ABSTRACT

South Africa is a semi-arid country with low volumes of rainfall (average of 500 mm per annum) and high evaporation (approximately 85 percent of mean annual precipitation). The highly variable and spatial distribution of rainfall across the country adds to the sparse availability of fresh water. Stream flows in most South African rivers are at relatively low levels for most of the year, and the infrequent high flows that do occur happen over limited and often unpredictable periods. Coupled with this problem is continuous pollution of surface water with wastewaters generated from domestic, institutional and industrial activities. Community concerns about environmental pollution resulting from the quality of wastewater disposed to sensitive environments have led to pressures on the water industry to treat wastewater to higher qualities before discharging to water. As a result of the above, wastewater reuse for potable and non-potable uses increases globally.

In South Africa, the shortage of water can significantly abated by the reuse of treated municipal wastewater through dual water reticulation systems. However, it is very likely that a water reuse project may fail if all the factors governing its implementation are not well addressed prior to its implementation. To achieve this goal, there is need to develop a decision support tool that would enable a balance between the social, economic, technical and environmental attributes involved in implementing wastewater reuse via dual reticulation. The aim of this research work is to develop a Decision Support System (DSS) for assessing the feasibility of implementing wastewater reuse systems for non-potable uses in South Africa.

The DSS is classified into quantitative and qualitative modules. The quantitative modules consist of technical and economic assessment criteria while qualitative modules consist of environmental and social assessment criteria. Under quantitative assessment, technical assessment starts with the estimation of the volume of non-potable water needed for agricultural irrigation, urban, domestic, mining and industry and in other uses. This module therefore, provides the basis to justify a reuse project economically by quantitative estimation of the volume of recycled water needed for various activities. Other quantitative assessments include pollutant removal efficiency to meet reuse water quality, capital and O&M costs of the 33 unit processes from which the DSS can form a diversity of wastewater treatment trains. Treatment train qualitative is classified into technical (i.e. reliability, adaptability to upgrade, varying flow rate, change in water quality, ease of O&M and ease of construction)

and environmental (i.e. power and chemical requirements, odour generation and impact on groundwater) criteria.

The social qualitative module of the DSS contains simplified questionnaires that were developed based on the implications of the results obtained from the application of the Theory of Planned Behaviour (TPB) for potential domestic and institutional users at Limpopo (Capricorn and Vhembe) and Cape Town (City of Cape Town) provinces to determine factors influencing intention to accept/reject wastewater reuse for non-potable water uses. The Triple Bottom lines of sustainability (TBL) were also used to investigate the ability of the service providers to manage reused facilities successfully. The results of the TPB study show that *attitude towards wastewater reuse, control over the source of water and its application, advantages of reuse on the environment* and *trust in the service provider* are the factors influencing respondent's intention to accept reuse. These factors were then incorporated into a simplified module of the DSS.

Testing of the developed DSS using a case study of the Parow wastewater treatment works in Cape Town showed it to be versatile and to provide a good assessment of both qualitative and quantitative criteria of the selected treatment trains. When the actual performance of the Parow wastewater treatment works was compared to the result of the DSS, Chemical Oxygen Demand and faecal coliforms removal was similar at average and maximum values. However, the DSS over estimates the Total Suspended Solids and under estimates Total Nitrogen and Total Phosphorus. In the current WWTWs monitoring procedure, plant personnel do not have performance data on the unit process pollutant removal efficiency (i.e. minimum, average or maximum). Hence, selecting operating efficiency for an existing treatment train requires good knowledge of each unit's process performance. The DSS thus provide a suitable information when data of this nature is not available.

The DSS quantitative assessment for Parow WWTW shows that the treatment and distribution cost wastewater that meets the quality requirement of all users has a payback of less than 3 years with annual revenue of R1 095 000.00. The qualitative assessment score for the same treatment configuration was calculated as 0.73 out of a maximum score of 1.00. This is interpreted as a good qualitative score. Further testing of the DSS perception module using questionnaires administered at the Goldfields gold mine, Driefontein shows that there is *high potential for reuse to be viable* if implemented.