3) Sanitary Landfill

Table J.3.1-3 outlines the contents of the sanitary landfill section W1 to be constructed during the stage 1 of the Master Plan.

Table J.3.1-3 Outline of Final Disposal Site

Items	Contents	Remarks
a. Target Year	1995	
b. Service Population	595,000	
c. Proposed Site	Franowo-Michalowo	Site area 47.4 ha
d. Waste to be Disposed	- Household Waste - Commercial Waste - Market Waste - Institutional Waste - Bulky Waste - Road Sweeping Waste - Other Wastes	
e. Capacity	700,000 cu.m	
f. Life of Site	3 years	From 1995 to 1997
g. Landfill Method	Sanitary landfill	Leachate is carried to sewage treatment facility
h. Landfill Area	4.0 ha	From 1995 to 1997
i. Facilities Outline		
- Main Facilities	Enclosing structure, drain system	
- Environmental Protection Facilities	Buffer zone, gas removal, leachate collection and monitoring facilities.	
- Building and Accessories	Office and weighbridge, garage and workshop	
j. Equipment	Compactors, traxcavator, dump truck and tractor	
k. Personnel	18 persons	
l. Construction Period	1 Year	1994 Design and Construction

J.3.2 Investment cost

1) Investment cost

The foreign currency portion of financial cost includes 10% of import tax and 5% of turn over tax. The local currency portion of it includes only 5% of turn over tax. The economic cost excludes import tax and turn over tax.

The investment costs of the 3 projects are estimated and shown in Table J.3.2–1.

Table J.3.2–1 Investment Cost unit: mill.zl

	Financial Cost			Economic Cost
	Foreign	Local	Total	
Public Recycling Centres	0	16,264	16,264	14,941
Incineration	379,155	160,000	539,155	401,852
Final Disposal	5,417	41,100	46,517	42,071
Total	384,572	217,364	601,936	458,864

Note:
1. Investment was estimated based on 1993 price.
2. Investments for Public Recycling Centres is a total of 3 years from 1995 to 1997.
3. Investment for an incineration plant is a total of 3 years from 1998 to 2000.
4. Cost for final disposal is the investment in 1994.
5. Total cost includes engineering fees and physical contingencies.

2) Operation cost

Operation cost consists of the depreciation cost and the operation / maintenance cost which covers costs for fuel, personnel, construction and management, etc.

Based on the above assumption, the operation cost in 2005 is calculated and shown below in Table J.3.2–2.

Table J.3.2-2 Operation Cost in 2005 unit: mill.zl

	Operation & Maintenance			Depreciation Cost	Total
	Personnel Cost	Fuel & Others	Maintenance Cost		
Public Recycling Centres	2,457	5,606	597	1,730	10,390
Incineration	6,380	7,540	3,480	30,610	48,010
Final Disposal	1,465	2,895	690	10,343	15,393
Total	10,302	16,041	4,767	42,683	73,793

J.4 Project Evaluation

J.4.1 Environmental Evaluation

The objectives for the evaluation are shown below:

- Project of eight public recycling centres
- Project of incineration plant phase 1; and
- Project of sanitary landfill section 1

The facilities installed are planned to be in accordance with EC standards. Environmental control equipments, regarding the emission of pollutants from incineration plants conforming with the levels of pollutants outlined in the table below, are planned to be installed.

Table J.4.1-1 EC Emission Standard of Incinerator

Pollutant	Permissible Amount (mg/Nm^3)
Total dust	30
Heavy metals	
- Pb+Cr+Cu+Mn	5
- Ni+As	1
- Cd and Hg	0.2
Hydrochloric acid (HCl)	50
Hydrofluoric acid (HF)	2
Sulphur dioxide (SO_2)	300

Evaluations were made on the following environmental aspects. However, there is a need for a secondary environmental impact assessment at the point where details of the main facilities are known.

- Water pollution (surface and ground water)
- Air pollution
- Odour
- Noise

A comment on the altering landscape and scattering of wastes was made accordingly.

1) Public Recycling Centre

a. Water Pollution

The aim of the public recycling centre is to reduce the amount of illegal dumping. If illegal dumping and the known illegal sites are eliminated and is reinstated, leachate which may leak from the present sites, causing considerable damage to the environment, should cease.

The actual operation of the public recycling centre seldom has any impact on the quality of the water in its vicinity.

b. Noise

The operation of the public recycling centre induces noise levels caused by citizens vehicles bringing wastes to the centre and trucks carrying out the wastes. The surrounding areas together with the access roads where vehicles operate further adds to the problem of noise pollution. However, as the amount of waste brought to one centre is 10 tons/day, if it is assumed that each load carried is 50 kg and the time taken to transport the waste is 6 hours, it amounts to only 30 vehicles entering the site per hour. This amount is comparatively small; the noise produced and its impact will also be minimal.

c. Landscape

There are a total of eight public recycling centres located in various parts of the city; with two of the largest having an area of 3,000 m^2, and the other six being smaller with an area of 2,000 m^2. The facilities on the site include just containers and an office and guard house. If management and separation of wastes is enforced in a proper manner, impact on the surrounding landscape is minimal. Also, with the operation of the public recycling centre and the termination of the illegal dumping, the landscape of the present site will be recovered.

2) Incineration Plant

a. Air Pollution

To lower the level of pollutants below the EC limits the incineration plant is planned to be installed. However, in the case regarding the nitrogen oxides (NOx) there are no EC regulations, therefore the Japanese standard shall be used as a guideline.

SO_2 : 300mg/Nm^3
NOx : 250mg/Nm^3
HCl : 50mg/Nm^3
SP : 30mg/Nm^3

By using these values and frequent weather conditions as a guideline, concentrations of pollutants emitted in the surroundings were estimated. From these estimations it is deemed that by the year 2010 the effect on the environment will be minimal.

Table J.4.1-2 Estimated Air Quality

Pollutant	Estimation	EC Standard *1	Polish Standard *2
SO_2	0.006 ppm	0.028 ppm	0.011 ppm
Nox	0.005 ppm	0.097 ppm (NO_2)	0.024 ppm (NO_2)
Hcl	0.001 ppm	-	-
SP	0.001 mg/m^3	0.040 mg/m^3	0.022 mg/m^3

*1 SO_2 : 80 μg/m^3 x 22.4 ÷ 64 x 10^{-3}
NO_2 : 200 μg/m^3 x 22.4 ÷ 46 x 10^{-3}
SP : 40 μg/m^3

*2 SO_2 : 0.032 mg/m^3 x 22.4 ÷ 64
NO_2 : 0.050 mg/m^3 x 22.4 ÷ 46
SP : 0.022 mg/m^3

In 1991, the amount of heat energy distributed to citizens was 8,760 TJ per annum. The amount of heat reclaimed from the Phase 1 incineration plant amounts to 4% of the total; the level of pollutants emitted from PEC shall decrease. Pollutants discharged from the plant are in accordance with the EC standard. Therefore, the total amount of pollutant shall decrease.

b. Water Pollution

Leachate produced within the waste pit is collected and sprayed into the incinerator to be burnt and the water is vaporized. Fumes are treated and pollutants removed in the semi-dry type removal plant and air is remitted into the atmosphere after its quality satisfies the EC requirements.

As the sewage from the incineration plant is directed to the sewage treatment plant, little harm to the environment is anticipated.

The possibility of pollution caused by leachate at the landfill is reduced in the case where by the waste is incinerated first and organic materials removed, compared to the instance where the waste is transported directly to the landfill.

c. Noise

It is deemed unlikely that noise pollution is a problem as the majority of the equipment audible from a distance remain within the building. However, the ventilation fans are installed outside of the building and the noise level at the boundary of the site is estimated 54.7 dB(A).
Approximately 150 collection vehicles enter and leave the site daily; if the working day is considered as six hours, it amounts to only 25 vehicles entering the site per hour and noise emission from the roadside is estimated about 65 dB(a).
These values exceed the upper limit of the sound emission acceptable in Poland, but as there are no housing areas in the vicinity the impact is considered to be very slight.

d. Odour

Offensive odour emitted from the incineration plant is produced on the platform as well as in the waste pit. An opening is needed on the platform for access of collection vehicles to and from the building, and therefore, there is a plan to install an air curtain at the opening to reduce the possibility of putrid gas diffusing out of the building.

Air including Odour from the waste pit is drawn into the incinerator for combustion. The final gas produced causes far less damage even outside the building.

Furthermore, by incineration, organic substances are decomposed and offensive odours at the final disposal site are then reduced.

e. Conservation of the Environment

In extracting and utilizing heat energy from the incineration plant, use of natural resources can be minimized conserving the natural environment.

3) Sanitary Landfill

a. Water Pollution

As the sides of the disposal site is to be lined with an impermeable liner it is impossible for the leachate to leak into the surroundings. The leachate produced shall be diverted by pipelines into the sewage treatment plant. The present Suchy Las disposal site bears high risks of polluting the surrounding waters, but, ceasing its operation and safely covering it with soil reduce further risks of pollution.

b. Odour

After incinerating organic substances and nullifying their negative impact on the environment, the main source of the offensive odour at the sanitary landfill is eliminated. On immediate coverage of the landfill further production of putrid fumes is minimized.

c. Noise

Spreading and soil coverage of the waste require construction equipment producing some amount of noise, but on the other hand as operation only takes place during the day and there is a limited amount of housing in the neighbouring areas there is very little impact. The access road leading to the site. The noise of the access road leading to the site has been analyzed in the evaluation of incineration plant.

Ceasing the operation of the current disposal site will further diminish the noise level as this leads to a reduction in the number of vehicles utilizing the access road.

d. Landscape

Section 1 of the final disposal site will have a net height of approximately 10m, the incineration building 30m and the stack 100m. Some impact on the landscape is otherwise unavoidable. However, citizens do not need to see the view of the site mundanely. The nearest residential area is more than six hundred metres away. Therefore its impact is believed to be very little. A line of trees is planned to be planted around the site, forming a Green Belt, preserving an aesthetic view of the disposal site from the residential areas.

A planned view of the disposal site from the residential area after 2010 is shown in the picture below:

Desisting the operation of the current disposal site in Suchy Las and planting trees in its place will accelerate the recovery of the landscape.

e. Scattering of Waste

A movable fence and immediate soil coverage is planned to be introduced at target landfill sections of the new disposal site to prevent the scattering of wastes.

Desisting the operation of the current disposal site in Suchy Las will also reduce the spreading of wastes.

J.4.2 Economic and Financial Evaluation

1) Outline of Project Evaluation Methods

a. Method of project evaluation

The objective of the economic and financial evaluation in the feasibility study is to determine whether the project is economically and financially necessary and feasible.

The methods of project evaluation applied in this study are summarized in Table J.4.2-1.

Table J.4.2-1 Project Evaluation Methods

Project	Public Recycling Centre	Incineration Plant	Sanitary Landfill
Economic Evaluation	- Cost-benefit analysis - Qualitative analysis	- Cost-benefit analysis - Qualitative analysis	(- Least cost method) - Qualitative analysis
Financial Evaluation (1)	nil	- Income and expen-diture analysis in 2005	- Income and expen-diture analysis in 2005
Financial Evaluation (2)	nil	- Cash flow analysis on Poznan Treatment and disposal Company from 1998 until 2015	

The method presented in the table were adopted for the following reasons:

- Economic evaluations on environmental projects are usually carried out based on a least cost method because quantitative benefits are too difficult to estimate.

- A cost-benefit analysis is used for the project that proposes an incineration plant in order to analyze its economic value on a national scale.

- The cost-benefit analysis is adopted for public recycling centres in order to analyze the cost saving effect of collection.

- Qualitative analysis is adopted for a sanitary landfill project which fulfil the EC standard because it is an indispensable facility for MSWM, which fulfil the EC standard, although the quantitative benefits are not expected.

- Financial evaluation is carried out on the following:

. Income and expenditure of the incineration plant in 2005.
. Income and expenditure of the sanitary landfill in 2005.
. Cash flow analysis of the Poznan Treatment and Disposal Company from 1998 to 2015.

- Financial evaluation is not carried out for public recycling centres because the Municipality proposes to operate them directly.

b. Methods of economic evaluation

The benefits, costs, etc., to be accounted for the economic evaluation are summarized in Table J.4.2-2.

Table J.4.2-2 Benefits, Costs and Criteria

	Public Recycling Centre	Incineration Plant	Sanitary Landfill
Benefit	- Recovery of reusable substances * - Cost saving on collection * - Cost saving on final disposal * - Termination of illegal dumping	- Recovery of heat * - Saving haulage cost - Reduction of final disposed volume * - Incineration of sewage sludge - Incineration of hospital waste - Others . Environmental improvement . Promotion of regional development	- Environmental improvement . Improvement of sanitary condition . Preservation of ground water . Protection from scattering waste
Cost	- Investment - O & M - Treatment and disposal	- Investment - O & M - Treatment and Disposal	- Investment - O & M
Criteria	B - C > O %	EIRR > 15 %	-
Evaluated Period **	from 1995 until 2010	from 1998 until 2015	-

Note: * These were analyzed quantitatively.
** Evaluation period was determined based on the construction year and their life years.

c. Methods of financial evaluation

The income, expenditure and evaluation criteria for financial evaluation are tabulated in Table J.4.2-3.

Table J.4.2–3 Income, Expenditure and Evaluation Criteria

	Incineration Plant	Sanitary Landfill
Income	– Sale of heat – Tipping fee . standard fee . special fee for * sewage sludge * hospital waste	– Treatment and Disposal
Expenditure	– O & M – Disposal cost of residues – Depreciation – Interest; rate=7.5%/year 3 years grace period	– O & M – Depreciation – Interest; rate=12.5%/year
Criteria 1	FIRR > 8 %	FIRR > 8 %
Evaluation Period	from 1998 until 2015	from 1994 until 2010 *
Criteria 2	FIRR > 15%	
Period for Evaluation	from 1998 until 2015 **	

Note: * Only the financial evaluation of the sanitary landfill project was determined based on the target year of the Master Plan.

** Evaluation period was determined based on the construction year and life year of the incineration plant.

Main assumptions on income and expenditure analysis are as follows:

- Income and expenditure of the incineration plant from 2010 will remain the same.
- The amount of investment, operation, maintenance and income after 2010 will remain the same until 2015.
- Income and expenditure of the landfill after 2000 will remain the same.

Table J.4.2-4 Investment and O & M cost for Evaluation

unit: mill.zl

	Investment		O & M cost	
	Incineration Plant	Sanitary Landfill	Incineration Plant	Sanitary Landfill
2006	0	23,103	29,000	3,880
2007	0	3,500	29,000	4,080
2008	0	18,763	29,000	4,280
2009	252,770	1,200	29,000	4,500
2010	0	21,903	40,600	3,360
2011	0	10,203	40,600	3,360
2012	0	1,200	40,600	3,360
2013	0	0	40,600	3,360
2014	0	28,606	40,600	3,360
2015	0	16,760	40,600	3,360

d. Economic prices

The economic prices used for cost-benefit analysis are shown in Table J.4.2-5.

Table J.4.2-5 List of Economic and Market Prices

	Unit	Economic Price	Market Price
- Sale of heat	zl/GJ	92,100	88,300
- Haulage of waste	zl/ton	314,000	314,000
- Incineration of sewage sludge	zl/ton	1,790,000	1,790,000
- Final disposal	zl/ton	139,000	139,000
- Compensation	zl/ton	52,200	-
- Land use	USD/ha	241.5	-
- Reusable components			
. Glass	zl/ton	60	60
. Textile	zl/ton	580	580
. Paper	zl/ton	400	400
. Metal	zl/ton	4,650	4,650
- Incineration plant			
. Foreign currency portion	mill. USD	21	24.15
. Local currency portion	mill. zl	75,200	160,000
. O & M	mill. zl/year	17,400	17,400

Note:

- The sale price of heat of the assumed 50 MW district heating model plant with a 15 % FIRR was adopted. The market price, on the other hand, was calculated taking the inflation rate of the 1992 market price into account. Refer to J.4.2-6.
- The haulage price of waste includes the depreciation and present haulage price.
- The sewage sludge incineration price of the assumed 65 ton/day model sewage sludge incineration plant with a 15 % FIRR was adopted. Please refer to J.4.2-7.
- The disposal price set was intended to attain a 15 % FIRR between 1994 and 2015. Refer to J.4.2-8.

- The compensation for Suchy Las was estimated as a surrogate market price of the environmental protection costs.

  Cost of environmental protection = compensation in 1992 + waste amount disposed
  = 10,500 mill.zl + 201,000 ton/day
  = 52,200 zl/ton

- Land use price as opportunity cost was determined by subtracting the direct production cost from the import price of wheat.

  Wheat production quantity in Poland in 1987 3.7 ton/ha
  Import of wheat of Poland in 1986 155 mill. USD
  Import quantity of wheat of Poland in 1986 1,662 mill. ton
  Direct production ratio 30 %
  Land use price = 3.7 x (155/1,662) x 0.7 = 241.5 USD/ha

- Reusable components price includes the inflation rate on the market price in 1992.
- The local portion of investment for the incineration plant was set up for its phase 1 construction. In addition, the labour costs were amended in account of the unemployment ratio.

[Reference for Incineration Project]

- The local portion of investment for the incineration plant was set for its construction in the 1st phase 1. (50 % of the estimated investment for the 1st phase project.)

  160,000 mill.zl x 50 % = 80,000 mill.zl

- The salvaged book value of the incineration plant in 2016 was taken into account as minus cost, because its life time is more than 30 years.

  80,000 mill.zl x 50 % = 40,000 mill.zl

- The shadow price, approximately 70 % of the current price, was used as construction labour price, because the unemployment rate was very high in Poland.

  Construction labour cost 80,000 mill.zl x 20 % = 16,000 mill.zl
  Economic prices 16,000 mill.zl x 70 % = 11,200 mill.zl
  Construction costs, other than labour cost, excludes turn over tax.
  80,000 mill.zl x 80 % ÷ 1.05 = 60,952 mill.zl
  Construction cost (economic price) = construction labour cost (economic price) + construction costs other than labour cost + Foreign portion of investment
  = 401,852 mill.zl

- Estimated cost was used for O & M cost.

Table J.4.2-6 Revenue and Expenditure of 50 MW District Heat Plant

unit: mill.zl

Year	Revenue	Expenditure				Discount ratio 15 %	
		Invest-ment	O & M cost	Disposal cost	Sub-total	Revenue	Expendi-ture
1998	0	43,000	0	0	43,000	0	43,000
1999	0	107,500	0	0	107,500	0	93,478
2000	0	64,500	0	0	64,500	0	48,771
2001	92,100	0	45,552	4,635	50,187	60,557	32,999
2002	92,100	0	45,552	4,635	50,187	52,658	28,695
2003	92,100	0	45,552	4,635	50,187	45,790	24,952
2004	92,100	0	45,552	4,635	50,187	39,817	21,697
2005	92,100	0	45,552	4,635	50,187	34,624	18,867
2006	92,100	0	45,552	4,635	50,187	30,108	16,406
2007	92,100	0	45,552	4,635	50,187	26,181	14,266
2008	92,100	0	45,552	4,635	50,187	22,766	12,405
2009	92,100	0	45,552	4,635	50,187	19,796	10,787
2010	92,100	0	45,552	4,635	50,187	17,214	9,380
2011	92,100	0	45,552	4,635	50,187	14,969	8,157
2012	92,100	0	45,552	4,635	50,187	13,016	7,093
2013	92,100	0	45,552	4,635	50,187	11,319	6,168
2014	92,100	0	45,552	4,635	50,187	9,842	5,363
2015	92,100	0	45,552	4,635	50,187	8,558	4,664
Total	1,381,500	215,000	683,280	69,527	967,807	407,216	407,150

Table J.4.2-7 Revenue and Expenditure of 65 ton/day Sewage Treatment Plant

unit: mill.zl

Year	Revenue	Expenditure			Discount ratio 15 %	
		Invest-ment	O & M cost	Sub-total	Revenue	Expendi-ture
1998	0	24,492	0	24,492	0	24,492
1999	0	61,230	0	61,230	0	53,243
2000	0	36,738	0	36,738	0	27,779
2001	31,426	0	10,800	10,800	20,663	7,101
2002	32,406	0	11,037	11,037	18,528	6,311
2003	33,321	0	11,259	11,259	16,566	5,598
2004	34,366	0	11,513	11,513	14,857	4,977
2005	35,412	0	11,766	11,766	13,313	4,423
2006	36,392	0	12,004	12,004	11,896	3,924
2007	37,502	0	12,273	12,273	10,660	3,489
2008	38,613	0	12,543	12,543	9,545	3,100
2009	39,789	0	12,828	12,828	8,552	2,757
2010	40,965	0	13,113	13,113	7,657	2,451
2011	40,965	0	13,113	13,113	6,658	2,131
2012	40,965	0	13,113	13,113	5,790	1,853
2013	40,965	0	13,113	13,113	5,034	1,612
2014	40,965	0	13,113	13,113	4,378	1,401
2015	40,965	0	13,113	13,113	3,807	1,219
Total	565,017	122,460	184,699	307,159	157,905	157,861

Table J.4.2-8 Revenue and Expenditure of Disposal Site

Year	Revenue	Expenditure			Discount ratio 15 %	
	Tipping Fee	Invest-ment	O & M cost	Sub-total	Revenue	Expendi-ture
1994	0	46,517	0	46,517	0	46,517
1995	26,397	0	5,700	5,700	22,954	4,957
1996	26,037	0	5,650	5,650	19,688	4,272
1997	25,667	24,103	5,600	29,703	16,876	19,530
1998	25,332	4,700	5,570	10,270	14,484	5,872
1999	25,083	0	5,550	5,550	12,471	2,759
2000	24,830	28,606	5,550	34,156	10,735	14,766
2001	17,488	13,630	4,350	17,980	6,575	6,759
2002	18,265	0	4,530	4,530	5,971	1,481
2003	19,036	21,903	4,700	26,603	5,411	7,562
2004	19,848	3,500	4,880	8,380	4,906	2,071
2005	20,669	6,703	5,050	11,753	4,443	2,526
2006	13,460	23,103	3,880	26,983	2,516	5,043
2007	14,338	3,500	4,080	7,580	2,330	1,232
2008	15,241	18,763	4,280	23,043	2,154	3,257
2009	16,179	1,200	4,500	5,700	1,988	700
2010	9,076	21,903	3,360	25,263	970	2,700
2011	9,076	10,203	3,360	13,563	843	1,260
2012	9,076	1,200	3,360	4,560	733	368
2013	9,076	0	3,360	3,360	638	236
2014	9,076	28,606	3,360	31,966	555	1,953
2015	9,076	16,760	3,360	20,120	482	1,069
Total	362,329	274,897	94,030	368,927	137,723	136,892

2) Project Evaluation on Public Recycling Centres

a. Economic evaluation

The following benefits can be expected:

i. Recycling reusable materials
ii. Saving collection cost
iii. Saving disposal cost
iv. Restoration of illegal dumping sites
v. Motivate citizens to cooperate in SWM.

The benefits of item i, ii, iii and iv were estimated.

i. Effect of recycling reusable materials

The effects are shown in Table J.4.2-9.

Table J.4.2-9 Benefits in Recycling Materials in P.R.C.

Materials	Quantity Recycled (ton/day)	Unit Rate (zl/ton)	Benefit (mill.zl/ton)
Glass	1.4	60,000	30.66
Textile	0.7	580,000	148.19
Paper	4.2	400,000	613.20
Metal	4.8	4,650,000	8,146.80
Total	11.1		8,938.85

The benefit in 2005 was estimated as follows:

7.0 tons/day x 8,938.85 mill.zl ÷ 11.1 tons/day = 5,637 mill.zl

ii. Effect of saving collection cost

The collection cost required for the wastes carried to public recycling centres from sources can be saved. This benefit in 2005 is estimated as follows:

314,000 zl/ton x 69.1 tons/day x 365 days = 7,920 mill.zl

iii. Effect of saving disposal cost

The disposal cost required for wastes recycled in public recycling centres can be saved. This benefit in 2005 is estimated as follows:

138,000 zl/ton x 7.0 tons/day x 365 days = 353 mill.zl

iv. Restoration of illegal dumping sites

This benefit is to save removal cost of waste illegally dumped in public recycling centres. Assuming the amount of waste, which is protected from illegal dumping in public recycling centres, is 6 % of the total waste generation amount, the benefit in 2005 is estimated as follows:

314,000 zl/ton x 389.9 tons/day x 0.06 x 365 days = 2,681 mill.zl

The cost and benefit between 1995 and 2010 estimated according to the above concept are tabulated in Table J.4.2-10.

Table J.4.2-10 Benefit by Cost of P.R.C

unit: mill.zl

Year	Benefit					Cost			Discount ratio 15 %	
	Reusable Material	Cost save Collection	Cost save Landfill	Protection Illegal d.	Sub-total	Invest-ment	O & M cost	Sub-total	Benefit	Cost
1995					0	5,987	0	5,987	0	5,987
1996	1,530	2,395	96	127	4,149	5,539	3,406	8,945	3,607	7,779
1997	3,463	4,859	218	579	9,119	3,415	6,472	9,887	6,895	7,476
1998	4,590	6,579	289	988	12,446	0	8,320	8,320	8,184	5,471
1999	4,671	6,682	294	1,436	13,082	0	8,320	8,320	7,480	4,757
2000	4,751	6,808	299	1,857	13,716	1,314	8,320	9,634	6,819	4,790
2001	4,993	7,026	315	2,386	14,719	1,314	8,320	9,634	6,364	4,165
2002	5,073	7,243	320	2,457	15,093	1,613	8,320	9,933	5,674	3,734
2003	5,234	7,438	330	2,531	15,533	895	8,320	9,215	5,078	3,012
2004	5,396	7,690	340	2,604	16,030	448	8,660	9,108	4,557	2,589
2005	5,637	7,920	355	2,681	16,593	1,314	8,660	9,974	4,102	2,465
2006	5,718	8,149	360	2,762	16,988	1,314	8,660	9,974	3,652	2,144
2007	5,879	8,412	370	2,842	17,504	718	8,660	9,378	3,272	1,753
2008	6,201	8,676	391	2,927	18,194	0	8,660	8,660	2,957	1,407
2009	6,281	8,940	396	3,013	18,630	895	8,660	9,555	2,633	1,350
2010	6,523	9,249	411	3,101	19,284	2,210	8,660	10,870	2,370	1,336
Total	75,940	108,066	4,784	32,291	221,081	26,978	120,418	147,396	73,642	60,216

B-C = 13,426
B/C = 1.22

Table J.4.2-11 EIRR of P.R.C

unit: mill.zl

Year	Benefit					Cost			Discount ratio 29.4 %	
	Reusable Material	Cost save Collection	Cost save Landfill	Protection Illegal d.	Sub-total	Invest-ment	O & M cost	Sub-total	Benefit	Cost
1995					0	5,987	0	5,987	0	5,987
1996	1,530	2,395	96	127	4,149	5,539	3,406	8,945	3,206	6,913
1997	3,463	4,859	218	579	9,119	3,415	6,472	9,887	5,446	5,905
1998	4,590	6,579	289	988	12,446	0	8,320	8,320	5,744	3,840
1999	4,671	6,682	294	1,436	13,082	0	8,320	8,320	4,666	2,967
2000	4,751	6,808	299	1,857	13,716	1,314	8,320	9,634	3,780	2,656
2001	4,993	7,026	315	2,386	14,719	1,314	8,320	9,634	3,135	2,052
2002	5,073	7,243	320	2,457	15,093	1,613	8,320	9,933	2,485	1,635
2003	5,234	7,438	330	2,531	15,533	895	8,320	9,215	1,976	1,172
2004	5,396	7,690	340	2,604	16,030	448	8,660	9,108	1,576	895
2005	5,637	7,920	355	2,681	16,593	1,314	8,660	9,974	1,261	758
2006	5,718	8,149	360	2,762	16,988	1,314	8,660	9,974	997	586
2007	5,879	8,412	370	2,842	17,504	718	8,660	9,378	794	426
2008	6,201	8,676	391	2,927	18,194	0	8,660	8,660	638	304
2009	6,281	8,940	396	3,013	18,630	895	8,660	9,555	505	259
2010	6,523	9,249	411	3,101	19,284	2,210	8,660	10,870	404	228
Total	75,940	108,066	4,784	32,291	221,081	26,978	120,418	147,396	36,613	36,582

B-C = 32
B/C = 1.00

In case the discount ratio is 15 %, it is concluded to be feasible because the cost-benefit ratio is 1.22, the net present value is 13,246 mill.zl and EIRR is 29.4 %.

This is concluded to be qualitatively feasible because it contributes to environmental improvement such as restoration of illegal dumping sites.

b. Financial evaluation

The financial analysis shows that the expenditure would exceed the income. This means that public recycling centres can not be operated unless the municipality financially supports them.

Table J.4.2-12 Income and Expenditure of P.R.C. in 2005.

unit: mill.zl

Item	Amount
Income	
- Sale of reusable materials	5,637
Total	5,637
Expenditure	
- O & M	6,960
- Haulage cost of residue	1,700
- Disposal cost of residue	12,172
Sub-total	20,832
- Depreciation	1,730
- Interest	0
Total	22,562
Balance	-16,925

3) Project Evaluation on Incineration Plant

a. Economic evaluation

i. Benefits

The following benefits are expected:

- Recovery of heat
- Saving haulage costs
- Decrease of final disposal volume
- Sanitary treatment of sewage sludge
- Others
  - . Sanitary treatment of hospital waste
  - . Decrease in the generation of methane
  - . Improving sanitary level of landfill
  - . Promoting regional development with utilization of heat

Recovery of heat

The benefit in 2005 is estimated as follows:

92,000 zl/GJ x 320,835 GJ/year = 29,549 mill.zl

Saving haulage cost

If an incineration plant is not included in the facilities to be constructed, the disposal site's location may be farther than the existing one in Suchy Las, consequently leading to a decrease in the working ratio of vehicles and a haulage cost 1.5 times more than what was proposed. However, the selection of Franowo–Michalowo and the realization of its use as a disposal site is estimated to bring about curtailed haulage cost in 2005.

157,000 zl/ton x 389.9 ton/day x 365 days = 29,549 mill.zl

Decrease of final disposal volume

Incineration of waste will lead to the decrease in final disposal volume, thus curtailing disposal cost and environmental protection cost. For example, the benefit in 2005 will be as follows:

(139,000 + 52,200) zl/ton x (104.8 – 54.1) ton/day x 365 days
= 3,538 mill.zl

An indirect effect will be the effective use of land. For example, the benefit in 2005 will be as follows:

241.5 USD/ha x (60 – 45 + 2.5) ha x 15,700 zl/USD = 66 mill.zl

Sanitary treatment of sewage sludge

Incineration is the best treatment measure for sewage sludge. However, it is more economical to construct an incineration plant designed for the mix incineration of sewage and wastes. For example, the benefit in 2005 is as follows:

1,790,000 zl/ton x 54.2 tons/day x 365 days = 35,412 mill.zl

Other benefits

The following benefits were not quantitatively, but qualitatively analyzed.

- Sanitary treatment of hospital wastes`

The law presently imposes hospital waste incineration. Few hospitals own incinerators. The construction of an incineration plant will, therefore, help curtail costs and improve the treatment methods.

- Decrease in amount of methane generated at landfills

  Methane generated from the landfill will decrease due to decrease in final disposal volume.

- Improvement of sanitary landfill conditions

  Dumping ashes of incinerated wastes is more sanitary than dumping waste directly.

- Promotion of regional development by using heat energy

  The development of industrial zones can be expected from the utilization of heat and construction of the incineration plant.

ii. Cost-Benefit Analysis

The cost-benefit analysis between 1998 and 2015 are summarized in Table J.4.2-13.

(Unit: million zl)

Year	Benefit						Cost			Discount ratio 15.8 %	
	Heat Supply	Cost save Landfill	Land use	Cost save Haulage	Sewage	Sub-total	Invest-ment	O/M cost	Sub-total	Benefit	Cost
1998							80,370		80,370	0	80,370
1999							200,926		200,926	0	173,511
2000							120,556		120,556	0	89,902
2001	30,557	3,964	47	29,220	31,426	95,215	0	17,400	17,400	61,317	11,205
2002	30,255	3,859	47	30,102	32,406	96,670	0	17,400	17,400	53,760	9,676
2003	30,120	3,762	66	30,985	33,321	98,254	0	17,400	17,400	47,185	8,356
2004	29,851	3,650	66	31,913	34,366	99,847	0	17,400	17,400	41,408	7,216
2005	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	36,323	6,231
2006	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	31,367	5,381
2007	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	27,087	4,647
2008	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	23,391	4,013
2009	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	20,200	3,465
2010	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	17,444	2,993
2011	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	15,064	2,584
2012	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	13,008	2,232
2013	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	11,233	1,927
2014	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	9,701	1,664
2015	29,549	3,538	66	32,859	35,412	101,424	0	17,400	17,400	9,701	1,664
2016	0	0	0	0	0	0	-36,076	0	-36,076	0	-2,980
Total	445,822	54,155	957	483,666	521,047	1,505,647	365,776	261,000	626,776	418,188	414,061

The result of the analysis concluded that this project is feasible because of a 15.8 % EIRR.

The results of the qualitative analysis concluded that this project is feasible because of the benefits described in "v. other benefits".

iii. Sensitivity Analysis

The sensitivity analysis on main factors which may influence benefit and cost is shown in Table J.4.2-1.

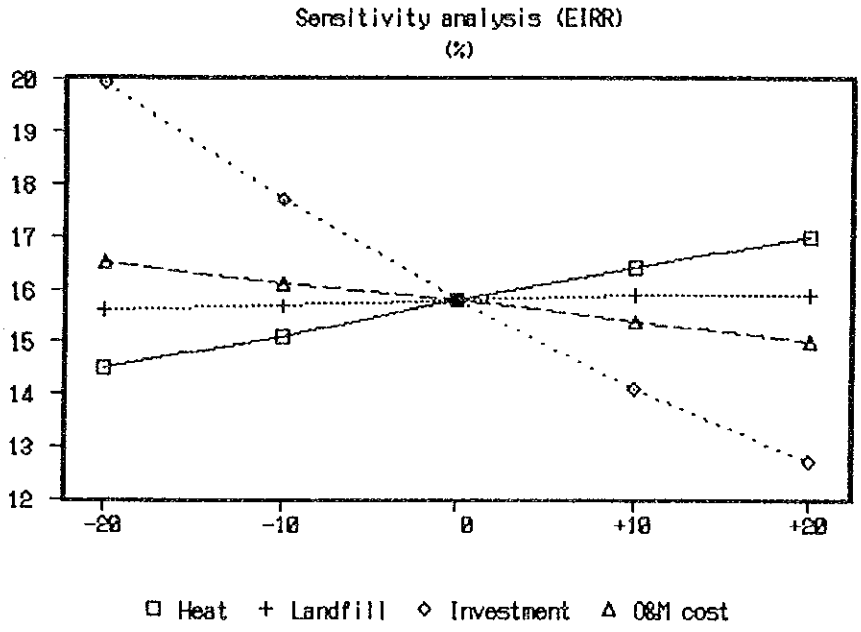


Fig.J.4.2-1 Sensitivity Analysis Diagram

The above diagram shows the following:

- Heat sale, saving

b. Financial Evaluation

i. Income

The following incomes were assumed:

- Heat sale : 88,300 zl/GJ
- Tipping fee (until 2000) : 138,000 zl/ton
  Tipping fee (after 2001) : 456,000 zl/ton

- Special fee : 1,790,000 zl/ton

ii. Income and Expenditure Analysis

The income and expenditure in 2005 is shown in Table J.4.2-14.

Table J.4.2-14 Balance of Incineration Plant

Item		Calculation
Income		
Heat sale	28,330	88,300 zl/GJ x 320,835 GJ/year
Tipping fee	20,541	537,000 zl/ton x 104.8 ton/day x 365 days
Special fee	35,412	1,790,000 zl/ton x 54.2 ton/day x 365 days
Total	84,283	
Expenditure		
Labour cost	6,380	
Lime, electricity	4,640	
Disposal cost of residue	774	33,000 zl/ton x 54.1 ton/day x 365 days
Maintenance cost	3,480	
Administration cost	2,126	
Sub-total	17,400	
Depreciation	30,610	
Interest	33,307	Long-term:7.5%, short-term 13.5%
Total	81,317	
Balance	2,966	

ii. FIRR

The financial evaluation between 1998 and 2015 of only the incineration plant Phase 1 was concluded to be 7.7 % FIRR. In addition, the FIRR of the incineration project including Phase 1, 2 and 3, between 1998 and 2015, was estimated to be 9.9 %. Refer to J.4.2-15 and -16.

Table J.4.2-15 Revenue and Expenditure of 50 MW District Heat Plant

Year	Revenue				Expenditure			Discount ratio 7.7 %	
	Heat Supply	General Fee	Special Fee	Sub-total	Invest-ment	O & M cost	Sub-total	Revenue	Expendi-ture
1998	0	0	0	0	107,831	0	107,831	0	107,831
1999	0	0	0	0	269,578	0	269,578	0	250,304
2000	0	0	0	0	161,747	0	161,747	0	139,445
2001	29,297	21,737	31,426	82,460	0	17,400	17,400	66,008	13,928
2002	29,007	21,443	32,406	82,856	0	17,400	17,400	61,583	12,933
2003	28,878	21,169	33,321	83,367	0	17,400	17,400	57,533	12,008
2004	28,620	20,855	34,366	83,841	0	17,400	17,400	53,723	11,150
2005	28,330	20,541	35,412	84,283	0	17,400	17,400	50,145	10,352
2006	28,330	20,541	35,412	84,283	0	17,400	17,400	46,560	9,612
2007	28,330	20,541	35,412	84,283	0	17,400	17,400	43,231	8,925
2008	28,330	20,541	35,412	84,283	0	17,400	17,400	40,140	8,287
2009	28,330	20,541	35,412	84,283	0	17,400	17,400	37,271	7,694
2010	28,330	20,541	35,412	84,283	0	17,400	17,400	34,606	7,144
2011	28,330	20,541	35,412	84,283	0	17,400	17,400	32,132	6,634
2012	28,330	20,541	35,412	84,283	0	17,400	17,400	29,834	6,159
2013	28,330	20,541	35,412	84,283	0	17,400	17,400	27,701	5,719
2014	28,330	20,541	35,412	84,283	0	17,400	17,400	25,721	5,310
2015	28,330	20,541	35,412	84,283	0	17,400	17,400	23,882	4,930
Total	427,428	311,158	521,047	1,259,632	539,155	261,000	800,155	630,070	628,366

Table J.4.2-16 Revenue and Expenditure of 50 MW District Heat Plant

Year	Revenue				Expenditure			Discount ratio 9.9 %	
	Heat Supply	General Fee	Special Fee	Sub-total	Invest-ment	O & M cost	Sub-total	Revenue	Expendi-ture
1998	0	0	0	0	107,831	0	107,831	0	107,831
1999	0	0	0	0	269,578	0	269,578	0	245,293
2000	0	0	0	0	161,747	0	161,747	0	133,918
2001	29,297	21,737	31,426	82,460	0	17,400	17,400	62,122	13,109
2002	29,007	21,443	32,406	82,856	0	17,400	17,400	56,798	11,928
2003	28,878	21,169	33,321	83,367	0	17,400	17,400	52,000	10,853
2004	28,620	20,855	34,366	83,841	0	17,400	17,400	47,585	9,876
2005	28,330	20,541	35,412	84,283	252,770	17,400	270,170	43,527	139,525
2006	67,875	51,432	36,392	155,699	0	29,000	29,000	73,165	13,627
2007	67,617	51,099	37,502	156,218	0	29,000	29,000	66,796	12,400
2008	67,617	50,765	38,613	156,996	0	29,000	29,000	61,082	11,283
2009	67,327	50,412	39,789	157,529	252,770	29,000	281,770	55,768	99,752
2010	107,292	81,224	40,965	229,482	0	40,600	40,600	73,922	13,078
2011	107,292	81,224	40,965	229,482	0	40,600	40,600	67,263	11,900
2012	107,292	81,224	40,965	229,482	0	40,600	40,600	61,204	10,828
2013	107,292	81,224	40,965	229,482	0	40,600	40,600	55,691	9,853
2014	107,292	81,224	40,965	229,482	0	40,600	40,600	50,674	8,965
2015	107,292	81,224	40,965	229,482	0	40,600	40,600	46,109	8,158
Total	1,058,320	796,800	565,017	2,420,137	1,044,695	446,601	1,491,296	873,706	872,178

iii. Sensitivity Analysis

The sensitivity analysis on main factors which may influence benefit and cost is shown in Fig. J.4.2-2.

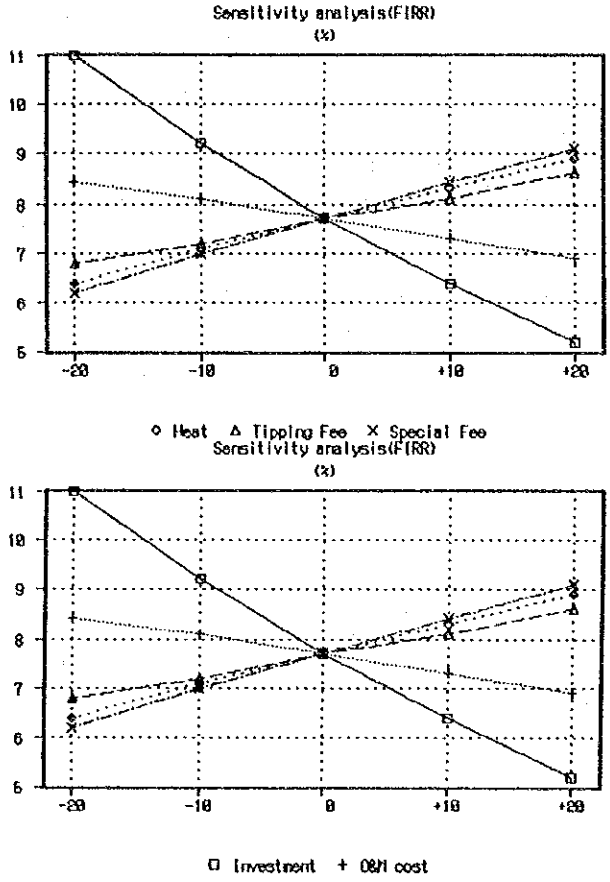


Fig.J.4.2-2 Sensitivity Analysis

Since the cost of the Phase 1 construction of the incineration plant holds the biggest influence, it is necessary to minimized the costs. The income balance is largely affected by special fees, followed by sale of heat. Studies should be fully conducted prior to implementation.

The sensitivity analysis results concluded that adequate tipping fees and special fees made the incineration project feasible.

4) Sanitary Landfill

a. Economic analysis

The following benefits are expected from the sanitary landfill:

- Improvement of landfilling method improves surrounding environment and public health condition.
- Installation of impermeable liner will prevent ground water pollution due to leachate.
- Installation of a fence will prevent wastes from scattering.

Qualitative analysis is not carried out because quantification of these benefits is difficult and also because sanitary landfill is the least among the technologies in conformity with EC standard, albeit its importance.

b. Financial analysis

i. Income and expenditure analysis

The analysis of income and expenditure in 2005 shows a positive result as income exceeds expenditure (see Table J.4.2-17).

Table J.4.2-17 Income and Expenditure of Sanitary Landfill

Item	Amount	Calculation
Income		
Tipping fee	20,669	139,000 zl/ton x(461.5-54.1)ton/d x 365 days
Total	20,669	
Expenditure		
Labour cost	1,465	
Heavy oil	682	
Soil	976	
Maintenance cost	690	
Administration cost	1,237	
Sub-total	5,050	
Depreciation	10,343	
Interest	854	Long-term loan:4.5%
Total	16,247	
Balance	4,422	

* Income does not include tipping fees for ash discharged from the incineration plant, as the incineration plant and the landfill are operated by the same company.

** The long-term loan with the same condition for the incineration plant project was assumed for the investment in 1994.

ii. FIRR

The sanitary landfill project is deemed feasible because of 18.8 % FIRR between 1994 and 2000, as shown in Table J.4.2-18. FIRR between 1994 and 2010 is estimated at 40.5 %, as shown in Table J.4.2-19.

Table J.4.2-18 FIRR between 1994 and 2000 of Disposal Site

unit: mill.zl

Year	Revenue	Expenditure			Discount ratio 18.8 %	
	Tipping Fee	Investment	O & M cost	Sub-total	Revenue	Expenditure
1994	0	46,517	0	46,517	0	46,517
1995	26,397	0	5,700	5,700	22,220	4,798
1996	26,037	0	5,650	5,650	18,449	4,003
1997	25,667	24,103	5,600	29,703	15,308	17,715
1998	25,332	4,700	5,570	10,270	12,718	5,156
1999	25,083	0	5,550	5,550	10,600	2,345
2000	24,830	28,606	5,550	34,156	8,832	12,150
2001	17,488	13,630	4,350	17,980	5,236	5,384
2002	18,265	0	4,530	4,530	4,603	1,142
2003	19,036	21,903	4,700	26,603	4,039	5,644
2004	19,848	3,500	4,880	8,380	3,544	1,497
2005	20,669	6,703	5,050	11,753	3,107	1,767
2006	13,460	23,103	3,880	26,983	1,703	3,414
2007	14,338	3,500	4,080	7,580	1,527	807
2008	15,241	18,763	4,280	23,043	1,366	2,066
2009	16,179	1,200	4,500	5,700	1,221	430
2010	9,076	0	3,360	3,360	577	213
Total	316,947	196,226	77,230	273,456	115,050	115,047

Table J.4.2-19 FIRR between 1994 and 2010 of of Disposal Site

unit: mill.zl

Year	Revenue	Expenditure			Discount ratio 40.5 %	
	Tipping Fee	Investment	O & M cost	Sub-total	Revenue	Expenditure
1994	0	46,517	0	46,517	0	46,517
1995	26,397	0	5,700	5,700	18,788	4,057
1996	26,037	0	5,650	5,650	13,190	2,862
1997	25,667	24,103	5,600	29,703	9,254	10,709
1998	25,332	4,700	5,570	10,270	6,501	2,636
1999	25,083	0	5,550	5,550	4,581	1,014
2000	24,830	28,606	5,550	34,156	3,228	4,440
2001	67,563	13,630	4,350	17,980	6,251	1,664
2002	70,562	0	4,530	4,530	4,647	298
2003	73,541	21,903	4,700	26,603	3,447	1,247
2004	76,677	3,500	4,880	8,380	2,558	280
2005	79,852	6,703	5,050	11,753	1,896	279
2006	52,000	23,103	3,880	26,983	879	456
2007	55,391	3,500	4,080	7,580	666	91
2008	58,880	18,763	4,280	23,043	504	197
2009	62,506	1,200	4,500	5,700	381	35
2010	35,065	0	3,360	3,360	152	15
Total	785,384	196,226	77,230	273,456	76,924	76,796

5) Financial Evaluation of Poznan Treatment and Disposal Company

a. FIRR

Financially it is evaluated to be feasible due to a 17.5 % FIRR. Refer to Table J.4.2-20.

Table J.4.2-20 Revenue and Expenditure of PTDC between 1998 and 2015

Year	Revenue				Expenditure			Discount ratio 17.5 %	
	General Fee	Special Fee	Heat Supply	Sub-total	Invest-ment	O & M cost	Sub-total	Revenue	Expendi-ture
1998	25,332	0	0	25,332	112,531	5,570	118,101	25,332	118,101
1999	25,083	0	0	25,083	269,578	5,550	275,128	21,348	234,151
2000	24,830	0	0	24,830	190,352	5,550	195,902	17,984	141,894
2001	89,300	31,426	29,297	150,023	13,630	21,750	35,380	92,479	21,809
2002	92,005	32,406	29,007	153,417	0	21,930	21,930	80,487	11,505
2003	94,710	33,321	28,878	156,908	21,903	22,100	44,003	70,058	19,647
2004	97,532	34,366	28,620	160,518	3,500	22,280	25,780	60,995	9,796
2005	100,394	35,412	28,330	164,135	259,473	22,450	281,923	53,081	91,173
2006	103,432	36,392	67,875	207,699	23,103	32,880	55,983	57,165	15,408
2007	106,490	37,502	67,617	211,609	3,500	33,080	36,580	49,567	8,568
2008	109,645	38,613	67,617	215,876	18,763	33,280	52,043	43,035	10,375
2009	112,918	39,789	67,327	220,035	253,970	33,500	287,470	37,331	48,773
2010	116,290	40,965	107,292	264,547	21,903	43,960	65,863	38,199	9,510
2011	116,290	40,965	107,292	264,547	10,203	43,960	54,163	32,509	6,656
2012	116,290	40,965	107,292	264,547	1,200	43,960	45,160	27,668	4,723
2013	116,290	40,965	107,292	264,547	0	43,960	43,960	23,547	3,913
2014	116,290	40,965	107,292	264,547	28,606	43,960	72,566	20,040	5,497
2015	116,290	40,965	107,292	264,547	16,760	43,960	60,720	17,055	3,915
Total	1,679,409	565,017	1,058,320	3,302,746	1,248,973	523,680	1,772,653	767,880	765,413

b. Money Flow

The overall money flow analysis showed profitable results, although loss was estimated in 1999 and 2000. Please refer to Fig.J.4.2-3.

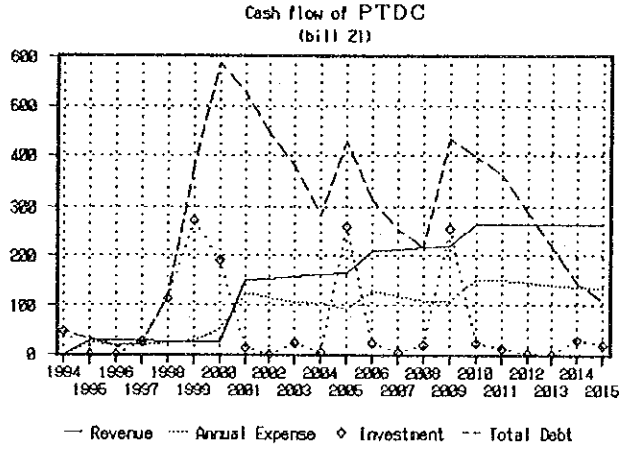
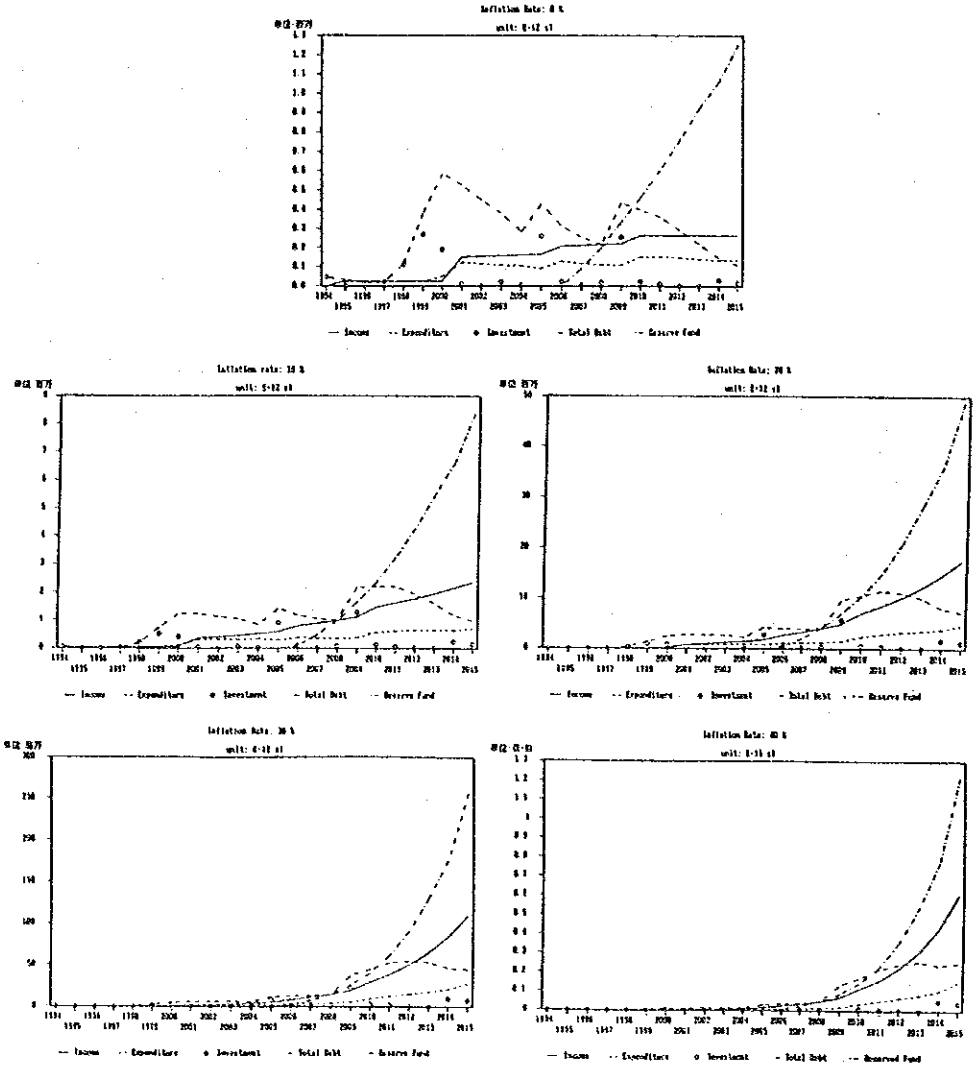


Fig.J.4.2-3 Money Flow Diagram of Poznan Treatment and Disposal Company

c. Influence of Inflation

Inflation effects increase in loan payments to international lending agencies due to fluctuations in exchange rates. However, problems can be overcome if income increases in proportion to inflation because internal reserve increases, too.
Money flow diagrams for 10, 20, 30 and 40 % inflation rates are shown in Fig.J-.4.2-4.



6) Conclusion

The first priority projects studied in this report were all considered feasible.

J.5 Implementation Plan

J.5.1 Project Implementation Schedule

1) Project Implementing Bodies

The implementing bodies of the 3 projects will be as follows:

- Public Recycling Centres : Department for MSWM
- Incineration Plant : Poznan Waste Treatment and Disposal Company
- Sanitary Landfill : Poznan Waste Treatment and Disposal Company

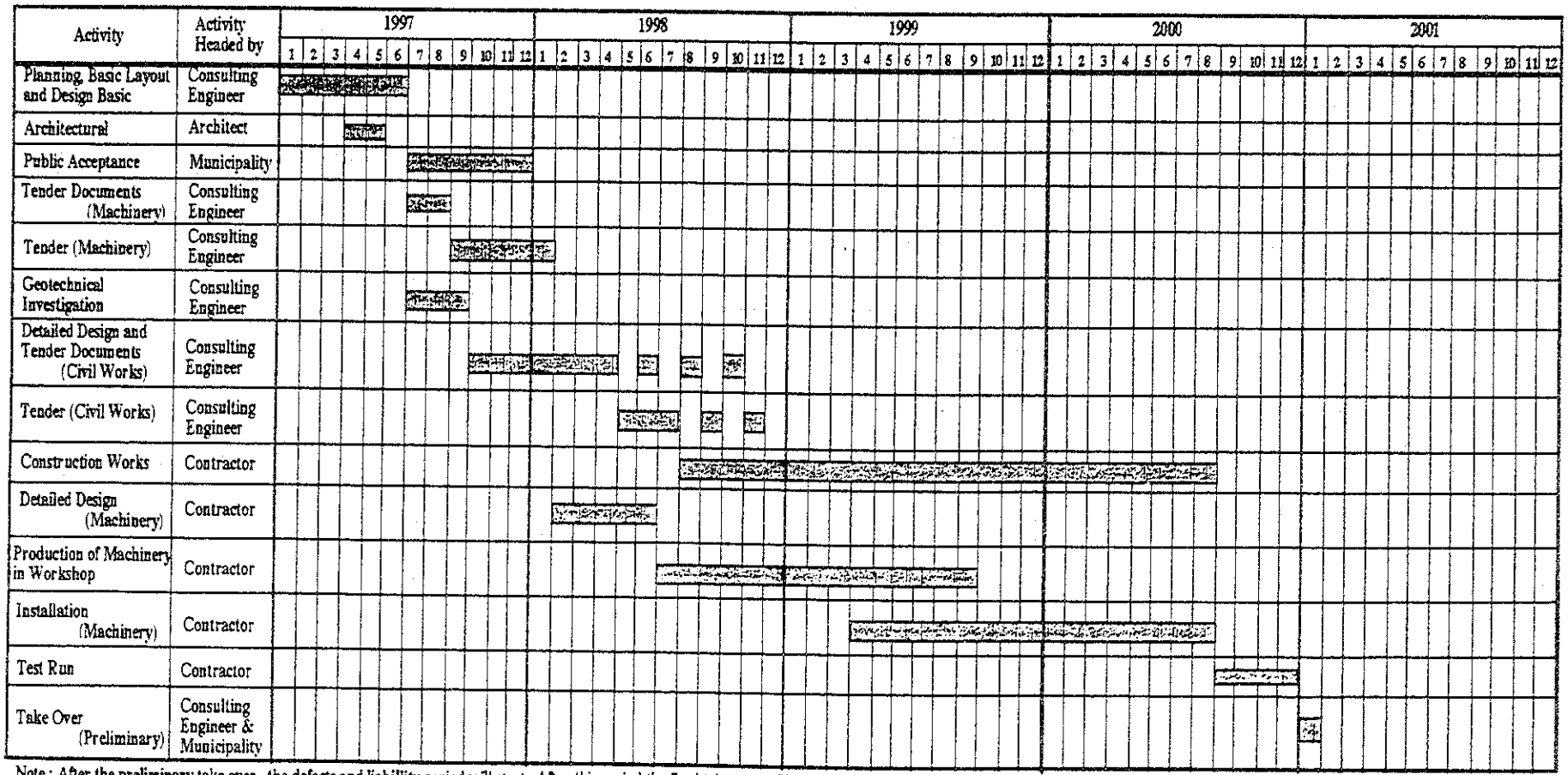
2) Implementation Schedule

The proposed implementation schedule of the 3 projects are tabulated in Table J.5.1-1. A detailed implementation schedule for the incineration plant is also prepared as shown in Fig.J.5.1-1.

Table J.5.1-1 Implementation Schedule

Project / Schedule	Public Recycling Centres	Incineration Plant	Sanitary Landfill
1. Design Target Year	1997	2001	1995
2. Service Commencement Year	No. 1,2,3: 1996 No. 4,5,6: 1997 No. 7, 8 : 1998	January 2001	January 1995
3. Preparatory Period			
- Acquisition of Fund	1994	1996	1993
- Detailed Design	1994	Jan. 1997 - Apr. 1998	1993
- Tender	1994	Machinery: Sep. 1997 - Jan. 1998 Civil: May 1998 - July 1998	
4. Construction			
- Construction	No. 1,2,3: 1995 No. 4,5,6: 1996 No. 7, 8 : 1997	July 1998 - Aug. 2000	1994
- Test Run	-	Sep. 2000 - Dec 2000	-
- Take Over	-	January 2001	January 1995

Fig.9.1-1 Implementation Schedule of Incineration Plant



Note : After the preliminary take over , the defects and liabillity period will start. After this period the final take over will take place.

J.5.2 Financial Plan

The financial plan was based on the results of the financial analysis described in the section 8.4.2. In the financial analysis of the Poznan Treatment and Disposal Company, corporation tax was excluded. However, 40 % corporation tax is included in the financial plan.

1) Public Recycling Centres

As shown in Table J.9.2-1, required finance and its source will be secured from the budget of Poznan Municipality.

Table J.5.2-1 Required Finance and Source for P.R.C unit: mill.zl

	1995	1996	1997	1998	1999	2000	Total
Required investment	6,508	6,038	3,718	0	0	* 1,380	17,644
Budget of Municipality	6,508	6,038	3,718	0	0	1,380	17,644
O & M Cost		4,370	8,405	10,943	10,984	11,034	34,793
Budget of Municipality		4,370	8,405	10,943	10,984	11,034	34,793

Note: * The investment in 2000 will be based used for the replacement of old containers.

2) Incineration Plant

a. Financial Source

Financial sources are proposed as follows:

- Long-term loan from an international lending agency
- Short-term loan from a lending agency in Poland

Table J.5.2-2 Required Finance and Source for Incineration Plant unit: mill.zl

	1998	1999	2000	Total
Required investment	107,831	269,578	161,747	539,156
Breakdown				
Long-term loan	75,831	189,578	113,747	379,156
Short-term loan	32,000	80,000	48,000	160,000

The operation and maintenance cost shall be covered by income of heat sale and treatment and disposal fee.

Table J.5.2-3 Breakdown of Financial Sources for Operation unit: mill.zl

	2001	2002	2003	2004	2005	Total
Required O & M cost	48,010	48,010	48,010	48,010	48,010	240,050
Sources						
Heat sale	29,297	29,007	28,878	28,620	28,330	144,132
Tipping fee						
Standard	21,737	21,443	21,169	20,855	20,541	105,745
Special	31,426	32,406	33,321	34,366	35,412	166,931
Total	82,460	82,856	83,368	83,841	84,283	416,808

b. Expenditure

Investment and O & M cost are presented in Table J.5.2-4.

Table J.5.2-4 Investment and Annual Expenses for Incineration Plant

unit: mill.zl

Year	Investment	Annual Expense	
		O & M	Depreciation
1998	107,831	0	0
1999	269,578	0	0
2000	161,747	0	0
2001	0	17,400	30,610
2002	0	17,400	30,610
2003	0	17,400	30,610
2004	0	17,400	30,610
2005	0	17,400	30,610

3) Sanitary Landfill

a. Financial sources

The short-term loan of local lending agencies are planned as investment source. O & M cost is planned to be covered by tipping fee.

Table J.5.2-5 Required Finance and Source for Sanitary Landfill unit: mill.zl

	1994	1995	1996	1997	1998	1999	Total
Required investment	46,517	0	0	24,103	4,700	0	75,320
Short-term loan	46,517	0	0	24,103	4,700	0	75,320
Required O & M		15,034	14,984	14,934	19,604	14,884	79,440
Tipping fee		26,397	26,037	25,667	25,332	25,083	128,516

b. Expenditure

Investment and O & M cost are presented in Table J.5.2-6.

Table J.5.2-6 Investment and Annual Expenses for Sanitary Landfill

unit: mill.zl

Year	Investment	Annual Expense	
		O & M	Depreciation
1994	46,517		
1995	0	5,700	9,334
1996	0	5,650	9,334
1997	24,103	5,600	9,334
1998	4,700	5,570	14,034
1999	0	5,550	9,334

Note: Investment for replacing old equipment is included.

4) Financial Plan of Poznan Treatment and Disposal Company

The balance sheet and the money flow sheet are shown in Table J.5.2-1.

These tables prove that the income basically tends to exceed expenditure excepted for in 1999 and 2000. The total debt decreases after the peak in 2000. Consequently, the financial status of the Poznan Treatment and Disposal Company will be sound accordingly to the financial plan.

Table J.5.2-7 Balance Sheet and Money Flow of PTDC unit:mill.zl

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Revenue													
Sale													
Heat supply	0	0	0	0	0	0	0	0	29,297	29,007	28,878	28,620	28,330
Special Fee	0	0	0	0	0	0	0	0	31,426	32,406	33,321	34,366	35,412
Tipping Fee													
Incineration plant	0	0	0	0	0	0	0	0	21,737	21,443	21,169	20,855	20,541
Final disposal	0	0	26,397	26,037	25,667	25,332	25,083	24,830	67,563	70,562	73,541	76,677	79,852
Subtotal(A)	0	0	26,397	26,037	25,667	25,332	25,083	24,830	150,023	153,417	156,908	160,518	164,135
Expense													
O/M	0	0	5,700	5,650	5,600	5,570	5,550	5,550	21,750	21,930	22,100	22,280	22,450
Depreciation	0	0	9,334	9,334	9,334	14,034	9,334	9,334	45,251	40,954	40,954	44,454	40,954
Interest	0	0	6,280	4,608	2,826	4,179	12,801	36,910	58,163	55,131	49,984	47,109	41,049
Subtotal(B)	0	0	21,313	19,592	17,759	23,783	27,685	51,794	125,164	118,014	113,038	113,842	104,453
Profit or Loss (C=A-B)	0	0	5,084	6,446	7,907	1,549	-2,601	-26,964	24,858	35,403	43,870	46,676	59,682
Profit tax	0	0	2,034	2,578	3,163	620	0	0	9,943	14,161	17,548	18,670	23,873
Profit excluding tax	0	0	3,050	3,867	4,744	930	-2,601	-26,964	14,915	21,242	26,322	28,005	35,809

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Balance	0	0	3,050	3,867	4,744	930	-2,601	-26,964	14,915	21,242	26,322	28,005	35,809
Depreciation	0	0	9,334	9,334	9,334	14,034	9,334	9,334	45,251	40,954	40,954	44,454	40,954
Subtotal(C)	0	0	12,384	13,201	14,078	14,963	6,733	-17,631	60,166	62,196	67,276	72,459	76,763
Money Demand													
Investment	0	46,517	0	0	24,103	112,531	269,578	190,352	13,630	0	21,903	3,500	6,703
Loan													
Long Term	0	0	0	0	0	0	0	0	54,165	54,165	54,165	54,165	54,165
Short Term	0	0	12,384	13,201	0	0	0	0	0	8,031	0	14,794	15,895
Subtotal	0	46,517	12,384	13,201	24,103	112,531	269,578	190,352	67,795	62,196	76,068	72,459	76,763
Money Supply													
Budget from PM	0	0	0	0	0	0	0	0	0	0	0	0	0
from Inn.Fund	0	0	0	0	0	0	0	0	0	0	0	0	0
Long Term	0	0	0	0	0	75,831	189,578	113,747	0	0	0	0	0
Short Loan	0	46,517	0	0	10,025	21,737	73,267	94,236	7,629	0	8,792	0	0
Subtotal	0	46,517	0	0	10,025	97,568	262,845	207,983	7,629	0	8,792	0	0
Surplus of Money	0	0	0	0	0	0	0	-0	-0	0	0	0	0
Reserved Fund	0	0	0	0	0	0	0	0	0	0	0	0	0
Total of Debt	0	46,517	34,132	20,931	30,956	128,524	391,369	599,351	552,815	490,619	445,246	376,287	306,227

J.5.3 Establishment of Monitoring System

1) Incineration Plant

a. Monitoring Programme

The monitoring programme for the incineration plant must comprise the following issues:

- Control of waste supply
- Control of the operation and emissions from the incineration plant

The proposed monitoring programme is in brief described in the following. Moreover, measuring of noise emission and control of waste water from the flue gas cleaning must be carried out.

b. Control of waste supply

At the weigh bridge of the incineration plant all incoming waste is controlled. The following is registered by the computer system of the weigh bridge:

- Specification of waste supply (type and quantity)
- Name of customer who must pay for the waste supply

The computer system must as a minimum be able to provide the following material:

- Making out of bills prepared for each customer
- Preparation of statistics for the waste supply

c. Control of operation and emission from the incineration plant

The following emissions and parameters must continuously be registered for each incineration line:

- Co-concentrations of the flue gas after the boiler, based on dry flue gas at 11 % O_2

- O_2 percentage after the boiler

- Temperature of the flue gas in the furnace, in the zone for after burning, after the boiler and in the stack

- The opacity of the flue gas after the flue gas cleaning equipment

- HCL–concentration in the flue after the cleaning equipment, based on dry flue gas at 11% O_2

The above registrations should be carried out at least 2 times a minute. The registrations must be elaborated by the computer system of the plant and utilized for adjustment of the operation of the plant. The computer system must each day supply reports on the above data. Further the reports must state operation periods of auxiliary fired burners.

Control of the following emissions should be performed at least each second month: particles, Cd, Pb, Cr, Cu, Mn, Hg, HF, SO_2 and TOC.

Requirements to the emission from the incineration plant is presented in Table J.5.3–1.

Table J.5.3–1 Requirements to Emissions from the Incineration Plant

Type of emission period for average	Max. emission (mg/Nm^3) Dry flue gas, 11 O_2 273°Kelvin, 1013 M Bar	Method for control
Particles		
Week	30	Continuous
24 hours	40	continuous
HCL		
week	50	Continuous
24 hours	65	Continuous
CO		
Hour	100	Continuous
90% quintile		
0.5 hour	150	Continuous
NO_x	–	Continuous
SO_2	300	Spot test
HF	2	Spot test
TOC	20	Spot test
Pb + Cr + Cu + Mn	5	Spot test
Ni + As	1	Spot test
Cd + Hg	0.2	Spot test
Pb	1	spot test

The control of all instrumentation should be automatic and take place continuously.

Report for the planning of the operation and maintenance of the incineration plant should be elaborated at least twice a year. Further, reports should be elaborated on the following:

- Incinerated quantities of waste, quantity of consumed auxiliary fuel, daily heat production and quantity and quality of produced slag and ash.

- The operation of each stage of the flue gas cleaning equipment including descriptions of each disturbance which might occur.

2) Sanitary Landfill

The purpose of the monitoring programe for the sanitary landfill is to supervise the surroundings which are influenced by the landfill. The programe must comprise the following issues:

- Control of waste supply

- Control of water (leachate, ground water and surface water)

The proposed monitoring programe for the above issues is described below.

All results from the monitoring programe must be recorded and approved by the supervising authority.

Further, the quantity of leachate which is removed from the landfill must registrated.

Moreover, measuring of noise from the landfill must be carried out at regular intervals as well as incidences of air pollution or noxious animals should be recorded.

a. Control of waste supply:

The type and quantity of waste of each truck load must be registered.

The registration must be carried out to facilitate statistics to be utilized for the planning of the sectional expansion of the disposal area.

The following division of waste types may be utilized at the registration of waste which is disposed of on the landfill sections which are furnished with bottom liner and drainage system for collection of leachate:

- Household waste (from kitchens, ash from heating, furnitures etc.)
- Commercial waste
- Market waste
- Institutional waste
- Garden waste
- Waste from street sweeping
- Industrial waste (no chemicals)
- Sludge from sewerage treatment plants (min. 20% dry matter)
- Soil polluted with oil (max. 5% oil)
- Construction waste polluted with e.g. painting

The following division of waste types may be utilized at the registration of waste which will be disposed of on landfill sections without bottom liner or system for collection of leachate:

- Unpolluted construction waste, e.g. concrete, tile and glass
- Unpolluted soil

b. Control of water:

The monitoring programme must be planned and the parameters for the control of leachate should be in agreement with the parameters for the control of ground and surface water. The parameters must be able to determine leachate characteristics and enable the comparison of a pollution-free and a polluted area. These parameters must be used at an early stage to detect whether the landfill is polluted with leachate or not.

It is recommended that the monitoring programe is planned at the following 3 levels: "basis", "enlarged" and "supplementary".

The 3 levels comprise an encreasing number of parameters to be controlled. The basis programe is regularily supplemented with the enlarged programe. Further, the enlarged programe or the supplementary programe is applied in case the results from the basis programe indicate a possible pollution.

c. Control of leachate:

The objective of the monitoring programme for leachate is to determine the degree of pollution. This information will be used as basis for the selection of parameters for control of ground and surface water.

Samples of leachate are taken from the collection tank for leachate. During the first year of operating the landfill, samples of leachate are recommended to be analyzed each month. Later on the frequency may be reduced to e.g. 4 times a year.

The programe for analyzing of leachate is presented in Table J.5.3-2

Table J.5.3-2 Program for Analyzing of Leachate

	Parameter	Programe		
		Basis	Enlarged	Supplementary
Characterization	Odeur	Z+	+	+
	Colour	+	+	+
	Clearness	+	+	+
	pH	+	+	
	Condutct.	+	+	+
	Dry matter	+	+	+
Organic matter	BOD	+	+	+
	COD	+	+	+
Nutrient salts	Total-N			+
	NH_4	+	+	+
	Kj.-N			+
	Total-P	+	+	+
Other salts	Cl	+	+	+
	Bor.B		+	+
	Fe		+	+
	Ca			+
	K			+
	Na			+
	SO_4		+	+
Heavy metals	Zn			+
	Pb			+
	Cd			+
Other toxics	Phenol		+	+
Frequency of analysies	1. year	8	4	as required
	Later on	2	2	as required

d. Control of ground water:

The object of the monitoring programe for ground water is to watch over possible alterations of the ground water caused by pollution from leachate.

Samples of ground water are taken frequently from borings which are establised at the initial construction of the landfill. The number of borings and locations is to be planned in accordance with hydrogeological investigations carried out before the construction of the landfill.

The programe for analyzing of ground water is presented in Table J.5.3-3

Table J.5.3-3 Programe for Analyzing of Ground Water

	Parameter	Programe		
		Basis	Enlarged	Supplementary
Characterization	Odeur	+	+	+
	Colour	+	+	+
	Clearness	+	+	+
	Condutct.	+	+	+
	Dry matter	+	+	+
Organic matter	COD		+	+
	$KMnO_4$	+	+	+
Nutrient salts	Total-N			+
	NH_4		+	+
Other salts	Cl	+	+	+
	Bor.B		+	+
	Fe		+	+
	Ca			+
	Mn		+	+
	SO_4		+	+
Heavy metals	Zn			+
	Pb			+
	Cd			+
Other toxics	Phenol			+

The frequency for analyzing ground water depends on the velocity of the ground water flow, which in turn depends on actual soil conditions. A ground water maximum flow was taken between 2 sample and is recommended for use.

ANNEX K

GENERAL RECOMMENDATION FOR THE IMPROVEMENT OF ISWM

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ANNEX K GENERAL RECOMMENDATION FOR THE IMPROVEMENT OF ISWM

K.1 Method of the Study

K.1.1 Scope of the Study

In this study general recommendations for the improvement of the Industrial Solid Waste Management (ISWM) in Poznan City are proposed based on the existing information and data.

K.1.2 Method of the Study

Investigation of reports regarding the present status of ISWM, review of plan for the future waste management system, and interviews of relevant organs and some industries were carried out in this study.

The following reports were referred to.

- Industrial Waste Management System in Poznan Agglomeration and Poznan Province, Stage I, Zielona – August 1988, High Engineering School in Zielona Gora Institute for Sanitary Engineering.

- A Preliminary Conception of Solid Waste Management in Poznan and Poznan Province (a master thesis), Poznan – 1990, Poznan Technical University, Institute for Environmental Engineering, Jack Furgal/supervisor Jozef Grabowski.

- Series: Statistical Data on Materials 68 (Nature Preservation 1989)

K.2 Present Industrial Solid Waste Management

K.2.1 Laws and Regulations

1) Poland

The laws and regulations in Poland on waste do not distinguish industrial waste and municipal waste.

The basic laws and regulations concerning waste management are presented below.

Law on Environmental Protection and Modelling of 31 January 1980 amended on 27 April 1989 and 10 May 1990

The law describes the basic principles involved in proceeding in all fields of environmental protection measures against pollution and also the legal responsibility for keeping the appropriate state of the environment. Also, the law defines that local administrative authorities (municipalities) must provide organizational and technical conditions necessary for the protection of the environment.

Law of Ministers' councils of 30 September 1980 concerning Protection of the Environment against Waste and other Impurities and Cleanness of the Towns and Villages

This laws is the executive law of the Law on Environment Protection and Modelling concerning waste management. It defines the duty of the municipalities; among others:

- Considers environmental protection tasks in preparation of development plans.
- Provide facilities for treatment and disposal and guarantee their proper operation.
- Define tasks to be provided by the municipal cleaning enterprises and durantee the fulfilment of their duties.

Also, the law defines the duties of the landfill operator, e.g. to keep record of quantities and types of waste received, and refuse waste of unknown composition. Finally, the law defines the duties of owners and administrators of real estates in relation to the disposal of waste in non-developed parts and areas destined for

public use and the equipping of the estate with facilities for waste storing and provision of a sanitary storage area.

Law of Ministers' Council of 21 December 1991 concerning Charges for Use of Environment

The law settles charges for 151 types of waste categorized under into 4 levels according to its harmfulness.

Examples of waste in the four groups are given below:

Group I; 60 types of hazardous waste, e.g.:

- Waste containing mercury
- Used galvanic baths
- Waste containing strong acids and strong bases
- Deposits from the preliminary treatment of municipal sewage and from the mechanical–chemical and chemical sewage treatment plants
- Sanitary waste from hospitals and waste contaminated biologically

Group II; 40 types of wastes, Some of the types in Group I are also present in Group II (with a lower content of harmful substance). Further, e.g.:

- Oil sawdust
- Waste from the soda industry, production of mineral wool and water–soluble paints.

Group III; 35 types of wastes, e.g.:

- Steel works slag
- Sediments from the water treatment plants
- Rubber–textile waste
- Waste from dairy, plastic and fruit–vegetable processing industries

Group IV; 16 types of waste of the lowest grade of environmental hazard, e.g. :

- Post–floatation waste from the sulphuric, coal, and barite industries
- Cable scrap
- Demolition waste–broken glass/cullet
- Textile, paper, rubber
- Waste from the timber industry (saw dust, chips, shavings etc.)

Every year a decree on charges is issued. For 1992 the decree caused many complaints from industries due to a considerable raise in the charges.

Law of the Ministry of Environmental Protection, Natural Resources and Forest of 23 April 1990 concerning Investments specially Harmful to the Environment and Human Health and the Conditions to be included in the Environmental Impact Assessment

The law is issued on basis of the act for the protection and forming of the environment of 31st January 1980 and of 12th July 1984 on physical planning.

It determines the type of investments specially harmful to the environment and human health, which before obtaining location should be approved by the Ministry of Environmental Protection, Natural Resources and Forestry and the General Sanitary Inspectorate.

Investments producing waste enumerated in Group I, regardless of quantity, are considered specially harmful to the environment. Therefore, their impact on the environment should be assessed.

Law of the President of National Atomistic Agency of 19 May 1989

The law describes the basic principles and procedures of classifying Wastes as Radioactive and their Qualifying and Registering, and Conditions of Treatment and Storage.

The radioactive waste is categorized in the following groups:

- Beta and Gamma radioactive wastes, grouped according to temperature:
  - Warm
  - Moderate
  - Hot
- Alpha radioactive waste
- Empty, sealed radioactive sources

The law determines in detailed form the principles and methods for handling of radioactive waste.

2) EC Legislation and Directives

The EC has a comprehensive regulation on hazardous wastes. A number of the directives concern transfrontier shipment of hazardous waste and dumping at sea.

The cornerstone in the EC-policy concerning hazardous waste is the Directive on Toxic and Dangerous Waste of 20 March, 1978 (78/319/EEC).
The directive lays down the principle that the disposal of toxic wastes must not pose a threat either to health or the environment and provides a series of measures to achieve this end.

A proposal on dangerous wastes has been discussed and amended between EC nations. Proposal for a directive on dangerous waste is negotiated in the EC and as the proposal is now (it has been amended), it will replace the 1978 directive, which into some extend has proved difficult to administrate and also the sector has developed a great deal since 1978.

In the latest proposal for a new directive, the term "dangerous waste" is amended by reference to three annexes to allow for greater precision in defining waste as hazardous:

- A list of types and categories of hazardous waste (the one from the 78 directive, but increased by several groups of substances).
- A list of substances or materials which render a waste hazardous.
- A list of characteristics which render a waste hazardous.

K.2.2 Administration and Organization

This section provides a status for the institutional system on industrial solid waste management (ISWM). Paralleled to the ongoing transition of the political and administrative systems also the institutional system for ISWM is under reformation and thus not consistent in all matters.

Among various administrative organizations in Poland, the following ministries, bureaus and agencies have some relation to industrial solid waste management as well as solid waste management.

1) Administration

a. National level

Currently, the ministries responsible for industrial solid waste management are:
- Ministry of Environmental Protection, Natural Resources and Forestry
- Ministry of Health and Social Assistance

The Ministry of Environmental Protection, Natural Resources and Forestry is responsible for the following activities in relation to the ISWM:
- Formulation of environmental policies and strategies.
- Preparation of legislation and guidelines related to the protection of the natural environment.
- Monitoring and control through the State Inspectorate of Environmental Protection represented at national and provincial levels

The Ministry of Health and Social Assistance is responsible for the human health aspects of solid waste management and exercises their power through the SANEPID. The SANEPID is represented at national, provincial and local level.

In addition to the two mentioned ministries, Ministry of Industry and Trade should be mentioned for initiation of the development of industries manufacturing equipment for waste management and utilization of secondary materials.

b. Provincial level

The Provincial Government (Voivodeship) has a central figure in the Polish administrative system as the executive body of the central Government.
The departments involved in municipal waste as well as ISWM are:

The Department for Environmental Protection

The Department for Environmental Protection is responsible for the issuance of permits for the industrial use of the environment. The use of the environment concerns all kinds of disposal and discharge to the environment (air, water and waste).

In connection with the ISWM, other duties of the department are:

- Decision about charges for use of the environment

- Collection of charges for use of the environment
- Conduct activities related to proper management of natural resources
- Issue statements concerning plans for change in the utilization of land

The charges for use of the environment are collected by the Department for Environmental Protection based on declarations from the industries.

c. Poznan City

The following bodies in Poznan Municipality are involved in execution of municipal waste management.

- The Department for Communal and Residential Affairs
- The Investment Department
- The Municipal Police
- The Department for Environmental Protection
- The Department for Urban Development, Architecture and Construction Supervision

Of these bodies, only the Department for Environment Protection is actually directly involved in ISWM. This department is under reorganization. Some duties concerned control of industries have been taken over by the State Inspectorate for Environmental Protection, but it is expected that new laws concerning water management will give new duties to the department.

d. The State Inspectorate of Environmental Protection

This body is recently transformed from a unit subordinated to the Provincial Government (Voivodeship) to a direct reference of the Ministry of Environmental Protection, Natural Resources and Forestry.

Also, the body issues certificates for industrial waste on the request of the industries. The purpose of the certificates is to determine the optimum way of disposal and allow operators of disposal sites to decide if they can fulfil the requirement and receive the waste or not.

The certificates include:

i. Determination of fee for "the use of the environment"

All industries must submit an annual report about their environmental impact (waste, waste water, emissions etc.). This report includes a record of amount of waste and based on this record and the classification, the industry pays a fee to the Provincial Fund of Environmental Protection and Water Management administered by the Department for Environment Protection at the Provincial Government.

ii. Determination of the "Degree of negative impact on the environment"

This classification states the requirements to the disposal. The landfill operator takes the decision whether to allow the waste to the site or not depending on actual conditions on the site and its suitability to dispose of the waste. The landfill operator is not obliged to report on the receipt of the waste, but must keep a record for all waste received and must file a copy of the certificate.

Presently, there are problems with this classification as it takes place through Temporary Guidelines issued in 1980. In case of disagreement, the industries claim that temporary guidelines cannot be legal basis for a decision.

A new law determining the classification is expected.

e. The State Sanitary and Epidemiological Inspectorate (SANEPID)

SANEPID is an authority under Ministry of Health and Social Assistance. SANEPID operates at three levels:

- National level
- Provincial level through Provincial (Voivodeship) SANEPID.
- Local level through Municipal SANEPID

SANEPID's area of responsibility is focused on environmental impact on health, including also occupational health.

The provincial SANEPID issues certificates for the disposal of industrial waste. This issuing of certificates is shared with State Inspectorate of Environmental Protection depending on the geographic area; e.g.. In Poznan, the State Inspectorate of Environmental Protection issues the certificates.

2) Organization

Organizational aspects for the national and the provincial level are covered in previous sections. In this section, relevant remarks will be added on the local level for Poznan Municipality.

As for ISWM, Poznan Municipality has introduced a regulation on repair works in order to control the generation and disposal of construction waste. When construction companies apply for permission to use municipal road for access to a working site, the permission is followed by a request to sign contract with SANITECH on collection of the waste generated during the work.

The matters related to administration and organization on the ISWM are as stated above.
As for the industrial companies cooperation on the ISWM, there are very few examples of industries cooperating on the safe disposal of waste. It is very difficult to secure the candidate site of the disposal facilities due to local protesting against localization. It is impossible to overrule local protecting due to a lack of power to enforce localization by referring to the best interest of the whole population.

Also, the industries are required to submit information on their waste generation to the Provincial Government (Voivodeship) and the State Inspectorate of Environmental Protection. Based on the information, the industries are obliged to pay charges in accordance with the type of waste. The contribution, however, does not relieve the industries for the obligation of proper handling of the waste.

K.2.3 Generation

Concerning the industrial wastes generated in the City of Poznan, Table 5.2.3-6 and Table 5.2.3-7 provide the details. Table 5.2.3-6 shows the data from the study that was carried out in 1988 by High Engineering School Institute of Sanitary Engineering Zielona Gora. Also, Table 5.2.3-7 shows the data obtained in 1991 through the questionnaire we asked them for at each enterprise when making our factory inspection. Each table shows names of plant, types of waste and amount of the waste discharged, of the wastes economically utilized, of the wastes stored on the disposal site and of the waste disposed of.
The data for 1988 is provided by thirty one (31) industrial enterprises. This data indicates that only two one enterprises keep their generated industrial waste at their site.

46.9% in weight of the whole industrial waste generated is used for the utilized and recycling, 19.3% for storage, and 33.8% disposed of outside their site. Most of the amount of waste disposed outside the factory is sent to the municipal disposal site, Suchy Las, and some of these wastes (e.g., plating sediments and used oil) may have significant effects to the environment due to their toxic contents.

As for reutilization, slag is sent to cement factories, metal scraps to steel enterprises, and used oil to oil refineries. (CPN).

The JICA Study Team conducted an interview with 21 enterprises in 1992 regarding industrial waste management. The result of the survey is shown in Table K.2.3-7.

The total amount of industrial waste discharged from 21 representative enterprises is about 229,107 t/year. 28% of the total amount is reutilized or recycled and 46% of that is stored on their own premises although approximately 39,000 t/year is disposed of in Such Las disposal site or in other sites. In case of Garbary - Karolin, 596,000 ton of ash and slag has been already stored on its own site.

In order to compare data for both 1988 and 1991, five enterprises are chosen. A comparison is made in such as the total amount of generated industrial wastes and of disposal and the amount of the representative waste generated by each enterprise.

1) H. Cegielski

Data on H. Cegielski enterprise are summarized below.

Table K.2.3-1 Waste generation and Disposal (H. Cegielski) (unit: ton)

Item	1988	1991	1991/1988
Total amount of waste generated	31,598	18,610	59%
Total amount of waste disposed of	1,989	319	16%
Ash and slag generated	29,600	17,191	58%

The total amount of waste generated in 1991 is 59 % of the 1988 total.
The total amount of waste disposed in 1991 is 16 % of the 1988 total. The waste generation of ash and slag is about 58 % of the 1988 total.

Except for the carbide residue, the total amount of waste generated in 1991, including toxic wastes like galvanic sediment has considerably decreased compared to the 1988 amount.

2) Pomet

Data on Pomet enterprise are summarized below;

Table K.2.3-2 Waste Generation and Disposal (Pomet)

(unit:ton)

Item	1988	1991	1991/1988
Total amount of waste generated	83,318	41,780	50%
Total amount of waste disposed of	5,040	21,480	426%
Moulding core sand generated	74,600	19,370	26%

The total amount of waste generated in 1991 is about 50 % of the 1988 total.
The total amount of waste disposed in 1991 is about four times in the 1988 total seemingly due to the disposal of the moulding core sand reserved inside the factory.
In 1991, however, the amount of used oil and coolant which were not shown in the 1988 data has considerably increased..

3) Romet

Data on Romet enterprise are summarized below;

Table K.2.3-3 Waste Generation and Disposal (Romet)

(unit: ton)

Item	1988	1991	1991/1988
Total amount of waste generated	901	257	30 %
Total amount of waste disposed of	701	90	13 %
Slag generated	500	125	25 %

The total amount of waste generated in 1991 is about 30 % of the 1988 total. The total amount of waste disposed in 1991 is about 13 % of the 1988 total.
The total generation of slag, representing the kind of waste disposed in this enterprise is about 25% of the 1988 total. This is due to introduction of the energy from heat-supply plant.

4) Stomil

Data on Stomil enterprise are summarized below;

Table K.2.3-4 Waste Generation and Disposal (Stomil)

(unit: ton)

Item	1988	1991	1991/1988
Total amount of waste generated	10,200	6,868	67 %
Total amount of waste disposed of	900	1,346	150 %
Slag generated	8,300	5,300	64 %
Municipal-like waste	-	977	-

The total amount of waste generated in 1991 is 67 % of the 1988 total.
The total amount of waste disposed in 1991 is about 150 % of the 1988 total seemingly due to the inclusion of municipal-like waste not evident in the 1988 data.

5) Pollena-Lechia

Data on Pollena-Lechia enterprise are summarized below;

Table K.2.3-5 Waste Generation and Disposal (Pollena-Lechia)

(unit: ton)

Item	1988	1991	1991/1988
Total amount of waste generated	1,147	997	86 %
Total amount of waste disposed of	820	611	75 %
Soaping mud generated	180	20	11 %
Slag generated	467	503	108 %

The total amount of waste generated in 1991 is 86 % of the 1988 total.
The total amount of waste disposed in 1991 is about 75 % of the 1988 total.

6) Overall trend

The trend of the above five enterprises shows decreasing tendencies in the total amount of waste generated and disposed of as compared with those in 1988.
The same trend seems to prevail in other enterprises, too.

The reasons are assumed to be as follows;

i) decreasing in the amount of waste generated

- decreasing tendencies of or stagnancy in the sales of enterprises
- enterprise's effort (e.g., change in material)

ii) decreasing in the amount of waste disposed

- decrease in waste generation
- expanded reutilization measures of waste

Further, the disposal method employed by each enterprise has not changed a bit since 1988.

In the food factory, Amino, studies on reuse of post-filtrated sludge and coffee extracted wastes are being conducted. Nevertheless, wastes are still being disposed of at the municipal disposal site.

The changes form 1988 to 1991 are:

- In Amino, Farandpol and Pomet, the amount of waste has quite decreased due to the supply of energy from heat plants.

- In Pollena-Lechia, the amount of soaping mud has quite decreased due to the use of modified soap materials.

- In H. Cegielski, hardening salts are being delivered to salt producers.

- In Polkork, sound insulating materials with the use of gums and cork wastes are being produced.

Table K.2.3-6 Amount of Industrial Waste Produced in Plants of Poznan City in 1988

(High Engineering School Institute of Sanitary Engineering Zielona Gora, August, 1988)

No.	Name of plant	Type of waste	Amount of waste produced (t/year)	Amount of waste economically utilized (t/year)	Amount of waste stored on the premises (t/year)	Amount of waste stored on the disposal site (t/year)	Notes
	1	2	3	4	5	6	7
1	Zaklady Przemyslu Metalowego H. Cegielski	galvanic sediments	220.00			220.00	
		used coolants, oil-water emulsions	800.00	740.00		60.00	party render harmless, the rest stored on the disposal site
		oiled up textile wastes	200.00			200.00	
		grinding and polishing dusts	160.00			160.00	
		slags and welding welds	300.00			300.00	
		carbide residue	300.00	300.00			
		ceramic and building material waste	8.00			8.00	lack of data concerning rendering harmless
		hardening salts	10.00				
		cullet				25.00	
		ashes and slags	29,600.00	29,600.00		300.00	
		sawdust, chips, bark				680.00	
		lacquer wastes				36.00	
2	Zaklady Naprawcze Taboru Kolejowego	oiled textile waste and sawdust	100.00			100.00	
		moulding-core sands waste	2,400.00			2,400.00	
		galvanic sediments	100.00			100.00	
		carbide residue	100.00	100.00			
		slags and fly-ashes	12,300.00	12,200.00		100.00	
		chips, sawdust	100.00	100.00			
3	Wielkoposkie Zaklady Teleelektroniczne "Teletra"	galvanic sediments					
		waste from photo-chemical treatment of printed circuits	30.00			30.00	
			1.00		1.00		stored in glass-containers
4	Fabryka Samochodow Polniczych "Polmo"	painting waste	45.00			45.00	
		used coolants	0.60			0.60	
		carbide residue	26.00	26.00			
		sediment from waste-water treatment plant	1.20			1.20	
		furnace slags	1,340.00	1,340.00			
5	Poznanskie Zaklady Opon Samochodowych "stomil"	used oil	100.00				
		rubber and textile-rubber waste	1,000.00	900.00		100.00	
		raw material packages	800.00				
		fly ashes and slags	8,300.00	7,500.00		800.00	raw materials do not contain toxic substance
6	Huta Szkla "Antoninck"	fly ashes and slags	100.00	100.00			
		ceramic materials waste	300.00	100.00		200.00	
		cullet	2,000.00	2,000.00			
7	Poznanska Fabryka Maszyn Zniwnych "Agromet"	moulding-core snads waste	5,600.00			5,600.00	
		painting wastes	40.00			40.00	
		cupola slags	2,300.00			2,300.00	
		dust and sludge from shooters and magnetoes	465.00			465.00	
		fly ashed and slags	2,600.00	2,600.00			
		used coolants				40.00	
		sludge from departure gas-cleaning plants				600.00	
8	Poznanska Fabryka Lozysk Tocznych	galvanic sediments	100.00			100.00	waste dump in Biedrusko
		wastes from coolant cleaning and neutralization	220.00			220.00	
		grinding and polishing dusts	500.00			500.00	
		wastes from barrel finishing plant	700.00			700.00	
		slag from boiler house	3,400.00	3,400.00			
9	Fabryka Obrabiarek Specjalnych "Ponar-Wiepofama"	moulding core sands	2,900.00	216.00		2,900.00	
		used hardening salts	0.20			0.20	
		used coolant and water-oil emulsion	300.00			300.00	
		carbide residue	2.00	2.00			sold to the workers
		metallurgical slags	375.00			375.00	
10	Wytwornia Sprzetu Komunikacyjnego PZL Mielec"	oiled up chips from machning	216.00	216.00			oilturned to CPN
		galvanic sediments					chips turned to SURMET
11	Fabryka Kosmetykow "Pollena-Lechia"	soaping mud, fattyacid, fats	180.00			180.00	
		waste from glycerin room	400.00			400.00	
		furnace slag	467.00	227.00		240.00	
		cullet	100.00	100.00			

	1	2	3	4	5	6	7
12	Przedsie-biorstwo Aparatury Urzadzen Komunalych	moulding core sands	7,000.00			7,000.00	
		galvanic sediments	0.10			0.10	
		painting wastes	11.00			11.00	
		scraps	365.00	365.00			being sold to steel plants or SURMET
		fly ashes and slags	1,600.00	1,600.00			
		metallurgical slags	1.20			1.20	
13	Zaklady Metalurgiczne "Pomet"	moulding core sands	74,600.00		74,600.00		
		metallurgical slags	6,978.00	1,978.00		5,000.00	sold or remelted
		fly ashes and slags	1,700.00	1,700.00			
		cleaning materials	10.00			10.00	
		used coolants	30.00			30.00	
14	Zaklady Przemyslu Rowerowego "Romet"	used oil					
		galvanic sediments	200.00			200.00	turn to CPN
		painting wastes	0.50			0.50	
		scrap, chips	200.00	200.00		200.00	
		fly ashes and slags	500.00			300.00	
15	Poznanska Fabryka Maszyn Pakujacych "Spomaz"	galvanic sediments	40.00			40.00	stored in container on the premises
		carbicle residue	8.00	8.00			stored in hermatic container
		wsater-oil emulsions	0.50	0.50			
		coating production	1.50				
		furnace slag	540.00	540.00			
16	Zaklacly Maszyn Chemisznych "Metal-Chem"	galvanic sediments	80.00			80.00	
		painting wastes	10.00			10.00	
		furnace slags	40.00				part of it economically utilized
17	Chemiczna Spoldzielnia Pracy "Synteza"	fly ashes and slags and mineral dusts	800.00	800.00			
18	Wojewodzkie Przedsie-biorstwo Energetyki Cieplnej	fly ashes and slags	120,000.00	89,650.00		30,350.00	
19	Wojskowe Zaklady Motoryzacyjne	galvanic sediments	6.00			6.00	waste dump in Uscikowo rendered harmless
		painting wastes	4.00				
		used water-oil emulsions	3.00				
		oiled up cleaning materials	8.00				
		sewage treatment sediments from elements prewashing	40.00			40.00	
		ashes and slags	1,600.00	1,600.00			
20	Spoldzielnia Niwidonych "SIMPO"	galvanic sediments	2.50			2.50	
		furnace slags					
21	Fabryka Pomocy Naukowych "Fapon"	galvanic sediments					
22	Zaklady Piwowarskie	furnae slag	3,300.00	3,300.00			
		cullet	248.00	248.00			
23	Wielkopolskie Okregowy Zaklady Gazownictwa	furnae slag	2,200.00	2,200.00			
24	Zaklady Prezmyslu Cukierniczego Goplana	furnae slag	1,200.00	1,200.00			
25	Poznanskie Zaklady Prezmyslu Spirytusowego "Piomos"	furnae slag	300.00	300.00			
		cullet	700.00	700.00			
26	Poznanskie Przedsie-biorstwo Ceramiki Budowlanej "Cerabud"	crushed brick	2,256.00	2,256.00			
		calcareous-sand debris	1,300.00	1,040.00		260.00	
27	Okregowy Zarzad Lasow Panstwowych	bark of coniferous tree	9,250.00	9,250.00			
28	Wielkopolskie Przedsie-biorstwo Przemyslu Drzewnego	sawdust from coniferous and deciduous tree	1,100.00	330.00			770 tones undisposed
		sawmill edings	400.00	400.00			

	1	2	3	4	5	6	7
29	Zakłady Przemysłu Odzieżowego Komuuy Paryskiej "Modena"	wood fabrics cutting other fabrics cutting	100.00 125.00			100.00 125.00	undisposed
30	Poznanskie Zakłady Farmaceu-tyczne "Polfa"	cullet sludge and distillation sediments pcv foil polyethlene foils	50.00 18.00 3.00 3.00	50.00 3.00 3.00		18.00	
31	Poznanskie Zakłady Koncentratow Spozywczych	filtration mud extraction wastes productio wastes energetistic slags	729.00 50.00 250.00 655.00	 250.00 		729.00 50.00 655.00	Sold to PGR
	Total		386,562.96	181,222.50 (46.9%)	74,601.00 (49.3%)	130,739.45 (33.8%)	

No.	Name of plant	Type of waste	Amount of waste produced (t/year)	Amount of waste economically utilized (t/year)	Amount of waste stored on the premises (t/year)	Amount of waste stored on the disposal site (t/year)	Notes
	1	2	3	4	5	6	7
1	H. Cegielski	used electroplting bath	0.43			0.43	
		post-neutralization sediment	0.30		0.30		
	metallurgical factory	used post-mardening salts	3.00		3.00		high cost of treatment
		used oil and lubricants	40.80	26.40	0.60		13.8 (burnt)
		used mardening oils	3.40	3.40			
		remaining after cleaning of boilers	0.80	0.80			
		lacquer wastes, lacquer dusts	36.80		2.80	0.60	33.4 (burnt)
		used coolants	115.40	2.00	0.10		113.3 (treated)
		mud and sludge from vehicle chassis	2.00			2.00	
		polluted solvents or their mixtures	4.55		4.50		0.05 (burnt)
		post-neutralization sediments from the electroplating shop	9.40		7.10		2.3 (treated)
		oily sawdust and cleaning cloths	8.90		4.80	3.50	0.6 (burnt)
		post-grinding sludge containing oils	7.70		0.50	7.20	
		foundry wastes	0.20		0.20		
		construction materials after demolishing of furnaces	4.15	4.00		0.15	
		foundry wastes unfit to the category	5.00		0.50		
		wastes containing battery mawganese	35.60	35.60			used batteries
		voltaile ashes and slag from the heat and power plant	17,191.00	17,191.00			
		carbide residue	500.00	500.00			
		enamel wastes	0.33	0.33			
		exceedingly polluted sand	18.60		3.00	15.60	
		grinding wastes without oils	36.50	0.80	15.10	20.60	
		uses filtration wastes	32.00	32.00			
		sludge and slag from enamel shop	3.12		3.12		
		rubber wastes	0.90	0.90			
		welding slag and dscales	263.00		3.00	260.00	
		textile wastes	0.90	0.90			
		decarbonization wastes	100.00	100.00			
		scale from the forging shop	5.00			5.00	
		wastes paper	6.40	2.40		4.00	
		chips and sawdust	171.70	170.90		0.30	0.5(burnt)
		used absorbents	0.50				0.5 (neutralized)
		lead melting loss	0.30		0.30		
		TOTAL	18,609.98	18,071.43	54.72	319.38	164.45
2	Pomet	used coolant	10,500.00				
		oily cleaning agent	3,600.00				
	metallurgical factory	moulding sand	19,370.00			19,370.00	
		ashes and slag from the heating plant	1,200.00	1,200.00			
		ceramic wastes	900.00			900.00	
		slag from ferrous and steel works	900.00			900.00	
		municipal wastes	310.00			310.00	
		used oil	5,000.00				
		TOTAL	257.00	1,200.00		21,480.00	
3	Romet	post-neutralization sediments	22.00		12.00	10.00	
		polishing shop sediments	110.00		30.00	80.00	
	metallurgical factory	slag from the heating plant	125.00	125.00			
		TOTAL	257.00	125.00	42.00	90.00	
4	ZNTK	residues after cleaning boilers	11.00			11.00	
		lacquer wastes	3.60			3.60	
	railroad	mud from vehicle chassis washing	60.00			60.00	
	stock repair	sediments from the sewage chemical					
	factory	treatment plant	6.00			6.00	
		oily sawdust, partially textiles	17.00			17.00	
		foundry wastes	360.00			360.00	
		slag from steelworks	12.00			12.00	
		chips, sawdust, back	22.00			22.00	
		construction material	24.00			24.00	
		glass waste	5.00			5.00	
		TOTAL	520.60			520.60	
5	WSK-PZL	post-neutralization sediments	3.00		3.00		
		used oil	12.00	12.00			delivered to CPN
	transportation	slag	28.00	28.00			
	equipment	wood waste	27.00	2.00			burnt
		metal chips	162.00	162.00			delivered to waste metal storage
		TOTAL	207.00	204.00	3.00		

	1	2	3	4	5	6	7
6	Dolon electrorical and engineering industry	non-ferrous metal waste	13.60	13.60			recycled by other other firms
		steel waste	38.30	38.30			
		lacquer waste	5.00			5.00	
		electroplating sediments	0.30		0.30		
		slag from the heating plant	200.00	200.00			recycled by other other firms
		sandust	3.00			3.00	
		used oil	0.30	0.30			recycled by other other firms
		TOTAL	260.50	252.20	0.30	8.00	
7	Telkom-Teletra telecommuni-cation factory	post-neutralization hydrated sediments	3.00			3.00	
		post-neutralization dehydrated sediments	1.00			1.00	
		post-etching agent (copper)	1.20	1.20		1.00	
		dichloromethane, trichloroethane	1.00				
		"Peblum" oil	5.00	5.00			to the air disposing
		Freon	10.00				to sewage system
		coolant	0.80				
		trichloroethy lene	0.15	0.15			
		dye waste	1.40				burnt
		TOTAL	49.55	6.35		(35.00)	
8	Stomil tyre factory	rubber waste	259.00	204.00		55.00	
		used oil	18.00	15.00	3.00		
		slag	5,300.00	5,300.00			
		rubble	314.00			314.00	
		municipal-like waste	977.00			977.00	
		TOTAL	6,868.00	5,519.00	3.00	1,346.00	
9	Polkork cork producer	crushed cork	64.60	64.60			sold for insulation
		cork-rubber waste	74.70	54.70		20.00	sold for insulation
		cork waste	9.00	9.00			sold for insulation
		cork-dust	48.00			48.00	sold for insulation
		waste paper	7.00	7.00			sold
		slag	20.00	20.00			sold
		TOTAL	(173.30)	(155.30)		68.00	
10	Swarzeds furniture factory	municipal like wastes	370.00			370.00	
		lacquer wastes	7.00		7.00		
		waste of the wood industry	300.00	300.00			
		slag	230.00	100.00		130.00	
		TOTAL	907.00	400.00	7.00	500.00	
11	Malta paper industry	waste paper	178.00	178.00			158 sold
		paper sludge	1,550.00			1,550.00	
		scrap metal	38.00	38.00			38 sold
		slag	1,953.00	1,953.00			sold
		used oil	-	-		-	to CPN
		TOTAL	3,719.00	2,169.00		1,550.00	
12	Garbary-Karolin						
	Garbary	ashes and slag	30,049.00	30,049.00	12,075.00		stored from previous years
		post-decarbonizatio waste	182.40		182.40		
		municipal-like wastes	384.00			384.00	
		rubble	1,166.00		1,166.00		
	Karolin	ashes and slag	103,074.00		595,701.00		including the already stored
		post-decarbonizatio waste	338.00		338.00		
	head and power plant	municipal-like wastes	1,211.00			1,211.00	
		rubble	2,108.00			2,108.00	
		TOTAL	138,512.40	30,049.00	608,296.40	4,869.00	
13	MPK municipal transportation company	oil and lubricants	0.90		0.90		
		wastes of brake disks	8.00			8.00	
		asbestos wastes of brake disks	2.00			2.00	
		ashes and slags	250.00	70.00		180.00	
		TOTAL	260.90	70.00	0.90	190.00	
14	Pollena-Lechia cosmetics factory	waste paper	70.00	70.00			sold
		waste glass	19.00	19.00			sold
		aluminium scrap	77.00	77.00			52 sold
		soaping mud	20.00			20.00	
		rock salt	300.00			300.00	
		post-production solvent	3.00	3.00			
		slag	503.00	212.00		291.00	
		TOTAL	992.00	381.00		611.00	

	1	2	3	4	5	6	7
15	Polfa pharmaceutical enterprise	grease catcher (vasline, paraffin)	10.00			10.00	sold
		waste glass	10.00			10.00	
		waste paper	80.00	70.00		10.00	
		aluminium scrap	20.00	15.00		5.00	
		paraffin oil	20.00	10.00	10.00		
		plastics (homogenous)	30.00	20.00		10.00	
		plastics (mixed)	20.00			20.00	
		construction waste	100.00			100.00	
		TOTAL	290.00	115.00	10.00	165.00	
16	Synteza chemical and pharmaceutical industry	alcohol waste	4.00	4.00			sold outside
		first running after vinyl acetate	1.00	1.00			sold outside
		ashes from boiler	0.30			0.30	
		slag	100.00	100.00			to external clients
		cardboard waste	2.00			2.00	
		rubble	40.00			40.00	
		TOTAL	147.00	105.00		42.30	
17	Farmapol pharmaceutical industry	ashes and slags	69.00			69.00	
		glass waste	0.80			0.80	
		packaging from chemical components	0.30			0.30	
		TOTAL	70.10			70.10	
18	Dairy-Cooperative foodstuffs industry	foil PS	18.00	18.00			
		foil AL	2.70	2.70			sold to customer
		glass waste	75.80	75.80			sold to customer
		slag	1,073.00	1,073.00			
		TOTAL	1,169.50	1,169.50			
19	Amino food concentrates enterprise	Division at Baltycka					
		post-filtration mud	327.00				sold
		post-extraction wastes	750.00			750.00	
		organic wastes (dinner)	9.30				sold
		desert wastes	2.70				sold
		sugar wastes	0.10				sold
		macaroni (noodle) waste	22.80				sold
		bone meal	7.70				sold
		coffee smell (scale)	2.20			2.20	
		aluminium tubes	1.00				sold
		Division at Starolecka					
		dye-wastes	17.90				sold
		desert waste	6.70				sold
		nut smell (scale)	3.90				sold
		slag	110.00			110.00	
		TOTAL	1,261.30			862.20	
20	Pozmeat foodstuffs industry	minicipal wastes and rubble	950.00			950.00	
		steel scrap	110.50				sold
		aluminium scrap	6.00				sold
		plastic waste	6.50				sold
		technical blood	1,156.00				sold
		slaughterhouse wastes	1,568.00				sold
		TOTAL	3,787.00			950.00	
21	Ema-Centra electro-chemical enterprise	acidic accumulators	240.90		240.90		
		plates and girls	950.20	656.30	1,169.50		from previous years
		lead sludge	402.70	388.20	173.10		from previous years
		lead melting loss	582.50	583.90	212.40		from previous years
		steel scrap	336.20	325.40			
		cast iron scrap	16.40	16.40			
		non-ferrous scrap	119.10	119.10			
		nickel scrap	3.10	3.10	5.10		from previous years
		scale containing nickel	43.70	43.70	31.60		from previous years
		scale containing cadmium	21.00		93.90		from previous years
		sludge containing cadmium	24.00		34.90		from previous years
		used oils and lubricants	1.60	1.60			
		sediment form water iron removal	4.10	4.10			
		carbide residue	19.00	19.00			
		suspension of grease catchers	1.50			1.50	
		sludge from wet-dustremoving facilities	0.30	0.30			
		waste paper	32.30	32.30			
		plastics	25.80	21.70	77.00		from previous years
		municipal-like wastes	5,140.00			5,140.00	
		post-nuetralization sediments	2.20		2.20		
		slag	1,300.00	1,300.00			
		TOTAL	9,266.60	3,756.00	1,799.70	5,141.50	

K.2.4 Collection and Haulage

Table K.2.4-1 shows the result of industrial survey in Poznan City in 1991 through the distribution of questionnaires.

1) Critical issues concerning the industrial waste of each enterprise

The critical issues concerning the industrial waste of enterprises are as follows:

- Technology
- Cost
- Others

This "Technology" means the pure technology for industrial waste management at the enterprise.

Also, in the other items, it seems that the enterprise complains about the lack of the companies that are engaged in the industrial waste disposal.

2) Industrial waste collection and transportation method

Most enterprises independently transport their waste to the disposal site or require contractors to do so. However, waste to be reused in other factories is collected and transported by their own staff and trucks. One enterprise especially transports industrial waste in containers to another industry by train. There are also some industries who pay SANITECH for the collection and transportation of their wastes.

The number of staffs that are engaged in collection and transportation of the waste within the factories is approximately from 5 to 10 persons.

3) Industrial Waste Disposal Method

Large amount of industrial waste is transported to Suchy Las disposal site. "Others" in the questionnaires include other sites and companies such as SURMET, CPN and factories which reuse waste.

4) Waste Loading Method

Most enterprises directly load wastes on to the truck for transportation. However, liquid and hazardous wastes are transported by container.

5) The Time of Measurement of the Amount of Industrial Waste

As for the time of measurement, most of enterprises measure the amount of industrial waste during transport or after collection. Not all enterprises, however, are quipped with measuring devices, i.e., truck scale, thus waste amount is only assumed not weighed correctly.

Table K.2.4-1 Answers in questionnaires about Collection and Haulage

(1) What are the critical issues relating to the industrial waste?

No	Answer	Number of companies
1	cost	8
2	manpower (number of staff)	0
3	technology	13
4	others	7

(2) Who collects the industrial waste?

No	Answer	Number of companies
1	by own staff	18
2	by contractors	8
3	by SANITECH	5
4	by others	1

(3) How many workers for industrial waste collection and transportation do you have?

No	Answer	Number of companies
1	more than 10 persons	5
2	more than 5 and less than 10	8
3	less than 5	9
4	no staff	0

(4) What kind of vehicle do you use for transportation of the industrial waste?

No	Answer	Number of companies
1	company's truck	16
2	constructor's truck	13
3	cart or small vehicle	1
4	others	5

(5) Where do you transport the industrial waste?

No	Answer	Number of companies
1	Suchy Las disposal site	14
2	SANITECH	6
3	Others	10
4	Unknown	1

(6) How do you transport the industrial waste?

No	Answer	Number of companies
1	loading directly the waste	16
2	by using containers	4
3	after the special packing	6
4	Others	4

(7) When do you measure the amount of the industrial waste?

No	Answer	Number of companies
1	before the collection	3
2	after the collection	10
3	at the time of the transport	14
4	Others	3

K.2.5 Processing and Recycling

1) Processing

The answer in the questionnaire survey concerning processing and final disposal of industrial waste is shown in Table K.2.5-1.

Three of seven enterprises which generate used oil neutralize it. Two enterprises treat it by oil-separation method. All three enterprises which generate water-oil emulsion treat waste by oil-separation method. Some uses the drying and burning method. All four enterprises which generate galvanic sediment adopt the method of neutralization and dehydration. Painting waste, plastic waste and sawdust are burned for treatment.

Most of the representative enterprises treat waste with the basic process. However, the treatment facilities are old and need to be improved.

Table K.2.5-1 Answers in questionnaire about Processing and Final disposal

(1) How do you process each industrial waste?

Process / Type of waste	neutral-ization	dehydra-tion	drying	oil-separation	burning	size-reduction
used oil	3	1		2	1	
water-oil emulsion	2		1	3	1	
galvanic sediment	4	4	2			1
painting waste					2	
sludge		2			1	1
plastic waste					1	
sawdust					4	1
other (name:)						1

(2) Where do you dispose of industrial waste finally?

No	Answer	Number of companies
1	inside your company	5
2	inside Poznan city	3
3	outside Poznan city	18
4	Others	3

2) Recycling

The amount of industrial waste reutilized is also shown in Table K.2.3-2. Most of the main enterprises in Poznan City reutilize the industrial waste. However, the amount of reutilization is less than 28% of whole waste amount. The reutilization or recycling of the waste is either conducted by the enterprise which produces the waste or by other enterprises. Following cases are shown.

- Used oil is sent to CPN (State Gasoline and Oil Distribution) for treatment
- Slag is utilized as materials for road construction
- Sawdust is utilized in heating plants or disposed of in the disposal site
- Chips of steel and scrap metals are utilized for steel works
- Food wastes are utilized as fodder
- Glass wastes are utilized for glass works

K.2.6 Final Disposal

At present, there is no disposal site for industrial waste inside Poznan City. Such Las disposal site, located next to the boundary of the City, is not prepared to accommodate industrial waste.

The answer for the questionnaire concerning the place of industrial waste disposal is shown in Table 5.2.5-1 (2).

A disposal site "inside Poznan City" refers to some illegal dump sites, and the site "outside Poznan City" refers to Suchy Las disposal site. More than 60% of the representative enterprises use the municipal disposal site to dispose of their industrial waste.

It seems that the industrial waste collected by "SANITECH" is treated at Suchy Las disposal site. Almost all types of industrial waste, such as glass ceramic, hazardous waste and sediments including heavy metal and asbestos, are disposed of at the site.

There are many illegal dumping places in Poznan. Some of the places are listed with comments in Table K.2.6-1, Fig. K.2.6-1 and Photo K.2.6-1.

Table K.2.6-1 Illegal Dumping Site

No	Location district street	Surface	Remark
1	Karpia St.	30,000 m²	. Waste is dumped as indicated by the land owner. Waste includes construction waste and industrial waste. - General waste Can, Plastic bag, Fruit, Plastic bottle, Paper etc. - Construction Waste Concrete scraps, Brick etc. - Industrial Waste Ash, Asbestos, Tyre etc. . The bulldozer is operated.
2	Chemiczna St.	2,000 m²	. The area of illegal dumping site is expanding. Now, bulldozer is operated and the dumping area is extended to Warta river. . Mostly, the construction waste (concrete scrap and brick) is dumped. General waste is can, plastic bottle, plastic bag. Industrial waste is tyre etc. but amount of the waste is a little. . A bicycle is also dumped.
3	Baltycka St.	15,000 m²	. The site is located along the way to Stomi Tyre Factory. Waste dumping is not observed in the day time. . Industrial waste and construction waste is mostly dumped. Industrial waste Ash, Metal, Tyre, Asbestos, Glassfiber, Sediment Construction waste Concrete scrap, Brick

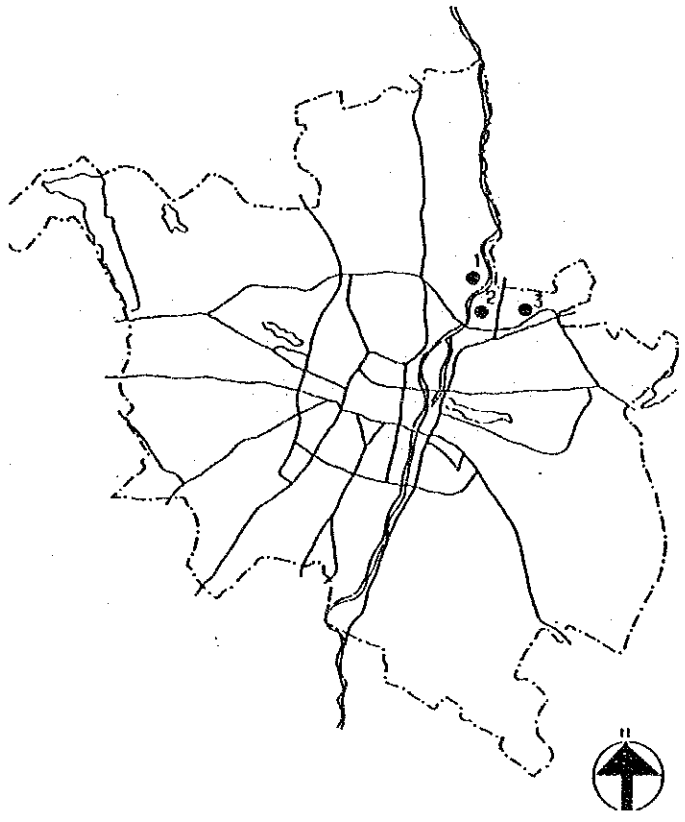


Fig.K.2.6-1 Location of Existing Illegal Dumping Sites

K.2.7 Financial Situation

The Act of the Environmental Protection and Modelling describes "economic means of environmental protection" which includes the method for raising funds, objectives of these funds and their allocation.

These funds shall be raised from payments for the use of the environment and from fines imposed on environmental violations. These funds shall then be divided between the provincial and central governments.

Provincial government (voivodeship) is earmarked to support the construction of environmental protection facilities especially important for the area. These shall be done through subsidies. The fund in Poznan in 1992 is only 100 billion Zl., although 70 projects are planned. Of these 70 projects, 25 are on solid waste and includes the construction or expansion of landfill sites, purchase of containers for recycling and preparation of a disposal site for industrial waste. The 1991 budget for solid waste management was 2.1 billion Zl., and is estimated to reach 10 billion Zl in 1992.

The National Fund for Environmental Protection and Management shall come from provincial funds. 100% of the charge for NO_X and 40% of the charge for SO_2 which goes to the provincial fund shall be transferred to the national fund, but 90% of these will be reimbursed in the form of interest payable loans for provincial projects.

There is no budget else in voivodeship of Poznan for industrial waste management. There is one private fund "Warta River Basin. EC financed 500,000 ECU (about 800,000 US$) to formulate a master plan of watershed management and identify immediate projects, in which there are some candidate projects for solid waste management.

K.3 Issues and Problems

1) Laws and Regulations

In EC, laws related to the discharge of industrial wastes have been strengthened to reduce the amount of discharge, increase recyclable resources and enable the implementation of appropriate treatment methods. In addition, a new policy on industrial waste from an economical point of view was also formulated. Likewise, the same strategies are also necessary in Poland.

2) Administration and organization

In Poland, the administration and organization of industrial wastes are explained hereunder.

On the national level, the ministry in charge of industrial waste management is the Ministry of Environmental Protection, National Resources and Forestry.

This Ministry is responsible for the following activities;

- Presentation of environmental policy
- Lawmaking for natural environmental protection and preparation of guidelines
- Monitoring and control through the State Inspectorate of Environmental Protection in the national and provincial level

In the provincial level, the department in charge of industrial waste management is the Department for Environmental Protection. The department prepares programs and plans that promotes the implementation of national policies on a provincial scale.

The department is also responsible for issuing licenses to the factories wanting to use environment.

Their duties also include the followings:

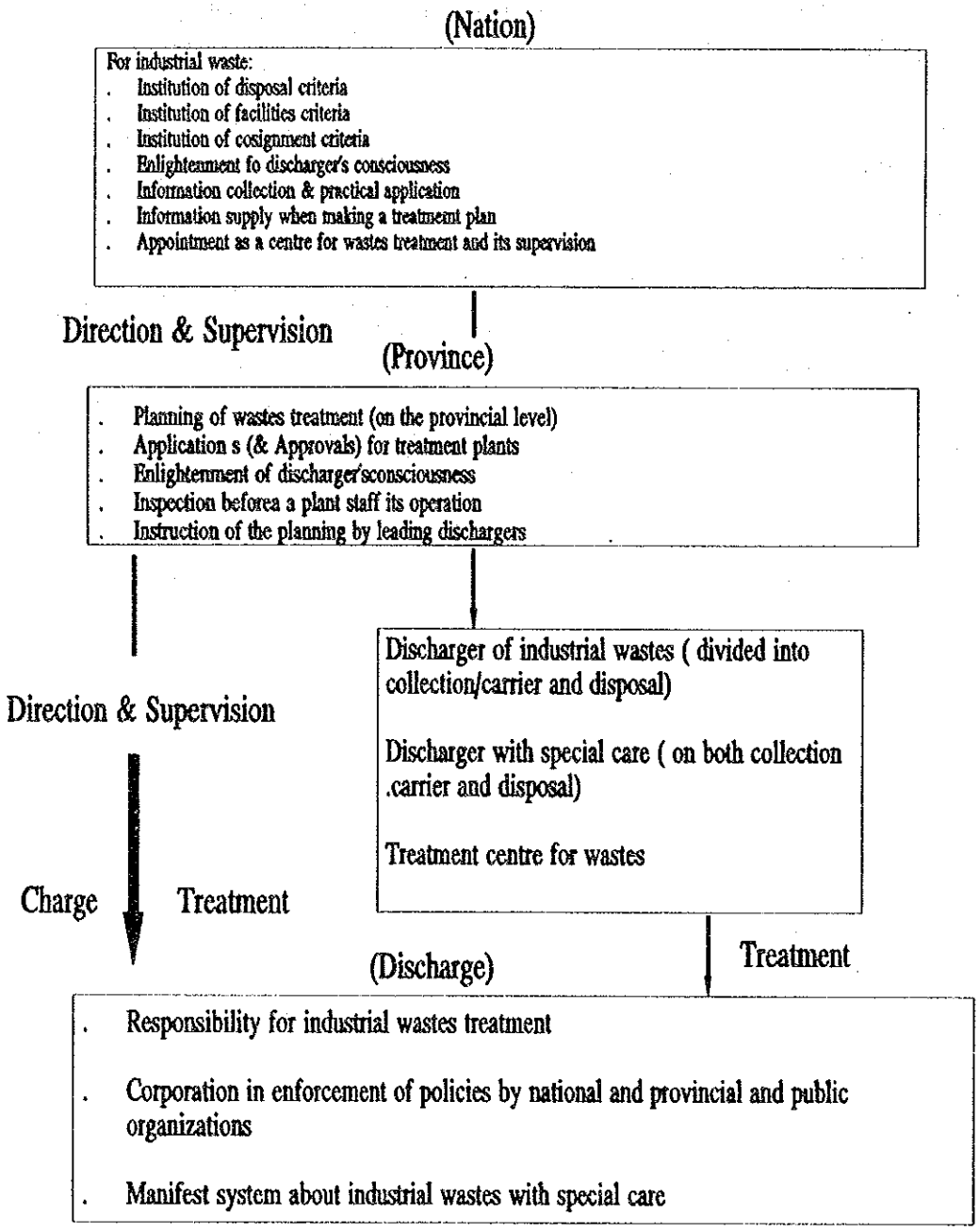
- Decision on the fees for the use of the environment
- Fee collection for the utilization of the environment
- Conduct activities for the proper handling of natural resources

- Formulation of reports on plans for modification of land utilization
- Formulation of reports on planned disposal site.

The amount of the fee to be paid for the use of the environment will depend on the data penned in the application paper. The fees shall be collected by the department.

Away from one of lower branches of Voivodship, The State Inspectorate of Environmental Protection was recently relocated under direct control of the Ministry of Environmental Protection, Natural Resources and Forestry. Observations are controlled in the national and provincial levels. Eventually, the organization who will directly observe waste treatment shall be the State Inspectorate of Environmental Protection only.

For reference, the revised plan of industrial waste treatment in Japan is shown below;



The administrative and organizational conditions in Poland and Japan are almost the same.

However, in spite of established laws, administration and organizational structure, things do not seem to work well enough. This may be attributed to the following observations made during interviews with enterprises and administration.

- The provincial government does not supervise the activities of each enterprise.
- The provincial government does not have any plans concerning industrial waste disposal.
- The provincial government only assigns one staff to supervise industrial waste management.

3) Enterprises and contractors

Problems on industrial waste vary according to the type of enterprise. Although these enterprises are supposed to conduct waste treatment themselves, proper treatment or waste management processes are not always implemented.

Some enterprises discharge industrial waste within their own factory premises, and then let them dry up. It is then mixed with soil and sand, and transported to the municipal disposal site. This process pollutes the factory environment and also the disposal site.

Another case is the leaving of containers of hazardous wastes in the open within the factory site. These containers usually undergo corrosion and further endanger the environment. This may be attributed to inadequate factory inspection measures and lack of guidance or advice. The ignorance of enterprises with respect to such matters can only be traced to a failed corporate policy.

On the other hand, the problems of SANITECH should be looked over. SANITECH has dealt with some of the liquid waste at a sewage treatment plant and has disposed of asbestos at places other than the only available treatment plant, Pasieka. Some of hazardous wastes seem to be disposed of at the Suchy Las disposal site which is under SANITECH's jurisdiction.

Only a very few number of enterprises and contractors were found to keep records on industrial waste storage, and only a rough estimate of the weight of generated waste was found in the available data.

Enterprises must conduct data strorate, especially since a data base is not difficult to be set up and maintained.

Illegal dumping of industrial waste leads to environmental deterioration, therefore, enterprises and contractors must formulate a corporate policy regarding the proper discharge of waste. If proper measures are not taken, the administration should conduct factory inspections and impose compulsory regulations and court actions as the occasion demands.

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4) Recycling

The following table shows the efficient utilization of wastes generated through manufacturing works.

	1988 (%)	1991(%)
H. Cegielski	96.97	97.11
Pomet	4.41	2.87
Romet	22.21	48.46
ZNTK	82.12	0
Teletra	0	12.82
Stomil	82.35	80.36
Lechia	28.51	38.41
Polfa	75.68	39.66

Among the above enterprises, the utilization rate in ZNTK decreased to 0 % from about 82% due to the disappearance of slag in 1991, materials which almost monopolized the entire ratio of wastes generated in 1988. Another reason is the provision of energy from the heat plant since 1991.

The utilization rate of Polfa is reduced to 40% from approximately 76% due to the generation of large amount of construction wastes from the reconstruction of some buildings within their site.

Except for these two enterprises, the utilization rate of others slightly indicates upward trend.

In the same manner, the typical methods of recycling industrial wastes in 1991 are summarized below.

Slag ..... Road construction enterprises
Used oil ..... Recycling at CPN
Sawdust ..... Used as fuel by other enterprises
Carbide residue .... Used by other enterprises
Scrap metal ..... Sold to steel works
Glass waste ..... Sold to glass works
Food waste ..... Sold to feed traders

Nevertheless, through further consideration of the industrial wastes of each enterprise, there are still factors that would enable an increase in the recycling ratio.

Some enterprises take sawdust and glass wastes to the disposal site directly through contractors. These wastes can also be recycled. Polfa makes use of rubber and cork wastes in making sound absorbers.

Paper and aluminum scraps are sold and reused for recycling purposes also.

5) Disposal Site

Dischargers are responsible for the disposal of industrial waste. However, they cannot treat and dispose of the entire industrial waste since they have no disposal site. Some wastes are stored in their own site and some are dumped illegally. Therefore, it is important for the disposal site for industrial waste to be constructed and an appropriate disposal system to be established.
An organization, PASTICHE, for the disposal of industrial waste in Poznan City was jointly established by 9 dischargers (seven from Poznan). Presently, the organization is trying to acquire land to be used as a disposal site.
Approximately 20ha of land is being required for the construction of a disposal site that would accommodate the industrial wastes of all enterprises within the province.

K.4 General Recommendation

This section deals with the general recommendations on the ISWM of Poznan City;

1) Laws and Regulations

Primarily laws and regulations should be established in keeping with the EC legislations and guidelines. It is necessary not only to treat industrial wastes, but also to control the generation and discharge of waste, and further to reduce the amount through recycling.

- Control of the generation of waste

Enterprises must also develop processes which would enable the treatment of industrial waste at generation source. A good example would be that of the enterprise Pollena-Lechia which examined the materials they use and made modifications. As a result, large amount of soaping mud was reduced. Conclusively, it is necessary that enterprises examine the raw materials they use and take the necessary steps that would mitigate the environmental pollution caused by their waste.

- Reduction through recycling

In Japan, guidelines, stating legal responsibilities which require the promotion of the utilization of recyclable material, are provided to 10 leading dischargers of industrial waste. These guidelines are meant to promote the implementation of the said responsibility collectively. All enterprises are required to plan the utilization of these recyclable materials, and to increase the means for their utilization. They are also required to fully equip themselves with the required machineries and to improve their techniques.

Similarly in Poland, it is also possible to promote the utilization of recyclable papers in the paper industry and residues from glass manufacturing companies, and to reuse concrete as raw material for construction work.

Furthermore, the introduction of a "manifest system" shall be also required to ensure the preservation of the environment by preventing improper treatment methods for industrial wastes and accidents during the implementation of these methods.

2) Administration and Organization

In Poland, the administrative organization for industrial wastes management is getting more structured, although other issues start surfacing in the actual operation.

- The Provincial governments have done almost nothing to accomplish their obligations concerning the plans that they must make with regard to industrial waste management, the supervision and guidance they should give to enterprises.

- The factory inspection procedures are inconsistent.

The necessity of a storage area for industrial waste and the method of storing data will be made known to the enterprises through the execution of factory inspections. With regard to this, it will be essential to review the personnel disposition within the administration and organization and increase the staff responsible for industrial waste management, and then conduct the necessary training courses.

Furthermore, in keeping with the EC standards, the administration is required to have technical knowledge (in discharge, treatment, recycling, disposal methods, etc.), collect information and develop new techniques. The administration has to transfer technical information to enterprises and provide them with technical aid through subsidies and other schemes.

3) Generation

Only few of the enterprises seem to introduce appropriate waste managerial measures by classifying industrial waste into groups according to degree of harmfulness.
Almost all enterprises have no complete information on the amount, composition and toxicity of industrial wastes generated from their factories.

- Improvement of inventory system

Every factory submits to the provincial government information on the characteristics and amount of industrial waste they generate. The amount of money changed for the use of the environment is registered. The information can be used for the management of industrial waste. Inventory system is effective for supervising ISWM.

Therefore, precise registration and continuous updating of inventories shall be implemented.

- Change of production process and primary materials

Manufacturers should adopt new production processes and change the primary materials they use to reduce industrial solid waste generation.

- Separation of industrial waste

Dischargers should try to separate hazardous wastes from non-hazardous ones in order to reduce the amount of hazardous industrial solid wastes to be disposed of and facilitate waste reuse and recycling.

- Reuse and recycling of waste

Manufacturers should try to reuse and recycle their industrial solid waste to reduce the amount to be disposed of.

4) Transportation

- Labelling on package

Hazardous waste to be transported should be packaged properly with appropriate labelling. Packaging and labelling standards should be set for each type of hazardous waste by the provincial government. Establishment of appropriate standards for collection vehicles to be used in the transportation of hazardous wastes is also important. Accidental mixing of non-compatible wastes should be avoided.

- Granting of permission to transportation company

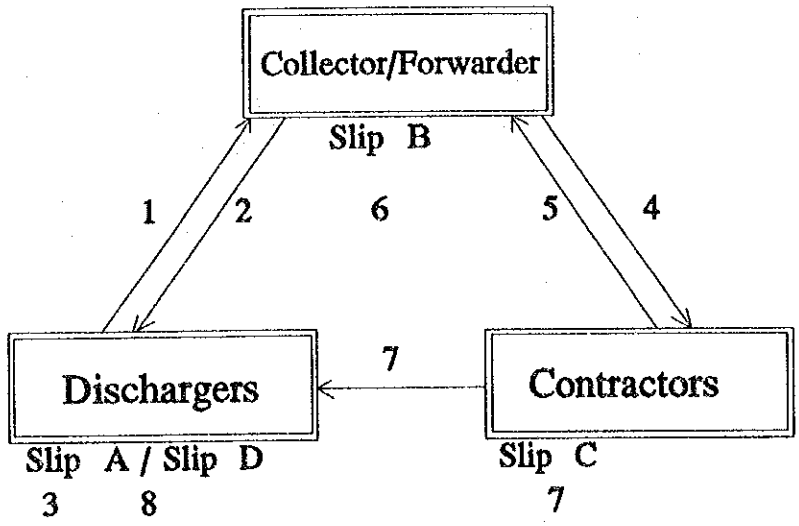
The companies which actually transport or plan to transport hazardous industrial solid wastes have to get a permit from the provincial government. To apply for the permit, the following information should be submitted:

. Type of wastes to be transported
. Equipment to be used
. Name of personnel responsible for the service
. Emergency procedure

- Manifest system

The manifest system is an effective method to precisely grasp the flow of the treatment of the industrial waste and to confirm that the wastes have been appropriately treated.

In this system, the manifests containing the routes from the forwarding location to the destination, matters to be noted when handling, etc., are attached to the cargoes so that the contents of the cargoes can be checked at each transit point to confirm whether a part or whole of the cargoes is missing or not and the necessary documents are signed and invoices received.



Explanations;

1 Dischargers fill in a 4-slip copy of the manifest form and sign on it and then, give it to Collector/Forwarder together with the waste.

2 Collector/Forwarder sign on the form when receiving the waste and then, return Slip A to Discharger.

3 Dischargers keep Slip A.

4 Collector/Forwarder give a 3 slips manifest copy to Contractors together with waste.

5 Contractors sign on the manifest when receiving the waste and then, return Slip B to Collector/Forwarder.

6 Collector/Forwarder keep Slip B.

7 Contractors sign on the manifest when having disposed of the waste and then, keep Slip C by themselves and give Slip D to Dischargers.

8 Dischargers check on Slip D and A to check up with them.

5) Treatment and Disposal

Basic treatment and final disposal methods of industrial waste are chemical treatment such as neutralization, oxidation and reduction, thermal treatment such as incineration, and secured landfill. The characteristics of industrial solid waste are so variable that it is necessary to find out the best alternative of treatment and final disposal in each case from technical and economic point of view.

In many cases the most convenient method of treatment and final disposal is secured landfill, because its cost is relatively low. The provincial government may be requested to construct such facility for the sake of environmental protection, if it is very difficult for the private sector to acquire land and fund for such construction.

PASTICHE, an organization for the disposal of industrial waste in Poznan city was jointly established by nine enterprises and is trying to acquire land for disposal site. The provincial government is expected to encourage the organization to accomplish the purpose.

Environmental impact assessment is also necessary to be carried out before construction of an industrial waste disposal site.

6) Supervision and advice

Appropriate supervision and sound advices from the provincial government are must important to steadily implement industrial solid waste management. It is, therefore, important to primarily analyze and improve administrative capacity, then conduct inspection and give advices on the operation of the storage, transportation and final disposal of industrial solid wastes.

Supervision and advice include the following duties:

- prepare the inventory of generators of industrial solid waste and update it continuously
- evaluate the permit applications of transporters and users of final disposal sites
- issue permits
- process manifests
- inspect and advise on the operation of storage, transportation and final disposal of industrial solid waste.