# INTRINSIC BIOREMEDIATION IN THE CASE OF A DIESEL OIL CONTAMINATION AT A RAILWAY YARD: INVESTIGATION AND POSSIBLE IMPLEMENTATION.

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## INTRODUCTION

A cardinal development in the field of soil clean-up techniques is the use of natural attenuation and the application of extensive clean-up techniques. This can lead to a significant reduction in the cost of soil decontamination. Recent literature, chiefly American, has revealed that intrinsic remediation is taking place at a number of contaminated locations.

Specialists from the Environment Group at Holland Railconsult have investigated the occurrence of intrinsic bioremediation at a diesel oil contamination site located in the NS yard Susteren. The study was undertaken as part of supplementary investigations commissioned by the Dutch Railways Foundation for Soil Remediation. The research results were analysed by the Netherlands TNO Institute for Applied Geosciences. The results are to be taken into account in performing the clean-up study.

In the yard at Susteren, diesel oil contamination had taken place in the past as a result of NS activities in the vicinity of a fuel station. The yard is situated in a water protection area.

The contaminated site in question can be ideal for intrinsic biorestoration, due to:

- the limited depth of groundwater contamination
- the fact that benzene (which is not, by nature, easily degradable) is present in small amounts only
- the feature that the principal contaminants (mineral oil, toluene and xylene) are, by nature, easily degradable.

## OBJECT OF THE STUDY

The total project involves several phases between the determination of the extent of the contamination in soil and groundwater and the clean-up study study. This publication focusses on the determination of the site specific potential of intrinsic bioremediation.

## METHODS

Findings relating to intrinsic bioremediation were obtained by determining a number of macroparameters in and close to the contamination site. The dissolved components determining the redox status and the carbonate chemistry of the groundwater (Fe, Mn,

$NO_3$, $O_2$, $SO_4$, $CH_4$ and Ca, Fe, $HCO_3$ and pH respectively) are of chief importance here. These parameters were established not only within the contaminated area, but also downstream and upstream of the contaminated site. The latter can serve as a background reference, providing a record of the natural composition.

## RESULTS OF THE MACROPARAMETRIC STUDY

The monitoring wells that were sampled to provide a picture of the underlying composition revealed groundwater that was rich in sulphate and iron. Nitrate and oxygen were below the detection limit and $HCO_3$ concentration was low.
The monitoring wells in the contaminated area all revealed groundwater without nitrate and oxygen. The presence of methane in the groundwater was apparent, with concentrations of up to 18 mg/l. Iron and $HCO_3$ concentrations also ranged from high to very high. The sulphate concentrations were relatively low in the area contaminated with diesel oil. The higher anaerobic status of the groundwater inside the contaminated area is a clear indication of the intrinsic bioremediation of organic compounds. This suggests the degradation of, above all, aromatic compounds, since these are in principle degradable in all redox conditions.
At this site an increase in pH from 5 - 5.5 to 6.5 can further be noted at the two upstream wells in the direction of the wells in the contaminated area. This can also be seen as an indication of the occurrence of intrinsic bioremediation.
The groundwater in the monitoring wells downstream from the contamination was characterised as anaerobic with a good deal of iron, a little methane, quite large amounts of sulphate and a moderate quantity of $HCO_3$. The composition can indeed be considered as originating at the edge of a contamination area where intrinsic attenuation is taking place.
The groundwater from the contamination diffusion area is characterised as groundwater containing no organic contaminants, but revealing redox-sensitive components in solution which are a direct indication of intrinsic attenuation.

## CONCLUSIONS

On the basis of the results of this study, it can be concluded that the real risk of the migration of contaminants is considerably smaller than the prevalent notion of the risk of it spreading as determined by urgency systematics would have it: intrinsic attenuation of mono-aromatics is an additional mechanism limiting the migration of contaminants as a whole. The real risk of contamination spreading is probably strongly dependent on the diffusion of the mineral oil in the groundwater. For mineral oil, intrinsic bioremediation is only possible from the edges of the contamination area if the non-contaminated groundwater contains oxygen or is oxic. This is not considered impossible at this location. Furthermore, sorption and dispersion are two mechanisms that lead to an intrinsic reduction in groundwater contamination.
Since intrinsic bioremediation has been indicated, this aspect is to be taken into special account in the next phase of the work, a study comparing applicable clean-up methods. Because the location is in a groundwater protection area, special attention will be paid to monitoring and minimising the risk of diffusion.
The poster contains further details of the processes of intrinsic bioremediation and on the remit for the follow-up phases comprising the clean-up study (comparing applicable clean-up methods) and plan.