M cost of Public recycling centres
- Cost of public cleansing works
- Cost of supervision
- Subsidy for purchasing containers required through introduction of separate collection

3) Financial Sources

a. Basic conditions

The following institutions were assumed to be involved in MSWM:

[1] MSWM department in Poznan Municipality
[2] Rethman-Poznan Waste Management Co., Ltd
[3] Poznan Treatment and Disposal Company
[4] Others

Costs are allocated as shown in Table I.5.6-3

Table I.5.6-3 Allocation of MSWM Cost

Type of operation	Investment	O & M	Remarks
Regular collection	[2],[4]	[2],[4]	Municipality sublet this to contractors.
Bulky waste collection	[1]	[1]	Shouldered by bulky waste collection fee.
Public recycling centres	[1]	[1]	
Treatment	[3]	[3]	
Disposal	[3]	[3]	
Public area cleansing	[4]	[4]	Municipality sublet this to contractors.

*1 The municipality of Poznan is responsible for fee collection from householders, shops, etc.
*2 The municipality of Poznan subsidizes the O & M cost of public recycling centres.
*3 Regular collection work and public cleansing work are sublet to contractors.
*4 The municipality of Poznan pays contract fee for collection work to Rethman-Poznan Waste Management Co., and Rethman-Poznan Waste Management Co., pays fee for treatment and disposal to Poznan Treatment and Disposal Company.
*5 Poznan Treatment and Disposal Company gets income from selling heat and treatment and disposal fee.

b. Money Flow and Financial Source

Overall money flow for MSWM is presented in Fig.I.5.6-1.

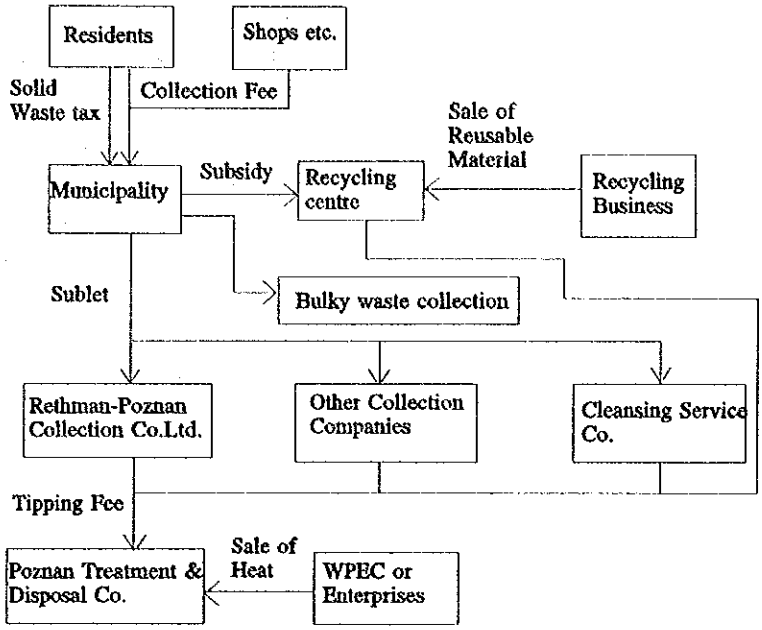


Fig.I.5.6-1 Money Flow for to MSWM

4) Fee System

The fee system consists the following:

- Collection fee
  - . Regular collection fee
  - . Bulky waste collection fee

- Treatment and disposal fee
  - . Standard fee
  - . Special fee

*1 Collection fee refers to regular collection fee and bulky waste collection fee. Regular collection fee is the fee for regular household waste collection. Bulky waste collection fee is charged to the discharger of bulky wastes.

*2 Treatment and disposal fee refers to standard fee and special fees. The special fees are charged for sewage sludge and hospital waste. The standard fee is charged for common household waste.

*3 Tipping fees, including treatment and/or disposal costs, shall be the same at the incineration plant and landfill to avoid waste flow concentration in either areas.

*4 The charging of special fees shall be implemented when operation of the incineration plant starts.

5) Implementation of Fee Collection System

a. Unit of fee

- Fees shall be collected directly
- Department of MSWM in the municipality is responsible for collection of fees
- Poznan Treatment and Disposal Company is responsible for treatment and disposal fees

Advantages and disadvantages of various fees are summarized in Table I.5.6-4.

Table I.5.6-4 Comparison of Fees

Type of Fee	Advantages	Disadvantages
Poll fee	- Unit can be identified distinctly.	- Waste amount variation due to income level can not be taken into account. - More burden on lower income people.
Tax based on income	- Waste amount variation due to income level can not be taken into account. - Cost of fee collection can be saved.	- Waste amount variation due to number of dischargers can not be taken into account. - People pay less attention to SWM.
Combination of Poll fee and tax based on income	- Waste amount variation due to number of dischargers can be partially taken into account.	- Implementation method is complicated.
Based on weight of waste	- Reasonable system.	- There are many problems on weighing waste. - Big investment is necessary to introduce weighing system.

Every fee collection system has its advantages and disadvantages. A fee collection system according to weight of waste discharged should be introduced by 2010 in order to maintain equality. However, the waste fee system based on the number of persons and waste tax based on their income were proposed, because there are many difficulties involved in introducing the former.

b. Methods of fee collection

The methods of fee collection are presented in Table I.5.6-5

Table I.5.6-5 Methods of Fee Collection

Type of Fee	Unit of Fee	Method of Fee Collection
Household	poll	Collectors collect fees once a month.
Shop	floor area	Collectors collect fees once a month.
Market	weight	Collectors collect fees once a month.
Bulky Waste	weight	After a collection worker issues an invoice to the discharger when waste is collected, collectors collect its fee within a week.
Solid Waste Tax	income	Solid waste tax is included in local tax.
Treatment and Disposal Cost	weight	Waste is weighed at the reception areas of facilities. Collectors collect fees once a month.

In accordance with the Master Plan targets, the following targets were set up for the formulation of the financial system.

- To establish independence of financial source
- To establish the fair fee collection system
- To promote more privatization

In order to promote the above mentioned targets, the following are required:

- To expand the control and supervision capabilities of the municipality related to MSWM.
- To establish a reasonable fee collection system.

I.5.7 Laws and Regulations

The Polish legislation is appropriate and the authorities involved are handling their duties in responsible.

Due to the complete reformation of the Polish society decentralizing a centralised government, not all formalities and tools are introduced for the new institutional system. Also, concerning privatization and the municipalities' possibilities to act in private business function the laws should be reviewed by the ministries responsible.

Section I.3.1 outline appropriate actions to be taken at a regional and national level in order to provide an appropriate frame for local governments MSWM. Provided these measures are taken, the municipalities are allowed for an improved, cost effective planning and execution of the services.

Local Regulations

For Poznan Municipality a possibility to enforce obligatory participation of households in waste collection and to control the waste flow from industries and commercial activities, will allow for an optimum MSWM.

With introduction of the Master Plan, a new set of local regulations are required to determine the obligations of the waste producers and the Municipality.

There are several ways to work out regulations and it is found appropriate to elaborate the following:

- Households (covering household waste and bulky waste).
- Commercial enterprises.
- Hospital waste.
- Other waste.

The regulations must instruct the waste generators and define penalty areas.

The regulations are mainly used for administration of the services including decisions in cases where citizen or collector complain about the conditions. Normally, the regulation cannot be used for general information due to a technical and complicated languages. Thus, the regulations should be supported by more comprehensive information about the services.

As an example a list of content for regulation for households, the following can be provided:

1: Geographic area covered by the regulation.
2: Legislation in force.
3: Waste included in the regulation.
4: Waste not included in the regulation.
5: The collection service (segregation of the waste etc.).
6: The duties and responsibilities of the waste producer.
7: Number, purchase and maintenance of waste bins and containers.
8: Placing and use of waste bins and containers.
9: Fees.
10: Exemption.
11: Claims.
12: Supervision and control.
13: Coming into force.

I.5.8 Public Education

With the introduction of source separation, public education is significantly affect the results. Information must be addressed to the right target group, in the right amount, and at the right place and time.
Public education must be planned and executed at two levels:

- For the proper use of services, the information shall be directed to those involved. It shall include information on how to use the service given in pamphlets and stickers on containers and about results of the citizen's efforts and other motivative information published through mass media.

- For general understanding of environmental problems and individual obligations, mass events and media can be used. Mass events such as the Ecological Marathon, already introduced in Poznan, are recommendable.

Finally, with the introduction of the municipal companies for collection, treatment and disposal efforts towards schools can be put into operation. Visits from schools to landfill sites, incineration plants etc. can draw the attention of the new generation on important issues.

I.5.9 Training of MSWM Personnel

With the organization in municipal companies, the training of MSWM personnel can be highlighted and made into a regular activity. Generally, an initial upgrading is required followed by a regular, less intensive updating.

The need for training can be divided into two main categories:

- Business management. Training in modern (private) business environment designed for the chief level.

- Technical ability training addressed to administrative as well as operation staff.

Generally, in purchasing equipment and machinery it must be ensured that proper instructions are given by the suppliers to the staff. Especially, for the incineration plant, a comprehensive training programme must be included in the contract for the machinery, so the suppliers' experience is transferred to the operators. Therefore a smoother operation is expected.

I.6 Financial Plan

I.6.1 Required finance and its source

The required financial amount and its proposed sources are presented in Table I.6.1-1.

Table I.6.1-1 Required Financial Amount and Sources unit: mill.zl

	1994 - 2000	2001 - 2005	2006 - 2010	Total
Public Recycling Centres	17,644	5,864	5,394	28,902
Incineration Plant	539,155	252,770	252,770	1,044,695
Sanitary landfill	103,926	45,736	46,566	196,228
Bulky Waste Collection	640	640	640	1,920
Total	661,365	305,010	305,370	1,271,745
Budget of Poznan Municipality	18,284	6,504	6,034	30,822
Poznan Treatment & Disposal Co.	643,081	298,506	299,336	1,240,923
(long-term loan)	(379,155)	(252,770)	(252,770)	(884,695)

Note: - The cost of replacing old trucks for regular collection, road sweeping and public area cleansing is not included.
- Long-term loan is only for the incineration project. As for the sanitary landfill project, the investment for Section 1 will be covered by short term loan and the investment for Section 2 will be made by the internal reserves.

The required annual expenditure is presented in Table I.6.1-2.

Table I.6.1-2 Annual Expenditure unit: mill.zl

Category	1995	2000	2005	2010
Regular Collection	46,073	38,211	44,686	51,689
Public Recycling Centres	-	9,989	10,390	10,390
Incineration Plant	-	-	48,010	104,913
Sanitary landfill	15,034	14,884	15,393	14,291
Bulky Waste Collection, Road Sweeping and Public Area Cleansing	9,008	9,008	9,008	9,008
Total	70,115	72,092	127,487	190,291

Note: - O & M cost and depreciation are included in the figure above.
- Annual expenditures between 1995 and 2010 are presented in Table I.6.1-3 to --8.

Table I.6.1-3 Basic Calculation Data for Regular Collection Work

Year	Investment	Annual Expense		
		O & M	Treatment and Disposal	Depreciation
1995	-	46,073	20,249	-
1996	-	43,563	19,146	-
1997	-	40,973	18,007	-
1998	-	39,013	17,146	-
1999	-	38,635	16,980	-
2000	-	38,211	16,793	-
2001	-	39,770	57,754	-
2002	-	40,950	59,469	-
2003	-	42,176	61,250	-
2004	-	43,403	63,031	-
2005	-	44,686	64,895	-
2006	-	46,028	66,842	-
2007	-	47,368	68,790	-
2008	-	48,778	70,837	-
2009	-	50,222	72,934	-
2010	-	51,689	75,065	-

Table I.6.1-4 Basic Calculation Data for Public Recycling Centres

Year	Investment	Annual Expense		
		O & M	Treatment and Disposal	Depreciation
1995	6,508	0	0	0
1996	6,038	3,406	957	676
1997	3,718	6,472	1,919	1,292
1998	0	8,320	2,604	1,669
1999	0	8,320	2,644	1,669
2000	1,380	8,320	2,695	1,669
2001	1,380	8,320	9,171	1,669
2002	1,694	8,320	9,470	1,669
2003	940	8,320	9,720	1,669
2004	470	8,660	10,053	1,730
2005	1,380	8,660	10,336	1,730
2006	1,380	8,660	10,652	1,730
2007	754	8,660	11,002	1,730
2008	0	8,660	11,318	1,730
2009	940	8,660	11,684	1,730
2010	2,320	8,660	12,084	1,730

Table I.6.1-5 Basic Calculation Data for Incineration Plant

Year	Investment	Annual Expense		
		O & M	Treatment and Disposal	Depreciation
1998	97,940	0	-	0
1999	244,850	0	-	0
2000	146,910	0	-	0
2001	0	17,400	-	27,313
2002	0	17,400	-	27,313
2003	0	17,400	-	27,313
2004	0	17,400	-	27,313
2005	219,800	17,400	-	27,313
2006	0	29,000	-	41,967
2007	0	29,000	-	41,967
2008	0	29,000	-	41,967
2009	219,800	29,000	-	41,967
2010	0	40,600	-	56,620

Table I.6.1-6 Basic Calculation Data for Sanitary Landfill

Year	Investment	Annual Expense		
		O & M	Treatment and Disposal	Depreciation
1994	45,810		-	
1995	0	5,700	-	9,275
1996	0	5,650	-	9,275
1997	23,985	5,600	-	9,275
1998	4,700	5,570	-	13,975
1999	0	5,550	-	9,275
2000	28,370	5,550	-	9,275
2001	13,630*	4,350	-	14,559
2002	0	4,530	-	10,261
2003	21,785	4,700	-	10,261
2004	3,500	4,880	-	13,761
2005	6,585	5,050	-	10,261
2006	22,985	3,880	-	12,339
2007	3,500	4,080	-	12,824
2008	18,645*	4,280	-	9,324
2009	1,200	4,500	-	10,976
2010	0	3,360	-	9,726
2011	4,700	-	-	4,700

Note: Investment for replacing old equipment is included.

Table I.6.1-7 Basic Calculation Data for Bulky Waste Collection Work

Year	Investment	Annual Expense		
		O & M	Treatment and Disposal	Depreciation
1994	640	0	0	0
1995	0	926	249	82
1996	0	926	254	82
1997	0	926	258	82
1998	0	926	261	82
1999	0	926	266	82
2000	0	926	270	82
2001	640	926	924	82
2002	0	926	954	82
2003	0	926	979	82
2004	0	926	1,009	82
2005	0	926	1,039	82
2006	0	926	1,069	82
2007	0	926	1,099	82
2008	640	926	1,133	82
2009	0	926	1,168	82
2010	0	926	1,203	82

Table I.6.1-8 Basic Calculation Data for Road Sweeping Work

Year	Investment	Annual Expense		
		O & M	Treatment and Disposal	Depreciation
1995	-	8,000	212	-
1996	-	8,000	217	-
1997	-	8,000	222	-
1998	-	8,000	222	-
1999	-	8,000	227	-
2000	-	8,000	232	-
2001	-	8,000	237	-
2002	-	8,000	247	-
2003	-	8,000	252	-
2004	-	8,000	262	-
2005	-	8,000	267	-
2006	-	8,000	277	-
2007	-	8,000	287	-
2008	-	8,000	292	-
2009	-	8,000	302	-
2010	-	8,000	307	-

Based on the following conditions, the waste collection fee shown in Table I.6.1-9 were estimated.

- International lending agencies shall be the financial source of the incineration plant and the landfill project.
- Required internal rate of return is more than 15 %.
- Other projects should be self-financed.

Table I.6.1-9 Solid Waste Fee unit: zl/ton

	in 1992	1995 - 2000	2001 - 2010
Treatment and Disposal	117,000	139,000	537,000
Collection	278,000	314,000	314,000

[Calculation of Present Fees]

- Present collection fee: 7,800 zl/person/month
  7,800 zl/person/month ÷ (650 g/person x 365 days ÷ 12 months) = 395,000 zl/ton

- Present costs of SANITECH work
  Collection work: 31,399 zl/m^3 = 150,000 zl/ton
  Disposal work: 13,139 zl/m^3 = 63,000 zl/ton

- Present fees are estimated as follows.
  Collection work: 395,000 x 150,000 ÷ (150,000 + 63,000) = 278,000 zl/ton
  Disposal work: 395,000 x 63,000 ÷ (150,000 + 63,000) = 117,000 zl/ton

For the time being, a fee consisting of the fee based on the number of dischargers and the solid waste tax based on income is planned to be employed.

The waste fee list until 2010 is shown in Table I.6.1-10.

Table I.6.1-10 Waste Fee List unit: zl

Fee	unit	Present	1995 - 2000	2001 - 2005	2006 - 2010
Collection Fee					
- General Waste					
. Household	zl/person/month	5,500	5,635	5,635	5,940
. Shops	zl/m²/month	NA	1,210	2,420	2,910
. Market	zl/ton	NA	453,000	851,000	851,000
- Bulky Waste	zl/ton	-	625,000	1,023,000	1,023,000
Solid Waste Tax	zl/household/ month	-	8,290	27,920	33,580
Tipping Fee					
- Standard	zl/ton	117,000	139,000	537,000	537,000
- Special	zl/ton	-	-	1,790,000	1,790,000

Note:

- Collection fee for shops, market and bulky waste shall include collection, treatment and disposal costs.
- Collection fee for household waste shall include collection cost only.
- Solid waste tax shall include treatment and disposal costs.
- Collection fee shown at "present" excludes disposal cost from the Corporative apartments.

I.6.2 Money Flow

Overall money flow is presented in Fig.I.6.2-1.

The Municipality collects fees from householders. The expenses of the activities of Poznan Treatment and Disposal Company are covered by the sale of heat and tipping fees.

Estimation of profit and loss is presented in Table I.6.2-1.
Money flow table is presented in Table I.6.2-2.
This plan will enable a 100% self financing capability by 2010.

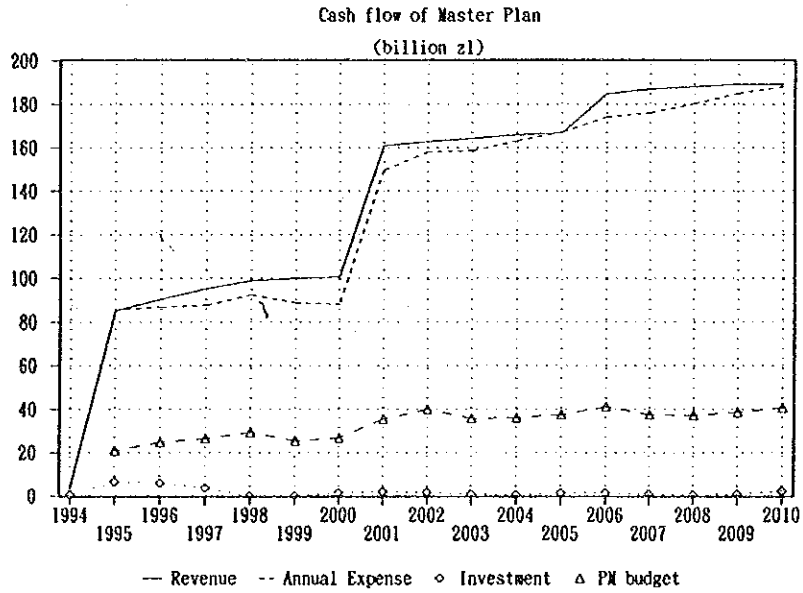


Fig.I.6.2-1 Overall Money Flow of Master Plan

Table I.6.2-1 Balance Sheet of SWM Master Plan

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Residencial B(mill.zl)	62,531	62,714	62,897	63,741	64,755	64,938	108,251	109,632	110,636	111,197	111,593	126,548	128,113	128,541	129,173	128,379
per Houth/month(1,000zl)	28.937	28.940	28.944	29.251	29.635	29.637	49.273	49.760	50.079	50.196	50.238	56.816	57.363	57.400	57.527	57.021
share(%) basic case	0.76	0.74	0.72	0.71	0.70	0.68	1.08	1.03	0.98	0.93	0.88	0.94	0.90	0.85	0.80	0.75
pesimistic case	0.76	0.74	0.72	0.71	0.70	0.68	1.09	1.06	1.02	0.98	0.94	1.02	0.99	0.95	0.92	0.87
Municipality B(mill.zl)	20,804	24,709	26,429	29,163	25,295	26,731	35,504	40,124	35,770	36,071	37,334	41,097	37,570	37,208	38,619	40,489
share(%) basic case	2.27	2.62	2.72	2.91	2.45	2.52	3.15	3.36	2.83	2.69	2.63	2.73	2.35	2.20	2.15	2.13
pesimistic	2.27	2.62	2.72	2.91	2.45	2.52	3.20	3.46	2.95	2.85	2.82	2.97	2.60	2.46	2.45	2.46

Table I.6.2-2 Overall Money Flow of SWM Master Plan

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Balance	0	-368	3,458	7,563	6,697	11,400	12,255	11,260	4,645	5,760	2,935	-14	10,677	10,971	7,763	4,431	1,067
Depreciation	0	82	758	1,374	1,751	1,751	1,751	1,751	1,751	1,751	1,812	1,812	1,812	1,812	1,812	1,812	1,812
Subtotal(C)	0	-286	4,216	8,937	8,449	13,152	14,007	13,011	6,396	7,511	4,747	1,798	12,489	12,783	9,575	6,243	2,879
Money Demand																	
Investment	640	6,508	6,038	3,718	0	0	1,380	2,020	1,694	940	470	1,380	1,380	754	640	940	2,320
Loan																	
Long Term	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short Term	0	0	926	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	640	6,508	6,964	3,718	0	0	1,380	2,020	1,694	940	470	1,380	1,380	754	640	940	2,320
Money Supply																	
Budget from PM**	0	6,508	6,038	3,718	0	0	1,380	1,380	1,694	940	470	1,380	1,380	754	0	940	2,320
from Inn.Fund	640	0	0	0	0	0	0	640	0	0	0	0	0	0	640	0	0
Long Term	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short Loan	640	286	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	1,280	6,794	6,038	3,718	0	0	1,380	2,020	1,694	940	470	1,380	1,380	754	640	940	2,320
Surplus of Money	0	-0	3,290	8,937	8,449	13,152	14,007	12,371	6,396	7,511	4,747	1,798	12,489	12,783	8,935	6,243	2,879
Reserved Fund	0	-0	3,290	12,226	20,675	33,827	47,834	60,205	66,601	74,112	78,859	80,657	93,146	105,929	114,864	121,106	123,986
Total of Debt	640	926	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

I.6.3 Amount Shouldered by Citizens and Poznan Municipality

Amount shouldered by citizens is presented in Table I.6.3-1.

Table I.6.3-1 Amount shouldered by Citizens

	unit	1992	1995	2000	2005	2010
Citizens' Cost-Burden						
- Solid Waste Tax	mill.zl	-	17,914	18,164	62,019	75,604
- Collection Fee	mill.zl	41,486	40,240	40,801	41,363	44,194
- Bulky Waste Collection Fee	mill.zl	-	1,129	1,225	2,330	2,700
- Dustbin	mill.zl	-	3,248	4,748	5,882	5,882
Total	mill.zl	41,486	62,531	64,938	111,594	128,380
Number of Family	nos	178,573	180,081	182,594	185,108	187,621
Burden per Family	zl	19,360	28,937	29,637	50,238	57,021
Average Monthly Income	1000 zl	3,824	3,792	4,335	5,723	7,556
Rate of Citizens' Cost-Burden	%	0.51	0.76	0.68	0.88	0.75

Amount shouldered by the municipality of Poznan is presented in Table I.6.3-2.

Table I.6.3-2 Amount shouldered by Poznan Municipality

	unit	1992	1995	2000	2005	2010
Municipality's Cost-Burden						
- Capital Investment	mill.zl	10,500	6,508	1,380	1,380	2,320
- O & M cost of P.R.C.	mill.zl	-	0	11,034	20,832	22,890
- Public Area Cleansing	mill.zl	10,100	8,213	8,233	9,039	9,196
- Control and Supervision	mill.zl	0	6,083	6,083	6,083	6,083
- Subsidies for Containers	mill.zl	0	0	0	0	0
Total	mill.zl	20,600	20,804	26,730	37,334	40,489
Budget of Municipality	bill.zl	916	916	1,062	1,421	1,902
Municipality's Cost-Burden	%	2.25	2.27	2.52	2.63	2.13

Note: * Subsidies for purchase of containers are required only in 1998, 2002 and 2006. They are, therefore, not shown in this table.

* The capital investment includes the construction cost of P.R.C., replacement cost of containers for P.R.C, and the first purchase cost of bulky waste collection equipment.

The rate of the municipality's cost-burden is shown in Table I.6.3-3.
Overall, the result proves that the estimated municipality's burden meet the criteria.

Table I.6.3-3 Defrayment of Residents and Poznan Municipality

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Residencial B(mill.zl)	62,531	62,714	62,897	63,741	64,755	64,938	108,261	109,632	110,636
per Houth/month(1,000zl)	28.937	28.940	28.944	29.251	29.635	29.637	49.273	49.760	50.079
share(%) basic case	0.76	0.74	0.72	0.71	0.70	0.68	1.08	1.03	0.98
pesimistic case	0.76	0.74	0.72	0.71	0.70	0.68	1.09	1.06	1.02
Municipality B(mill.zl)	20,804	24,709	26,429	29,163	25,295	26,731	35,504	40,124	35,770
share(%) basic case	2.27	2.62	2.72	2.91	2.45	2.52	3.15	3.36	2.83
pesimistic	2.27	2.62	2.72	2.91	2.45	2.52	3.20	3.46	2.95

2004	2005	2006	2007	2008	2009	2010
111,197	111,593	126,548	128,113	128,541	129,173	128,379
50.196	50.238	56.816	57.363	57.400	57.527	57.021
0.93	0.88	0.94	0.90	0.85	0.80	0.75
0.98	0.94	1.02	0.99	0.95	0.92	0.87
36,071	37,334	41,097	37,570	37,208	38,619	40,489
2.69	2.63	2.73	2.35	2.20	2.15	2.13
2.85	2.82	2.97	2.60	2.46	2.45	2.46

I.7 Selection of First Priority Project

1) Contents of the First Priority Project

Since the Poznan City Council approved the selection of the Alternative 5 in December 1992, the contents of the first priority project for feasibility study are as follows:

- Construction of 8 public recycling centres;
- Construction of Franowo–Michalowo incineration plant Phase 1; and
- Construction of Franowo–Michalowo sanitary landfill Section 1 (W1).

2) Preliminary Design

Franowo–Michalowo proposed disposal site located within 7 km from the centre of the city will make a considerable benefit by the reduction of the transportation cost comparing a remote disposal site out of the city border. On the other hand, it will require a strict environmental protection standard of the proposed facilities for obtaining both incineration plant and landfill at Franowo was conducted n order to meet with EC environmental standard. The images of the 3 projects are illus–trated in Plate 2,3 and 4.

ANNEX J

FEASIBILITY STUDY FOR THE FIRST PRIORITY PROJECT

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ANNEX J FEASIBILITY STUDY OF THE FIRST PRIORITY PROJECT

J.1 Preliminary Design of Technical System

J.1.1 Design Conditions

The following conditions are set up for formulation of the preliminary design.

- Waste categories for incineration
- Waste Amount for incineration
- Lower calorific value of waste incinerated

  . Upper limit value
  . Mean value
  . Lower limit value

1) Waste Categories for Incineration

The following wastes are planned to be treated with an incineration plant.

- Combustible components of municipal solid waste such as:

  . kitchen waste
  . paper
  . textile
  . plastic
  . leather
  . rubber

- Sewage sludge

2) Waste Amount for Incineration

The waste amount to be incinerated is planned as shown in Table J.1.1-1.

Table J.1.1-1 Design Waste Amount for Incineration

	Unit	1992	2001	2006	2010	2005
Total amount of combustibles	t/d	302.3	360.0	421.0	477.1	408.0
Incineration amount	t/d	0	159.0	318.1	477.1	159.0
Breakdown						
MSW	t/d	0	110.9	262.4	414.4	104.8
Sewage sludge	t/d	0	48.1	55.7	62.7	54.2
Incineration ratio	%	0	44.2	75.6	100.0	39.0

3) Lower Calorific Value of Waste for Incineration

The lower calorific value of wastes to be incinerated is presented in Table J.1.1-2.

Table J.1.1-2 Design Lower Calorific Value of Waste for Incineration

		1992	2001	2006	2010	2005
MSW	kcal/kg	2,199	2,270	2,309	2,338	2,300
Sewage sludge	kcal/kg	400	400	400	400	400

- The lower calorific value of MSW presented in ANNEX I.1.3 "Forecast for Waste Amount and Composition", is used.

- The datum in Japan is used for the lower calorific value of sewage sludge.

Table J.1.1-3 presents the design lower calorific values which was calculated by weighing average of those data.

Table J.1.1-3 Design Lower Calorific Value of Waste for Incineration

Year	1992	2001	2006	2010	2005
Waste Amount (ton/day)					
Incineration Amount	0	159.0	318.1	477.1	159.0
MSW	0	110.9	262.4	414.4	104.8
Sewage Sludge	0	48.1	55.7	62.7	54.2
Lower Calorific Value					
MSW (kcal/kg)	2,199	2,270	2,309	2,338	2,300
Sewage Sludge (kcal/kg)	400	400	400	400	400
Weighing Average (kcal/kg)	0	1,704	1,975	2,083	1,652

Although the data shown in Table J.1.1-3 represents the yearly mean lower calorific value of waste, in addition, the yearly fluctuation has to be taken into account.

The yearly fluctuation rate obtained by the survey are shown in Table J.1.1-4.

Table J.1.1-4 Fluctuation of Lower Calorific Value

	Summer	Winter
Upper	1.14	1.22
Mean	1.00	1.00
Lower	0.83	0.87

Based on the data in Table J.1.1-4, the design fluctuation rates are determined as follows.

- 1.22 for upper limit value
- 1.00 for mean value
- 0.87 for lower limit value

The lower calorific values were calculated and shown in Table J.1.1-5.

Table J.1.1-5 Lower Calorific Values

Year	Rate	1992	2001	2006	2010	2005
Lower Calorific Value			1,704	1,975	2,083	1,652
Upper limit	1.22	-	2,079	2,410	*2,514	2,015
Mean	1.00	-	1,704	1,975	*2,083	1,652
Lower limit	0.87	-	1,482	1,718	1,812	*1,437

Therefore, the design lower calorific values of wastes were determined as follows.

- Upper limit value : 2,500 kcal/kg
- Mean value : 2,100 kcal/kg
- Lower limit value : 1,300 kcal/kg

J.1.2 Intermediate Treatment: Incineration Plant

1) Introduction

Incineration is a hygienic and efficient method for waste treatment. The main reasons are as follows:

- Disinfection of the waste. The method reduces the risk of polluting ground water. Ground water pollution has caused serious epidemic in other cities.

- Substantial reduction of the weight (75% reduction) and the volume of combustible waste. The method reduces the pressure on finding areas for new landfills and is prolonging the life of existing landfills.

- Production of heat. Energy from waste incineration can be utilized for the production of district heating and/or electricity. The income from sale of energy contributes to the economics of the plant.

Modern waste incineration and flue gas cleaning technology make minimization of emissions and the location of incineration plants even in urban areas, possible, leading to reduced waste transportation costs.

Due to results from earlier surveys on Polish municipal waste (low calorific value, caused by high moisture content and contents of soil and ash from heating) incineration is up to date considered not suitable for Polish conditions. However, the waste composition survey carried out by this study proved the present calorific value of municipal solid waste from Poznan to be adequate for incineration.

From a national point of view, the following aspects should be included in the considerations on introducing waste incineration in Poznan:

- Waste is a resource to be utilized as a new raw material for energy.

- Energy produced on waste will save fossil fuels, thus, extending the life time of these fuels. In Poland, the save in fossils can be exported creating an income to the national economy.

Like in most countries, aspects of energy production from waste incineration should therefore be included - in Poland especially due to the present economy.

From a municipal point of view, the following aspect should be included in the considerations:

- Utilization of energy is a source of income reducing the deficit to be covered by the waste treatment, thus reducing the fees to be paid by the citizens.

As Poznan City operates a network for district heat distribution, heat production is very likely a most feasible solution, considering an increased general welfare of the country leading to higher calorific value of municipal waste.

2) Design Data

Though incineration is a versatile treatment method, the waste to be incinerated has to meet some basic requirements. The main requirement concerns the lower calorific value of waste. Another requirement is that bulky combustible waste must be reduced in size by shredding prior to combustion.

Calorific Value

In relation to this study, surveys on waste composition and quantity have been carried out in June and December 1992. The results are presented in ANNEX H. The calorific value has been measured as follows:

Table J.1.2-1 Calorific Value of Waste from Poznan City

Waste Type	Waste Amount (ton/day)	Lower Calorific value, kcal/kg	
		June 1992	December 1992
Domestic Waste	283.2	1,576	2,034
Market Waste	6.0	536	1,110
Commercial Waste	32.5	1,126	2,004
Institutional Waste	9.3	2,987	2,870
Weighing Average	331	1,553	2,038

Generally, waste with a calorific value of more than 5,000 kJ/kg (1,200 kcal/kg) can be combusted without use of auxiliary fuel. However, the incineration plant must be specially designed for such low calorific waste. For the function as well as for the feasibility of the incineration plant, higher calorific waste values are preferred.

For Poland and Poznan Municipality, the energy aspects must be included in the total evaluation of the feasibility of incineration. Poland and Poznan Municipality cannot afford to implement waste incineration based on the environmental benefits only. In fact, the financial result (the waste treatment fee balancing the budget) will be decisive for the decision.Thus, the highest possible calorific value of the waste should be aimed at.

There are a number of methods to increase the calorific value of waste which is brought to an incineration plant. Some of these methods are mentioned below:

- Separate collection system for the higher calorific municipal wastes could be introduced. This system is supposed to remove ash and soil from waste taken to the incineration plant.
  Also, separate collection of vegetable matter may be considered. This option has the possibility of combining well with proposals for compost-ing the vegetable fraction. However, the cost of separate collection systems is high and the total financial viability of such a scheme would require a careful study.

- Municipal waste could be supplemented with selected high calorific value wastes from industry and commerce, such as paper, cardboard, plastics, etc. Alternatively, the problem with the low calorific value of the waste could be solved by using supplementary fuels.

- A feedstock preparation plant could be installed to process the municipal waste prior to incineration. Such a plant would have to be adapted to the conditions in Poznan, but would likely include a screening plant to separate material less than about 50 mm in size, which would comprise mainly ash, soil and glass.

It should be noted that an incineration plant operates satisfactorily only within a spectrum of calorific values and that the plant should be designed according to the expected characteristics of the waste.

Forecasts for the waste composition has been prepared in ANNEX I.1.5. The forecasts are based on developments in Western Europe and linked with the anticipated changes of lifestyle, economic and social conditions in Poland.

The following determination of the capacity of the incineration plant is based on an assumed average calorific value of 2,100 kcal/kg in 2010. The plant must be capable of accommodating a possible future increase of up to 2500 kcal/kg and must also be able to incinerate waste with a calorific value down to 1300 kcal/kg.

Working Hours

It is assumed that the incineration plant will be operated 24 hour/day, 7 days a week: 6 shifts are required.

The number of effective operation hours per year is calculated as follows:

- Hours per year	8,736
- 2 stops per year, each 3 weeks	- 1,008
- Additional small stops (4 weeks)	- 672
Effective operation hours per year	7,056

Thus, the annual operational availability of the plant is assumed at 7,000 hours per year.

Waste Quantity

Forecast on the quantity of combustible waste to be treated at the incineration plant is presented in ANNEX I.1.5. The main figures appear in the Table below assuming the incineration plant starts operation in year 2001.

Table J.1.2-2 Quantity of Combustible Waste from Poznan

Year	Combustible waste from Poznan (tons/year)
2001	131,000
2006	154,000
2010	174,000

3) Required Capacity

The required capacity of the incineration plant is calculated based on the following preconditions:

- Waste quantity: 174,000 tons/year in year 2010.
- Calorific value of waste: 2100 kcal/kg in year 2010.
- 7,000 operation hours per year
- 20% monthly variation in generated waste quantity.
- The required capacity of the incinerators is specified at a calorific value of 2100 kcal/kg.

Required capacity: $\frac{17{,}400 \times 1.20}{7{,}000} = 30$ *tons/hour*

or 3 incineration lines each 10 tons/hour.

The construction of the incineration plant is recommended to be carried out in 3 phases based on financial considerations.

Phase 1 comprising:

- 1 incineration line including machinery for flue gas cleaning, energy production, etc.

- All building facilities for 3 incineration lines.

Phase 2 comprising:

- 1 incineration line including separate line for flue gas cleaning and energy production.

Phase 3 comprising:

- 1 incineration line including separate line for flue gas cleaning and energy production.

Alternatively, the plant might be built in 2 phases, allowing for 2 incineration lines in Phase 1. This alternative is more attractive from a technical point of view, since the whole plant need not to be closed in case one incineration line has a break down.

4) Localization of Incineration Plant

An area of approx 180 ha situated at Franowo–Michalowo has been selected by the Municipality of Poznan for a future sanitary landfill and for future waste treatment plants.

The required area for the proposed incineration plant is estimated at 5 ha.

The location for the incineration plant has been selected due to advantages as follows:

- The Site is located at a distance of approx. 1 km from apartment buildings to the north–east and approx. 1 km from an residential area south of the site. Thus, the selected site will take due consideration to the most important residential areas.

- Geotecnical investigations carried out for the Site implies an upper, 12 m thick layer of sand. Thus, the Site is less appropriate for the construction of the sanitary landfill. Other parts of the selected area of 180 ha are considered more appropriate for the construction of the sanitary landfill since they comprise boulder clay.

- The Site is located next to the area planned for the sanitary landfill. Thus, the distance for transport of slag and ash from the incineration plant is minimized.

- The Site is located next to an existing main road. Thus, the length of the new access road to the incineration plant is minimized.

The proposed location of the incineration plant is shown in Fig.J.1.2–1.

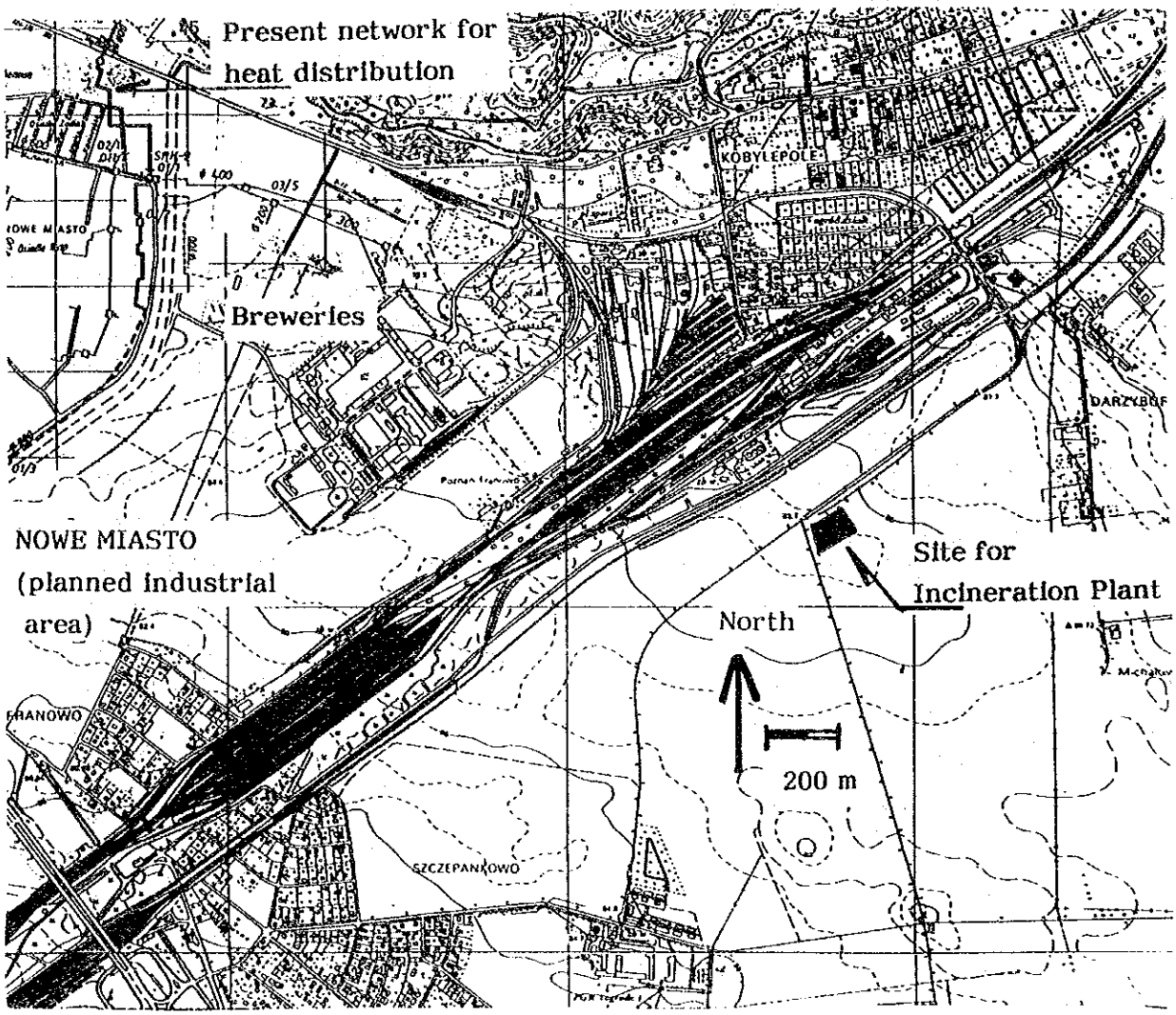


Fig J.1.2-1 Location of the Site for the Incineration Plant.

5) Sale of Energy

a. Conditions for Sale of Energy

The present conditions for sale of heat and electricity to Poznan City are in short described as follows:

- The supply of electricity is covered by the national network. Poland is producing and exporting electricity.

- Approximately 60% of the population of Poznan (590,000) is supplied by heat from the heat distribution network that is operated by the municipal heat supply company, PEC.

This network is supplied with heat from the following sources:

- The district heating plant Karolin (630 MW).
- The district heating plant Garbary (245 MW).
- Approx. 300 local heating plants (total 320 MW).

- In 1991, a total of 8,760 TJ heat was distributed by PEC. The monthly fluctuation appears in Fig.J.1.2-2.

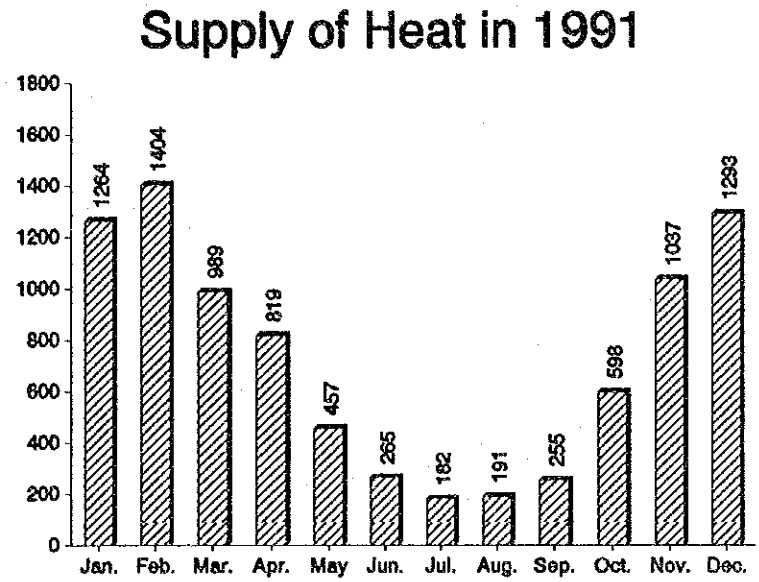


Fig.J.1.2-2 Supply of Heat to the City of Poznan in 1991

- Approximately 40% of the population of Poznan independently produces heat from coal, cokes, etc.

- The former plan for the City included the construction of a new district heating plant at Franowo-Michalowo. All former plans, however, were cancelled after 1989.

- The new plan for the City includes the construction of a new industrial area (Nowe Miasto) west of the recommended incineration plant. New plans for heating plants have not been drawn yet.

The location of the incineration plant at Franowo-Michalowo combines well with the present planning comprising the new industrial area, Nowe Miasto.

Because of the well-established network for district heating in Poznan, and the present situation of surplus production of electricity in Poland it is considered feasible that the waste incineration plant produces district heating only.

Based on the forecasts for waste quantity and composition (refer ANNEX I.1.5), the estimated heat production from the incineration plant appears in Table J.1.2-3. 80% of the energy comprised by the waste is assumed to be utilized.

Table J.1.2-3 Estimated Input and Output for the Incineration Plant.

Year	Waste received		Heat for sale TJ/year
	ton/year	Calorific value (kcal/kg)	
2001	58,000	1,700	332
2006	116,000	1,970	769
2010	174,000	2,100	1,215

The monthly consumption of energy supplied by the PEC- network was in 1991 more than 180 TJ per summer month.

Assuming 174,000 ton waste per year is incinerated in year 2010 the heat for sale is calculated at 120 TJ/month. This quantity of heat can be utilized even in the present PEC-network. Thus, it should not be necessary to dispose combustible waste on the landfill even in the summer month if 3 lines (3 x 10 tons/hour) are operated.

b. Substitution: Incineration Plant / District Heating Plant

As Poznan City operates a network for district heat distribution and the waste incineration plant is proposed to be erected near a developing industrial area, it is assumed that the heat from the waste incineration plant may substitute heat from the planned district heating plant at Franowo-Michalowo.

Therefore, it is considered appropriate that the price for heat from the waste incineration plant is compared with the real price for heat from a district heating plant based on coal.

Initial investments and operation costs for the district heating plant to be substituted are calculated as follows. All estimates are elaborated assuming price level as described in Annex I.1.5.

c. Design Data, District Heating Plant

A future district heating plant is assumed substituted by the proposed waste incineration plant, capacity 174,000 tons/year. The calorific value of waste is assumed at 2,100 kcal/kg in year 2010.

The effect of the corresponding district heating plant is calculated as follows, assuming 7,000 working hours/year and a thermal plant efficiency of 0.8:

$$\text{Effect:} \quad \frac{174{,}000 \times 0.8 \times 2{,}100 \times 4.19}{7{,}000 \times 3{,}600} = 50\ MW$$

d. Initial Investment, District Heating Plant

Based on the required effect of the district heating plant and the price level for coal based district heating plants in Western Europe, the initial investment for the district heating plant (50 MW) is estimated as follows:

Table J.1.2–4 Initial Investment for 60 MW District Heating Plant

Mechanical and electrical equipment and civil works	Price level in:	
	Western Europe mill. USD	Poland mill. Zl
TOTAL: Investments	10.0	58,000

Note: Investments for purchase of land and connection fees (sewerage, electricity, water, etc.) are not included.

e. Operation Costs, District Heating Plant

The operation costs for the district heating plant are estimated as follows:

Table J.1.2-5 Operation Costs for 50 MW District Heating Plant

Operation costs, average for period 2000 to 2010	Price level in Poland mill. Zl/year
Labour Costs (25 persons)	3,248
Coal[a]	31,320
Disposal costs for residues[b]	928
Maintenance	4,640
Administration	6,264
TOTAL, Annual operation costs	46,400

Note:

(a) Corresponding to the proposed waste incineration plant it is assumed that the average sale of heat during the period 2,000 to 2010 will be 1 mill.GJ/year. The coal price is assumed at 2 USD/GJ.

(b) Disposal costs assumes existing Polish price level at 33,000 Zl/tonne residue. This rate may go up as more constraints are put on landfills.

5) Technical Description

Several incineration technologies have been developed, but today the most appropriate is considered to be the movable grate incineration system based on mass burning of waste without pre-treatment (except for shredding of bulky combustible waste). The moving grate incinerator is very versatile and tolerates large variations in waste composition.

Other incineration technologies, such as those applying fluidized bed incinerators, have been developed, but due to technical problems, high costs, and limited data and experience, the movable grate incineration system based on the mass burning principle is considered as most reliable.

The movable grate incinerator revolves and transports wastes slowly through the furnace. The first section of the grate dries waste, while ignition, combustion and burn-out are carried out in the following grate sections. The air needed for combustion is added through the grates and via injectors above the waste. In the incinerator, waste is burned at a minimum temperature of 850°C, to ensure that all odours are destroyed during the combustion.

The incinerator is followed by a unit like an electrostatic precipitator or a bag filter for collection of dust. Dust filtering has also proven efficient against emissions of most heavy metals.

During the past 5 to 10 years, the collection of dust has been supplemented by purification systems for removal of acidic components like HCl, HF and SO_2. These systems are usually either dry (injection of dry lime), semi-dry (injection of lime slurry),wet (scrubbing of the flue gas with water or a solution) or a combination of the three.

Conventional mass burning incineration of waste without prior sorting or shredding and with a movable grate incinerator is undoubtedly the most widely used and the best tested technology for the thermal treatment of waste. The combination of this with an advanced flue gas cleaning system has been developed and tested, and can meet the current technical performance and environmental standards required by EC (emission standards) on incineration of waste.

To exemplify the lay-out of a grate incineration plant, a more detailed description is presented in the following text. The numbers in parentheses refer to the items shown in Drawing C.1. Furthermore, reference is made to Drawings C.2 and C.3 presenting the lay-out and bird's eye view of the incineration plant.

The plant is furnished with 3 grate incinerator units each furnished with a boiler for production of hot water for district heating. Each incineration line is furnished with a semi-dry scrubber and a bag filter for flue gas cleaning.

It should be pointed out that the tender documents for the incineration plant in Poznan must be elaborated to encourage more contractors to participate in the tender. Thus, the following text purposes only to present an example of the proposed incineration plant in Poznan.

a. Reception Facilities

The reception facilities comprise:

- Access road
- Weigh bridge and weigh house
- Building for waste reception including paved area in front of the building facilitating easy access and unloading of the trucks

The building for waste reception shields against winds and secures that the working area is kept dry. The inlet of combustion air fans will be placed in the waste pit

hall which ensures that odours from the waste are burned as a part of the combustion process. Unpleasant odours from the plant are thereby reduced to an absolute minimum.

b. Waste pit

The waste pit is designed according to the following requirements:

- Since there is no collection during the weekend the silo must have minimum a volume which ensures that waste collected during weekdays and incinerated during the weekend can be stored before the weekend (3 days).
  The density of waste in the silo is assumed at 250 kg/m^3. The capacity of the waste pit is calculated as follows:

$$\frac{174{,}000 \times 1.20 \times 3}{0.25 \times 52 \times 7} = \text{min. } 6{,}900\ m^3$$

- A minimum volume which ensures that the nominal amount of waste can be received even with one line out of operation for a week.

- A width (min. 8 to 12 m) which ensures that an adequate mixing of the waste can be performed.

c. Waste cranes

Overhead cranes including drivers cabin are recommended for feeding the incinerator lines. The cranes must as a minimum have a capacity corresponding to the capacity of the incineration plant. The cranes will also be used for mixing the waste before feeding and for removing of waste from the unloading area. These functions will require additional capacity.

Two waste cranes each with the capacity of the total plant is recommended to secure that the total plant will not be stopped if one crane is out of order.

d. Incineration Lines

The following numbering of elements refers to Drawing C2.

The cranes carry the waste from the pit to the hopper (4) where it is transported via the chute to the grate (7). On the grate the waste is dried and burned at high temperature. Primary and secondary air are supplied to the combustion process to maintain the correct temperature and amount of oxygen in the furnace. When necessary, the primary air is pre-heated before it is injected into the furnace. When the waste is transformed into bottom ash it falls via the ash chute into the bottom as discharger(9). From here it is transported via a vibration conveyor belt (23) to the ash pit.

The elements are described more detailed as follows.

Reception Hopper (4)

Waste will be discharged by the crane into the reception hopper. The hopper will be located above the furnace. The upper end of the hopper will be curved outward to stiffen the hopper and catch dust and refuse.

Safety gates will be mounted in the sides of the reception hopper to prevent further charging after closing. The safety gates are activated by hydraulic cylinders. The gates act as safety devices in the plant process since the gates will automatically close if the temperatures in the boiler of the furnace exceed normal and remain in that position until normal conditions have been obtained. The functioning of the feed gates will be assured by a hydraulic accumulator which will be activated in the event of power failure.

Feed Chute (5)

The feed chute transports the waste from the hopper to the feed ram which will be mounted below the feed chute in the furnace. The chute acts as a storage bin for the refuse before it is fed into the grate.

During operation, the chute is filled with refuse, preventing intake of uncontrolled excess air through the chute. The chute will be attached to the furnace and will be shaped as a hopper with the larger opening against the furnace. This construction prevents the refuse from sticking in the chute. The chute will be constructed of steel surrounded by a welded jacket which forms a water cooling chamber. The double cooled walls will resist the heat stresses caused by the furnace.

Feeder (6)

The feeder consists of a cast iron platform and a hydraulically operated feed ram which pushes the waste into the first step of the grate and controls the amount of waste on the grate. The feed ram is equipped with flange wheels running on rails during the forward and backward motion. The speed of the feed ram is adjusted by a microprocessor located in the main control room.

Furnace and Refractory (7)

The furnace is a refractory lined fully welded membrane wall construction stiffened externally with buck stays and covered with insulation and cladding. It forms a strong gas tight enclosure.

The geometry of the furnace room must be selected according to the character of the waste. The basic requirements for the furnace are among others adequate temperatures (950–1,050°C) good mixing of the flue gasses in the furnace and correct heat load.

The furnace will have auxiliary oil fired burners for start up and controlled shut down periods and also to stabilize the furnace temperature if it should drop below 850°C during operation.

Grate (7)

The grate is one of the key parts of the system. It forms the bottom of the furnace and is installed at an angle of 25° to 30° to the horizontal.

The grate comprise a number of independent sections. In order to obtain an adequate drying and total combustion of the waste the grate will have a long drying/heating section.

Each grate section is equipped with a complete driving mechanism. Waste is fed through the furnace by the action of the grate. Due to the tilting action of the grate it causes considerable agitation of the waste as it moves through the furnace facilitating all waste to be fully burnt.

Each grate section is controlled from the main control room and operates at a variable speed, adapted to the character and quantity of the waste to be incinerated. All actuation and control equipment is located externally to the furnace. This will permit routine maintenance whilst in full operation.

Hopper for Grate Siftings (8)

A plate hopper is mounted under each grate section for the collection of grate siftings and for the distribution of the primary air.
Each hopper is furnished with an airtight inspection door. Under each hopper, a double flap valve is mounted to eliminate intake of uncontrolled air.

Bottom Ash Discharger (9)

Bottom ash from the grate is discharged through a chute which connects the furnace to the hydraulically driven bottom ash discharger.

The bottom ash discharger is equipped with internal spray nozzles to cool the ash with water before discharging to the conveyor system.

Primary Air (10)

Combustion air is injected into the furnace by primary and secondary combustion air fan operated by the microprocessor system.

The primary air is added through the grate to cool the grate systems. The air will be distributed by a duct system to the individual hoppers allowing independent regulation of the air supply to each grate section.

Secondary Air (11)

Secondary combustion air is injected at high velocities into the furnace through nozzles in the front and rear walls. The addition of secondary air through the nozzles creates turbulence in the stream and promotes the combustion of volatilizes in the gas.

Cooling Air (12)

To prevent thermal stresses, a centrifugal fan cools the grate-beams and the feed ram by blowing cooling air through pipes into the steel construction.

e. **Boiler (18)**

The boiler is a water tube boiler constructed with 3 vertical radiation passes with natural water circulation and 1 convection pass with forced water circulation. It is specially designed for operation in connection with a furnace for waste incineration.

Generally, the radiation part is dimentioned for the flue gas to have sufficient retention time ensuring an effective cooling of the flue gas and the particles before reaching the convection part. The temperature of the flue gas before the inlet to the convection part is kept at max. 600°C.

The first radiation pass serves as a secondary combustion chamber (after burning chamber) to ensure complete burn out of the flue gases. Refractory lining ensures a minimum gas retention time of 2 seconds at a temperature above 875°C after the last secondary air supply which takes place through secondary air nozzles placed at the inlet to the first pass.

The inlet area is restricted in order to obtain strong turbulence and good mixing of the flue gasses at Reynolds figures (R_e) larger than 60,000. This also reduces the risk of corrosion.

The velocity of the induced secondary air through the nozzles is kept rather high, about 50 m/sek. The flue gas velocity in the different passes is kept low, between 3,5–6 m/sek with the lowest velocity in the first pass. This reduces the risk of erosion and ensures a certain quantity of initial precipitation of fly ash.

The convection pass is constructed in one pass with strictly in–line tube pitches and sufficiently large heating surface to obtain a flue gas discharge temperature of 180°C at 130°C feed–water temperature.

The boiler plant is equipped with instrumentation, valves, and safety equipment according to the rules of the classification society.

Shot Cleaning (19)

In order to obtain long intervals between manual cleaning of the boiler, shot cleaning of the convection pass is arranged.

The transportation of the steel shots takes place pneumatically with a blower.

When cleaning is initiated a valve is opened, and the shots fall through distributor pipes and are spread over the heating surface. The shots are led from the dust hopper to the tank under the heating surface. The whole operation is automatically controlled with preset intervals.

Ash Hoppers (22)

The second and third radiation passes and the convection pass are furnished with ash hoppers.

Insulation

The boiler plant is insulated so that the surface temperature does not exceed 50°C at 20°C surrounding air.

The insulation is covered with a minimum 0.7 mm galvanized steel plate.

f. Bottom and Fly Ash Handling System

Pipe Vibration, Conveyor for Grate Siftings (21)

Furnace hoppers for grate siftings and boiler hoppers are equipped with vertical pipes, dual flap valves and heat-resistant flexible connections.

Via pipe vibration conveyors the ash is transported to the transverse vibration conveyor where it is moistened.

The pipe conveyor is made of closed through sections fitted with electric vibrators, shock absorbers and springs. The pipe vibration conveyor inlet is equipped with wear plate and access door.

Screw Conveyor for Fly Ash (22)

Ash is transported from the convection pass to the transverse vibration conveyor by screw conveyors.

The screw conveyor comprise a screw casing, a screw and a driving system.

g. Flue Gas Cleaning System

The proposed flue gas cleaning system comprises a semi-dry scrubber (a gas suspension absorber) and a bag filter.

The gas suspension absorber is located in between the incinerator and the dust and ash precipitator. It comprises:

- A cylindrical reactor (26).

- A separating cyclone (27) including a system for recycling of separated materials to the reactor (25).

- A slurry preparation system which proportions the slurry to the reactor via a spray nozzle.

The flue gases from the boiler are fed into the bottom of the reactor where they are mixed with vaporized lime slurry.

The hot gases dry the lime slurry and during the drying process the lime slurry undergoes a chemical reaction with the acid flue gases. thus capturing and neutralizing them.

The partially cleaned flue gases are passed on via the separating cyclone to a bag filter (28) which removes the dust and ash particles. The flue gases have now been cleaned to the following level:

- Dust: 15 mg/Nm^3
- HCL: 100 mg/Nm^3
- SO_2: 200 mg/Nm^3

(dry gas, 11 pct. 0_2)

The solids containing the removed substances and residual lime are separated in the cyclone. About 99 %. of the solids are fed back to the reactor via a screw conveyor, while only about 1 pct. leaves the system in the form of by-product.

The 99 % which is recirculated to the reactor is still reactive. This means that the recirculated lime is still able to react with and neutralize the acid gases in the flue gases.

Automatic Process Adjustment

An effective monitoring and control system automatically ensures the required level of cleaning while keeping lime consumption to an absolute minimum.

The main parts of the system comprise three control loops:

1. The first loop continuously controls the flow of circulating absorbent to the reactor based on monitoring of the amount of flue gas.

The large reaction area and even distribution in the reactor of the absorbent provides for efficient mixing of the lime with the flue gas. At the same time, the large volume of dry material prevents the slurry from adhering to the sides of the reactor.

2. The second control loop ensures that the flue gas is cooled down to a suitably low temperature in order to optimize the chemical processes. This is achieved by the addition of extra water through the lime slurry nozzle.
   It is important that the amount of water sprayed into the system is always matched to the volume and temperature of the flue gas as a too low temperature means a risk of acid condensation.

3. The third control loop controls lime addition. This is done partly by monitoring the flow of fly gas and its acid content and partly by continuous in-process comparison of the current level of cleaning with that required.
   These parameters are constantly monitored and are used by the control system to calculate the proportioning rate of the lime slurry pump.

h. Stairs, Ladders and Galleries

Stairs, ladders and galleries are going to be arranged in a way that entrance to cleaning and inspection doors, valves and instruments is ensured.
All ladders and galleries are constructed with a minimum width of 800 mm and designed for a load of 300 kg/m^2 and point load of 500 kg. As escape route all gallery levels are equipped with a common ladder.

Galleries and ladders are constructed with hot galvanized grates.

i. Auxiliary Equipment

This equipment includes:

- Instrumentation
- Monitoring and control system
- Hydraulic installations
- Compressor installations
- Low and high voltage installations
- Fire fighting installations
- Drainage systems
- Heating and air conditioning

- Lighting
- Cleaning facilities
- Supply systems (air, water, electricity, etc.)

j. Buildings and Site

The layout of the incineration plant is presented in Drawing C2.
The required buildings area is approx 5,000 m^2.

Furthermore, internal roads and open areas are required.

k. Waste Flow

Input to and output from the incineration plant is presented in Fig.J.1.2-3.

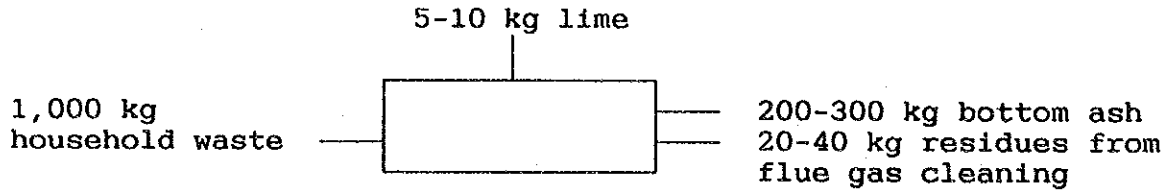


Fig.J.1.2-3 Input and Output by Weight from the Incineration Plant, assuming a Semi Dry Flue Gas Cleaning System

The waste reduction will typically be 75% by weight and 95% by volume of the quantity input.

Depending on the content of heavy metals in the incoming waste, the bottom ash may - after screening - be utilized for road building or filling materials.

6) Cost Estimates

Based on the described lay-out,of the incineration plant this Section presents cost estimates for the construction and operation of the incineration plant. All estimates are elaborated assuming price level as described in Annex I.1.5.

The initial investments for the described incineration plant (capacity 30 tons/hour at 2100 kcal/kg calorific value of waste) is estimated as follows:

Table J.1.2-6 Initial Investments for Incineration Plant: Capacity: 30 tons/hour

Descriptions	PRICE LEVEL IN WESTERN EUROPE MILL. USD	PRICE LEVEL IN POLAND MILL. ZL
Mechanical and Electrical works:		
- Furnaces, boilers, semidry flue gas cleaning system incl. bag filters, blowers and computerized operation/monitoring system:	35.0	
- Various machinery cranes, shredder, weigh bridge, compressors etc.:	3.2	
Civil works:		
- Construction works incl. waste silo, buildings (approx. 5,000 m^2), chimney, earth works, roads etc:		127,600
Design, supervision and training:	3.4	17,400
Miscellaneous 10%:	4.4	15,000
Extra work for 3 stages construction	3.0	0
TOTAL: Investments	49.0	160,000

Note: * Investment for purchase of land and connection fees (sewerage, electricity, water, transmission pipe for heat etc.) are not included.
* Turn over tax is included in the local portion amount.

Table J.1.2-7 Operation Costs for Incineration Plant: Capacity 30 tons/hour

Operation costs at 30 tons/hour	Price level in Poland mill. ZL/year
- Labour Costs (80 persons):	10,440
- Lime, electricity etc.:	13,920
- Disposal costs of residues:	2,320
- Maintenance:	10,440
- Administration	3,480
TOTAL: Annual operation costs	40,600

Note: Disposal costs assumes existing polish price levels at 33,000 zl/tonne residue. This rate may go up as more constraints are put on landfills.

The construction of the incineration plant is recommended to be carried out in 3 phases. The investments and operation costs are estimated as follows,:

Phase 1:

– 1 incineration line and other machineries	21 mill USD
– Building facilities for 3 incineration lines	160,000 mill ZL
– Operation costs for plant with 1 incineration line, capacity 10 tons/hour	17,400 mill ZL/year

Phase 2:

– 1 incineration line	14 mill USD
– Operation costs for plant with 2 incineration lines; capacity 20 tons/hour	29,000 mill ZL/year

Phase 3:

– 1 incineration line	14 mill USD
– Operation costs for plant with 3 incineration lines; capacity 30 tons/hour	40,600 mill ZL/year

7) Summary for Incineration Plant

Summary for the described incineration plant is presented in the Table below, including quantity of waste treated, sale of heat, investments and operation costs.

Table J.1.2–8 Summary for Incineration Plant, Capacity 30 tons/hour at 2100 kcal/kg, 3 lines in operation.

Capacity of plant at 7,000 operation hours/year		174,000 tons/year	
Investment		49.0 mill. USD + 140,000 mill. ZL	
Annual operation costs (average year 2001 to 2010)		33,000 mill. ZL/year	
Year	Waste received (tons/year)	Slag and ash (tons/year)	Heat for sale (TJ/year)
2001	58,000	19,700	332
2006	116,000	39,500	769
2010	174,000	59,200	1,215

The incineration plant is recommended to be constructed in 2 or 3 phases.
It is recommended that the heat from the incineration plant is substituted with heat from a district heating plant. In calculating costs and benefits, the real price for heat should be applied including world market price for coal and without subsidies for heat. The incineration plant is assumed to substitute the following district heating plant:

- Effect of the district heating plant 50 MW
- Average sale of heat during the period 2001 to 2010 is estimated at 1 mill GJ/year.
- Initial investment of plant: 10 mill USD + 58,000 mill ZL
- Operation cost of plant 46,400 mill Zl/year

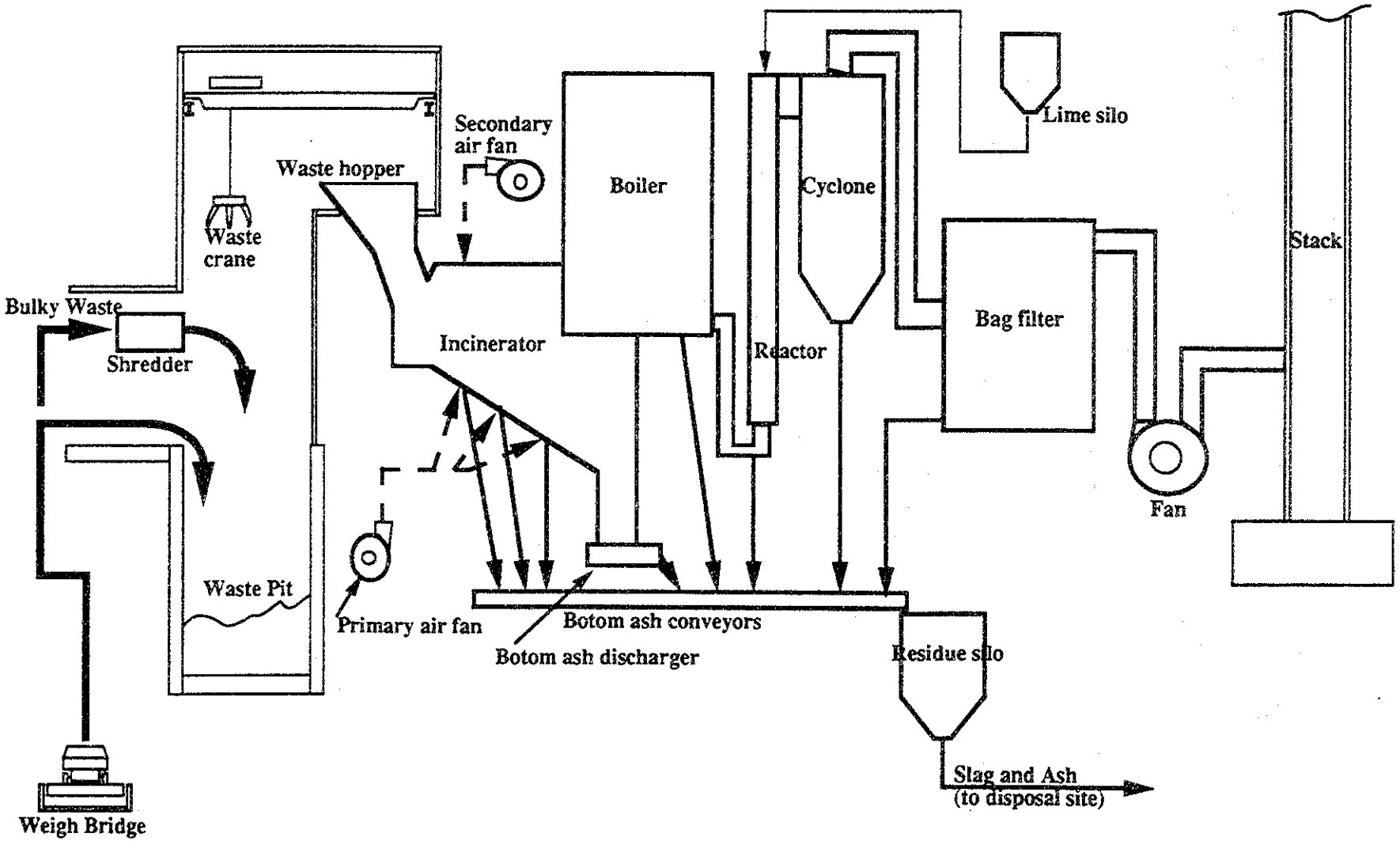
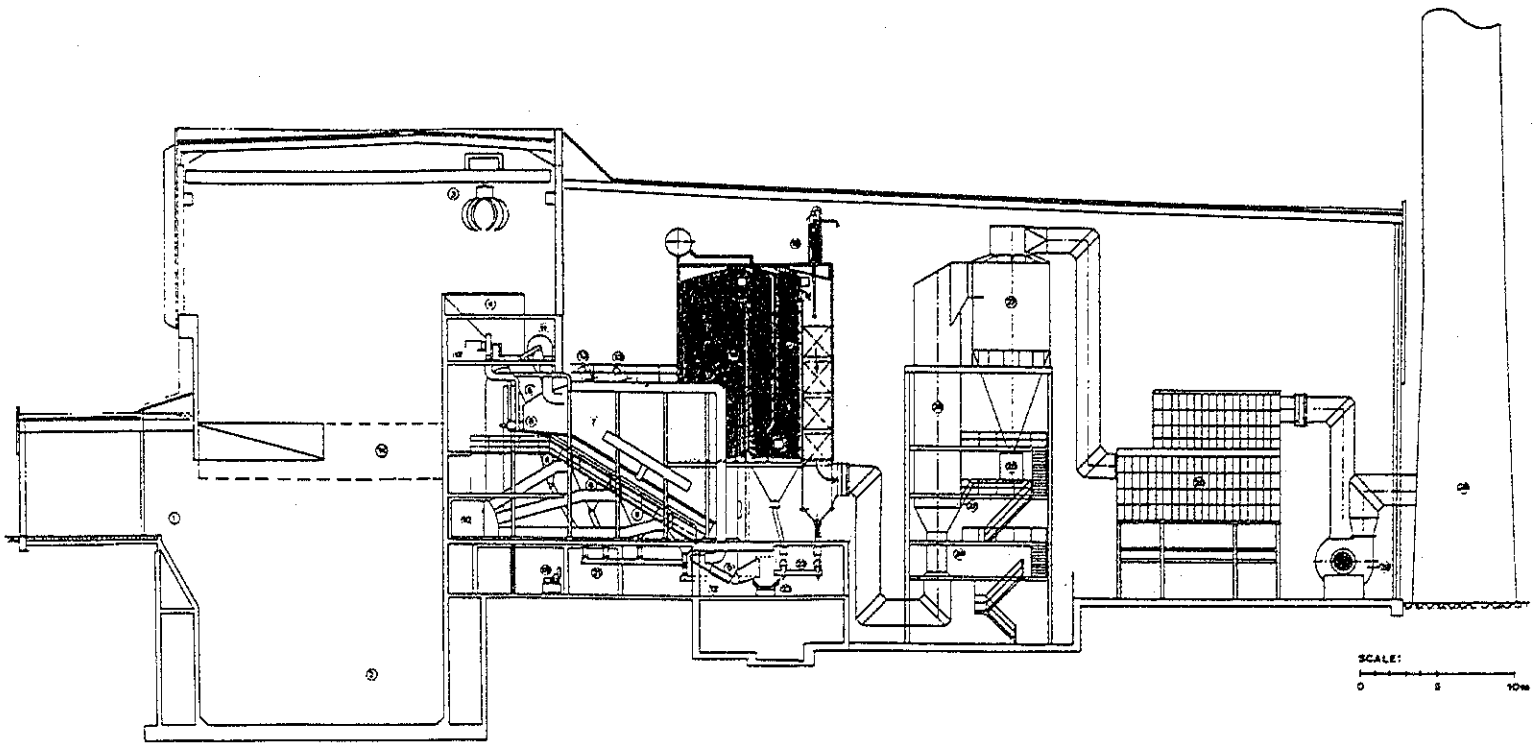


Fig.J.1.2–4 Flow Diagram of Incineration Plant



1.	Waste reception	14.	Control and operator room for cranes
2.	Waste pit	18.	Boiler
3.	Waste cranes	19.	Shot cleaning
4.	Waste hopper	21.	Vibration conveyor for grate shiftings
5.	Feed chute	22.	Conveyors for fly ash
6.	Feeder	23.	Bottom ash vibration conveyor
7.	Incinerator	24.	Slurry injection
8.	Hopper for grate sifting	25.	Recirculation of solids
9.	Bottom ash discharger	26.	Reactor
10.	Primary air with pre-heating	27.	Cyclone
11.	Secondary air fan	28.	Bag filter
12.	Cooling air fan	35.	Fan
13.	Burner (optional)	36.	Stack

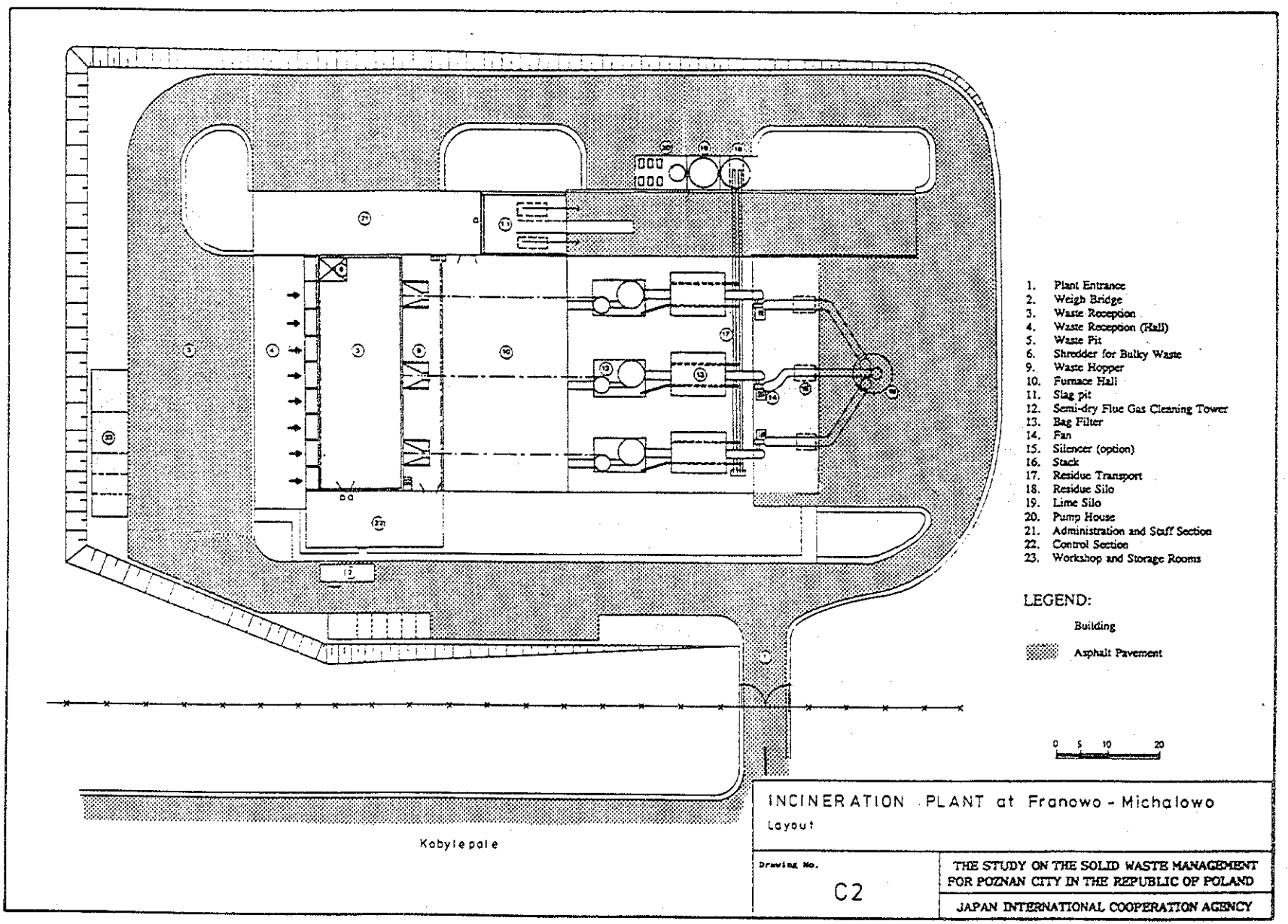
INCINERATION PLANT at Franowo - Michalowo

Sectional View

Drawing No. C1

THE STUDY ON THE SOLID WASTE MANAGEMENT FOR POZNAN CITY IN THE REPUBLIC OF POLAND

JAPAN INTERNATIONAL COOPERATION AGENCY


1. Plant Entrance
2. Weigh Bridge
3. Waste Reception
4. Waste Reception (Hall)
5. Waste Pit
6. Shredder for Bulky Waste
9. Waste Hopper
10. Furnace Hall
11. Slag pit
12. Semi-dry Flue Gas Cleaning Tower
13. Bag Filter
14. Fan
15. Silencer (option)
16. Stack
17. Residue Transport
18. Residue Silo
19. Lime Silo
20. Pump House
21. Administration and Staff Section
22. Control Section
23. Workshop and Storage Rooms
LEGEND:
Building
Asphalt Pavement
0 5 10 20
Kobyle pole
INCINERATION PLANT at Franowo - Michalowo
Layout
Drawing No.
C2
THE STUDY ON THE SOLID WASTE MANAGEMENT FOR POZNAN CITY IN THE REPUBLIC OF POLAND
JAPAN INTERNATIONAL COOPERATION AGENCY

J.1.3 Intermediate Treatment: Public Recycling Centres

1) Introduction

The purpose of introducing recycling centres is to make it easier for householders and small enterprises to get rid of their waste (e.g. bulky waste, garden waste, materials for recycling and hazardous waste), which is not collected as part of the regular service for kitchen waste.

Another purpose is to make sure that waste is separated into categories for maximum utilization (recycling, composting or incineration), and a minimum for dumping.

The recycling centres receive all types of waste, except kitchen waste. However, it is a condition that households separate their waste into the appropriate categories before delivery to the recycling centre.

The recycling centres will increase costs, but the important benefits will be;

- current illegal dumping may terminate,
- easy collection of recyclable materials from householders,
- incidences of hazardous waste mixed with kitchen waste may terminate.

2) Technical Description

The conceptual lay-out of a recycling centre is presented in Fig.J.1.3-1.

Bird's eye view of a typical recycling centre is presented in Plate 2.

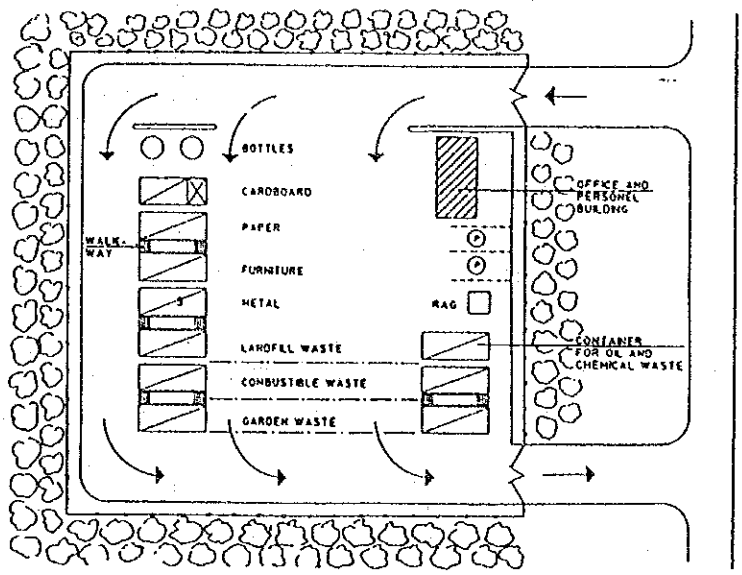


Fig.J.1.3-1 Conceptual lay-out of Recycling Centre

The recycling centre comprises:

- Covers an area of 2,000 to 3,000 m^2 depending on the number of house-holds to be served.
- Paved in asphalt, except for the parking area for containers which is paved in concrete.
- Covered with fences and plants.
- Installed with a guard house.
- Has 10 or more maxi containers (8 to 25 m^2) depending on the number of households to be served. These containers are collected by container hoist trucks.
- Has 2 or more mini containers (1.5 to 3 m^2), one for bottles and one for textiles.
- Has a storeroom or container for hazardous wastes (used oil, solvents, batteries, discarded medicine, etc.).

Each maxi container is designed differently facilitating households unloading of the different waste categories. It is assumed that the containers can be produced in Poland. A typical container equipment for a small and a large recycling centre is presented in Table J.1.3-1.

The recycling centre is staffed for control and guidance. It is open everyday, including weekends. Delivery of waste might be free of charge, except for waste from smaller enterprises, who may pay a fixed fee per load (adjusted to the landfill fee; so it is cheaper to directly dispose of one's waste to the landfill if the quantity is huge). It might also be possible to pay households for recyclable materials.

Table J.1.3-1 Container Equipping for a Small and Large Recycling Centre and Destinated Treatment

Waste type	Container equipping for recycling centre (nos.)		Destinated treatment
	small centre	large centre	
Bottles	mini container		Recycling
	2	4	
Metal, including refr-igerators, etc.	maxi container		Recycling
	1	2	
Textiles	mini container		Recycling
	1	1	
Cardboard	maxi container with compaction equip ment		Recycling
	1	1	
Paper (newspapers)	maxi container		Recycling
	1	1	
Garden waste	maxi container		Incineration or landfill
	2	4	
Furniture	maxi container		Landfill or incineration after crushing
	1	1	
Combustible waste, including plastic	maxi container		Incineration or landfill
	2	4	
Incombustible (soil and stone)	maxi container		Dump area
	1	2	
Chemical and oil	shed or container		Special treatment
	1	1	
TOTAL, nos. of containers	3 mini 10 maxi	5 mini 16 maxi	
Area required	2,000 m^2	3,000 m^2	

3) Design Data

In West European cities, one recycling centre is appropriate for every 10,–20,000 households. In this project it is decided to implement on centre for each 15,000 households (46,500 inhabitants). Eight recycling centres are planned to be provided to cover approximately 380,000 citizens.

Based on Western European experiences, the typical composition of materials collected at recycling centres is presented in Table J.1.3–2.

Table J.1.3–2 Typical Composition of Materials from Recycling Centres

Description		Destinated treatment
– Bottles	1.5 %	Recycling
– Textiles	0.5 %	
– Cardboard	1.0 %	
– Paper, incl. newspaper, etc.	3 %	
– Metal, incl. refrigerators, etc.	4 %	
– Garden waste, bulky	20 %	Composting, incineration or landfill
– Combustible, incl. furniture and plastic	35 %	
– Incombustible, soil and stone	35 %	

For this study the waste flow for recycling centres is assumed as follows:

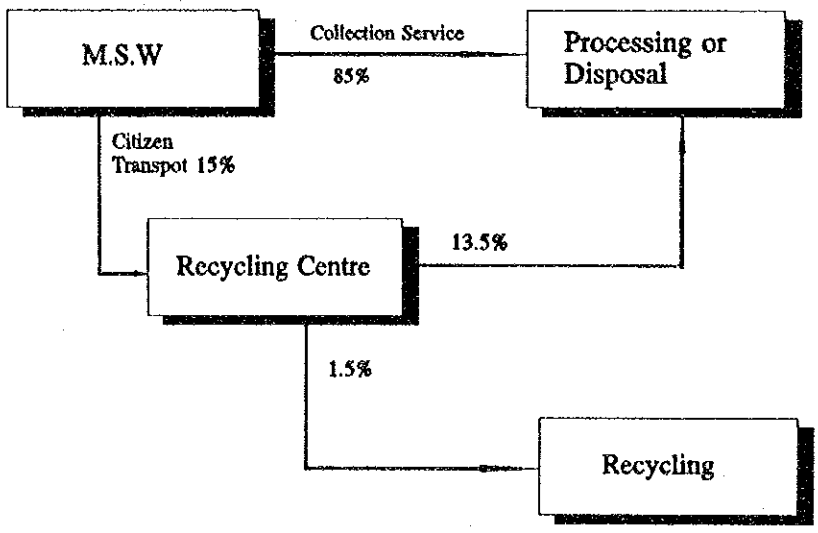


Fig.J.1.3–2 Assumed Waste Flow for Recycling Centres

4) Cost Estimates

Based on the lay-out described, this section presents the cost estimates for the construction and operation of recycling centres in Poznan.

The following size and capacity of the recycling centres have been implied:

Small recycling centre:

- Site of approx.: 2,000 m^2
- 10 maxi containers.
- 3 mini containers.

Large recycling centres:

- Site of approx.: 3,000 m^2
- 16 maxi containers.
- 5 mini containers.

All estimates are based on price level as described in ANNEX I.1.5.

Table J.1.3-3 Cost Estimates for Small Recycling Centre

Recycling centre, Type: Small (Site of 2,000 m^2, 10 maxi containers)	Price level in Poland, June 1992, mill. Zl
Investments:	
- Earthworks, 1,000 m^2 pavement and sewerage	580
- Fencing and planting	116
- Guard house (30 m^2)	174
- 10 maxi containers	348
- 3 mini containers	29
- Shed for hazardous waste	58
- Miscellaneous	319
TOTAL, investment	1,624
Annual Operation Costs:	
- Salary, 2 men 7 days a week	197
- Treatment costs for garden waste, combustible, soil and stone	406
- Maintenance of containers (7%)	29
- Maintenance of constructions (0.5%)	12
- Administration, 15% of above	110
TOTAL, annual operation costs	754

Table J.1.3-4 Cost Estimates for Large Recycling Centre

Recycling centre, Type: Large (Site of 3,000 m^2, 16 maxi containers)	Price level in Poland, June 1992, mill. Zl
Investments:	
- Earthworks, 1,500 m^2 pavement and sewerage	870
- Fencing and planting	151
- Guard house (30 m^2)	174
- 16 maxi containers	580
- 5 mini containers	46
- Shed for hazardous waste	58
- Miscellaneous	441
TOTAL, investment	2,320
Annual Operation Costs:	
- Salary, 3 men 7 days a week	290
- Treatment costs for garden waste, combustible, soil and stone	696
- Maintenance of containers (7%)	46
- Maintenance of constructions (0.5%)	12
- Administration, 15% of above	174
TOTAL, annual operation costs	1,218

5) Localization

For this study 8 recycling centres are planned to be build in Poznan.

The Municipality (Town Planning Office) has proposed 20 possible locations as presented in the Figure below.

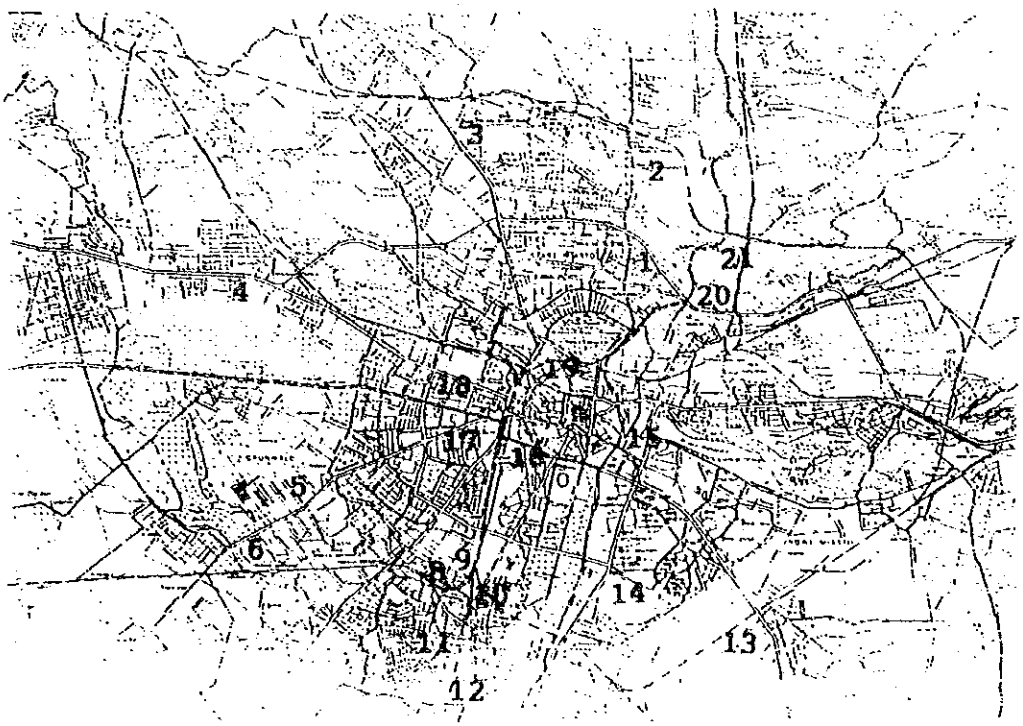


Fig.J.1.3-3 Locations for Recycling Centres Proposed by Town Planning Office

Based on the above proposal and considering the population density of Poznan, the following locations are recommended, (refer to Fig.J.1.3-4).

No.1	between Naramowicka St. and Lechicka St.
No.3	in Marysienki Resydential Area
No.4	in Sytkowo near Dabrowskiego St.
No.6	at the crossing of Grunwaldzka St. and Malwowa St.
No.11	in Swierczewo near Opolska St.
No.15	at the river Cybina near Zamenhofa St.
No.18	in Polna St. near Dabrowskiego St.
No.L	at the site (Franowo-Michalowo) for the future waste treatment plants, as family cars are not wanted on the landfill and at the incineration plant.