

3.1.3 Previously conducted soil surveys and their conclusions **besluiten**

Various soil investigations have been carried out on the site since 1998, when the Decree on Soil Remediation came into effect. This concerns the following titles:

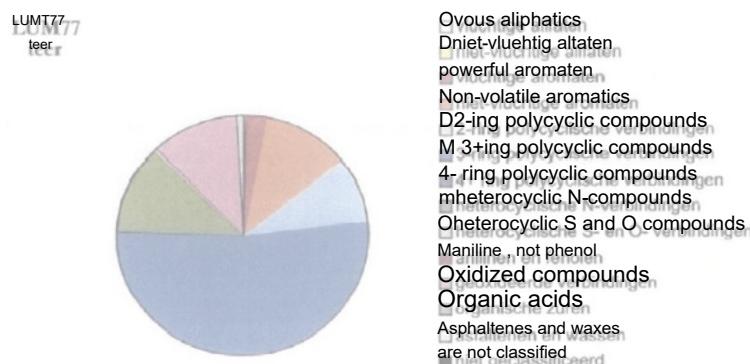
Datum	title	Reference
7-11-1998	Report on exploratory soil research by Esher BVBA	Lummerzheim Ghent xxxx 7
25-09-2000	Descriptive Soil Investigation Report by Esher BVBA	Lummerzheim Gent xxxx
10-04-2002	Interim report descriptive soil research by Esher BVBA	2
18-08-2003	Interim report descriptive soil research by Esher BVBA	Lummerzheim Ghent (010221) 2
19-12-2003	Final report Descriptive Soil Investigation by Esher BVBA	Lummerzheim Gent 020807
16-03-2004	Writing from Esher BVBA to OVAM - OVAM	HDKL KV V020807
22-03-2005	Additional descriptive soil research Soil remediation project Lummerzheim NV in Ghent, Zeeschipstraat 107	2800401
20-07-2005	Bodemverontreiniging project Lummerzheim NV te Gent, Zeeschipstraat 107	2800402 BSP
17-10-2005	_ Proposal for amendment or addition	Lummerzheim te Gentent
27/10/2005	_ Discussion report not in accordance with BSP Lummerzheim NV statement	050801 BOA-S/V-KDT/2005513818 001 001

To gain a better insight into the nature of the soil contamination, the descriptive soil research and tar characterization carried out by Esher BVBA in collaboration with TTE and the University of Twente. For this purpose, Esher BVBA took a soil and groundwater sample supplied from bore/monitoring well LUM77.

In TTE's report of 22/11/2002 it was decided that:

- The soil contamination (17,427 mg/kg DM mineral oil) found in LUM77 exists according to the classification into substance groups for § 114 % non-volatile aromatics, 12% heterocyclic N-compounds, 11% oxidized compounds, 9% from 2-ring polycyclic compounds and 2.7% volatile aromatics (xylenes):

«Figure 3-1: Composition of soil contamination with tar LUM77;

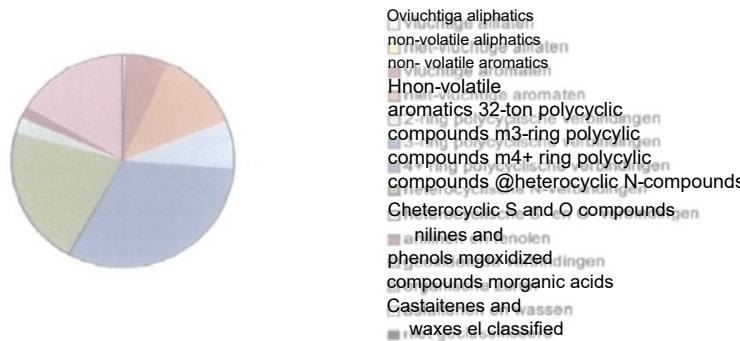


- The composition of carbon chains (largely CirC39) shows that the contamination is a relatively light tar with a low content of aromatic hydrocarbons and phenols. Dit kan verklaard

because BTEXN and phenolic compounds were distilled off from the starting product (tar from the Ghent gas factory) as a useful product (fuel for vehicles before WO II);

- After carrying out an equilibrium sorption test measured the equilibrium concentration of 31,400 ug/l ICC and 30,300 ug/l ICC, which mainly consists of 3- ring polycyclic compounds, heterocyclic N-compounds and oxidized compounds. Since the sampled groundwater sample from LUM-77 (which was also included in the study) is in the source of the contamination (incl. DNAPL) and not filtered, the conclusions from this sample are worst-case (cf. 3.2.1.3). This is also confirmed by the limited presence of phenols and anilines in the groundwater plume and the high levels in the groundwater sample compared to the equilibrium concentration (under normal conditions) the measured concentrations are 10 = smaller than the equilibrium concentration).

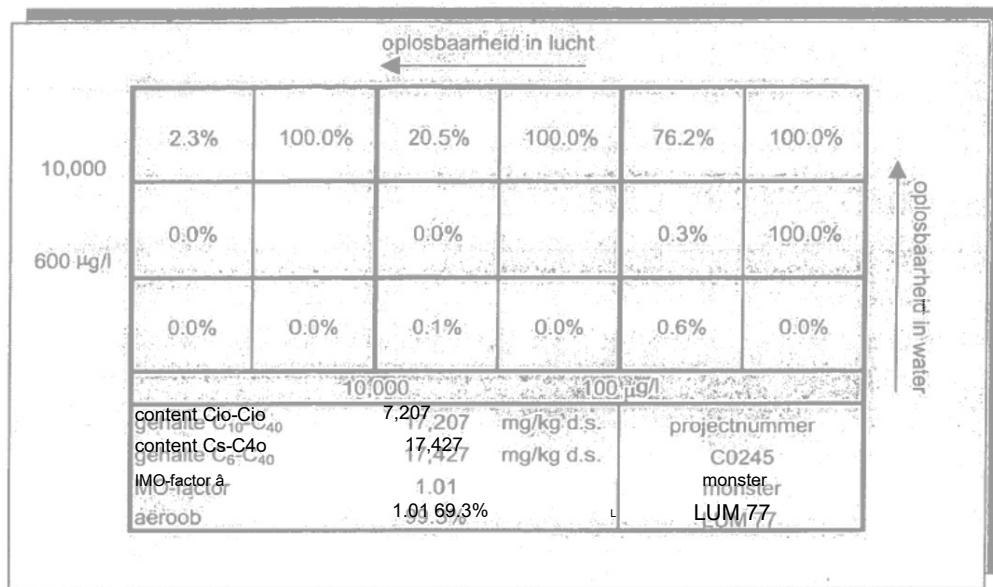
and Figure 3-2: Composition of emissions to groundwater from soil LUM-77;



- Gén van de teercomponenten verspreidt zich sneller dan benzeen, ca. 8% van de teercomponenten disperse faster than xylenes and 100 % of the tar components disperse faster than anthracene;
- According to the study , there is a potential human risk components of the tar. This mainly concerns concentrations that exceed standards in crawl space air and in living room air for aromatic fractions EC8-10 and EC 10-12. Since This concerns an industrial estate , there is no human risk;
- The potential remediation options are broadly determined by three characteristic aspects of the contamination found , namely: solubility in air and water and biological degradation . The mass percentages of nine fractions are given in a remediation matrix .



eFiguur 3-3: Sanitation matrix LUM-77.



The top left box represents the components that are well soluble in both water and air:

Het linkervak boven links vertegenwoordigt de componenten die heel goed oplosbaar zijn in zowel water als lucht;

The top right box represents the components that are well soluble in water but poorly in air:

Het rechtsbovenvak vertegenwoordigt de componenten die heel goed oplosbaar zijn in water maar slecht in lucht;

The bottom right box represents the components that are poorly soluble in both air and water .

Het rechtsondervak vertegenwoordigt de componenten die slecht oplosbaar zijn in zowel lucht als water.

- e Based on the above figure it can be concluded that:

1. 99,0 % of the tar is easily soluble in water;
2. 0,3% of the tar is moderately soluble in water;
3. 2,3 % of the tar is easily soluble in air;
4. 20,6% of the tar is moderately soluble in air;
5. 99,3 % of the tar is potentially aerobically degradable;
6. 0,6% of the tar is poorly soluble in water and air.

- e Although the tar is in principle almost completely degradable, it must first dissolve in the water phase. Given the many DNAPL fractures in the subsurface of the investigated location , supply this to the water phase for a long time. Because of this, biodegradation will be a long-term affair become. As a result, the degradation rate of the tar does not determine the remediation time , but rather the speed at which the tar dissolves in water .

- During remediation , the tar changes composition and the percentage at the bottom right of the remediation matrix will increase. The way this happens and how quickly depends on the remediation variant and the location-specific circumstances. Monitoring this percentage provides a good picture of the progress of the remediation.



To get a better picture of the biological degradation of groundwater contamination, a reiniging werd een groundwater characterization carried out on 27/9/2004 by ESA BVBA:

	T112	T141	T18	T179	T20	T121	T71	T695	T722	T689	T1090	T122
1450 1340 0 892 temperature 7C 134 131 33 17 redoxpotentiaal m -40 48 E-18 [zuurstof]	61	61	17	628	13	124	14	6,95	7,22	628	6,87	
gl < o << [manganen m 0452_04a15]_0278] 048] [opgelost ijzer gl 83 3 E_131 sufaat]	52	52	1210 143	689	1090							710
gl 387 443 233 263 suide 7 myt <005 <005 <005 <005 TOC mgf 809 3L TS UT	11,7	11,7	141 222 45	13	12,4	14	12,4	14	14	12,8		
nitraat mg/NT <02 <02 <02 [nitraat ammonium mg Ni 28 25 2,1 23 et mg/NT <001 <001-18	0,5	0,5	a <pos[0243	42	42	-37	-37	-37	-37	-18		
<001 <001 [total phosphate g/ 022 018 0021 0,39 [methaan ng ng ng] 3900 [ethene	0,5	0,5	- 0299	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	BE	0,5	
ng ng ng -160 [ethaan ng ng 14 [benzeen zo2] <002 <02 toluene <03 <02 02 12	0,48	0,243	0,239	0,2	0,137	G541	0197	<0,215	<0,215			
[tetyphenzeen n:021 <02 13 xylenen E : N 097 naphthalene u <05 <05 <05 <03	3,1	5,4	7,1	6,4	13,5	2,5	4,4					
phenol ng ng ngl <005 [cyclohexanon r of of off <20 [benzoates (som)] 1gn ng ng] 283	<10	241	204	277	176	84						
ngf <19]												
suide	mg/l	< 0,05	< 0,05	< 0,05	< 0,05	< 0,05	< 0,05	< 0,05	< 0,05	< 0,05	< 0,05	< 0,05
T.O.C.	mg/l	80,9	73	71,5	177,1	110,7	85,8	5,1	7,8	4,8	16,8	
nitraat	mg N/l	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2	< 0,2
ammonium	mg N/l	2,6	2,5	2,1	2,3	1,3	3,4	3,2	1,2	2,1	1,6	
nitriet	mg N/l	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01
totaal fosfaat	mg/l	0,22	0,18	0,21	0,39	0,38	0,43	0,4	0,26	0,35	0,35	
methaan	ug/l	n.g.	n.g.	n.g.	3900	58000	2700	240	74	25000	n.g.	
ethleen	ug/l	n.g.	n.g.	n.g.	160	< 5	< 5	< 5	< 5	< 5	n.g.	
ethaan	ug/l	n.g.	n.g.	n.g.	14	10	10	< 5	< 5	< 5	n.g.	
benzeen	ug/l	< 0,2	< 0,2	< 0,2	120	400	2,8	64	3,9	2,1	31	
tolueen	ug/l	< 0,2	< 0,2	0,22	1,2	2,5	0,36	0,62	0,24	0,4	< 0,2	
ethylbenzeen	ug/l	0,21	< 0,2	< 0,2	13	6,8	< 0,2	< 0,2	< 0,2	< 0,2	1,4	
xyleneen	ug/l	< 0,5	< 0,5	< 0,5	0,91	30	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	
naftaleen	ug/l	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	0,78	
fenol	ug/l	n.g.	n.g.	n.g.	< 0,05	< 0,05	< 0,05	n.g.	n.g.	n.g.	n.g.	
cyclohexanon	ug/l	n.g.	n.g.	n.g.	< 2,0	< 2,0	< 2,0	n.g.	n.g.	n.g.	n.g.	
benzoaten (som)	ug/l	n.g.	n.g.	n.g.	< 1,0	< 1,0	< 1,0	n.g.	n.g.	n.g.	n.g.	

* Source of Sulfate < 20 of 0 to sulfide Tmg | 1 1 manganen | mg | ng | og total 4 4 4 geno 1 nitrate reducing 2 ijzer reducing 3 tot sulfe reducing

* bij elke groundwater/bemesting werd een rode geur aangetroffen, wat wijst op de aanwezigheid van H2S, door vermoedelijk een verkeerde conservering werd analytisch geen waterstofsulfide aangetroffen;

Redox score per peilbuis volgens D-Na in SKB project SV-513

	1	1	1	1	1	1	1	1	1	1	1	1
zuurstof < 0,5 mg/l	1	1	1	1	1	1	1	1	1	1	1	1
nitraat < 1 mg/l	1	1	1	1	1	1	1	1	1	1	1	1
ijzer > 1 mg/l	1	1	1	1	1	1	1	1	1	1	1	1
sultaat < 20 mg/l	0	0	0	0	0	1	0	0	0	0	0	0
sulfide > 1 mg/l	1	1	1	1	1	1	1	1	1	1	1	1
methaan > 1 mg/l	n.g.	n.g.	n.g.	1g	1	1	1	n.g.	n.g.	1	n.g.	
totaal	4	4	4	4	5	6	5	4	4	5	4	

0: aeroob

1: nitraatreducerend;

2: ijzerreducerend;

3: ijzer tot sultaatreducerend;

4: sultaatreducerend;

5: sultaat tot methanogenen;

6: methanogenen;

All monitoring wells reduce sulphate to methanogen

A score is determined for each monitoring well based on the analysis results of the redox parameters. Op basis van de analyse resultaten van de verschillende redox condities voor elke peilbuis een score vastgesteld en The predominant redox condition is determined using this score. De voorlopige redox conditie bepaald wordt met behulp van deze score de overnecende redox conditie bepaald:

Op basis van het uitgevoerd veldwerk en de verkregen analyseresultaten kunnen we het volgende besluiten:

- There are very favorable conditions for bacteriological degradation, namely: neutral pH, sufficiently high concentration of phosphate and nitrogen compounds present (at this site below form of ammonium present) and high TOC levels in the upstream monitoring wells (so the TOC level is not related to the contamination). The presence of favorable conditions for bacteriological degradation is also confirmed by the high concentration of methane mainly in the core of the contamination, which indicates a high bacteriological (anaerobic) activity.



- Also based on an assessment according to D-NA of the SKB project SV-513, we can conclude that the groundwater reduces sulphate to methanogenic and therefore the bacteriological activity is anaerobic expires;
- However no specific benzene breakdown products were found in the sample groundwater. The degradation of the degradation products is probably preferential to the starting products. In other words, the further degradation of the degradation products proceeds much faster than the first degradation steps of benzene (see also the very high concentrations of methane, which indicate high bacteriological activity). The first steps of breaking down benzene (making it hydrophilic of the benzene core) lead to the breakdown products on which analysis was carried out. By means of Due to the rapid further degradation of the degradation products, these degradation products are probably difficult to detect. (is a known phenomenon in the breakdown of benzene);
- The sampled groundwater is characterized by the absence of oxygen and nitrates and the presence of dissolved iron and sulfide



To gain a better insight into the potential spread of soil contamination to the saturated zone, descriptive soil research was carried out by Esher BVBA in collaboration with the VITO. VITO carried out a leaching test in accordance with NVN 7344 Leaching characteristics of solid soil and stony building materials and waste. Determination of the leaching of PAH, PCB, EOX from powder and granular materials with the column test. Esher BVBA supplied a bottom made of bore/monitoring well LUM77 for this purpose.

- This comparison shows that the measured concentrations lie between the limit of quantification and the remediation standard for groundwater as given by VLAREBO.
- The measured values remain well below the solubility of the component in question, with the exception of indeno(1,2,3-c,d)pyrene. The measurable values are for this component slightly above the solubility.

Figure 34 The calculated cumulative emissions in mg/kg

Component	Cumulative emissions in mg/kg
Naphthalene	0,0014
Acenaphthylene	0,0074
Acenaphthalene	0,00011 - 0,00012
Acenaphthalen	0,0002 - 0,0003
Fluoreen	0,00033
Fenantreen	0,0004
Antraceen	0,001
Fluorantheen	0,001
Pyreen	0,0002
Benz(a)antraceen	0,00015 - 0,00018
Benz(a)antraceen	0,00020 - 0,00027
Chrysene	0,00020 - 0,00027
Benz(b)fluoranteen	0,00008 - 0,00034
Benz(k)fluoranteen	0,00029 - 0,00034
Benz(a)pyreen	0,00027 - 0,00033
Indeno(1,2,3-c,d)pyrene	0,00035 -
Indeno(1,2,3-c,d)pyrene	0,00010 - 0,0011
Dibenzo(a,h)pyreen	0,00041
Benz(ghi)peryleen	0,0010 - 0,0011
DOC	0,00072 - 0,00080

- The cluates can generally be regarded as having limited contamination with PAHs. Only for the lower PAHs is a measurable leaching observed over the entire course of the process.
- A full assessment of the environmental risk of the material caused by leaching of PAHs, cannot yet be made, in the absence of a suitable evaluation method.