ISIS RIVER MODELLING SOFTWARE
Urban Pollution Management in Sydney, Australia

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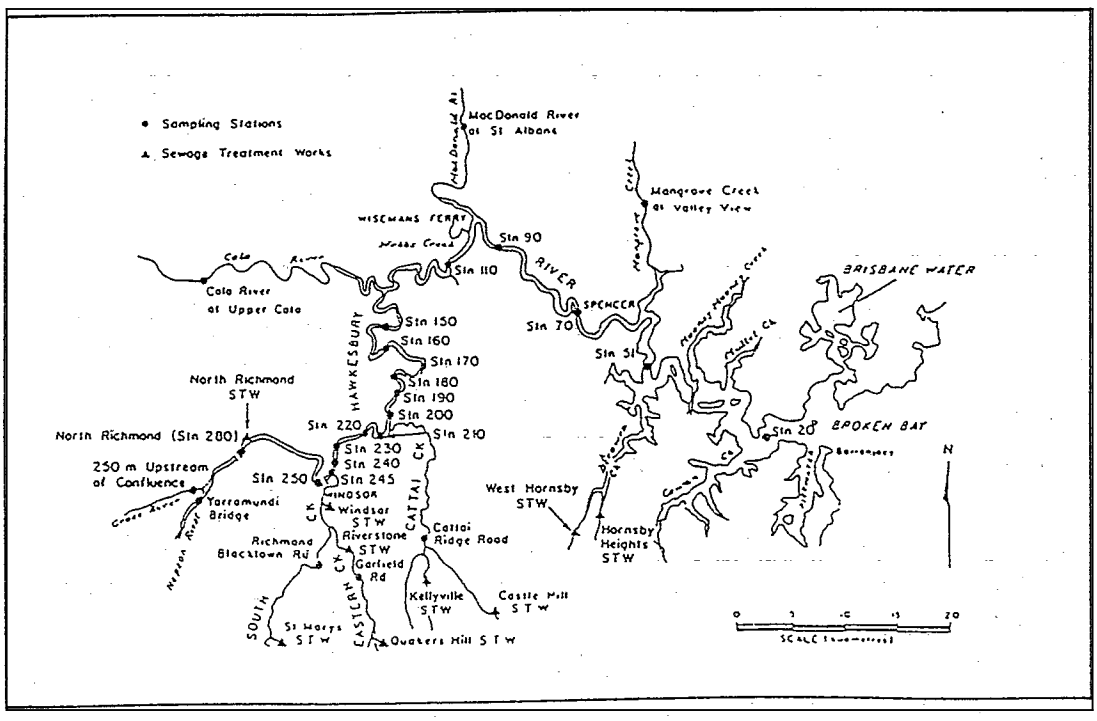
INTRODUCTION

ISIS is a state-of-the-art model with integrated modules for simulating flow, hydrology, water quality and sediment transport in open channel networks: canals, rivers and estuaries. ISIS Quality simulates oxygen and nutrient balance (including phytoplankton, benthic algae and macrophytes) and a wide range of pollutants. ISIS is especially suited to urban pollution modelling, it accepts input from HydroWorks QM and permits the user to specify inputs and analyse results on a statistical basis.

ISIS is developed jointly by HR Wallingford Ltd and Sir William Halcrow & Partners Ltd. It builds on the strengths of the SALMON and ONDA river models. The water quality module ISIS quality has been developed from SALMON-Q which has been used extensively to investigate water quality problems in the UK, Europe, the Far East and Australia.

HAWKSBURY-NEPEAN URBAN POLLUTION STUDY, AUSTRALIA

One major river water quality study was of the Hawkesbury-Nepean river system in Australia. The Hawkesbury Nepean system comprises over 300kms of river and estuary channels to the West and North of Sydney.



In the early 1980's the river experienced frequent severe algal blooms. Increased effluent treatment has dramatically improved water quality. Nevertheless, the river is still considered to be ecologically stressed with

- extensive algal blooms during low flow conditions
- poor microbiological quality with high levels of faecal coliforms particularly after rainfall

The sewered population in the catchment is predicted to double by 2021, from a present population equivalent of some 550,000 to 1.1 million.

Sydney Water commissioned a water quality model of the river system to help plan future investment in its treatment works. Available data were very limited and, in particular, there was no reliable information on pollutant loads during rainfall events and a major concern was to develop an appropriate water quality data collection programme. The upper Nepean river is heavily controlled and during low flows operates essentially as a series of linked narrow reservoirs. The model was initially used with steady flows to simulate periods of low flow when sewage effluent loads dominated. Calibration of the model highlighted a number of areas where further investigation was required. During low flows (50 megalitres/d at Penrith Weir) it can take up to 9 months for a parcel of water to travel from Pheasants Nest at the head of the Nepean to Penrith. However, periods of low flows rarely extend for more than 3 months so that water quality in the upper Nepean river is always affected to some extent by inputs during previous rainfall events. Residence times in the lower part of the river system are much shorter. Data collection programmes were set up to permit calibration of catchment load models for each of the sub-catchments so that dynamic simulations could be undertaken.

At present, there are 25 existing sewage treatment plants (STPs) discharging into the river system. Of these 10 will be decommissioned by 2021 when 6 new STP's will be operational. The largest existing STP (160,000 pe) will expand to serve a population of 275,000. The largest new plant will serve a population of 31,000 whilst the remainder will serve populations of 3,500 - 13,000. Strict new water quality criteria are being introduced for the receiving waters. It was therefore important to determine, as a matter of urgency, the level of treatment needed at each STP to achieve these standards. Preliminary studies were undertaken with the model calibrated for low flow conditions against data that included a severe algal bloom, which occurred during a prolonged drought in 1991.

The preliminary tests indicated that only 5 STP's (four new and one existing) would require effluent qualities higher than that originally planned in order to meet even the strictest of several proposed criteria. The third largest STP would require no additional effluent treatment.

Calibration of the catchment load models is now complete. The river model calibration for dynamic conditions highlighted the importance of phosphorous adsorption onto bed sediments and also the role of macrophytes in controlling phytoplankton growth downstream of some effluent inputs. In 1995 the modelling was reviewed by an

international panel of water quality specialists who have made recommendations for further use of the model.

Dynamic predictions are now being made covering a period of 10 years to refine the earlier preliminary test results.

The ability to simulate accurately the conditions in such a complex system has enabled Sydney Water to optimise sewage treatment levels in existing and planned STPs to meet new water quality criteria which at the strictest level could require a total nitrogen concentration of less than 0.5 mg/l and a total phosphorus of 0.05mg/l. Careful phasing of model calibration, data collection and predictive tests allowed the data collection programme to be focussed on processes which were most significant and permitted some preliminary predictions to be made to aid planning at an early stage.

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Question Ian Noble Montgomery Watson

It looks as though agricultural inputs could be as much the cause as the treatment works, who is responsible for policing them ?

Answer

The key issue is that to come up with a solution you need to understand the whole problem. The Phosphates were a problem. The EA needed to look at all these issues not just slap tighter and tighter consents on the treatment works that they picked up round the world.

You can only solve a problem if you know what it is.

Question Ian Garside Montgomery Watson

Was continuous modelling carried out using the ISIS software?

Answer

Yes continuous modelling has been done with the past 5 years of data. Not all of the results shown were from ISIS but they were from modules that have now been built into ISIS.