APPLICATION OF THE MODELLING CODE OF PRACTICE

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1. INTRODUCTION

The idea for a Code of Practice came from concerns expressed at the Blackpool Conference in 1990, that Quality Assurance could be misleading if there was no accepted standard for the production of models. Following this the WaPUG Committee set up a small task group, to draft a Code of Practice. The Task Group members were Nick Orman (WRc), Richard Allitt (DHV), Phil Deakin (Entec Model Solutions) and Tom Chapman (later Barry Luck, both of Southern Projects).

The Code of Practice was drafted as a guide to the most appropriate methods and practice for the building, verification and use of hydraulic models. The Code is intended to provide guidance to both Clients and to Modelling Teams. It is not intended to replace any detailed specifications that may be drawn up by the Client.

Quality Assurance Systems are becoming more widespread throughout the industry. The Code may be referenced as a Procedual Document in a Quality System.

The Code is intended to augment the Program User Manuals and the WaPUG User Notes. It is not intended to take the place of training nor is it intended as a step by step guide to modelling.

2. PROJECT DEFINITION AND DATA REQUIREMENTS

Hydraulic models are expensive to build and historically many models have been built with neither the final purpose of the models nor the appropriate data requirements being fully appreciated at the outset. A key element of the Code is to set out at an early stage of the project the objectives of the model so that appropriate levels of data requirements are understood.

The level of detail required for a model will be dependent on the project objectives. In most instances the greater level of detail (and the highest cost) will be targeted to the problem areas with the level of detail (and cost) progressively reducing for the remainder of the catchment.

It is likely that most models built will fall within one or more of the following four categories:-

Type I - Skeletal Planning Model
This type of model is characterised by considerable simplification and could be catchment wide or be the outer portions of a more detailed model. These models would typically have between 2 and 6 nodes per thousand population and would have specific objectives, eg:- simulation of flows and conditions at one or more specific locations (eg outfall).
Due to the considerable levels of simplification this type of model is normally not suitable for detailed modelling of flooding nor for Drainage Area Planning.

Type II - Drainage Area Planning Model
This type of model is intended to give an overview of all of the problems within a specific drainage area and are primarily planning tools to identify hydraulic problems etc.
These models should include all ancillaries and all known problem areas and would typically have 6 to 20 nodes per thousand population.

Type III - Detailed Design Model
This type of model would be used for detailed investigations, scheme appraisals and for the detailed design of schemes. These types of models would typically be applied only in a portion of a catchment

with Type I or II models for the remainder. The areas of greater detail would correspond with the specific problem areas. It is likely that most manholes will be included as nodes.

Type IV - Model for Sewer Quality Modelling
Where a Sewer Quality Model is to be produced, a verified hydraulic model is the first stage in the process. The model could be a combination of a Type I, II or III model with dry weather flow inputs in a form which allows different water quality parameters to be applied. The accuracy required for these models is generally in excess of that required for any other type and should accurately simulate dry weather flows in order that sediment deposition and movement is modelled correctly.

Typically a Town Centre with flooding problems may require a Type III model with a Type II model for the remainder of the core area and a Type I model for the periphery.

Input data can be collected at a number of different levels of accuracy and the level required will depend upon the objectives of the study. In some cases inaccuracies in the data will have little impact on the accuracy of the final model whilst in other cases they will be highly important. The most cost effective balance between data checking and model verification will depend on the purpose of the model and should be carefully considered.

The Code describes data collection levels ranging from A (maximum accuracy) to D (minimum accuracy) for 12 different data types. Typical examples of these are:-

Sewer Record Data
Level A - fully validated STC 25 records.
Level B - existing record with surveys for missing data. Full consistency check.
Level C - existing records with missing data (max 5%) estimated or interpolated. Consistency check of sample.
Level D - existing records with missing ground level data interpolated or estimated and invert levels estimated or assumed. No routine consistency checks.

Contributing Area Data
Level A - full Impermeable Area Survey.
Level B - from sample survey and sewer record maps.
Level C - judged from experience and sewer record maps, sample survey of partially separate areas.
Level D - estimated or assessed from separate flow survey results.

The Code sets out suggested data collection levels for the different types of models. It is important that the data collection levels are fully documented as these are essential for any future users to appreciate the accuracy of a model and it fitness for any purposes other than the original objectives.

3. MODEL BUILDING

Detailed guidance on the form of data input is given in the relevant software manuals and is outside the scope of the Code.

Simplification of the model can either be carried out during the model building process or afterwards as a refinement of the model. Simplification of the model, especially outside the core area, is usually fundamental in meeting the study objectives with the following benefits:-

- data collection levels and volumes can be reduced outside the core area;
- costs for data collection are reduced outside the core area and timescales are improved;
- faster simulation run times are achieved (important with time-series rainfall);
- the model is kept within program limits.

In carrying out model simplification it is necessary to ensure that the model will still accurately simulate the flows under two different conditions:-
- correct simulation of hydrographs in low storm flows;
- correct simulation of flooding in high flows.

Detailed guidance on simplification is provided in the Code with the basic techniques of pruning, merging and equivalencing retained. However for the merging of pipes the Code goes away from simple comparison of pipe gradients and introduces the need to consider ground levels in relation to the hydraulic gradient. The hydraulic gradient for a particular pipe may be limited by flooding at the upstream end and in these cases the pipes should not be merged.

The recommended simplification procedure is:-

i) Prepare a plan or plans on which the simplification is marked *(this should form part of the model documentation)*;
ii) Check Ground Levels to identify any areas where the ground levels of connected areas are below manhole cover levels *(where lower levels are used in place of manhole cover levels or where dummy branches are introduced they should be documented)*;
iii) Remove small peripheral pipes (pruning) *(the Code includes a flow chart for this)*;
iv) Group pipes together (merging) *(the Code gives detailed guidance)*;
v) Further simplification (equivalencing);
vi) Adding Unmodelled storage *(see WaPUG User Note 15)*.

Testing of models is essential to identify any instabilities both at ancillaries and in the pipe system. Initial model testing should be carried out with a variety of different storm profiles and gauge pipes selected along branches at intervals of no more than 10 pipes. The flow and depth hygrographs at the gauges and at the ancillaries should be plotted and studied for any signs of instability. The volumes balances for the whole model and for each ancillary should be checked to ensure the balances are within 10%. The testing should also check that any assumptions made (eg ancillary coefficients) are valid for the range of rainfall profiles considered.

Testing should also be carried out routinely with the volume balances checked for every simulation run. The outfall hygrographs should also be checked to ensure that the storm flows have emptied from the system and that generated volumes are not masked.

4. FLOW SURVEYS AND VERIFICATION

Historic verification should always be carried out to check that the model performs generally in line with the reported performance, particularly with respect to flooding and surcharge. In addition verification using flow survey data is almost always required.

Criteria for acceptance of verification are given in the Code. The criteria for verification of simulated hygrographs compared to flow survey data are as follows:
- Peak flow rate:- +25% to -15%.
- Volume of flow:- +20% to -10% over the period for which the observed flows are expected to be accurate.
- Surcharge:- +0.5m to -0.1m.
- The general shape of the two hygrographs should be similar and should continue until substantial recession has occurred.

In addition to this, any predicted or reported flooding during verification storms should be corroborated.

It will not always be possible to meet these recommendations for all events, but they should be achieved in at least 2 out of the 3 events. If this cannot be achieved a model can only be considered verified if it can be positively demonstrated that the discrepancy does not significantly affect the achievement of the objectives of the model.

Only one set of criteria is given in the Code and not one for each type of model. The accuracy required is the same for each type of model, the only difference being the number of points in the system where this accuracy is demonstrated. For example a Type I model may only required verification near to the outfall whereas more detailed models will required verification at a larger number of point in the system according to the objectives.

5. DOCUMENTATION

The Code puts a major emphasis on documentation of models as they represent a considerable investment. Sufficient information, and in particular any assumptions need to be recorded so that the model can be reused or developed further in the future.

An audit trail which includes clear explanations of the sources of the input data and the data processing will also allow models to be updated more easily as well as being an essential requirement for Quality Assurance of the models.

The documentation will include three reports:

- A Model Building Report which contains information on the objectives and the project definition, the sources of the data used in the model building and details of any calculations, assumptions of data manipulation carried out.
- A Verification Report giving details of the flow survey, initial and final plots of predicted and measured hygrographs, a statement as to whether the verification meets the criteria and explanations for any shortcomings.
- Whatever additional documentation or reports the client may require.

Minimum levels of documentation are described in the Code but the Client may wish to specify additional requirements. Documentation is best produced during the course of the work and may be used as milestone reports to the client.

It should become normal that, whenever a modeller receives an existing model, it should be accompanied by a copy of the documentation.

6. CONCLUSION

We recommend that the Code of Practice is used by all those involoved in sewer modelling. It lists various functions some of which will be carried out by the client and some by the modelling team. The Client may include any special requirements in a company policy document. Modelling teams may also wish to produce detailed procedural guidance on the application of the Code to their own situation, (eg specific to the modelling and support software they use). This might also form part of a company QA scheme.