



ONE HEALTH

CONTAMINANTS OF EMERGING CONCERN

2026



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INTRODUCTION

Contaminants of Emerging Concern (CECs) are an increasingly important challenge for water security, public health and environmental sustainability. These substances, including pharmaceuticals, personal care products, industrial chemicals, pesticides, microplastics and antimicrobial-resistant microorganisms, are entering our water resources through a variety of human activities. Although often present in very low concentrations, their long-term impacts on people, animals and ecosystems are not yet fully understood, making them a growing concern worldwide.

The Water Research Commission (WRC) recognises that addressing CECs requires a One Health approach, which acknowledges the close connection between human health, animal health and the environment. Pollutants released into rivers, groundwater and wastewater can move across these interconnected systems, affecting drinking water, food production, biodiversity and ecosystem resilience. Protecting one depends on protecting all.

Scientific research is therefore essential to identify emerging contaminants, understand their sources and pathways, assess their risks, and develop innovative technologies to detect, treat and prevent them. By advancing knowledge and supporting evidence-based decision-making, the WRC is helping South Africa build resilient water systems that safeguard public health, protect ecosystems and support sustainable development. The brochure highlights some of the latest WRC-funded research on this topic.



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ASSESSING THE IMPACT OF
DIFFERENT POLLUTION SOURCES
ON THE TYPE OF MICROPLASTICS,
ASSOCIATED MICROBIAL
COMMUNITIES, ANTIMICROBIAL
RESISTANCE, AND TRANSPORT OF
MICROPLASTICS IN SELECTED URBAN
RIVERS IN SOUTH AFRICA

WRC report no. 3230/1/25

Plastic polymers, while revolutionising modern industries with their affordability, durability, and versatility, have created a global environmental crisis: the accumulation of nonbiodegradable microplastics (MPs). These MPs contaminate aquatic ecosystems, including rivers, lakes, and oceans, posing significant ecological and health risks. Notably, MPs can act as substrates for microbial biofilm formation, fostering diverse microbial communities with potential ecological implications. This study aimed to evaluate the impact of various pollution sources on the type, associated microbial communities, and transport of MPs in selected urban rivers in South Africa. This study investigated microplastic pollution in two South African rivers, namely the Msunduzi River (KwaZulu-Natal Province) and the Swartkops River (Eastern Cape Province).

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MICROPLASTICS IN MUNICIPAL DRINKING WATER, BOTTLED WATER AND BEVERAGES

WRC report no. 3220/1/25

Microplastic pollution has been identified as a direct or indirect hindrance to achieving twelve of the seventeen Sustainable Development Goals set by the United Nations. These goals are a universal call to action made to safeguard our coexistence with nature and as a species by eradicating poverty, protecting the environment, and ensuring that everyone lives in peace and prosperity. Microplastics are made up of different polymers, which behave differently in the environment. During manufacturing, different metals are added to polymers, which may later be desorbed and released into the environment. This study aimed to conduct a comprehensive characterisation of MPs in river water, sediments, groundwater, drinking water (tap and bottled), tea, and beverages and model their potential physical-chemical behaviour in such systems. This would provide a benchmark on which future and advanced studies can hinge and provide insights into how these contaminants could be removed from water.

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NATIONWIDE MONITORING OF PER- AND POLYFLUOROALKYL SUBSTANCES IN WATER IN SOUTH AFRICA

WRC report no. TT 931 1-3/23

Per- and polyfluoroalkyl substances (PFASs) are synthetic chemicals used in textiles, packaging, papers, carpets and building and construction materials. During usage or disposal of products treated with PFASs, these chemicals can be released from products into the environment. The presence of these substances in water resources is of concern because of their bioaccumulative, persistent, long-range transport and toxic characteristics. Their presence in the environment, particularly water, therefore, needs to be monitored. The overall aims of the project were to monitor the concentrations of legacy and emerging PFASs in different water sources in pre-selected cities and towns from all the nine provinces in South Africa; use an appropriate model to identify the PFASs sources and assess the amounts of pollution by resolving the measured mixture of chemical species into the contributions from the individual source types; develop a nationwide database on PFASs concentrations in different water sources from different parts of the country, and apply a test battery of bioassays covering a range of endpoints commonly responsive to drinking water to monitor water quality of source and drinking water.

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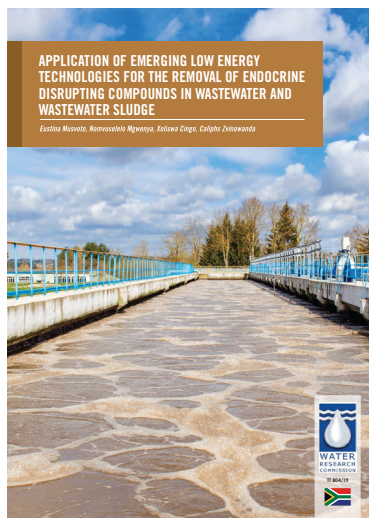


CHEMICALS OF CONCERN IN RECREATIONAL WATERS – OCCURRENCE AND ASSESSMENT OF POTENTIAL HUMAN HEALTH RISKS OF CHEMICALS IN PUBLIC SWIMMING POOLS

WRC report no. 2804/1/20

Swimming pool water, if not well managed, may act as a medium for exposure to harmful pathogens and chemicals. In South Africa, the quality of public swimming pool water has to meet the South African National Standards (SANS) 241 for drinking water of 2015 as stipulated by Notice 943 of 2013 (Government Gazette, 2013). However, current practice shows that public swimming pools are largely managed only to protect the bather from pathogens that might have been introduced by bathers themselves. The focus of this study was to investigate the presence of selected chemical compounds of concern in public swimming pools and evaluate the potential risks due to exposure during swimming. One factor that has not been investigated extensively is the endocrine disruption effect of swimming pool water, especially due to the presence of mixtures of chemicals of concern such as metals, disinfectant by-products and other organic compounds of concern such as pharmaceuticals and personal care products. The latter two classes of compounds are known for their unintended ability to cause interference in the hormonal processes of vertebrate bodies. This study, serves as a baseline for establishing the health implications due to exposure of bathers to chemicals of concern in public swimming pools.

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APPLICATION OF EMERGING LOW ENERGY TECHNOLOGIES FOR THE REMOVAL OF ENDOCRINE DISRUPTING COMPOUNDS IN WASTEWATER AND WASTEWATER SLUDGE

WRC report no. TT 804/19

To date, only a handful of studies have been undertaken on monitoring and removal of endocrine disrupting compounds (EDCs) from both wastewater and sludge in South Africa. The sludge management regulations in South Africa advocate beneficial utilisation and most of the sludge generated at municipal wastewater treatment plants (WWTPs) is disposed on land and also reused for agriculture. Global research has indicated increased concerns over the risks potential leaching of EDCs from sludge disposed on land into groundwater and uptake by plants pose to the environment and human health. In view of this, it is thus important for the South African wastewater sector to understand the levels of EDCs in sludge, the associated risks as well as measures to lower them. This project therefore aimed to address the gaps in knowledge on processes and technologies that remove EDCs from wastewater sludge, as part of the ongoing South African research programme on EDCs.

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EMERGING CONTAMINANTS IN WASTEWATER TREATED FOR DIRECT POTABLE REUSE: THE HUMAN HEALTH RISK PRIORITIES IN SOUTH AFRICA

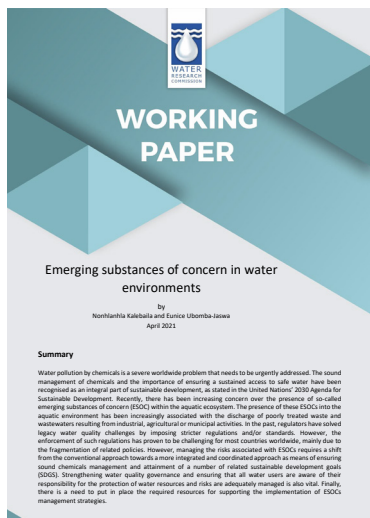
WRC report no. TT 742/1/17

If not treated properly, reclaimed water can act as a possible exposure pathway to a high number of emerging contaminants and their metabolites. Many of these compounds may pass through conventional wastewater treatment systems without removal and accumulate in potable water supplies. The possible presence of emerging contaminants in the final reclaimed water is of critical concern because of potential adverse impacts on human health. Thus, there is uncertainty over the magnitude of risk of human exposure to emerging contaminants of concern in wastewater treated for direct potable reuse. This project was undertaken to identify the emerging contaminants of concern in reclaimed potable water, their sources, pathways and receptors, potential risk from exposure to these chemicals, indicative removal potential of these chemicals by water reclamation and wastewater treatment plants, and risks for potable water reuse.

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WORKING PAPER: EMERGING SUBSTANCES OF CONCERN IN WATER ENVIRONMENTS

There has been increasing concern over the presence of so-called emerging substances of concern (ESOC) within the aquatic ecosystem. The presence of these ESOCs into the aquatic environment has been increasingly associated with the discharge of poorly treated waste and wastewaters resulting from industrial, agricultural or municipal activities. In the past, regulators have solved legacy water quality challenges by imposing stricter regulations and/or standards. However, the enforcement of such regulations has proven to be challenging for most countries worldwide, mainly due to the fragmentation of related policies. However, managing the risks associated with ESOCs requires a shift from the conventional approach towards a more integrated and coordinated approach as means of ensuring sound chemicals management and attainment of a number of related sustainable development goals. Strengthening water quality governance and ensuring that all water users are aware of their responsibility for the protection of water resources and risks are adequately managed is also vital. Finally, there is a need to put in place the required resources for supporting the implementation of ESOCs management strategies.

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OTHER REPORTS

Are South African groundwater resources under threat from emerging contaminants and their transformation products leached from biosolids and commercial inorganic fertiliser amended soils

Among others, the main objectives of this study were to assess the emerging contaminant status of representative agricultural lands and the underlying groundwater in Gauteng, to quantify the concentration of selected emerging contaminants and their transformation products on sludges, and other biowastes, and to quantify the concentration range of selected emerging contaminants and their transformation product transfer to the human food chain through crop uptake from sludge amended agricultural land.

WRC report no. 3215/1/25

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Ecological and human health risk assessment of microplastics in the Diep and Plankenburg rivers, Cape Town, Western Cape

The assessments of the amount of plastic are scarce but important and the introduction of plastics into the environment can come from production plastics (called virgin pellets), after-use products and landfilled plastic waste. To fully assess the risks of microplastics in Cape Town, Western Cape freshwaters, it is important to consider the fate of microplastic particles which enters the environment in the Diep and Plankenburg Rivers, including the ecological and human health risk assessment of the microplastics.

WRC report no. 3156/1/24

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Evaluating the removal of contaminants of emerging concern in drinking water and wastewater treatment systems

This project explored the integration of effect-based methods and chemical analysis to assess the efficiency of CEC removal in drinking water and wastewater treatment plants.

WRC report no. 3166/1/24

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Development of a mathematical model for the assessment of water quality variations due to emerging contaminants with special emphasis on antibiotics in Msunduzi River

Existing water quality models face limitations due to their site-specific nature, operational complexity, and the demand for high-level skills and extensive datasets. These constraints hinder

their application in regions with limited data, including many developing countries like South Africa. In response to these challenges, this project endeavoured to develop a user-friendly and flexible water quality model explicitly tailored to simulate the movement of antibiotics along water channels. The envisioned model aimed to overcome the limitations of current models and ensure adaptability to South African rivers.

WRC report no. 3160/1/24

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Investigation and monitoring of emerging contaminants from point sources on the Modder River catchment system in the Free State, South Africa

Exposure to organic pollutants has been reported to lead to health implications such as endocrine disruption, immunotoxicity, neurological disorders, reductions in fertility, spontaneous abortions, birth defects, poisoning of genes, resistance to antibiotics, and congenital disorders, even at low concentrations. This project, reportedly the first in the Free State province, was undertaken to investigate and monitor emerging contaminants from point sources on the Modder River catchment system in the Free State, South Africa.

WRC report no. 3159/1/24

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The establishment of a knowledge hub for contaminants of emerging concern in South African water resources

Research efforts into CECs can be approved by allowing for research collaborations between scientists in the same discipline. The creation of an interactive knowledge hub with databases for comprehensive information on growing pollutants of concern in South African surface water sources was the project's primary goal. Additionally, it sought to develop a platform for citizen science that would have fact sheets and brief videos that were supported by scientific evidence.

WRC report no. 3105/1/23 (Volume 1) and 3105/2/23 (Volume 2)

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Real-time sensing as alert system for substances of concern

With the demonstrated risk of toxicity to humans as well as the ecosystem, there is clearly a need for the establishment of smart sensors that are affordable with sufficient adaptability to be suitable for use in varying conditions. The overall goal of this project was therefore to collate information on relevant technologies, including those that are currently not considered for CEC detection but have the potential to expand this field.

WRC report no. 3103/1/23

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Microplastics as emerging contaminants: Method development, ecotoxicity testing and biomonitoring in South African water resources

This project filled an important knowledge gap by investigating the occurrence and distribution of microplastics in the Swartkops and Buffalo River systems in the Eastern Cape, as well as the ecotoxicity of microplastics and plasticisers on selected test organisms at environmentally realistic concentrations.

WRC report no. 2919/1/22

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Risk assessment on nano- and macro-scale emerging contaminants in freshwater systems using experimental and modelling techniques

The key objective of the project was to investigate implications of both individual and mixtures of emerging contaminants (ECs) in the ecological systems. Consequently, the project's outcomes have the potential to contribute towards long-term minimisation, elimination, and/or improve management of water quality impacts from individual and mixtures of ECs of focus in this project.

WRC report no. 2509/1/22

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Detection and quantification of emerging micro-pollutants using capillary electrophoresis

The aim of the project was to investigate emerging pollutants in water by developing the capillary electrophoresis technique. This technique was investigated for the detection and quantification of different classes of emerging and persistent contaminants.

WRC report no. 2887/1/21

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Emerging and persistent contaminants/pathogens: Development of early warning system and monitoring tools

Among others, this study sought to make a case for selected analytical methods to detect and monitor emerging contaminants, persistent contaminants and pathogens, while laboratory experiments and cost-benefit analysis were undertaken for selected methods.

WRC report no. 2516/1/20

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Substances of emerging concern in South African aquatic ecosystems

This study investigated the potential of alternative treatment technologies to improve on CEC and EDC degradation. In this regard, two advanced water treatment systems were evaluated: the HYBrid ACtivated Sludge (HYBACS®) and the Carbon-based ElectroChemical Oxidation (CabECO) treatment systems.

WRC report no. 2733/1/20 and 2733/2/20

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Quantification, fate and hazard assessment of HIV-ARVs in water resources

The high prevalence and vast volume of antiviral drugs being consumed and excreted via various pathways into the natural environment pose an ever-increasing risk of pharmaceutical pollution. As a result of previous research and an increasing demand to fulfil the many gaps in knowledge about this particular subject, the project team set about to complete a thorough risk assessment, quantification, and fate of HIV antiretrovirals (ARVs) in the water resources of South Africa.

WRC report no. 2594/1/19 and 2594/2/19

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Development of novel fluorescent sensors for the screening of emerging chemical pollutants in water

Data relating to the occurrence of emerging chemical pollutants (ECP) in South African waters is currently very limited, which can be ascribed in part to the high cost of performing the complex analyses involved. In this project, we addressed this shortcoming by further developing novel fluorescence sensors for target ECPs of relevance to South Africa, as a follow-on study from our previous work in this regard.

WRC report no. 2752/1/19

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Emerging and persistent contaminants/pathogens: Monitoring methods development

The aim of the project was to investigate and develop detection/monitoring methods for a large range of emerging and persistent contaminants. In order to achieve the aim, the project, among others, developed clear, concise and suitable effluent sampling procedures, developed suitable extraction procedures for the detection of a variety of emerging micropollutants, and developed a new rapid screening analytical method based on plasmonic nanosilver coated track-etched membranes that can be used as a platform for Surface Enhanced Raman spectroscopy (SERS) for the detection of emerging micropollutants in water samples.

WRC report no. 2521/1/19

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The removal of endocrine disrupting compounds by wastewater treatment plants

The design and operating conditions of wastewater treatment plants have an influence on endocrine disrupting compound (EDC) removal efficiency. Among others, the objectives of this study were to screen the EDCs in wastewater influent and monitor various stages of three selected types of wastewater treatment plants for target EDCs; determine and compare EDC removal efficiencies using a mass balance approach; and set up laboratory-scale activated sludge and anaerobic digestion reactors and determine how efficient they are at removing selected EDCs during steady state operation.

WRC report no. 2474/1/18

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Degradation of emerging micropollutants by combined advanced oxidation with immobilised plasmon titanium dioxide nanocomposites in an electrohydraulic discharge reactor

Emerging micropollutants present a great threat in drinking and wastewater due to their adverse health effects on living organisms. Most conventional technologies in water and wastewater treatment are not designed to eliminate these xenobiotics; instead pollutants are merely transferred from one phase to another (liquid to solids). Titanium (IV) oxide has continued to attract considerable and diverse interest in the field of material science as a result of its promising photocatalytic activity in the area of wastewater purification and destruction of microbes and organic pollutants in water.

WRC report no. 2364/1/18

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