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Hydraulic Modelling in the 1990's

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INTRODUCTION

This paper aims to explore some of the issues that the 1990's will bring and discuss how the problems raised by these issues can be solved.

HISTORY

Hydraulic modelling as we know it today started in the UK in the 1960's with the publication of the Road Note 35 and the RRL hydrograph method. In the 1970's computers became more widely available to technical staff and an improved version of the RRL method was produced. The main advance came in the 1980's with the publication of the Wallingford Procedure and the introduction of personal computers capable of running hydraulic models. What then will be the advances in the 1990's?

ISSUES FOR THE 1990'S

To predict the advances in the 1990's we first need to look at the issues that will be effecting the water industry. We believe these can be summarised into three main issues.

Environmental Standards

There is increasing pressure from EC, NRA, environmental pressure groups and public opinion to reduce pollution to inland and coastal waters in the UK. Many pollution problems are caused by inadequate hydraulic capacity in sewer systems with storm overflows frequently discharging into rivers and coastal waters. Andy Eadon predicted at this event last year that '1990 would be the year of the storm overflow'. We believe that the 1990's will be the decade of the storm overflow.

To help assess the effect of overflow discharges on water quality, integrated modelling procedures are being developed. These procedures incorporate, not only hydraulic and quality sewer models, but also hydraulic and quality marine and river models and a dynamic sewage treatment model. Models of the effects of sludge disposal and disperse pollutant sources will also be required. The models will need to be verified so river flow data will be required as well as quality data in sewers, treatment plants and receiving waters. Large amounts of other data, such as sediment depths in sewers, will also need collecting, interpreting and processing. To properly understand the true environmental impact of intermittent overflow discharges it will necessary to look not only at the effects of individual events but also at frequencies of occurrence. The integrated approach brings with it several problems these are increased computer processing times, a need for

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more staff with new skills, and handling large amounts of data.

When designing hydraulic upgrading works it is important to have a model which is accurate enough to predict the location of flooding. However, the prediction of overflow discharges is more sensitive and greater accuracy will therefore be required for quality modelling.

The whole area of environmental modelling involves a complex interaction between a number of models. Any inaccuracy in one model may critically affect the results of another model and so reduce confidence in the end result.

Quality Assurance

Quality systems are seen as a way of improving the standard of technical and professional work over a wide range of applications within the UK water industry. A quality system is conformity to a set of requirements or procedures. Put simply this means; set down what you are going to do, do it, and record that you have done it. BS5750.1987 lays down guidelines for such Quality Systems.

A Quality Assured system can only ensure a consistent standard of work not necessarily an adequate one. The only way to ensure that the quality of work is consistently good is by adopting a good set of procedures. One example of such procedures would be BS8110.1985 The Structural Use of Concrete. No such code of practice exists for hydraulic modelling of sewer system and so there is no consistent standard. WRc have found models which, though regarded as verified by the originator, we would not consider to be verified. Given that national performance standards are now being applied by the NRA, a recognised standard is now required.

When a Quality system has been established there are three types of checking systems in use. These are self audited systems, internally audited systems and externally audited systems. An externally audited and certified system should be more reliable than one where only the users check compliance.

For a Quality system to improve the standard of sewer system modelling it will need to lay down procedures for all aspects of model building. The Quality system should cover the management and collection of large amounts of data with an audit trail to ensure that any item of data can be traced and all calculations are checked. Rigorous checking procedures need to be applied to the completed model to ensure all instabilities and anomalies are found so that the results can be confidently applied.

Operational Planning

Recent legislation has focused the attention of operational staff on the need to meet specified standards of service. This, together with the search for increased operational efficiency is leading towards more detailed planning of operational policies.

Models are already being used to assess the impact of proposed developments on existing sewer systems. As more catchments are modelled this is likely to become more widespread. It is therefore essential that models are accurate and kept up to date. Effective planning of maintenance programmes, for example sewer cleaning, can be enhanced with a proper understanding of the hydraulics of the system. There is a need to have contingency plans for failure of key assets and other eventualities. Hydraulic models should enable the operations manager to predict the likely effect of any incident and to plan accordingly.

TECHNOLOGICAL ADVANCES

We have looked at the issues for the 1990's and the problems that they raise. Now we shall look at the tools that will be required to solve these problems. Some of these tools already exist and others are being developed.

Geographical Information Systems (GIS)

A GIS is a database which stores information relative to its geographical location and is able to display this information graphically. It allows easy access to large amounts of data and can provide a framework for good data checking procedures. It should also give an audit trail. Since there is a single source of data, updating the sewer record information will automatically update the model. WRc are working on a prototype tool that can produce simplified models from records held in a GIS.

Remote Sensing

Remote Sensing refers to the use of electromagnetic sensors to collect data remotely from airborne platforms. WRc has applied these techniques to provide a fast, accurate method of determining the impermeability in any area. It is especially useful for completely combined systems but can also be used for separate systems, in conjunction with a field survey. The data is obtained in the form of scanned images and can be loaded directly into a GIS. The main problem with Remote Sensing is that it is very expensive at present. WRc is currently researching cheaper ways of using such techniques.

Expert Systems

Expert systems are computer programs which are able to simulate the reasoning of a human expert and communicate this knowledge and information to a user. The main advantage of expert systems is that they can be used by inexperienced staff to do a job that would normally need an experienced person. Applied to hydraulic modelling, they could help to solve the problem of staff shortages and overcome the need for new skills. WRc are currently developing an expert system framework which will cover the whole area of sewerage rehabilitation planning.

Computer Hardware

The use of additional models and methods will require much more computer processing power. PC's are becoming much more powerful all the time. 486 machines rated at 33 MHz processors and with 300 Megabyte disks are now available and the 586 machines will be available by the mid 1990's. 100 mip workstations will be available shortly but the gap between these two types of platform is narrowing rapidly. The role of the mainframe is not clear but the market is by no means static. There still may be a role for them in conjunction with PC's and workstations in an integrated network.

Quality Assurance

To improve standards and accuracy, Quality systems should be applied to both modelling and data collection work. At WRc, we have established internally audited procedures to BS5750 for our work in building and verifying models,hydraulic assessment and flow surveys. We are seeking external recognition of these procedures in the near future.

Code of Practice

Without a recognised standard, a Quality Assured system can only ensure a consistent standard of work not necessarily an adequate one. Standards exist for certain aspects of data collection, e.g. for manhole location surveys, and indeed a code of practice exists for water distribution network analysis. If the industry is to obtain the greatest benefit from Quality Assurance, a nationally agreed code of practice for sewerage hydraulic modelling is required.

CONCLUSIONS

Modelling in the 1990's is likely to be substantially different to past practice. It will have to include integrated pollution modelling to meet new performance standards. Technology advances will be as follows:

- Impermeability will be measured by remote sensing to increase accuracy of data collection.
- GIS will allow effective management and storage of the large amounts of data involved and allow continuous updating of the model.
- Expert systems will enable better use to be made of the limited resources of skilled staff.
- Computer hardware will have become sufficiently advanced to provide the necessary additional processing power.
- Finally, models will be produced to an assured consistent standard of accuracy with externally certified quality systems.