EXECUTIVE SUMMARY

INTRODUCTION

Background to the study

The National Water Act (NWA) prescribes the minimum components of a catchment management strategy and prime amongst these are the formulation of water allocation principles and a Water Allocation Plan for each Water Management Area. This Project was proposed to focus on a very particular part of the allocation challenge, namely the allocation of "Water Quality Use". Intuitively, allocation may be associated with water quantity, but a significant innovation of the NWA is that it defines "water use" very broadly – amongst others to include the use of the resource to dispose of waste. The complexity of point and non-point delivery and transport processes that determine the water quality constituent loads in a catchment, the relatively poor water quality databases and the role that statutory Resource Quality Objectives are required to play in water resource management (WRM) (Section 13 of the NWA) all indicated that a focused research effort was required to unpack the conceptual and technical components of the water quality part of the allocation challenge.

An objective of the project was to effect a process of "learning-by-doing" by applying the framework in a stressed catchment with water quality concerns. For this purpose the ACRU*Salinity* models applied to the Berg River catchment as it also offered a ready-made water quality information system (WQIS) previously developed under a WRC Project. However, resolving technical problems during the ACRU modelling phase expended most of the project resources and the team had to forgo the critical testing of the 'water quality use' allocation framework.

Aims of the project

The project objectives as formulated in the Agreement with the Water Research Commission, were to :

- develop a conceptual framework for water quality use allocation procedures, and
- develop and disseminate Technical Guidelines for water quality use allocation procedures.

Research outputs The research outputs from this project were two reports:

- Rossouw, J.N., Kamish, W. and Görgens, A.H.M. (2006). *Technical Instruments to Support Water Quality Use Allocation*. WRC Report No. TT 363/08, Water Research Commission, Pretoria.
- Kamish, W, Rossouw, J.N., Görgens, A.H.M. and Clark, F. (2006). *Improvements to the ACRUSalinity model and upgrading of the Berg River Water Quality Information System*. WRC Report No. 1301/1/08, Water Research Commission, Pretoria. **(This report)**

Improvements to the ACRU*Salinity* model

Objective To configure a hydrological model which could realistically represent the daily catchment run-off as well as the associated Total Dissolved Solids (TDS) concentrations and TDS loads contributed by the various tributaries, especially those which have previously been identified (DWAF, 1993) as major contributors of salt to the Berg River mainstem.

Methodology The model selected for application was the β-version of the ACRU*Salinity* Model (Teweldebrhanet al., 2003) developed by the School of Bioresources Engineering and Environmental Hydrology (BEEH) at the University of Natal. Initial model runs, however, revealed that the model was not ready for application in a catchment which produces highly saline run-off and subsequently the following changes had to be introduced:

- Monthly variation in salt generation parameters
- Conditional abstraction of water from the river based on salinity and flow bands
- Conditional abstraction from a dam based on salinity bands
- Addition of a thin surface layer to allow for interaction between soil and "quickflow" as well as delayed stormflow
- Modelling of surface salt accumulation due to capillary action.

Additionally, interpretation of the routine monitoring samples collected by the Department of Water Affairs and Forestry (DWAF) revealed that in certain sub-catchments (e.g.

Sandspruit (G1H043) and Matjies (G1H035)), the TDS concentrations actually increased during the winter months when there was supposed to be sufficient dilution capacity in the system. This phenomenon was also accounted for in the calibration process for TDS.

In this study, the ACRU model was configured from Paarl (G1H020) to Misverstand Dam (G1R003) at a static 1998 level of development and was verified for flow and calibrated for TDS at the following gauging stations viz. G1H037, G1H041, G1H036, G1H002/G1H028, G1H008, G1H043 and G1H035.

As expected, the ACRU*Salinity* model produced representative simulated flow outputs requiring very little refinement (sub-division) of the verification sub-catchments.

The simulated TDS concentrations, however, required considerable calibration, especially for the highly saline catchments.

Conclusions

Based on the results and discussions in the report, the following conclusions may be drawn from the application of the ACRU model to the Berg River System:

- The patterns of salinity production and mobilisation as observed in the highly saline catchments of the Berg River Basin can be adequately simulated using the current module for salinity generation and mobilisation. Since the salinity module used for modelling the salt generation process is not entirely mechanistic, it can currently be adjusted on an empirical basis to simulate TDS concentrations which are representative of reality.

- A calibrated ACRU*Salinity* model would allow for the quantification of the effects of further development (e.g. new dam or change in land-use) on the quantity of run-off as well as the quality of the run-off by taking into account the spatial distribution of rainfall, abstractions, imports, irrigation demands and the effect of dams.

- Since ACRU*Salinity* operates on a daily timestep, the input data requirement is quite substantial, although daily rainfall data seems to be readily available. The lack of availability of sufficiently detailed electronic land-use information for a catchment could severely hamper the application of the model.

- When TDS concentrations are the driving concern within a catchment, the delineation of a sub-catchment should be guided by the level of detail required to address the problem. In the Berg River catchment the concern is the quality of discharge from the tributaries and the catchment has been delineated accordingly.

- Pseudo sub-catchments should be based on the land-use types of non-cultivated, dryland agriculture and irrigated lands. In this way, distinction can be made between the values of the salt generating parameters used in each of these pseudo sub-catchments.

Recommendations Based on the preceding discussions and conclusions, the following recommendations on future research may be made:

- A deterministic module for salinity generation and mobilisation should be incorporated into the ACRU*Salinity* model. In this way, the simulation of saline run-off will use measurable (or referenced) salinity related parameters specific to the natural geology and land-use. The current Water Research Commission project *Land-use impacts on Salinity in Western Cape Waters* (K5/1503) could deliver the deterministic model which could be used in ACRU*Salinity*.

- Additional field studies to determine the typical ranges of these salinity-related parameters should be undertaken to provide a database that can be used with an updated ACRU*Salinity* model.

- Since the task of testing the model's performance in supporting Water Quality Use Allocation was not completed in this project, it is recommended that the extended and updated WQIS be used to quantify water quality loads for salinity at suitable locations in the Berg River system for a range of catchment development scenarios. Testing the application of the Conceptual Framework for Water Quality Use Allocation across the range of scenarios should then take place.