

# Characterisation of some South African water treatment residues and implications for land application

LW Titshall\* and JC Hughes

Soil Science, School of Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, South Africa

## Abstract

Land application of water treatment residue (WTR) the by-product from the production of potable water, is becoming the preferred method of disposal, as there are environmental concerns and increasingly high costs associated with other disposal options. However, before WTR can be applied to land, consideration needs to be given to their chemical and physical characteristics to determine potential impacts. Six WTR samples were obtained from five South African water treatment facilities (Faure Water Treatment Plant (two samples), Rand Water, Umgeni Water, Amatola Water and Midvaal Water Company). The Rand Water WTR was a CaO, FeCl<sub>3</sub>, long-chain organic polymer (LCP) residue with activated silica and CO<sub>2</sub> being added. The Umgeni and Amatola Water WTRs were lime and LCP residues. The Midvaal Water WTR was an Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>·nH<sub>2</sub>O, FeCl<sub>3</sub>, lime and LCP residue and the Faure WTRs were Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>, activated charcoal, lime and LCP residues. These WTR samples were analysed for some physical (particle size distribution, particle density and plant available water) and chemical attributes (pH, electrical conductivity, cation exchange capacity, calcium carbonate equivalence, exchangeable acidity, extractable bases and metal cations, total and plant available nutrients, total elemental analysis and metal fractionation) and mineralogical properties, and their potential for application to land considered. The WTRs tended to be neutral to alkaline in pH, with low electrical conductivity. Generally, amounts of N, P and K were low, but some of the WTRs showed potential to supply other plant nutrients (Ca, Mg, S, Zn, Cu and Fe). Their physical characteristics were variable, showing a wide range in particle size distribution as well as plant available water. Heavy metal concentrations tended to be low, but Mn was elevated in some WTRs, especially in the Faure WTRs, which may lead to plant growth problems. Land application of these WTRs appears to be a feasible disposal option, but currently they are regulated by the 'minimum requirements for disposal of hazardous waste'. Delisting would firstly be required for land application and if then permitted by legislation, the application rates would need to be based on existing soil conditions, the characteristics of a particular WTR, and the proposed land use.

**Keywords:** Water treatment residue, land application, potable water, minimum requirements, disposal

## Introduction

Water treatment residue (WTR) is the by-product from the production of potable water. It consists mainly of the precipitated hydroxides of the treatment chemicals that are added to coagulate and flocculate dissolved and suspended material in the raw water source and also during the residue dewatering process (Elliott et al., 1990b). Types and dosages of treatment chemicals vary depending on the quality of the raw water and their cost and availability. The chemicals typically include Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>·nH<sub>2</sub>O, FeCl<sub>3</sub>, Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>, long-chain organic polymers (LCP), activated charcoal, activated silica and lime.

In the past, WTRs were discharged into watercourses (AWWARF, 1969), and more recently have been disposed of in landfills, due to the environmental concerns over direct river discharge (Basta, 2000). In many parts of the world, including South Africa, WTR has conventionally been disposed of by landfilling (Department of Water Affairs and Forestry, 1998). Basta (2000), in a review paper, has indicated that currently landfill is the most commonly used disposal option, but due to increased costs, land application is becoming the preferred disposal method. In South Africa, the reason for the previous popularity of landfills was that, with environmental concerns being

of low priority, landfill constituted a convenient method of waste disposal. Since 1994, however, South Africa has seen the closure of numerous landfill sites for both social and environmental reasons (Department of Water Affairs and Forestry, 2003). International agreements since 1994 have also put increasing pressure on the South African government to improve environmental policy (Department of Water Affairs and Forestry, 2003). As South Africans become more environmentally aware of the potential hazards of landfills, and legislation is made stricter, alternatives for waste disposal are being sought. Land disposal presents an appealing alternative to conventional disposal as it suggests that wastes can be assimilated, without inducing negative effects on soil quality. Indeed, there have also been reports suggesting that land disposal of WTR may improve soil quality (Roy and Couillard, 1998).

Land disposal of waste, a methodology also known as land application or treatment, has been described by Overcash and Pal (1979) as 'the intimate mixing or dispersion of wastes into the upper zone of the soil-plant system, with the objective of microbial stabilisation, adsorption, immobilisation, selective dispersion or crop recovery, leading to an environmentally acceptable assimilation of the "waste"'. Therefore, land disposal constitutes an open system offering potential for waste treatment, as opposed to simply waste disposal such as is associated with landfill. Elliott et al. (1990a) and USEPA (1996) consider some processes and management practices for land disposal to be a viable option, while Basta (2000) reviews a number of the studies that have considered the effects on soil properties and plant growth of land application of WTR. Most studies report

\* To whom all correspondence should be addressed.

☎ +2733 260-5415; fax: +2733 260-5426;

e-mail: [Titshall@ukzn.ac.za](mailto:Titshall@ukzn.ac.za)

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