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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Wastewater treatment

Prevalence of bacteria and pathogens in WWTW effluents

A completed Water Research Commission (WRC) study assessed the prevalence of human viral, faecal indicator bacteria and Vibrio bacteria and pathogens in the final effluents of the WWTW in the Eastern Cape.

Background

The majority of wastewater treatment works (WWTWs) that discharge their effluents into environmental water bodies are supposed to comply with the discharge standards and the requirements of Green Drop certification. However, for WWTWs to produce effluents of acceptable quality has become a major challenge in South Africa.

The major challenge in the Eastern Cape is that it is mostly non-urban, poor and without adequate infrastructure, and that a significant proportion of its communities lack pipe-borne water, and as such rely on beaches, streams, rivers, groundwater and other water bodies for drinking, domestic and recreational purposes.

Many of these water bodies are often polluted by industrial and municipal wastewater effluents. These effluents harbour the potential to impact on agricultural, recreational and drinking-related water uses, and their characteristics may, depending on the health status of the community contributing wastewater to a WWTW, contain enteric bacterial and viral pathogens.

Human enteric viruses are causative agents of many non-bacterial gastrointestinal and respiratory tract infections, as well as other clinical syndromes, including conjunctivitis, hepatitis, and other diseases. The majority of these viruses are non-enveloped, which makes them highly resistant to decontamination processes used in both wastewater and drinking water treatment.

The monitoring of sewage effluents for viral and bacterial pathogens may prove a suitable approach for the study of circulating pathogens and their persistence in treated effluents.

The efficiencies of the WWTWs in the Eastern Cape with regards to producing final effluents of acceptable bacteriological and virological quality remains inadequately documented, and are to a significant extent reflective of the shortage of skilled manpower in the water sector in the province, especially in the area of microbial water quality.

This WRC study was therefore designed to assess the prevalence of human viral, faecal indicator bacteria and *Vibrio* bacteria pathogens in the final effluents of 14 WWTWs in Eastern Cape as a vehicle for skills development in microbial water quality science among previously disadvantaged demographic groups.

Main findings

The WWTWs performed optimally with the compliance to physico-chemical parameters indicating that the effluents were of acceptable standards for discharge into freshwater ecosystems without upsetting their nutrient balance. These effluents can potentially be used for irrigation without increasing the salinity of the soils.

All effluents from the 14 WWTWs tested were compliant with the set regulatory guideline values for temperature and pH. A total of 78.5% of the WWTWs chlorinated their effluents to compliant levels more than 50% of the time. Cases of chlorine under-dosing were also reported for more than 20% of the times.

With the exception of effluents from Amalinda, Fort Beaufort and Queenstown WWTWs, effluents compliance to set guidelines for both DO and BOD was higher than 50%, indicating the efficiency of the WWTWs in removing organic matter from the effluents.

There was overall compliance in phosphate levels indicated by 75% of the effluents from Amalinda, 92% of effluents from Keiskammahoek and Komga and 100% for the remaining effluents throughout the study period.

The levels of nitrates, nitrites, EC and TDS were largely compliant to set guidelines and, where non-compliance was observed, the overshoot was mostly marginal.

It is concluded that 24% of the WWTWs did not comply to set microbiological (faecal coliform) guidelines and the release of pathogenic enteric microorganisms into aquatic environments can be a source of disease when water is used for drinking, recreational activities or irrigation.

On average, 86% of the WWTWs had a compliance rate of over 50% with respect to the faecal coliform guideline of 1 000 CFU/100 ml in their effluents. This contrasts with the Green Drop 2012 average compliance value of 36% for the selected WWTWs. There was no detection of *E.coli* 0157.

An independent samples T-Test comparison of mean faecal coliform bacteria counts from the discharge point samples with the mean faecal coliform bacteria counts from the final effluent samples (of all WWTWs) showed no significant differences between the bacteriological qualities of the final effluent and discharge point samples.

Both *Vibrio* and *E.coli* samples were detected in final effluent samples. Multiple antibiotic resistance patterns were also evident.

While prevalence of antibiotic resistance of *E.coli* pathotypes to the test antimicrobials was remarkably lower than what was observed for *Vibrio* pathotypes, resistance against sulfamethazol, tetracycline and ampicillin was more than 50% for all the three *E.coli* pathotypes detected.

The dynamics of RNA viruses (hepatitis A virus, enterovirus and rotavirus) in wastewater effluents were acutely different from those of adenovirus, the only DNA virus in this study. Enterovirus and hepatitis A virus were not detected in any of the 14 WWTWs, while rotavirus was detected in four of the WWTWs.

Identified risks

The public health risk is increased if the pathogenic enteric bacteria present in wastewater effluents (and hence in receiving water sources) are antibiotic resistant because of the reduced efficacy of antibiotic treatment against human diseases caused by such bacteria.

WWTWs constitute important reservoirs of enteric bacteria, which carry potentially transferable resistance genes which are aided by a large concentration of donor and recipient bacteria of transferable genes and availability of nutrients in the wastewater matrix.

Presence of viruses in treated sewage will considerably contribute to the virus burden of the receiving water bodies.

Consumption of even treated drinking water may result in infection if it coincides with failed water treatment while exposure to recreational activities and shellfish consumption may present a public health risk. Risk of infection calculations (with adenovirus) showed that effluents from the Alice WWTW presented the highest risk of infection values for irrigation crop consumption and accidental ingestion of pond water.

Other WWTWs whose effluents presented substantial risk of infection when irrigated crop is consumed fresh and wet (with irrigation water) included Mdantsane, Fort Beaufort and Amalinda.

The presence of enteric viruses in wastewater final effluents suggests that a significant portion of the human population contributing wastes to these WWTWs are infected with these viruses.

Recommendations for future interventions

Municipalities may need to consider installing influent flow meters and automated chlorine dosing systems to curb cases of irregular chlorine dosing regimens. This will result in economic, public health and ecological gains.

Municipal managers may also need to assess the qualifications of the technical staff employed to operate the WWTW and to conduct refresher courses for their technical staff to keep them up-to-date with the latest operating and maintenance procedures for optimal WWTW performance. This will positively contribute to the municipalities improving in their compliance with the Green Drop assessment.

Detection of bacterial and viral pathogens in sewage effluents points to large pockets of infected individuals in the communities, most of which go unreported and untreated. Health awareness campaigns may need to be carried out to educate people on the benefits of hygiene and seeking early treatment in cases of illness. This may be a collaborated effort between the municipality and the local public health practitioners.

The design of some WWTWs may have to be modified to allow for the minimum chlorine contact time before effluent discharge as stipulated by the operational guidelines of the WWTW.

Other pathogens such as *Salmonella, Shigella* and *Vibrio* may need to be included in routine monitoring of wastewater final effluent quality to complement general faecal indicator bacteria.

Further reading:
To order the report, ***Surveillance of viral, faecal indicator bacteria and Vibrio pathogens in the final effluents of wastewater treatment facilities in the Eastern Cape Province: A vehicle for capacity development in microbial water quality science in the province*** (**Report No. 2145/1/14**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.