

An Investigation of a Modelling System for Assessing the Impact of Stratification on Mixing in Drinking Water Service Reservoirs

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Drinking water distribution systems have received a lot of attention lately, as more and more people have become aware that sound management is essential for ensuring that drinking water received at customers' taps is of adequate quality. In the past, most distribution system studies have focused on the networks, and many have overlooked the importance of the service reservoirs. Mixing within a service reservoir, however, has a crucial effect on the water quality both within and leaving the reservoir as well as further downstream into the distribution system. A better understanding of mixing inside service reservoirs is needed. Therefore, this research investigated the development of a new modelling approach to modelling distribution systems that is capable of simulating the complex mixing and water quality behaviour inside the reservoirs.

Traditional modelling philosophy focuses on either distributed or lumped modelling, which have their strengths and weaknesses. Hence, a benefit should be obtained if the two classes of models can be combined. In the proposed modelling system, this was achieved by firstly setting up a distributed model that provided the detailed hydrodynamic information of a typical reservoir. This information was then fed into a lumped model that is capable of directly receiving and processing such information. Important in this regard are how the lumped model was set up, and the linkage of the information flow between the two models. In this research, a distributed model has been set up using the RMA software, and the model was satisfactorily calibrated against field data obtained from temperature monitoring. This information produced by this model was used subsequently to establish the various model parameters of the lumped model. Water quality simulations based on both a hypothetical and a real reservoir were performed to demonstrate the preliminary success achieved.

In the past, service reservoir modelling has been restricted to case studies. However, given the diverse design of reservoirs and the operational modes that are present in any given distribution system, a model specifically developed for one reservoir may not be applicable when other reservoirs in the same system are studied. In the proposed modelling system, the generality of the model was emphasised, and was achieved by incorporating into the modelling system the identification of representative reservoir design and operational characteristics of a given distribution system. One such characterisation study has been carried out in this research using Sydney Water's distributions system as a case study.

The occurrence of thermal stratification inside service reservoirs was not established previously. In this research, extensive temperature monitoring has been conducted in several service reservoirs. It was found that stratification occurred inside reservoirs, and the vertical temperature differential reached 2-3°C for an online reservoir, and SOC for an offline reservoir. Temperature differential in the lateral direction was insignificant. It was established that the temperature differential was predominantly a result of solar heating. The impact of stratification on reservoir influent mixing was investigated also, and it was found that only a small temperature differential was required to significantly inhibit the mixing.