Water quality modelling – qualsoc application essay

Precipitation that accumulates in natural or constructed storage and stormwater systems during and immediately following a storm event, are described as stormwaters.

The earliest sewer systems were designed to carry both sewage and stormwater to the treatment plant simultaneously (combined sewer overflows, CSOs) (Porteous, 2000). In a combined sewer area, the maximum capacity of the sewer system can be exceeded during a storm. The design of the sewer system allows the excess of water to overflow directly into bodies of water without treatment, this way the excess of water does not overflow by domestic appliances (toilets, sinks and so on).

Figure 1 schematises the paths of different waste waters from an urban area as well as stormwater and displays the representation of CSOs and separate sewer systems.

Figure 1: Separate sewer systems and combined sewer systems in an urban area (EPA, Internet 1).

However, this overflow water is contaminated by diverse pollutants (pathogens, debris, industrial wastes) and do represent a major health concern and can restrict the recreational activities. Control and treatment of stormwater discharges and combined sewage overflows from urban areas are problems of increasing importance concerning water quality management (Jrgensen & al, 1995).

Environmental planners and managers need to be able to predict the quality impact of stormwater overflows. Water quality modelling has been developed for this purpose.

River water quality models are used extensively in research as well as in the design and assessment of water quality management measures. The application of mathematical models for that purpose are constantly refined and updated to meet new and emerging problems of surface water pollution.

QUALSOC is one of the software designed to predict the optimum level of the CSO weir.

QUALSOC EXERCISE

The data obtained through the QUALSOC software provided are related in Appendix 1, 2, and 3.

1. Histogram

Using those data, a 3-D histogram of the DWJ multiples against the BOD concentrations and percentile river flows, has been produced below.

The highest BOD concentrations are obtained for Q5 and lowest are obtained for Q50.

2. 1 to 12 DWF multiples for BOD downstream

From the data sheets obtained through QUALSOC, the highlighted data in pages and are the BOD concentrations downstream from the sewer. There is a different BOD for each DWF multiple (1 to 12), and a different set of data for each quartile (Q5, Q10, Q25, Q50).

3. DWF multiple of the actual overflow setting

Appendix 1, 2 AND 3, pages 6, 7 and 8, displays the calculated values with QUALSOC. The required ssosetting is 1296 m/day and thus after calculation of the DWF, the ratio ssosettinbg/DWF is 1. 56:

?= 1. 56DWF

4. Optimum DWF setting

Pages 7 and 8 of the Appendix are the results of calculated mass balance at different percentile river flow.

> Q5 flow

A BOD concentration of 5mg/l or less is obtained for a factor F of 2 (4. 7mg/l). It is actually ranging in between a factor F 3 and 2.

> Q10 flow

A BOD concentration of 5mg/l or less is obtained for a factor F of 3 (4. 9mg/l).

> Q25 flow

A BOD concentration of 5mg/l or less is obtained for a factor F of 10 (5mg/l).

> Q50 flow

A BOD concentration of 5mg/l is obtained for a factor F higher than 12. Here the factor F corresponding to the NRA target has not been calculated as the QUALSOC software allows calculation of a maximum of 12 DWF only.

5. Maximum overflow of 100m

At Q5, the flow of the receiving stream or river is at its lowest (5%). The concern about the discharged of the CSO is the greatest for this percentile as the impact upon the chemistry and the biological community of the receiving stream or river will be the greatest for a lower flow. Thus, the minimum requirement of BOD concentration of 5mg/l should be respected at least for this percentile. It is obtained with a DWF multiple comprised between 2 and 3.

At Q10, it is obtained for a DWF multiple of 3; at Q25, it is obtained with a DWF multiple of 10; and at Q50, it is obtained for a DWF multiple greater than 12.

However, the DWF multiple of the actual weir setting has been calculated and is F= 1. 56, thus this setting is lower than the minimum optimum setting described for Q5. This system does enable of BOD concentration of 5mg/l or lower to be found at Q5, it is then satisfactory.

Referring to the histogram obtained above, it is noticed that Q5 has a corresponding BOD concentration within the NRA recommendation for a factor F below 3, Q10 has a corresponding BOD concentration within the NRA recommendation for a factor F below 4, Q25 has a corresponding BOD concentration within the NRA recommendation for a factor F below 11, and

Q50 has a corresponding BOD concentration within the NRA recommendation for a factor F above the limit of the QUALSOC software.

The weir overflow setting of this site is 1296 m/day, although it is noticed that the maximum overflow expected at this site is only 100 m. This means that during a wet weather event, the maximum overflow going through the weir will be of 100 m, thus the 100 mof CSO water will be diluted in the receiving water without having much impact. Indeed, the DWF is 829. 92 m/day, the maximum expected overflow is then more than 8 times smaller than 1DWF, and as the weir setting will be able provide a satisfactory BOD concentration for a weir setting at 1. 56 DWF, it will also deliver satisfactory for a volume 8 times smaller than this.

6. Limitations of the methods

The QUALSOC software allows the operator to predict the impact upon the BOD concentration of a receiving freshwater body of a CSO. It actually calculates the optimum setting of the CSO weir for a given BOD.

However, this method does not allow the operator to statistically test the results, and no degree of confidence can be provided. Indeed, this type of model is used for general screening purposes to give a rough estimate. However, QUALSOC model can be routinely use when the discharge of the CSO have a low significance (Department of the Environment, 1999). In the example below the discharge is small, 100m, thus the use of QUALSOC is justified.

It is also noticed that this design model is a 1-D model, its scope is limited to deal with only the flow level. Although it is simple to use and open to any type of operator, it will not allow the operator to take into consideration many biochemical processes. Moreover, this 1-D model will provide answers under steady state conditions, the dynamic of the receiving water will not be taken into account meaning that the answers provided are limited to a time scale and the impact predicted are restricted to the acute effect of the CSO upon the receiving water.

QUALSOC model has been developed to take into account a maximum population of 2000, thus this system can not be use for town over this number, this limits its use and another model should be use for bigger town, which means it is not economically advantageous.

However, this model could also be use in combination with others. Indeed, it has been recently demonstrated that combining models of different dimensions has a benefit (Pollert & Strï¿½nsky, 2003).

REFERENCES

> Department of the Environment. 1999. The Urban Waste Water Treatment Regulations (Northern Ireland)- Guidance Note.

> Jrgensen, M et al. 1995. General Assessment of Potential CSO Reduction by Means of Real Time Control. Water Science & Technology 32: 1 pp 249-257.

> Pollert, J., Strï¿½nsky, D. 2003. Combination of Computational Techniques- Evaluation of CSO Efficiency for Suspended Solids Separation. Water Science & Technology. Vol. 47 No 4 pp 157-166.

> Porteous, A. 2000. Dictionary of Environmental Science and Technology. (Third Edition). John Wiley & Sons, Ltd.