Remediation of the large waste dumpsite " Volgermeerpolder"

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Introduction:

The Volgermeer is located north of Amsterdam the Netherlands. Until the 11th century the land was more than 4 meters above sea level and consisted of organic material (peat). It was formed because the plants that died did not completely decompose due to the lack of oxygen. Due to cultivation and lowering of the water level the peat became oxidized and in the 14th century the soil was so much oxidized that the top was at about sea level. Around the Volgermeer several lakes were formed and those lakes were reclaimed later (fig1) .These polders (Pieces of low-lying land reclaimed from sea or river) are deeper than the Volgermeer.

Fig.1

After the Second World War peat was used for heating purposes and canals were formed in the Volgermeer. Municipal waste was dumped in the canals. The waste was brought there by boats. Officially there was a lock between the Volgermeerpolder and the other waters but in practise the area was in open connection with the surrounding waters. Not only municipal waste was dumped but also wastes from several chemical factories. Among those was one that produced 2,4,5-T. Between 1960 and 1969 more than 10000 drums of waste were dumped. Not only 2,4,5-T was produced but among others also Lindane, Parathione, Tedion and Tetrasul. Also batches of products that did not meet quality criteria were dumped. An explosion took place on the 6th of March 1963 in the factory during the production of 2,4,5-T and the waste was dumped in the Volgermeerpolder[1]. In 1980, chemical waste was found on the dumpsite and analysed. Most of the pieces of waste that was found were mainly chlorinated benzenes but one piece of waste was the Sodium salt of 2,4,5-T. This piece of waste contained as expected 2,3,7,8-TCDD. Later a large number of soil samples were analyzed. It was found that 2,3,7,8 TCDD was not the only dioxin found in the soil there. Many samples were analysed and an example of 2 samples is given in table 1. S1 is sediment from one of the canals inside the dump and S2 is sediment from the canal just outside the dumpsite. Concentrations are in ppt dry weight. Not only the 2,3,7,8 substituted PCDD/Fs were found but also a number of PCDD/Fs where no all the 2,3,7,and 8 position was occupied by Chlorine. A complete list is available on request.

	S1	S2
2,3,7,8-TCDD	154	32
1,2,3,7,8-P5CDD	8.7	5.4
1,2,3,4,7,8-H6CDD	8.3	5.4
1,2,3,6,7,8-H6CDD	31	27
1,2,3,7,8,9-H6CDD	25	25
1,2,3,4,6,7,8-H7CDD	205	216
OCDD	7484	1729
2,3,7,8-TCDF	165	48
1,2,3,7,8-P5CDF	100	33
2,3,4,7,8-P5CDF	834	278
1,2,3,4,7,8-H6CDF	632	268
1,2,3,6,7,8-H6CDF	22	17
1,2,3,7,8,9-H6CDF	1.6	6.4
2,3,4,6,7,8-H6CDF	12	12
1,2,3,4,6,7,8-H7CDF	216	143
1,2,3,4,7,8,9-H7CDD	77	13
OCDF	4170	666
I-TEQ	681	223

Table 1.

The patterns reflect mostly a combination of the waste of the 2,4,5-T production and the Lindane production.

Remediation options:

Several options for the final remediation have been considered.

1. The transport of the waste to another dumpsite. This option was cancelled because the amount of waste is too great and transport presents an additional risk.
2. Decontamination of the waste. This was not an option because the large amount of different compounds in the site.
3. Isolation of the site by placing an iron wall around the site. This option has been considered but is expensive. More importantly, if the wall leaks, it may go undetected and contaminate a very large area.
4. Isolation of the site from rainwater and monitoring the area round the site.

Remediation:

The first action in 1981 was to stop the transport of waste to the site. Due to the fact that the dumpsite was in open connection with surrounding waterways the second action was to close that connection at the place where the lock was located. The contaminated sediment in the canals outside the dumpsite was dredged and brought inside the site. The next action was to remove the drums that were visible at the surface of the site. 1100 drums were removed.
The 4th option for the final remediation is now on its way. One of the advantages of the site is the high carbon content of the site, which absorbs much of the compounds of interest. Isolation of the top will make that rainwater goes through the site and leave the site and goes to the surrounding lower polders.
The soil especially in the small canals is rather soft and there was the risk that the amended top layer could move the soil. New methods have been developed to secure that no moving of the soil in the canals takes place during the construction of the top layer. Sand spraying was used and it was concluded after a trial that this worked satisfactory. A large number of water sampling wells were placed around the side at such a distance that when one of the drums starts leaking the contamination will not be further away from the site than 50 meters before the leaking is found as contaminants in the sampling wells[2]. The samples are taken at different depth and monitored for a large number of compounds every year. Fig2 and Table2.

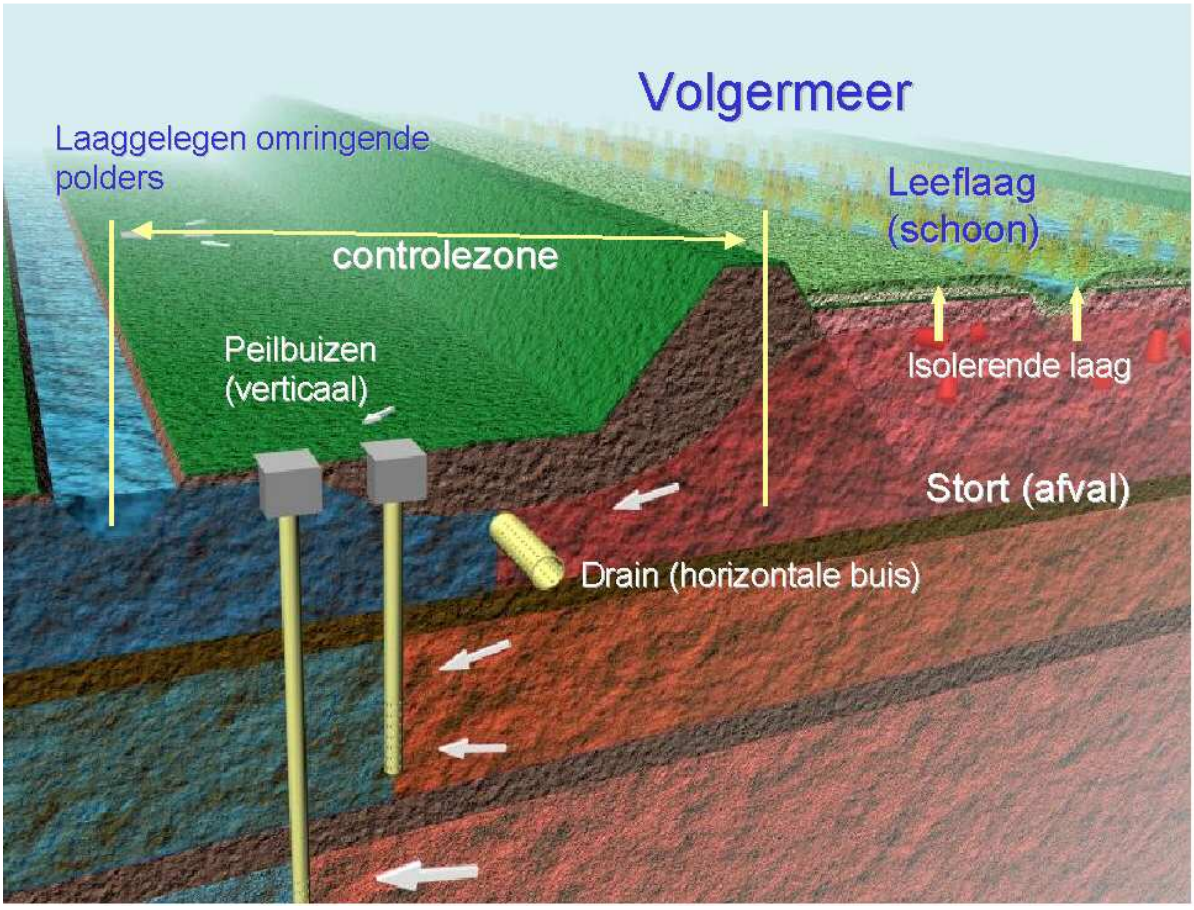

Fig 2.

In all pipes volatile aromatics, mono- and dichlorobenzene are measured. Especially benzene, mono- and dichloro-benzene are good tracers for the leakage of pesticides and dioxins because they are dumped together with and/or degradationproducts of pesticides. They are very stable under anaerobic circumstances and mobile. They are present on the Volgermeer in high concentrations.
10% of the pipes are analyzed for polar and apolar pesticides.
5 % of the samples are analyzed for chlorinated dioxins and dibenzofurans.

Class of compounds	Number of compounds
Metals	15
Volatile aromatics	5
Phenol index	1
Polycyclic Aromatic Hydrocarbons	10
Volatile chlorinated hydrocarbons	10
Chlorinated Benzenes	6
Chlorinated Phenols	5
Organochloro pesticides	41
Organophosphor pesticides	51
Organonitrogen pesticides	29
N-methyl carbamates	3
pyrethoids	23
Carboxyl like compounds	12

Table 2.

Whenever in the future leaking takes place an interception system will be build to clean the leaking water.
The top of the site will be kept wet so that formation of peat can start again. The Burkmeer next to the site is a polder now but will be used as a reservoir for rainwater. This avoids that it will be necessary to use water from the lake Markermeer for irrigation.
It is hoped that after several years the landscape will reflect a more natural environment.

Reverences:

1: Holmstedt, B. *Archives of Toxicology,* 44 (1980) pp 211-230

2: Olie, K.; Bockting,G.J.M.; van Klaveren,J. *Organohalogen Compounds*, 54 (2001) pp 274-277