5) Cost Estimates

Based on the described conceptional lay-out, this Section presents cost estimates for the construction and operation of the composting plant in Poznan.

All estimates are elaborated assuming price level as described in Section H.1.2.

Table H.5.4-3 Initial Investments. Mechanical, Electrical and Running Equipment for Composting Plant, 60 tonnes/hour capacity.

MODEL 1: CAPACITY 60 TONNES/HOUR 200,000 tonnes/year	PRICE LEVEL IN	
MECHANICAL, ELECTRICAL AND RUNNING EQUIPMENT	WESTERN EUROPE USD X 1000	POLAND MILL.ZL
Weighing bridge, 1 nos	100	150
Overhead crane, 2 nos	520	50
Pre-treatment plant - Bag opener, 2 nos - Primary screen, 2 nos - Inspection belt, 2 nos - Magnetic extractor, 3 nos - DANO-drum, 2 nos - Conveyor belts - Baler for paper and plastic sheets, 2 nos - Baler for tin cans, 2 nos	3,500	800
Maturing area - Tripping conveyor, 4 nos - Watering equipment	1,600	300
Fine screen plant - Feed hopper, 2 nos - Fine screen, 2 nos - Stone separator, 2 nos - Conveyor belts	700	200
Electrical installation	50	5,000
Spare parts	400	50
Laboratory equipment	30	
Design, supervision, training, 20 %	1,500	1,300
Running equipment - Loader, 2 nos - Turning machine, 2 nos - Tractors (5 nos) with trailers	900	4,000
Miscellaneous, 20 %	2,700	2,150
TOTAL: Mechanical, electrical and running equipment	12,000	14,000

Table H.5.4–4 Initial Investments. Civil Works for Composting Plant, 60 tonnes/hour capacity.

Model 1: Capacity 60 tonnes/hour 200,000 tonnes/year Civil Works	Price level in Poland mill. Zl
Buildings: – Reception building – Waste silo (3,000 m^3) – Building for pre-treatment plant and fine screen plant – Administration building with weigh house and laboratory (200 m^2)	40,000
Maturation and storage area (6 ha)	45,000
Roads and fences	4,000
Design, supervision, 15 %	14,000
Miscellaneous, 20 %	22,000
TOTAL: Civil works	125,000

Table H.5.4–5 Operation Costs for Composting Plant, 60 tonnes/hour capacity

Model 1: Capacity 60 tonnes/hour 200,000 tonnes/year Operation costs, average for period 2000 to 2010	Price level in Poland mill. Zl/year
Labour costs, 2 shifts each: – 2 men at weigh bridge – 3 men at cranes and control room – 6 men at pre-treatment plant – 2 men at fine screen plant – 9 drivers – 5 cleaners, pickers – 1 foreman	2,700
Power supply (15 kWh per tonne waste)	1,800
Maintenance of mechanical equipment (2.5 %)	4,000
Maintenance of buildings and pavings (0.5 %)	600
Operation of running equipment, 9 pieces – Diesel and lubricants – Maintenance (7 %)	2,700
Disposal costs of residues (30,000 tonnes/year)	2,000
Administration, 15 % of above	2,200
TOTAL: Annual operation costs	16,000

Table H.5.4-6 Initial Investments. Mechanical, Electrical and Running Equipment for Composting Plant, 30 tonnes/hour capacity

Model 2: Capacity 30 tonnes/hour 100,000 tonnes/year	Price level in	
Mechanical, electrical and running equipment	Western Europe USD x 1,000	Poland mill. Zl
Weighing bridge, 1 nos	100	150
Overhead crane, 1 nos	300	50
Pre-treatment plant:	2,600	600
- Bag opener, 2 nos		
- Primary screen, 2 nos		
- Inspection belt, 2 nos		
- Magnetic extractor, 3 nos		
- DANO-drum, 2 nos		
- Conveyor belts		
- Baler for paper and plastic sheets, 1 nos		
- Baler for tin cans, 1 nos		
Maturing area:	900	200
- Tripping conveyor, 2 nos		
- Watering equipment		
Fine screen plant:	500	150
- Feed hopper, 2 nos		
- Fine screen, 2 nos		
- Conveyor belts		
Electrical installation	50	4,000
Spare parts	350	50
Laboratory equipment	30	
Design, supervision, training, 20 %	1,000	1,000
		2,600
Running equipment:	450	
- Loader, 2 nos		
- Turning machine, 1 nos		
- Tractor (3 nos) with trailers		
Miscellaneous, 20 %	1,220	1,700
TOTAL: Mechanical, electrical and running equipment	7,500	10,500

Table H.5.4-7 Initial Investments. Civil Works for Composting Plant, 30 tonnes/hour capacity

Model 2: Capacity 30 tonnes/hour 100,000 tonnes/year	Price level in Poland mill. Zl
Civil Works	
Buildings:	25,000
- Reception building	
- Waste silo (1,500 m^3)	
- Building for pre-treatment plant and fine screen plant	
- Administration building with weigh house and laboratory (200 m^2)	
Maturation and storage area (3 ha)	25,000
Roads and fences	3,000
Design, supervision, 15 %	8,000
Miscellaneous, 20 %	14,000
TOTAL: Civil works	75,000

Table H.5.4–8 Operation Costs for Composting Plant, 30 tonnes/hour Capacity.

Model 2: Capacity 30 tonnes/hour 100,000 tonnes/year	Price level, June 1999, in Poland mill. Zl/year
Operation costs, average for period 2000 to 2010	
Labour costs, 2 shifts each: - 1 man at weigh bridge - 2 men at cranes and control room - 5 men at pre-treatment plant - 1 man at fine screen plant - 4 drivers - 4 cleaners, pickers - 1 foreman	2,000
Power supply (15 kWh per tonne waste)	900
Maintenance of mechanical equipment (2.5 %)	2,600
Maintenance of buildings and pavings (0.5 %)	400
Operation of running equipment, 6 pieces - Diesel and lubricants - Maintenance (7 %)	1,600
Disposal costs of residues (15,000 tonnes/year)	1,000
Administration, 15 % of above	1,500
TOTAL: Annual operation costs	10,000

6) Summary, Cost Estimates for Composting Plant

Summary of cost estimates for the described composting plants is presented in the tables below, including quantity of waste treated, output, investments and operation costs. Mixed collection is assumed.

Table H.5.4–9 Summary for Composting Plant, capacity 200,000 tonnes/year.

Capacity of plant at 3,350 working hour/year			200,000 tonnes/year	
Investment			12 mill. USD + 139,000 mill. Zl	
Annual operation costs (average year 2000 to 2010)			16,000 mill. Zl	
Year	Waste received (tonnes/year)	Reject to landfill (tonnes/year)	Compost (tonnes/year)	Metal (tonnes/year)
2001	147,000	44,000	30,000	800
2005	165,000	52,000	35,000	850
2010	194,000	65,000	43,000	900

Table H.5.4-10 Summary for Composting Plant, capacity 100,000 tonnes/year.

Capacity of plant at 3,350 working hour/year			100,000 tonnes/year	
Investment			7.5 mill. USD + 88,500 mill. Zl	
Annual operation costs (average year 2000 to 2010)			10,000 mill. Zl	
Year	Waste received (tonnes/year)	Reject to landfill (tonnes/year)	Compost (tonnes/year)	Metal (tonnes/year)
2001	73,500	22,000	15,000	400
2005	82,500	26,000	17,500	425
2010	97,000	32,000	21,500	450

Assuming segregated collection is introduced the quantity of waste to the composting plant will decrease, refer section H.1.2, while the quality of the waste for composting will increase. The required capacity of the composting plant and especially the pre-treatment plant will be reduced.

Cost estimates for the composting plants are presented in the tables below, including quantity of waste treated, output, investments an operation costs. Segregated collection is assumed.

Table H.5.4-11 Summary for Composting Plant, capacity 160,000 tonnes/year

Capacity of plant at 3,350 working hour/year		160,000 tonnes/year	
Investment		10 mill.USD + 110,000 mill.Zl	
Annual operation costs (average year 2000 to 2010)		13,000 mill.Zl	
Year	Waste received (tonnes/year)	Reject to landfill (tonnes/year)	Compost (tonnes/year)
2001	102,000	20,400	30,000
2005	117,000	23,400	35,000
2010	143,000	28,600	43,000

Table H.5.4-12 Summary for Composting Plant, Capacity 80,000 tonnes/year

Capacity of plant at 3,350 working hour/year		80,000 tonnes/year	
Investment		6.0 mill. USD + 70,000 mill.Zl	
Annual operation costs (average year 2000 to 2010)		8,000 mill.Zl	
Year	Waste received (tonnes/year)	Reject to landfill (tonnes/year)	Compost (tonnes/year)
2001	51,000	10,200	15,000
2005	58,500	11,700	17,500
2010	71,500	14,300	21,500

H.5.5 Sorting Plant

1) Introduction

Sorting and recycling of materials from the waste stream has the following main aims:

- reduction of the waste quantity by separating the usable material from the not-usable, thus reducing the required volume of the landfill.
- to bring in recycling income from re-usable materials.

The method is well known in Poland but has faced many problems in the past eg. like organizing sufficient equipment or negative attitudes from industries who should form the market for the recycled materials. This section presents a sorting plant for source separated waste. The plant serves the following purpose.

- To salvage recyclable materials from source separated waste in order to obtain a reduction of the waste quantity for disposal and increase the amount of recycling. The rejects are disposed of at a landfill or incinerated.

2) Design Date

a. Waste characteristics

The input waste should be separated at the source or be of similar high quality. In order to improve the working conditions of the sorting personnel, the waste should be dry and free of difficult wastes such as organic material, oil, chemicals, clinic wastes etc.

The primary consideration in planning a sorting plant is that the output has to comply with the requirements set by the market for the material in question. Thus, the saleable output from the sorting plant depends heavily on the type and quality of the input material which has to comply with the following requirements.

- the waste has to be dry.
- the waste should not contain large quantities of dust.
- the waste should not contain difficult wastes (oil, chemicals, clinical wastes etc.);
- the waste should not contain organic fractions.

These requirements mean that only recyclable materials separated at the source by discharge persons are appropriate for treatment at the sorting plant.

b. Waste Quantities

Based on the above condition, the quantities to the sorting plant have been estimated in Section H.1.2.

The planned input and output from the sorting plant appear in the following table.

Table H.5.5-1 Input and Output of the Sorting Plant

Year	Waste Received tonnes/year	Output Sellable materials (tonnes/year)					
		Paper and cardboard	Textiles	Metal	Glass	Plastics	Residues tonnes/year
2001	38,000	15,000	3,000	3,500	7,000	3,000	6,500
2005	44,500	18,000	3,500	4,000	8,000	3,500	7,500
2010	55,500	24,000	4,000	4,500	9,000	4,500	9,500

c. Working Hours

It is assumed that the sorting plant will be operated in one shifts i.e, 8 hours/day 5 days a week. Assuming a plant availability of 0.8 the annual working hours will be approx. 1,550 hours.

3) Required Capacity

Assuming 10 % variation from month to month of the generated waste quantity and year 2010 to be the target year, the overall capacity of the sorting plant is calculated as follows:

$$\frac{55{,}500 \times 1.1}{1{,}550} = 40 \ \textit{tonnes/hour}$$

or 4 sorting liner each 10 tonnes/hour.

4) Technical Description

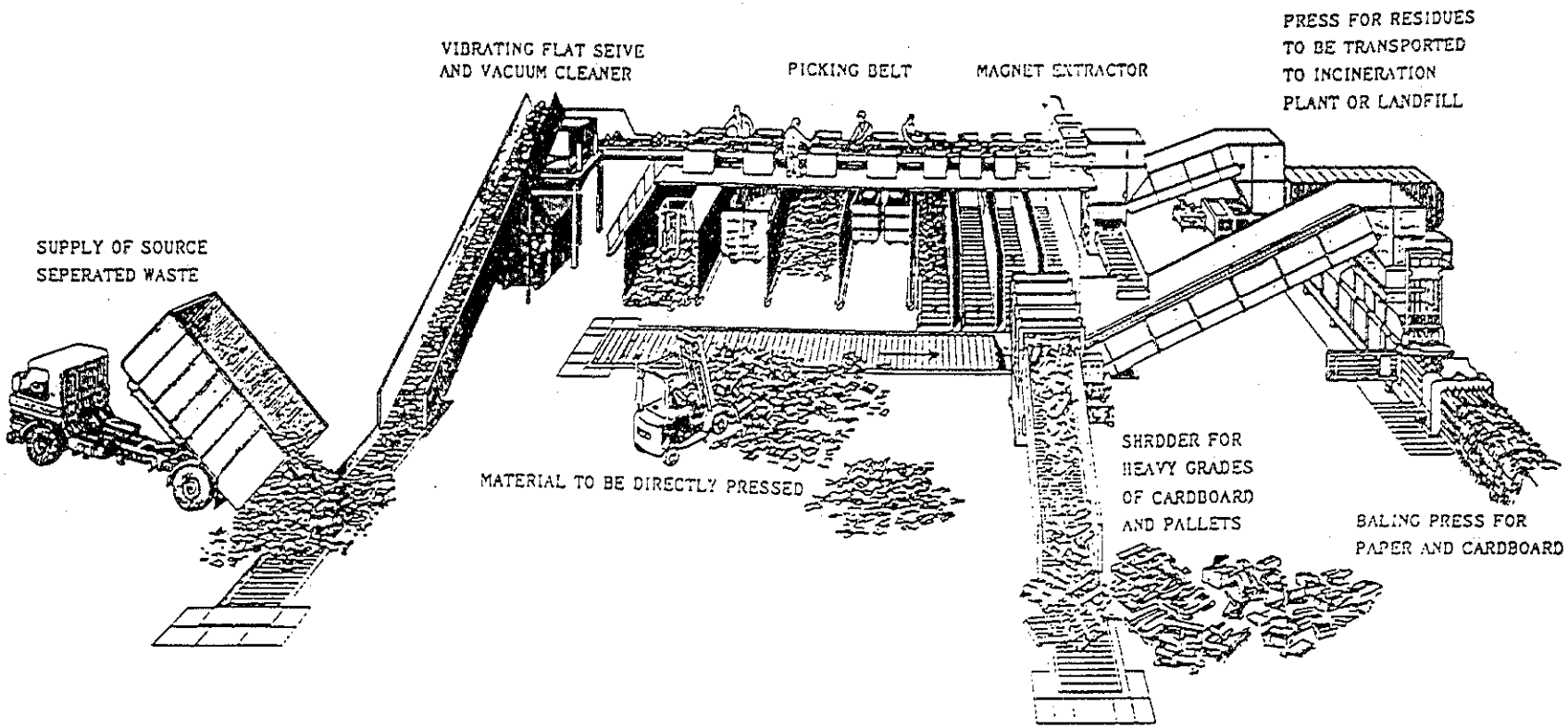
Experience has shown that pure mechanical sorting of the waste is unadvisable. In order to obtain an acceptable quality of the output some degree of manual sorting is necessary.

One of the primary considerations when planning a sorting plant is to secure acceptable working conditions for the sorting personnel. Several plants in Western Europe have been shut down because of unsatisfactory occupational health conditions and thus great care should be taken when designing a sorting plant in this respect.

The factors which determine the applicability and success of a sorting plant are:

- The availability of a market for reclaimed materials in Poland.
- Market price of output materials.
- Quality of input materials (efficiency of source separation)
- Ability to avoid occupational health problems.

The conceptual lay-out of the proposed sorting plant is shown in Fig.H.5.5-1. The main installation are described below.



SORPTING PLANT FOR SOURCE SEPARATED WASTE. BESIDES RESIDUES FOR INCINERATION OF LANDFILL THE FOLLOWING MATERIALS ARE RECOVERD: PAPER CARDBOARD, TEXTILES, PLASTICS, METALS AND GLASS

Fig.H.5.5-1 Conceptual Layout of the Sorting Plant

The Sorting Plant is based on input waste consisting of source separated waste from households, offices and institutions.

Reception and Storage

After having been weighed at the weigh bridge the truck is unloaded on the floor of the reception hall for storage and preliminary inspection of the waste.

Storage is required to even out variations of the incoming waste quantities and so allow the sorting plant to be operated over a period where no waste is delivered. The storage area is serviced by overhead cranes.

The preliminary inspection of waste is meant as a control for the quality of the collection system and the source separation. It provides a feed-back of information to the waste collectors and gives them the chance to offer differential pricing policy. In the long run this will help to increase the quality of the incoming waste and consequently the quality and sales price of the output material.

Feeding Equipment

The input waste is feeded into the waste feeder which changes the intermittent bulk feeding by the cranes into a more continuous feed required by the sorting lines.

By an ascending conveyor the waste is transported to a vibrating flat sieve where the input materials are screened and vacuum cleaned in order to remove dust etc. before sorting, thereby improving working conditions for the sorting personnel.

Sorting Lines

The 4 sorting lines comprise:

- Picking belts operated from two sides on a platform with space for a number of operators who are responsible for the salvaging of materials.

- Containers for storage of salvaged materials. The containers are located under the platforms for the picking belts.

- Magnetic extractors for the removal of ferrous metals.

- De-ducting systems for the protection of personnel against the inhalation of dust and particles.

- Systems for the protection of workers against stench and noise.

Baling Equipment

At the end of the picking belts remain residues that will mainly comprise waste paper and plastics. These materials are baled in a press for later transport to a sanitary landfill. Salvaged paper and cardboard is baled in a paper baler and tin cans are baled in a metal-baler. Baled materials are stored in a storage area.

5) Cost Estimates

Based on the described the conceptional lay-out this Section presents cost estimates for the construction and operation of the sorting plant in Poznan.

All estimates are elaborated assuming price level as described in Section H.1.2.

Table H.5.5-2 Initial Investment for Sorting Plant, 40 tonnes/hour capacity

Sorting Plant Capacity: 60,000 tonnes/year at 1,550 working hours	PRICE LEVEL IN WESTERN EUROPE MILL USD	 POLAND MILL.ZL
Mechanical electrical and running equipment: - Weigh bridge - 2 Overhead cranes - 4 feeding conveyors - 4 vibrating sieves - 4 picking belts and platforms - 20 containers - 4 magnetic extractors - 1 press for residues - 2 baling press for paper - 1 metal baler - 1 shredder - 3 forklifts	6.0	8,500
Civil Works 1) - Reception building - Sorting building - Storage area with a shed - Earth works roads etc.		33,000
Design, supervision and training,15pct	0.9	6,500
Miscellaneous 15pct:	1.1	7,000
TOTAL: INVESTMENTS	8.0	55,000

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

Table H.5.5-3 Operation Costs for Sorting Plant, 40 tonnes/hour capacity.

Sorting Plant Capacity: 60,000 tonnes/year at 1,550 working hours	Price level in Poland
Operation costs, average for period 2000 to 2010	mill. Zl/year
Labour Costs (30 persons):	1,500
Power supply	600
Maintenance of mechanical equipment	2,600
Maintenance of buildings and pavings	400
Operation of running equipment	1,600
Disposal costs of residues:2)	500
Administration, 15% of above	1,300
TOTAL: Annual operation costs	8,500

2) Disposal costs assume existing polish price levels of 33,000 zt/tonne residue. This rate may go up as more constraints are put on to landfills.

6) Summary, Sorting Plant

Summary of cost estimates for the described sorting plant is presented in the tables below, including quantity of waste treated, output, investments and operation costs. Source separation of waste is assumed:

Table H.5.5-4 Summary for Sorting Plant, Capacity 60,000 tonnes/year

Capacity of plant at 1,550 working hour/year		60,000 tonnes/year					
Investment		8.0 mill.USD + 55,000 mill.ZL					
Annual operation costs (average year 2001 to 2010)		8,500 mill. ZL					
Year	Waste Received (tonnes/year)	Output, Salable Materials tonnes/year					
		Paper and Cardboard	Textiles	Metal	Glass	Plastics	Residues tonne/year
2001	38,000	15,000	3,000	3,500	7,000	3,000	6,500
2005	44,500	18,000	3,500	4,000	8,000	3,500	7,500
2010	55,500	24,000	4,000	4,500	9,000	4,500	9,500

H.5.6 Public Recycling Centre

1) Introduction

The purpose of introducing recycling centres is to make it easier for householders and small enterprises to get rid of their waste (eg. 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 the 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,
- incidence of hazardous waste mixed with kitchen waste may terminate.

2) Technical Description

The conceptual lay-out of a recycling centre is presented in Fig.H.5.6-1:

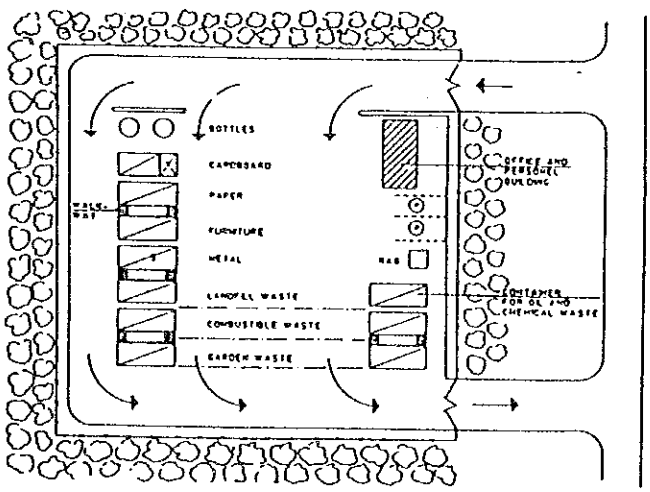


Fig.H.5.6-1 Conceptual lay-out of Recycling Centre

The recycling centre comprises:

- A site of 1,500 to 3,000 m^2 depending on the number of households to be served.
- Asphalt pavement, except for the parking area for containers. This area is paved with concrete.
- Fencing and planting.
- Guard house.
- 10 or more maxi containers (8 to 25 m^2) depending on the number of households to be served. The containers are collected by container hoist trucks.
- 2 or more mini containers (1.5 to 3 m^2), one for bottles and one for textiles.
- Store room or container for hazardous waste (used oil, solvents, batteries, discarded medicine, etc.).

Each maxi container has its own special design 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 H.5.6-1.

The recycling centre is staffed for control and guidance. It is open every day, 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 go to the landfill if you have a bigger quantity of waste). It might also be possible to pay households for recyclable materials.

The centres might be operated in a cooperation between the private recycling enterprises (eg. SURMET) and the Municipality of Poznan.

Table H.5.6-1 Container Equipping for a Small and Large Recycling Centre and Destinated Treatment

Waste type	Container equipping (nos) for recycling centre		Destinated treatment
	small centre	large centre	
Bottles	mini container		Recycling
	2	4	
Metal, including refrigerators, etc.	maxi container		Recycling
	1	2	
Textiles	mini container		Recycling
	1	1	
Cardboard	maxi container with compaction equipment		Recycling
	1	1	
Paper (newspapers)	maxi container		Recycling
	1	1	
Garden waste	maxi container		Composting site
	2	4	
Furniture	maxi container		Incineration after crushing or landfill
	1	1	
Combustible waste, including plastic	maxi container		Incineration or landfill
	2	4	
Incombustible (soil and stone)	maxi container		Dump area or landfill
	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 one centre for each 15,000 households (46,500 inhabitants). Eight recycling centres are planned to be provided to cover approximately 380,000 citizens.

The composition of materials collected at recycling centres is assumed as follows based on Danish experiences:

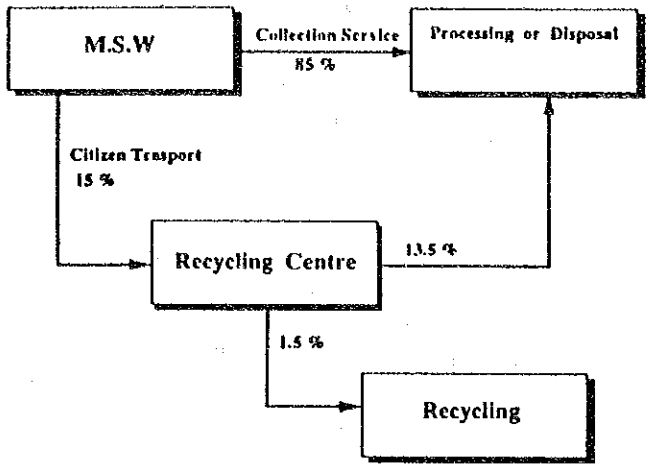


Fig.H.5.6-2 Waste Flow Data of Recycling Centres in Copenhagen

4) Cost Estimates

Based on the described conceptional lay-out this section presents 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 section H.1.2.

Table H.5.6–2 Cost Estimates for Small Recycling Centre.

Recycling centre, Type: Small (Site of 2,000 m², 10 maxi containers)	Price level in Poland, June 1992 mill. Zl
Investments:	
– Earthworks, 1,000 m² pavement and sewerage	500
– Fencing and planting	100
– Guard house (30 m²)	150
– 10 maxi containers	300
– 3 mini containers	25
– Shed for hazardous waste	50
– Miscellaneous, 20 %	225
TOTAL, investment	1,350
Annual Operation Costs:	
– Salary, 3 men 7 days a week	150
– Treatment costs of tonnes garden waste, combustible, soil and stone	350 25
– Maintenance of containers (7 %)	10
– Maintenance of constructions (0.5 %)	80
– Administration, 15 % of above	
TOTAL, annual operation costs	615

Table H.5.6–3 Cost Estimates for Large Recycling Centre.

Recycling centre, Type: Large (Site of 3,000 m², 16 maxi containers)	Price level in Poland, June 1992 mill. Zl
Investments:	
– Earthworks, 1,500 m² pavement and sewerage	750
– Fencing and planting	130
– Guard house (30 m²)	150
– 16 maxi containers	500
– 5 mini containers	40
– Shed for hazardous waste	50
– Miscellaneous, 20 %	324
TOTAL, investment	1,944
Annual Operation Costs:	
– Salary, 4 men 7 days a week	200
– Treatment costs of garden waste, combustible, soil and stone	600 40
– Maintenance of containers (7 %)	10
– Maintenance of constructions (0.5 %)	127
– Administration, 15 % of above	
TOTAL, annual operation costs	977

H.5.7 Sanitary Landfill

1) Introduction

It is generally recognized that a sanitary landfill is the basic element for modern solid waste management.

Thus, it is acknowledged that a considerable quantity of waste has to be disposed of even if efforts are provided to reuse (recycling) or utilize (incineration, composting) the waste.

Therefore, as a first step towards modern solid waste management Poznan is recommended to strengthen the landfill activity minimizing the environmental impact. Having the requirements for sanitary landfill clarified and proper design and operation implemented, it is possible to draw the attention to other treatment methods.

This Section presents the conceptual lay-out and cost estimates for a new landfill located at Franowo-Michalowo which has been selected by the Municipality of Poznan to be the future location for a landfill as well as for treatment facilities. The site comprises an area of approx. 180 ha. as shown in Fig.H.5.7-1.

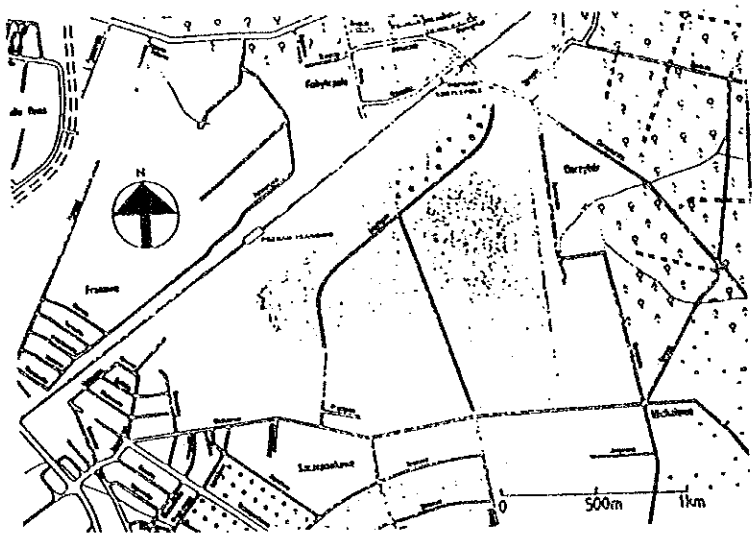


Fig.H.5.7-1 Location of the Selected Area for the New Landfill and Future Treatment Plants.

2) Design Data

Waste Quantity for Disposal

Estimates for the quantity of waste generated in Poznan have been elaborated in Section H.1.2. The main figures appear from Table H.5.7-1 as well as the required volume of a new landfill which is assumed to be put into operation from 1994. The required landfill volume stated in the Table implies that no treatment plant (incineration or composting) is introduced in Poznan within the planning period.

Table H.5.7-1 Estimated Waste Generation in Poznan City and Required Capacity of New Landfill assuming no Treatment Plants are established.

Year	Waste Generation (tonnes/year)	Required Landfill Volume	
		Annual m^3/year	Generated m^3
1992	181,000	-	-
1994	184,000	231,000	231,000
1995	186,000	233,000	464,000
2001	200,000	249,000	1,922,000
2005	226,000	282,000	3,000,000
2010	270,000	338,000	4,573,000

However, the required capacity of the landfill depends on treatment facilities which might be introduced in Poznan.

Estimates for the required landfill capacity have been elaborated in Section H.1.2, assuming one of the following alternative treatment plants is put into operation in year 2001:

- Incineration Plant, capacity 226,000 tonnes/year (all combustible waste is incinerated).
- Incineration Plant, capacity 113,000 tonnes/year (half of the combustible waste is incinerated).
- Composting Plant, capacity 200,000 tonnes/year (all compostable waste is composted).
- Composting Plant, capacity 100,000 tonnes/year (half of the compostable waste is composted).

The main figures for the required landfill capacity appear from the tables below:

Table H.5.7-2 Required Capacity of the New Landfill assuming Maximum Incineration or Maximum Composting from year 2001.

Year	Required Landfill Volume			
	From year 2001 all Combustible waste is incinerated		From year 2001 all Compostable waste is composted	
	Annual m^3/year	Generated m^3	Annual m^3/year	Generated m^3
1994	231,000	231,000	231,000	231,000
2000	247,000	1,671,000	247,000	1,671,000
2001	92,000	1,764,000	119,500	1,721,000
2005	100,500	2,153,000	132,500	2,231,000
2010	114,900	2,697,000	155,300	2,959,000

Table H.5.7-3 Required Capacity of the New Landfill assuming Treatment Plant from year 2001 for half of the Combustible/Compostable Waste.

Year	Required Landfill Volume			
	From year 2001 half of the Combustible waste is incinerated		From year 2001 half of the Compostable waste is composted	
	Annual m^3/year	Generated m^3	Annual m^3/year	Generated m^3
1994	231,000	231,000	231,000	231,000
2000	247,000	1,671,000	247,000	1,671,000
2001	82,700	1,755,000	114,500	1,786,000
2005	90,000	2,103,000	127,200	2,275,000
2010	102,900	2,590,000	149,100	2,974,000

3) Capacity of Landfill Sections

The area for disposal of waste is proposed to be divided into sections as shown in Drawing No. 1002. Each section of the sanitary landfill is to be filled up corresponding to the planned final terrain (see Drawing No. 1001) before a new section is commenced. This way, the total area open for penetration of rain water is kept at a minimum, as well as the generation of leachate.

It is appropriate to design and construct landfill sections with a capacity complying with the volume required for 2 to 3 years disposal.

Complying with the estimated waste generation and the required landfill capacity presented above the recommended capacity of the landfill sections as well as the year for construction appears from the tables below:

Table H.5.7–4 Required Capacity of Landfill Sections assuming only a Sanitary Landfill is constructed for Poznan.

Landfill Section No.	Year for Construction	Capacity of Landfill Section (m^3)	Disposal Period (year)
1	1993	900,000	1994 - 1997
2	1996	900,000	1997 - 2000
3	2000	900,000	2001 - 2003
4	2003	900,000	2003 - 2006
5	2006	900,000	2007 - 2010

Table H.5.7–5 Required Capacity of Landfill Sections assuming a Composting or Incineration Plant (capacity approx. 200,000 tonnes/year) starts operation in year 2001.

Landfill Section No.	Year for Construction	Capacity of Landfill Section (m^3)	Disposal Period (year)
1	1993	900,000	1994 - 1997
2	1996	900,000	1997 - 2000
3	2000	400,000	2001 - 2003
4	2003	400,000	2003 - 2006
5	2006	400,000	2007 - 2010

Table H.5.7-6 Required Capacity of Landfill Sections assuming a Composting or Incineration Plant (capacity approx. 100,000 tonnes/year) starts operation in year 2001.

Landfill Section No.	Year for Construction	Capacity of Landfill Section (m^3)	Disposal Period (year)
1	1993	900,000	1994 - 1997
2	1996	900,000	1997 - 2000
3	2000	650,000	2001 - 2003
4	2003	650,000	2004 - 2006
5	2006	650,000	2007 - 2010

4) Technical Description

Future Use of the Landfill Area

Designing a sanitary landfill, it is important to know the future use of the area when landfilling has ended. Thus, the phases of the filling can be adjusted to the future landscape.

Assuming future use of the selected area will be a combined public park and sports centres the future landscape might be planned as shown in Drawing No. 1001. Approx. 20 mill. m^3 of compacted waste may then be disposed of on the site. This is more than 4 times as much as the required volume for the planning period, up to year 2010.

The proposed future landscape does not include any filling in the north eastern part of the selected area. This area (approx. 10 to 30 ha.) might be reserved for future treatment plants, incineration or composting plants.

The final coverage of the landfill consists of at least 1 m. soil. Uncontrolled overpressures of gas released from the waste are avoided by a layer of gravel, which is recommended as one of the required precautions against gas.

Most of the soil required for final coverage as well as for daily coverage of waste may be excavated on the site when preparing areas for later sections of the landfill.

Main Principles for Design and Operation of the Sanitary Landfill

The main task of the sanitary landfill is to allow waste disposal under full control, thus avoiding pollution of the environment. The main hazards of a landfill are:

- Ground water pollution.
- Surface water pollution.
- Air pollution.
- Diseases spread by insects, rodents, birds, etc.
- Noise.

Fig.H.5.7-2 illustrates the above mentioned hazards.

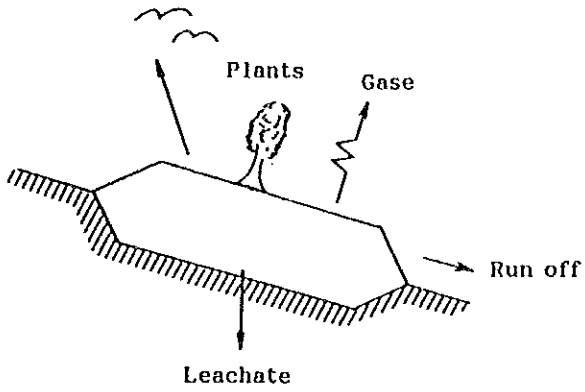


Fig.H.5.7-2 Hazards at a Landfill.

Preliminary lay-out and principles for the sanitary landfill (Phase 1) located at Franowo-Michalowo is shown in Drawing No. 1002.

The above mentioned hazards are meet by the following measures:

- Bottom liner is constructed to obstruct leachate from percolating into the ground. It is assumed that an appropriate formation of clay might be available on or near the site. Otherwise, an artificial bottom liner (eg. polyethylene) might be applied.

- Above the bottom liner a gravel layer comprising a system of stone drains is constructed for collection of leachate. The leachate is assumed to be pumped to a future municipal sewerage treatment plant.

- Compaction of waste by heavy equipment to reduce the required volume of the landfill, and also to reduce hazards of diseases being spread by rodents.

- Daily coverage of waste with soil to prevent air pollution and spreading of diseases by insects, etc.

- Avoiding fires on the site to prevent air pollution.

- Planting of trees and construction of embankments around the landfill area to prevent visual nuisance.

- Boundary fencing to prevent scavenging.

- Control of incoming waste including construction of a weigh bridge.

- Construction of a leachate control and monitoring system based on a set of boreholes at the landfill area.

- Phased restoration of landfill areas including approx. 1 m. soil coverage, measures against gas and planting.

The quantity of leachate and contaminated run-off water produced is limited by the following precautions:

- Construction of landfill sections which have a capacity of no more than for 2 to 3 years' disposal.

- Construction of ditches around the landfill area to prevent run-off water from the surrounding areas entering the waste.

- The daily coverage of waste with soil will also reduce the quantity of rain water to penetrate the waste.

The sanitary landfill will be operated by the following permanent staff:

- A foreman, who will supervise the operation at the landfill.

- Inspectors, who will undertake the registration at the weigh bridge and guide the trucks to the correct site for unloading of waste.

- Operators of heavy equipment, who will be responsible for compacting and covering the waste with soil.

- Labourers, who will take care of maintaining tidiness of the surroundings.

Working hours 6.00 to 15.00 hours are assumed.

Arrangement of Sanitary Landfill, Phase 1

The proposed arrangement of the sanitary landfill (Phase 1) is shown in Drawing No. 1002. The arrangement includes the following main items:

- Access road to the sanitary landfill
- Fencing and planting
- Entrance area with weigh bridge and guard house
- Administration building
- Workers' canteen and staff rooms
- Garage with workshop
- Heavy equipment for compaction of waste
- Construction of bottom liner and drainage system for the disposal area, Section 1
- Construction of sewerage system for leachate including pumps, reservoir and pipe to the nearest municipal facility for treatment of sewerage
- Ditches and embankments around the landfill Phase 1
- System of boreholes for control of leaking leachate

Leachate from the sanitary landfill is assumed to be pumped for treatment at the nearest municipal sewage treatment plant. Alternative methods for treatment and removal of leachate are as follows:

- Pumping and recirculation of leachate into old waste. This method is based on the idea of old waste working as a biological filter that will clean leachate deriving from new waste.

- Pumping and sprinkling of leachate on top of landfill areas in order to utilize the evaporation during the summer months.

- Pumping of excess leachate to the municipal system for rain water should be avoided, unless the landfill is equipped with its own sewerage treatment plant.

5) Cost Estimates

Based on the described preliminary design of the sanitary landfill, this section presents cost estimates for the construction, operation and re-establishment of the sanitary landfill.

All estimates are elaborated assuming:

- Price level as described in Section 2.3.2.

- Leachate can be treated in a future municipal sewerage plant located near the sanitary landfill.

- Bottom liners can be constructed from a clay formation located on or near the site.

- Investments for pre-investigation (location, hydrogeological investigations, etc.) are not included.

Initial Investments

The following initial investments for facilities have to be performed when constructing the sanitary landfill, Phase 1. These facilities will be utilized throughout the life span of the sanitary landfill:

Table H.5.7-7 Initial Investments for Sanitary Landfill.

Item		Price level in Western Europe USD x 1000	Price level in Poland mill. ZL
–	Access road and entrance area including 2,000 m^2 asphalt pavement		1,650
–	Weigh bridge, computerized	100	100
–	Guard house and weigh room (50 m^2)		250
–	Administration building (200 m^2) and staff rooms		850
–	Garage (250 m^2)		800
–	Water, electricity and sewerage		450
–	Installation for leachate · Storage tank · Pump installation · Conduct for leachate (1,000 m.) · Electrical installation		2000
–	Boreholes (50 m.) for control of ground water		700
–	Fencing		750
–	Planting		500
–	Connection fee (electricity, water, sewerage)		500
–	Training of employees	20	
–	Design and supervision	100	1,300
–	Miscellaneous (20 %)	30	2,150
TOTAL, initial investments		250	12,000

Equipment

Complying with the composition and quantity of waste (approx. 200,000 tonnes/year up to year 2000) the landfill is proposed to be equipped as stated below:

Table H.5.7–8 Proposed Equipment up to year 2000.

Sanitary landfill, capacity 200,000 tonnes/year Equipment	Price level in Poland mill. Zl
– 2 compactors	3,000
– 1 traxcavator	1,200
– 1 dump truck	500
– 1 tractor with brush and watering equipment	200
– Others, tools and spare parts	100
TOTAL, equipment	5,000

Landfill Sections

The following cost estimate meets the costs for construction of a landfill section with a capacity of 900,000 m^3

Table H.5.7–9 Cost Estimate for Landfill Section, capacity 900,000 m^3

Capacity:	Volume: 900,000 m^3 Area: 40,000 m^2 Waste quantity: 200,000 t/year	
	Price level in	
	Western Europe USD x 1,000	Poland mill. Zl
– Clearing and earthworks for bottom and embankment		3,300
– Bottom liner (0.5 m clay 40,000 m^2)		11,000
– Drainage layer (0.3 m gravel, 40,000 m^2)		4,400
– Leachate drains		2,200
– Temporary roads		300
– Design and supervision, 15 %	100	2,000
– Miscellaneous, 20 %		4,800
TOTAL, landfill section 900,000 m^3	100	28,000

Cost estimates for landfill sections with capacity of 650,000 m^3 and 400,000 m^3 are elaborated as follows:

Table H.5.7–10 Cost Estimates for Landfill Section, Capacity 650,000 m^3 and 400,000 m^3

Capacity:	Volume:	650,000 m^3		400,000 m^3	
	Area:	25,000 m^2		15,000 m^2	
	Waste quantity:	150,000 t/year		100,000 t/year	
		Price level in			
		Western Europe USDx1,000	Poland mill. Zl	Western Europe USDx1,000	Poland mill. Zl
TOTAL, landfill section		100	18,000	100	12,000

Operation Costs

The following cost estimates meets the average annual costs for operation and maintenance of the landfill, capacity: 200 tonnes/year. These costs may vary considerably from year to year, especially the costs for maintenance of equipment.

Table H.5.7–11 Operation Costs for Capacity 200,000 tonnes/year.

Operation Costs – 900,000 m^3 landfill sections	Mill. Zl/year
– Salaries	1,000
. 5 operators of equipment	
. 1 mechanician	
. 1 operator of weighbridge	
. 1 foreman	
. 10 workers	
– Administration	100
– Diesel and lubricants	700
– Maintenance of equipment	600
– Maintenance of buildings	100
– Current earth works:	1,000
. Excavation of soil for daily coverage	
. Measures against bio gas	
. Internal roads	
– Operation and maintenance of system for leachate	200
– Insurance, electricity and water	50
– Control and monitoring	50
– Miscellaneous (20 %)	700
TOTAL, operation costs	4,500

Based on the annual waste quantity disposed of at the landfill the operation costs are estimated when operating landfill sections of other capacities. The estimated operation costs are as follows:

Table H.5.7-12 Operation Costs for Landfill Sections 150,000 tonnes/year and 100,000 tonnes/year.

Landfill section Volume: Waste quantity:	650,000 m³ 150,000 t/year	400,000 m³ 100,000 t/year
	Mill. Zl/year	Mill. Zl/year
TOTAL, operation costs	3,500	2,500

Re-establishment of the Site

When the capacity of the landfill site is fully utilized the landfill is closed. The site must be covered with soil and the final measures against bio gas must be established.

The cost estimate for one landfill section (4 ha. - 900,000 m³) is as follows:

Table H.5.7-13 Cost Estimate for re-establishment of Landfill Section, 4 ha.

Re-establishment, landfill section 900,000 m³	Mill. Zl
- Final coverage (0.2 m gravel and 1.0 soil) including measures against gas.	3,000
- Planting of grass and bushes	500
- Miscellaneous	500
TOTAL	4,000

Estimates for other landfill sections are elaborated as follows:

Table H.5.7-14 Cost Estimate for re-establishment of Landfill Sections, 2.5 ha and 1.5 ha.

Landfill section Volume: Area:	650,000 m³ 25,000 m²	400,000 m³ 15,000 m²
	Mill. Zl	Mill. Zl
TOTAL, re-establishment	2,500	1,500

Operation after Completion

Operation costs for the following items will continue after completion of the landfill. The cost estimate is as follows:

Table H.5.7–15 Operation Costs after completion of the Landfill.

Operation after completion	Mill. Zl
– Operation and maintenance of system for leachate	200
– Control and monitoring	50
– Miscellaneous	50
TOTAL, operation after completion	300

6) Summary, Cost Estimates for Sanitary Landfill

Based on the cost estimates and the described alternative capacities for the sanitary landfill, the following tables present payment schedules for construction costs, operation costs and costs for re-establishment of the sanitary landfill.

Table H.5.7-16 Investments for a Sanitary Landfill in case only a Landfill is constructed.

Year	Initial invest-ment	Equip-ment	Landfill section	Operation costs	Re-esta-blishment	Costs after completion	Utilized capacity (mill. m^3)
1993	S	E	L				0,0
1994				O			
1995				O			
1996			L	O			
1997				O	R		0.9
1998				O			
1999				O			
2000		N	L	O			
2001		N		O	R		1.8
2002				O			
2003			L	O			
2004				O	R		2.7
2005				O			
2006			L	O			
2007		N		O	R		3.6
2008		N		O			
2009				O			
2010				O			
2011					R	C	4.5
2012						C	
2013						C	
2014						C	
2015						C	
2016						C	
2017						C	
2018						C	
2019						C	
2020						C	

S = 250,000 USD + 12,000 mill. Zl.
E = 5,000 mill. Zl.
N = 2,500 mill. Zl.
L = 100,000 USD + 28,000 mill. Zl (capacity: 900,000 m^3).
O = 4,500 mill. Zl per year.
R = 4,000 mill. Zl.
C = 300 mill. Zl.

Table H.5.7–17 Investments in Case an Incineration or Composting Plant (capacity: approx. 200,000 tonnes/year) is put into operation year 2001.

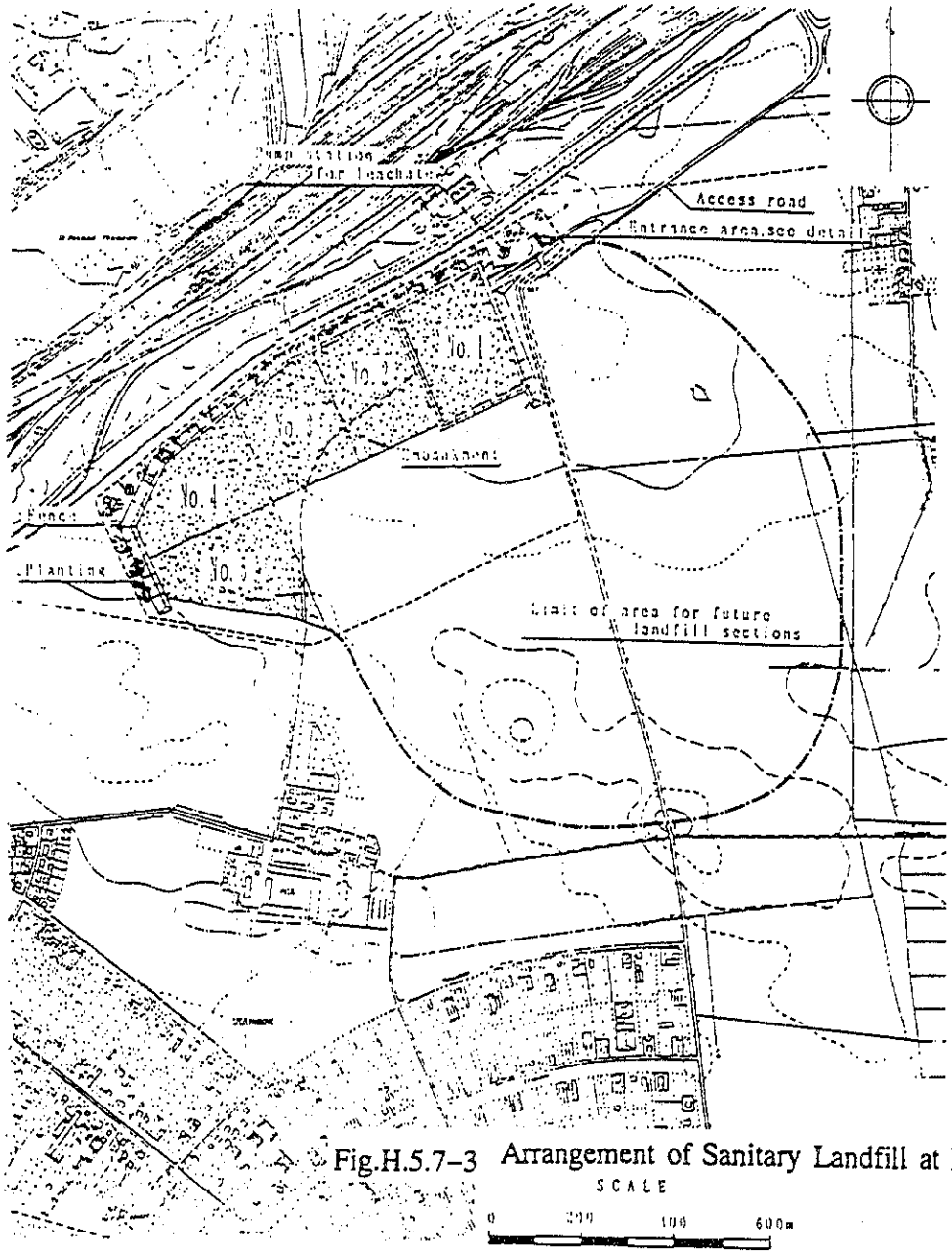
Year	Initial invest-ment	Equip-ment	Landfill	Operation costs	Re-esta-blishment	Costs after completion	Utilized capacity (mill. m^3)
1993	S	E	L1				
1994				O1			0.0
1995				O1			
1996			L1	O1			
1997				O1	R1		0.9
1998				O1			
1999				O1			
2000		N	L2	O1			
2001				O2	R1		1.8
2002				O2			
2003			L2	O2			
2004				O2	R2		2.2
2005				O2			
2006			L2	O2			
2007		N		O2	R2		2.6
2008				O2			
2009				O2			
2010				O2			
2011					R2	C	3.0
2012						C	
2013						C	
2014						C	
2015						C	
2016						C	
2017						C	
2018						C	
2019						C	
2020						C	

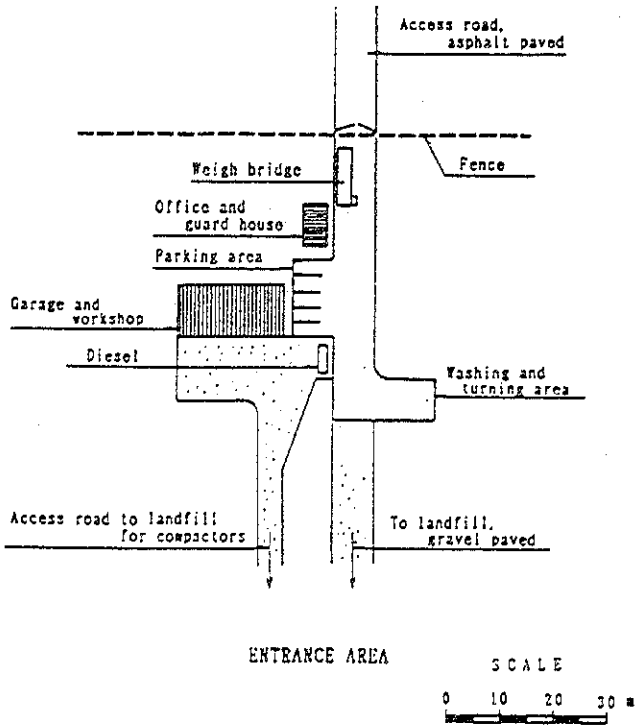
S = 250,000 USD + 12,000 mill. Zl.
E = 5,000 mill. Zl.
N = 1,500 mill. Zl.
L1 = 100,000 USD + 28,000 mill. Zl (capacity: 900,00 m^3).
L2 = 100,000 USD + 12,000 mill. Zl (capacity: 400,000 m^3).
O1 = 4,500 mill. Zl per year.
O2 = 2,500 mill. Zl per year.
R1 = 4,000 mill. Zl.
R2 = 1,500 mill Zl.
C = 300 mill. Zl.

Table H.5.7–18 Investments in Case an Incineration or Composting Plant (capacity: approx. 100,000 tonnes/year) is put into operation year 2001.

Year	Initial invest-ment	Equip-ment	Landfill	Operation costs	Re-esta-blishment	Costs after completion	Utilized capacity (mill. m^3)
1993	S	E	L1				
1994				O1			0.0
1995				O1			
1996			L1	O1			
1997				O1	R1		0.9
1998				O1			
1999				O1			
2000		N	L2	O1			
2001				O2	R1		1.8
2002				O2			
2003			L2	O2			
2004				O2	R2		2.45
2005				O2			
2006			L2	O2			
2007		N		O2	R2		3.1
2008				O2			
2009				O2			
2010				O2			
2011					R2	C	3.75
2012						C	
2013						C	
2014						C	
2015						C	
2016						C	
2017						C	
2018						C	
2019						C	
2020						C	

S = 250,000 USD + 12,000 mill. Zl.
E = 5,000 mill. Zl.
N = 2,000 mill. Zl.
L1 = 100,000 USD + 28,000 mill. Zl (capacity: 900,000 m^3).
L2 = 100,000 USD + 18,000 mill. Zl (capacity: 650,000 m^3).
O1 = 4,500 mill. Zl per year.
O2 = 3,500 mill. Zl per year.
R1 = 4,000 mill. Zl.
R2 = 2,500 mill. Zl.
C = 300 mill. Zl.

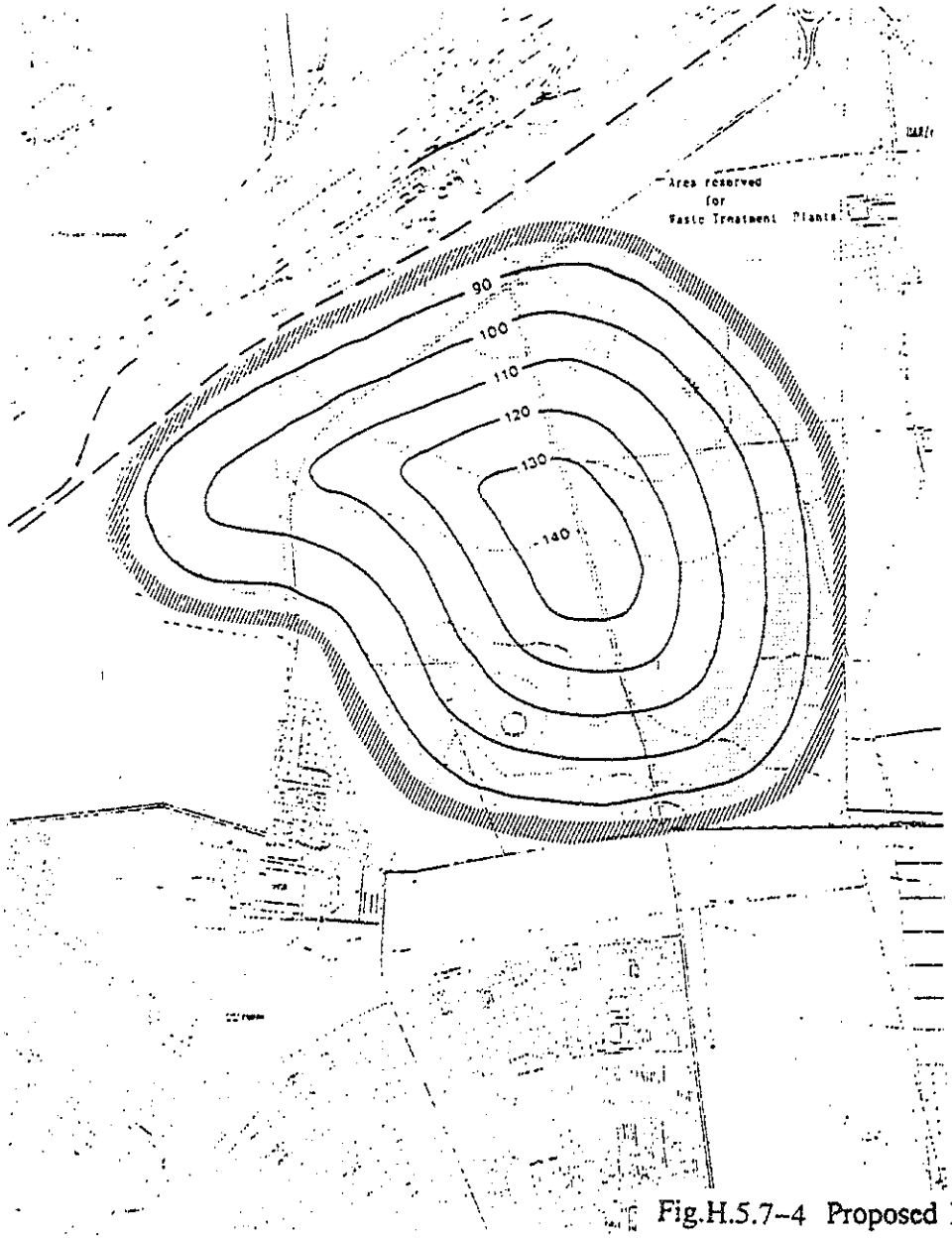




SIGNATURES AND NOTES:

- Landfill Section No.2(approx. 10,000 m³) fulfilling the requirements for approx. 3 years disposal.
- The landfill sections No.1 to 5 comprise approx. 3 mill m³ volume for disposal. This volume corresponds to the required volume for disposal of waste from Poznan in the period 1994-2010 assuming an incineration plant(240,000 tons/year capacity) is constructed.
- In case no treatment plant is constructed the required volume is approx. 4.5 mill m³ and the required area for landfill will increase.

Fig.H.5.7-3 Arrangement of Sanitary Landfill at Franowo-Michalowo



SIGNATURES:

- Area for embankments of soil. The present ground to be raised by soil filling
- Area for disposal of waste
- Level for future terrain

NOTE:

- The proposed hill is up to 50m heigh with a general slope of 1:10 allowing approximately 20 mill m^3 of waste to be disposed of. The proposed area for disposal of waste is approximately 125ha.
- Locally the slope of the hill could be steeper (up to 1:4) depending on the design of a professional architect.
- The area reserved for waste treatment plants could be extended and the Sanitary Landfill reduced accordingly.

SCALE

0 200 400 600m

Fig.H.5.7-4 Proposed Future Terrain

H.6 Institutional Requirements

The institutional requirements to be implemented independently from the recommended Master Plan Alternative will be presented in this Section. Section 4.2, on the other hand, presents the specific requirements of the Master Plan Alternatives.

In the selection of an optimum alternative, the institutional requirements must be analyzed. The basic constraint is if the optimum alternative is technically not in conformity with the legislation in force. It is also crucial to appropriately secure financing for the alternative, including sufficient contributions from the citizens.

In the following, the institutional requirements are defined based on considerations concerning private versus public participation in MSWM and basic principles for execution of services and the payment.

H.6.1 Private versus Public Participation in MSWM

In the forthcoming determination of the scope of work for the joint venture project, general considerations must be made on the advantages and disadvantages of private involvement in public MSWM duties. The table below shows the six key consequences of private participation.

Table H.6.1-1 Evaluation of Private Involvement

Advantages and Disadvantages with Private and Public Involvement in Waste Services + = *Advantage* − = *Disadvantage*	**Public**	**Private**
Responsibility for general health standard	+	−
Responsibility for protection of external environment on short and long terms	+	−
Ability to bear risk of extensive environmental damage caused by waste	+	−
Short decision process and viable solutions	−	+
Independent of political fluctuations	−	+
Experience with effectiveness and operation of contract works	−	+

The evaluation indicates that private companies do not properly observe their roles in protecting the environment and public health, due to the financial repercussions involved. However, the public system may be less efficient due to an extended administration and is more vulnerable to political changes.

In Western Europe, inter-municipal companies are formed on joint venture basis among municipalities in order to combine the advantages from the public involvement with the advantages of having an organization independent from the municipal administration. These companies are fully controlled by the municipalities through Board of Directors, but operate as a private company business-wise and financially.

By forming the joint venture with a private, foreign company, the possible advantages and disadvantages for Poznan Municipality are:

- **Advantages**
  - Access to new technology.
  - Access to funds/more favourable loans.
  - Access to modern business environment.

- **Disadvantages**
  - In case of liquidation of the joint venture, the municipality may be forced to take over stocks possessed by the partner in liquidation.
  - It is not possible to put projects into competitive bidding and thereby minimize the costs.
  - It is not possible for the municipality to get access to technology offered by other private companies.

The advantages are fully dependent on the financial and technological capabilities of the private company and its intention to further improve and develop these capabilities.

H.6.2 Basic Principles

In this section further principles will be discussed leading to the basic institutional requirements in sections H.6.3 and onwards.

1) Participation in Waste Services

The present MSWM is characterized by a variation in the service actually executed and the incomplete coverage of service.

The MSWM should be based on the fact that for hygienic reasons, wastes created by human activities should be handled properly on a regular basis. Accordingly, the following needs are recognized :

- A minimum level of waste service based on the considerations about waste generation and collection frequency.

- Waste service directed to all citizens.

In the case where the waste service is supported by financial means from the general taxation, an additional argument for a regular waste service covering all citizens is found.

2) Principles for Determination of Fee and Collection of Fee

In Western European Countries, a fee system based on the amount of actually produced waste is adopted for domestic waste collection services. It promotes minimization of waste, but may lead to uncontrolled disposal in case of insufficient public education and awareness. Poland, however, is not yet ready for such a system requiring the installment of weighing cells on all collection vehicles and an advanced registration system to keep records on data and fee calculation.

In a short term basis, the fee system should be based on simple methods to minimize administration procedures. This would mean imposition of fees based on average calculations. The basis could be weekly collection of fees for 110 liter containers from detached houses, which is deemed to be an appropriately minimal solution, and collection of fees for other types of containers.

The above system introduces the collection of fee through property taxes, wherein expenses are charged to the property owner who is responsible for the cleanliness of the area. The landowner in turn claims from the tenants a fair share of the fee collected.

H.6.3 Legislation and Enforcement

As a rule, the imposed legislations should provide the municipality and the people with means to conduct proper management of MSWM. Some of the important things lacking in the MSWM legislation are:

- licensing of private collectors to maintain control over waste collection services

- clarification of the compulsory duties of the citizens in public waste collection (the proposed law on waste indirectly states the compulsory duties of the people by stating the municipality responsible for MSWM).

The general clarification of the handling of the liability aspect in private operation of waste utilities is required, too.

Finally, difficulties in the localization of waste utilities partly caused by the absence of a law giving access to land for the interest of the community (land acquisition under compulsory power) should be focused on too.

H.6.4 Administration, Organization and Management

1) National and Regional Levels

Countries with undeveloped environmental protection measures must often upgrade administration considerably and implement new procedures to apply to modern waste management. Administration in Poland is well developed and by strengthening tasks, responsibilities and enforcement, the present administration can cope well with modern waste management without major obstacles.

In the ongoing decentralization process, it is important to strengthen central enforcement to control local activities and to ensure accordance with national strategies and standards.

These considerations will lead to the recommendation of establishment of anauthority responsible for licensing and monitoring of waste management operations. Licensing should be based on 4 years periods and shall not replace the present procedure with construction permits, but guarantee the better operation of utilities and a better control with the activities.

The present State Inspectorate for Environmental Protection could be the authority empowered to carry out the licensing. It should have the power to ensure that:

- All present waste utilities should apply and frequently reapply for the licensing of their activities

- New activities must apply for licensing before the initiation of the project (simultaneous to the application of the construction permit)

- Monitoring of activities and issuing of fines for violation, including the deprivation or confiscation of a license.

2) Poznan Municipality

Recommendations are given on the prerequisites for a joint venture with foreign companies. As stressed several times above, a joint venture may limit the independence of the municipality in decision making concerning MSWM. It is recommended, therefore, that Poznan Municipality should be a major shareholder to gain control. However, if the partner opposes this condition on grounds of inequality, an article specifying areas where the municipality can veto must be formulated.

The present system where the participation of an unlimited number of contractors is theoretically possible is not appropriate, because it will not optimize transportation and thus will not minimize expenses. The sudden appearance and disappearance of a number of small-scale contractors in the market is also foreseen. Given these situation, a monopolized collection is preferred to joint venture, although it would involve difficulties in securing inexpensive services as the City Council will not be able to enforce changes to secure a reasonable cost level. Bidding must be implemented, therefore, on a collection district of suitable size to control the price level. Furthermore, competitive bidding must be conducted regularly to ensure competitive prices for joint venture services.

In the formulation of the articles for a joint venture, it is important to carefully study the legislations of Poland on joint venture/companies with limited liabilities. In addition to the items mentioned above, the following should be studied also:

- Limitation on dividend to ensure the accumulation of profit

- First refusal on stocks/limitation on the sale of stocks(to prevent unknown partners from getting access to the joint venture)

- Procedure for future extension of share capital

Parallel to the formation of the joint venture, the organization structure of Poznan Municipality should be considered also. The public's obligation to waste management should be acknowledged also and the Municipality must establish a relationship with the citizens to inform them on important matters such as:

- Participation in collection (registration)

- Payment

- Handling of complaints and exemptions

At present, SANITECH takes care of the payment and complaints of the citizens they serve. The involvement of the municipality would ensure better participation, collection of fees through property tax, and the implementation of control required.

Fig.H.6.4-1 shows the proposed Poznan Municipal Organization and Joint Venture Structure. The organization of the municipality will basically remain unchanged. The Department for Communal and Residential Affairs will have extended responsibilities related to the registration of those enrolled in MSWM services, fee collection in cooperation with the financial department. The operation of waste utilities should be placed under the jurisdiction of this department, too. The figure also shows the proposed recruitment procedures of board members for joint venture.

A joint venture is proposed to be organized with a small Technical Advisory Committee to support the Director in the formulation of new activities. The committee will act as an informal Board of Director which may conduct prior discussions on proposals before handing them over to the Board of Directors.

The proposed members of the Board are:

- The Vice Mayor for Technical Matters and Infrastructure as Chairman.
- The Director for the Department for Communal and Residential Affairs.
- Members from the City Council and employees from the Department for Communal and Residential Affairs.

The Technical Advisory Committee is proposed to be settled with members of the Board.

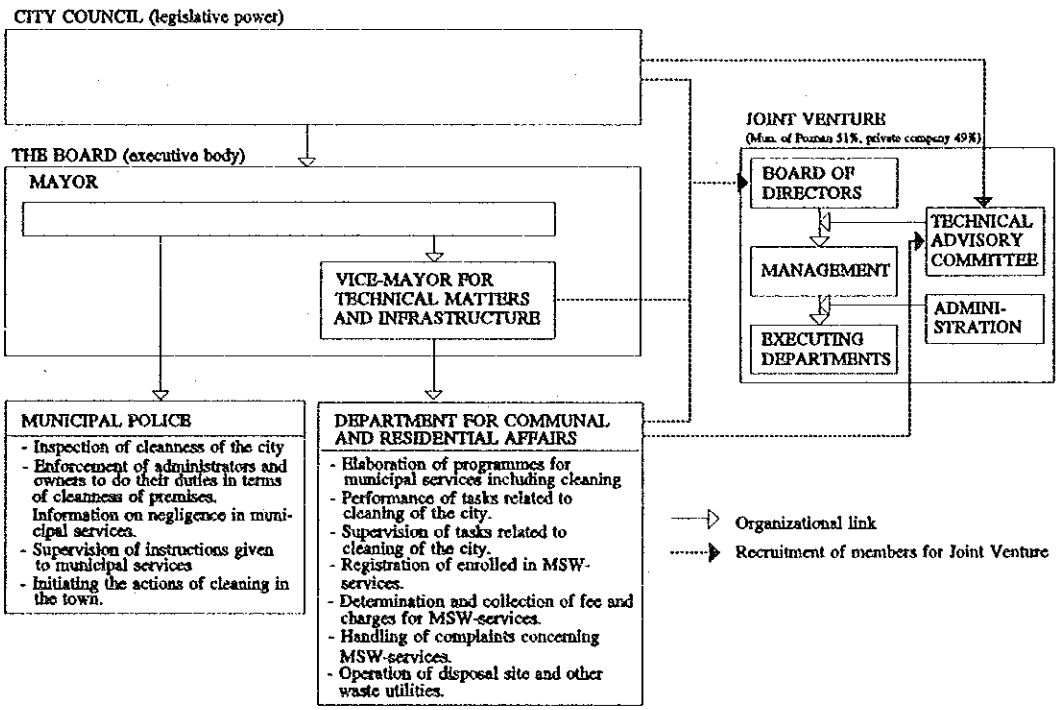


Fig.H.6.4-1 Proposed MSWM Organization of Poznan Municipality

H.6.5 Revenue Source

Solid Waste Management in the city of Poznan basically functions from collection and tipping fees. However, the municipality spends 30 billion zl annually, 2.3% of the whole municipal budget, for the compensation fee of the disposal site, road sweeping costs, snow removing costs, and the reinstatement cost of illegally dumped wastes.

The implementation of the SWM Master Plan is expected to increase the collection fee, and the introduction of intermediate treatment facilities will bring more financial burden to the citizens. In order to establish a self-finance source in 2010, the following two important issues should be taken into account:

- a collection fee system based on the citizens' affordability
- budget allocation

1) Pay Principle

SWM services are essential for the establishment of a comfortable urban life, and also to attain the goal of this study. Technologically, it is important to develop a rational SWM system. Financially, the collection and final disposal costs should be shouldered by the dischargers in accordance with the settled discharge amount, based on the "Polluter Pay Principle".

Table H.6.5-1 Proposed Assignment of Payer for SWM

Payer	Items to be payed
Citizen	Collection and disposal cost for domestic waste
Enterprises (Discharger)	Collection and disposal cost for commercial, market and institutional wastes generated through business activities
Public Authorities	Wastes generated in road, rivers and public areas are shouldered by the government authorities in charge

2) Citizens' Affodability

At present, the citizens of Poznan spend 0.4 to 0.5% of their income on waste collection fees. Considering the percentage allocated to costs such as electricity, water supply, sewerage services, etc., the estimated upper limit of the citizens' share in collection fees is 1% of their income. If the collection fee exceeds the estimated limit, it is the duty of the municipality to provide subsidies for the SWM.

Waste collection fees should cover the following:

- all operation and maintenance costs for waste collection and final disposal in 2001

- all operation and maintenance costs for waste collection and final disposal, including depreciation cost in 2010.

3) Fee Collection Methods

At present, fees are directly collected from waste discharges by waste collectors. this method is deemed effective in suppressing waste generation ratio, as incentives are given to dischargers with less discharge. However, this system could lead to the increase of illegal dumping as well. This direct fee collection system is easy to implement in corporate buildings but difficult in detached and semi-detached housing areas. Therefore, the tax collection method should be considered.

Table H.6.5-2 Comparison of Fee Collection Methods

Item	Advantages	Disadvantages
Direct collection	- Fee can be fairly set based on received services. - Revenue directly related to the fee collection endeavour. - Customers' favour to services can be reflected directly.	- Can lead to illegal dumping - have no proper control system for non payers - An expensive collection fee - customers demand for more services
Corporative collection	- Less expensive collection cost.	- It is not very effective to suppress the waste discharge amount, as it diminishes the interest of the people.
Fee collection other fare of public service	- Less expensive collection cost.	- Most people are dissatisfied because the the services are not worthy of the collection fee imposed.
Tax collection	- The least expense collection cost. - Regional characteristics can be taken into account when deciding to the collection fee.	- People tend to loose interest in collection services.

H.6.6 Public Cooperation

Implementation of modern waste management in Poland necessitates an increased public cooperation mainly in the fields of financing and compliance towards services necessitating public involvement (i.e., source segregation). Therefore, the following environmentally educational programs for the public are recommended.

- Information programmes presenting municipal services as necessary for the betterment of the society and financial contribution as a necessity for obtaining and maintainingservices.

- Information programmes presenting how households can live in an environmentally sound way.

- Changes in attitude: to consider environmental preservation with more importance and environmental misuse a crime.

In other countries, ecological education in schools significantly influence not only the students, but also their parents. The organization of school trips to waste utilities will stimulate the attention and interest of the pupils, students, and school officials.

Economic incentive is deemed important to optimize public cooperation. In the case of recycling, bus tickets are good and useful payments for recyclable materials. The holder may value the bus tickets more than the municipality as they shall be payment for recyclable materials and enables the use of public transportation.

H.6.7 Summary of General Institutional Requirements

The summary of the general institutional requirements is presented in this section.

1) National and Regional Levels

a. Determination of National Policy on MSWM including an Implementation Schedule.

Purpose: To clarify initiatives which necessitate action at national level.

The aim is to define the prerequisites for planning of a local MSWM services at an early stage. The national policy should include a plan for the implementation of legal initiatives and standards.

Responsible: A Responsible Ministry

b. Completion of legislation and standards related to MSWM including improved possibilities for acquisition of land under compulsory powers.

Purpose: To implement the national policy and complete the background for local MSW–plans and projects (legislation and standards). Necessary tools for proper municipal management shall be implemented (possibility for enforcement of compulsory participation in MSW–services, enforced public control of private operation in MSWM etc.).

Responsible: A Responsible Ministry

c. Provision of proper means for financing including municipalities possibilities to raise loans.

Purpose: To furnish local authorities with the possibilities to finance feasible project through loans, taxation etc.

Responsible: A Responsible Ministry

d. Implementation of a Licensing Institution responsible for licensing of waste utilities.

Purpose: To strengthen operation of waste utilities and to ensure sufficient education and training of operation personnel.

A regular licensing of waste utilities will strengthen the public control with operation of waste utilities.

The licensing shall also ensure that data to complete the waste flow is made available to improve the background for new initiatives.

Responsible: A Responsible Ministry

e. Strengthening of supervision during implementation of projects.

Purpose: To ensure that implementation (construction) is in accordance with the approved design.

Increased public supervision is necessary to cover up the inefficient supervision conducted by the investors and the contractors.

Responsible: A Responsible Ministry in cooperation with relevant authorities.

f. Clarification of Private Operational Aspects in MSWM

Purpose: To clarify items where private operation is appropriate or acceptable from the public's point of view

Clarification should be followed by guidelines for private operation including the elaboration of guidelines and legislation concerning competitive bidding.

Responsible: A Responsible Ministry

g. Initiation of Public Education Programmes

Purpose: To prepare the public on increased cooperation in the field of environmental protection.

Initiation can take place through general campaigns making use of the mass-media and through introduction of environmental education in schools.

Responsible: A Responsible Ministry in cooperation with relevant ministries for communication and education.

2) Poznan Municipality

a. Public Control in MSWM

Purpose: In the new joint venture with participation of private investor formed on former Sanitech, public control of services related to municipal solid waste must be preserved to maintain the duty of the municipality for provision of proper and timely services,

Compulsory municipal services must be made independent of commercial activities in order to control the costs.

Responsible: Poznan Municipality.

b. Strengthening of Organization within Department Communal and Residential Affairs

Purpose: To strengthen municipal activities related to MSW-planning and to control of activities in municipal subordinated units a strengthening of Department for Communal and Residential Affairs is appropriate A strengthening may also serve to secure that all matters related to determination of extend of MSW-services and the contact to the citizen (hereunder determination and collection of payment), are performed by the municipal administration.

The operation of the disposal site should be kept as a municipal responsibility, incorporated in the Department for Communal and Residential Affairs to preserve the municipal responsibility on this vital point.

Responsible: Poznan Municipality.

c. Specification of Minimum Waste Services

Purpose: To determine an appropriate level of compulsory waste service to be implemented when legal possibility is clarified.

The aim is to introduce unified service and a unified system for payment.

Responsible: Poznan Municipality.

d. Development of Fee for collection system

Purpose: To collect fees for waste services under municipal responsibility.

Responsible: Poznan Municipality.

e. Introduction of competitive bidding

Purpose: To secure highest value for the money and to introduce private operation in a public service.

The competitive bidding should include daily operation of collection systems and construction of services and facilities in the selected Master Plan alternative.

Responsible: Poznan Municipality

f. Stimulation of Public Cooperation at the Local Level

Purpose: To increase the public cooperation at local level.

An annual ecological marathon similar to the one organized by the JICA Study Team could be an opportunity to meet the citizens with messages and allow for a better communication.

Responsible: Poznan Municipality.

g. Determination of a Fee System Supporting the Waste Flow

Purpose: Formulation of economic incentives to ensure an appropriate waste flow.

Subsidies should be directed to areas where a full charge in collection services is expected to prevent uncontrolled flow of waste. The need for subsidies will be reduced and phased out over a period of time.
Future fees and charges should be announced to reduce later opposition.

Responsible: Poznan Municipality.

h. Nursing of General Public Consensus

Purpose: Poznan Municipality must nurse the general public consensus through fair and informative measures to gain acceptance for localization and implementation of specific projects (eg. localization of new disposal site in Franowo). Ignorance on facts about pollution hazards may cause misunderstandings among the public. Proper information will minimize the opponency.

Responsible: Poznan Municipality.

H.6.8 Institutional Requirements for Master Plan Alternatives

In addition to the general institutional requirements presented in section 4.1.7, the following specific institutional requirements to the Master Plan Alternatives are deemed appropriate:

Master Plan Alternative 1

- Construction of the new disposal site should be subject to competitive bidding.

No further institutional actions required.

Master Plan Alternative 2

- It is necessary to ensure correct use (and thus obtain full benefit) of the recycling centres by stimulating local public cooperation.
- Construction of the recycling centres and the new disposal site should be subject to competitive bidding.

No further institutional actions required.

Master Plan Alternative 3

- It is necessary to succeed in the segregated collection and to ensure correct use (and thus obtain full benefit) of the recycling centers with an intensified stimulation of local public cooperation.
- Poznan Municipality most likely intends to incorporate the recycling plant in the scope of work for the joint venture. It is recommended, however, that the cooperation of private recy cling businesses should be gained to learn of their expertise and to investigate possibilities for better utilization of their equipment before investments are made.
- Construction of the new disposal site, and as much as possible, of the recycling plant should be subject for competitive bidding.

No further institutional actions required.

Master Plan Alternative 4

- The introduction of the incineration plant will considerably increase finances and institutional demands. Gaining the cooperation of the power generating industry, in terms of joint venture, would be of great help to the financing of the incineration plant. The power generating industry is capable of extensive investments and an established cooperation can guarantee a stable market for the produced energy.
- Localization of the incineration plant will necessitate public consensus and the difficulty to obtain it is similar as to the disposal site. A combined localization of incineration plant and disposal site may ease the total resistance for the two projects.
- It is necessary to ensure correct use (and thus obtain full benefit) of the recycling centers by stimulating local public cooperation.
- Construction of the recycling centres, the incineration plant and the new disposal site should be subject to competitive bidding.

No further institutional actions required.

Master Plan Alternative 5

- The introduction of the incineration plant will considerably increase finances and institutional demands. Gaining the cooperation of the power generating industry, in terms of joint venture, would be of great help to the financing of the incineration plant. The power generating industry is capable of extensive investments and an established cooperation can guarantee a market for the produced energy.
- Localization of the incineration plant will necessitate public consensus and the difficulty to obtain it is similar to for the disposal site. A combined localization of incineration plant and disposal site may ease the total resistance for the two projects.
- It is necessary to succeed in the segregated collection and to ensure correct use (and thus obtain full benefit) of the recy cling centers by an intensified stimulation of local public cooperation.

No further institutional actions required.

Master Plan Alternative 6

- Similar to the incineration plant, the composting plant necessitates a considerable investment. To find a partner for joint investment seems more difficult than for the incineration plant. A reliable technical partner may, however, be crucial for successful implementation of composting.
- Localization of the composting plant will probably be more easy with regards to the public acceptance.
- It is necessary with a stimulation of local public cooperation to ensure correct use (and thus obtain full benefit) of the recycling centres.
- Cooperation of the recycling centers, the composting plant and the new disposal site should be subject to competitive bidding.

No further institutional actions required.

Master Plan Alternative 7

- Similar to the incineration plant, the composting plant necessitates a considerable investment. To find a partner for joint investment seems more difficult than for the incineration plant. A reliable technical partner may, however, be crucial for successful implementation of composting.
- Localization of the composting plant will probably be more easy with regards to the public acceptance.
- It is necessary to ensure the correct use (and thus obtain full benefit) of the recycling centers by stimulating local public cooperation.
- Cooperation of the recycling centers, the composting plant and the new disposal site should be subject to competitive bidding.

No further institutional actions required.

Conclusively, the implementation of modern waste management sets comprehensive demands to institutional development, and Poznan Municipality is not an exception.

It is of vital importance to strengthen the municipal organizational structure to fulfill the expectations of the citizens and to comply with the duty of appropriately administering tax revenues.

H.7 Evaluation

H.7.1 Summary of the Alternatives

1) Summary of Alternative Systems

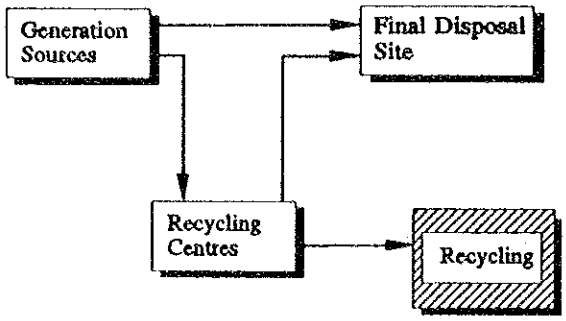
7 alternatives are described below, and their comparison table of 7 alternatives is presented in Table H.7.1-1

Alternative 1

Mix Collection (present system)
Sanitary Landfill

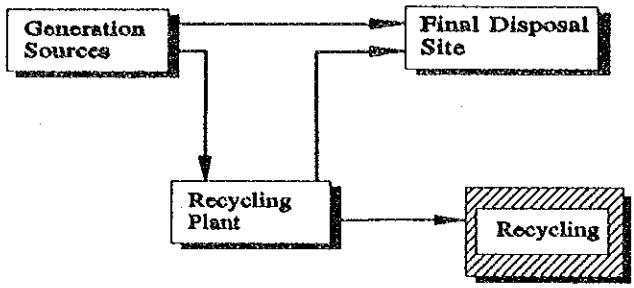
Alternative 2

Mix Collection
Recycling Centres (2-large and 6-small)
Sanitary Landfill



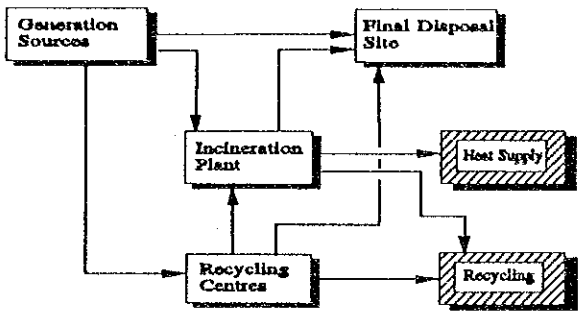
Alternative 3

Separate Collection
Recycling Plant
Sanitary Landfill



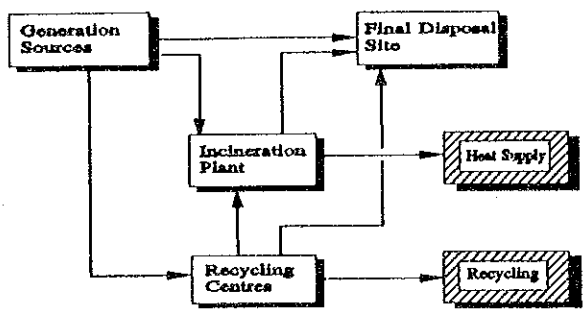
Alternative 4

Mix Collection
Recycling Centres (2–large and 6–small)
Incineration Plant
Sanitary Landfill



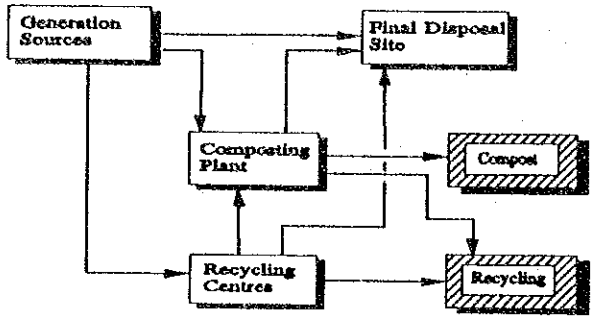
Alternative 5

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



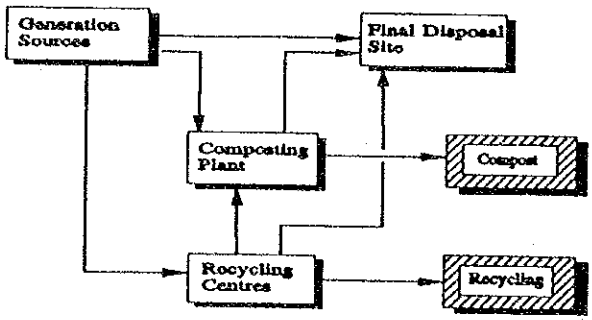
Alternative 6

Combined Collection
Recycling Centres (2-large and 6-small)
Composting Plant
Sanitary Landfill



Alternative 7

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



2) Waste Flow Forecast in the Year 2010 of Each Alternative

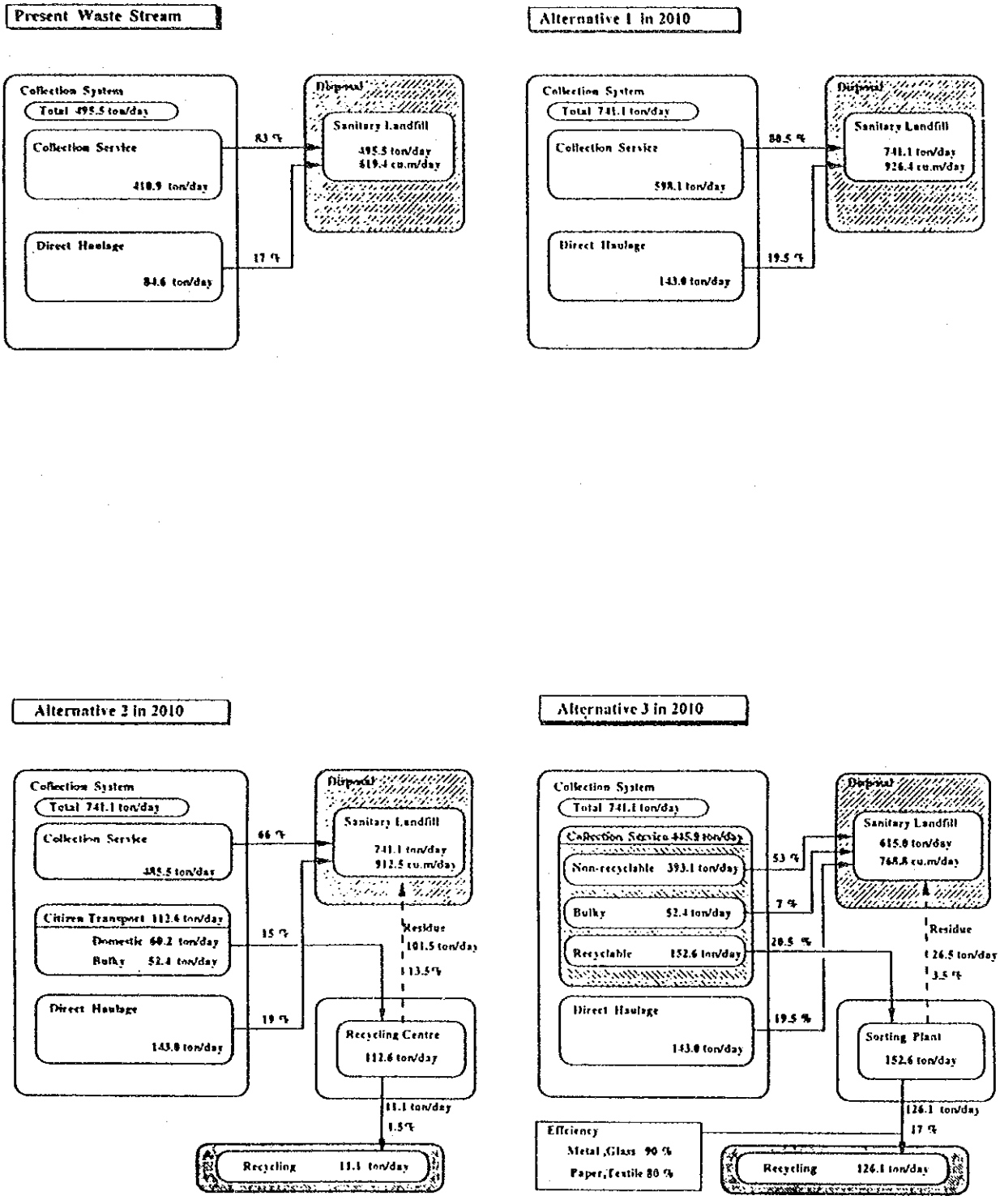
The present waste flow and the waste flow forecast in 2010 of each alternative are presented in Fig.H.7-1.

3) Investment and Annual Expenses

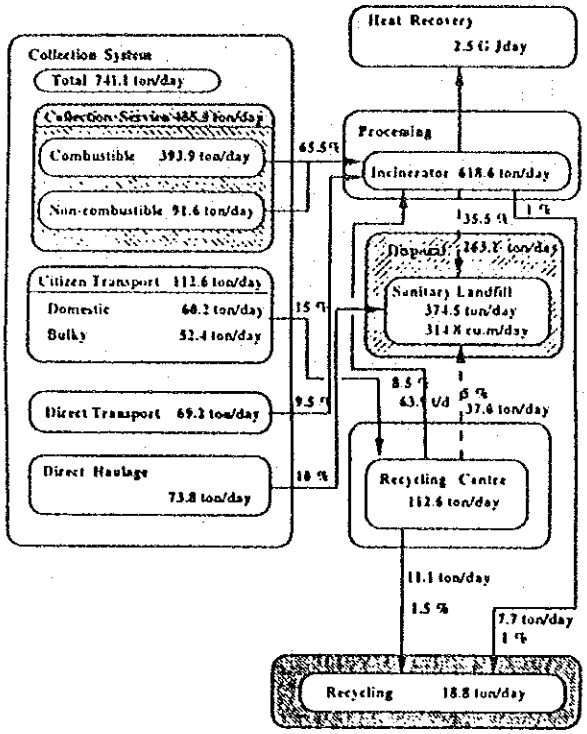
The investment and the annual expenses of the 7 alternatives in 2010 are presented in Table H.7.1-2 and -3.

Table H.7.1-1 Summary of Alternative Systems

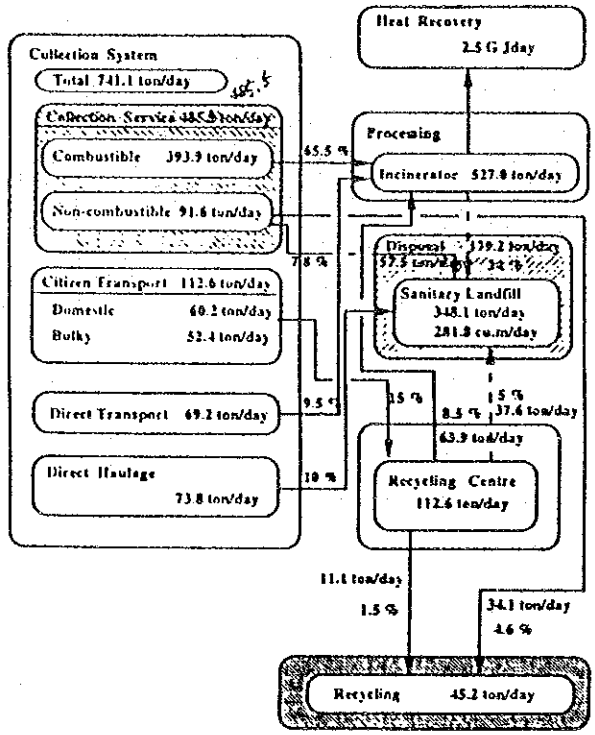
Fig.H.7.1-1 Waste Flow Forecast



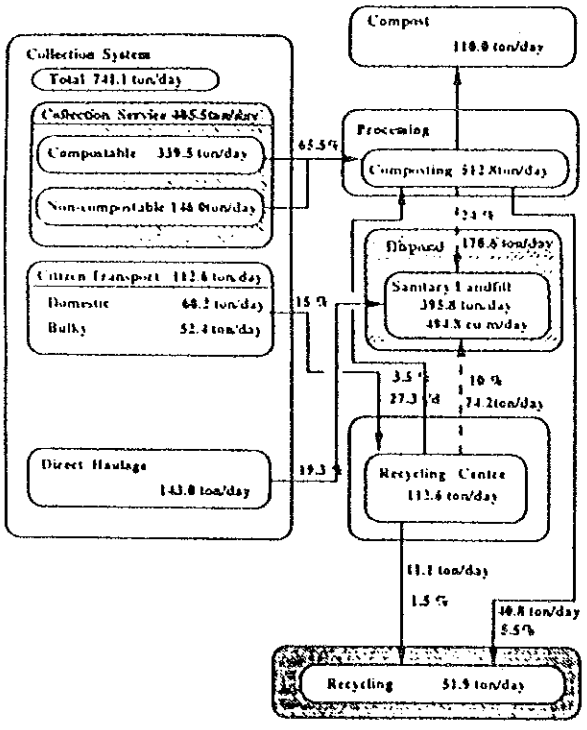
Alternative 4 in 2010



Alternative 5 in 2010



Alternative 6 in 2010



Alternative 7 in 2010

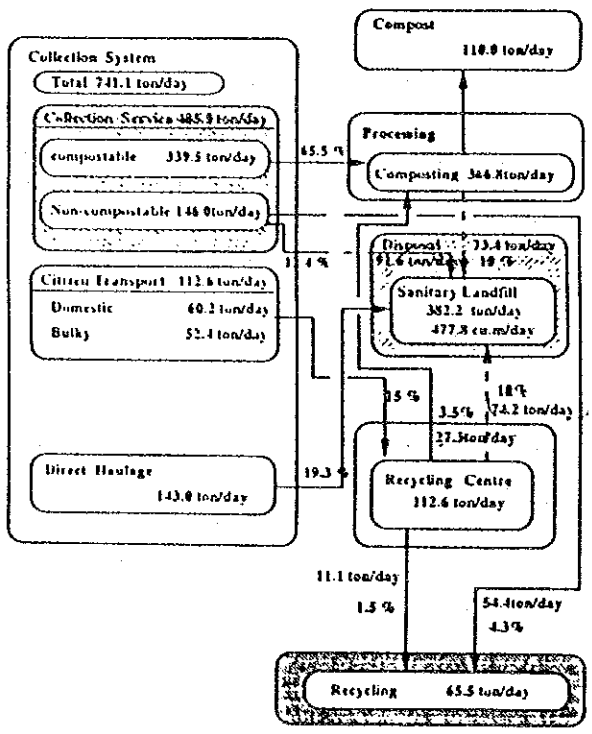


Table H.7.1-2 Investment Cost

unit: mill. zl

	Alt.1	Alt.2	Alt.3	Alt.4	Alt.5	Alt.6	Alt.7
A.Construction							
1) Sorting P. - Civil Work - Machinery			163,000 43,735 119,265				
2) Recycling C. - Civil Work		8,958		8,958	8,958	8,958	8,958
3) Incinerator - Civil Work - Machinery				643,500 90,000 553,500	560,950 79,000 481,950		
4) Composting - Civil Work - Machinery						284,850 125,000 159,850	232,170 100,000 132,170
5) Landfill - Civil Work 1* - Civil Work 2*	182,125 15,375 166,750	182,125 15,375 166,750	182,125 15,375 166,750	98,875 15,375 83,500	98,875 15,375 83,500	126,625 15,375 111,250	126,625 15,375 111,250
Sub Total	182,125	191,083	345,125	751,333	668,783	420,433	367,753
B. Purchase of Vehicles etc.							
1) Collection - Vehicle	51,585	45,405	57,155	45,405	49,305	45,405	49,305
2) Composting - Heavy Eq.						16,150	12,830
3) Landfill - Heavy Eq.	15,000	15,000	15,000	5,600	5,600	8,000	8,000
4) Cleansing - Road Sweeper	12,240	12,240	12,240	12,240	12,240	12,240	12,240
Sub Total	63,825	57,645	69,395	57,645	61,545	73,795	74,375
C. Purchase of Containers							
1) Collection - Container	52,026	42,230	86,267	42,230	70,032	42,230	70,032
2) Recycling C. - Container		3,030		3,030	3,030	3,030	3,030
Sub Total	52,026	45,260	86,267	45,260	73,062	45,260	73,062
Total A + Bx2 + Cx3	465,854	442,152	742,715	1,002,402	1,011,058	703,802	735,688

Note:

*1 The life span of the civil work 1 (building, etc.) is assumed to be 30 years.

*2 The life span of the civil work 2 (liner, earthwork, etc.) is assumed to be 10 years.

Table H.7.1-3 Annual Expenses in 2010

(mil zl)

	Alt.1	Alt.2	Alt,3	Alt.4	Alt.5	Alt.6	Alt.7
Collection							
Depreciation	17,038	14,283	24,602	14,284	20,346	14,284	20,346
Personnel Cost	10,568	8,955	11,689	8,955	9,769	8,955	9,769
Maintenance	2,065	1,817	2,288	1,817	1,973	1,817	1,973
Fuel & etc	13,690	11,452	15,151	11,452	12,507	11,452	12,507
Sub Total	43,360	36,508	53,730	36,508	44,595	36,508	44,595
Recycling C.							
Depreciation		905		905	905	905	905
Personnel Cost		1,613		1,613	1,613	1,613	1,613
Maintenance							
Fuel & etc.							
Sub Total		2,517		2,517	2,517	2,517	2,517
Sorting Plant							
Depreciation			9,409				
Personnel Cost			1,362				
Maintenance			3,742				
Fuel & etc.			4,988				
Sub Total			19,501				
Incinerator							
Depreciation				39,900	34,763		
Personnel Cost				2,340	2,110		
Maintenance				10,632	7,800		
Fuel & etc.				19,113	15,400		
Sub Total				71,985	60,073		
Composting							
Depreciation						16,900	13,794
Personnel Cost						2,610	2,240
Maintenance						4,600	3,738
Fuel & etc						8,700	7,070
Sub Total						32,810	26,843
Landfill							
Depreciation	12,250	12,250	12,250	6,144	6,144	8,085	8,085
Personnel Cost	868	868	868	503	503	503	503
Maintenance	950	950	950	443	443	528	528
Fuel & etc.	3,693	3,693	3,693	1,721	1,721	2,052	2,052
Sub Total	17,761	17,761	17,761	8,811	8,811	11,168	11,168
Cleansing							
Depreciation	1,574	1,574	1,574	1,574	1,574	1,574	1,574
Personnel Cost	864	864	864	864	864	864	864
Maintenance	612	612	612	612	612	612	612
Fuel & Cost	2,682	2,682	2,682	2,682	2,682	2,682	2,682
Sub Total	5,732	5,732	5,732	5,732	5,732	5,732	5,732
Administration							
Depreciation							
Personnel Cost	3,852	3,908	4,607	4,551	4,669	4,607	4,697
Maintenance							
Fuel & etc.							
Sub Total	3,852	3,908	4,607	4,551	4,669	4,607	4,697
Total	70,704	66,425	101,330	130,103	126,397	93,341	95,552

H.7.2 Methodology

1) Planning Objectives

The procedure adopted for the evaluation of the proposed alternatives is shown in Fig.H.7.2-1, and consists of the three following steps:

- formulation of alternative plans in accordance tith the prescribed objectives;
- evaluation of individual alternatives based on four evaluation criteria; and
- synthesis of individual evaluation results.

The goal of the Master Plan is "the development of environmentally sound solid waste management system in Poznan". This can be achieved through the following steps:

- citizen's participation;
- establishment of self-sustainable solid waste management; and
- resource recovery and recycling.

2) Evaluation Criteria

The four evaluation criteria used for highlighting the distinguished features of the alternatives are:

- technical desirability;
- social acceptability and public cooperation;
- environmental acceptability; and
- economic/financial viability.

The alternatives identified are ranked quantitatively and qualitatively based on the above-mentioned evaluation criteria.

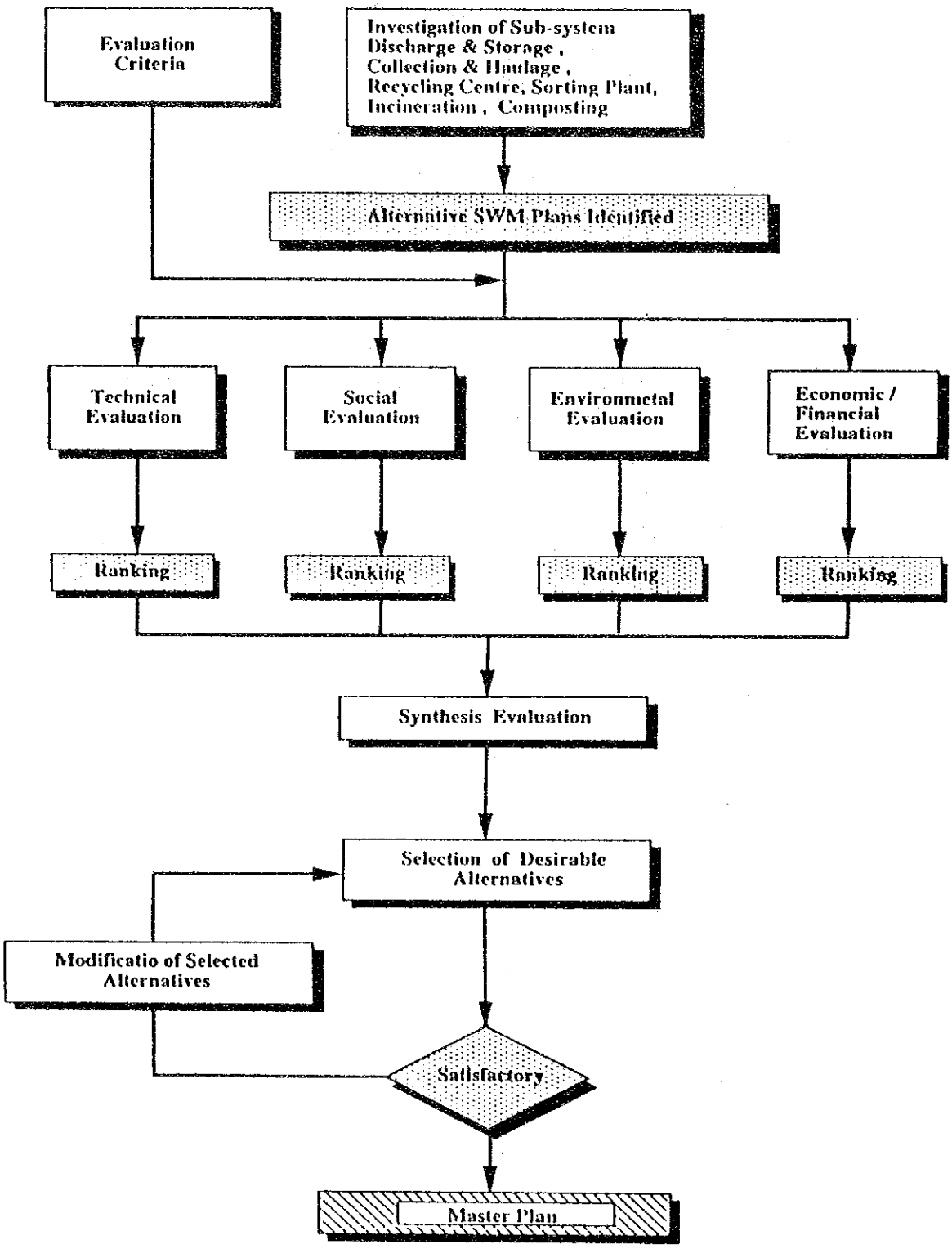


Fig.H.7.2-1 Procedure for the Evaluation of Alternatives

H.7.3 Technical Evaluation

1) Evaluation Factors

The technical evaluation of each alternative plan was conducted on the basis of the following four factors, and the alternatives were ranked accordingly as shown in Table H.7.3-1.

a. Working conditions

- safety and hygiene; and
- equal work load and work suitability.

b. Operation and maintenance

- reliability and maintainability of facilities; and
- difficulty of operation and maintenance

c. Construction

- local availability for construction

d. Indirect advantages

- prospect of future technical development; and
- contribution to fostering or upgrading engineering skills.

2) Evaluation

a. Working Conditions

Workers involved in solid waste management are engaged in different types of work determined by such processes as collection, transportation, control of recycling centres, operation of sorting plant, incineration plant and composting plant and final disposal. The following three types of works in particular require improved working conditions to ensure both safety and hygiene.

- work in each intermediate treatment facilities;
- loading of solid waste into collection trucks; and
- landfill work at disposal sites.

Although the same technical systems will be applied to the discharge/storage, collection/haulage and final disposal, the final disposal amount will vary depending on the alternative. The final disposal amount of Alternative 4, 5, 6 and 7 are one half to one third of Alternative 1, 2 and 3 respectively. Moreover, the working environment at the final disposal site of the Alternative 4, 5, 6 and 7 is much better than in the Alternative 1, 2 and 3, because humus organic materials can be intercepted before arrival in the final disposal site by the intermediate treatment.

Additionally, the improvement of the work conditions for the following operations should be given full consideration.

- segregation work at the sorting plant;
- removal work of bottom ashes at the incineration plant; and
- secondary fermentation work at the composting plant.

Segregation work at the sorting plant is particularly very labour intensive work.

b. Operation and maintenance

i. Operation and maintenance difficulties in the disposal site are estimated to be almost the same at every alternative plan. Operation and maintenance work in Alternatives 4 and 5, however, is estimated to be the easiest, because the amount of waste disposed is the least in these areas and because humus organic wastes are incinerated.

ii. Only few problems can be observed in the operation and maintenancework at the recycling centers as they only involve the transportation of large containers with a roll on-roll-off truck.

iii. Difficulties observed in the operation of the sorting plant lies on the sorting work itself. It is necessary to educate and train the workers to create an effectively functioning sorting plant.

iv. Incineration control is very important and difficult to operate and maintain. Therefore, its operation shall be made automatic. Nevertheless, the workers must be trained and educated to acquire the skills required for a smooth O & M implementation.

v. The quality control of compost products is most important in the operation and maintenance of the composting plant.

Waste segregation should be strictly conducted at generation sources for Alternative 7,because composts of low quality will lead to loss of customers. In addition, organic materials like manuare and night soil must be mixed with municipal organic solid waste to produce composts of fine quality.

c. Construction

The proposed SWM site for the 7 Alternatives is the same, namely Franolowo–Michalowo. The construction of the incineration plant, composting plant, and sorting plant, in this order, will require highly advanced technology. The technology used in Poland presently will be good enough for the construction of all facilities except the incineration plant.

d. Indirect Advantage

Future technological development and the upgrading of engineering skills can be expected from the introduction of the incineration, composting and sorting plants. The introduction of an incineration plant will especially contribute to the establishment of a foundation for incineration technology. (The first incineration plant is under construction in Swietochtowice).

3) Summary of Technical Evaluation

Table H.7.3–1 Summary of Technical Evaluation

Criteria	Alternatives						
	1	2	3	4	5	6	7
a. Working Condition	B	B	C	A	A	A	A
b. Operation and Maintenance	B	B	B	B	B	B	B
c. Construction	A	A	A	B	B	A/B	A/B
d. Indirect Advantage	B	B	A	A	A	A	A
Overall Assessment	B	B	B	A	A	A	A

Note. A:good, B:fair, C:poor

H.7.4 Social Evaluation

1) Evaluation Factors

The social evaluation of each alternative was conducted based on the following factors, and the alternatives were ranked accordingly as shown in Table H.7.4-3.

a. Possibility for land acquisition;

- land use restriction
- land ownership

b. Compatibility with regional development plans

c. Possibility of acquiring neighbourhood consensus;

d. Introduction of public cooperation

- haulage to the recycling centre by citizen
- separate discharge

e. Introduction of resource recovery and recycling system

- recycling centre
- sorting plant
- incineration plant
- composting plant

2) Evaluation

a. Possibility of Land Acquisition

The acquistion of the land for the intermediate treatment facilities is expected to be easy as it is a state agricultural land at present.

The acquisition of the land intended for the recycling centers is also expected to be easy as one recycling center only requires an area of 1,500 to 3,000 m^2.

b. Compatibility with Regional Development Plans

At present, the formulation of the Urban Development Master Plan is being carried out by the Poznan Municipality. According to the Master Plan, only Franowo-Michalowo area is supposed to be proposed as a solid waste facilities site.

c. Possibility of acquiring neighbourhood consensus

The nearest residence is located 200 m away from the border of the proposed site. The approval of the inhabitants is required prior to the costruction of the facilities.

The approval of the majority of the Poznan citizens even only for the sanitary landfill project is said to be very difficult to obtain. In order to obtain the support of the majority of the citizens, the addition of a modern intermediate treatment facility would be very effective.

The facility most attractive to Poznan citizens seems to be the incineration plant which can supply energy and provide amenities such as a thermal swimming pool.

d. Introduction of Public Cooperation

Citizens' particiation is essential to attain the goal of the Master Plan, and all Alternatives except Alternative 1 shall require the cooperation of the public. The recycling center system shall require public cooperatio in carrying wastes from houses to the recycling centers and separate collection shall require it in source segregation. It is difficult, however, to acquire public cooperation. The level of public cooperation required is estimated and shown in Table H.7.4-1.

Table H.7.4-1 Required Public Cooperation Level

Public cooperation item	Alternative						
	1	2	3	4	5	6	7
Self haulage to recycling centres		+		+	+	+	+
Source separation discharge			+		+		+
Required public cooperation level	C	B	B	B	A	B	A

Note: + : necessary
A : more necessary and more difficult
B : necessary and difficult
C : same as present

e. Introduction of Resource Recovery and Recycling System

The recycling centres and the sorting plant are effective measures for recycling, while the composting plant and incineration plant are important in resource recovery. The benefits obtained through the alternative systems were calculated and summarized in Table H.7.4-2.

Table H.7.4-2 Level of Resource Recovery and Recycling (mill Zl)

	Alternative						
	1	2	3	4	5	6	7
Benefit	0	78	246	328,166	328,054	6,779	20,112
- Recycle	0	78	246	190	78	282	78
- Heat recovery	0	0	0	327,976	327,976	0	0
- Compost	0	0	0	0	0	6,497	20,034
Order of recycling and resource recovery	7	6	5	1	2	4	3

Note: Economic price base and total benefit from 2001 to 2010.

f. Transactional Facilitation

Obtaining the approval of the neighborhood on Alternatives 1,2 and 3 would require enormous effort due to the possibilities of environmental pollution by organic wastes.

It will not be that difficult, however, to obtain the approval of the neighborhood for the establishment of an incineration plant operation unit required in Alternatives 4 and 5.

It would also take enormous effort to gain the approval of the neighborhood concerning the establishment of a composting plant operation unit in Alternatives 6 and 7, due to the odor that would emanate from the plant.

3) Summary of Social Evaluation

Social evaluation is summarized in Table H.7.4-3.

Table H.7.4-3 Summary of Social Evaluation

Criteria	Alternatives						
	1	2	3	4	5	6	7
a. Possibility of land acquisition	A	A	A	A	A	A	A
b. Compatibility with regional development	A	A	A	A	A	A	A
c. Possibility of acquiring people's consensus	C	C	B	A	A	B	B
d. Introduction of public cooperation							
e. Introduction of resource recovery and recycling system	C	C	B	A	A	B	B
f. Transactional facilitation	C	C	C	A	A	B	B
Overall Assessment Result	C	C	B	A	A	B	B

Note. A: Good, B: Fair, C: Poor

H.7.5 Environmental Evaluation

1) Evaluation Factor

Since the 7 alternatives may have a diverse environmental impact on the surrounding area, estimating the extent of such impact will not be easy, due to difficulties in obtaining pertinent data at this stage of the study. Efforts are made, therefore, to examine the possibilities regarding the following sensitive issues associated with the planning considerations.

- Surface water pollution
- Groundwater pollution
- Soil contamination
- Air pollution
- Odour
- Dust and scattered wastes
- Traffic noise
- Traffic safety
- Operation noise
- Impact on landscape
- Others (treatment of hospital waste and sewage sludge)

2) Evaluation

a. Surface Water Pollution, Groundwater Pollution and Soil Contamination

There is still a minimum possibility of leachate seepage even if a liner is applied at the proposed landfill to prevent groundwater pollution in accordance with the EC standard.

The possibilities were estimated based on the final disposal amount, and the results are shown in Table H.7.5-1.

Table H.7.5-1 Possibility of Water Pollution

	Alternative						
	1	2	3	4	5	6	7
Final disposal amount from 1993 until 2010 ($1,000m^3$)	4,573	4,531	4,096	2,697	2,762	3,038	3,199
Possibility of pollution	1	2	3	7	6	5	4

At the composting plant site, water pollution may occur due to run-off rain water at the compost stock pile during the second fermentation done outdoors for a period of 6 weeks.

The possibility of water pollution occurring at the incineration plant is only minimum as the plant is completely covered.

b. Air Pollution

The incineration plant can also produce a minimum amount of air pollution, but its effect on people is within the permissible amount because of the installation of a flue gas cleaning system based on the semi-dry principle, which is fully in compliance with the EC standard.

c. Odour

Among the facilities, the composting plant, followed by the landfill site, produces a lot of pungent odor.

d. Dust and Scattered Wastes

The production of dusts and scattered wastes is difficult to prevent in landfill sites regardless of the perfect and immediate execution of the earth coverage operation. The impact is said to be related to the final disposal amount.

e. Traffic Noise and Safety

This impact is related to the traffic volume to the SWM facilities. The biggest traffic volume is observed in Alternative 3, an estimate of 348 vehicles daily. The smallest is in Alternative 4, an estimate of 270 vehicles daily. Only a

small difference was observed between impacts related to traffic noise and traffic safety.

f. Operation Noise

The sources of noise in landfill sites and intermediate plants are heavy construction machines and composting plants, the former being the noisiest.

g. Impact on Landscape

In terms of the required scale for the final disposal site, the impacts of Alternatives 1,2 and 3 are respectively bigger, and in terms of the scale of the intermediate treatment facilities, the composting plant has the biggest impact.

h. Others

There is a serious possibility that the environment could get polluted by hazardous wastes, due to the sewage sludge and hospital wastes disposed of at the landfill site. And this situation will not be improved in Alternatives 1,2 and 3. In Alternatives 6 and 7, the compost produced from sewage sludge will act as secondary pollutants due to the contamination of heavy metals. Incineration is the only method that would enable the neutralization of such hazardous wastes. Therefore, it is most preferable for environmental protection.

3) Summary of Environmental Evaluation

Table H.7.5-2 Summary of Environmental Evaluation

Criteria	Alternative						
	1	2	3	4	5	6	7
a. Surface water pollution	B	B	B	A	A	A/B	A/B
b. Groundwater pollution	B	B	B	A	A	A/B	A/B
c. Soil contamination	B	B	B	A	A	A/B	A/B
d. Air pollution	A	A	A	B	B	A	A
e. Odour	B	B	B	A	A	B	B
f. Dust and scattered wastes	C	C	C	A	A	B	B
g. Traffic noise	B	B	B	B	B	B	B
h. Traffic safety	B	B	B	B	B	B	B
i. Operation noise	B	B	B	A	A	A/B	A/B
j. Impact on landscape	C	C	C	B	B	B/CC	B/C
k. Others (hospital waste, sewage sludge)	C	C	C	A	A		C
Overall Result	C	C	C	A	A	B	B

Note. A: Good, B: Fair, C: Poor

H.7.6 Economic and Financial Evaluation

1) Principles for Evaluation

The establishment of a rational and cheap SWM system shall take precedence over other factors in consideration of the increasing tendencies inherent in public services.

However, the system should not only be determined according to a country or region's rational and economic conditions in terms of a global environmental viewpoint. At present, it is supported by the majority with the idea that costs for environmental protection should be fairly shouldered by everybody.

Although a rapid economic and social development is difficult to attain due to the current recession, the following principles were formulated for the evaluation of the MSWM Master Plan.

- To quantitatively and qualitatively analyse the direct benefits in terms of the above view regarding economic evaluation.

- To conduct a financial evaluation based on long-term views, considering not only the least cost but also the affordability of the Poznan citizens and municipality.

2) Economic Evaluation

The costs and benefits between 1998 and 2020 were computed based on the pre-conditions described below.

a. Pre-Conditions for Economic Evaluation

i. Economic Effects

The following effects were calculated as the direct effects.

- Recycling and resource recovery
- Reduction of collection cost and disposal cost

The effect brought about by the prolongation the life span of the final disposal site was included in the shadow price of the land as effective use of land.

ii. Economic Prices

The economic price was calculated on the basis of the cost estimation result of the proposed project. However, for the following prices, the economic prices were used instead of the market prices.

- Heat price — The heat price of the incineration plant was set in 3.5 USD/GJ similar to the price offered by the heat plant of equivalent scale.
- Land prductivity — The land price was calculated to be 241.5 USD/ha based on the wheat production rate since this land is used for agriculture.
- Compost — The present price used for fine compost, 3.7 USD/ton, was maintained. The price established for the compost produced in alternative 6 is 1.2 USD/ton, 1/3 of the fine compost price, as it is of lowerquality.
- Recyclable material — The prices set for the recyclable materials were based on the present price data in Poznan and Japan.

iii. Investment Schedule for Facilities

- The scheduled construction period is 3 years.
- All proposed facilities are supposed to be constructed in this period.
- Investment schedule is as follows;
  - in 1998: 43 %
  - in 1999: 24 %
  - in 2000: 33 %

iv. Final Disposal Site

- Expiration of a use term is 2010.
- The required term for monitoring is 10 years after the completion of landfill.
- The evaluated term is until 2020, and only costs for monitoring and land occupation are included after 2011.

v. Book Value of Plant

The salvaged book value of SWM plants are calculated as the minus cost in the year of 2011 because it is expected to be used for 15 years in calculation.

vi. O & M cost of SWM Facilities

O & M cost is assumed to vary in proportion to the disposal amount.

b. Evaluation of Benefits

i. Benefit by the improvement of service coverage

The objectives from SWM are to maintain satisfactory sanitary conditions for public and to maintain a fine environment through the immediate collection and removal of wastes generated by the urban activities.

The general benefits from obtained by the improvement of service coverage are as follows:

- Periodical collection is effective for the prevention of the wide-spread of diseases as it contributes to the suppression of the generation of flies, mosquitoes and maggots.

- Periodical collection is indispensable to the maintenance of the city landscape as it prevents wastes from scattering.

- The periodical collection creates a fine environment and gives the charming impression to the tourist.

- Improvement in the collection work condition improves collection work effeciency.

The benefits of an improved service coverage were not quantitatively analyzed because of difficulties and because they are equally generated in all Alternatives. Only qualitative analysis was thereby conducted.

The cost incurred by the present waste collection system was considered to be beneficial.

Increase in the recovery rate of recyclable materials obtained from the introduction of separate collection was calculated as a direct benefit.

ii. Benefits from Sanitary Landfill

The benefits that can be obtained from the final disposal site, Franowo–Michalowo, is the minimum effort needed in its acquisition. The land can be used for a long term as it is wide and located within Poznan City. Moreover, the compensation money presently spent on Such Las can be used for other purposes.

These benefits were not quantitatively analyzed due to difficulties and because they are also equally generated in other alternatives. Only qualitative analysis was thereby conducted.

The cost incurred by the present system was considered as a benefit.

iii. Benefits from recycling centers

The benefits obtained from the introduction of recycling centers are divided into two: recovery of reusable materials and the reduction of collection cost. Further, this system also reduces the final disposal amount, albeit at a small scale.

The collection cost will be reduced by 10% as compared to the total cost of collection and recycling centers. The collection amount will decrease by 20% and the final disposal amount by 1.5%.

- Benefits of recycling are shown in Table H.7.6–1.

Table H.7.6-1 Benefit of Recycling in Recycling Centres

Material	Recycled amount ton/day	Unit rate zl/ton	Amount mill. zl/year
Glass	1.4	50,000	25.55
Textile	0.7	500,000	127.75
Paper	4.2	350,000	536.55
Metal	4.8	4,010,000	7,025.52
Total			7,715.37

- Benefit of the reduction of collection cost is as follows.

	Alt.1	Alt.2
Collection cost	43,360.3	36,507.5
Recycling centres cost	**2,517.4**	
Total cost (mill.zl/year)	43,360.3	39,024.9

Benefit = 43,360.3 – 39,024.9 = 4,335.4 mill. zl/year

- Benefit of reduction of the final disposal cost

	Alt.1	Alt.2
Disposal amount (m^3/day)	926.4	912.5
Disposal cost (mill. zl/year)	17,760.5	17,494.0

Benefit = 17,760.5 – 17,494.0 = 266.5 mill. zl/year

This benefit was not included in the economic evaluation because it is very small.

iv. Benefit from the sorting plant

The benefits obtained from the sorting plant are divided into two; recovery of reusable materials and the reduction of final disposal cost. The collection cost will increase due to the introduction of separate collection.

The final disposal amount will decrease by 17 %.

Benefit of recycling is shown in Table H.7.6-2.

Table H.7.6-2 Benefit of Recycling from the Sorting Plant

Material	Recycled amount ton/day	Unit rate zl/ton	Amount mill. zl/year
Glass	24.6	50,000	448.95
Textile	10.9	500,000	1,989.25
Plastic	13.0	100,000	474.50
Paper	65.4	350,000	8,354.85
Metal	12.2	4,010,000	17,856.53
Total			29,124.08

- Benefit of reduction of the final disposal cost

	Alt.1	Alt.3
Disposal amount (m^3/day)	926.4	768.8
Disposal cost	17,760.5	14,739.1

Benefit = 17,760.5 - 14,739.1 = 3,021.4 mill. zl/year

v. Benefit from the incineration plant

The benefits from the incineration plant are mainly divided into three; waste volume reduction, waste neutralization and heat recovery.

- Waste volume reduction will prolong the life span of the landfill site and reduce the final disposal cost.

- Neutralization of hazardous waste will facilitate safe treatment of hospital waste and sewage sludge.

- As for the heat energy situation in Poznan, 60 % of the total demand is covered by the district heating plants which do not have proper environmental protection measures. It is said that 10 % of the GDP is lost to environmental pollution wherein 46 % is caused by air pollution. The introduction of the recovery of heat energy generated by the incineration plant, which meets the severe environmental standard specified by European Community, will reduce the effect of coal, a raw resource, and help in protecting the environment. These benefits were estimated by conducting a comparison with the conditions of the plant providing an equivalent amount of heat.

The incineration plant with a capacity of 224,000 ton/year supplies the same amount of heat provided by a heating plant of one million GJ/year. (Note. Calorific vale of waste is 7,000 kJ/kg; working hour is 8,000 hours/year; and efficiency is 0.8)

Table H.7.6-2 Comparison of Heat Supply Plant and Incineration Plant

Items		Heat Supply Plant	Incineration Plant
Initial investment	(mill.zl)	185,000	643,500
O & M cost	(mill.zl/year)	35,000	29,000
Depreciation	(mill.zl/year)	12,300	42,900
Total cost	(mill.zl/year)	47,300	71,900
Amount of heat generation	(GJ/year)	1,000,000	1,000,000
Price	(USD/GJ)	3.5	5.3

Accordingly, the calculated benefits of heat supply in 2010 amount to 30,080 mill. zl, using 3.5 USD/GJ as an for the economic price level.

- The final disposal amounts in weight (in volume) will be reduced to 50 % (34 %) in Alternative 4 and 52 % (35 %) in Alternative 5 by the effect by incineration up to the year 2010. The reduction will result in curtailed final disposal costs, saving an amount of 8949.4 mill.zl/year,(50 %).

  A reduced final disposal amount will also lead to the reduction of the area required for the disposal site, enabling the use of the surplus area for the other purpose.
  If the surplus area is used for the cultivation of wheat, the benefits will include the following :

  . the crop of wheat in Poland in 1987 3.7 ton/ha
  . the import amount of wheat in 1986 155 mill. USD
  . the import quantity of wheat 1.662 mill. ton

  The direct expense rate for production is assumed to be 30 %,

  3.7 x (155/1.662) x 0.7 = 241.5 USD/ha
  241.5 x 13,500 zl/USD x (70-45.5) = 79.9 mill. zl

- The old method of disposing sewage sludge at the landfill site still continues at present. It is most recommendable for sewage

sludges to undergo incineration prior to their disposal. The benefits from the treatment of sludge by incineration are as follows:

. amount of sludge in 2010: 69.2 ton/day
. required coal for incinerating 1 ton sludge: 99 kg
. international price of coal: 25 USD/ton

Hence;
Benefit = 69.2 x 365 days x 0.099 x 25 x 13,500 zl/USD = 843.9 mill. zl

- The total benefits from incineration is summarized in Table H.7.6-3.

Table H.7.6-3 Benefit from the Incineration Plant

Items	Benefit (mill. zl)
Heat supply	47,300
Reduction amount of final disposal	8,949
Reduction of final disposal area	80
Sewage sludge treatment	844
Total	57,173

Table H.7.6-4 Cost of the Incineration Plant (Annual Expenses in 2010)

Items	Cost
Alternative 4	71,985 mill.zl
Alternative 5	60,073 mill.zl

According to the analytical results of the costs and benefits, the costs exceed the benefits in both alternatives.

vi. Benefit from the composting plant

The benefits that can be obtained from the introduction of a composting plant are divided into three; waste volume reduction, neutralization of waste, and production of compost.

- Benefits of compost production

The possibility of selling the fine composts produced in Alternative 7 according to the market price is considered a direct benefit. If the price of compost produced in Alternative 6 is only 1/3 of the market price, this compost is not of good quality and can only be used for recultivation and dressing of garden soil.

- Benefits of a reduced final disposal cost

The final disposal amount in Alternatives 6 and 7 will be reduced to 46% and 52%, respectively, up to the year 2010 through composting and will deduct 37%, 6,592.5 mill. zl/year, from the final disposal cost.

- Benefits of a reduced final disposal site area

The reduction in the final disposal amount will lead to the reduction of the area required for the disposal site, enabling the use of the surplus area for other purposes. If the surplus area is used for the cultivation of wheat, the benefits will include the following:

.	the crop of wheat in Poland in 1987	3.7 ton/ha
.	the import amount of wheat in 1986	155 mill. USD
.	the import quantity of wheat	1.622 mill. ton

The direct expense rate for production is assumed to be 30 %,

3.7 x (155/1.662) x 0.7 = 241.5 USD/ha

Alternative 6:

241.5 x 13,500 zl/USD x (70 - 57.0) = 42.4 mill. zl

Alternative 7:

241.5 x 13,500 zl/USD x (70 - 56.0) = 45.6 mill. zl

- The total benefits from the composting plant is summarized in Table H.7.6-5.

Table H.7.6-5 Benefit and Cost from the Composting Plant

Items	Benefit (mill.zl)	
	Alt.6	Alt.7
Compost production	650	2,005
Reduction amount of final disposal	6,593	6,593
Reduction of final disposal area	42	46
Total	7,280	8,638
Cost of the composting plant	32,814	26,849

According to the analysis result of the costs and benefits, the costs exceed the benefits in the both alternatives.

c. Summary of Economic Evaluation

All the benefits from 2001 to 2010 are summarized in Table 16. The cost saving benefits and the indirect benefits were included in the cost of each alternative, and the pure cost which is obtained by excluding recovery benefit from the total cost was used for the evaluation.

The total cost and benefits between 1998 and 2020 are summarized in Table 17. The cost benefit ratios of the alternatives are below 1. The economic internal rate of return is thereby meaningless. The total cost of each alternative varies depending on the discount rate. The composting plant alternatives are better than the incineration plant alternatives in terms of the net cost because the total investment is less.

Table H.7.6-6 Benefit (from 2001 to 2010) of Each Alternative

unit: mill. zl in 1992 price level

	Discount Ratio / Benefit			0%	5%	10%
Alt 2	Direct	Recovery	Heat Supply	0	0	0
			Compost Supply	0	0	0
			Recycling	78	43	24
		Cost-save	Transportation	58,597	30,746	16,858
			Landfill	8,297	4,194	2,228
	Indirect		Land-use	0	0	0
	Total			66,971	34,982	19,111
Alt 3	Direct	Recovery	Heat Supply	0	0	0
			Compost Supply	0	0	0
			Recycling	246	133	75
		Cost-save	Transportation	-103,994	-65,071	-42,599
			Landfill	16,503	8,621	4,732
	Indirect		Land-use	-29	-17	-11
	Total			-87,274	-56,334	-37,803
Alt 4	Direct	Recovery	Heat Supply	327,976	177,631	100,817
			Compost Supply	0	0	0
			Recycling	190	104	60
			Sludge Treatment	7,242	3,921	2,225
		Cost-save	Transportation	85,601	49,362	29,975
			Landfill	108,813	63,510	38,789
	Indirect		Land-use	366	154	72
	Total			530,188	294,681	171,937
Alt 5	Direct	Recovery	Heat Supply	327,976	177,631	100,817
			Compost Supply	0	0	0
			Recycling	78	43	24
			Sludge Treatment	7,242	3,921	2,225
		Cost-save	Transportation	2,154	-2,817	-4,165
			Landfill	103,718	60,740	37,212
	Indirect		Land-use	365	154	72
	Total		Land-use	441,532	239,671	136,184
Alt 6	Direct	Recovery	Heat Supply	0	0	0
			Compost Supply	6497	3,511	1,988
			Recycling	282	155	89
		Cost-save	Transportation	85,601	49,362	29,975
			Landfill	91,604	53,285	32,452
	Indirect		Land-use	242	93	39
	Total			184,227	106,404	64,543
Alt 7	Direct	Recovery	Heat Supply	0	0	0
			Compost Supply	20,034	10,825	6,131
			Recycling	78	43	24
		Cost-save	Transportation	2,154	-2,817	-4,165
			Landfill	91,604	53,286	32,453
	Indirect		Land-use	254	100	43
	Total			114,123	61,436	34,486

Table H.7.6-7 Economic Evaluation

unit: bill. zl

	Alt.1	Alt.2	Alt.3	Alt,4	Alt.5	Alt,6	Alt.7
Discount ratio (0%)							
Total Cost 1998-2010	593.9	508.0	878.1	1125.9	1123.5	798.2	810.1
Total Benefit 2001-2010		0.1	0.2	328.2	328.1	6.8	20.1
Net Cost	593.9	507.9	877.9	797.7	795.4	791.4	790.0
Rank	2	1	7	6	5	4	3
Discount ratio (5%)							
Total Cost 1998-2010	346.9	297.6	550.5	788.9	773.6	525.6	525.2
Total Benefit 2001-2010		0.0	0.1	177.7	177.7	3.7	10.9
Net Cost	346.9	297.6	550.4	611.2	595.9	521.9	514.2
Rank	2	1	5	7	6	4	3
Discount ratio (10%)							
Total Cost 1998-2010	213.9	184.1	362.0	565.9	548.0	360.2	355.4
Total Benefit 2001-2010		0.0	0.1	100.8	100.8	2.1	6.2
Net Cost	213.9	184.1	361.9	465.1	447.2	358.1	349.2
Rank	2	1	5	7	6	4	3
Assessment	A	A	B	C	C	B	B

3) Financial Evaluation

The financial evaluation for the year 2010 was carried.
The following rates were assumed;

Table H.7.6-8 Basic Rates

Items		Unit rate
Heat price	(zl/GJ)	49,000
Recycling		
- Glass	(zl/ton)	50,000
- Textile	(zl/kg)	500
- Plastic	(zl/kg)	100
- Paper	(zl/kg)	350
- Metal	(zl/kg)	4,010
Compost (The compost in the alternative 6 can not be sold due to the poor quality.)	(zl/ton)	50,000

The expenditure includes depreciation and no interest.
The Alternative 2 is the least cost alternative. Among the alternatives including the intermediate facility, the alternative 5 is the least cost alternative. However, it is not the least cost alternative if the interest of 6 % is considered.

If the Municipality of Poznan bears the cost required for item iii below, the financial share for all alternative will only amount to 6% of the overall municipal budget. Long term and low interest loans will be necessary for alternatives requiring incineration plants, however, as the estimated expenses will exceed the total budget by 10% from 1998 to 2000.

On the other hand, it would be difficult to transfer the financial burden to the citizens, especially with regard to Alternatives 3,4,5,6 and 7, because they are only capable of allocating 1% of their average annual income to the cause, an amount estimated by the case 2 economic growth forecast of lower growth.

In order to identify the financial source, the assignment of the cost burden was calculated by each alternative on the basis of the following pre-conditions.

i. The defrayments of each party in the year 2010 for Alternative 1 is shown in Table H.7.6-9

Table H.7.6-9 Defrayments of Each Party

	Collection (mill.zl)	Cleansing (mill.zl)	Landfill (mill. zl)	Total (mill. zl)	Defrayment per ton (zl)
Citizen	36,741		11,081	47,822	305,413
Enterprises					
- Collection and disposal	9,780		3,230	13,010	305,413
- Direct haulage			3,520	3,520	70,770
Municipality					
- Collection and disposal					
- Road sweeping		6,178	174	6,352	2,597,039
Total	46,521	6,178	18,005	70,704	

The ratio of the share to income of citizen is shown in Table H.7.6-10 for Case 1 and Case 2, respectively.

Table H.7.6-10 Citizen's Defrayment

	Case 1	Case 2
Number of households (nos.)	194,950	194,950
Average income (real term) (zl/household/month)	5,653,800	3,972,600
Citizen's burden (mill. zl)	47,822	47,822
Rate of burden to income (%)	0.36	0.51

As for Alternatives 2,4,5,6 and 7, the citizens will be requested to cooperate by carrying wastes to the recycling centers, and incentives will be formulated to smoothly implement the system. The introduction of recycling centers will reduce collection cost by 10% and collected amount of waste by 20%. Assuming a similar fee system, the revenue of Alternatives with recycling centers, which is gained through the collection of fees, will be less.

In the analysis, a constant increase in the rate of the collection fee was assumed to avoid a sharp increase.

ii. The loan conditions for the initial investment was assumed as follows;
- Grace period: 5 years
- Term of redemption: 20 years
- Interest rate: 6 %/year

iii. The Municipality is assumed to bear the followings;
- O & M cost for road sweeping and public area cleansing
- Investment for refuse vehicles and landfill
- Repayment of loan for intermediate treatment
- Subsidization of household waste collection during the implementation of a higher fee tariff.

According to the Table, the municipality must spend 4 to 6 % of its budget on SWM in the year 2005 for Alternative 3, 4, 5, 6 and 7.

4) Summary of Economic and Financial Evaluation

Alternative 2 involves minimum cost both in the economic and financial evaluation. Therefore, it is considered as the optimum technical system of the MSWM Master Plan.

Table H.7.6-11 Summary of Financial Evaluation

unit:bill. zl

Alternative	1	2	3	4	5	6	7
Investment Cost	465.9	442.2	742.7	1002.4	1011.1	703.8	735.7
Rank	2	1	5	6	7	3	4
Annual Expenses (excluding depreciation)	39.8	37.4	53.5	67.3	62.7	51.6	50.8
Rank	2	1	5	7	6	4	3
Annual Expenses (including depreciation) (C)	70.7	66.4	101.3	130.1	126.4	93.3	95.6
Rank	2	1	5	7	6	3	4
Sale of Heat etc. (R)		0.0	0.0	39.5	39.5	0.0	2.4
(C)-(R)	70.7	66.4	101.3	93.0	90.5	93.3	93.2
Rank	2	1	7	4	3	6	5
Actual Cost (including interest of 6 %)	70.7	66.4	106.5	113.6	108.4	102.9	101.0
Rank	2	1	5	7	6	4	3
Assement	A	A	B	B	B	B	B

Table H.7.6-12 Changes in the allocation of share of MSWM Cost (Interest Rate: 6 %)

unit: mill. zl/year

	Present	2001	2010
Alternative 1			
Citizen	19,147 (6,586)	27,349	47,822
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	143.6	245.3
Ratio (%)	0.5 (0.15)	0.5	0.5
Enterprise	6,128	7,704	12,662
Municipality	14,579	19,254	10,220
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	0.4	0.4
Total	39,854	54,307	70,704
Alternative 2			
Citizen	19,147 (6,586)	21,879	38,258
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	114.9	196.2
Ratio (%)	0.5 (0.15)	0.4	0.4
Enterprise	6,128	7,704	12,662
Municipality	14,579	22,896	15,497
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	0.4	0.5
Total	39,854	52,479	66,417
Alternative 3			
Citizen	19,147 (6,586)	27,349	47,822
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	143.6	245.3
Ratio (%)	0.5 (0.15)	0.5	0.5
Enterprise	6,128	7,704	12,662
Municipality	14,579	52,471	46,032
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	3.1	1.6
Total	39,854	89,748	106,516
Alternative 4			
Citizen	19,147 (6,586)	21,879	38,258
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	114.9	196.2
Ratio (%)	0.5 (0.15)	0.4	0.4
Enterprise	6,128	7,704	12,662
Municipality	14,579	85,776	59,618
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	5.1	2.1
Total	39,854	115,359	110,537
Alternative 5			
Citizen	19,147 (6,586)	21,879	38,258
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	114.9	196.2
Ratio (%)	0.5 (0.15)	0.4	0.4
Enterprise	6,128	7,704	12,662
Municipality	14,579	77,537	53,281
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	4.6	1.9
Total	39,854	107,120	104,200
Alternative 6			
Citizen	19,147 (6,586)	21,879	38,258
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	114.9	196.2
Ratio (%)	0.5 (0.15)	0.4	0.4
Enterprise	6,128	7,704	12,662
Municipality	14,579	64,490	52,024
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	3.9	1.8
Total	39,854	94,073	102,944
Alternative 7			
Citizen	19,147 (6,586)	21,879	38,258
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	114.9	196.2
Ratio (%)	0.5 (0.15)	0.4	0.4
Enterprise	6,128	7,704	12,662
Municipality	14,579	52,471	52,471
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	3.1	1.9
Total	39,854	89,751	100,996

Note:

i. Interest (6%) is only considered in the depreciation of intermediate treatment facilities for the Alternative 3, 4, 5, 6 and 7.
ii. Present share was calculated based on the revenue and expenditure of the Sanitech in 1991.
iii. The figures in parentheses are based on the present fee tariff.
iv. Enterprises include disposal fee for market, commercial, institutional and direct haulage wastes.
v. Citizen refers to collection and disposal fee of household waste.
vi. Income of household and budget of Municipality increase in accordance with the economic growth forecasted in Case 2 which isdescribed in the section 2.3.1 of page 2–16 of the Interim Report.

Table H.7.6-13 Changes of Burden of MSWM Cost (Interest Rate: 12%)

mill. zl/year

	Present	2001	2010
Alternative 1			
Citizen	19,147 (6,586)	27,349	47,822
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	143.6	245.3
Ratio (%)	0.5 (0.15)	0.5	0.5
Enterprise	6,128	7,704	12,662
Municipality	14,579	19,254	10,220
Total Budget (bill.zl/year)	849.7	1,673.4	2,829.0
Ratio (%)	1.7	1.2	0.4
Total	39,854	54,307	70,704
Alternative 2			
Citizen	19,147 (6,586)	21,879	38,258
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	114.9	196.2
Ratio (%)	0.5 (0.15)	0.4	0.4
Enterprise	6,128	7,704	12,662
Municipality	14,579	22,896	15,497
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	1.4	0.5
Total	39,854	52,479	66,417
Alternative 3			
Citizen	19,147 (6,586)	27,349	47,822
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	143.6	245.3
Ratio (%)	0.5 (0.15)	0.5	0.5
Enterprise	6,128	7,704	12,662
Municipality	14,579	64,475	51,249
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	3.1	1.8
Total	39,854	99,528	111,732
Alternative 4			
Citizen	19,147 (6,586)	21,879	38,258
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	114.9	196.2
Ratio (%)	0.5 (0.15)	0.4	0.4
Enterprise	6,128	7,704	12,662
Municipality	14,579	124,386	80,210
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	7.4	2.8
Total	39,854	153,969	131,129
Alternative 5			
Citizen	19,147 (6,586)	21,879	38,258
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	114.9	196.2
Ratio (%)	0.5 (0.15)	0.4	0.4
Enterprise	6,128	7,704	12,662
Municipality	14,579	111,194	71,231
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	6.6	2.5
Total	39,854	140,777	122,150
Alternative 6			
Citizen	19,147 (6,586)	21,879	38,258
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	114.9	196.2
Ratio (%)	0.5 (0.15)	0.4	0.4
Enterprise	6,128	7,704	12,662
Municipality	14,579	82,550	52,024
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	4.9	1.8
Total	39,854	112,133	112,576
Alternative 7			
Citizen	19,147 (6,586)	21,879	38,258
Income (mill.zl/year/household)	24.1	29.3	47.7
Burden (1000 zl/year/household)	101.6 (34.9)	114.9	196.2
Ratio (%)	0.5 (0.15)	0.4	0.4
Enterprise	6,128	7,704	12,662
Municipality	14,579	52,471	52,471
Total Budget (bill.zl/year)	849.7	1,673.7	2,829.0
Ratio (%)	1.7	3.1	1.9
Total	39,854	104,451	108,836

H.8 Selection of the Optimum Alternatives

H.8.1 Overall Evaluation

The evaluation results based on each of the four evaluation criteria are summarized in a matrix form in Table H.8.1-1.

The matrix shows the following overall ranking of the alternatives:

i. In terms of technical, social and environmental evaluation, Alternatives 4 and 5 excel regardless of any set of weights associated with the evaluation criteria.

ii. The economic and financial evaluation in Table H.7.6-7 and -11, Alternative 5 as superior to Alternative 4.

iii. The economic and financial evaluation in Table H.7.6-7 and -11, the Alternative 2 dominates the other alternatives.

iv. Consequently, Alternative 2 and 5, shall be kept for the selection by the Steering Committee of the Study. The Polish side is requested to select an optimum alternative from the Alternative 2 and 5.

Table H.8.1-1 Overall Evaluation

Criteria	Alternatives						
	1	2	3	4	5	6	7
1. Technical Evaluation	B	B	B	A	A	A	A
2. Social Evaluation	C	C	B	A	A	B	B
3. Environmental Evaluation	C	C	C	A	A	B	B
4. Economic/Financial							
a. Economic Evaluation	A	A	B	C	C	B	B
b. Financial Evaluation	A	A	B	B	B	B	B
Overall Result	C	C	C	B	A	B	B

Note. A: Good, B: Fair, C: Poor

H.8.2 Selection of the Optimum Alternatives

1) Recommendation

The Study Team Recommends the following:

i. Upon consideration of the financial capacity of the municipality and its citizens, Alternative 5 should be selected as the optimum technical system for the MSWM Master Plan, that is if the Municipality will shoulder the finances and wish to achieve the goal established.

ii. If the Municipality and its citizens will not shoulder the finances for the introduction of an incineration system, Alternative 2 should be selected as the optimum technical system for the MSWM master Plan.

2) Selection of the Optimum Alternative

Seven alternative plans were analyzed and evaluated for the selection of MSWM technical system in the Interim Report which was submitted to the Polish side in October, 1992.

The Steering Committee selected the Alternative No.5, which was constituted of separate collection, recycling centres, an incineration plant and a sanitary landfilling, as the MSWM technical system for the master plan on October 12, 1992, provided that this decision was confirmed and approved by the Poznan City Council till November, 1992.

This decision made by the Steering Committee had been approved by the environmental committee and the communal management committee of the Poznan city council by the end of November, 1992. The Poznan main city council also approved this decision on December 15, 1992.

ANNEX I

THE MASTER PLAN

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ANNEX I THE MASTER PLAN

This annex describes details of the Solid Waste Management Master Plan for Poznan City until the year 2010. The Master Plan will cover a Planning Framework, Technical System Plan, Institutional System Plan and Phased Implementation Plan. The special feature of the Master Plan is to adopt an incineration plant for a primary processing facility.

I.1 PLANNING FRAMEWORK

I.1.1 Goal, Targets and Strategy

1) Goal

Development of Environmentally Sound Solid Waste Management System

The goal of the Solid Waste Management Master Plan is achieved through:

- **Citizens' Participation,**
- **Establishment of Self-sustainable Solid Waste Management and**
- **Resource Recovery and Recycling.**

2) Targets

- To attain 100% collection service rate by the year 2001.
- To incinerate all combustible waste by the year 2010.
- To operate the sanitary disposal site by the year 1995.
- To terminate illegal dumping by the year 2001.

Table I.1.1-1 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

3) Strategy for the Attainment of Goal

The proposed strategies for the attainment of the Goal are detailed in the following six paragraphs:

a. Provision of facilities to apply to the basic objective for the execution of Solid Waste Management:

- Solid waste management must be able to control or mitigate the adverse impacts of waste on the environment and human health.
- Solid waste is a natural resource to be utilized through appropriate means.

b. Provision of solid waste services and facilities to comply with the following priority:

- Minimization of solid waste production
- Minimization of the need for landfill
- Sanitary Landfill
- Utilization of solid waste as second raw materials, production of compost and energy productions, according to the nature of the solid waste.

c. Provision of appropriate and scheduled services to the citizens for the proper storage, collection and reception of solid waste. Illegal dumping must be eliminated.

- The offered solid waste services must comply with the generation of waste.

- The offered solid waste services should make it relatively easy for the citizens to get rid of their waste.

- The easy access to waste services must be encourage producers to use the services appropriately.

d. Self-financed solid waste management.

- The "polluter pays principle" will be advocated, but where appropriate (to minimize administration), common principles for financing will be employed.

- All costs (also capital costs) must be covered by fees and charges.

- One activity may "subsidize" another activity (differentiation in fees to promote solid waste strategy – eg. in case composting is introduced, the fee for delivery to composting plant could be equal to delivery to landfill).

e. Increase in public involvement in environmental protection and increase in public attention on environmental matters.

- The citizens must be made responsible for/aware of his own role in the production of pollutants and the proper handling of waste (however, everybody should have the right to solid waste services, provided they pay).

- The citizens must participate actively in the solid waste services (eg. through waste segregation).

f. Full control over activities related to Solid Waste Management and the cleanliness of the City.

- Involvement of private enterprises will be encouraged when appropriate and feasible.

- Private enterprises will be invited to participate through competitive bidding.

- Private cooperation will be supervised and controlled by the municipality. The municipality will maintain the full contact with the citizens in matters related to payment, complaints and exemption.

3) Strategy Elements

The goals are specifically obtained through the following:

- Establishment of a self-sustainable solid waste management system
- Establishment of resource recovery and recycling system which employ sufficient measures for the protection of the environment and human health
- Construction of a sanitary disposal site which employs sufficient measures for the protection of the environment and human health
- Establishment of Beneficiary-Pay-Principle under which service recipients pay waste collection and tipping fees
- Establishment of proper local regulations through the modification and revision of the existing ones.
- Establishment of proper roles of the organizations involved in solid waste management
- Strengthening of the management and administration system
- Development of public participation and education programmes
- Training of human resources involved in solid waste management

I.1.2 Target Year and Population

1) Target Year

The master plan covers the period 1994 to 2010. The targeted years for the master plan are as shown in Table I.1.2-1.

Table I.1.2-1 Target Year

Plan	Target Year
Master Plan	1994 to 2010
Long Term Improvement Plan	2004 to 2010
Medium Term Improvement Plan	1999 to 2003
Short Term Improvement Plan	1994 to 1998

2) Service Coverage

The present service coverage level of Poznan city is approximately 90 %. The city aims to attain and maintain 100% service coverage by and after 2001.

Table I.1.2-2 Target of Service Coverage

	1992	2001 - 2010
Service Coverage	90 %	100 %

The general principles of the Urban Development Master Plan of Poznan City which is being formulated by the Poznan municipality are as follows;

- to compact city by using the present resources and assets in optimally way, and
- cross of green area.

In order to achieve this goal, the service coverage of waste collection services ought to be improved to 100 %. In terms of the development level and the area of Poznan City, as a whole, a 100 % collection service is obviously reasonable.

3) Population Forecast

a. Present population

The basic indices concerning population in Poznan are as follows;

- Population : 590,100
- Total Number of households : 178,573
- Average dwellers per flat : 3.18 person/flat
- Population density : 22.5 person/ha

b. Population forecast

The Urban Development Master Plan of Poznan City estimated a population ranging from 610,000 to 620,000 in 2010. Consequently, the 620,000 population estimate in 2010 was adopted for the SWM Master Plan.
The annual population growth rate is, therefore, estimated at 0.275 %. The population forecast are shown in Table I.1.2-3, I.1.2-4 and Fig.I.1.2-1.

Table I.1.2-3 Population Forecast

Year	1992	1995	2001	2005	2010
Population	590,100	595,083	603,388	611,693	620,000

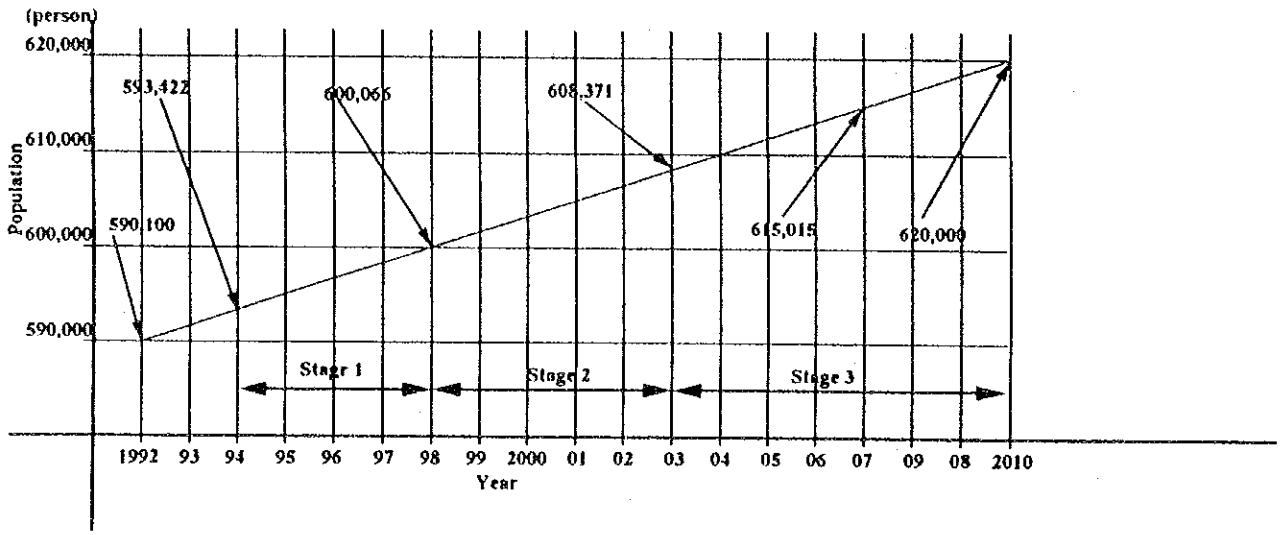

Fig.I.1.2-1 Population Forecast

Table I.1.2–4 Population Distribution Forecast

Year	1992	1995	2000	2005	2010
A 1	46,342	46,342	47,043	47,666	48,286
2	38,668	38,989	39,579	40,103	40,627
B 1	59,654	60,149	61,059	61,867	62,676
2	25,101	25,310	25,693	26,033	26,373
3	655	661	671	680	689
4	4,125	4,159	4,222	4,276	4,334
5	39,625	39,955	40,559	41,096	41,633
6	10,690	10,779	10,942	11,087	11,232
7	611	616	626	634	642
8	933	941	955	968	981
9	508	512	520	527	534
10	302	305	309	313	317
C 1	29,431	29,675	30,124	30,523	30,922
2	5,642	5,689	5,775	5,852	5,928
3	17,457	17,602	17,868	18,105	18,341
4	16,563	16,700	16,953	17,177	17,402
5	17,714	17,861	18,131	18,371	18,611
6	42,915	43,272	43,926	44,508	45,090
7	30,321	30,573	31,035	31,446	31,857
8	2,038	2,055	2,086	2,114	2,142
9	30,509	30,762	31,227	31,641	32,055
10	3,866	3,898	3,957	4,009	4,062
11	8,696	8,768	8,901	9,019	9,137
12	2,739	2,762	2,803	2,840	2,878
13	4,984	5,025	5,101	5,169	5,236
D 1	3,535	3,564	3,618	3,666	3,714
2	48,499	48,902	49,642	50,299	50,957
3	29,815	30,063	30,518	30,922	31,326
4	13,103	13,212	13,412	13,589	13,767
5	1,766	1,781	1,808	1,832	1,856
6	4,707	4,746	4,818	4,882	4,945
7	730	736	747	757	767
8	1,928	1,944	1,973	1,999	2,026
9	4,167	4,202	4,265	4,322	4,378
10	1,506	1,519	1,542	1,562	1,583
E 1	5,653	5,700	5,786	5,863	5,940
2	11,033	11,124	11,293	11,442	11,592
3	4,937	4,978	5,053	5,120	5,187
4	694	700	711	720	730
F 1	1,395	4,498	4,627	4,627	4,687
2	4,461	4,498	4,566	4,627	4,687
Z 1	35	35	36	36	37
2	965	973	988	1,001	1,014
3	620	625	635	643	652
4	4,197	4,232	4,296	4,353	4,410
5	2,290	2,309	2,344	2,375	2,406
6	4,357	4,390	4,456	4,517	4,572
Total	590,100	595,000	604,000	612,000	620,000

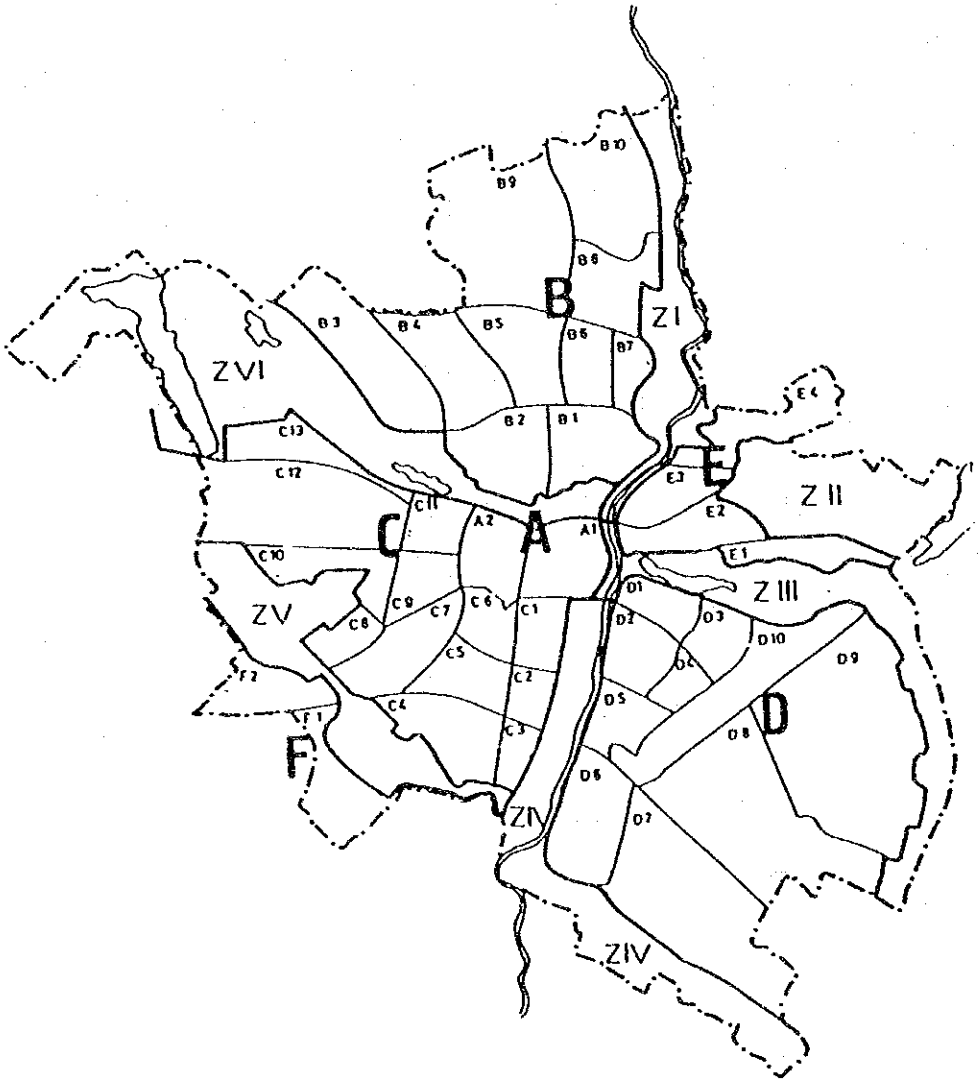

Fig.I.1.2–2 Population Distribution Map

I.1.3 Forecast for Waste Amount and Composition

1) Forecast Model

The Waste Amount and Composition Survey (WACS) carried out by the JICA Study Team was used as a reference in the elaboration of the MSWM estimate of Poznan Municipality.

The forecast model will include interim estimates for the years 1994, 1998, 2001, 2003, 2007 and 2010 of the planning period. The types of waste to be forecast are:

i. MSW

- Household waste (including domestic ash)
- Commercial waste
- Market waste
- Institutional waste
- Road sweeping waste
- Bulky waste

ii. Other wastes

a. Factors in waste increase and composition

The following factors will have an influence on the future generation of waste and its composition:

- The social welfare and the financial capacity of the single consumers/families

  The welfare determines the general level of consumption and for the "throw away"-mentality.

- Industrial technology.

  Technology determines the amount and composition of industrial wastes and may influence the products in the market and finally the waste produced by consumers.

- Import of goods.

  The import of goods for consumption will, as stated above, affect the generated waste.

Forecast are difficult to conduct in Poland due to its particular situation. From a financial viewpoint (e.g., the GDP), the wastes of Poland should identify with the developing state of the country. However, with the breakdown of the iron curtain and the opening up to the west, rapid changes in the nature of wastes can be observed due to the inflow of western goods. The Polish industry with its new business environment seems to be buzzing with competition, unlike in the socialist regime where it was protected from it.

Conclusively, it is not reliable to solely base estimates on predictions concerning the general economic development and comparisons with other country's development. The nature of the wastes in Poland compared to its present welfare system will most likely resemble that of Western-European countries faster.

b. Methodology for the Forecast-Model

The forecast-model covers two (2) items. The first item is the forecast of the total amount of waste and its composition. The forecast of the total waste amount will require a study on the relation between GDP and the generation of waste.

The second item is the forecast of the calorific value for the evaluation of the quality of waste to incinerate.

For the type of wastes to be forecast, the following assumptions were made:

i. Household waste

The weighed result for the PEC and non-PEC residential areas will be used. Waste generation will be projected based on the number of inhabitants, with a margin of the increase of generation ratio as a result of a GDP increase.

ii. Domestic ash

Discharge ratio of the domestic ash from households is assumed to decrease to zero (0) by the year 2001. The reasons are as follows;

- According to the "Research on Technological Properties of Poznan Municipal Waste", the heat supply population in 1985 was 276,000.

- The heat supply population increased up to 354,060 in 1992. The annual increase ratio in this 7 years was 11,150 person/year.

- Supposing the increase ratio will be kept up to 2001, the heat supply population will be about 454,410 equivalent to 75.1% of the total population in 2001 (605,000).

- In addition, the population not using coal for heating and those not using the heat supply from the district plant is increasing rapidly. The remaining 25%, therefore, is assumed to cover the population not using coal for heating.

- In most developed countries, the rapid change in heat source, from coal heat to the other modes, in households occurred with economic growth.

iii. Commercial waste

Waste generation will be forecast based on the floor area of shops which will increase in accordance with the increase of population, with a margin of the increase of generation ratio as a result of a GDP increase.

iv. Market waste

Waste generation will be forecast based on the number of shops in the market which will also increase with the population, with a margin for the effects of a GDP increase.

v. Institutional waste

Waste generation will be forecast based on the number of employees which will also increase with the population, with a margin for the effects of a GDP increase.

vi. Road sweeping and bulky waste

Waste generation will be projected based on the number of inhabitants, with a margin of the increase in generation ratio as a result of a GDP increase.

vii. Other waste

Waste generation will be forecasted based on the population, with a margin for the effects of a GDP increase.

2) Increase in Population

The most direct influence on waste generation is the change in population. According to section I.1.2, the estimated annual population growth in Poznan Municipality for the planning period is 0.275 %.

3) Relation between GDP and Waste Generation

To determine the relation between GDP and the generation of waste , the increased amount of welfare was taken into account. A strict relation is not expected in advance, but some indication for further analysis may be identified.

An increase in the GDP is expected to have a big impact on the generation of waste per capita of developing countries than of developed countries. Also, at a certain welfare level, increase in GDP will remarkably change the composition of waste.

Japan has fine statistics allowing for the analysis of the relation of GDP and waste generation in a developing economy (1963 - 1970) and a developed economy (1975 - 1988). The years 1970 - 1975 are excluded due to fluctuations in data resulting from a new treatment law and economic recession and instability caused by the oil crisis.

a. Developing economy

Based on data of Japan for the period 1963–1970, a developing economy can be characterized as follows:

- Average increase in waste generation per capita: 5.789 %/year
- Average increase in GNP *: 10.438 %/year

* GNP was used due to the unavailability of a GDP.

b. Developed economy

Based on data of Japan for the period 1975-1988, developed economies are characterized as follows:

- Increase in waste generation per capita: 1.276 %/year
- Increase in GDP: 4.415 %/year

Based on these figures, we assume that the change in GDP will affect the waste generation as follows:

- Flexibility for a developing economy: 0.55 of GDP-change in %
- Flexibility for a developed economy: 0.29 of GDP-change in %

A 4% annual increase in GDP would result to increase in waste generation due to increased welfare, 2.2% and 1.2% for developing economies and developed ones, respectively.

The ratio to be selected will depend on the estimated actual capacity of the economy. Although the increase in the GDP ratio may be high, the actual value could be low, thus effecting a lower impact ratio than the figures shown in the data of Japan.

The GDP of Poland (taken from the 1990 constant) is supposed to develop as follow:

- 1993 - 1995 0 %
- 1995 - 2000 + 3.0 %
- 2001 - 2010 + 6.0 %

Despite the high increase in percentage, the actual GDP is low for the entire planning period. It is , therefore, assumed that a background that may trigger a Japanese "boom" is unlikely in Poland in spite of the developing state of the economy. The economy of Poland is assumed to develop in the entire planning period, particularly so in the latter half. It is assumed that a 0.45 % increase in GDP can be constantly observed in the planning period 1993 - 2010 due to increased welfare on waste generation. The increase in waste generation per capita per year is, therefore, estimated as:

- 1993 - 2000 3.0 x 0.45 = 1.35 %/year → Say 1.4 %/year
- 2001 - 2010 6.0 x 0.45 = 2.7 %/year

4) Forecast on Waste Amount

The forecast on MSW and other wastes is presented in Table I.1.3-3 based on the WACS results, the assumptions in section 1) (Forecast Model on each type of waste) and the impact of GDP growth, and the coefficients from Table I.1.3-1 and 2.

Table I.1.3-1 Forecast for Waste Discharge Ratio

	Unit	1992	1994	1998	2001	2003	2007	2010
1. MSW								
Household	g/pers/d	480.0	493.5	521.8	551.0	581.1	646.5	700.2
Domestic ash	g/pers/d	174.0	130.6	43.8	-	-	-	-
Shop	g/m²/d	24.0	24.7	26.1	27.9	29.1	32.3	35.0
Catering	g/m²/d	160.0	164.5	173.9	183.7	193.7	215.5	233.4
Market	g/nos./d	3040.0	3125.7	3304.5	3489.4	3680.3	4094.2	4434.9
Institutional	g/empl/d	58.0	59.6	63.0	66.6	70.2	78.1	84.6
Road Sweeping	g/pers/d	6.8	7.0	7.4	7.8	8.2	9.2	9.9
Bulky	g/pers/d	26.6	27.4	28.9	30.5	32.2	35.8	38.8
2. Other Wastes	g/pers/d	139.6	143.5	151.7	160.2	169.0	188.0	203.7

Table I.1.3-2 Forecast for Population and Others

	Unit	1992	1994	1998	2001	2003	2007	2010
Household	person	590,100	593,422	600,066	605,049	608,371	615,015	620,000
Shops	m²	202,966	204,107	206,393	208,107	209,249	211,534	213,249
Catering	m²	172,725	173,695	175,639	177,098	178,070	180,015	181,474
Market	nos.	1,970	1,982	2,004	2,021	2,032	2,054	2,071
Institutional	employee	161,085	161,992	163,806	165,166	166,073	167,887	169,248

Table I.1.3-3 Forecast for MSW, and Other Wastes Poznan Municipality

unit:ton/day; 1 year=365 days

	1992	1994	1998	2001	2003	2007	2010
1. MSW							
Household	283.2	292.9	313.1	333.4	353.5	397.6	434.1
Domestic Ash	102.8	77.5	26.3	0	0	0	0
Shop	4.9	5.0	5.4	5.7	6.1	6.8	7.5
Catering	27.6	28.6	30.5	32.5	34.5	38.8	42.4
Market	6.0	6.2	6.6	7.1	7.5	8.4	9.2
Institutional	9.3	9.7	10.3	11.0	11.7	13.1	14.3
Road Sweeping	4.0	4.2	4.4	4.7	5.0	5.7	6.1
Bulky	15.7	16.3	17.3	18.5	19.6	22.0	24.1
2. Other Wastes	82.4	85.2	91.0	96.9	102.8	115.6	126.3
Total	535.9	525.6	504.9	509.8	540.7	608.0	664.0

5) Forecast on Waste Composition

A change in the composition of waste is expected due to new products and a changed consumption pattern.

In table I.1.3-1, WACS results for domestic waste are compared with the data in Poland provided in the EC-Study; Municipal Waste - Strategy for Waste Management and Applicable Methods for Collection and Treatment, 1992. Data from a developed country, like Denmark, were also included.

Table I.1.3-4 Comparison of Waste Composition Data for MSW

	* WACS 1992 without Ash	WACS 1992 with Ash	EC-Study, 1992	EC-Study, forecast 2010	Denmark 1985
1. Combustibles	**76.6**	**58.5**	**56**	**64**	**85**
Garbage	33.9	25.9	38	27	35
Paper	19.3	14.7	14	28	41
(Dry Paper)	-	-	-	-	(17)
(Wet Paper)	-	-	-	-	(24)
Textile	7.3	5.6	2	2	-
Plastic	7.9	6.0	2	5	6
Grass and Wood	5.9	4.5	-	-	-
Leather and Rubber	2.3	1.8	-	-	-
Other Combustibles	-	-	-	2	3
2. Non-Combustibles	**23.4**	**41.5**	**44**	**36**	**15**
Metal	3.8	2.9	2	14	4
Glass	15.2	11.6	7	-	7
Ceramic and Soil	1.5	1.2	-	-	-
In-organic	-	23.7	35	22	-
Other(Non-Comb.)	2.9	2.2	-	-	4
Total	100	100	100	100	100

Note; * The figure shows the composition of MSW (without ash and measured) other than road sweeping and bulky waste.

Provided that the figure for grass and wood is added to garbage, equilibrium can be achieved among the WACS figures.

The JICA Study Team found that the existing data on Poland to be insufficiently updated and has observed rapid changes in waste composition, especially the change in heat source from coal to other modes.

The analysis was, therefore, focused on the comparison of the data provided by WACS and Denmark assuming that changes in waste composition would result to wastes characteristic of a developed economy.