DEVELOPMENT OF THE HYDROWORKS™ DM WATER QUALITY MODEL (SYNOPSIS)

K.J. Neylon
Wallingford Software

HydroWorks™ DM (Drainage Manager) is an urban drainage simulation package produced by Wallingford Software Ltd. It models the movement of sediment and pollutant through a drainage system. It is based on experience from two previous water quality modelling packages: MOSQITO at HR Wallingford and FLUPOL at Anjou Recherche in France.

This paper is a synopsis of the oral presentation which will be given at the WaPUG meeting. This presentation will describe the overall modelling approach taken in the development of HydroWorks™ DM. The description includes the motivation for a phased development process, identification of the stages for the decomposition of the model, and their inclusion in a product release schedule. A full version of this paper will be available at the WaPUG meeting.

Motivation for Modelling in Stages

The development, and release, of the package is decomposed into stages. Planning of the various stages is undertaken through consultation with potential customers. The package includes the primary water quality processes at the first stages. At each new stage, the underlying model becomes more complex.

This approach makes the development schedule manageable. It also means that engineers can use the package without waiting the full duration of the project, and inexperienced users can become accustomed to the modelling of individual urban drainage network processes in stages. Also, since current understanding of some of the physical and (bio)chemical processes involved is not yet sufficiently advanced for these to be represented reliably, this has the added advantage that on-going and future research can be taken into account.

Stages in the Development of the Model

The construction of the physical model breaks down naturally into the following main sections.

- **Hydraulics** – Since hydraulics drives many of the water quality processes, robust hydraulic modelling is the foundation of any reliable water quality model.
- **Dissolved pollutants** – The simplest water quality package that is of practical use to engineers is one which only models dissolved pollutants. As such, this is the starting point of any water quality modelling package. Since the effect of a dissolved pollutant on the viscosity and density of the fluid is small, it is reasonable to assume that it does not influence the hydraulics.
- **Single suspended sediment fraction** – This type of sediment is either carried in suspension or deposited on the bed. The assumption about the presence of the pollutant not influencing the hydraulics of the system is less valid in the case of sediment. This is because sediment deposited on the bed of a conduit alters the effective geometry of the cross-section for the flow, and the presence of suspended sediment affects the conveyance. However, if the sediment is fine, these effects can still be assumed negligible.

- **Multiple sediment fractions** – Engineers can simulate sediment from washoff and wastewater more effectively if they are modelled as separate fractions. This is because they contain suspended loads with different physical properties. However, the sediment carrying capacity expressions available in the literature apply to single sediment fractions. These expressions must be generalised if they are to be extended to multiple sediment fractions.
- **Bed load** – This extension of the water quality model includes heavier sediment that can only be moved as bed load. Rather than being lifted into the flow, the sediment is transported by "trundling" along the bed. The speed of transport of the bed load is slower than the local flow speed. Also, the hydraulics is now influenced to a greater extent by changes in bed profile and roughness. At this stage of the model, the changing bed profile and roughness must be "fed back" to the hydraulic calculations to reflect this influence.
- **Secondary processes** – Although these can be ignored for simple modelling, they need to be included in a complex model. Among these processes are dispersive transport, consolidation of stationary sediment, physical degradation and (bio)chemical reaction of sediment and pollutants. Most of these processes are still quite poorly understood and their mathematical formulation is a matter of current research.

Grouping of Development Stages into Project Release Versions

The main motivation for the grouping used is to ensure a manageable development schedule while producing simulation packages that are of real use to drainage engineers.

The first version of the HydroWorks™ simulation package was the Project Manager (PM). This was purely a hydraulic model. Apart from being an essential simulation tool in its own right, it allowed engineers to become familiar with the project concept used in HydroWorks, and also the input file formats and the pre- and post-processing tools.

The second version of HydroWorks™ is the Drainage Manager (DM). This has dissolved pollutants and suspended sediment. Only one suspended sediment fraction is allowed, while up to nine dissolved pollutants are modelled and up to nine pollutants may be attached to the single sediment fraction. By only including one suspended sediment fraction at this stage, it is reasonable to assume that the hydraulics are unaffected by the water quality. The hydraulic model is therefore the same as that used in PM.

The next version of DM, currently under development, will have the extension to multiple suspended sediment fractions. This allows a more realistic representation of the behaviour of sediment from the two main distinct sources – washoff and wastewater. Again, there will be no feedback to the hydraulics. This will come when the bed load is introduced in a later version.

Conclusions

To date, the development path has led to a proven, stable, fast, *robust* and accurate hydraulic simulation package (HydroWorks™ PM). The second version of the hydraulic simulation package (HydroWorks™ PM+) which has improved pre- and post-processing tools, and the first version of the water quality simulation package (HydroWorks™ DM v2.0), have been released recently.

The detailed hydraulic information provided by PM shows engineers *when* sewers are likely to spill or flood for a range of event scenarios. The water quality information provided by DM indicates what pollutants will be discharged. This allows engineers to take appropriate and highly focused preventative action, by storing or diverting flows.