Abstract

This dissertation investigated the questions of sustainable development, in the context of water and sanitation provision, for the eThekwini Municipality. The Durban Water Recycling (DWR) plant, run by Veolia Water, was initially the focus of this investigation. The use of recycled water in Durban has freed potable water supplies for a potential 200 000 new consumers. Industry also benefits as the recycled water is supplied at a lower cost.

In order to create a holistic picture of the effect of water recycling, a network incorporating the abstraction, use, re-use and disposal of water in the South Durban Region was investigated. This water supply network was identified consisting of the following units: Inanda Dam, Wiggins Waterworks, the pumping and reticulation network, Durban Southern Wastewater Treatment Works, Durban Water Recycling and the Durban Southern Deep Sea Outfall.

For the environmental analysis the Life Cycle Assessment (LCA) tool was chosen. Life cycle assessment is a systematic way to evaluate the environmental impacts of products or processes by following a scientific methodology in which the impacts are quantified. LCA provides objective answers to environmental questions while suggesting more sustainable forms of production and consumption. It is the only tool which has a cradle-to-grave approach and by this it avoids positive ratings for measurements which only consist in the shifting of burdens. The objective of this LCA was twofold. The first was to quantify and evaluate the environmental performance of relevant processes and so help decision makers choose amongst options. The second objective was to provide a basis for assessing potential improvements in the environmental performance of the system. Once these areas and the contributors to the high burdens were identified, improvement options were investigated. One of the key outcomes of this analysis was the development of an electricity index as an indicator of environmental performance for water and wastewater systems.

The GaBi 3 software package, which uses the CML (Centre for Environmental Science, University of Leiden, The Netherlands) LCA methodology, was used to compile environmental impact scores for each impact category. For the non standard systems such as Inanda Dam and the Durban Southern Deep Sea Outfall a new way of assessing the impacts was developed.

There is an emerging trend to combine the LCA methodology with social issues so as to improve the decision making capability. The social analysis was carried out using an LCA type

methodology. The impact categories selected were; *job creation* and *health and health risks*. During the course of the study the issue of land displacement arose when investigating the social issues surrounding the construction of a dam. This was then incorporated into the entire study.

The system was broken up into sub-systems which were studied separately and then combined to create a holistic picture. Each sub-system was further divided into three stages for analysis; the construction, operation and decommissioning. This method of analysing the system allows for the detailed description of individual process units with the highest social and environmental burden. For example it was identified that the operation of the activated sludge systems at the wastewater treatment works had an environmental burden due to the electricity consumption during this stage. For the impact category of global warming it was discovered that 40% of the total environmental impact of the system could be attributed to the secondary treatment stage at the wastewater works. The construction of the dam had the largest social burden due to the displacement of the communities living in the dam area.

The final part of the study was a scenario analysis. The aim of this analysis was to develop a sustainability framework for municipalities seeking to expand their provision of water and sanitation services. Different scenarios for increasing the water supply of a municipality were considered. The environmental impact of each scenario was also investigated. In this stage various options were considered to see how changes in the system affected the environmental profile. Improvements using new, modified or alternate technologies were suggested and their effects calculated. An operating procedure, for the current system, with the lowest environmental impact was also suggested. The results of this research will prove valuable to designers and planners looking to expand existing water supply networks in a sustainable manner. A sustainability framework was developed to complement the existing DWAF framework for municipalities expanding their provision of water and sanitation services.

The key findings of this study were:

- The quantification of the environmental burdens for the supply of water and sanitation in the eThekwini Municipality first for the individual units then for the system.
- An improvement analysis which suggested ways of reducing the environmental burdens of the existing system.
- The development of a sustainability framework for a municipality to increase its water and sanitation service levels.

- The incorporation of social indicators into the LCA methodology.
- The development of a technique that could be incorporated into the LCA methodology, for assessing the toxicity of complex effluents.
- The development of a method of evaluating the environmental performance of a water and sanitation system using an electricity index.

The thesis provides a holistic view of the abstraction, use, re-use and disposal of water in the eThekwini Municipality and provides a guideline for decision makers when assessing options for expansion or improvement in water supply networks.