

Table 12. Mechanical composition and physical-chemical properties of waste

Zone code: H2

Mechanical composition	Monday sample		Thursday sample		Average
	[kg]	[%]	[kg]	[%]	[%]
paper	13,50	10,42	23,50	15,46	58,36
textile	1,50	1,16	0,50	0,33	3,15
plastics	5,50	4,25	5,00	3,29	16,56
glass	4,50	3,47	19,00	12,50	37,07
grass, greens	0,00	0,00	0,00	0,00	0,00
lether	0,00	0,00	0,00	0,00	0,00
rubber	0,00	0,00	0,00	0,00	0,00
metals	1,50	1,16	4,00	2,63	8,68
kitchen garbage	93,00	71,81	94,00	61,84	294,95
stones, ceramics	2,00	1,54	0,00	0,00	3,15
other	8,00	6,18	6,00	3,95	22,08
Total	129,50	100,00	152,00	100,00	444,01

Physical properties	Monday sample	Thursday sample	Average
Effective moisture [%]	58,64	62,79	60,72
Higroscopic moisture* [%]	4,88	3,47	4,18
Ash content* [%]	13,27	9,05	11,16
Combustibles* [%]	81,85	87,48	84,67
Physical composition:			
- moisture** [%]	60,66	64,08	62,37
- ash** [%]	5,22	3,25	4,24
- combustibles** [%]	34,12	32,67	33,40

* air-dry waste

** raw waste

Calorific data	Monday sample	Thursday sample	Average
Calculated heating value			
- air-dry waste [kJ/kg]	14480	13260	13870
- raw waste [kJ/kg]	5990	4940	5465
Measured (air-dry waste)			
- heat of combustion [kJ/kg]	27200	22300	24750
- heating value [kJ/kg]	25600	21100	23350

Chemical composition (air-dry base)	Monday sample	Thursday sample	Average
- nitrogen [%]	1,7053	1,9260	1,8157
- carbon [%]	47,8703	41,3197	44,5950
- hydrogen [%]	7,4967	5,6922	6,5945
- sulphur [%]	0,0994	0,0036	0,0515
- oxygen [%]	34,4195	33,0186	33,7191
- total [%]	91,5912	81,9601	

Table 13. Mechanical composition and physical-chemical properties of waste

Zone code: M1

Mechanical composition	Monday sample		Thursday sample		Average
	[kg]	[%]	[kg]	[%]	[%]
paper	4,00	57,14	4,50	26,47	35,42
textile	0,00	0,00	0,00	0,00	0,00
plastics	1,00	14,29	2,00	11,76	12,50
glass	0,00	0,00	1,00	5,88	4,17
grass, greens	0,00	0,00	0,00	0,00	0,00
lether	0,00	0,00	0,00	0,00	0,00
rubber	0,00	0,00	0,00	0,00	0,00
metals	1,50	21,43	2,00	11,76	14,58
kitchen garbage	0,00	0,00	3,00	17,65	12,50
stones, ceramics	0,00	0,00	0,00	0,00	0,00
other	0,50	7,14	4,50	26,47	20,83
Total	7,00	100,00	17,00	100,00	100,00

Physical properties	Monday sample	Thursday sample	Average
Effective moisture [%]	7,89	46,89	27,39
Higroscopic moisture* [%]	5,81	3,53	4,67
Ash content* [%]	5,14	8,63	6,89
Combustibles* [%]	89,05	87,84	88,45
Physical composition:			
- moisture** [%]	13,24	48,76	31,00
- ash** [%]	4,46	4,42	4,44
- combustibles** [%]	82,30	46,82	64,56

* air-dry waste

** raw waste

Calorific data	Monday sample	Thursday sample	Average
Calculated heating value			
- air-dry waste [kJ/kg]	15510	15180	15345
- raw waste [kJ/kg]	14290	8060	11175
Measured (air-dry waste)			
- heat of combustion [kJ/kg]	23900	25400	24650
- heating value [kJ/kg]	22500	23900	23200

Chemical composition (air-dry base)	Monday sample	Thursday sample	Average
- nitrogen [%]	0,2625	3,7100	1,9863
- carbon [%]	43,2459	44,9205	44,0832
- hydrogen [%]	6,3063	6,9374	6,6219
- sulphur [%]	0,0040	0,0051	0,0046
- oxygen [%]	42,7575	32,2012	37,4794
- total [%]	92,5762	87,7742	

Table 14. Mechanical composition and physical-chemical properties of waste

Zone code: M2

Mechanical composition	Monday sample		Thursday sample		Average
	[kg]	[%]	[kg]	[%]	
paper	10,00	66,67	10,50	35,00	45,56
textile	0,00	0,00	0,00	0,00	0,00
plastics	3,00	20,00	2,00	6,67	11,11
glass	0,10	0,67	1,00	3,33	2,44
grass, greens	0,00	0,00	0,00	0,00	0,00
lether	0,00	0,00	0,00	0,00	0,00
rubber	0,00	0,00	0,00	0,00	0,00
metals	0,00	0,00	7,50	25,00	16,67
kitchen garbage	0,00	0,00	3,50	11,67	7,78
stones, ceramics	0,00	0,00	0,00	0,00	0,00
other	1,90	12,67	5,50	18,33	16,44
Total	15,00	100,00	30,00	100,00	100,00

Physical properties	Monday sample	Thursday sample	Average
Effective moisture [%]	27,27	42,51	34,89
Higroscopic moisture* [%]	5,50	5,44	5,47
Ash content* [%]	8,77	14,39	11,58
Combustibles* [%]	85,73	80,17	82,95
Physical composition:			
- moisture** [%]	31,27	45,64	38,45
- ash** [%]	6,03	7,82	6,93
- combustibles** [%]	62,70	46,54	54,62

* air-dry waste

** raw waste

Calorific data	Monday sample	Thursday sample	Average
Calculated heating value			
- air-dry waste [kJ/kg]	19530	11780	15655
- raw waste [kJ/kg]	14200	6770	10485
Measured (air-dry waste)			
- heat of combustion [kJ/kg]	23600	17500	20550
- heating value [kJ/kg]	22300	16600	19450

Chemical composition (air-dry base)	Monday sample	Thursday sample	Average
- nitrogen [%]	0,4539	1,4008	0,9274
- carbon [%]	42,7702	32,3049	37,5376
- hydrogen [%]	6,2288	4,4987	5,3638
- sulphur [%]	0,1031	0,0000	0,0516
- oxygen [%]	43,3890	29,7223	36,5557
- total [%]	92,9450	67,9267	

Table 15. Mechanical composition and physical-chemical properties of waste

Zone code: O

Mechanical composition	Monday sample		Thursday sample		Average (%)
	(kg)	(%)	(kg)	(%)	
paper	15,50	83,78	17,00	33,01	46,43
textile	0,00	0,00	1,00	1,94	1,43
plastics	1,00	5,41	1,50	2,91	3,57
glass	0,50	2,70	1,00	1,94	2,14
grass, greens	0,00	0,00	1,00	1,94	1,43
lether	0,00	0,00	0,00	0,00	0,00
rubber	0,00	0,00	0,00	0,00	0,00
metals	0,00	0,00	0,50	0,97	0,71
kitchen garbage	0,00	0,00	5,50	10,68	7,86
stones, ceramics	0,00	0,00	8,50	16,50	12,14
other	1,50	8,11	15,50	30,10	24,29
Total	18,50	100,00	51,50	100,00	100,00

Physical properties	Monday sample	Thursday sample	Average
Effective moisture (%)	21,34	52,24	36,79
Higroscopic moisture* (%)	9,02	3,52	6,27
Ash content* (%)	18,88	36,96	27,92
Combustibles* (%)	72,10		72,10
Physical composition:			
- moisture** (%)	28,44	53,92	41,18
- ash** (%)	13,51	17,03	15,27
- combustibles** (%)	58,05	29,05	43,55

* air-dry waste

** raw waste

Calorific data	Monday sample	Thursday sample	Average
Calculated heating value			
- air-dry waste (kJ/kg)	17260	11690	14475
- raw waste (kJ/kg)	13570	5580	9575
Measured (air-dry waste)			
- heat of combustion (kJ/kg)	20900	17700	19300
- heating value (kJ/kg)	19800	16700	18250

Chemical composition (air-dry base)	Monday sample	Thursday sample	Average
- nitrogen (%)	0,9707	3,3074	2,1391
- carbon (%)	39,0877	32,3510	35,7194
- hydrogen (%)	5,2364	4,5990	4,9177
- sulphur (%)	0,0028	0,0057	0,0043
- oxygen (%)	36,4832	23,8568	30,1700
- total (%)	81,7808	64,1199	

Table 16. Mechanical composition and physical-chemical properties of waste

Zone code: P

Mechanical composition	Monday sample		Thursday sample		Average
	[kg]	[%]	[kg]	[%]	[%]
paper	0,50	16,67	2,50	14,29	14,63
textile	0,08	2,67	3,50	20,00	17,46
plastics	0,50	16,67	2,50	14,29	14,63
glass	0,50	16,67	1,50	8,57	9,76
grass, greens	0,00	0,00	0,00	0,00	0,00
lether	0,00	0,00	0,00	0,00	0,00
rubber	0,00	0,00	0,00	0,00	0,00
metals	0,15	5,00	1,00	5,71	5,61
kitchen garbage	0,50	16,67	3,50	20,00	19,51
stones, ceramics	0,00	0,00	0,00	0,00	0,00
other	0,77	25,67	3,00	17,14	18,39
Total	3,00	100,00	17,50	100,00	100,00

Physical properties	Monday sample	Thursday sample	Average
Effective moisture [%]	23,74	51,62	37,68
Higroscopic moisture* [%]	4,39	4,31	4,35
Ash content* [%]	8,91	12,13	10,52
Combustibles* [%]	86,70	83,56	85,13
Physical composition:			
- moisture** [%]	27,09	53,71	40,40
- ash** [%]	6,50	5,61	6,06
- combustibles** [%]	66,41	40,68	53,55

* air-dry waste

** raw waste

Calorific data	Monday sample	Thursday sample	Average
Calculated heating value			
- air-dry waste [kJ/kg]	13710	15300	14505
- raw waste [kJ/kg]	10450	7400	8925
Measured (air-dry waste)			
- heat of combustion [kJ/kg]	23400	24700	24050
- heating value [kJ/kg]	22100	23300	22700

Chemical composition (air-dry base)	Monday sample	Thursday sample	Average
- nitrogen [%]	0,5457	2,3822	1,4640
- carbon [%]	42,5458	44,5996	43,5727
- hydrogen [%]	6,1612	6,5312	6,3462
- sulphur [%]	0,0048	0,0033	0,0041
- oxygen [%]	42,0010	32,5762	37,2886
- total [%]	91,2585	86,0925	

Table 17. Metal components
in municipal waste

	Monday average* [mg/kg]	Thursday average* [mg/kg]	Calculated average** [mg/kg]
Toxic metals:			
Arsenic	20,0	18,0	19,0
Barium	35,0	34,0	34,5
Cadmium	1,2	0,6	0,9
Cobalt	1,1	0,6	0,9
Chromium	5,0	7,0	6,0
Copper	99,0	35,0	67,0
Mercury	< 0,1	< 0,1	0,1
Manganese	73,0	60,0	66,5
Nickel	6,4	6,2	6,3
Lead	34,0	26,0	30,0
Strontium	43,0	42,0	42,5
Selenium	< 0,1	< 0,1	0,1
Antimony	< 0,1	< 0,1	0,1
Tin	< 0,1	< 0,1	0,1
Tellurium	< 0,1	< 0,1	0,1
Thallium	< 0,1	< 0,1	0,1
Vanadium	3,8	1,7	2,8
Other metals:	[%]	[%]	[%]
Calcium	3,20	2,20	2,7
Potassium	0,90	0,80	0,9
Magnesium	0,44	0,23	0,3
Sodium	0,49	0,52	0,5

*Average sample is mixed from individual
samples proportional to amount of collected waste
** Aritmethical average of Monday and Thursday samples

5. Discussion of results

Detailed discussion of following measured results are given:

- bulk density,
- mechanical composition,
- physical properties,
- heating value.

Comparative data have been available for above properties from Analytical Dept. of FKFV. for a 5 year long period (1987-1991).

5.1. General remarks about results

The municipal solid waste is extremely heterogeneous and their composition is varying in wide range. The reliability of survey is depending on the size of sampling zones and the sampling frequency (No. of test conducted). The relevant Hungarian (MSZ 21976/1-81) and foreign standards recommend allocation of sampling zones with at least 1000 inhabitants in case of residential areas. Number of samples and the sampling frequency was also lower in this survey than the number recommended by Hungarian standard.

The quantity of collected samples varied substantially with the zone and time of collection. This effect was partly compensated by modifying the amount reduction procedure as described in chapter 2.1. As a consequence the differences of waste composition and output during the sampling period inside allocated zones or the differences of waste output in zones of different locations can be made only very carefully. Deviations in waste output and waste composition on different collection days and different locations is rather random than significant therefore the results obtained for zones of identical character were averaged. The mechanical composition was calculated as a weighted average (proportional to the amount of waste in given zone), the physical properties were averaged from original data using plain (arithmetical) average method. The average results are summarised in Table 18. Average mechanical composition and physical properties of samples are grafically presented on bar diagrams shown in Figures 1. and Figures 2.

It should be noted that in park area (zone P) there was no maintenance work in the time period of sampling so the collected waste represents the usual public and household waste.

5.2. Bulk density

Bulk density varied between $47,3 \text{ kg/m}^3$ and $141,8 \text{ kg/m}^3$. It was the lowest in the market zone (M1+M2) and highest in the low income residential area (E+F). In residential area (zones A..F) and hotel zone (H1+H2) the bulk density is very similar ($128,9 \text{ kg/m}^3$ and $123,45 \text{ kg/m}^3$ respectively). In office area (zone O) the bulk den-

Table 18. Summary of mechanical composition and physical properties

Mechanical composition (%) (weighed average)	Zones							
	A+B	C+D	E+F	A...F	H1+H2	M1+M2	O	P
paper	18,58	13,77	13,89	15,64	16,10	42,03	46,43	14,63
textile	8,98	5,71	13,89	9,12	0,69	0,00	1,43	17,46
plastics	6,97	8,39	7,17	7,52	4,92	11,59	3,57	14,63
glass	5,57	6,85	4,75	5,81	9,69	3,04	2,14	9,76
grass, greens	7,12	10,48	13,89	10,09	0,09	0,00	1,43	0,00
lether	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
rubber	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
metals	2,35	2,75	2,96	2,65	1,94	15,94	0,71	5,61
kitchen garbage	30,96	20,15	25,99	25,83	59,31	9,42	7,86	19,51
stones, ceramics	0,00	4,37	0,00	1,54	0,67	0,00	12,14	0,00
other	19,47	27,54	17,47	21,79	6,60	17,97	24,29	18,39
Total	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00

Physical properties (average values)	A+B	C+D	E+F	A...F	H1+H2	M1+M2	O	P
- moisture** (%)	59,15	55,24	59,22	57,87	54,69	34,73	41,18	40,40
- ash** (%)	12,36	13,53	15,51	13,80	6,55	5,68	15,27	6,06
- combustibles** (%)	28,50	31,23	25,27	28,33	38,76	59,59	43,55	53,55
- total (%) (**raw waste)	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Bulk density [kg/m ³] (raw waste)	136,85	108,05	141,80	128,90	123,45	47,30	68,10	81,30
Calculated heating value (averages):								
- air-dry waste [kJ/kg]	14508	13373	14995	14292	13850	15500	14475	14505
- raw waste [kJ/kg]	6200	6143	6343	6228	6585	10830	9575	8925

Figure 1. Average mechanical composition of waste samples

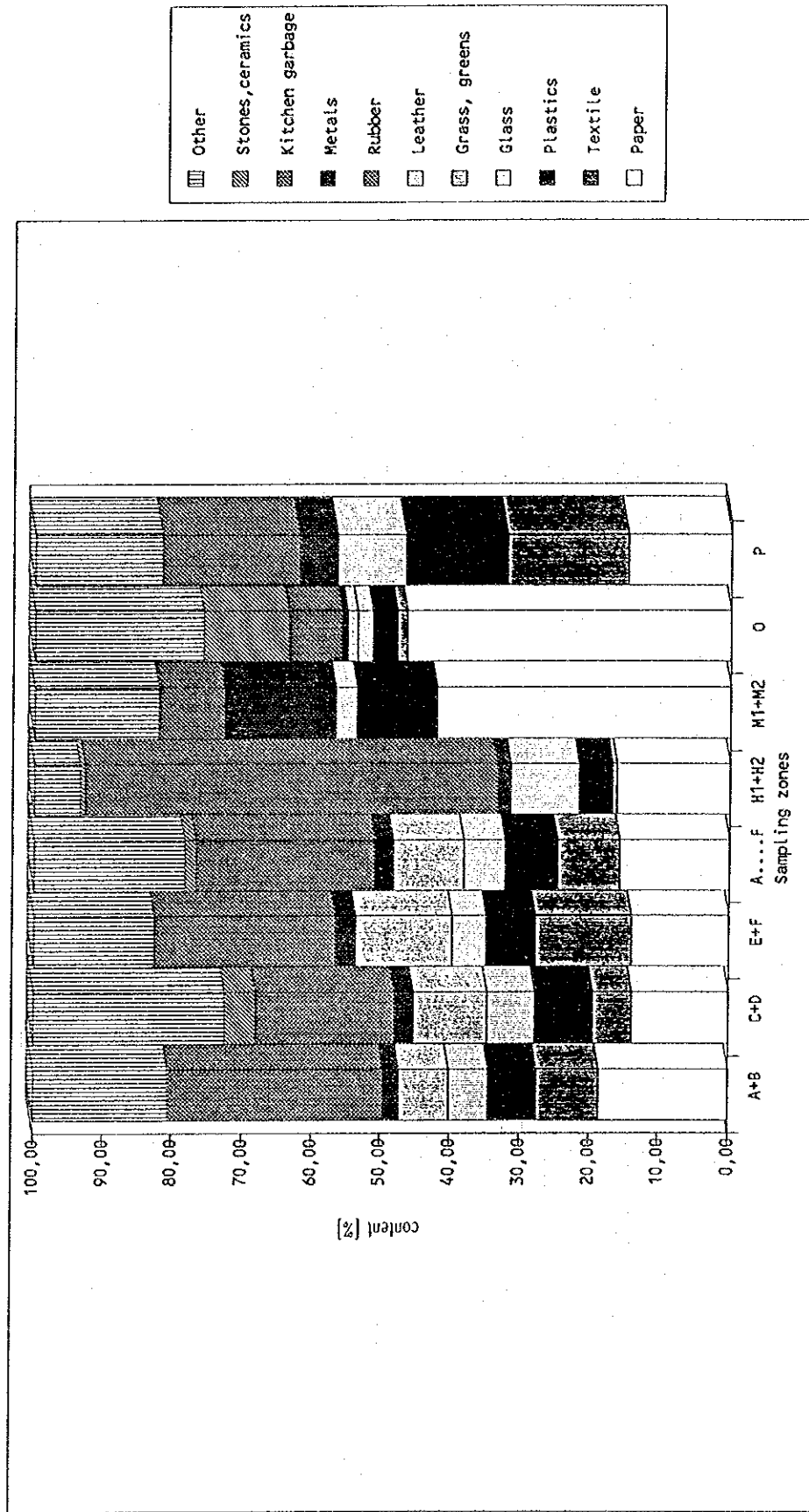
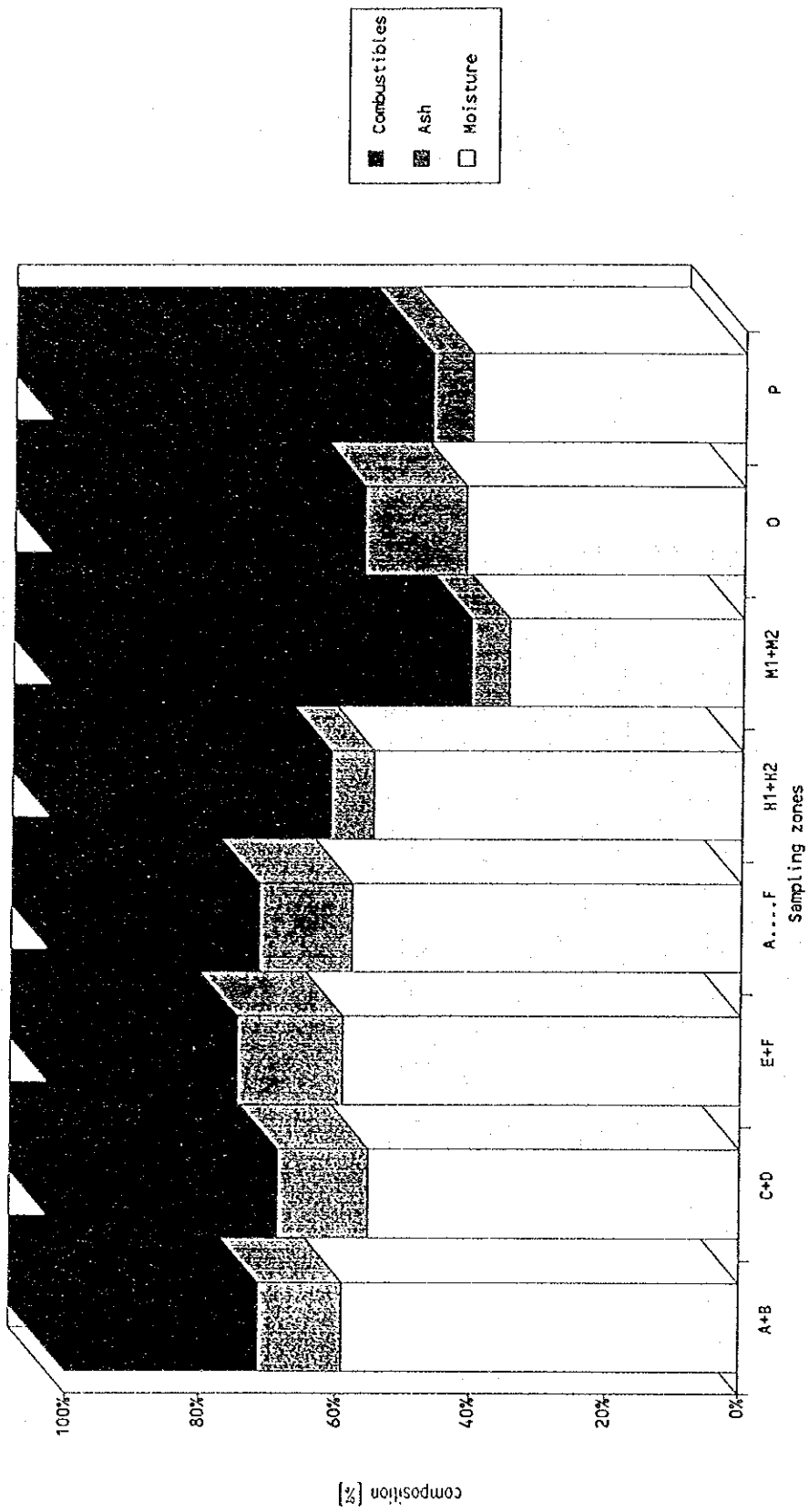


Figure 2. Average physical composition of waste samples



sity ($68,1 \text{ kg/m}^3$) is nearing to the lowest value measured in market zones ($47,3 \text{ kg/m}^3$)

It must be mentioned that the bulk density of waste is also influenced by collection frequency (higher frequency means lower bulk density).

5.3. Mechanical composition

5.3.1. Paper content

Paper content varied between 14.75 % and 46.43 % in waste samples. As expected the waste from office zone (O) and market zone (M1+M2) contains paper in very high percentage (46,43 % and 42,03 %). In these zones the paper quality is homogeneous: in market zone mainly cardboard and packaging paper while in office zone mainly computer printer paper. The waste from residential areas (A..F) contains 15.64 % paper and difference between high income and low income area is minimal (18,58 % and 13,89 %). The paper content of waste in hotel (H1+H2) and park (P) zones are similar (16,10 % and 14,63 %) to results obtained for households. The paper quality in these zones is rather heterogeneous ranging from cardboard to newspapers.

5.3.2. Textile content

Textile was occurring in all zones except for zone M1+M2 (market area). Textile content varies between 0,69 % and 17,46 % this proportion is higher than it is expected. The big deviation in textile content is due to small amount of samples rather to differences in zones. E.g. the 15 ± 2 % textile content in waste from zones P and E+F is the result of big clothing items put in the waste on the sampling day.

5.3.3. Plastics content

Plastics content shows a smaller deviation (3,6 % - 14,6 %) than the textile content and some characteristic differences can be observed among waste from different zones. Waste from zone P (park area) has the highest plastic content (14,6 %) and it is composed mainly from bottles. Waste from zone M1+M2 has the second highest plastic content (11,6 %) and it is mainly packaging foil. Proportion of plastics in domestic waste (zones A..F) is relatively high ($7,5 \pm 0,5$ %) and independent of social parameters.

5.3.4. Glass content

Glass content of waste in different zones varied between 2 % and 10 %. The high glass content in zones H1+H2 and P (9,69 % and 9,76 %) can be explained by the

characteristics and customer's customs of these zones. The glass content of waste from residential areas (zones A..F) is around $5,8 \pm 1,0$ % is higher than the expected value. The vast majority of glass content was in form of unbroken glass bottles which can be recycled.

5.3.5. Grass, greens content

The greens content is almost negligible in waste from hotels, markets, offices and park area (see remark about park area in chapter 5.1.). Waste from residential area (zones A..F) contains about 10 ± 3 % greens. The deviations can be explained by the types of residential area (houses with or without garden) and social circumstances.

5.3.6. Metals content

Metals were occurring in relatively high proportion in collected samples. Waste from residential areas (zones A..F) contained about $2,7 \pm 0,3$ % metal residues independently of social circumstances.

The extremely high metal content (15,94 %) of waste from market area (zone M1+M2) is not characteristic rather incidental and is due to small number of samples.

5.3.7. Kitchen garbage content

Proportion of kitchen garbage was highest (nearly 60 %) in waste from hotel zone and lowest in waste coming from office zone. In residential areas (zones A..F) the proportion of kitchen waste was around 26 ± 5 %, and no correlation was found between amount of kitchen garbage in waste and the income of inhabitants.

5.3.8. Stones and ceramics content

Proportion of stones and ceramics in waste from different zones shows great variations which are rather incidental than characteristic for the given sampling zone especially the extremely high ceramics content (12,14 %) in office area (zone O).

5.3.9. Rubber and leather content.

Rubber and leather was not found in collected samples. It is probably due to small number of collected samples.

5.3.10. Others content

In samples from different zones a portion of 6,6 % - 24,3 % could not be separated in one of above categories and this residue was classified as "others". Their proportion is strongly influenced by mixing during transportation.

This group consist mainly from ash, slag, soil and other inorganic dust. The constituent mixed inseparable during transportation were also assigned to group "other". The paper and plastics originating from kitchen waste amounted to about one fifth of the group "other". A similar proportion of group "other" was coming from complex waste made out of multiply materials and hazardous components occurring in municipal waste (medicines, dry batteries, etc.)

5.4. Physical properties

Total moisture of collected samples was around 45 ± 15 %. The moisture content of samples containing high proportion of kitchen garbage is higher then 50 %. The great proportion of kitchen and green components with high moisture content in samples are due to summer period.

Ash content of waste samples was between 5,7 % and 15,5 % which is due to high combustibles content of waste during sampling period.

The high proportion of combustible materials can also be seen from the heating value calculated from mechanical composition of samples.

From calculated heating value it can be concluded that waste from all zones are suitable for incineration. The heating value calculated for row sample (original moisture content) is around 10.000 kJ/kg in zones M,O and P where combustible components with low moisture content (paper, plastics) dominate in mechanical composition.

It should be noted that the measured combustion values obtained from automatic elementary anayser in some cases are about 30-40 % higher than the values calculated from mechanical composition. The measured values are less reliable because of very small amount of samples (2-5 mg) used for measurements. The calculation are based on data obtained from more representative samples (10-129 kg) and therefore this data were used as a representative heating value fro waste samples.

5.4. Results obtained by JICA and FKFV methodology

Small number of samples taken during this survey can not satisfy the demands necessary for representative survey. Therefore it was found advisable to compare the results obtained in this survey to those collected by FKFV during longer time period. Analytical department of FKFV has been doing qualitative and quantitative analysis of the municipal solid waste for more than two decades at a rate of more than 150 samples/year.

According to FKFV methodology samples are taken evenly distributed during the whole year from following zones:

- residential area of inner city with old type buildings,
- residential area of modern high-rise block buildings,
- residential area of family houses with gardens.

In comparison the average values of results obtained by JICA methodology for zones A..F were taken into account except in case of mechanical composition where average values from all sampling zones A..P were calculated.

The values obtained by FKFV methodology are averages samples collected during last five years (1987-1991).

Loose bulk density is $128,9 \text{ kg/m}^3$ and $157,0 \text{ kg/m}^3$ according to JICA (average of zones A..F) and FKFV methodologies, respectively. This difference is almost negligible taking into account the methods used.

Mechanical composition of municipal solid waste according to different methodologies is summarised in Tables 19 and 20. Maximum ± 10 percent deviation was found in mechanical composition between FKFV data and average values from JICA survey (averages from residential zones and averages from all zones). Mechanical composition of waste from residential areas according to FKFV and JICA results (in JICA survey average for sampling zones A..F) is presented graphically on bar diagram in Figure 3, and on pie diagrams in Figures 4. and 5., respectively.

Despite the small number of samples taken during the survey the data are very close to values obtained by FKFV over longer period.

Results of physical properties obtained by different methodologies are summarised in Table 21.

Table 21. Physical and thermal properties of municipal solid waste obtained by different methodologies

Physical property*	JICA method**	FKFV method***
Moisture [%]	57,87	36,67
Ash content [%]	13,80	28,19
Combustibles [%]	28,33	35,14
Heating Value [kJ/kg]	6230	6730

*relative to raw sample

**average for residential zones A..F

***average for residential zones from years 1987-1991

Significant difference in moisture content and ash content can be observed from Table 21. The difference is due to seasonal variation of waste composition which was not taken into account in JICA survey. Samples of JICA survey was taken during summer period when the municipal waste contains high proportion of kitchen and garden garbage with substantial moisture content. Combustible fraction and heating value shows a smaller difference.

Table 19. Mechanical composition of waste according to JICA and FKFV methodologies

Mechanical composition (weighed average)	JICA survey* zones A...P	FKFV data**	Difference
paper	20,12	18,72	1,40
textile	4,95	4,46	0,49
plastics	6,73	4,56	2,17
glass	6,83	5,00	1,83
grass, greens	4,79	7,18	-2,39
lether	0,00	0,00	0,00
rubber	0,00	0,00	0,00
metals	3,31	5,05	-1,74
kitchen garbage	35,33	28,16	7,17
stones, ceramics	1,88	0,00	1,88
other	16,06	26,87	-10,81
Total	100,00	100,00	

*weighted average for all sampling zones

**weighted average of years 1987-1991

Table 20. Mechanical composition of waste according to JICA and FKFV methodologies

Mechanical composition (weighed average)	JICA survey zones A...F	FKFV data	Difference
paper	15,64	18,72	-3,08
textile	9,12	4,46	4,66
plastics	7,52	4,56	2,96
glass	5,81	5,00	0,81
grass, greens	10,09	7,18	2,91
lether	0,00	0,00	0,00
rubber	0,00	0,00	0,00
metals	2,65	5,05	-2,40
kitchen garbage	25,83	28,16	-2,33
stones, ceramics	1,54	0,00	1,54
other	21,79	26,87	-5,08
Total	100,00	100,00	

*weighted average for residential zones only

**weighted average of years 1987-1991

Figure 3. Waste composition based on JICA and FKfV surveys

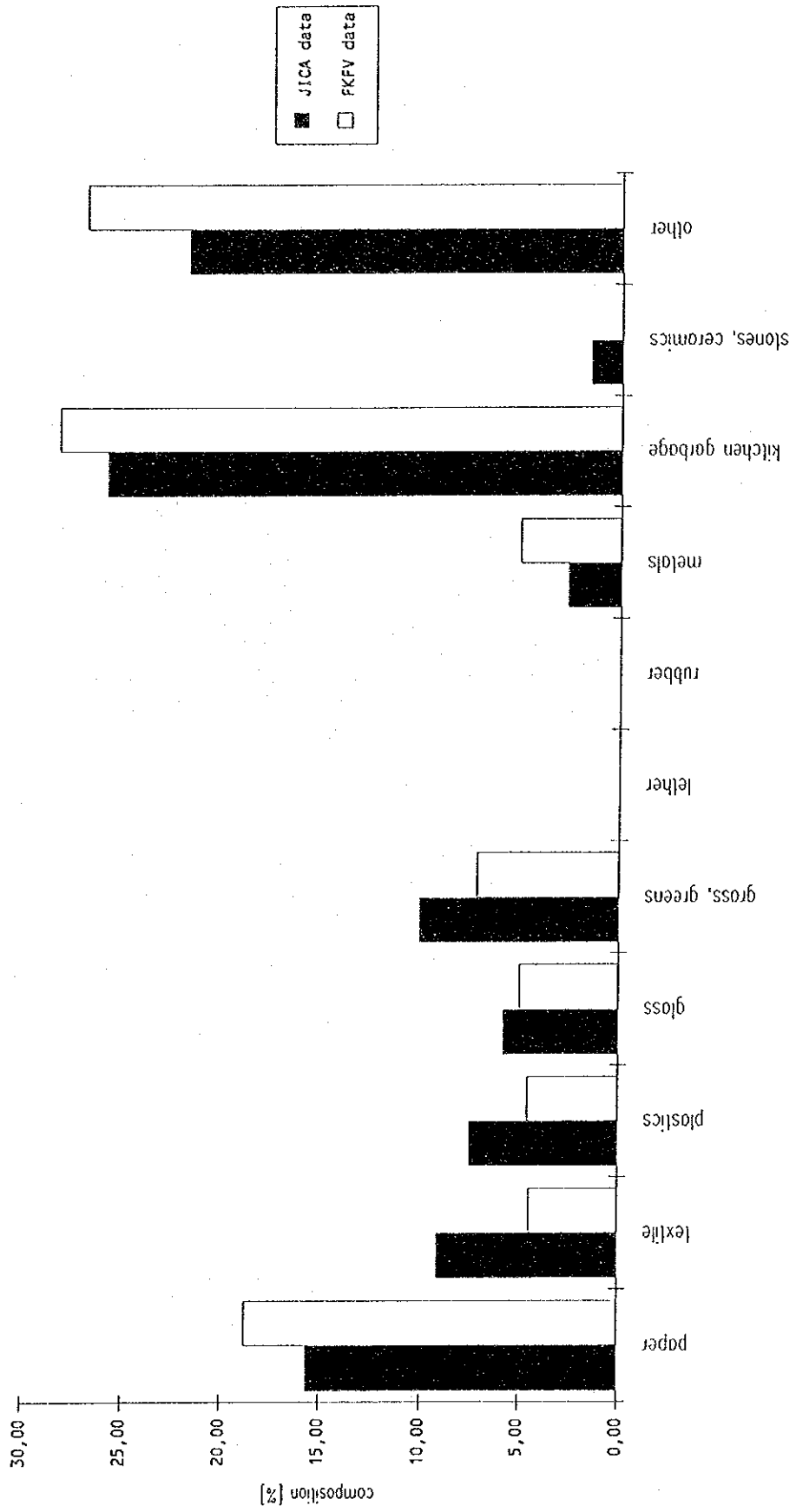


Figure 4. Mechanical composition of waste from residential area based on JICA survey

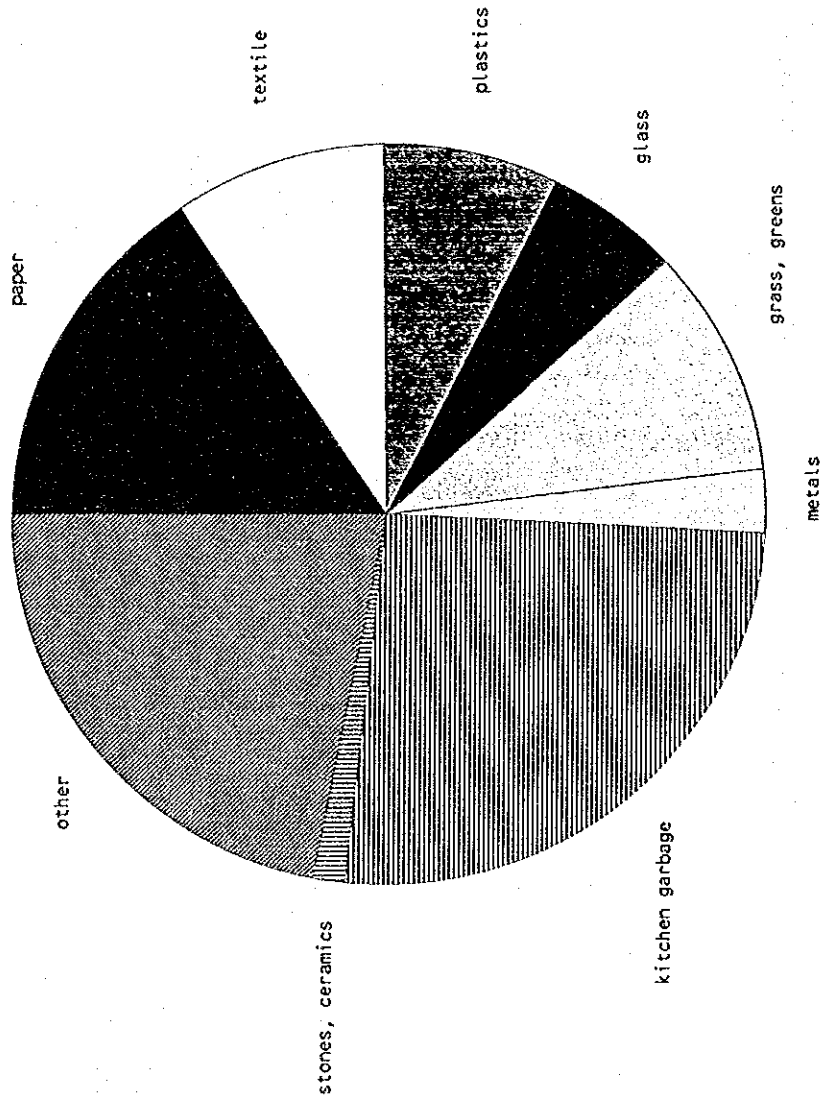
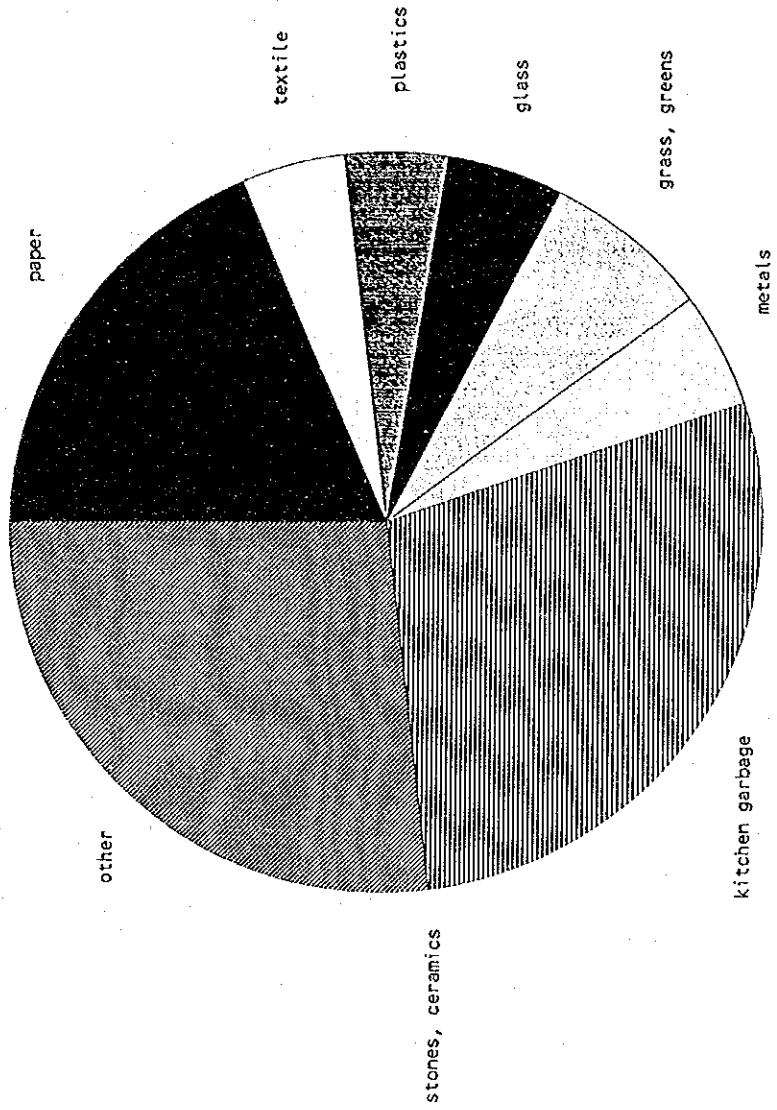


Figure 5. Mechanical composition of waste from residential areas based on FKFV data



6. Comparison of waste sampling methodologies

The aim of this chapter is to present a comparison of the waste sampling and analysis methodologies according to:

- Hungarian standard (MSZ),
- German standard,
- method given by JICA.

Literature used:

The comparative study was made on basis of following materials

- MSZ 21976/1-81, Analyses of municipal solid waste: Sampling
- MSZ21976/11-83, Determination of mechanical composition
- Bestimmung der Menge fester Abfälle, Müll und Abfall Handbuch 1990, p:10900
- Müllanalysen, Bestimmung der Menge fester Abfälle, Müll und Abfall Handbuch 1990, p:11026-11028
- Ermittlung des Volumens des Mülls, Bestimmung der Menge fester Abfälle, Müll und Abfall Handbuch 1990, p:11022
- The methodology given by JICA.

Copy of Hungarian and German standards are found in Appendix II. and III., respectively

6.1. Review of different sampling methodologies

6.1.1. Hungarian methodology

Hungarian sampling system reflect the Eastern-european practice developed in the seventies. Instead of the social circumstances, the heating system in the houses was the primary standpoint in selecting the zones. Accordingly, the inhabited area was divided into three main zones:

- dwellings with modern, ash-free heating,
- dwellings with solid fuel heating without garden,
- dwellings with solid fuel heating with garden.

If necessary, the examination of 14 public institutions (hospitals, hotels, markets, etc.) is also possible.

Sampling takes place at the sources of the waste, using standard vessels and special collecting vehicles.

After collecting and transporting the samples to the waste disposal plant:

- the total mass is determined,

- the waste is tipped to a place selected for this purpose,
- the waste pile is reduced by repeated quartering,
 - = to 0.5-0.6 m³ for determination of mechanical composition,
 - = to 0.1-0.2 m³ in case of other determinations.

Frequency of sampling is

- 12 weeks/year in large towns,
- 4-6 weeks/year in small towns.

During the sampling week the samples are collected and tested every day.

For the determination of basic data necessary for designing waste treatment technologies (incineration, composting), size distribution (classification by sizes) is also determined:

Mesh size	Fraction label
< 16 mm	F I
16-40 mm	F II
41-100 mm	F III
101-250 mm	F IV
> 250 mm	F V

The mechanical composition is determined by sorting.

The municipal solid waste is divided into 12 groups according to different classes of materials.

Material class	Group label
Iron	S 1.
Non-iron metals	S 2.
Glass	S 3.
Porcelain, stone, ceramic, concrete, etc.	S 4.
Plastics	S 4.
Rubber, leather	S 5.
Textile	S 6.
Paper, cardboard	S 7.
Bones	S 9.
Wood	S 10.
Kitchen waste, food and vegetable residue	S 11.
Ash, slag, other waste	S 12.

The selected groups are collected into vessels of known mass, and the mass of the groups are determined in raw condition (with original moisture content).

6.1.2. German methodology

The German regulations follow the aims of analysis, and there is an overlap with the principle of the Hungarian standards.

The aims of the tests:

- determination of waste output,
- classification of the waste components by sizes,
- analysis of mechanical composition,
- determination of physico-chemical parameter (moisture, heating value).

For the determination of mass output and bulk density of the waste social circumstances are not considered, the character of the zone is determined by the attractive area of the waste treatment plant.

Allocation of zones with minimum 1500 inhabitants are recommended. Since the waste output shows a certain seasonal periodicity, the tests are performed in the whole year with a frequency of two days/week. Prior to the tests the number of population in the zone is determined, and the results are given in units kg/inhabitant/week or kg/inhabitant/year. Special vehicles are used for transporting the waste from the zones to the waste treatment plants, and the mass is regularly measured.

Loose bulk density (kg/m^3 or t/m^3 units) are determined in the original collection vessels (in loose state) with random weighing. Occasionally, for random preliminary tests a sampling frequency of five days per two weeks or five days per week is used.

For the mechanical tests the waste of original moisture and composition is divided into four fraction by size:

< 8 mm	fine waste
8-4 mm	medium waste
40-120 mm	large, lumpy waste
> 120 mm	residue.

The frequency of the determination of mechanical composition is decided by the designer of the waste treatment technology.

The waste composition is determined by manual selection, for 2x5 days tests daily, for other tests randomly but minimum once monthly.

Prior to the determination of mechanical composition reduction of the volume and mass is performed by successive quartering so that minimum 0.5 m^3 , maximum 1.0 m^3 sample remains for tests.

The following mechanical components are determined:

- a. iron and other metals,
- b. concrete, glass, porcelain, other hard materials,
- c. textile waste,
- d. paper, cardboard,
- e. wood, rubber, leather, plastic,
- f. organic kitchen waste.

The laboratory samples for the physico-chemical tests are taken from the original waste by quartering so that the raw laboratory sample is around 1 kg.

6.1.3. JICA methodology

This sampling procedure allocates two main areas as sampling zones:

- residential areas,
- public institutions (market, hotel, etc.).

The residential zones are divided into three categories according to different social circumstances.

- residential areas with high income,
- residential areas with medium income,
- residential areas with low income.

The number of examined households (families) was 20-30. Before sampling a detailed survey was conducted on the family sizes and number of inhabitants.

The usual sampling vessels were used in the zones, and they were emptied on schedule and transported to the Waste Incinerator of FKFV. After weighing the waste was tipped out, reduced by quartering to about 10 kg and sorted manually.

The following groups of material were selected:

- 1. Paper, cardboard,
- 2. Textile,
- 3. Plastic,
- 4. Glass,
- 5. Grass,
- 6. Leather,
- 7. Rubber,
- 8. Metal,
- 9. Kitchen waste,
- 10. Stones, ceramics,
- 11. Other

The actual number of samples for determination of bulk density was five for each zone. The mechanical composition was determined twice a week (on Mondays and on Thursdays) in each zone. One raw laboratory sample was taken on Monday and on Thursday from each zone for the determination of the physico-chemical composition. The size distribution of the waste was not studied.

6.2. Comparison of sampling methodologies

Comparing the sampling performed according to the JICA method to the Hungarian and German methods, the following remarks are to be considered:

1. Location of the zones

The Japanese and Hungarian methods of locating the zones show certain similarities. In the 1980-s it was not possible to write in a Hungarian standard "District of residents with high income or low income". The selection according to the heating system and the character of dwelling (house with garden), however, has been reflecting the social circumstances of the inhabitants. That is, the zones according to the Japanese and conventional Hungarian method are comparable.

The number of inhabitants involved in the sampling, however, shows a difference. Both the Hungarian and German methodology recommends sampling of minimum 1000-1500 inhabitants. The number of people belonging to 20-30 flats is far more smaller and therefore it seems to be less representative sample for the generalization of the results.

2. The frequency of collection, seasonal distribution of sampling

Both domestic and foreign examples show that the composition of the waste and consequently the physico-chemical properties fluctuate seasonally. This fluctuation is considerable in Eastern Europe (e.g. vegetable and fruit consumption in summer increases, the heating value of waste is decreased). Therefore the analysis of a given zone should be done in several occasions (e.g. winter period, summer period, etc.).

According to the Hungarian standards sampling must be taken in greater towns at a frequency of at least 12 weeks per year, while German standards impose at least two occasions per year for sampling. Therefore the data obtained in the present test should only be used for drawing some general conclusions.

More detailed analysis is necessary for determining the seasonal distribution and for designing the collection routes for collecting vehicles.

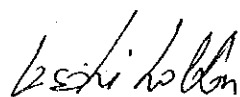
The remarks above are also based on tests done by several foreign firms in big rural towns (Pécs, Miskolc).

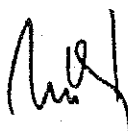
III. Report on the Sampling and Analysis of Monitoring
Wells Around the Budapest Waste Incinerator



KÖRNYEZETVÉDELMI Kft.
ENVIRONMENTAL PROTECTION Ltd.

Report on the sampling and analysis of monitoring wells
around the Budapest Waste Incinerator


(dr. Zoltán Izsáki)
project manager


(dr. János Kálmán)
director

Budapest, 10th March, 1993

TABLE OF CONTENTS

1. Introduction	3
2. Analytical methods	4
2.1. Determination of pH	4
2.2. Determination of chloride.....	4
2.3. Determination of sulphate.....	4
2.4. Determination of ammonia	4
2.5. Determination of COD	4
2.6. Determination of BOD5	5
2.7. Determination of total nitrogen content.....	5
2.8. Determination of PCBs	5
2.9. Determination of toxic heavy metals.....	5
3. Results of determinations.....	7
4. Discussion.....	7

**List of Hungarian Standards (MSZ) and Technological Guidelines (MI) for
analytical procedures and report preparation**

MI-10-433/3-84	Quality of groundwater: Sampling, sampling frequency, concentration limits
MSZ 12750/21-71	Quality of surface waters: Determination of COD (chromate and permanganate method)
MSZ 448/6-80	Quality of drinking water: Determination of ammonium ion content
MSZ 448/13-83	Quality of drinking water: Determination of sulphate ion content
MSZ 448/15-82	Quality of drinking water: Determination of chloride ion content
MSZ 448/24-84	Quality of drinking water: Determination of soluble oxygen content
MSZ 12750/22-73	Quality of surface waters: Determination BOD ₅
MSZ 448/20-64	Quality of drinking water: Determination of COD (permanganate method)

1. Introduction

In June 1992 Environmental Protection Ltd. (EP) carried out sampling of monitoring wells in surroundings of Péteri and Dunakeszi municipal solid waste (MSW) landfills. The sampling and analysis was carried out according to relevant Hungarian Standards (Magyar Szabvány: MSZ) regulating the quality, sampling and analytical methodologies of surface and ground waters.

JICA Study team contracted EP in February 1993 to perform sampling and analysis of monitoring wells in surrounding of Budapest Waste Incinerator (Fővárosi Hulladék Haszosító Mű HHM). Three monitoring wells have been drilled in surrounding of HHM during February, 1993. The monitoring wells was sampled on March 1, 1993 (three days after completion of drilling). From every well three parallel samples (each about 500 ml) were taken which means 9 samples altogether. All water samples were rather murky due to high amount of suspended solids. The suspended solid content was removed from samples by filtration before further analysis (exempt when noted otherwise). The applied analytical methodologies were in almost every case same as described in our pervious study, the few modifications are indicated in sections of chapter 2.

All samples were analysed for following components:

pH, specific conductivity, chloride ion content, sulphate ion content, ammonium ion content, nitrite ioncontent, nitrate ion content, total nitrogen content, chemical oxygen demand (COD) with chromate and permanganate methods, five-day biological oxygen demand (BOD₅), PCB (polychlorinated biphenyl's) content and toxic heavy metals (arsenic, barium, zinc, mercury, cadmium, chromium, manganese, lead, copper, selenium and iron) content. Temperature and pH of samples were determined on-site during sampling.

2. Analytical methods

2.1. Determination of pH

pH was measured by glass membrane electrodes directly from water samples.

2.2. Determination of chloride

Chloride ion concentration was measured according to standard MSZ 448/15-82. Principle of determination: water sample is titrated in slightly alkaline (pH: 6,5-8,5) medium with standard solution of silver-nitrate in presence of potassium-chromate as indicator. Control measurements were made by electrochemical titration using silver electrode.

2.3. Determination of sulphate

Sulphate ion concentration was measured according to standard MSZ 448/13-88. Principle of determination: sulphate content is precipitated with barium-chloride solution in form of barium-sulphate, the precipitate is filtered and its mass is determined with gravimetric method.

2.4. Determination of ammonia

Ammonium ion content of samples were determined according to standard MSZ 448/6-55. Principle of determination: Ammonium ion is oxidised with sodium-dichlor-isocyanurate, the oxidation product gives a deep-blue colouring with sodium-salicylate, the blue colouring is proportional to original ammonium-ion content and the intensity of blue colouring is determined by spectrophotometer.

2.5. Determination of COD

Chemical oxygen demand (COD) of samples were measured according to standards MSZ 12750/21-71 (chromate method) and MSZ 448/20-64 (permanganate method).

Principle of determination:

chromate method: samples are boiled with known amount of standard solution of potassium-dichromate in strongly acidic medium (sulphuric acid) and the surplus of potassium-dichromate (not consumed for oxidation of components) is determined by titration with standard solution of iron (II)-ammonium-sulphate in presence of ferroine indicator,

permanganate method: samples are oxidised with known amount of standard solution of potassium-permanganate in acidic medium at boiling temperature, the surplus of potassium-permanganate is reacted with known amount of oxalic-acid and the surplus of oxalic-acid is determined by titration with standard solution of potassium-permanganate.

2.6. Determination of BOD₅

Biological oxygen demand BOD₅ (for five days incubation period) was determined according to standard MSZ 12750/22-73. Principle of determination: water samples are incubated in thermostat at 20±1 °C for five days and the soluble oxygen content of samples is monitored during incubation period, the BOD₅ is determined from difference of soluble oxygen concentration before and after incubation.

BOD₅ of samples were determined prior and after filtration of samples, too.

2.7. Determination of total nitrogen content.

Total nitrogen content was measured according to standard MSZ 448/27-85. Principle of standard: nitrite and nitrate content of samples are reduced to ammonia with nascent hydrogen, nitrogen containing organic compounds are digested with conc. sulphuric acid in presence of potassium -, and mercury-sulphate (Khejda-method) to ammonia, the produced ammonia produced in above reactions is distilled into standard solution of boric acid and its quantity is determined by titration with standard solution of sulphuric acid.

2.8. Determination of PCBs

For determination of PCB (polychlorinated-biphenyl's) content of water samples there is no Hungarian standard available. The measurements were made using the recommendation of US EPA 505 method (Determination of pesticides and PCBs in drinking water). Principle of determination: water samples were extracted three times consecutively with n-hexane (HPLC grade) in separatory funnel (300 ml sample extracted with 3x30 ml n-hexane). The hexane extract for each sample were joined and concentrated under vacuum in rotary evaporator to about 1 ml volume. The concentrated extracts were analysed by gas chromatography (GC) type: Hewlett-Packard 5890A. GC conditions used: splitless injection at 280 °C electron capture detector (ECD) at 300 °C, fused silica capillary column HP5 (95% methyl-, 5% phenyl-polysiloxane, 25 m long, 0,2 mm in diameter), oven temperature: 40 °C isothermal for 2 min then to 240 °C with 35 °C/min and isothermal at 240 °C for 15 min, carrier gas helium 35 cm/s, auxiliary gas nitrogen 55 cm³/min Quantitative determination was carried out by external calibration of ECD response factor with standard solution of industrial PCB mixture in concentrations of; 62.5; 125; 313; and 616 µg/l. Detection limit of applied method was found to be 1 µg/l (0.001 mg/l) related to the original sample conditions.

2.9. Determination of toxic heavy metals

Sample preparation. Portion of samples used for metal content determination was acidified by 1.0 mol/l nitric acid solution. The acidified samples (pH=1) were filtered and used afterward for metal concentration measurements.

Concentration of iron, manganese, zinc, chromium, copper and barium was measured by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) technique using

Thermo Jarrell Ash ICAP 61 type instrument. Conditions applied: plasma power 1.15 kW, torch gas 18 cm³/min, auxiliary gas: 0.5 cm³/min, sample input 0.55 cm³/min. Calibration: external two point calibration of response signal with prepared standard concentration solutions. Detection limit: between 0.001 and 0.004 mg/l for different components (see tables of measurements results)

In case of components (cadmium, arsenic, lead and selenium) where the detection limit of ICP-AES method was not sufficient in comparison to regulatory limits (general rule was obeyed during all methods that detection limit should be at least 10 times lower than the regulatory limit) the determinations were made using atomic absorption spectroscopy (AAS) with graphite furnace (GF-AAS). Instrument type: Perkin-Elmer 4100ZL. Calibration: external two point calibration of response signal with prepared standard concentration solutions. Detection limits: Cd 0.00005 mg/l; Pb 0.0005 mg/l; As 0.004 mg/l and selenium 0.001 mg/l.

Note: Chromium is determined as total chromium. According to contract Cr⁶⁺ ion concentration should have to be determined but it was found that the total concentration of chromium is less than the 0,05 mg/l limit imposed for groundwater for all samples therefore no spectrometric determination was further carried out specific to Cr⁶⁺ content.

Mercury concentration was measure by AAS using cold vaporisation technique. Calibration: external two point calibration of response signal with prepared standard concentration solutions. Detection limit: 0.0005 mg/l;

3. Results of determinations

Measured data from monitoring wells No 1, 2 and 3 are summarised in Tables 1, 2 and 3, respectively. In each table the following data are summarised: detection limits, measurement results for three parallel samples, the calculated average from parallel measurements and the regulatory limits according to MI-10-433/3. In all tables the averaged results are also expressed as percentage fraction of regulatory limit. This is useful for easier interpretation of measurement data: in cases this value is greater than 100 % the concentration of given component have surpassed the regulatory limit.

In Table 4. the data for all three monitoring wells have been summarised. Content of Table 4: measurement results for three monitoring wells, the results for three wells are averaged and standard deviation is calculated, the regulatory limit is indicated and the averaged results are also expressed as percentage fraction of regulatory limit.

4. Discussion

In discussion of results we will only mention cases where the concentration of some measured component have surpassed the regulatory limit for groundwater quality. In Tables 1.- 4. the values exceeding the regulatory limit are indicated by shaded fields.

- nitrite ion concentration was 2.51 and 2.3 times higher than the limit in the samples from wells 2 and 3 respectively,
- chloride ion concentration was higher from regulatory limit only in sample from well No. 1 (by a factor of 1.88),
- ammonium ion concentration was higher from regulatory limit only in sample from well No. 1 (by a factor of 1.4),
- concentration of manganese was above the limit in all samples, its concentration surpassed the regulatory limit by a factor of 2.49; 18.53 and 25.35 in the case of wells 1, 2, and 3, respectively
- lead content was slightly higher from regulatory limit only in sample from well No. 1 (by a factor of 1.02),
- concentration of iron surpassed the regulatory limit by a factor of 6.5 and 16.73 in samples from monitoring wells No. 1 and 3. but its concentration was very near to limit in samples from other three wells, too.

The concentration of manganese and iron in measured samples seems to be extraordinary high and their concentration in different wells shows very big deviations. The concentration of manganese (average value for three monitoring wells) is 3.092 ± 2.346 mg/l which exceeds the regulatory limit of 0.2 mg/l by 1546 %. The concentration of iron (average value for three monitoring wells) is 2.34 ± 2.51 mg/l which exceeds the regulatory limit of 0.3 mg/l by 780 %. This data are probably due to acidic pretreatment of samples before metal determination.

Samples were acidified together with suspended solids (before filtration) this method is known as "total metal content" in difference to "filtered metal content" when the samples are acidified after removing the suspended solid content by filtration. As samples contained undefined amount of suspended solids (sampling conditions, water level and other conditions inside wells) the dissolved amounts of manganese and iron shows big deviations. The high suspended solids content of samples can be explained by fact that the wells were drilled few days before sampling.

Table 1. Results for monitoring well No. 1 at Budapest Waste Incinerator

Sample identification	detection limit	sample No. 1	sample No. 2	sample No. 3	calculated average	average as percent of regulated limit	regulated limit according to MI-10-433/3
temp. (on-site) [°C]	-	13.4			13.4	-	max. 30
pH (on-site) [-]	-	7.31			7.3	-	6,8-8,5
spec. conductivity mS/cm	0.001	1.062			1.062	70.8%	1.500
chloride [mg/l]	0.1	188.0	188.2	188.0	188.1	188.1%	100
sulphate [mg/l]	0.1	131.4	131.2	131.5	131.4	43.8%	300
ammonia [mg/l]	0.001	0.28	0.28	0.28	0.28	140.0%	0.2
nitrite [mg/l]	0.001	0.258	0.257	0.257	0.257	85.8%	0.3
nitrate [mg/l]	0.001	1.00	1.00	1.00	1.00	2.5%	40
total nitrogen [mg/l]	0.01	0.75	0.74	0.75	0.75	n.r.	n.r.
COD(permang) [mg/l]	0.1	2.30	2.32	2.30	2.31	65.9%	3.5
COD(chromate) [mg/l]	0.1	12.80	12.70	12.80	12.77	n.r.	n.r.
BO15 [mg/l]	0.1	2.74	2.72	2.75	2.74	n.r.	n.r.
BO15(filtered) [mg/l]	0.1	1.66	1.68	1.66	1.67	n.r.	n.r.
PCB [mg/l]	0.001	n.d.	n.d.	n.d.	n.d.	n.r.	n.r.
arsenic [mg/l]	0.004	0.012	0.010	0.009	0.010	20.7%	0.05
barium [mg/l]	0.001	0.122	0.150	0.135	0.136	13.6%	1
zink [mg/l]	0.004	0.030	0.025	0.027	0.027	2.7%	1
mercury [mg/l]	0.0005	n.d.	n.d.	n.d.	n.d.	50.0%	0.001
cadmium [mg/l]	0.00005	0.00045	0.00040	0.00055	0.00047	9.3%	0.005
chromium [mg/l]	0.005	0.015	0.017	0.013	0.015	30.0%	0.05
manganese [mg/l]	0.001	0.560	0.452	0.487	0.500	249.8%	0.2
lead [mg/l]	0.0005	0.054	0.041	0.059	0.051	102.7%	0.05
copper [mg/l]	0.002	0.014	0.017	0.011	0.014	1.4%	1
selenium [mg/l]	0.001	n.d.	n.d.	n.d.	n.d.	10.0%	0.01
iron [mg/l]	0.005	1.90	2.10	1.85	1.95	650.0%	0.3

n.r. = no regulation limit for given component

n.d. = not detected (value smaller than the detection limit given in first column of tables 1-3)

Table 2. Results for monitoring well No. 2 at Budapest Waste Incinerator

Sample identification	detection limit	sample No. 1	sample No. 2	sample No. 3	calculated average	average as percent of regulated limit	regulated limit according to MI-10-433/3
temp. (on-site) [oC]	-	12.7			12.7	-	max. 30
pH (on-site) [-]	-	7.67			7.7	-	6,8-8,5
spec. conductivity mS/cm	0.001	0.738			0.738	49.2%	1.500
chloride [mg/l]	0.1	34.0	34.1	34.0	34.0	34.0%	100
sulphate [mg/l]	0.1	97.2	97.2	97.3	97.2	32.4%	300
ammonia [mg/l]	0.001	0.18	0.18	0.18	0.18	90.0%	0.2
nitrite [mg/l]	0.001	0.691	0.690	0.693	0.691	230.4%	0.3
nitrate [mg/l]	0.001	9.10	9.00	9.10	9.07	22.7%	40
total nitrogen [mg/l]	0.01	3.88	3.86	3.88	3.87	n.r.	n.r.
COD(permang) [mg/l]	0.1	3.30	3.32	3.30	3.31	94.5%	3.5
COD(chromate) [mg/l]	0.1	14.90	13.90	15.20	14.67	n.r.	n.r.
BOI5 [mg/l]	0.1	2.54	2.52	2.54	2.53	n.r.	n.r.
BOI5(filtered) [mg/l]	0.1	2.24	2.23	2.24	2.24	n.r.	n.r.
PCB [mg/l]	0.001	n.d.	n.d.	n.d.	n.d.	n.r.	n.r.
arsenic [mg/l]	0.004	n.d.	n.d.	0.005	0.004	8.7%	0.05
barium [mg/l]	0.001	0.637	0.520	0.584	0.580	58.0%	1
zink [mg/l]	0.004	0.220	0.180	0.230	0.210	21.0%	1
mercury [mg/l]	0.0005	n.d.	n.d.	n.d.	n.d.	50.0%	0.001
cadmium [mg/l]	0.00005	0.00075	0.00071	0.00081	0.00076	15.1%	0.005
chromium [mg/l]	0.005	0.025	0.029	0.024	0.026	52.0%	0.05
manganese [mg/l]	0.001	3.720	3.700	3.700	3.707	1853.3%	0.2
lead [mg/l]	0.0005	n.d.	n.d.	n.d.	0.001	1.0%	0.05
copper [mg/l]	0.002	n.d.	n.d.	n.d.	n.d.	0.2%	1
selenium [mg/l]	0.001	n.d.	n.d.	n.d.	n.d.	7.0%	0.01
iron [mg/l]	0.005	0.05	0.05	0.06	0.05	16.6%	0.3

n.r. = no regulation limit for given component

n.d. = not detected (value smaller than the detection limit given in first column of tables 1-3)

Table 3. Results for monitoring well No. 3 at Budapest Waste Incinerator

Sample identification		detection limit	sample No. 1	sample No. 2	sample No. 3	calculated average	average as percent of regulated limit	regulated limit according to MI-10-433/3
temp. (on-site)	[oC]	-	11.3			11.3	-	max. 30
pH (on-site)	[-]	-	7.76			7.8	-	6,8-8,5
spec. conductivity	mS/cm	0.001	0.760			0.760	50.7%	1.500
chloride	[mg/l]	0.1	30.4	30.3	30.4	30.4	30.4%	100
sulphate	[mg/l]	0.1	110.4	110.2	110.4	110.3	36.8%	300
ammonia	[mg/l]	0.001	0.16	0.16	0.16	0.16	80.0%	0.2
nitrite	[mg/l]	0.001	0.754	0.752	0.754	0.753	251.1%	0.3
nitrate	[mg/l]	0.001	11.50	11.40	11.50	11.47	28.7%	40
total nitrogen	[mg/l]	0.01	4.79	4.75	4.78	4.77	n.r.	n.r.
COO(permang)	[mg/l]	0.1	3.42	3.40	3.42	3.41	97.5%	3.5
COO(chromate)	[mg/l]	0.1	19.70	19.80	19.70	19.73	n.r.	n.r.
BO15	[mg/l]	0.1	2.95	2.93	2.95	2.94	n.r.	n.r.
BO15(filtered)	[mg/l]	0.1	1.39	1.38	1.39	1.39	n.r.	n.r.
PCB	[mg/l]	0.001	n.d.	n.d.	n.d.	n.d.	n.r.	n.r.
arsenic	[mg/l]	0.004	0.005	n.d.	0.005	0.005	9.3%	0.05
barium	[mg/l]	0.001	0.518	0.505	0.510	0.511	51.1%	1
zink	[mg/l]	0.004	0.072	0.070	0.071	0.071	7.1%	1
mercury	[mg/l]	0.0005	n.d.	n.d.	n.d.	n.d.	50.0%	0.001
cadmium	[mg/l]	0.00005	0.00185	0.00095	0.00112	0.00131	26.1%	0.005
chromium	[mg/l]	0.005	0.040	0.035	0.038	0.038	75.3%	0.05
manganese	[mg/l]	0.001	5.010	4.950	5.250	5.070	2535.0%	0.2
lead	[mg/l]	0.0005	0.025	0.021	0.024	0.023	46.7%	0.05
copper	[mg/l]	0.002	0.032	0.030	0.031	0.031	3.1%	1
selenium	[mg/l]	0.001	n.d.	n.d.	n.d.	n.d.	10.0%	0.01
iron	[mg/l]	0.005	5.01	4.95	5.10	5.02	1673.3%	0.3

n.r. = no regulation limit for given component

n.d. = not detected (value smaller than the detection limit given in first column of tables 1-3)

Table 4. Summary results for monitoring wells No. 1-3 at Budapest Waste Incinerator

Sample identification	well No. 1	well No. 2	well No. 3	calculated average	standard deviation	average as percent of regulated limit	regulated limit according to MI-10-433/3
temp. (on-site) [oC]	13.4	12.7	11.3	12.5	±1.07	-	max. 30
pH (on-site) [-]	7.31	7.67	7.76	7.6	±0.24	-	6,8-8,5
spec. conductivity mS/cm	1.062	0.738	0.760	0.853	±0.181	56.9%	1.500
chloride [mg/l]	188.1	34.0	30.4	84.2	±90.01	84.2%	100
sulphate [mg/l]	131.4	97.2	110.3	113.0	±17.220	37.7%	300
ammonia [mg/l]	0.28	0.18	0.16	0.21	±0.06	103.3%	0.2
nitrite [mg/l]	0.257	0.691	0.753	0.567	±0.270	189.1%	0.3
nitrate [mg/l]	1.00	9.07	11.47	7.18	±5.48	17.9%	40
total nitrogen [mg/l]	0.75	3.87	4.77	3.13	±2.11	n.r.	n.r.
COD(permang) [mg/l]	2.31	3.31	3.41	3.01	±0.61	86.0%	3.5
COD(chromate) [mg/l]	12.77	14.67	19.73	15.72	±3.60	n.r.	n.r.
BO15 [mg/l]	2.74	2.53	2.94	2.74	±0.21	n.r.	n.r.
BO15(filtered) [mg/l]	1.67	2.24	1.39	1.76	±0.43	n.r.	n.r.
PCB [mg/l]	n.d.	n.d.	n.d.	n.d.	±0.00	n.r.	n.r.
arsenic [mg/l]	0.010	0.004	0.005	0.006	±0.003	12.9%	0.05
barium [mg/l]	0.136	0.580	0.511	0.409	±0.239	40.9%	1
zink [mg/l]	0.027	0.210	0.071	0.103	±0.095	10.3%	1
mercury [mg/l]	n.d.	n.d.	n.d.	n.d.	±0.0000	50.0%	0.001
cadmium [mg/l]	0.00047	0.00076	0.00131	0.00084	±0.00043	16.9%	0.005
chromium [mg/l]	0.015	0.026	0.038	0.026	±0.011	52.4%	0.05
manganese [mg/l]	0.500	3.707	5.070	3.092	±2.346	1546.1%	0.2
lead [mg/l]	0.05133	n.d.	0.02333	0.025	±0.025	50.1%	0.05
copper [mg/l]	0.014	n.d.	0.031	0.016	±0.015	1.6%	1
selenium [mg/l]	n.d.	n.d.	n.d.	n.d.	±0.000	9.0%	0.01
iron [mg/l]	1.95	0.05	5.02	2.34	±2.51	780.0%	0.3

n.r. = no regulation limit for given component

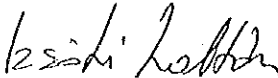
n.d. = not detected (value smaller than the detection limit given in first column of tables 1-3)

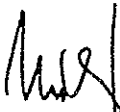
IV. Report on the Sampling and Analysis of Monitoring
Wells around the Municipal Solid Waste Landfills
in Peteri-Major and Dunakeszi



KÖRNYEZETVÉDELMI Kft.
ENVIRONMENTAL PROTECTION Ltd.

Report on the sampling and analysis of monitoring wells around the
municipal solid waste landfills in Péteri-major and Dunakeszi


(dr. Zoltán Izsáki)
project manager


(dr. János Kálmán)
director

Budapest, 27th July, 1992

TABLE OF CONTENTS

1. Introduction	1
2. Analytical methods	2
2.1. Determination of pH	2
2.2. Determination of chloride	2
2.3. Determination of sulphate	2
2.4. Determination of ammonia	2
2.5. Determination of COD	2
2.6. Determination of BOD5	3
2.7. Determination of total nitrogen content.	3
2.8. Determination of PCBs	3
2.9. Determination of toxic heavy metals	3
3. Results of determinations	4
4. Discussion	4
4.1. Results for monitoring wells in Péteri-major	4
4.2. Results for monitoring wells in Dunakeszi	5

1. Introduction

According to signed contract between JICA Study Team and Environmental Protection Ltd. (EP) the EP carried out sampling of monitoring wells in area of Péteri-major and Dunakeszi municipal solid waste landfills. The sampling and analysis was carried out according to relevant Hungarian Standards (Magyar Szabvány:MSZ).

In Péteri-major landfill altogether 4 monitoring wells were sampled. In Dunakeszi landfill only two monitoring wells were sampled instead of three because the third well dried-up as a consequence of summer period. It should be noted that water level in all monitoring wells was rather low. Sampling of wells took place in presence of members of JICA Study Team. From every monitoring well three parallel samples were taken which means 18 samples altogether.

All 18 samples were analyzed for following components: pH, chloride, sulphate, ammonia, COD (chromate method), BOD5, total nitrogen, PCBs and toxic heavy metals (arsenic, cadmium, chromium, mercury, lead, cobalt, copper, manganese, nickel, selenium, antimony, tin, tellurium, thallium, vanadium and silver). Control measurements were carried out by independent institutions for one sample from every monitoring well. In course of control measurement the samples were analyzed for above listed components and the following supplementary components were determined: nitrate, nitrite, hydrogen carbonate, sodium and potassium as total, calcium, magnesium, total hardness, carbonate hardness, specific electric conductivity and alkalinity. Temperature and pH of samples were determined on-site during sampling.

2. Analytical methods

Copy of Hungarian standards related to analysis of drinking water and ground-water are found in Appendix I of this report.

2.1. Determination of pH

pH was measured by glass membrane electrodes directly from water samples.

2.2. Determination of chloride

Chloride ion concentration was measured according to standard MSZ 448/15-82. Principle of determination: water sample is titrated in slightly alkaline (pH:6,5-8,5) medium with standard solution of silver-nitrate in presence of potassium-chromate as indicator.

2.3. Determination of sulphate

Sulphate ion concentration was measured according to standard MSZ 448/13-88. Principle of determination: sulphate content is precipitated with barium-chloride solution in form of barium-sulphate, the precipitate is filtered and its mass is determined with gravimetric method.

2.4. Determination of ammonia

Ammonium ion content of samples were determined according to standard MSZ 448/6-55. Principle of determination: Ammonium ion is oxidized with sodium-dichlor-isocyanurate, the oxidation product gives a deep-blue colouring with sodium-salicylate, the blue coloring is proportional to original ammonium-ion content and the intensity of blue colouring is determined by spectrophotometry.

2.5. Determination of COD

Chemical oxygen demand (COD) of samples were measured according to standards MSZ 12750/21-71 (chromate method) and MSZ 448/20-64 (permanganate method).

Principle of determination:

- chromate method: samples are boiled with known amount of standard solution of potassium-bichromate in strongly acidic medium (sulfuric acid) and the surplus of potassium-bichromate (not consumed for oxidation of components) is determined by titration with standard solution of iron (II)-ammonium-sulphate in presence of ferroine indicator,

- permanganate method: samples are oxidized with known amount of standard solution of potassium-permanganate in acidic medium at boiling temperature, the surplus of potassium-permanganate is reacted with known amount of oxalic-acid and the surplus of oxalic-acid is determined by titration with standard solution of potassium-permanganate.

2.6. Determination of BOD₅

Biological oxygen demand BOD₅ (for five days incubation period) was determined according to standard MSZ 12750/22-73. Principle of determination: water samples are incubated in thermostat at 20 ± 1 °C for five days and the soluble oxygen content of samples is monitored during incubation period, the BOD₅ is determined from difference of soluble oxygen concentration before and after incubation.

2.7. Determination of total nitrogen content.

Total nitrogen content was measured according to standard MSZ 448/27-85. Principle of standard: nitrite and nitrate content of samples are reduced to ammonia with nascent hydrogen, nitrogen containing organic compounds are digested with conc. sulfuric acid in presence of potassium -, and mercury-sulphate (Khejda-method) to ammonia, the produced ammonia produced in above reactions is distilled into standard solution of boric acid and its quantity is determined by titration with standard solution of sulfuric acid.

2.8. Determination of PCBs

For determination of PCBs (polychlorinated-biphenyls) content of water samples there is no Hungarian standard available. The measurements were made using the recommendation of US EPA 505 method (Determination of pesticides and PCBs in drinking water). Principle of determination: water samples were directly injected into chromatograph (type: Hewlett-Packard 5890 A) using splitless injection technique, electron capture detector (ECD) and fused silica capillary column HP5 (95% methyl-, 5% phenyl-polysiloxane, 25 m long, 0,2 mm in diameter), Quantitative determination was carried out by external calibration of ECD response factor with standard solution of industrial PCB mixture in concentrations of 62,5; 125; 313; and 616 µg/l (ppb). Detection limit of applied method was found to be 20 µg/l (20 ppb).

2.9. Determination of toxic heavy metals

Concentration of toxic heavy metals was measured primarily by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) technique using Labtest Plasmalab ICP instrument. During central measurements (by independent institution) in case of components where the detection limit of ICP-AES method was not

sufficient in comparison to limits imposed by standard MI-10-433/3-84 for groundwater the determinations were repeated by atomic absorption spectroscopy (AAS) with graphite furnace (GF-AAS) using AAS instrument Varion Techtron AA6 with Perkin-Elmer HGS-400 graphite furnace.

Note: Chromium is determined as total chromium. According to contract Cr^{6+} ion concentration should have to be determined but it was found that the total concentration of chromium is less than the 0,05 mg/l limit imposed for groundwater (and lower than detection limit of 0,020 mg/l) for all samples therefore no spectrometric determination was further carried out specific to Cr^{6+} content.

3. Results of determinations

Measured data from all determinations are summarized in Tables 1-6. In one table results for one monitoring well are included (four tables for wells in Péteri-major two tables for wells in Dunakeszi). In each table the results of three parallel samples, the calculated average from parallel measurements and the results of independent control determinations are indicated. Components which determination is included into contract between JICA and EP are found in shaded cells. Results for components not included in contract are found in plain white fields.

The current Hungarian limits for regulated (according to Technological Guideline MI-10-433/3-84 enclosed in Appendix I.) parameters in groundwater are listed in last columns of tables.

4. Discussion

In discussion of results we will only mention cases where the concentration of some measured component have surpassed the relevant Hungarian limit for groundwater quality.

As a general remark about obtained results it should be mentioned that data from regular and independent control measurement correlate rather well and they are inside acceptable limits in all cases.

4.1. Results for monitoring wells in Péteri-major

In case of water samples from monitoring wells around municipal solid waste landfill in Péteri-major a surpassing of groundwater quality limits was for following components:

- nitrate ion concentration was 6,5; 3,55; 5,0 and 4,5 times higher then the limit in the wells 1,2,3 and 4, respectively,
- nitrite concentration surpassed the limit only in case of well No. 2,

- total hardness was slightly above the limit (5 and 15 %) in case of wells No. 1 and 3, and in the case of wells No 2 and 4 it was also very near to limit,
- concentration of manganese was above the limit in case of all wells, its concentration surpassed the limit 1,2; 2,7; 2,4 and 1,54 times in the case of wells 1,2,3 and 4, respectively
- concentration of lead was above the limit in case of all wells, its concentration surpassed the limit 1,35; 3,98; 1,11 and 1,46 times in the case of wells 1,2,3 and 4, respectively
- concentration of zinc slightly surpassed the limit (5%) at well No. 2. but its concentration was very near to limit in samples from other three wells, too.

4.2. Results for monitoring wells in Dunakeszi

In case of water samples from monitoring wells around municipal solid waste landfill in Dunakeszi a surpassing of groundwater quality limits was for following components:

- concentration of arsenic was found to surpass the limit in case of wells No. 1 with about 60 %, and in case of monitoring well No. 2., its concentration was 30,7 and 38 times higher (!!) than the limit according to regular and control measurements, respectively
- concentration of lead was found for both well No. 1 and 2 to be higher than the limit by 2,1 and 5,2 times, respectively
- pH of well No. 2. was found to be 8,9 and it is more alkaline then the allowed range of 6,8 -8,5; alkalinity (determined with methyl-orange) was found also to be rather high (14,9 mmol/l) for this sample.

Appendix I

Copy of Hungarian Standards (MSZ) and Technological Guidelines (MI) used for analysis of water samples

Standard No	Content
MI-10-433/3-84	Quality of groundwater: Sampling, sampling frequency, concentration limits
MSZ 12750/21-71	Quality of surface waters: Determination of COD (chromate and permanganate method)
MSZ 448/6-80	Quality of drinking water: Determination of ammonium ion content
MSZ 448/13-83	Quality of drinking water: Determination of sulphate ion content
MSZ 448/15-82	Quality of drinking water: Determination of chloride ion content
MSZ 448/24-84	Quality of drinking water: Determination of soluble oxygen content
MSZ 12750/22-73	Quality of surface waters: Determination BOD
MSZ 448/20-64	Quality of drinking water: Determination of COD (permanganate method)

Table 1. Results for monitoring well No 1. in Péteri-mojor

Sample identification		1/1	1/2	1/3	calculated average	1/1 independent control measurement	Limit according to regulation MI-10-433/3
temp. (on-site) [oC]		12,9	12,9	12,9	12,9	n.a.	max. 30
ph (on-site) (-)		6,74	6,74	6,74	6,7	7,1	6,8-8,5
chloride [mg/l]		80,8	80,8	80,8	80,8	72	100
sulphate [mg/l]		271,9	271,8	271,8	271,8	273	300
ammonia [mg/l]		0,03	0,03	0,03	0,03	n.a.	0,2
COD(chromate) [mg/l]		23,20	23,20	23,20	23,20	2,3	n.r.
BCO5 [mg/l]		1,51	1,50	1,52	1,51	n.a.	n.r.
total nitrogen [mg/l]		1,43	1,42	1,43	1,43	n.a.	n.r.
PCB [mg/l]		< 0,030	< 0,030	< 0,030	< 0,030	n.a.	n.r.
COD(permag) [mg/l]		1,84	1,82	1,84	1,83	n.a.	3,5
nitrate [mg/l]						260	40
nitrite [mg/l]						0,14	0,3
hydrogen-carbonate [mg/l]						250,1	n.r.
sodium+potassium [mg/l]						32,9	n.r.
calcium [mg/l]						228	n.r.
magnesium [mg/l]						38,8	n.r.
total hardness [CaO mg/l]						407,9	50-350
carbonate hardness [CaO mg/l]						114,8	n.r.
spec. el. conduct [uS/cm]						1276,2	1500
M. alkalinity [mmol/l]						4,1	n.r.

Toxic heavy metals

arsenic [mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	0,012	0,05
cadmium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,005
chromium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,020	0,05
mercury [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,001
lead [mg/l]	0,078	0,019	0,013	0,037	0,060	0,05
cobalt [mg/l]	0,016	< 0,01	< 0,01	0,012	< 0,020	n.r.
copper [mg/l]	0,500	< 0,01	< 0,01	0,173	< 0,040	1,0
manganese [mg/l]	0,790	0,013	< 0,01	0,271	n.a.	0,2
nickel [mg/l]	0,012	< 0,01	< 0,01	0,011	< 0,020	n.r.
selenium [mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	n.a.	0,01
antimony [mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	< 0,005	n.r.
tin [mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	< 0,01	n.r.
tellurium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
thallium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
vanadium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,015	n.r.
silver [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,005	n.r.
barium [mg/l]					0,030	1,0
magnesium [mg/l]					47,0	n.r.
zink [mg/l]					0,650	1,0

n.a. = no data available

shaded cells contain data undertaken according to contract

n.r. = no regulation for given component

Table 2. Results for monitoring well No 2. in Péteri-major

Sample identification		2/1	2/2	2/3	calculated average	2/1 independent controll measurement	Limit according to regulation MI-10-433/3
temp. (on-site)	[oC]	12,3	12,3	12,3	12,3	n.a.	max. 30
pH (on-site)	[·]	7,02	7,02	7,02	7,0	7,3	6,8-8,5
chloride	[mg/l]	42,0	41,9	42,0	42,0	42,4	100
sulphate	[mg/l]	174,3	174,0	174,5	174,3	169,7	300
ammonia	[mg/l]	0,04	0,04	0,04	0,04	0,20	0,2
COD(chromate)	[mg/l]	17,10	17,00	17,00	17,03	n.a.	n.r.
BCO5	[mg/l]	1,62	1,60	1,60	1,61	n.a.	n.r.
total nitrogen	[mg/l]	1,43	1,44	1,43	1,43	n.a.	n.r.
PCR	[mg/l]	< 0,030	< 0,030	< 0,030	< 0,030	n.a.	n.r.
COD(perman)	[mg/l]	2,08	2,06	2,08	2,07	2,3	3,5
nitrate	[mg/l]					142,0	40
nitrite	[mg/l]					1,2	0,3
hydrogen-carbonate	[mg/l]					176,9	n.r.
sodium+potassium	[mg/l]					14,7	n.r.
calcium	[mg/l]					132,0	n.r.
magnesium	[mg/l]					28,0	n.r.
total hardness [CaO mg/l]						248,9	50-350
carbonate hardness [CaO mg/l]						81,2	n.r.
spec. el. conduct [uS/cm]						802,5	1500
M. alkalinity [mmol/l]						2,9	n.r.

Toxic heavy metals

arsenic	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	0,01	0,05
cadmium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	0,0012	0,005
chromium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,020	0,05
mercury	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,001
lead	[mg/l]	0,165	< 0,01	< 0,01	0,062	0,135	0,05
cobalt	[mg/l]	0,024	< 0,01	< 0,01	0,015	< 0,020	n.r.
copper	[mg/l]	0,102	< 0,01	< 0,01	0,041	< 0,040	1,0
manganese	[mg/l]	2,370	< 0,01	< 0,01	0,797	n.a.	0,2
nickel	[mg/l]	0,035	< 0,01	< 0,01	0,018	0,030	n.r.
selenium	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	n.a.	0,01
antimony	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	< 0,005	n.r.
tin	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	0,012	n.r.
tellurium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
thallium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
vanadium	[mg/l]	0,025	< 0,01	< 0,01	0,015	0,026	n.r.
silver	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,005	n.r.
barium	[mg/l]					0,060	1,0
magnesium	[mg/l]					39,0	n.r.
zink	[mg/l]					1,050	1,0

n.a. = no data available

shaded cells contain data undertaken according to contract

n.r. = no regulation for given component

Table 3. Results for monitoring well No 3. in Péteri-major

Sample identification		3/1	3/2	3/3	calculated average	3/1 independent control measurement	Limit according to regulation MI-10-433/3
temp. (on-site)	[oC]	11,3	11,3	11,3	11,3	n.a.	max. 30
pH (on-site)	[-]	7,15	7,15	7,15	7,2	7,4	6,8-8,5
chloride	[mg/l]	62,0	62,2	62,1	62,1	59,3	100
sulphate	[mg/l]	250,5	249,5	250,6	250,2	233,4	300
ammonia	[mg/l]	0,03	0,03	0,03	0,03	0,2	0,2
COD(chromate)	[mg/l]	22,20	22,20	22,00	22,13	n.a.	n.r.
BOD5	[mg/l]	1,13	1,13	1,15	1,14	n.a.	n.r.
total nitrogen	[mg/l]	0,03	0,03	0,03	0,03	n.a.	n.r.
PCB	[ng/l]	< 0,030	< 0,030	< 0,030	< 0,030	n.a.	n.r.
COD(permag)	[mg/l]	1,44	1,46	1,44	1,45	1,6	3,5
nitrate	[mg/l]					200,0	40
nitrite	[mg/l]					0,16	0,3
hydrogen-carbonate	[mg/l]					213,5	n.r.
sodium+potassium	[mg/l]					9,2	n.r.
calcium	[mg/l]					184,0	n.r.
magnesium	[mg/l]					44,5	n.r.
total hardness	[CaO mg/l]					359,5	50-350
carbonate hardness	[CaO mg/l]					98,0	n.r.
spec. el. conduct	[uS/cm]					1082,8	1500
M. alkalinity	[mmol/l]					3,5	n.r.

Toxic heavy metals

arsenic	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	0,010	0,05
cadmium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,005
chromium	[mg/l]	0,300	< 0,01	< 0,01	0,102	< 0,020	0,05
mercury	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,001
lead	[mg/l]	0,780	< 0,01	< 0,01	0,267	0,120	0,05
cobalt	[mg/l]	0,017	< 0,01	< 0,01	0,012	< 0,020	n.r.
copper	[mg/l]	0,031	< 0,01	< 0,01	0,017	< 0,040	1,0
manganese	[mg/l]	0,650	< 0,01	< 0,01	0,223	n.a.	0,2
nickel	[mg/l]	0,015	< 0,01	< 0,01	0,012	< 0,020	n.r.
selenium	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	n.a.	0,01
antimony	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	< 0,005	n.r.
tin	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	< 0,01	n.r.
tellurium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
thallium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
vanadium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,015	n.r.
silver	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,005	n.r.
barium	[mg/l]					0,200	1,0
magnesium	[mg/l]					45,0	n.r.
zink	[mg/l]					0,970	1,0

n.a. = no data available

shaded cells contain data undertaken according to contract

n.r. = no regulation for given component

Table 4. Results for monitoring well No 4. in Péteri-major

Sample identification		4/1	4/2	4/3	calculated average	4/1 independent controll measurement	Limit according to regulation MI-10-433/3
temp. (on-site)	[oC]	12,5	12,5	12,5	12,5	n.a.	max. 30
oil (on-site)	[:]	7,19	7,19	7,19	7,2	7,4	6,8-8,5
chloride	[mg/l]	64,0	64,0	64,2	64,1	59,3	100
sulphate	[mg/l]	264,9	264,8	264,9	264,9	220,0	300
ammonia	[mg/l]	0,02	0,02	0,02	0,02	n.a.	0,2
COD(chromate)	[mg/l]	13,10	13,00	13,10	13,07	n.a.	n.r.
BOD5	[mg/l]	1,58	1,58	1,59	1,58	n.a.	n.r.
total nitrogen	[mg/l]	1,43	1,42	1,43	1,43	n.a.	n.r.
PCB	[mg/l]	< 0,030	< 0,030	< 0,030	< 0,030	n.a.	n.r.
COD(permang)	[mg/l]	1,68	1,65	1,65	1,66	2,6	3,5
nitrate	[mg/l]					180,0	40
nitrite	[mg/l]					0,25	0,3
hydrogen-carbonate	[mg/l]					213,5	n.r.
sodium+potassium	[mg/l]					11,0	n.r.
calcium	[mg/l]					176,0	n.r.
magnesium	[mg/l]					41,4	n.r.
total hardness [CaO mg/l]						341,1	50-350
carbonate hardness [CaO mg/l]						98,0	n.r.
spec. el. conduct [uS/cm]						1034,5	1500
M. alkalinity [mmol/l]						3,5	n.r.

Toxic heavy metals

arsenic	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	0,030	0,05
cadmium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,005
chromium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,020	0,05
mercury	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,001
lead	[mg/l]	0,210	< 0,01	< 0,01	0,077	0,200	0,05
cobalt	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,020	n.r.
copper	[mg/l]	0,052	< 0,01	< 0,01	0,024	< 0,040	1,0
manganese	[mg/l]	0,860	< 0,01	< 0,01	0,293	n.a.	0,2
nickel	[mg/l]	0,029	< 0,01	< 0,01	0,016	< 0,020	n.r.
selenium	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	n.a.	0,01
antimony	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	< 0,005	n.r.
tin	[mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	< 0,01	n.r.
tellurium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
thallium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
vanadium	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	0,030	n.r.
silver	[mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,005	n.r.
barium	[mg/l]					0,600	1,0
magnesium	[mg/l]					45,0	n.r.
zink	[mg/l]					0,930	1,0

n.a. = no data available

shaded cells contain data undertaken according to contract

n.r. = no regulation for given component

Table 5. Results for monitoring well No 1. in Dunakeszi

Sample identification		1/1	1/2	1/3	calculated average	1/1 independent controll measurement	Limit according to regulation MI-10-433/3
temp. (on-site) [oC]		13,4	13,4	13,4	13,4	n.a.	max. 30
pH (on-site) [-]		7,5	7,5	7,5	7,5	7,6	6,8-8,5
chloride [mg/l]		9,0	9,0	9,0	9,0	12,7	100
sulphate [mg/l]		99,3	99,3	99,3	99,3	44,0	300
ammonia [mg/l]		0,06	0,06	0,06	0,06	n.a.	0,2
COD(chromate) [mg/l]		12,10	12,10	12,00	12,07	n.a.	n.r.
BOD5 [mg/l]		1,84	1,82	1,84	1,83	n.a.	n.r.
total nitrogen [mg/l]		1,42	1,43	1,44	1,43	n.a.	n.r.
PCB [mg/l]		< 0,030	< 0,030	< 0,030	< 0,030	n.a.	n.r.
COD(permang) [mg/l]		2,16	2,12	2,16	2,15	2,3	3,5
nitrate [mg/l]						33,0	40
nitrite [mg/l]						n.a.	0,3
hydrogen-carbonate [mg/l]						231,8	n.r.
sodium+potassium [mg/l]						49,5	n.r.
calcium [mg/l]						43,0	n.r.
magnesium [mg/l]						15,9	n.r.
total hardness [CaO mg/l]						96,8	50-350
carbonate hardness [CaO mg/l]						96,8	n.r.
spec. el. conduct [uS/cm]						454,4	1500
H. alkalinity [mmol/l]						3,8	n.r.
soluted oxygen [mg/l]		9,33				n.a.	n.r.

Toxic heavy metals

arsenic [mg/l]	0,080	< 0,05	0,064	0,065	0,080	0,05
cadmium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,005
chromium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,020	0,05
mercury [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,001
lead [mg/l]	0,120	0,022	0,048	0,063	0,105	0,05
cobalt [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,020	n.r.
copper [mg/l]	0,020	< 0,01	0,014	0,015	< 0,040	1,0
manganese [mg/l]	0,011	< 0,01	< 0,01	0,010	n.a.	0,2
nickel [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,020	n.r.
selenium [mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	n.a.	0,01
antimony [mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	< 0,005	n.r.
tin [mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	< 0,01	n.r.
tellurium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
thallium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
vanadium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,015	n.r.
silver [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,005	n.r.
barium [mg/l]					0,025	1,0
magnesium [mg/l]					14,0	n.r.
zink [mg/l]					< 0,100	1,0

n.a. = no data available

shaded cells contain data undertaken according to contract

n.r. = no regulation for given component

Table 6. Results for monitoring well No 2. in Dunakeszi

Sample identification	2/1	2/2	2/3	calculated average	2/1 independent controll measurement	Limit according to regulation MI-10-433/3
temp. (on-site) [oC]	13,3	13,3	13,3	13,3	n.a.	max. 30
pH (on-site) [-]	8,8	8,8	8,8	8,8	8,9	6,8-8,5
chloride [mg/l]	26,6	26,6	26,6	26,6	25,4	100
sulphate [mg/l]	259,6	259,6	259,6	259,6	61,6	300
ammonia [mg/l]	0,10	0,11	0,10	0,10	0,2	0,2
COD(chromate) [mg/l]	27,20	27,10	27,10	27,13	n.a.	n.r.
BOD5 [mg/l]	1,78	1,73	1,79	1,77	n.a.	n.r.
total nitrogen [mg/l]	1,43	1,43	1,43	1,43	n.a.	n.r.
PCB [mg/l]	< 0,030	< 0,030	< 0,030	< 0,030	n.a.	n.r.
COD(permag) [mg/l]	4,88	4,85	4,88	4,87	5,0	3,5
nitrate [mg/l]					1,6	40
nitrite [mg/l]					< 0,100	0,3
hydrogen-carbonate [mg/l]					823,5	n.r.
sodium+potassium [mg/l]					381,8	n.r.
calcium [mg/l]					2,0	n.r.
magnesium [mg/l]					2,7	n.r.
total hardness [CaO mg/l]					9,2	50-350
carbonate hardness [CaO mg/l]					9,2	n.r.
spec. el. conduct [uS/cm]					1334,2	1500
M. alkalinity [mmol/l]					14,9	n.r.
soluted oxygen [mg/l]	4,4				n.a.	n.r.
carbonate [mg/l]	48,0				42,0	n.r.

Toxic heavy metals

arsenic [mg/l]	1,510	1,550	1,540	1,533	1,900	0,05
cadmium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,005
chromium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,020	0,05
mercury [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,001	0,001
lead [mg/l]	0,610	0,098	0,073	0,260	0,680	0,05
cobalt [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,020	n.r.
copper [mg/l]	0,052	0,026	0,021	0,033	< 0,040	1,0
manganese [mg/l]	0,059	0,021	0,021	0,034	n.a.	0,2
nickel [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,020	n.r.
selenium [mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	n.a.	0,01
antimony [mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	0,100	n.r.
tin [mg/l]	< 0,05	< 0,05	< 0,05	< 0,05	< 0,01	n.r.
tellurium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
thallium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	n.a.	n.r.
vanadium [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,015	n.r.
silver [mg/l]	< 0,01	< 0,01	< 0,01	< 0,01	< 0,005	n.r.
barium [mg/l]					0,030	1,0
magnesium [mg/l]					3,0	n.r.
zink [mg/l]					< 0,100	1,0

n.a. = no data available

shaded cells contain data undertaken according to contract

n.r. = no regulation for given component

Sampling of monitoring wells at municipal
solid waste landfill in Péteri-major



Sampling of monitoring wells at municipal
solid waste landfill in Péteri-major



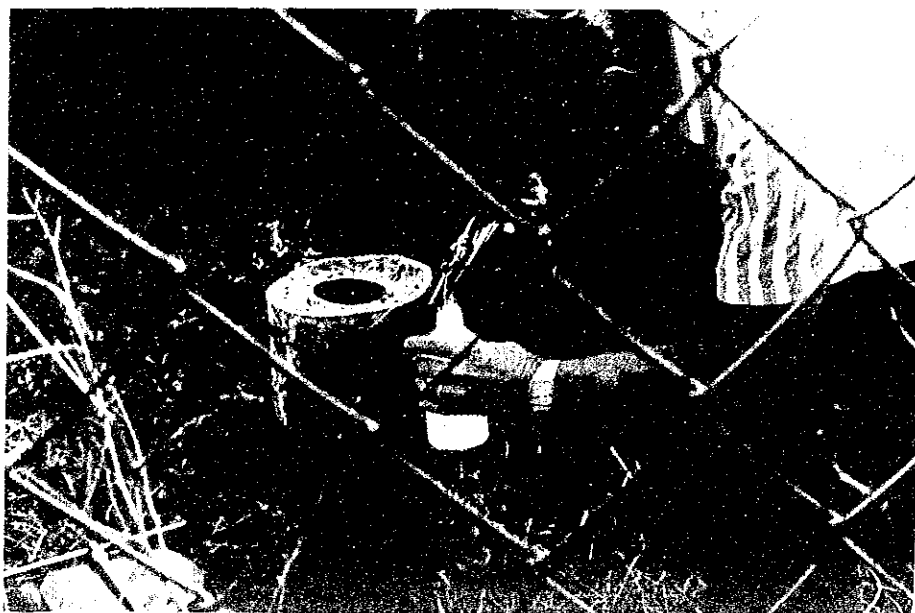
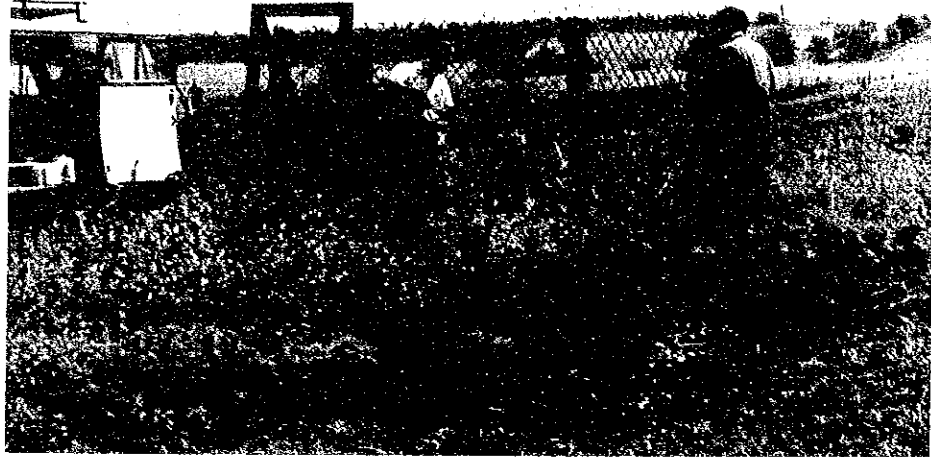
Sampling of monitoring wells at municipal
solid waste landfill in Péteri-major



On-site determinations performed
during sampling of monitoring wells



Sampling of monitoring wells at municipal solid waste landfill
in Dunakeszi



On-site determinations performed
during sampling of monitoring wells



Országos Vízügyi Hivatal MŰSZAKI IRÁNYELVEK	FELSZÍN ALATTI VIZEK MINŐSÉGE A törzshálózati mintavételi helyeken vizsgálandó komponensek körének, a mérések gyakoriságának és a határértékeknek a meghatározása	MI-10-433/3-84
		L 09

Качество подземных вод.
Определение исследуемых компонентов, частоты и предельных значений их в местах отбора проб базовой сети

THE QUALITY OF UNDERGROUND WATERS.
Determination of the analysed components, of the frequency and limit values of them in the sampling places of the base net

E Műszaki Irányelvek tárgya a felszín alatti vizek törzshálózati megfigyelési helyein vett vízminták alapján végzett alapállapot felmérések és rendszeres ellenőrző vizsgálatok elvégzésének a részletes előírásai.
Nem tárgya e Műszaki Irányelveknek a célvizsgálat.

Tartalom

1. Fogalommeghatározások
 2. Cél
 3. A vízminőségi komponensek kiválasztásának szempontjai
 4. A vízminőségi vizsgálatok gyakorisága
 5. A vízminőségi komponensek határértékei
- A szövegben említett magyar állami szabványkiadványok
A tárggyal kapcsolatos jogszabály

1. FOGALOMMEGHATÁROZÁSOK

Vízminőségi törzshálózat tagjai: az országos vízminőségfigyelő hálózathoz kiválasztott, az MI-10-433/2 szerint üzemeltetett azon megfigyelési helyek összessége, melyek vízminőségi adatainak értékelésével és minősítésével a felszín alatti vizek általános vízminőségi állapotát jellemezni lehet.

Alapállapot felmérés: az egyes törzshálózati megfigyelési pontokra vonatkozó adatok (MI-10-433/2), vizsgálatok és értékelések (MSZ-10-433/1) összessége.

Rendszeres ellenőrző vizsgálat: a teljeskörű alapállapot felmérési vízminőség-vizsgálatok közötti időszakban végzendő szűkebbkörű vízminőségi vizsgálat.

Védett vízelőfordulás: földtanilag védett vízelőfordulás az, amelyet 10 méternél vastagabb, gyenge áteresztő képességű, folytonos összefüggő réteg fed és a felszínről a víztartóba szivárgás ideje több mint 20 év.

Védett vízelőfordulásból üzemelő megfigyelési pont: az, ahova a szennyezett víz felülről vagy oldalról történő bejutásához szükséges idő a várható üzemelési feltételek mellett több mint 20 év.

Nem védett vízelőfordulás: ami a védett vízelőfordulás feltételeinek nem felel meg.

2. CÉL

E Műszaki Irányelvek célja, a felszín alatti vizek törzshálózati megfigyelési helyein az előírt mintavételi gyakorisággal meghatározott komponensek vizsgálati eredményeinek értékelésével és minősítésével az általános vízminőség jellemzése.

A jóváhagyás időpontja:

1984. július 3.

A közzététel időpontja:

1984. november