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SPIDA RTC IN THE USA

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1. Introduction

This paper is largely concerned with using the SPIDA Real Time Control (RTC) module in accurately modelling ancillaries that require changes from their initial state during a simulation run.

2. The Task.

The project is a study of the Combined Sewer Overflows (CSOs) for a medium sized catchment in the United States of America. The aim of the project is to allow our client to provide evidence to help them satisfy their discharge permit, namely that technology-based control measures incorporating best management practices (including non-capital intensive improvements) are being used to minimise discharges from CSOs and the consequent impact on receiving water quality. The study area is largely combined, with inflows from other areas outfalling into the system. The client, a large Reclamation Authority, controls the foul and combined sewers. However, the storm sewers which are mainly highway drains and culverted watercourses are controlled by the city authority.

The area is industrial and residential with few permeable areas. The study area includes 25 CSOs which are all controlled by complex mechanical regulators .

Figure 1 shows a typical regulator. In normal DWF conditions the flow comes down the combined sewer into a small sump and then into the regulator tube and off into the interceptor sewer to the sewage treatment plant. During periods of wet weather the depth of flow will steadily increase and force the float in the float chamber to rise (sewage enters the float chamber through the small opening towards the front of the sump). This in turn through a series of linkages causes the flap on the outfall side of the regulator to close down and hence divert all the flows to the receiving water course.

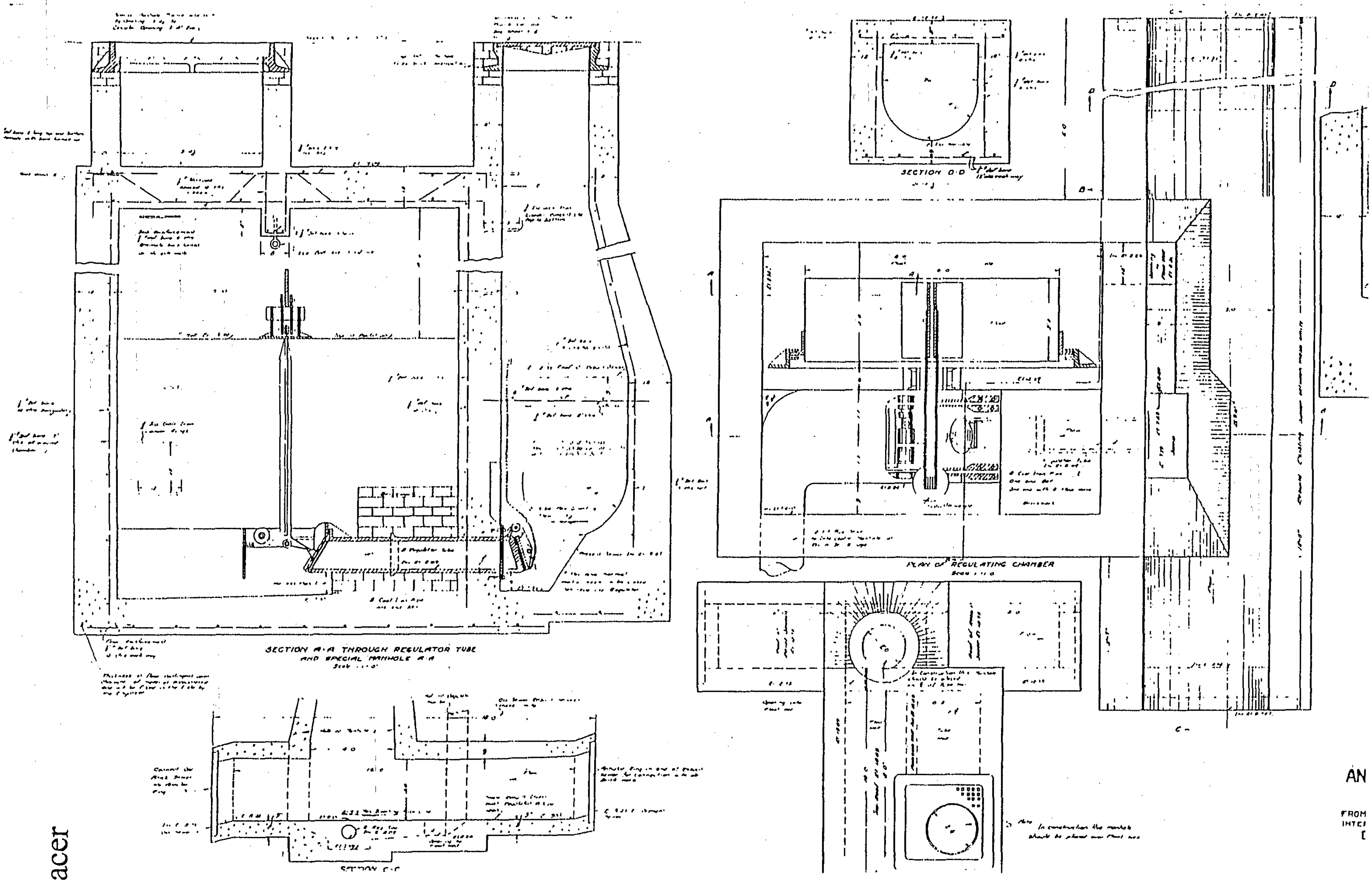

Figure 1 Typical Regulator Layout

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Therefore the regulators have three stages of operation.

1. All flows sent to treatment - Regulator valve fully open or just starting to close or open.
2. Flows being split between treatment and discharge to the rivers. - Regulator valve in process of opening or closing.
3. All flows diverted to the river - Regulator valve fully closed.

As can be seen the mode of operation of this type of CSO is mainly dependent on the water levels in the incoming sewer although the (fixed) regulator tube size will restrict the flow as the tube operates at full bore. Adjustment to the linkages will effect the depth at which the regulator valve will operate. Therefore the only way to model this type of set-up is by using a package that can:

- Analyse complex flow regimes such as free surface reverse flow.
- Reliably calculate depths of flow.
- Enable automation of valves dependent on depths of flow.
- Be flexible to enable fine tuning of CSO performance based on alterations carried out by those operating the system day to day.

The package used was SPIDA which is capable of handling the complex flow patterns, together with the RTC module which simulates the behaviour of ancillaries such as valves and pumps being adjusted in response to conditions elsewhere in the sewer system via a set of user-definable rules. In this case the depth of flow in the combined sewer is related to regulator opening size.

3. Site Work

Having defined the method of operation from the few drawings and manuals available, along with field observations, it was necessary to calibrate each of the 25 regulators from site tests in order to model the CSOs as they operate in practice.

There were 2 stages of testing.

- General test. This defines the depth of flow at which the regulators first start to close and at which depth they are fully closed, along with selected dimensions and observations on the general conditions of the ancillary.
- Calibration test. This was conducted on three regulators that represented different manufacturers or different layouts although their basic mode of operation is as outlined above. This defined the incremental amount of opening as the water level rose. The test was also carried out with different counterweights representing the usual changes made to the regulators by the operators of the system.

4. Maintenance and Operation.

These regulators require an enormous amount of maintenance to the extent that a three man crew is dedicated to looking after them. The regulators are checked after each storm to remove any debris and open those that have become jammed shut. Therefore the site work phase above is of utmost importance to note any problems and get them fixed before the flow survey stage in order to model the regulators as they would normally operate.

5. Modelling
As this is a CSO study a simplified model was produced of the main sewers including all of the regulators plus one 'junction box' (a weir type bifurcation).

The regulators have been modelled as adjustable penstocks with a fixed relationship between opening and the depth of flow in the incoming sewer.
By defining the opening/closing positions of the valve to the corresponding depths in the incoming sewer a graph can be drawn showing this relationship. The RTC file can be written to approximate to this relationship by a series of steps (Figure 2).

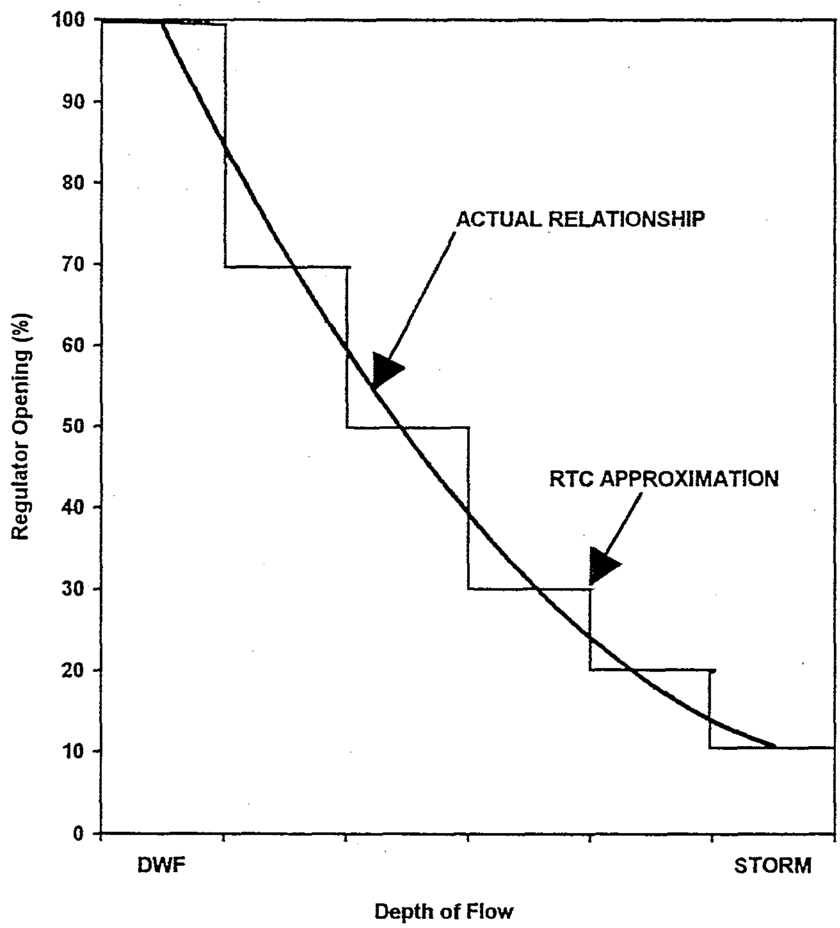

Figure 2. Definition of regulator mode of operation.

6. Conclusion
For simple networks involving a few variable ancillaries whose performance can easily be predicted the facilities within SPIDA whereby a simulation can be paused and changes made manually is a possible solution. For more complex networks with multiple ancillaries and complex control rules the increased sophistication of SPIDA RTC are justified. Accurate hydraulic models can now be produced of complex sewer systems and ancillary structures which were beyond the capability of modelling systems until very recently.