EXECUTIVE SUMMARY

1. Introduction

The *ACRU*- model was originally developed as an agrohydrological model by the Agricultural Catchments Research Unit of the Department of Agricultural Engineering at the University of Natal in Pietermaritzburg. The model is designed to model sediment yield, crop yield, irrigation water demands, supply, etc. The *ACRU*-model is a physical conceptual model which uses daily input values such as rainfall and temperature and revolves around daily multi-layered soil water budgeting. *ACRU* can either be used in a lumped or distributed form. When using the model in a distributed form the streamflow from cells above the cell of interest is taken into account for the streamflow from the cell of interest (Schulze, 1989a, Tarboton and Schulze, 1992, Schulze 1995).

The *ACRU*-model was developed to function on catchments with an urban land use comprising less than 20 percent. Working on the Mgeni catchment, Tarboton and Schulze (1992) modified the model to operate on catchments with more than 20 percent urban land use. The aim of this project is to develop or integrate existing urban models as sub-models for *ACRU*. It will enable *ACRU* to operate on a fully urbanized catchment in terms of runoff, hydrograph development and water quality simulations from non-point sources. The models that are to be integrated into *ACRU* are the *WASHMO*-

model for hydrograph simulation, and the washoff and accummulation equations used in the *SWMM, BMPSOFT* and *HSPF* water quality models.

2. Objectives.

The following objectives were set for this project:

2.1 The incorporation and/or refinement of existing models capable of simulating urban flow patterns.

2.2 The development and refinement of sub-models that can simulate water quality loads from different urban land uses.

3. Methodology.

The project can be divided into two main categories. The first category involves the incorporation and refinement of models into the existing *ACRU* modeling structure whilst the second category involves the collection of rainfall data and flow data measured at the weir in the Palmiet River.

Water samples were collected on a weekly basis at ten different points along the Palmiet River and its tributaries for a period of two years from 1 October 1992 to 30 September 1994. Rainfall data were collected for the same period at the University of Durban-Westville, using a syphon and standard rain gauge. At the weir situated in the Palmiet River at the University of Durban-Westville, which is one of the ten sample points, water samples on a weekly basis as well as on days of high flow events were collected. All the collected samples were sent to

the Waste Water Treatment Works of the Municipality of Pinetown for water quality analysis.The water samples from high flow events were collected with the aid of an ISCO sampler, which took a 200ml sample with every 5cm rise or fall in the river flow level. Three high flow events were sent to Umgeni Water for analysis of water quality changes over a hydrograph. All recorded data were sent to the Department of Agricultural Engineering for digitizing purposes and the digitized data were downloaded onto the computer at the Computing Centre for Water Research (CCWR).

Data collected by Simpson, 1986 on the Pinetown catchment were used to test the model on a fully reticulated catchment. Verification runs were done to test and calibrate the model against the collected data in order to give realistic outputs from the different simulation runs.

4. Results of the project.

The following results were established:

i) It was established that by incorporating the*WASHMO*-model into the *ACRU*-model, it became possible to generate realistic hydrographs from urban catchments. The *WASHMO*-model was altered to accommodate runoff from pervious as well as connected (adjunct) and unconnected (disjunct) impervious areas. Adjunct and disjunct impervious areas in this report have the same terminological meaning as in Tarboton and Schulze (1992). The *ACRU*-model was also changed to be used in conjunction

with the *WASHMO* section as a single event storm model. This enables *ACRU* to be used for design storm purposes similar to the *SCS*-models.

ii) It was established that the *ACRU*-model in its existing form (Tarboton and Schulze, 1992) can simulate runoff on a daily basis from fully urbanized catchments.

iii) After the inclusion of accumulation and washoff equations *ACRU* is capable of simulating non-point pollution from urban areas with a higher degree of accuracy from fully reticulated urban areas than from natural streams.This is due to the fluctuations in chemical loads in the baseflow component of the streamflow.

5. Recommendations and further research.

The following recommendations are made:

i) It is recommended that the models are to be tested on other catchments in order to exclude any bias towards a particular catchment. This will improve the model's capacity to do realistic simulations in terms of hydrograph development and water quality.

ii) It is recommended that further refinements should be made to represent natural streams more accurately in terms of water quality loads in the baseflow component as well as to accommodate chemical constituents attached to sediments. This will enable the model to give more accurate water quality simulations from urban catchments with natural streams.

iii) Further research is recommended to develop subroutines that will enable the *ACRU*-model to simulate changes over a hydrograph, so as to facilitate the first flush effect.

iv) Finally, the establishment of a data base for accumulation rates of different pollutants in different regions of southern Africa is recommended. This can then be used to assess the impact of urbanization on rural catchments.

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