USING WATER SYSTEM MODELS TO MANAGE IN GIPPSLAND WATER

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ABSTRACT

Gippsland Water has carried out a pilot scheme with Australian Water Technologies to provide training to systems operators in using computerised models of their water supply systems. Operators are under increasing pressure to manage their systems in a cost-effective manner, and computerised models are effective tools to achieve this outcome.

The Gippsland operators found that using quality operational models enabled them to pick out system problems caused by incorrect asset records and changed or unrecorded operations. The operators were also able to investigate other less obvious system problems such as water loss, water quality, high velocities and water flow reversals.

The pilot study was successful and demonstrated that operators can use quality operational models for managing their system.

KEY WORDS

Operators, models, system management

1.0 INTRODUCTION

Gippsland Water commissioned AWT to provide system models for the 22 cities and towns that they manage. AWT used their quality methodology for creating the models from the asset and customer demand records. These models were demonstrated to operations staff as part of the model development process. The operators determined very quickly and easily that there were significant differences between actual and official records of the assets and system operation.

Gippsland Water and AWT devised a pilot project to work with their operators to update the models, system records and provide training in the operation of the models. The objective was to have up to date and accurate hydraulic models and skilled staff to use them to their full potential. Gippsland water also wished to capture the knowledge of many of their more experienced operators who were approaching the end on their careers through the use of models.

A pilot study was carried out for the Tarago Distribution System. This pilot study clearly demonstrated that operators could successfully use models to analyse and manage their system operation, provided the models were produced through a quality methodology. Gippsland Water is extending the study to other parts of its systems with the operators undertaking the work. This study describes the study and the reasons for its success.

2.0 DISCUSSION

System modelling has long been the domain of system planners who have generally developed computerised models as a mathematical aid built for single use applications to develop system designs for worst case conditions. The planning models were built with the sole aim of simulating system performance under extreme conditions and were interpreted for normal operation by the System Planners using their technical abilities.

The increasing pressure on operators to manage their systems efficiently and effectively means that they must use appropriate tools. The increasing focus on drinking water quality is also difficult to manage without the use of models. Operators have vast experience in how their systems operate and are distrustful of models unless they mimic the system and show the same results as they get in the field. Model predictions in the office mean little if they do not match field-based reality.

AWT has a number of highly experienced system planners with operational backgrounds who understand the outcomes required for an operating Water Company. AWT have developed a quality system for producing models (Burgess et al 1998) which meet the needs of operators. The key element of the system is an accurate asset base to develop working models in conjunction with the operator. AWT has also developed several training packages in system planning for technical staff and operators to get the best system utilisation.

The experience at Gippsland water described in this paper is that the operators very quickly learn to use system models that provide an accurate representation of the system and the way it supposed to work. Direct use by operators of the models enabled the systems to be operated efficiently and provide more cost effective customer service.

2.1 Project Goals

Briefly the scope of work was to:

- upgrade water supply records
- compile operational models from existing models
- provide better operational control of system (eg incidents, shutdowns, fireflows, telemetry)
- upgrade operator skill and knowledge
- Indicate areas to save money by
- identifying Unaccounted for Water and Non Revenue Water
- increased system efficiency
- more effective monitoring
- provide water quality models and monitoring – address issues in pipe condition, chlorine dosing and decay, develop short and long term monitoring programs

The pilot study was carried out over two off one week periods at the offices of Gippsland Water.

2.2 Hydraulic Models

The models used for the study were developed using AWT's model development methodology. The models were as created from existing records and had not been calibrated. There were several anomalies obvious in the models.

The calibrated model may differ significantly from the base model due to the following factors:

- inaccurate records
- pipes with high friction
- high unaccounted for water
- leakage between zones, or
- unrecorded or abnormal operational changes

- changes to system controls or pump operation

The tradition calibration of a model utilises extensive field-testing where the operator attempts to capture a high demand period. The only issue with this method is that many of the anomalies are calibrated into the model. The method AWT used with Gippsland Water was to identify anomalies in the uncalibrated model. When these are identified the model can then be calibrated. However if the operational (calibrated) model differs from the base model, the reason for this should be identified rather than adjusting model. There are significant cost savings in identifying the issues this way as the operator fixes problems rather than trying to check all aspects of a system.

The pilot study addressed the following areas of the model as part of the training.

2.3 Demand Information

In previous model construction methods, model demand information was based on multiplier factors for meters. This was averaged across the model and was not effective in picking up errors. AWT used customer meter readings read directly into the model, which enabled anomalies to be detected. Such use of electronic data transfer makes this type of data easy to insert directly into the model and is thus recommended. The model can then provide a greater accountability in customer service.

2.4 System Operation

Current system operation and protocol information is usually documented from the following sources:

- System operators knowledge and experience.
- Existing records and operating documents.
- Gippsland Water operating policies and guidelines.

The model clearly demonstrated the system operation to the operators. The operator can pick up anomalies quite easily and the cause investigated. This enabled most significant problems to be identified. Most issues were found in the records from which the models were constructed. These were corrected through the quality system.

2.5 Pipe Layout Check

A comparison of pipe size and type in model can be carried out with the following sources:

- System operators knowledge and experience
- Recent amplifications, alterations and new watermain information such as Work-As-Executed drawings or operators field books (if they are available and have not yet been entered into the GIS)
- Detailed junction information (operators' drawings) if available.

Any changes to the model are documented to allow transfer of changes to GIS.

For the pilot study, the model was run using various tools such as headloss contours and velocities. This quickly alerted the operator to anomalies that could be attributed to incorrect pipe sizes. This focused the investigation to areas which were most affected by incorrect records. This saves money over trying to check every pipe in the system. The incorporation of a quality system for GIS records would gradually update all records.

2.6 Valve Position and Status Check

Identification and documentation of closed valves is critical in building models that simulate actual system conditions. Confirmation of closed valves as indicated in GIS to be done in conjunction with separate cross checking of closed valves with information from other sources, such as:

- System operator knowledge and experience
- Operator's field notes (if available)

The models in their raw state indicated areas where pressures were below minimum. The operators identified these as high-pressure zones, which should be separated by closed valves. The operators identified the valves they knew as closed; a reasonable guess was made about other possible closed valves that the operators quickly checked in the field. The quick feedback from the model was an extremely effective tool for the operators.

2.7 Pumping Station & Reservoir Detail Check

The operator was able to supply confirmation of existing pump characteristics, pump arrangement and operation with the most up to date information, such as:

- Pump operator's knowledge and experience.
- Control details from a combination of operator's knowledge, existing records such as technical specification/commissioning reports

This allowed the asset register to be updated. The clearer information enabled several unexplained anomalies in system operation to be determined. The operator was then able to test several different pumping regimes, which they had used from time to time with varying success. The model demonstrated the effect of the pumping changes and the operator was able to check the results.

2.8 Full Calibration

Full calibration involves an extensive field check of information to check the model including:

- A field check of key assets against records in GIS
- Pressure readings at key points in the system using calibrated pressure gauges
- Calibration of existing flow meters
- Use of portable flowmeters.

This check was not found to be necessary, as the operator was able to pick up most of the faults in the system assets and operations. This is a considerable cost saving over traditional calibration methodologies.

2.9 Water Quality analysis – Estimation of System Travel Times

Models are essential in the management of water quality and microbiological activity to meet water quality guidelines. Water quality sampling measures water that left treatment some time previously. Models track the water as it travels through the system and can be used to adjust the chlorine dose. The accuracy of the analysis depends on the effective calibration of the underlying hydraulic model to the system operating conditions.

AWT trained the operators in the use of the water quality module of the WATSYS software package to provide estimates of system travel times. The water quality module was be applied to the Operational Model - Present Average Day to identify system deficiencies. The average day flows are representative of the worst case scenario for microbiological problems.

The chlorine decay model shows areas that have low velocities, excessive travel times or flow reversals. These areas are most likely to suffer from water quality problems. The standard decay rates for the chlorine analysis are sufficient for operational water quality control. The expense of more comprehensive modelling and detailed calibration of water quality is not justified for small to medium systems except for intractable water quality problems.

The model was used to investigate an area where there were low chlorine counts. The model showed did not show the expected flows. The operator determined that the there were inconsistencies in the flow patterns which was traced to the incorrect connection of the town supply to a raw water source. This was corrected and noted for records. When this was corrected the low flows and flow reversals in the system became apparent.

3.0 OPERATOR TRAINING

By training the system operators in using hydraulic models, there are many benefits to be gained. These are:

- Increased system awareness, being able to become familiar with normal system operation more quickly and able to respond quicker to system abnormalities.
- Being able to implement planning decisions more efficiently and with a much smaller degree of uncertainty.
- Allowing the operator to maintain their models may reflect system changes in system models more quickly; these changes will then be transferred to GIS.
- System operational efficiency is increased with increased understanding of system conditions.

The training of operators should be seen as an investment in the future efficiency of the organisation rather than a straight cost.

This pilot indicate that operators can easily learn to use models provided they are set up to reflect the way the system works and are thus applicable to their work.

4.0 CONCLUSIONS

Quality computer models are important tools for operators to manage their systems effectively. The operators must be included in the construction of the model to facilitate training and transfer of knowledge. Models that mimic the normal operation of the system speed the training of operators as they can apply their system knowledge while learning the model. The pilot study indicated that there could be cost savings in the modelling process carried out in conjunction with operators.

5.0 ACKNOWLEDGMENTS

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6.0 REFERENCES

Burgess P.L. Coiro E., Nunes J, 1998, Computerised System models a quality approach to save you money AWWA WaterTECH conference Brisbane