

Natural capping of the landfill Volgermeerpolder

C.H. Clemens^{1,2*}, M. van der Wijk^{1,2}, P. Stook^{2,3} & J.C.N. van der Pal⁴

¹ Advies Combinatie Volgermeerpolder: a consortium of Witteveen+Bos and Tauw,

² Witteveen+Bos Consulting Engineers, Deventer, The Netherlands,

³ Tauw, Deventer, The Netherlands,

⁴ Municipality of Amsterdam, Amsterdam, The Netherlands.

* Rina Clemens, Witteveen+Bos, P.O. Box 233, 7400 AE Deventer, The Netherlands
phone. + 31 570 69 71 74, fax. +31 570 64 97 01, e-mail: c.clemens@witteveenbos.nl

Abstract:

The Volgermeerpolder is an area of approximately 105 hectares, located 5 kilometer north of the city of Amsterdam in a marshy polder with shallow groundwater, open water and deep peaty soils. In the twentieth century the Volgermeerpolder was used as a landfill for domestic and industrial waste. This included large amounts of chemical waste, making it one of the most heavily contaminated areas in Western Europe.

In the 1970's the discussion started that it would only be a matter of time before the toxic waste spread uncontrollably into the environment. The heavily polluted landfill was considered a 'chemical time bomb'. After the Volgermeerpolder closed in 1981, the local authorities took the initiative towards remediation. Because no groundwater pollution was measured in the surrounding marshy polder, it was concluded that the deep peaty soils acted as a natural barrier and prevented the spreading of contaminants. This led to the conclusion that the Volgermeerpolder could be remediated without a complete isolation of metal sheets surrounding the polder and bottom sealing underneath. The decision was made that for remediation it would be sufficient to only cover the landfill.

For the remediation an Eco-variant was chosen to prevent contact risks, prevention and control of waste spread and eventually to create conditions for developing a wetland. In 2001 the consortium ACV - Advies Combinatie Volgermeerpolder¹ - started remedial planning and design. In 2005 the remediation started with the construction of the standard soil/HDPE cover and will be completed in 2010. During the remediation, ACV noticed how the peat soil surrounding the Volgermeerpolder worked as a carbonfilter and prevented spreading of organic pollutants. To avoid replacement of the standard cover in the future, ACV developed a surprisingly simple and effective concept for landfill remediation: the 'natural cap'.

The 'natural cap' consists of a gradual, functional replacement of the standard cover (of soil and a synthetic foil) by a natural layer of living, organic material. It is based on the fact that you can use the time after remediation - the management phase - to create an alternative for the replacement of the standard cover, which is the case for every isolated landfill site.

The 'natural cap' on top of the Volgermeerpolder has a lot of advantages. The peat landscape that will arise over the years is very attractive from a landscape point of view. The landfill will fit in the surrounding Dutch landscape and fulfil recreational purposes. With the development of peat also significant amounts of CO₂ is captured. Furthermore, the creation of the wetland will provide scientists

¹ Advies Combinatie Volgermeerpolder is a consortium of Witteveen+Bos and Tauw.
More information can be found on www.naturalcap.eu.

knowledge about peat development, which can provide answers to stop degeneration of peat and consequently the lowering of the soil surface.

Therefore, natural capping is not only an innovative green remediation method, but will also help to mitigate the effects of climate change. When on the long term the 'natural cap' on top of the Volgermeerpolder prevents the replacement of the standard cover, it also avoids considerable costs and disruption of newly developed nature.

INTRODUCTION

History

The Volgermeerpolder is an area of approximately 105 hectares, which in the twentieth century was used as a landfill for domestic and industrial waste. This included large amounts of chemical waste, for instance 30.000 barrels of pesticide production waste, making it one of the most heavily contaminated areas in Western Europe. The Volgermeerpolder (52°44' N, 5°15' E) is located 5 kilometer north of the city of Amsterdam, in a marshy polder with shallow groundwater, open water and a deep peaty soil.

In the 1970's the discussion started that it would only be a matter of time before the toxic waste spread uncontrollably into the environment. The heavily polluted landfill was considered a 'chemical time bomb'. After the Volgermeerpolder closed in 1981, the local authorities took the initiative towards remediation. Still it took some time to find a suitable solution and start the remediation.

Before remediation

In the intervening period - before remediation and after the use of the Volgermeerpolder as landfill - nature had the opportunity to establish a new status quo. On the wet low-lying areas with large quantities of industrial waste, a thick growth of poplar, willow, elderberry and brambles arised. The higher dry areas, containing mainly domestic waste, resulted in a vegetation of mostly grass and brambles. Surprisingly the surface water in the waterways on the Volgermeerpolder had a good quality. This in spite of the heavily contaminated sediments and percolation water less than a metre from the surface water.

The groundwater surrounding the Volgermeerpolder was intensively monitored over a period of more than 30 years. This showed that the waste did not pollute the groundwater in the surrounding 'marshy polder'. The continuous peat layer surrounding the landfill acted as an impermeable natural barrier for organic contaminants. The deep peaty soil prevented the spreading of organic contaminants in horizontal and vertical direction. This led to the conclusion that the Volgermeerpolder could be remediated without a complete isolation of metal sheets surrounding the polder and bottom sealing underneath. The decision was made that for remediation of the Volgermeerpolder it would be sufficient to only cover the landfill.

REMEDICATION OF THE VOLGERMEERPOLDER

Remedial planning and design - the Eco-variant

Around 1998 the remediation of the Volgermeerpolder received a new stimulus. The so-called 'Eco-variant' was developed. The Eco-variant had the following specific aims: (1) preventing

contact risks, (2) prevention and control of waste spread and (3) creating conditions for developing natural wetlands. In the remediation plan a standard cover with soil and HDPE foil was chosen to obtain these aims. It also included the implementation of a buffer zone around the landfill for groundwater monitoring to in time detect the spreading of contaminants.

In 2001 the consortium ACV - Advies Combinatie Volgermeerpolder² - started remedial planning and design for the Volgermeerpolder. In addition to the remediation of the polder and adjacent areas, this also included the structural design of the landscape, including 59 sawa's (shallow ponds) with the purpose to eventually create a new and natural wetland.

The standard cover

The remediation of the Volgermeerpolder started in 2005, with covering the landfill with various soil layers. The first layer consists of soil from ground works in the region, which is then covered with HDPE foil. On top of this HDPE foil a second soil layer is placed. The existing waterways are also covered with HDPE foil and soil. On the 60 hectare wet low-lying areas a wetland is created, by making a system of shallow ponds – 59 sawa's and the existing waterways – with dikes on top of the soil/HDPE cover. The remaining 40 hectare is considered a dry area. As part of the remediation a buffer zone is created around the Volgermeerpolder in which the groundwater quality is intensively monitored.

The result of the groundwater monitoring before remediation was confirmed by the actual remediation of the Volgermeerpolder. The monitoring of the groundwater in the buffer zone has indicated virtually no spreading of contamination. The remediation confirmed that the spread of contamination was actually limited by the surrounding peat soil. This led to the conclusion that the chemical waste unintentionally was dumped at a very favourable location.

The standard cover on the Volgermeerpolder will be completed in 2010. The remediation will then be followed by a management phase. The standard cover, however, has a limited life span between 50 and 100 years. The remediation plan describes the aftercare that is necessary after a period of approximately 30 years: replacement of half of the standard cover (50 ha). A large scale replacement would again require considerable effort and resources, cause considerable nuisance for those living nearby and have a negative effect on the redeveloped flora and fauna.

NATURAL CAPPING

Introduction of the 'natural cap'

To avoid replacement of the standard cover, ACV developed a surprisingly simple and effective concept: the 'natural cap'. This concept consists of a gradual, functional replacement of the standard cover (of soil and a synthetic foil) by a natural layer of living, organic material.

The 'natural cap' is considered a sustainable and durable solution and a surprisingly simple and effective concept with great potential for landfill remediation. It is based on the fact that

² Advies Combinatie Volgermeerpolder is a consortium of Witteveen+Bos and Tauw. More information can be found on www.naturalcap.eu.

you can use the time after remediation - the management phase - to create an alternative for the replacement of the standard cover, which is the case for every isolated landfill site.

A ‘natural cap’ of peat on top of the Volgermeerpolder

The ‘natural cap’ on top of the Volgermeerpolder will be created during the management phase (> 2010) by actively stimulating peat growth in the sawa’s of the wetland. Peat grows naturally and has added value for the development of nature. Peat is known to have a low permeability for water and works as a natural carbonfilter for organic contaminants. It therefore is expected that a peat-layer in the sawa’s will contribute significantly to reducing the risk of spread. On the long term the developed peat layers in the wetland system will take over the impermeable function of the HDPE foil. Consequently, the HDPE foil does not have to be replaced anymore.

Lessons learned – integration of design, remediation and management

One of the lessons learned during the remediation of the Volgermeerpolder is that further integration of design, remediation and management is necessary to make a wetland less sensitive to nutrient loading. Because of the agricultural use of the surrounding polders and the high nutrient load, the water from outside the Volgermeerpolder is not suitable for use in the sawa system. For the wetland, the ideal situation would be a system fed only by rainwater.

Almost at the end of the remediation of the Volgermeerpolder it is necessary to take a critical look at the surface layer and the quality of the applied soil in the sawa’s. To prevent a negative influence on the quality of the surface water in the new water system, the amount of nutrients in the soil in direct contact with the surface water should be limited. Depending on the soil quality, measures might be necessary to keep the nutrient loading from the surface soil under the critical nutrient level for specific parts of the system to keep a sufficient water quality for the formation of peat.

The long term development and validation of the ‘natural cap’

The challenge after remediation is to manage the area in such a way that peat can form on the clean surface layer or a peat bog can be imported, placed and maintained in the sawa’s. Time is needed for forming a sufficient layer of organic material that can take over the environmental-, physical- and hydraulic qualifications of the HDPE foil. To answer the main question whether the peat layer eventually is sufficient for taking over the qualifications of the HDPE foil validation is necessary.

To validate the ‘natural cap’ as a sustainable solution a good understanding is needed of the processes that are involved, particularly in the boundary layer between the landfill and the surrounding peat soil. In this respect the question as to whether a peat layer is capable of sufficiently buffering the spread of contamination is particularly relevant. In cooperation with the Centre for Wetland Ecology³ and the municipality of Amsterdam ACV is conducting further research to continue the development of the ‘natural cap’ concept, and further optimize the design for the Volgermeerpolder.

³ The Centre for Wetland Ecology is a partnership of the Netherlands Institute of Ecology (NIOO-KNAW), Radboud University Nijmegen (RU), Utrecht University (UU) and the University of Amsterdam (UvA). More information can be found on www.wetland-ecology.nl

CONCLUSIONS

The ‘natural cap’, an example of green remediation

The ‘natural cap’ is a surprisingly simple and effective concept with great potential for landfill remediation. It is considered a sustainable and effective alternative for a standard remediation and thus a valuable contribution to the cost-effective remediation of a lot of landfills in the Netherlands and abroad.

The peat landscape that will arise over the years on the Volgermeerpolder is very attractive from a landscape point of view. The landfill will fit in the surrounding Dutch landscape and fulfill recreational purposes. With the development of peat also significant amounts of CO₂ is captured. Furthermore, the creation of this new wetland will provide scientists knowledge about peat development, which can provide answers to stop degeneration of peat and consequently the lowering of the soil surface. Therefore, natural capping with peat is not only an innovative and cost-effective green remediation method, but will also help to mitigate the effects of climate change. When on the long term the ‘natural cap’ on top of the Volgermeerpolder prevents the replacement of the standard cover, it also avoids considerable costs and the disruption of newly developed nature.