

## A NEW STAGE ON THE LANDFILLS OF ESTONIA: LEAKAGE WATER INVESTIGATIONS AND MANAGEMENT

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### KEYWORDS

landfill conditions, leakage water, investigations



### PREFACE

At the moment there is registered over 500 landfills with different sizes in the Estonian Landfill Catalogue. According to Estonian legislation and National Environmental Action Plan the number of landfills should be reduced and the present situation updated.

There are only few new small (<5 ha) landfills in Estonia which are built in accordance with environmental requirements.

In South-Estonia the biggest - Tartu landfill is under reconstruction. The landfill is located 5 km from town of Tartu and it serves app. 200 000 inhabitants of South-Estonia. Since 1971 that place is used for landfilling purposes. Total area of the landfill is 28.3 ha. Wastes cover around 10.6 ha of the area with estimated volume ca 500 000 m<sup>3</sup>.

Since 1996 environment research company KOBRAS LTD has carried out several environmental impact studies of the landfill. The results of the studies are showing that significant water pollution occurs on the landfill area. In order to reduce water pollution on the landfill area of town of Tartu reconstruction works of the landfill were started last year. Up to now the area covered with wastes is reduced. At the same time leakage water and stormwater collection systems and biological treatment for wastewater are built. Should be emphasised that these kinds of works are first such cases in Estonia.

## INVESTIGATIONS AND METHODOLOGY

### Sampling

Within the project in 1996 the groundwater and surface water quality was monitored respectively in five wells and one weir. Groundwater samples for comparison were taken app. 200 m in the SW direction from landfill.

6 surface water samples were taken from border channel for analysing pH, BOD<sub>7</sub>, NH<sub>4</sub>, NO<sub>2</sub>, NO<sub>3</sub>, P<sub>tot</sub>, Cl, SO<sub>4</sub> and conductivity (CTY). Concentration of oil products and phenols was measured twice. Sampling took place during the period from April to November.

In the most characteristic places 2 x 2 samples from additional weirs were taken. Concentration of pH, NH<sub>4</sub>, NO<sub>2</sub>, NO<sub>3</sub>, Cl, SO<sub>4</sub> and conductivity was found.

From five wells 5 x 6 samples were taken. Concentration of pH, COD Cr, NH<sub>4</sub>, NO<sub>2</sub>, NO<sub>3</sub>, P<sub>tot</sub>, Cl, SO<sub>4</sub> and conductivity was found. Concentration of oil products and phenols was measured twice. Sampling took place during the period from June to November. Also water table was measured.

The **leakage water** was sampled twice in 6 weirs. Concentration of pH, COD Cr, NH<sub>4</sub>, NO<sub>2</sub>, NO<sub>3</sub>, P<sub>tot</sub>, Cl, SO<sub>4</sub>, oil products, conductivity, phenols, As, Ba, Cd, Hg, Pb was found. The first sampling took place in May and the second in November. In April 2 samples for pH, NH<sub>4</sub>, NO<sub>2</sub>, NO<sub>3</sub>, P<sub>tot</sub>, Cl, SO<sub>4</sub>, conductivity were taken and analysed. 6 samples were taken from soil to analyse **oil products**. 4 samples were taken from **manure spill** and concentration of pH, BOD<sub>5</sub>, COD Cr, NH<sub>4</sub>, N<sub>tot</sub> and P<sub>tot</sub> was found.

### Comparison weirs

Samples from drainage system collector of Aardla polder were taken for water quality and pollution intensity comparison with monitoring wells. Aardla polder is located ca 200 m to SW from the landfill. Collector is located in similar hydrogeological conditions like landfill does.

In addition data from two other wells for comparison was used: Saare well with unpolluted and Raadi well with polluted groundwater.

### Geological situation

Tartu landfill is located on Aardla polder, which is built on the Konsu-Reola primeval valley. Polder is surrounded by highway in the north and east, and by Konsu channel in the south and west. In the central part of the polder small lake is situated.

**The landfill is located on the service area (watershed) of II pumping station which means that water runoff from the landfill area is not by gravity flow.**

Data available showing geological situation of the Konsu-Reola primeval valley is insufficient and therefore near the landfill 3 additional boreholes in depth 9.5 m to 16.5 m were drilled. The geological situation of the landfill can be described as follows: in depth 1.5-2.7 m peat; in depth 3.0-7.0 m various grain-sized sands, mainly fine and extrafine sand, also micro layers of gravel and gravel with sand and loam were found in the depth. Below sand varved clay occurs. In depth 9.0 m the Devonian sandstone occurs.

### Leakage water

At the time of investigations there are no leakage water collection and treatment facilities on the Aardlapalu landfill yet.

Table 1. Chemical concentrations of leakage water

		Leakage 6 weirs 14 samples			Uppersoilwa ter
		Mean	Max	Min	Mean
pH		8.4	9.1	7.6	7.03
Conductivity	µS/cm	8414	19800	2310	7149
COD Cr	mgO/l	1371	4300	460	404
NH <sub>4</sub>	mgN/l	214	650	20	51
NO <sub>2</sub>	mgN/l	1.6	8.0	0.001	0.001
NO <sub>3</sub>	mgN/l	35	150	0.04	0.44
P <sub>tot</sub>	mg/l	3.1	7.0	0.6	1.5
Cl	mg/l	1502	3340	220	655
SO <sub>4</sub>	mg/l	220	750	50	136
Oil products	mg/l	0.22	1.0	0.05	
Light phenols	mg/l	0.42	3.2	0.03	
As	mg/l	0.01	0.032	0.002	
Ba	mg/l	0.34	0.60	0.02	
Pb	mg/l	0.04	0.23		
Cd	mg/l	<0.002			
Hg	mg/l	< 0.0001			

Annually estimated water input to the landfill is 16 155 m<sup>3</sup>. Water incoming with waste and manure as well as evaporation/precipitation ratio is taken into account. Territorial changes in chemical compounds of filtrates are significant which can be explained with various age of the dump.

Changes in chemical concentrations in time and in different places occur.

### SURFACE WATER

At the time of investigations collector channels or ditches did not surround the landfill. In the neighbourhood are several polder drainage ditches. By such ditches was driven away also landfill leakage water.

Water level in the ditches is depending on pumping frequency. Also there are beavers dams on the ditches and these are regulating water outflow from the landfill area.

## Outflow

Hereby values of several parameters in the outflow from the landfill via polder drainage ditch are given.

Mean annual value of conductivity in the outflow was 1032  $\mu\text{S/cm}$ .

In comparison weir in the river with nature condition was the value 552  $\mu\text{S/cm}$ .

Mean annual value of pH in the outflow was 7.4. In the river it was respectively 7.95.

Alkalinity values were 14.8 and 13.8 mg-ekv/l.

Mean BOD<sub>7</sub> values were 6.4 mgO/l and 1.5 mgO/l respectively

During the last decade concentration of BOD<sub>7</sub> was increasing but in comparison weir it was decreasing.

Mean value of NH<sub>4</sub> in the outflow and in the river has significantly increased during the monitored period since 1982 (Table 2).

Mean value of NO<sub>2</sub> in the outflow was 0.02 mgN/l

0.95 mgN/l and in comparison weir it was 0.96 mgN/l. In the outflow significant fluctuations in NO<sub>3</sub> values during the years was found. At the same time there was no fluctuations of NO<sub>3</sub> values in the river.

Mean value of P<sub>tot</sub> was in the outflow 0.12 mg/l and maximum value was 0.17 mg/l. There has been increase in the values

Mean concentration of Cl<sup>-</sup> in the outflow was 75 mg/l and in the river it was 9.41 mg/l. In the outflow slight increase during the monitoring period occurred.

Course of SO<sub>4</sub> values is similar to Cl<sup>-</sup> values and mean values are 80 mg/l and 18 mg/l respectively.

In the samples oil products were not found.

## ESTIMATED WATERQUALITY IN OUTFLOW

During the investigation period since 1982 water quality of the landfill outflow continuously has worsened indicated especially in BOD<sub>7</sub>, NH<sub>4</sub>, P<sub>tot</sub>, Cl, SO<sub>4</sub> content. Values of the characteristics have been much higher than in comparison weir in the river.

It is necessary as soon as possible to treat leakage water of the landfill.

Table 2. Mean values of the characteristics of surface water in outflow of the landfill (L) and in the river (R).

Year	Number of samples	pH	BOD <sub>7</sub>	NH <sub>4</sub>	NO <sub>3</sub>	Cl	SO <sub>4</sub>
1982 L	5	7.5	2.8	0.75	0.18	12	48
R	9	7.94	2.3	0.161	1.30	12.56	22.67
1983 L	10	7.7	2.9	1.98	0.45	23	59
R	12	8.11	2.3	0.268	0.87	14.67	21.42

1984 L	12	7.7	3.1	2.08	0.17	37	79
R	12	8.02	2.1	0.196	0.88	15.74	21.58
1985 L	4	7.2	5.4	2.78	0.24	39	92
R	4	7.66	3.9	0.188	1.11	17.25	16.25
1993 L	4	7.6	5.2	0.79	2.84	27	135
R	12	7.95	2.0	0.108	1.05	10.10	19.95
1996 L	8	7.4	6.4	6.96	0.95	75	80
R	11	7.95	1.5	0.067	0.86	9.41	17.91

**Groundwater**

Table 3. Saare (unpolluted) and Raadi (polluted) well.

Well	Date	NH4 mgN/l	NO3 mgN/l	Ptot mg/l	Cl mg/l	SO4 mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	CTY μS/cm
Saare	26.09	0.05	<0.15	0.18	2.7	8.4	25.6	8.3	10	1.6	218
Raadi	29.09	0.68	35	0.022	210	70	149	51.5	150	20	1810

Table 4. Mean characteristics of the landfill groundwater

Characteristics		Sampling place					
		Well 1	Well 2	Well 3	Well 4	Well 5	Collector
pH	Mean	7.18	7.39	7.14	7.11	7.05	7.41
	Max.	7.48	7.72	7.42	7.24	7.37	8.23
	Min.	7.01	7.13	6.92	6.96	6.91	7.1
Conductivity μS/cm	Mean	1864	997	977	1061	7149	686
	Max.	2090	1060	1180	1220	7830	721
	Min.	1670	939	846	906	6300	645
COD Cr, mgO/l	Mean	242	202	232	235	500	31
	Max.	400	420	520	440	640	70
	Min.	90	13	22	100	360	7
NH4, mgN/l	Mean	45.43	0.66	4.58	3.84	50.95	0.02
	Max.	64	1.4	22	5.9	300	0.057
	Min.	26	0.26	0.45	2.3	0.03	0.005
NO2, mgN/l	Mean	0.04	0.01	0.05	0.02	0.003	0.002
	Max.	0.12	0.02	0.09	0.04	0.013	0.003
	Min.	0.002	0.003	0.022	0.001	0.001	0.001
NO3, mgN/l	Mean	0.4	0.2	3.0	0.3	0.4	7.5
	Max.	1.6	0.7	6.0	1.1	1.3	20.0
	Min.	0.03	0.04	0.23	0.04	0.04	4.2
Ptot, mg/l	Mean	0.31	0.13	0.25	0.15	1.46	0.05
	Max.	0.49	0.25	0.55	0.28	1.80	0.08
	Min	0.15	0.03	0.09	0.03	1.20	0.02
Cl, mg/l	Mean	100	39	47	52	656	40
	Max	130	64	64	110	750	50
	Min.	70	22	36	28	510	28
SO4, mg/l	Mean	254	229	117	112	136	68
	Max.	320	310	160	190	180	90
	Min.	180	170	62	40	90	42
Ca <sup>2+</sup> ,	Mean	141	165	129	167	175	105

mg/l							
Mg <sup>2+</sup> , mg/l	Mean	71	41	45	48	197	29
Na, mg/l	Mean	82.5	6.75	14	19.5	500	6.5
K, mg/l	Mean	55	4.65	3.8	4.35	360	1.7

## SUMMARY

### Leakage water

There are no facilities to collect and to treat leakage waters on the Aardlapalu landfill. Problem should be solved according to relevant requirements as soon as possible.

### Surface water

Quality of surface water worsened during the period 1982 ... 1996. There are direct inflows of heavily polluted leakage water into surface water bodies (ditches, channels).

### Groundwater

The landfill area is polluted especially by As, Ba, Pb, oil products, and phenols. Outside the dump area no pollution coming from landfill was found.