

# THE INFLUENCE OF NATURAL ATTENUATION ON THE RISKS AND AFTERCARE OF FORMER LANDFILLS

Hans Slenders<sup>1</sup>, Mari Marinussen<sup>2</sup>, J. van der Ben<sup>3</sup>, W. van Vossen<sup>2</sup>

<sup>1</sup>TNO-MEP

P.O Box 342 7300 AH Apeldoorn, The Netherlands

<sup>2</sup>IWACO B.V.

P.O. Box 525, 5201 AM 's-hertogenbosch

<sup>3</sup>IPO-NAVOS c/o Province Zuid-Holland

P.O. Box 90602 2509 LP The Hague

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## Summary

At this moment the results of an extensive set of soil and groundwater analyses of about 80 former Dutch landfills are being processed. The study not only has to produce an image of soil and groundwater quality in and around landfills, but also has to lead to a more solid estimate of aftercare measures at the 3800 former landfills in the Netherlands. Investigation of 80 of these landfills is currently performed to obtain more understanding of natural attenuation processes in and around landfills. The preliminary results show that in general the concentrations of contaminants are very low, even in the landfill body itself. Only anaerobically difficult degradable compounds (benzene, naphtalene) are more than incidentally found. Outside the former landfills, concentrations of both micro- and macro-components are very low, e.g. concentrations of heavy metals in leachate and leachate plumes often are lower than background concentrations. In advance of the final results it may be concluded that until now the risks and the necessary aftercare and related cost have been overestimated, and that the main future measure will be monitoring (MNA).

## 1 Introduction

The Netherlands has around 3800 former landfills, which vary in size and composition of the dumped waste. The landfills were mostly exploited during the 50's through 70's. Since then, they are no longer used, but appropriate

measures and facilities to protect the underlying soil have never been taken. This means that the quality of soil and groundwater can be affected due to leaching of contaminants from the waste material. Until now not all landfills have been investigated for the presence of leachate plumes, and the long term behaviour of landfills and leachate plumes is only partly known. Landfills have a bad image and in their surroundings social developments like the use of the land, development of nature, building of houses and industrial areas, etc. do not occur. Therefore the gathered Dutch Provinces (IPO) gave order to investigate the behaviour of leachate plumes as a result of natural attenuation (NA) processes in waste, (ground) water and surrounding sediments. For the execution of the NA-project IWACO formed a consortium with TNO, Bioclear, and the Free University of Amsterdam. On a national level, 10 Provinces are co-operating. Each of these provinces selects a number of landfills.

## 2 The NA-Project

The NA project comprises research on natural attenuation processes at 80 former landfills which have been selected according to composition of the dumped waste and the geohydrological situation. This selection represents a national cross section of the problem. The general hypothesis used is that:

*As a result of micro-biological transformation and precipitation few contaminants leave the landfill, and the wide range of redox conditions down-gradient from the landfill (from methanogenic to nitrate-reducing/oxic) nearly always contains specific boundary conditions necessary for biotransformation or precipitation of contaminants.*

Each landfill is analysed for:

### 1. Landfill processes:

- contaminants;
- redox-chemistry: macro-ions, hydrogen measurements;
- degree of decomposition (fermentation tests);
- micro-biology: DNA-profiles, BIOLOG's;
- precipitation (sulphides).

### 2. Attenuation processes in aquifer:

- contaminants;
- redox-chemistry: macro-ions, hydrogen measurements;
- oxidation-reduction potential;
- biodegradation (intermediates, batch-experiments etc.);
- Extensive GC-screenings.

### 3 Prediction tool

Through the extensive analysis programme and interpretation of the results, insight will be gained in the functioning of NA-processes in former landfills and leachate plumes. This will be carried out in such a way that for nearly every situation the NA-potential of a landfill can be predicted. One of the results of the research will be, that based upon (expected) waste composition and hydro-geological situation a prediction can be made for the existence of leachate plumes at landfills which are not investigated yet. On the basis of this prediction an estimate of future after care costs can be made, essential for the planning and budgeting of the after care by provinces and national government.

### 4 Interpretation and preliminary results

At this moment all site activities are finished, and the data are being processed. The project will be finished in the summer of 2000.

The interpretation is carried out in stages with increasing detail:

- a comparison between concentrations upstream, in, and downstream of the landfills. What is the extent of the national problem? At how many landfills an aggressive leachate plume is present? If not, is there a potential risk (high concentrations in landfill)?
- Are the results in line with the expectations regarding the governing processes (e.g. precipitation, biotransformation, redox-gradient)? Is a landfill a chemical time bomb, a slow release battery or only an old compost heap?
- Unexpected phenomena, what do we learn from DNA-screenings, BIOLOG's or data from more than 80 landfills?

The first results are in line with the expectations that only in a few cases significant groundwater contamination occurs. In regarding the results it is important to realise that they concern *former* landfills, where dumping stopped more than 10 years and in some cases over 50 years ago.

The following preliminary observations can be mentioned:

- In most cases the influence of the landfill on groundwater quality outside the landfill body is not or barely detectable. It is almost as if the landfill bodies are isolated geohydrological units. Contaminants are scarcely found outside the body, and also clearly different macro-chemistry is not common;

- Possible plume indicators are pH, redoxpotential, Dissolved Organic Carbon or BOD/COD. They show the clearest distinction between influenced and not influenced zones;
- The salinity, sulphate and redoxpotential are indicative for the origin of the groundwater (infiltration or seepage). E.g. in polder areas saline seepage is clearly noticeable, and can also be used as a tool to determine the extension of the landfill plume;
- In the landfill bodies themselves anaerobically recalcitrant compounds as benzene, monochlorobenzene and naphthalene are found. In case nitrate is measured in the landfill leachate/groundwater, these compounds are completely absent. This remarkable effect might be caused by degradation under nitrate reducing/oxic conditions;
- In some cases traces of phenols, methylbenzenes are found.
- Concentrations of heavy metals in plumes (if found) are lower than backgroundlevels.

## 5 Future perspective

The results of the NA research are expected to lead to the conclusion that former landfills represent less risk to their environment than generally thought by the public. The NA research may be able to lead to a reduction of the current estimates of the costs for the aftercare of former landfills. These two elements may be able to facilitate the integration of former landfills in spatial planning under socially acceptable conditions.

The public opinion plays a major role in this process. At the moment, former landfills have a very negative image in all layers of society and are considered to be a threat. For the integral MRE approach to be a success, it is absolutely essential that the public opinion is adjusted on the principle “from threat to chance”, which will lead to a more positive image for the former landfills.