# Storm Sewage Dilution in Smaller Streams

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# STORM SEWAGE DILUTION IN SMALLER STREAMS

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SUMMARY: A numerical model has been used to show how dilution in smaller streams can be affected by unsteady hydraulic conditions caused by a storm sewage overflow.

The discharge from storm overflows into smaller streams cause significant unsteady hydraulic phenomena, which can lead to an important influence on the transport and dilution of discharged matter. The storm overflow discharge will cause a deceleration of the basic flow and an upstream storage of water will occur. As long as this storage takes place a weaker dilution than predicted by a steady state assumption will be a reality.

This phenomenon has been simulated with a one dimensional integrated hydraulic-transport/dispersion model. The model is based on the Saint-Venant equations and the one-dimensional transport/dispersion equation, which with standard symbols (ref. 1) can be written:

Conservation of volume: $$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = q_i$$

Conservation of momentum: $$\frac{\partial Q}{\partial t} + \frac{\partial}{\partial x}(U \cdot Q) + g \cdot A\left(\frac{\partial h}{\partial x} - S_o\right) + g \cdot A \cdot S_f = q_i \cdot u_i$$

Conservation of matter: $$\frac{\partial}{\partial t}(A \cdot C) + \frac{\partial}{\partial x}(A \cdot U \cdot C) = \frac{\partial}{\partial x}\left(A \cdot K_x \cdot \frac{\partial C}{\partial x}\right) + \text{source}$$

The model set-up and the most important data can be seen on Fig. 1. In Fig. 2 the difference between a steady state assumption and a dynamic simulation is shown just downstream the overflow. In Fig. 3 the simulated flow and contration are shown in two stations downstream the overflow, and it can be seen that the dilution is significant weaker than predicted by a steady state model. Fig. 3 also shows another important unsteady phenomenon. In agreement with the theory a marked difference in wave celerity occurs between the flow and the transport of matter.

Conclusions: With this brief description it is shown that unsteady hydraulic phenomena caused by storm water overflows into a smaller stream can lead to a significant weaker dilution of discharged matter than predicted by a steady state assumption.

Reference: J.A. Cunge, F.M. Holly & A. Verwey, Pitman 1980: Practical Aspects of Computational River Hydraulics.

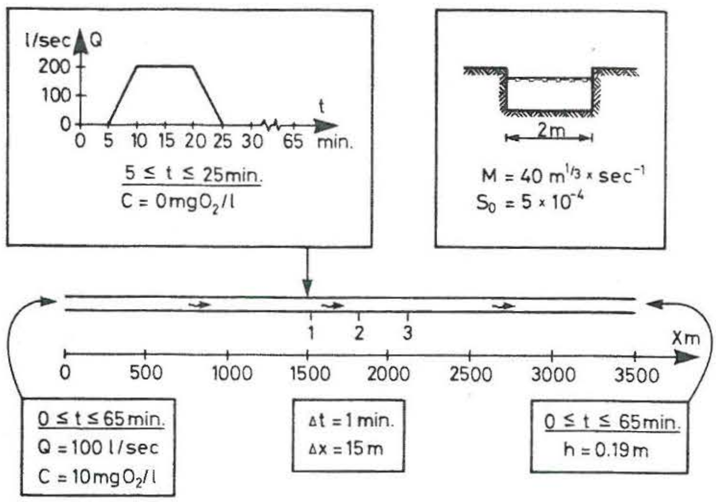


Fig. 1. Model set-up and the most important data.

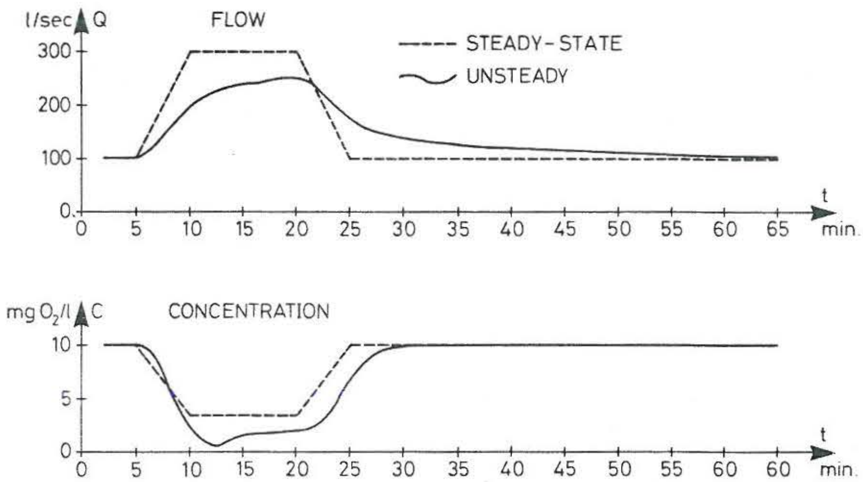


Fig. 2. Flow and oxygen concentration at st. 1 just downstream the overflow. A complete mixing across the cross section is assumed.

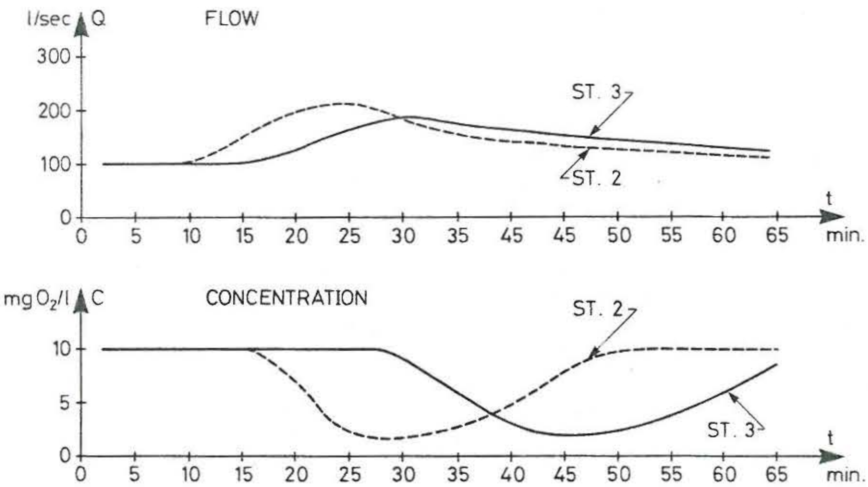


Fig. 3. Flow and oxygen concentration at st. 2 and 3. The concentration is still lower than the steady-state prediction at st. 1. The figure also shows that between st. 2 and 3 the wave celerity for flow is about three times greater than the wave celerity for transport of matter.