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 6.7.3-2.

Table 6.7.3-2 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 neighbourhood 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 neighbourhood 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 neighbourhood concerning the establishment of a composting plant operation unit in Alternatives 6 and 7, due to the odour that would emanate from the plant.

3) Summary of Social Evaluation

Social evaluation is summarized in Table 6.7.3-3.

Table 6.7.3-3 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	C	B	B	B	A	B	A
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

6.7.4 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 6.7.4-1.

Table 6.7.4-1 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 odour.

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 of the SWM facilities. The biggest traffic volume is observed in Alternative 3, an estimate of 348 trucks daily, which the smallest is in Alternative 4, an estimate of 270 trucks 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 6.7.4-2 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/C	B/C
k. Others (hospital waste, sewage sludge)	C	C	C	A	A	C	C
Overall Result	C	C	C	A	A	B	B

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

6.7.5 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 analyze 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 direct effects:

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

The effect brought about by the prolongation of 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 at 3.5 USD/GJ similar to the price offered by the heat plant of equivalent scale.

- Land productivity — The land price was calculated to be 241.5 USD/ha based on the wheat production rate since this land is for agricultural use.

–	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 lower quality.
–	Recyclable material	The prices set for 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 the term of use 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 economic evaluation of the incineration plant will cover the years 2001, the year when it starts its operation, to 2011. Since the plant is expected to have a life span of 15 years, the salvaged book value will be included in the final 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. Benefits from the improvement of service coverage

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

The general benefits from 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.

- Periodical collection creates a fine environment which would charm the tourist.

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

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 centres

The benefits obtained from the introduction of recycling centres 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 centres. The collection amount will decrease by 20% and the final disposal amount by 1.5%.

- Benefits from recycling are shown in Table 6.7.5-1.

Table 6.7.5-1 Benefits from 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

- Benefits from 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 from the 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. Benefits 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 %.

Benefits from recycling are shown in Table 6.7.5-2.

Table 6.7.5-2 Benefits from Recycling in 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 from the 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. Benefits 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, 46 % of which 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 the 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 tons/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 6.7.5-3 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 the economic price.

- The final disposal amount in weight (in volume) will be reduced to 50 % (34 %) in Alternative 4 and 52 % (35 %) in Alternative 5 by 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 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 imported amount of wheat in 1986 155 mill. USD
. the imported quantity of wheat 1.662 mill. tons

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 is still practised at present. It is most recommendable to incinerate sewage sludge prior to disposal. The benefits from the treatment of sludge by incineration are as follows:

. amount of sludge in 2010: 69.2 tons/day
. required coal for incinerating 1 ton of 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 are summarized in Table 6.7.5-4.

Table 6.7.5-4 Benefits from the Incineration Plant

Items	Benefits (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 6.7.5-5 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 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.

- 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 re-cultivation and dressing of garden soil.

- Reduced final disposal cost

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

- 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 tons/ha
  . the imported amount of wheat in 1986 155 mill. USD
  . the imported quantity of wheat 1.622 mill. tons

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

  $3.7 \times (155/1.662) \times 0.7 = 241.5$ USD/ha

  Alternative 6:

  $241.5 \times 13{,}500$ zl/USD $\times (70 - 57.0) = 42.4$ mill. zl

  Alternative 7:

  $241.5 \times 13{,}500$ zl/USD $\times (70 - 56.0) = 45.6$ mill. zl

- The total benefits from the composting plant are summarized in Table 6.7.5-6

Table 6.7.5-6 Benefit and Cost of the Composting Plant

Items	Benefits (mill.zl)	
	Alt.6	Alt.7
Compost production	650	2,005
Reduction of final disposal amount	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 analytical results of costs and benefits, the costs exceed the benefits in 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 6.7.5-7 Benefits (from 2001 to 2010) of Each Alternative

unit: mill. zl in 1992 price level

	Discount Rate / Benefits			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 6.7.5-8 Economic Evaluation unit: bill. zl

	Alt.1	Alt.2	Alt.3	Alt,4	Alt.5	Alt,6	Alt.7
Discount Rate (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 out and the following rates were assumed:

Table 6.7.5-9 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.
Alternative 2 requires the least cost. Among the alternatives with intermediate facilities, alternative 5 requires the least cost alternative if the 6% interest is not taken into consideration.

If the Municipality of Poznan bears the cost required for item iii below, the financial share for all alternatives 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.

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 6.7.5-10

Table 6.7.5-10 Defrayments of Each Party

	Collection (mill.zl)	Cleansing (mill.zl)	Landfill (mill. zl)	Total (mill. zl)	Defray-ment 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 the income of the citizens is shown in Table 6.7.5-11 for Case 1 and Case 2, respectively.

Table 6.7.5-11 Citizens' 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 centres, and incentives will be formulated to smoothly implement this. The introduction of recycling centres will reduce collection cost by 10% and collected amount of waste by 20%. Assuming a similar fee system, the revenue of Alternatives with recycling centres, 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 following:
- O & M cost for road sweeping and public area cleansing services
- Investment for refuse trucks and landfill site
- 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 Alternatives 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 6.7.5-12 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 6.7.5-13 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.

Table 6.7.5-14 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

6.8 Selection of the Optimum Alternatives

6.8.1 Overall Evaluation

The evaluation results based on each of the four evaluation criteria are summarized in a matrix form in Table 6.8.1-1.

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 6.7.5-7 and -11 show Alternative 5 as superior to Alternative 4.

iii. The economic and financial evaluation in Table 6.7.5-7 and -11 show Alternative 2 as superior over the other alternatives.

iv. Consequently, the optimum alternative will be selected from Alternatives 2 and 5, and the selection will be made by Steering Committee of the Study.

Table 6.8.1-1 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	A	A	B	B

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

6.8.2 Selection of the Optimum Alternative

At the Steering Committee meeting on the Interim Report, based on the overall evaluation, the Study Team recommended that:

i. Upon consideration of the financial viability of the Municipality and its citizens, Alternative 5 should be selected as an optimum technical system of the MSWM Master Plan if Poznan Municipality can afford its share of the burden and wishes to achieve the goal established.

ii. If the Municipality as well as its citizens will not shoulder the finances for the introduction of an incineration system, Alternative 2 should be selected as an optimum technical system of the MSWM Master Plan because the financial and economic evaluation results show Alternative 2 as superior.

1) 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 Alternative 5, which constituted separate collection, recycling centres, an incineration plant and a sanitary landfill, 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 by 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.

CHAPTER 7

THE MASTER PLAN

CHAPTER 7 THE MASTER PLAN

This chapter 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.

7.1 PLANNING FRAMEWORK

7.1.1 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 a 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 7.1.1-1 Target Schedule Unit:%

Target	1992	1995	2001	2006	2010
Collection Service	90	93	100	100	100
Incineration	0	0	33	66	100
Sanitary landfill	*1	100	100	100	100
Illegal dumping	10	7	0	0	0

Note: *1 The present landfill operation is not considered as a 100% sanitary landfill due to the insufficient environment protection measures.

3) Strategies for the Attainment of the 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 through the increase of citizens' burden.**

- The "polluter pays principle" will be advocated, but where appropriate (to minimize administration), general 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

7.1.2 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 7.1.2-1.

Table 7.1.2-1 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.

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 Urban Development Master Plan of Poznan City estimated a population ranging from 610,000 to 620,000 by 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 7.1.2-3, 7.1.2-4 and Fig.7.1.2-1.

Table 7.1.2-3 Population Forecast unit:person

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

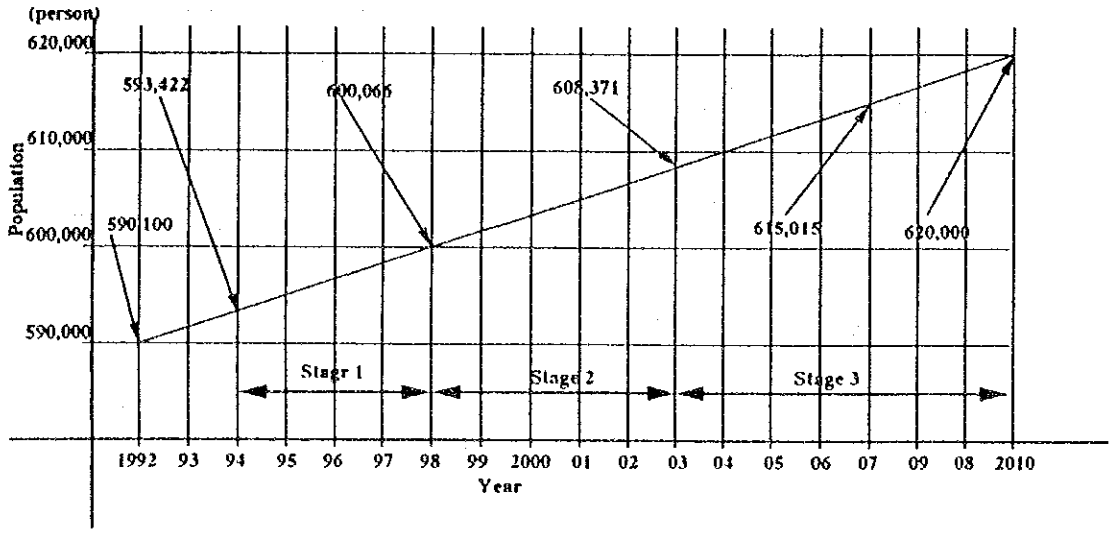


Fig.7.1.2-1 Population Forecast

7.1.3 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
- Industrial technology
- Import of goods

Forecasts 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 for the increase in generation ratio as a result of a GDP increase.

ii. Domestic ash

Discharge ratio of domestic ashes 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 to 354,060 in 1992. The annual increase ratio in 7 years is 11,150 persons/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 in population, with a margin for the increase in 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 for the increase in generation ratio as a result of a GDP increase.

vii. Other wastes

Waste generation will be forecast 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 7.1.2, 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 the 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 the 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 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 economics 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 follows:

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

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 7.1.3-3 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 7.1.3-1 and 2.

Table 7.1.3-1 Forecast on 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 7.1.3-2 Forecast on 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	m^2	202,966	204,107	206,393	208,107	209,249	211,534	213,249
Catering	m^2	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 7.1.3-3 Forecast on MSW and Other Wastes in 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 different consumption pattern.

In table 7.1.3-1, 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 7.1.3-4 Comparison of Waste Composition Data for MSW unit:%

	* 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.

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

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

Paper

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

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

Table 7.1.3-5 shows the forecast on waste composition.

Table 7.1.3-5 Forecast on Composition of MSW without Ash, Poznan unit:%

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

Note: MSW here excludes road sweeping and bulky waste.

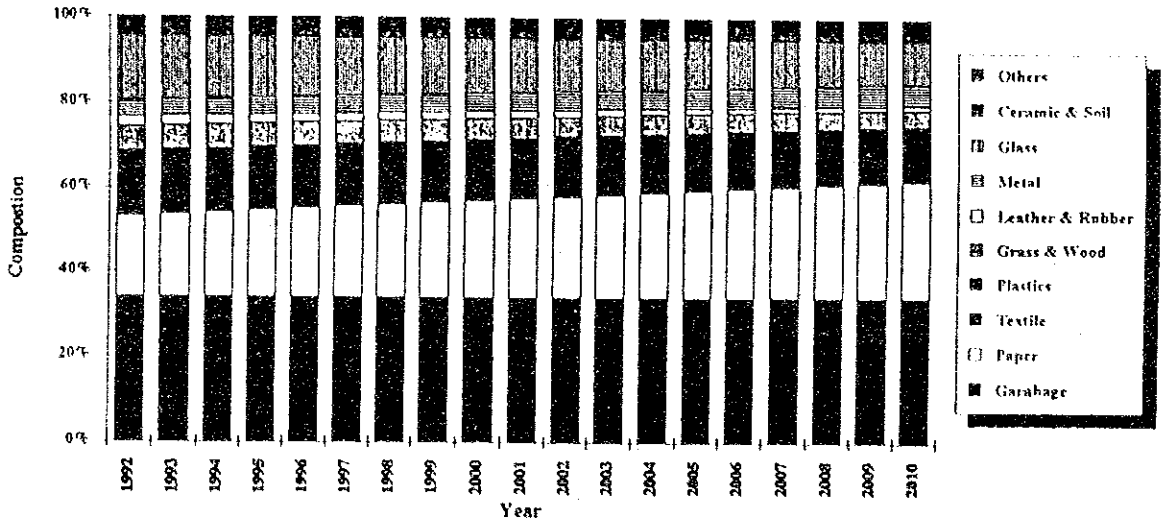


Fig.7.1.3-1 Forecast on Waste Composition

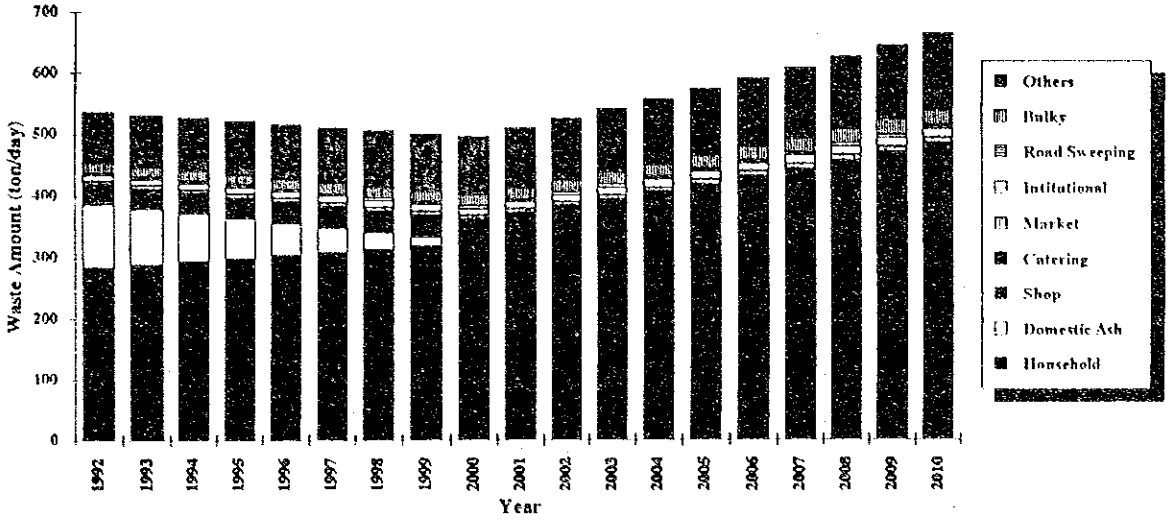


Fig.7.1.3-2 Forecast on Waste Amount

6) Forecast on Calorific Value

The calorific value of waste differs according to physical composition and three content, moisture content, combustible waste and ash. The ratio of combustible waste and ash depends on the change in physical composition. Table 7.1.3-6 shows our survey data and the data in 1984/85.

Table 7.1.3-6 Comparison of Three Contents and LCV, Poznan

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

Note: MSW excludes road sweeping and bulky waste.

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

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

a. Lower calorific value of each physical composition item

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

- Garbage 4,000 kcal/kg
- Paper 3,800 kcal/kg
- Textile 3,700 kcal/kg
- Plastic 9,800 kcal/kg
- Grass & Wood 4,000 kcal/kg
- Leather & Rubber 5,000 kcal/kg

Examining the above-mentioned calorific values and waste composition data obtained by this study, the LCV of combustible wastes in the wet base are calculated as shown in Table 7.1.3-7.

Table 7.1.3-7 Lower Calorific Value of Each Item

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

b. Lower Calorific Value Forecast

The future LCV of MSW is estimated by multiplying the LCV in Table 7.1.3-7 by the ratio of the future physical composition shown in Table 7.1.3-5, as described in B.5.1, 2 Waste Composition, iii. Estimation of the LCV.

The introduction of a separate collection system will, if not thoroughly, partly stop the inclusion of non-combustibles in combustibles. Consequently, based on the experience in Japan, the LCV of separated waste is estimated in Table 7.1.3-8, assuming a 10% inclusion of non-combustibles into combustible waste.

Table 7.1.3-8 Forecast on Lower Calorific Value

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

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

7.1.4 Future Waste Stream

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

1) Conditions of the Forecast

- The coverage rate of household waste and domestic ash is 90 % in 1992.
- The coverage rate of household waste and domestic ash will be 100 % in 2001.
- Discharge of ash from households will be terminated in the year 2001.
- The waste amount received at public recycling centres is 15 % of total discharge amount with reference to the actual data in Denmark.

- The sort of wastes received at the public recycling centres are some paper, textile, plastic, leather & rubber, metal, glass, ceramic, soil and all kinds of bulky wastes.
- The recycled amount of material in public recycling centres is 10 % of the received amount with reference to the actual data in Denmark.
- The sort of wastes recycled at public recycling centres are some paper, textile, metal, glass and bulky wastes.
- Eight public recycling centres start operation in:
  - 3 sites: in 1996
  - 3 sites: in 1997
  - 2 sites: in 1998

  The amount of wastes received and recycled at public recycling centres increase in proportion to the number of operating public recycling centres.
- Residues from incineration plants amount to 34 % with reference to the actual data in Denmark.
- The incineration plant is 80% efficient in producing heat from waste with reference to the actual data in Denmark.
- The incineration plant starts operation in:
  - 1st incinerator in 2001: 1/3 of the combustibles is treated.
  - 2nd incinerator in 2006: 2/3 of the combustibles is treated.
  - 3rd incinerator in 2010: all combustible wastes are treated.
- Apparent specific gravity of waste after compaction at the final disposal site is:
  - Residue of incineration: 1.1
  - Domestic ash: 1.1
  - Others: 0.8

2) Future Waste Stream

The future waste streams are shown in Fig.7.1.3-3 to -6.

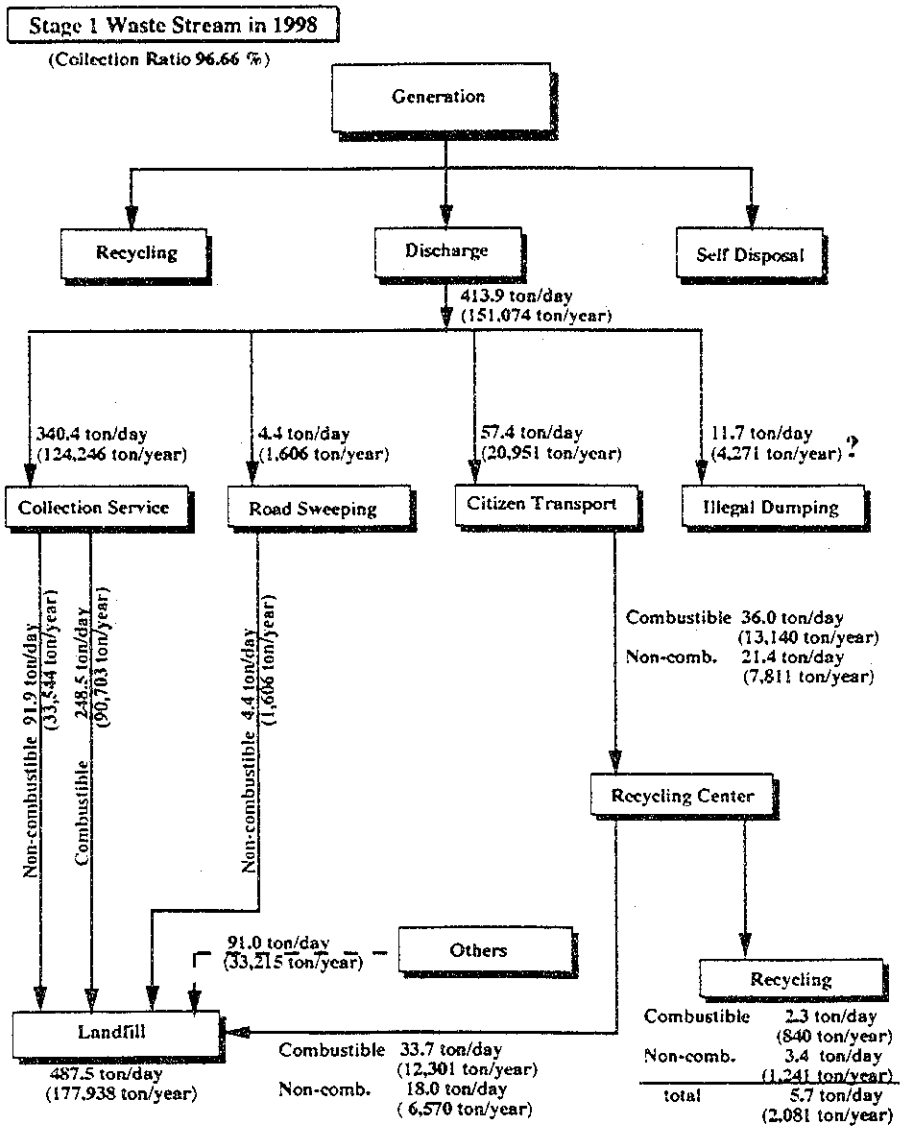


Fig.7.1.3-3 Stage 1 Waste Stream in 1998

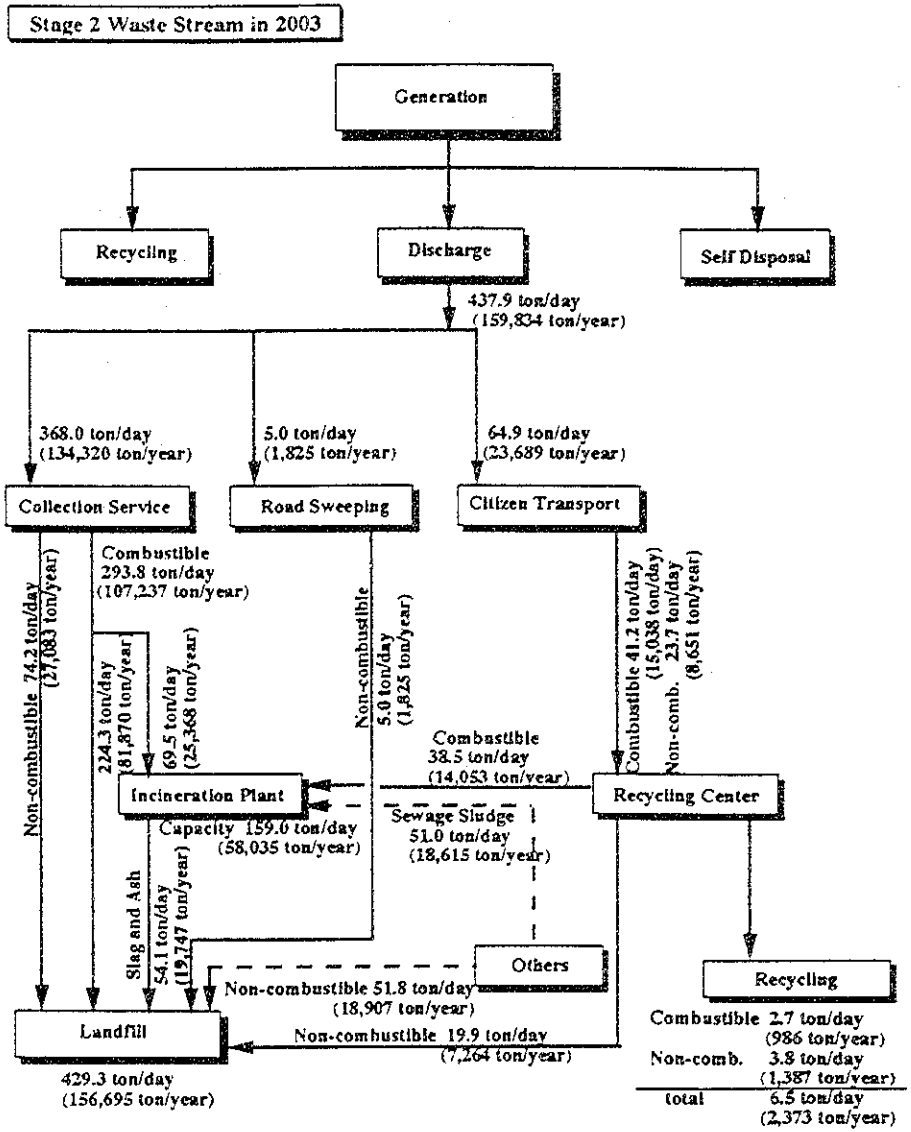


Fig.7.1.3-4 Stage 2 Waste Stream in 2003

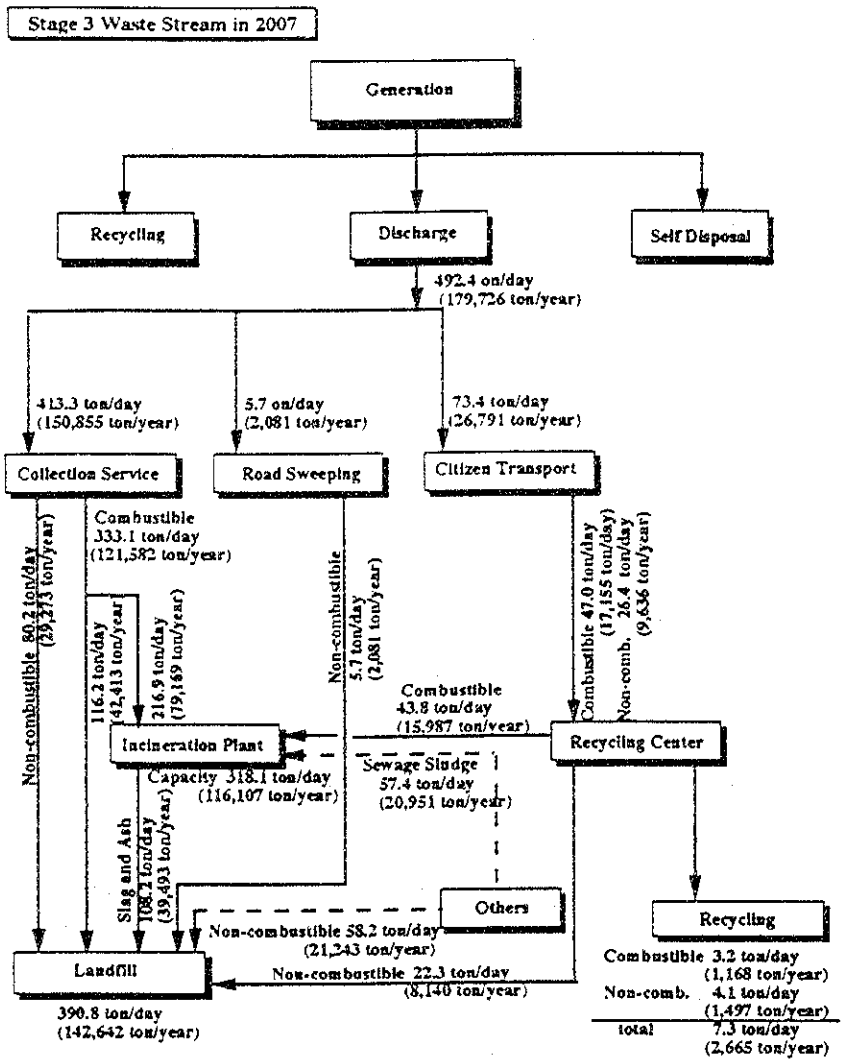


Fig.7.1.3–5 Stage 3 Waste Stream in 2007

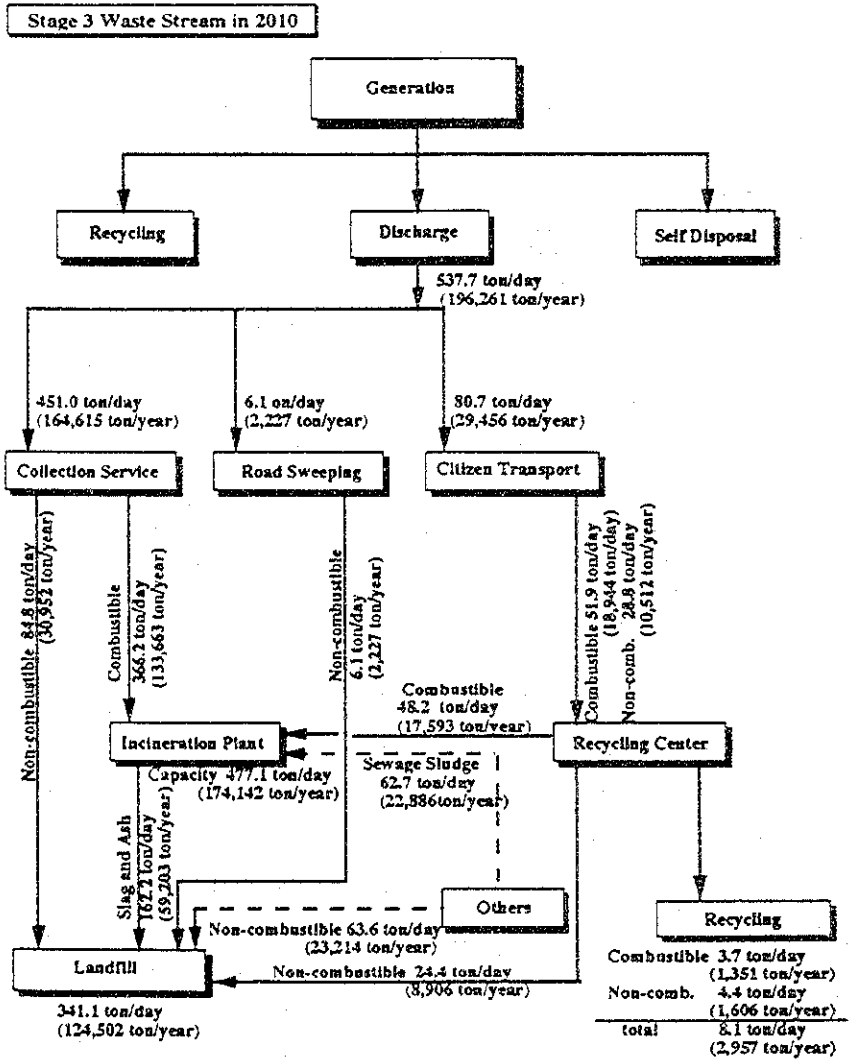


Fig. 7.1.3–6 Stage 3 Waste Stream in 2010

7.1.5 Economic and Financial Condition

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

1) Forecast on Economic Growth

The following two cases of economic growth rate were projected:

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

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

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

The changes in income level estimated from GDP per capita are shown in Table 7.1.5-1.

Table 7.1.5-1 Changes in Income Level

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

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

The calculation results are shown in Table 7.1.5-2.

Table 7.1.5-2 GDP Estimated in 1990 Constant Price (million USD)

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

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

A shift to a post-industrial society will take place in which trade and services will take the lead. The composition of industries in 2010 will be determined by extension of change in the term from 1970 to 1989, as shown in Table 7.1.5-3.

Table 7.1.5-3 Change in GDP (%)

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

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

7.1.6 Conditions for Cost Estimation

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

All cost estimates were conducted based on the following:

- The prices were based on the January 1993 prices.
- Labour costs and investments for constructions and equipment available in Poland reflect Polish price level. These prices are presented in Zloty (Zl). Table 7.1.6-1 presents information on the January 1993 unit prices in Poznan.
- Prices for equipment not available in Poland reflects price level available in Western Europe. These are presented in CIF prices of USD (1 USD = 15,700 Zl, January 1993).
- Costs for the acquisition of lands as well as for connection fees (electricity, water and sewerage) are not included.
- Costs for preliminary studies and design works to be conducted to gain the approval of the authorities for the construction of facilities is not included.
- All salaries are net salaries, including 20 % tax and 45 % social security services.
- The inflation rate is not taken into account.

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

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

Table 7.1.6-1 presents information on unit prices available in Poznan in January 1993.

Table 7.1.6-1 Information on Unit Prices Available in Poznan

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

7.2 Technical System

1) Outline of Technical System

The proposed technical system for the MSWM Master Plan is summarized and tabulated in Table 7.2-1.

Table 7.2-1 Outline of Technical System in 2010

Technical Sub-Systems	Contents and
1. Discharge and Storage a. Amount of discharge b. Type of Refuse Bins	196,261 ton/year (537.7 ton/day) In addition to the present system, paper bags will be used for detached houses.
2. Collection and Haulage a. Coverage Ratio b. Collection System Provided c. Amount of Waste Collected (304 days of work a year)	100% - Regular separate collection of combustibles and non-combustibles - Bulky waste collection - Recycling centre collection - Regular collection of combustible : 439.7 ton/day - Regular collection of Non-combustible : 101.8 ton/day - Bulky waste collection : 29.0 ton/day - Recycling centre collection : 67.8 ton/day Total : 638.4 ton/day
3. Public Recycling Centres a. Number of Centres b. Waste Amount (304 day/year)	8 places in total, 2 for large (3,000 m^2) and 6 for small (2,000 m^2) Input: from bulky waste collection : 29.0 ton/day from recycling centre collection : 67.8 ton/day Output: to incineration plant : 57.8 ton/day to recycling : 9.7 ton/day to final disposal : 29.3 ton/day
4. Road Sweeping and Public Area Cleansing	The same as the present system
5. Intermediate Treatment a. Proposed Site b. Received Waste c. Capacity d. Working Hours e. Heat Recovery	Franowo-Michalowo, Area 5.0 ha MSW excluding road sweeping and non-combustible wastes, sewage sludge and hospital wastes 10 ton/hour/line x 3 lines and 720 ton/day 24 hour/day and 7,000 hour/year Hot water supply 1,215 Tj/year
6. Final Disposal a. Proposed Site b. Daily Disposal c. Cumulative Disposal Amount d. Landfill Method e. Landfill Area	Franowo-Michalowo and site area 47.4 ha 369 cu.m/day and 341.1 ton/day 3,100,000 cu.m from 1995 to 2010 Sanitary landfill and leachate is carried to sewage treatment facility 24.8 ha from 1995 to 2010
7. Recycling a. Recycling Facility b. Others	Non specific facility will be provided except for those in the private sector. Administrative support to private recycling business and introduction of on-site composting.

2) Location of MSWM Facilities

The location of MSWM facilities proposed in the Master Plan are presented in Fig.7.2-1.

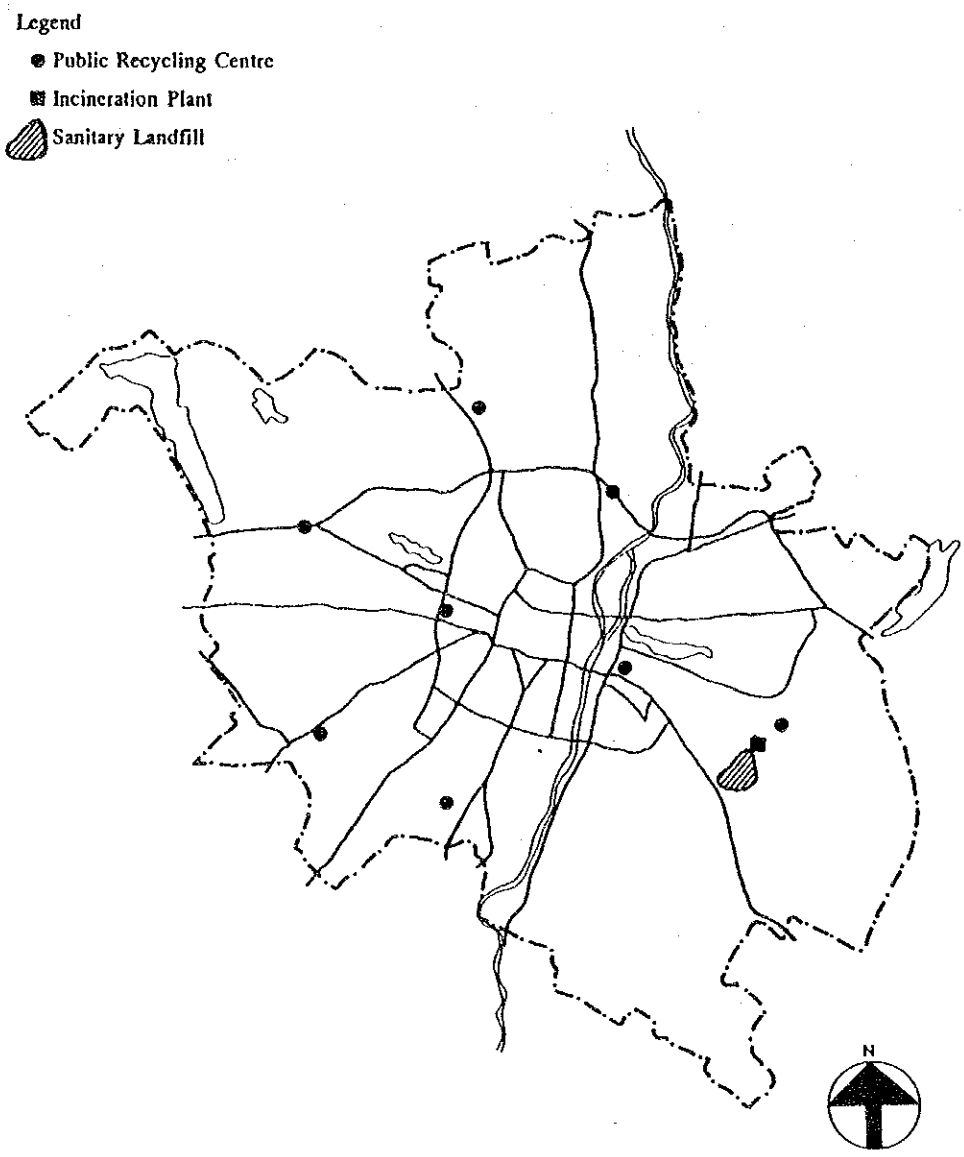


Fig.7.2-1 Location of MSWM Facilities

3) Franowo-Michalowo Site Development Plan

The site development plan for Franowo-Michalowo sanitary landfill and incineration plant up to the year 2010 is elaborated, as shown in Fig.7.2.1-1.

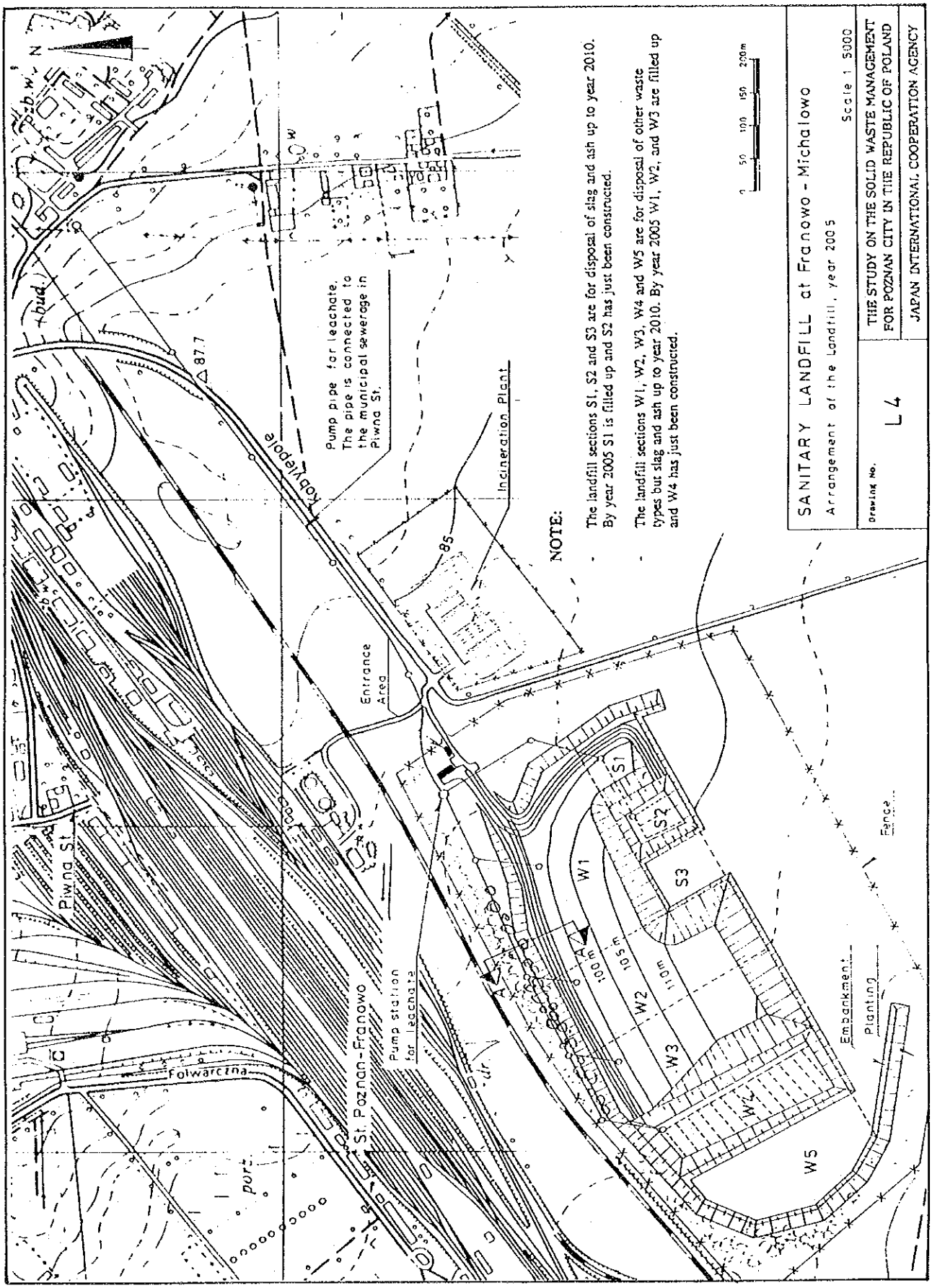


Fig.7.2-2 Franowo-Michalowo Site Development Plant up to 2010

4) MSWM Master Plan Waste Flow

The MSW Master Plan waste flow is presented in Fig.7.2-3.

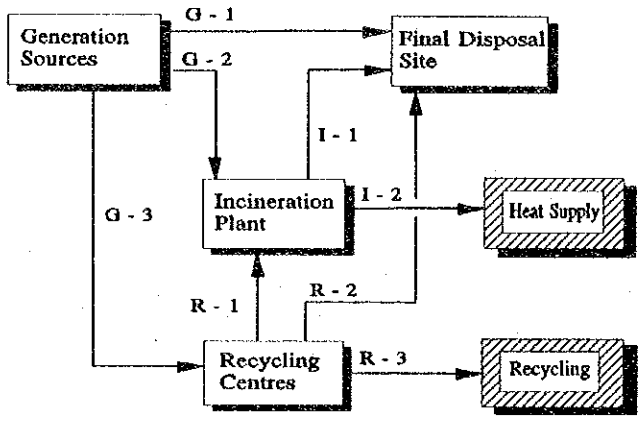


Fig.7.2-3 Planned Waste Flow

The explanation of the waste flow shown in Fig.7.2-3 follows hereafter.

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

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

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

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

7.3 Phased Implementation Plan

1) Examination of Implementation Schedule

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

- The Master Plan period is from 1994 until 2000.
- All municipal solid waste in Poznan will be carried into the Franowo-Michalowo site after the year 1994.
- The master plan will be implemented by in three stages.
- The phased implementation schedule of the incineration plant will be given more importance than the rest.
- The incineration plant consisting of 3 lines will be constructed line by line.
- Separate collection will be implemented on a gradual basis in accordance with the capacity of the line of the incinerator plant which will be constructed.
- 2 years of training will be conducted for separate collection.
- construction of public recycling centres will start in 1995 to control illegal dumping cases as soon as possible.

2) Phased Implementation Plan

Based on the above-mentioned conditions, the phased implementation plan of the MSWM Master Plan is elaborated in Fig.7.3-1 and Fig.7.3-2. For better understanding, the activity schedule of MSWM Master Plan is tabulated in Table 7.3-1.

Fig.7.3-1 Phased Implementation Plan of MSWM Master Plan for Technical System

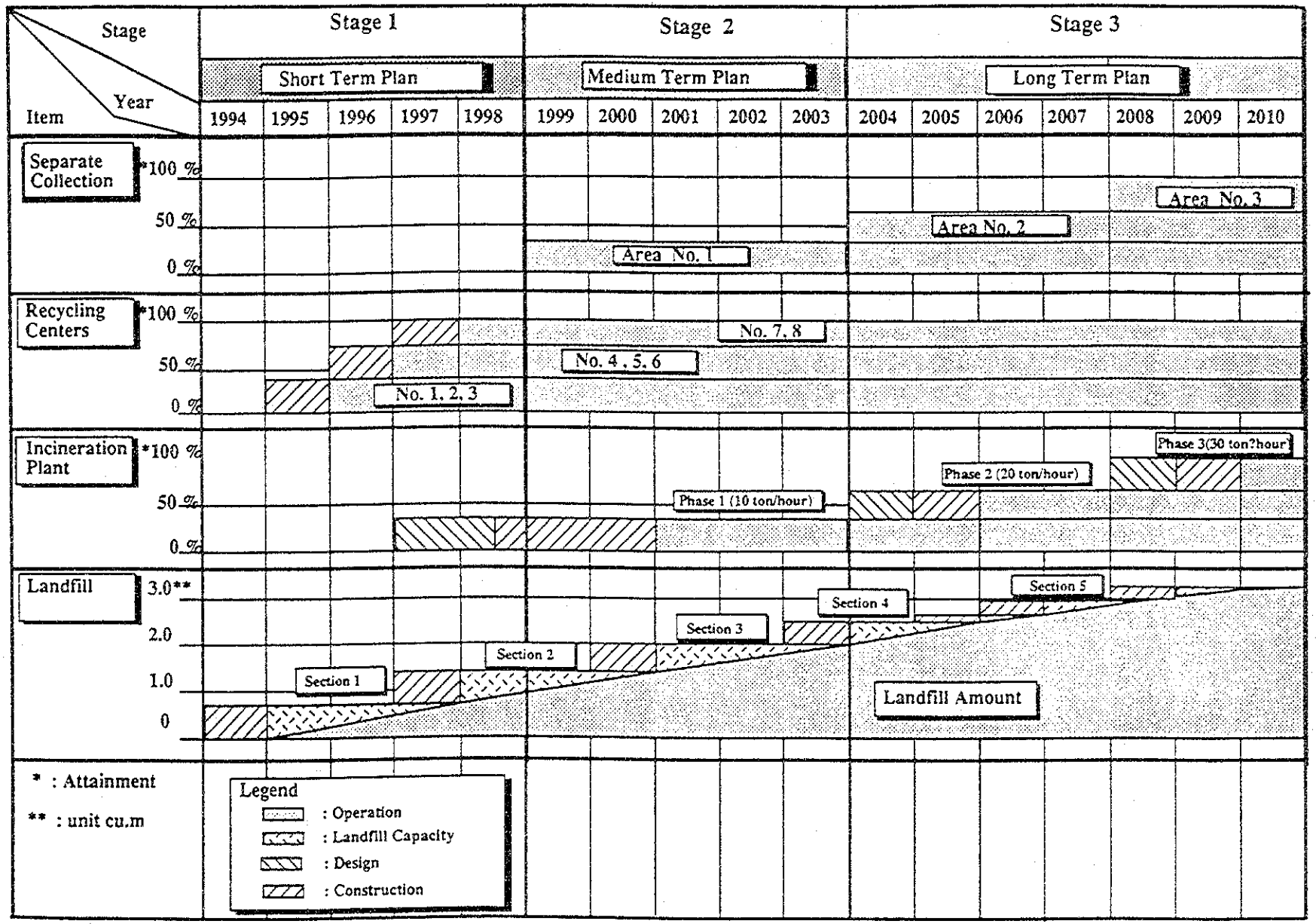


Fig.7.3-2 Implementation Schedule of Technical System for MSWM Master Plan

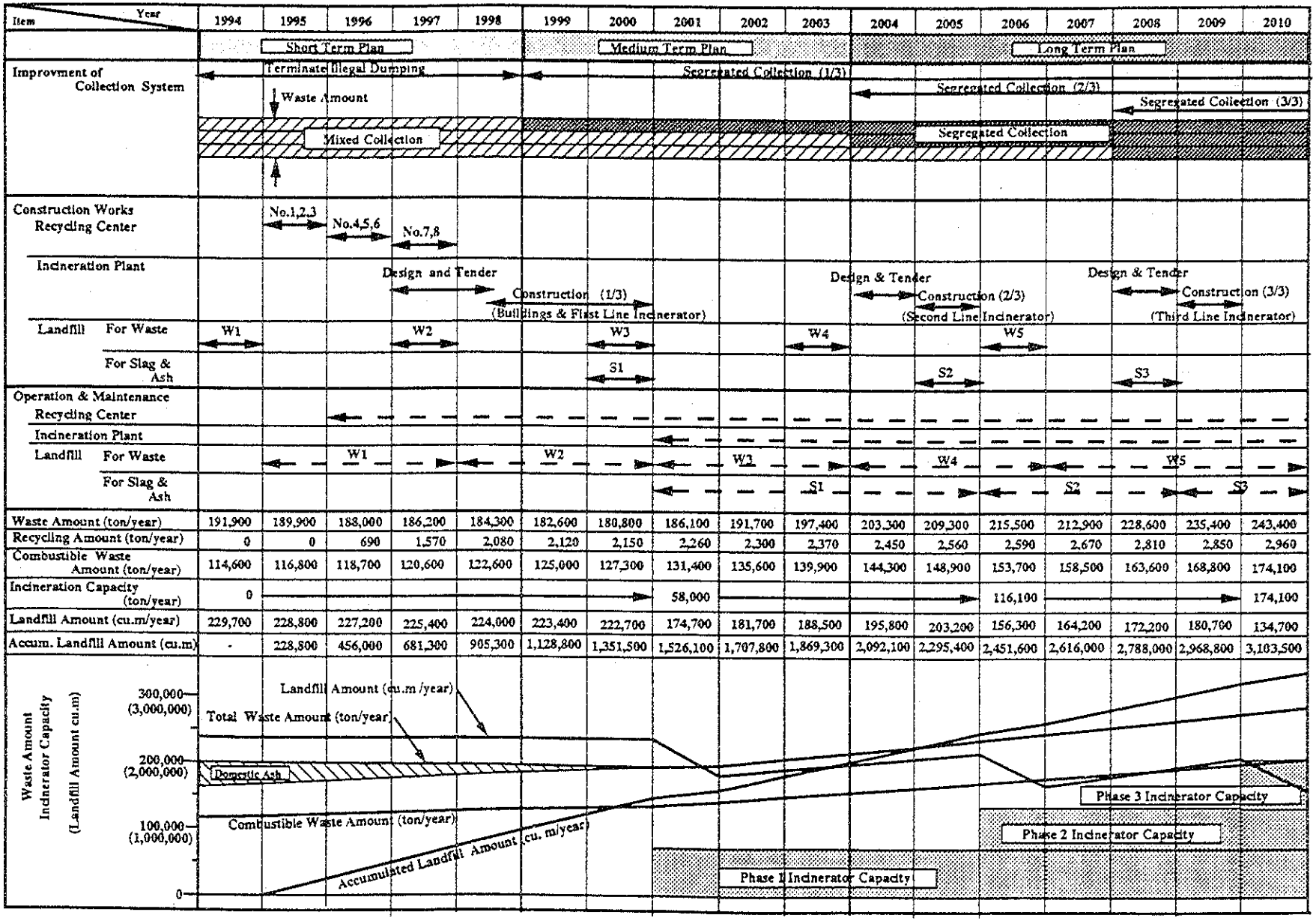


Table 7.3-1 Activity Schedule of MSWM Master Plan

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

7.4 Institutional System

This section will provide recommendations for institutional development for the optimum MSWM for Poznan Municipality. The activities to be considered in the institutional development are:

Administration

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

Technical systems

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

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

7.4.1 Strategy for Institutional and Organizational Development in Poznan Municipality

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

The basic philosophy is that MSWM is a public task and, thus, should be operated under public control. It is, however, recommended that subordinate municipal companies, business-like in structure and orientation, should be formed to

smoothen he daily operation. Aside from recommending the introduction of competitive bidding the following guidelines were also recommended:

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

- Competitive bidding regarding cleansing services (i.e. collection, road sweeping, etc.) must be introduced to secure the best service for least costs.

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

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

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

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

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

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

7.4.2 Overall Institutional System for Poznan Municipality

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

Table.7.4.2-1 Proposed overall Institutional System for Poznan Municipality

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

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

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

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

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

The above structure will enable the introduction and implementation of a business-orientated MSWM and will make municipal control over the duties through the

Department for Municipal Solid Waste Management. Tendering will also bring about cost minimization and well defined services.

7.4.3 Department for Municipal Solid Waste Management

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

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

1) Overall Planning of MSWM

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

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

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

2) Competitive Bidding

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

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

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

3) Collection of fees and charges

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

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

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

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

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

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

4) Control and Supervision

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

7.4.4 Executive Bodies

Generally, establishment of a municipal company is the recommendable way of organizing execution of MSWM where complex technology or high level of activity are involved, while direct tendering can be applied for well defined services as eg. road sweeping and public area cleansing.

The ideal institutional plan includes 2 companies under municipal control for execution of services related to collection of waste and treatment/disposal of waste respectively.

The limited liability company formed by Poznan Municipality and the private investor Rethman Recycling GmbH could be appointed as the municipal company responsible for all collection services, but since the latter holds majority of the shares, the company will be categorized as a private contractor. This would mean subordination to the municipality in the execution of the services.

Basically, municipal waste management is a public duty and a non-profit business. Thus, a municipal company should not be profit orientated. The division of the shares of Rethman-Poznan Waste Management Co. Ltd. cannot secure municipal control over activities related to compulsory waste services without special arrangements.

We recommend that the responsibility for execution of compulsory municipal waste collection services are maintained in the Department for Municipal Solid Waste Management and that the execution is carried out as follows:

- Through the tender of districts (at least 25% of the volume, or may be more as Rethman-Poznan Waste Management Co. Ltd., may participate in the tender). The tender must be made in appropriate districts, so smaller companies may also take part in the tender.

- Through direct contract with Rethman-Poznan Waste Management Co. Ltd. with determination of fees based on the result of the tender for the districts.

For execution of duties related to Incineration Plant and Sanitary Landfill, we propose the formation of a company with the municipality as a major shareholder.

For road sweeping and public area cleansing we propose to maintain the present system with direct tender of the activities.

These considerations led to the following institutional plan.

Table 7.4.4-1 Institutional Plan

Category	Responsible Organization	Work Items
RESPONSIBLE BODY	Department for Municipal Solid Waste Management in Poznan Municipality	- Planning - Administration - Collection of fees - Control and supervi sion
EXECUTIVE BODIES	Department fot Municipal Solid Waste Management in Poznan Municipality through direct tender	Opration of: - Collection system - Recycling centres - Bulky waste collection
	Poznan Waste Treatment and Disposal Company	Operation of: - Incineration plant - Sanitary landfill
	Provincial Road Authority and Department for Municipal Solid Waste Man-agement through direct ten-der	Execution of road sweeping
	Forest Authority and Green Area Authority through direct tender	Execution of public area cleansing
INVESTMENT	Department for Municipal Solid Waste Management in Poznan Municipality	- Recycling centres - Bulky waste collection
	Rethman-Poznan Waste Management Co., Ltd.	- Regular collection
	Poznan Waste Treatment and Disposal Company	- Incineration plant - Sanitary landfill
	Others	- Regular collection - Public area cleansing

7.4.5 Financial Plan

1) Targets

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

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

2) Allocation of Cost

a. Principle of cost allocation

In accordance with the "Polluter Pay Principle", the fee system based on the weight of waste amount discharged will be introduced by 2010. The allocation of MSWM cost is shown in Table 7.4.5-1.

Table 7.4.5-1 Allocation of MSWM Cost

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

b. Criteria of Affordability

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

Table 7.4.5-2 Affordability

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

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

c. Items to be paid by Citizens

Citizens shall bear the following costs:

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

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

d. Items to be paid by Municipality

The Municipality shall bear the following costs:

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

3) Financial Sources

a. Basic conditions

The following institutions were assumed to be involved in MSWM:

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

Costs are allocated as shown in Table 7.4.5-3

Table 7.4.5-3 Allocation of MSWM Cost

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

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

b. Money Flow and Financial Source

Overall money flow for MSWM is presented in Fig.7.4.5-1.
The Municipality collects fees from householders. The expenses of the activities of Poznan Treatment and Disposal Company are covered by the sale of heat and tipping fees.

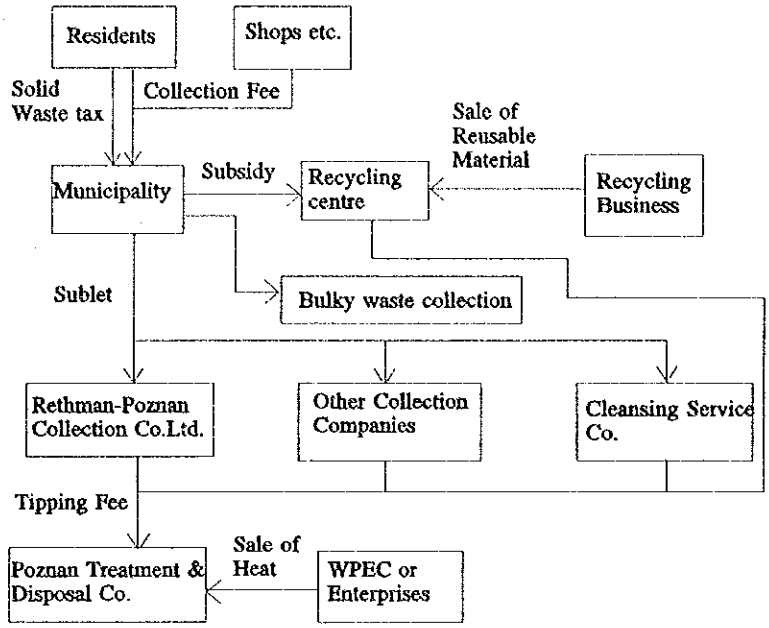


Fig.7.4.5-1 Money Flow for MSWM

4) Fee System

The fee system consists the following:

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

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

5) Required finances and their sources

The required financial amount and its proposed sources are presented in Table 7.4.5-4.

Table 7.4.5-4 Required Financial Amount and Source unit: mill.zl

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

Note:

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

The required annual expenditure is presented in Table 7.4.5-5.

Table 7.4.5-5 Annual Expenditure unit: mill.zl

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

Note: - O & M cost and depreciation are included in the figure above.

Based on the following conditions, the waste collection fee shown in Table 3.2-14 were estimated.

- International lending agencies shall be the financial sources of the incineration plant and the landfill project.
- Required internal rate of return is more than 15 %.

- Other projects should be self-financed.

Table 7.4.5-6 Solid Waste Fee unit: zl/ton

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

6) Fee collection system

Every fee collection system has its advantages and disadvantages. A fee collection system according to weight of waste discharged should be introduced by 2010 in order to maintain equality. However, the waste fee system based on the number of persons and waste tax based on their income were proposed, because there are many difficulties involved in introducing the former. The waste fee list is shown in Table 7.4.5-7.

Table 7.4.5-7 Waste Fee List unit: zl

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

Note:

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

7) Amount shouldered by citizens and Poznan Municipality

Amount shouldered by citizens is presented in Table 7.4.5-8.

Table 7.4.5-8 Amount shouldered by Citizens

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

Amount shouldered by the municipality of Poznan is presented in Table 7.4.5-9.

Table 7.4.5-9 Amount shouldered by Poznan Municipality

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

Note:
*1 The capital investment includes the construction cost of P.R.C., replacement cost of containers for P.R.C, and the first purchase cost of bulky waste collection equipment.
*2 Subsidies for purchase of containers are required only in 1998, 2002 and 2006. They are, therefore, not shown in this table.

Table 7.4.5-10 Balance Sheet

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Revenue																	
Waste Tax*		17,914	17,964	18,014	18,064	18,114	18,164	61,345	61,513	61,682	61,850	62,019	74,794	74,996	75,199	75,401	75,604
Collection Fee																	
General collection	0																
Household*		40,240	40,352	40,464	40,577	40,689	40,801	40,913	41,026	41,138	41,250	41,363	43,720	43,838	43,957	44,075	44,194
Shops etc.		5,501	5,516	5,532	5,547	5,562	5,578	11,186	11,217	11,248	11,278	11,309	13,636	13,673	13,710	13,747	13,784
Market etc.		2,662	2,712	2,761	2,794	2,844	2,894	5,622	5,777	5,964	6,119	6,305	6,492	6,678	6,896	7,082	7,299
Bulky collection*	0	1,129	1,150	1,170	1,184	1,205	1,225	2,072	2,140	2,196	2,263	2,330	2,397	2,464	2,543	2,621	2,700
Sale																	
Container*	3,248	3,248	3,248	3,248	3,916	4,748	4,748	3,931	4,953	5,621	5,834	5,882	5,637	6,814	6,843	7,075	5,882
PM budget allocation	0	14,296	19,347	24,003	26,918	26,964	27,020	35,793	36,185	36,499	37,331	37,683	38,095	38,546	38,938	39,408	39,898
Subtotal(A)	3,248	84,991	90,289	95,193	99,001	100,126	100,430	160,863	162,812	164,347	165,925	166,891	184,771	187,009	188,084	189,410	189,361
Annual Expense																	
Contract out																	
General collection	0	66,469	62,848	59,111	56,283	55,738	55,126	107,783	110,983	114,306	117,630	121,109	124,743	128,377	132,198	136,111	140,087
Public cleansing **	0	8,213	8,218	8,223	8,223	8,228	8,233	8,921	8,960	8,980	9,019	9,039	9,078	9,117	9,137	9,176	9,196
P.R.C**	0	0	4,370	8,405	10,943	10,984	11,034	19,120	19,473	19,767	20,499	20,832	21,204	21,616	21,988	22,420	22,890
Bulky collection	0	1,177	1,182	1,186	1,189	1,194	1,198	2,014	2,049	2,079	2,114	2,149	2,184	2,220	2,261	2,302	2,343
Control & Supervise**	0	6,083	6,083	6,083	6,083	6,083	6,083	6,083	6,083	6,083	6,083	6,083	6,083	6,083	6,083	6,083	6,083
Subsidy for container**	0	0	0	0	3,914	0	0	0	3,914	0	0	0	3,352	0	0	0	0
Purchase of container	3,248	3,248	3,248	3,248	3,916	4,748	4,748	3,931	4,953	5,621	5,834	5,882	5,637	6,814	6,843	7,075	5,882
Depreciation***	0	82	758	1,374	1,751	1,751	1,751	1,751	1,751	1,751	1,812	1,812	1,812	1,812	1,812	1,812	1,812
Interest	0	86	125	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal(B)	3,248	85,359	86,832	87,630	92,303	88,726	88,174	149,604	158,167	158,587	162,990	166,906	174,094	176,038	180,321	184,979	188,293
Balance	0	-368	3,458	7,563	6,697	11,400	12,255	11,260	4,645	5,760	2,935	-14	10,677	10,971	7,763	4,431	1,067

notes: Annual Expense is sum of O/M cost, Disposal cost of collection, depreciation cost and interest.

7.4.6 Selection of First Priority Project

1) Contents of the First Priority Project

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

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

2) Preliminary Design

In contrast to a disposal site distanced remotely from the city, the recommendation of Franowo–Michalowo, located within 7km from the centre of the city, as a disposal site will reduce transportation costs. To obtain the consensus of the residents, however, the proposed facilities must meet the strict environmental protection standard, hence the preliminary designs of both incineration plant and landfill for Franowo were made in accordance with the EC environmental standard. The designs were carried out in accordance with the European Standards and are summarized in Tables 4.1–1, 4.1–2, and 4.1–3. The illustrations are Plates 2,3 and 4.

PART III

FEASIBILITY STUDY

CHAPTER 8

FEASIBILITY STUDY OF THE FIRST PRIORITY PROJECT

CHAPTER 8 FEASIBILITY STUDY OF THE FIRST PRIORITY PROJECT

This chapter firstly describes the preliminary designs of the MSWM technical sub-systems, the institutional plan and estimation of project cost concerning the first priority projects. Secondaliry the project evaluation was conducted and it concluded that the first priority projects were feasible.

8.1 Preliminary Design of Technical System

8.1.1 Design Conditions

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

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

  . Upper limit value
  . Mean value
  . Lower limit value

1) Waste Categories for Incineration

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

- Combustible components of municipal solid waste such as:

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

- Sewage sludge

2) Waste Amount for Incineration

The waste amount to be incinerated is as shown in Table 8.1.1-1.

Table 8.1.1-1 Design Waste Amount for Incineration

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

3) Lower Calorific Value of Waste for Incineration

The lower calorific value of wastes to be incinerated is presented in Table 8.1.1-2.

Table 8.1.1-2 Design Lower Calorific Value of Waste for Incineration

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

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

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

Table 8.1.1-3 present the design lower calorific values which was calculated by weighing average of those data.

Table 8.1.1-3 Design Lower Calorific Value of Waste for Incineration

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

Although the data shown in Table 8.1.1-3 represents the yearly mean lower calorific value of waste, in addition, the yearly fluctuation has to be taken into account.
The yearly fluctuation rate obtained by the survey are shown in Table 8.1.1-4.

Table 8.1.1-4 Fluctuation of Lower Calorific Value

	Summer	Winter
Upper	1.14	1.22
Mean	1.00	1.00
Lower	0.83	0.87

Based on the data in Table 8.1.1-4, the design fluctuation rates are determined as follows:

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

The lower calorific values were calculated and shown in Table 8.1.1-5.

Table 8.1.1-5 Lower Calorific Values

Year	Rate	1992	2001	2006	2010	2005
Lower Calorific Value			1,704	1,975	2,083	1,652
Upper limit	1.22	-	2,079	2,410	*2,514	2,015
Mean	1.00	-	1,704	1,975	*2,083	1,652
Lower limit	0.87	-	1,414	1,639	1,729	*1,372

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

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

8.1.2 Intermediate Treatment: Incineration Plant

1) Introduction

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

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

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

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

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

2) Design Data

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

Calorific Value

In relation to this study, surveys on waste composition and quantity have been carried out in June and December 1992. The results are presented in ANNEX H.

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

as for the feasibility of the incineration plant, higher calorific waste values are preferred.

Forecasts on waste composition has been prepared in ANNEX I.1.5.

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

Working Hours

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

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

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

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

Waste Quantity

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

Table 8.1.2–1 Quantity of Combustible Waste from Poznan

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

3) Required Capacity

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

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

Required capacity: $$\frac{174{,}000 \times 1.20}{7{,}000} = 30 \ \textit{tons/hour}$$

or 3 incineration lines for every 10 tons/hour.

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

Phase 1 comprises:

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

- All building facilities for 3 incineration lines.

Phase 2 comprises:

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

Phase 3 comprises:

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

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

4) Sale of Energy

a. Conditions for Sale of Energy

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

- The supply of electricity is covered by the national network. Poland produces and exports electricity.
- Approximately 60% of the population of Poznan (590,000) is supplied with heat from the heat distribution network that is operated by the municipal heat supply company, PEC.

This network is supplied with heat from the following sources:

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

- In 1991, a total of 8,760 TJ heat was distributed by PEC. The monthly fluctuation appears in Fig.8.1.2-1.

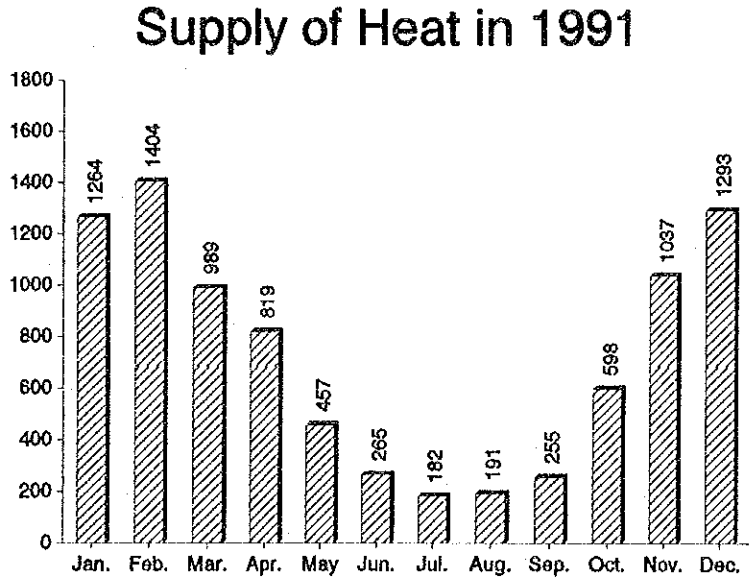


Fig.8.1.2-1 Supply of Heat to the City of Poznan in 1991

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

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

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

5) Selection of the Location of the Site for the Incineration Plant

The Municipality of Poznan has chosen approximately 180 ha of land in Franowo–Michalowo for the construction of the future sanitary landfill and waste treatment plants.

The proposed incineration plant is estimated to require an area of 5 ha.

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

- The Site is located at a distance of approximately. 1 k from apartment buildings to the northeast and approximately. 1 k from a residential area to the south. Thus, the site was selected for the incineration plant due to the existence of important residential areas.

- Geotechnical investigations carried out at the Site showed an upper, 12 m thick layer of sand, making it less appropriate for the construction of a sanitary landfill. Other parts of the selected area of 180 ha are considered more appropriate for the construction of the sanitary landfill since they comprise boulder clay.

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

- The Site is located next to a main road, therefore minimizing the length of the new access road to the incineration plant.

The proposed location of the incineration plant is shown in Fig.8.1.2–2.

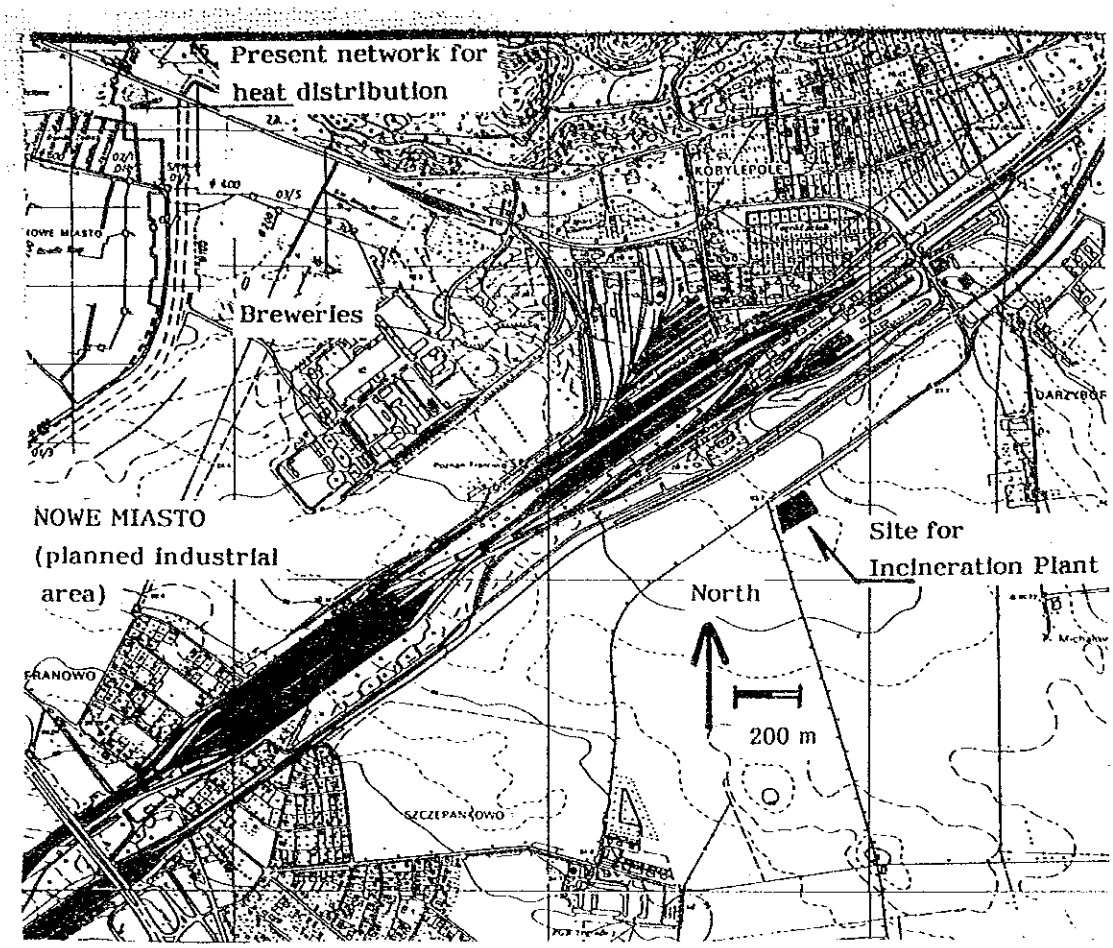


Fig 8.1.2-2 Location of the Site for the Incineration Plant

The location of the incineration plant at Franowo-Michalowo complements well the present plan for the construction of the new industrial area, Nowe Miasto.

Because of the well-established network for district heating in Poznan and the present surplus in the production of electricity in Poland, the waste incineration plant should only produce district heating.

Based on the forecasts on waste quantity and composition (refer ANNEX I.1.5), the estimated heat production from the incineration plant appears in Table 8.1.2-2. 80% of the energy taken from waste is assumed to be utilized.

Table 8.1.2-2 Estimated Input and Output for the Incineration Plant.

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

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

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

6) Technical Description

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

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

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

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

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

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

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

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

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

7) Cost Estimates

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

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

Table 8.1.2–3 Initial Investments for Incineration Plant: Capacity: 30 tons/hour

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

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

Table 8.1.2–4 Operation Costs for Incineration Plant: Capacity 30 tons/hour

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

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

Phase 1:

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

Phase 2:

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

Phase 3:

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

8) Summary for Incineration Plant

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

Table 8.1.2–5 Summary for Incineration Plant, Capacity 30 tons/hour at 2100 kcal/kg, 3 lines in operation.

Capacity of plant at 7,000 operation hours/year		174,000 tons/year	
Investment		49.0 mill. USD + 160,000 mill. ZL	
Annual operation costs (average year 2001 to 2010)		33,000 mill. ZL/year	
Year	Waste received (tons/year)	Slag and ash (tons/year)	Heat for sale (TJ/year)
2001	58,000	19,700	332
2006	116,000	39,500	769
2010	174,000	59,200	1,215

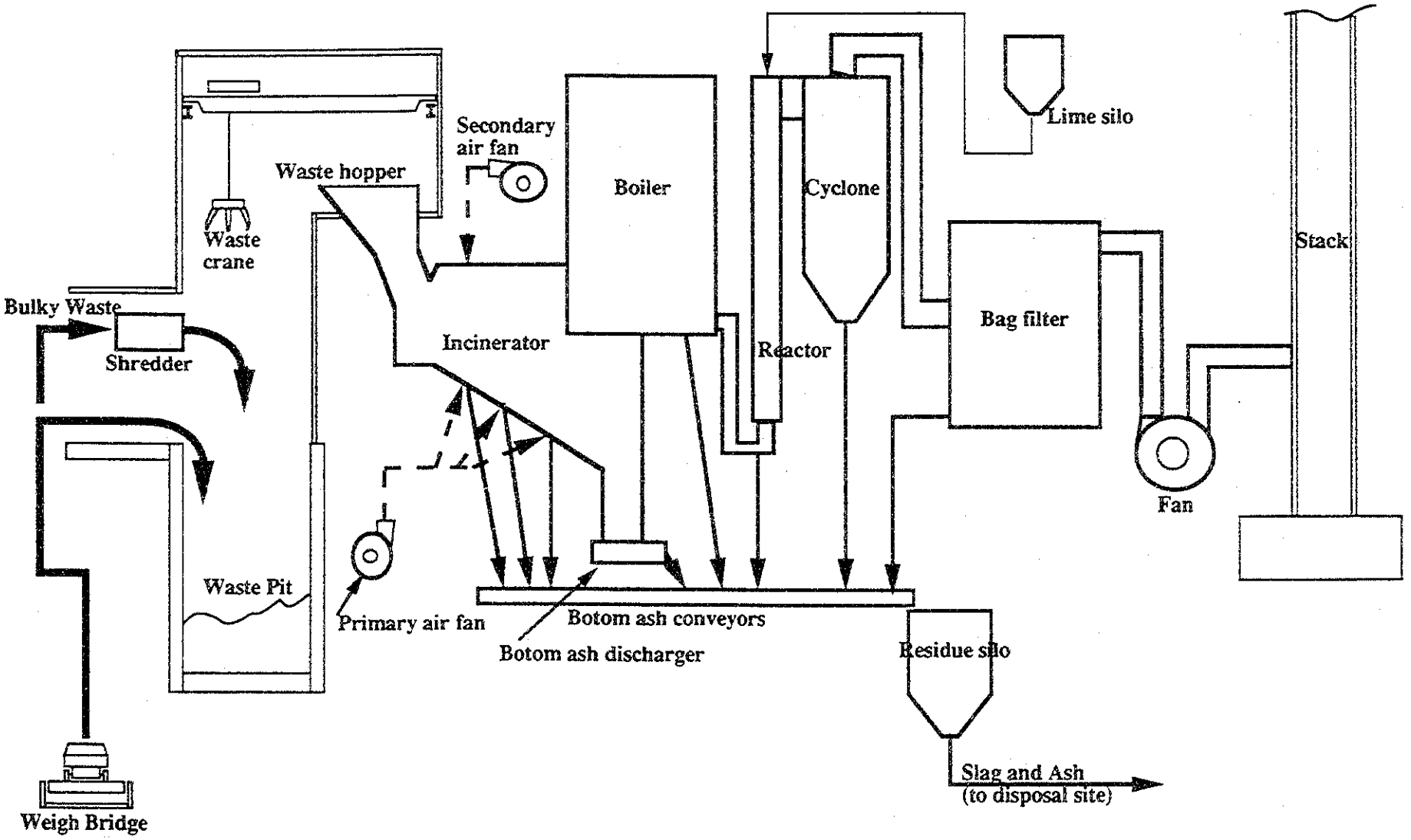
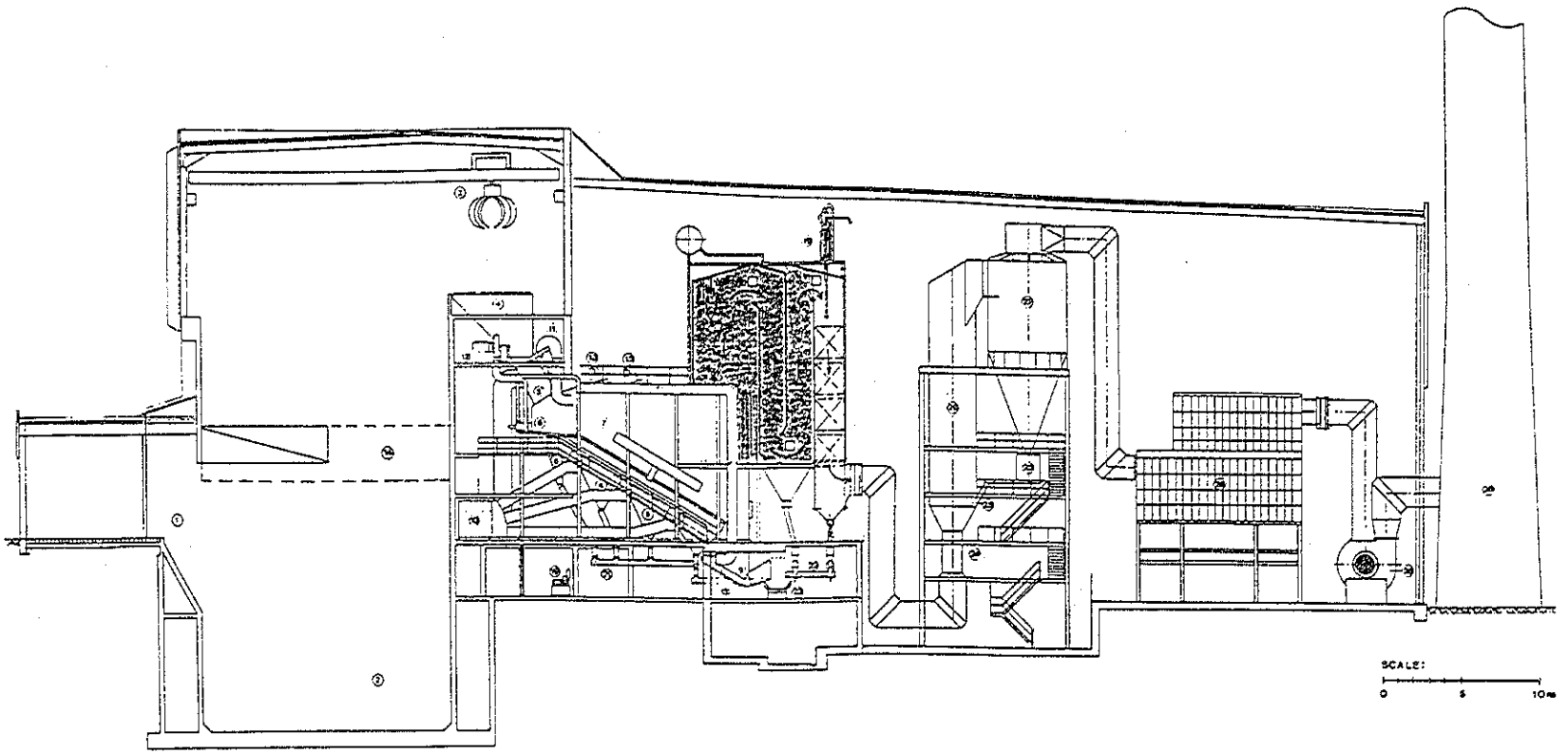


Fig.8.1.2-3 Flow Diagram of Incineration Processing



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

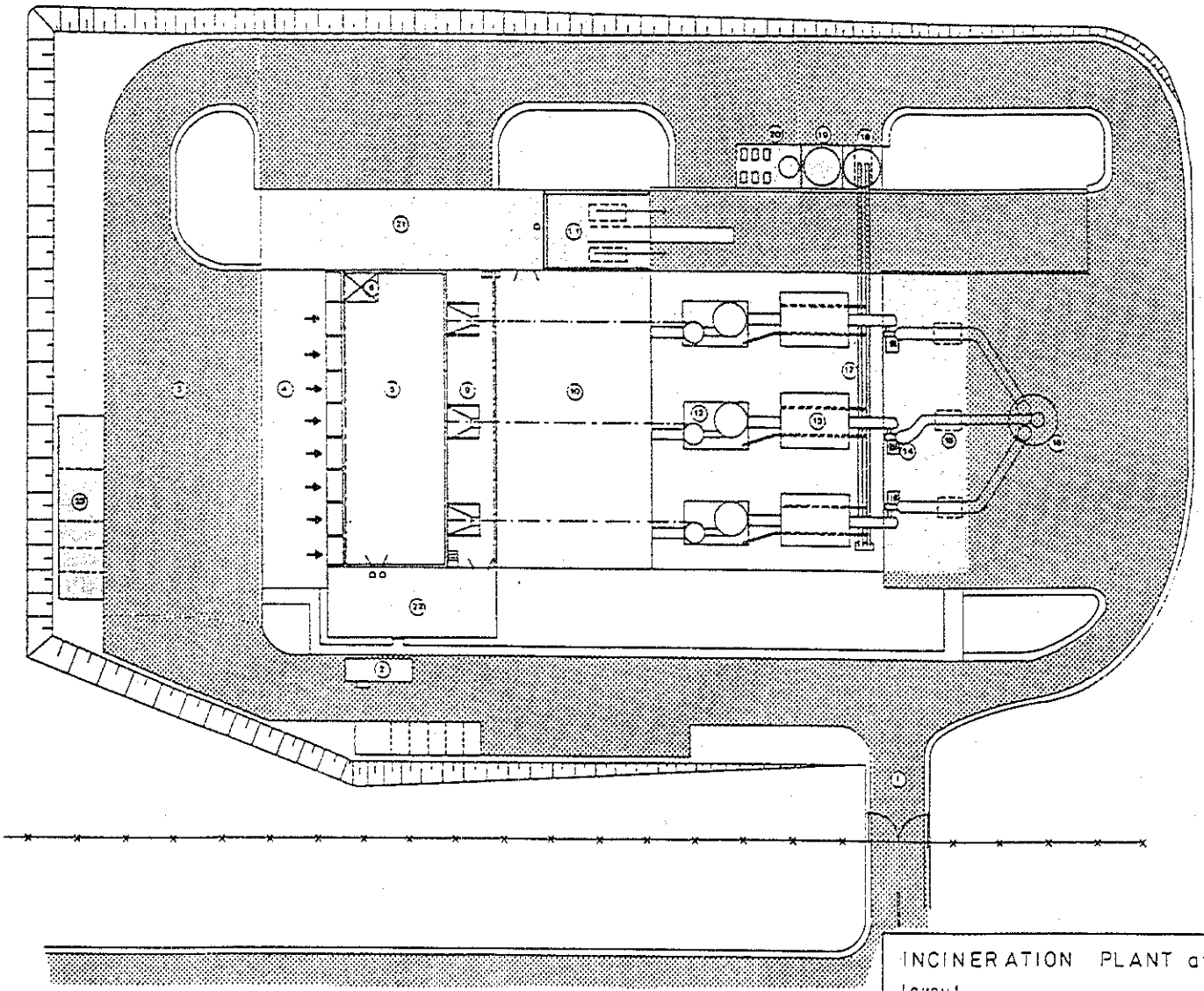
INCINERATION PLANT at Franowo - Michalowo

Sectional View

Drawing No. C1

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

JAPAN INTERNATIONAL COOPERATION AGENCY



1. Plant Entrance
2. Weigh Bridge
3. Waste Reception
4. Waste Reception (Hall)
5. Waste Pit
6. Shredder for Bulky Waste
9. Waste Hopper
10. Furnace Hall
11. Slag pit
12. Semi-dry Flue Gas Cleaning Tower
13. Bag Filter
14. Fan
15. Silencer (option)
16. Stack
17. Residue Transport
18. Residue Silo
19. Lime Silo
20. Pump House
21. Administration and Staff Section
22. Control Section
23. Workshop and Storage Rooms

SIGNATURES:

Building

Asphalt Pavement

0 5 10 20

INCINERATION PLANT at Franowo - Michalowo

Layout

Drawing No. C2

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

JAPAN INTERNATIONAL COOPERATION AGENCY

8.1.3 Intermediate Treatment: Public Recycling Centres

1) Introduction

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

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

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

2) Technical Description

The recycling centre:

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

Each maxi container is designed differently facilitating households unloading of the different waste categories. It is assumed that the containers can be produced in Poland.

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

Table 8.1.3-1 Container Equipping for a Small and Large Recycling Centre and Treatment Measure

Waste type	Container equipping for recycling centre (nos.)		Treatment Measure
	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 equip ment		Recycling
	1	1	
Paper (newspapers)	maxi container		Recycling
	1	1	
Garden waste	maxi container		Incineration or landfill
	2	4	
Furniture	maxi container		Landfill or incineration after crushing
	1	1	
Combustible waste, including plastic	maxi container		Incineration or landfill
	2	4	
Incombustible (soil and stone)	maxi container		Dump area
	1	2	
Chemical and oil	shed or container		Special treatment
	1	1	
TOTAL, nos. of containers	3 mini 10 maxi	5 mini 16 maxi	
Area required	2,000 m^2	3,000 m^2	

3) Design Data

Based on Western European experiences, the typical composition of materials collected at recycling centres is presented in Table 8.1.3-2.

Table 8.1.3-2 Typical Composition of Materials from Recycling Centres

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

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

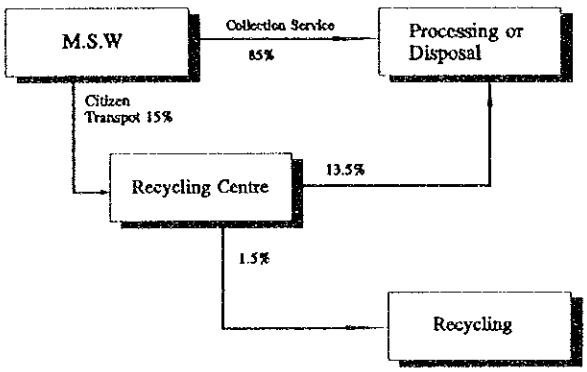


Fig.8.1.3-2 Assumed Waste Flow for Recycling Centres

4) Cost Estimates

Based on the lay-out described, this section presents the cost estimates for the construction and operation of recycling centres in Poznan. All estimates are based on the price level described in ANNEX I.1.5.

Table 8.1.3-3 Cost Estimate for Small Recycling Centres

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

Table 8.1.3-4 Cost Estimate for Large Recycling Centres

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

Note. Turn over tax is included in the local portion of the above estimate cost.

5) Localization

This study planned the construction of 8 recycling centres in Poznan.

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

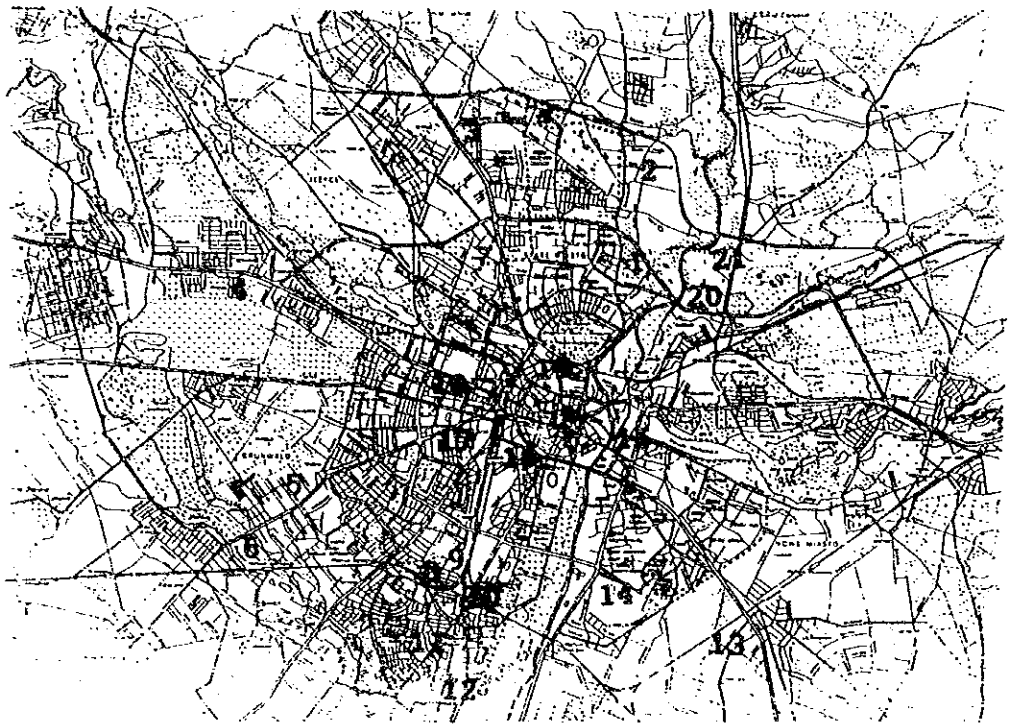
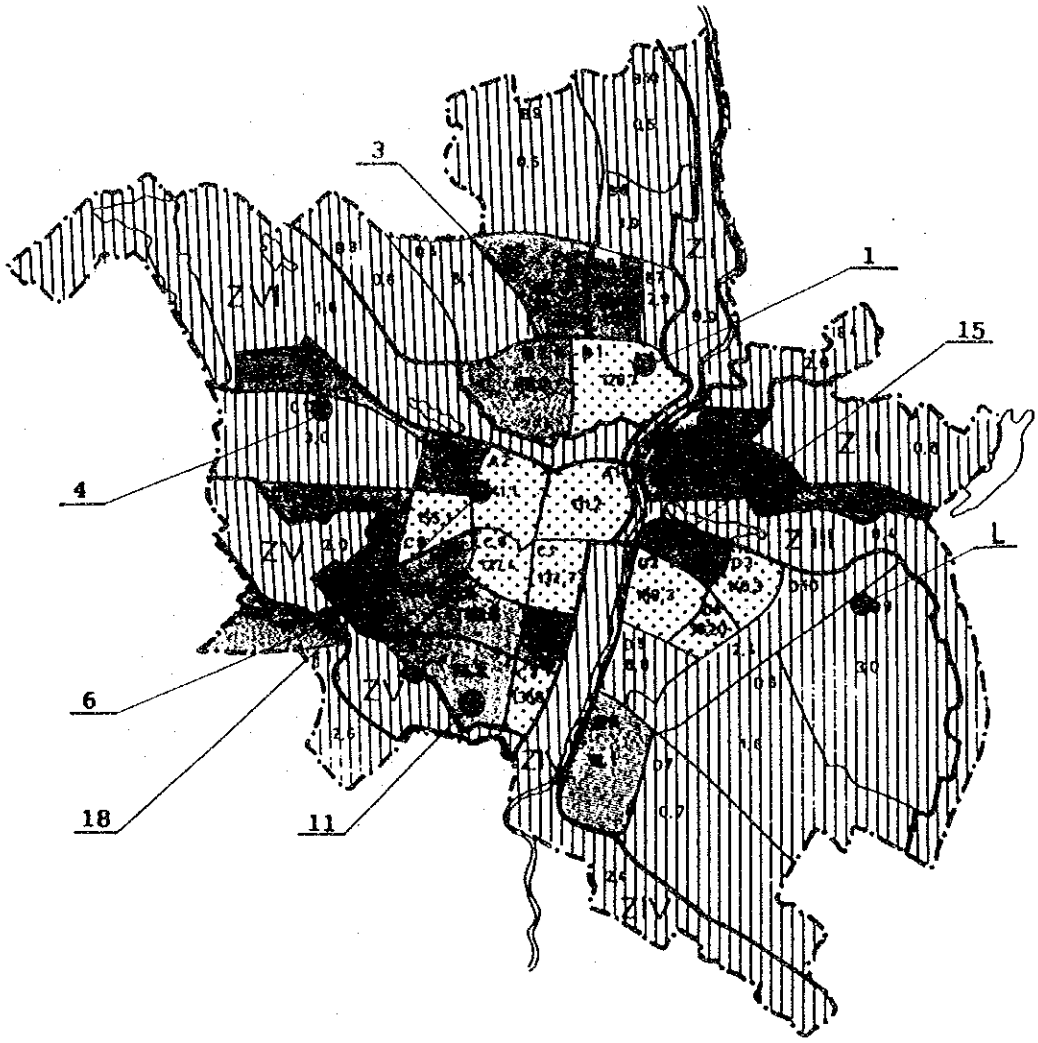


Fig.8.1.3-3 Locations for Recycling Centres Proposed by Town Planning Office

Based on the above proposal and considering the population density of Poznan, the following locations are recommended, (refer to Fig.8.1.3-4).

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



Note: The figures in the map refer to the population density (nos. people/ha) in districts of Poznan.

Signatures:

- Recommended location of recycling centre.
- Area with high density of population
- Area with medium density of population
- Area with low density of population

Fig.8.1.3-4 Eight Locations proposed for Recycling Centres in Poznan

The proposed lay-out of the recycling centre at Grunwaldzka St (location no.6, refer to Fig.8.1.3-4) is presented in Drawing No. R1.

This location is selected for the following reasons:

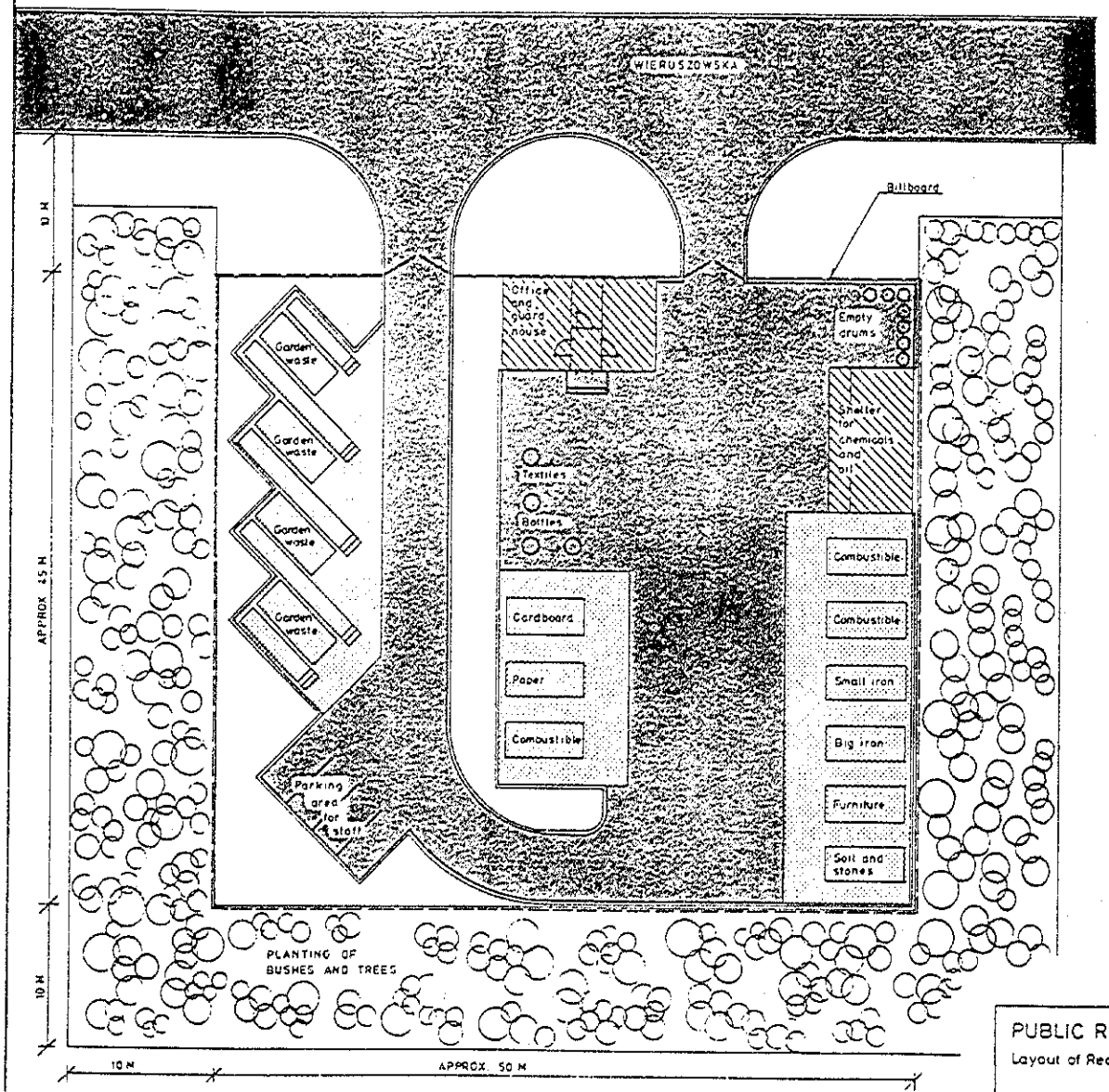
- Provided the recycling centre is surrounded with plants, embankments of soil and fences, it is considered to gain public acceptance.

- The disposal of garden waste is a problem in the area as many houses have gardens.

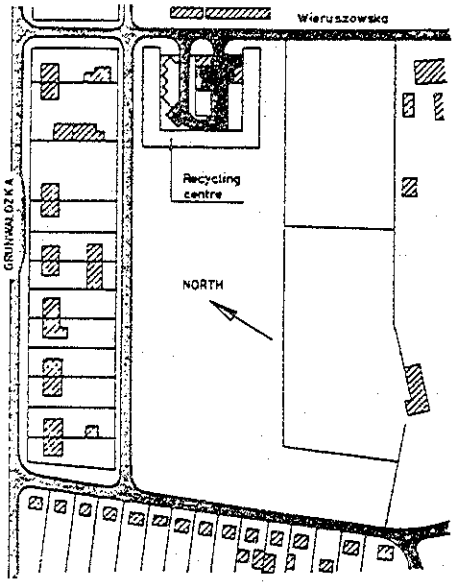
- The population is relatively affluent, therefore, transportation of recyclable materials to the centre is not a problem.

- It is relatively simple to construct an access road from the main public road to the proposed location for the recycling centre.

- The proposed location is appropriate (relatively little earthwork) for the construction of a recycling centre.



LAYOUT OF RECYCLING CENTRE, Scale 1:300



LOCATION OF RECYCLING CENTRE,
Scale 1:3000

NOTE:

All containers are designed in accordance with the type of waste to be received.

SIGNATURES:

- Asphalt pavement
- Pavement of concrete stones

PUBLIC RECYCLING CENTRE
Layout of Recycling Centre at Grunwaldzka

Drawing No.	THE STUDY ON THE SOLID WASTE MANAGEMENT FOR POZNAN CITY IN THE REPUBLIC OF POLAND
R1	JAPAN INTERNATIONAL COOPERATION AGENCY