

WRC Studies Shed Light on Groundwater Polluting Chemicals



While the pollution of South Africa's surface water has been receiving much attention lately, the degradation of the country's underground resources has largely gone unnoticed. The Water Research Commission (WRC) has been funding substantial research into understanding the extent of contamination of the country's aquifers by dense non-aqueous phase liquids (DNAPLs). Lani van Vuuren reports.

Dense non-aqueous phase liquids (DNAPLs) are chemicals or mixtures of chemicals that are heavier than water, and are only slightly soluble in water. This means that when released into the environment in sufficient quantities, they can move through soils and groundwater until they encounter an impermeable layer that will impede further mass vertical movement and allow the liquid to pool or move along the dip of an impermeable layer or within a fracture. DNAPLs have thus the potential to move in the opposite direction to that of the localised groundwater flow direction.

Contamination with DNAPLs is a worldwide phenomenon, but to date there has been limited awareness and understanding of the problem locally. There are thousands of potential sites in South Africa, as elsewhere in the world, where DNAPLs may have been released to the subsurface in varying quantities. Examples include chlorinated solvents (degreasers and dry-cleaning fluids), creosote, coal tar, and polychlorinated biphenyls (as found in dielectric oils, for example).

POTENTIALLY HARMFUL

Public awareness of DNAPL pollution to date has been very low. According to WRC Research Manager Dr Shafick Adams, South Africans should become more aware of the hazards DNAPLs pose to the environment, and specifically to groundwater resources. "Because of the low solubility of DNAPLs they often persist for several decades in the subsurface. In addition, some DNAPLs are highly toxic at even very low concentrations and can thus pose unacceptable health risks to both humans and the environment."

It is also reported that DNAPLs are not often released into the environment as pure chemicals but rather as solvents that contain varying amounts of other contaminants. These other components can significantly influence the overall properties of the DNAPL, and both aid detection and complicate remediation.

DNAPLs trapped in the subsurface act as continuing sources of dissolved contaminants to groundwater. Their removal from aquifers is very difficult and costly.

As a result, these chemicals have been classified as high priority pollutants in several countries, including South Africa.

INCREASING AWARENESS

While major industries are now becoming increasingly aware of the problems associated with organic pollution, the challenge exists that there is often no routine monitoring for organic compounds. When coupled with the current lack of analytical capabilities in South Africa, one can begin to understand why DNAPL contamination still often goes undetected.

"Large operators sometimes have systems in place to monitor organic pollution emanating from leaks and accidental spillage," explains Dr Adams. "However, until recently there were no specific guidelines for the assessment of DNAPLs in the country."

TAKING THE LEAD

Recently, the first comprehensive publicly-funded study into the fate and

transport of DNAPLs in groundwater in South Africa was concluded with support from the WRC. The project resulted in the development of guidelines for a range of activities linked to the identification, characterisation and monitoring of DNAPL-contaminated sites.

This is important as South Africa's aquifers are mainly fractured aquifers with a unique set of challenges when assessing the fate and transport of DNAPLs in the subsurface. "Because of our complex aquifer systems as well as the physical and chemical properties of these substances accurate prediction of the behaviour of the chemicals is challenging," Dr Adams tells *the Water Wheel*.


WRC-funded investigations into DNAPLs have found that the extent of the problem in South Africa's urban areas is potentially much greater than expected. The problem is not confined to large urban centres, as many of the potential sources (such as auto shops and dry cleaners) are found in all types of settlements across the country. This means that the development of groundwater resources to supply urban areas (one of the considerations under the Department of Water & Environmental Affairs' Water for Growth and Development Framework) is thus very likely to be affected by potential contamination from DNAPLs.

GUIDELINE DOCUMENTS

Rather than creating one large report, the study was split into a several, easier digestible, documents. The latest reports to be published include a layman's guide to DNAPLs in South Africa. This is a very important document as even wrongfully disposing of one's used car oil can lead to groundwater pollution.

There is also a handbook for DNAPL-contaminated sites. This publication provides an overview of the most important considerations for DNAPLs in South Africa. It discusses the sources and occurrences of DNAPLs and the most important factors controlling the migration and fate of DNAPLs and dissolved organics. It is aimed at site investigators, geohydrologists, site-owners and regulators.

The completed DNAPL study also laid the foundation for new research into light non-aqueous phase liquids (LNAPLs), which started in 2007. Crucial partnerships were built with industry partners during the DNAPL study, and the petrochemical sector, for example, has made some of its sites available for research for the new LNAPL study.

It is hoped that the outcome of these investigations will do much to aid the sustainable management and prevention of pollution of South Africa's precious groundwater. 



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TOP TEN SOURCES OF POSSIBLE DNAPL GROUNDWATER CONTAMINATION

- ◆ Production of agricultural chemicals (fertilisers, herbicides, pesticides)
- ◆ Metallurgical processes
- ◆ Metal (predominantly gold) and coal mining
- ◆ Transport
- ◆ Petrol service stations (underground storage tanks)
- ◆ Wood processing and preserving
- ◆ Manufacturing – chemicals
- ◆ Workshops (mechanical and electrical)
- ◆ Stormwater/sewer systems
- ◆ Automotive manufacturing

DNAPL REPORTS AVAILABLE FROM THE WRC:

Handbook for DNAPL Contaminated Sites in South Africa (WRC Report No: TT 326/07)

DNAPLs in South Africa: a Layman's Guide (WRC Report No: TT 325/07)

Manual for Site Assessment at DNAPL Contaminated Sites in South Africa (WRC Report No: 1501/2/08)

Guidelines for the Acceptance of Monitored Natural Attenuation Processes in South Africa (WRC Report No: 1501/3/08)

Groundwater Monitoring Guidelines for DNAPLs in South African Aquifers (WRC Report No: 1501/4/08)

Field and Laboratory Investigations to Study the Fate and Transport of DNAPLs in Groundwater (WRC Report No: 1501/5/08)

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