DEVELOPMENT OF CONSENT CONTROL ON AN ACTIVE STORM MANAGEMENT SYSTEM

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1. Introduction

1.1 The purpose of an active storm management system, as opposed to a fixed system, is to achieve the required target standard of environmental protection at a lower cost to the discharger. To ensure that the system is operated to meet environmental targets the operation must be controlled by the regulator through the discharge consents system. This paper gives an example of how this is being achieved for the sewerage system at Bournemouth.

1.2 The paper describes the sewerage system and its development. It details the environmental targets and the resulting principles for the operation of the system and describes how these are being incorporated in the regulatory framework. It concludes with some thoughts on future developments.

2. Description of the Sewerage System

2.1 The present layout of the sewerage network is shown in the attached Figure 1, which is reproduced by courtesy of Wessex Water Services Ltd and Bournemouth Borough Council. The town of Bournemouth lies between the sea to the south and the River Stour, which flows to the north and the east of the Borough, entering the sea at Christchurch Harbour.

2.2 Sewage from most of the town goes to the Holdenhurst treatment works. The catchment covers about 3,250 ha, with a connected resident population of about 121,000 people. At the height of the summer season this can rise to an estimated 200,000 people. The catchment is largely residential, with a mixture of older combined sewerage and newer separate foul and surface water sewers.

2.3 The treatment works discharges sewage to a 15/25/5 (ATU-BOD/SS/NH3-N) standard to the River Stour. The DWF is about 40,000 m3/d. Recent extensions at the STW have increased peak treatment capacity to 123,000 m3/d and storm tank capacity to 12,000 m3. Effluent dilution in the River Stour at DWF and Q95 in the river is about 3:1.

2.4 Until the early 1970s sewage from most of Bournemouth discharged untreated through several coastal outfalls. The site at Holdenhurst treated only a relatively small flow from inland parts of Bournemouth. The Coastal Interceptor Sewer (CIS) is a major tunnel system which intercepts the original sea outfalls. Most of the original outfalls have been retained as storm sewage discharges.

2.5 Pumping stations were constructed at the headworks of the outfalls at Bournemouth Pier, Boscombe Pier and Hengistbury Head. These pumping stations lift the sewage flows to the CIS, which is constructed beneath the cliffs on which Bournemouth stands. From the CIS sewage gravitates to Holdenhurst works. Flows are controlled by a penstock at Shaft 1 on Fig.1.

2.6 The CIS has a total length of 9.7 km and the diameter ranges from 1.5 to 1.95m. By controlling the penstock sewage can be stored in the CIS. The total usable storage volume is about 18,000 m3. Over 80%

of the sewage arriving at Holdenhurst comes via the CIS.

2.7 Until recently the CIS was used to store and balance diurnal sewage flow variations to the works. However, since the recent extensions this is no longer necessary. The CIS is now used to store storm sewage flows, as part of the storm management system.

2.8 There are only seven significant storm sewer overflows on the Bournemouth sewerage system. These are:–

(a) Cooper Dean overflow from the Winton area, discharging to the Sheepwash lagoon on the River Stour. This discharges via an attenuation/storm tank.
(b) Iford pumping station storm overflow discharging to the Stour, just upstream of Christchurch Harbour.
(c) Tuckton High Street storm overflow from the Southbourne area, discharging to the Stour.
(d) Bournemouth No 1 pumping station from the town centre catchment. This discharges 6mm screened storm sewage about 500m offshore from Bournemouth Pier via two of the original sea outfalls.
(e) Boscombe pumping station from the Springbourne/Boscombe catchment. This discharges 6mm screened storm sewage about 500m offshore from Boscombe Pier, through two of the original outfalls.
(f) Hengistbury Head pumping station from the Southbourne catchment. This discharges some 300m offshore through one of the original outfalls.
(g) Fishermans Walk is the CIS overflow. It operates as a high-level emergency overflow and has not operated since the new system was commissioned last year.

2.9 Bournemouth No 1, Boscombe, Iford and Hengistbury Head pumping stations all pump directly to the CIS. The storm overflows operate when the pumps are beaten by the inflow. The pumping stations at Bournemouth No 1 and Hengistbury Head also discharge when the pumps at the pumping stations are automatically switched off. This happens when sewage in the CIS reaches preset levels, to prevent surcharging of the CIS. The pumps are only restarted when sewage in the CIS falls below a preset level.

2.10 The sewerage system can be operated to spill storm sewage mainly to the sea or mainly to the River Stour. It can also be controlled by operating the penstock at Shaft 1 to optimise the use of the two storm sewage storage resources, in the CIS and the works storm tanks. The next section describes the principles developed for controlling the system and how these have been put into practice.

3. Control of Storm Sewage Discharges

3.1 The River Stour offers limited dilution for the treated effluent at summer flows. The unrestricted discharge of storm sewage could damage the river. In the earliest days of the CIS there were two major fish kills in the lower Stour resulting from storm discharges. The Stour flows into Christchurch Harbour, which is a popular water recreation area. The outflow from Christchurch Harbour flows past the identified bathing beach at Avon Beach, Christchurch. There is therefore a need to limit storm discharges to the Stour.

3.2 The whole of the Bournemouth seafront is identified as bathing waters under the EC Directive. Although the discharge of storm sewage several hundred metres offshore offers some protection to the bathing water compliance, there is a risk that storm sewage could cause bathing water failure.

3.3 Because of these constraints, the NRA has required the water company to operate to the following principles:–

(a) maximum use is made of available storm sewage storage
(b) storm sewage is allowed to discharge from the STW storm tanks up to the maximum allowable capacity in the River Stour
(c) when the maximum rate of discharge to the river is reached. the additional storm sewage is discharged to the sea.

3.4 The storm discharge to the river is controlled by a real time mass balance ammonia model. Ammonia was selected as it is a discharge dependant determinand, which can be continuously monitored. The river flow is fed to the works from a NRA gauging station at Throop. about 2 km upstream of the works. The treated and storm sewage flows are measured at the works. The upstream ammonia concentration in the river is set at a fixed value of 0.1 mg/l, which is the measured 90%ile value. The effluent ammonia concentration is measured by a continuous ammonia monitor on the combined treated and storm flows. Before the storm discharge commences a default value of 10 mg/l of ammonia is assumed by the model for the combined effluent. The target downstream peak ammonia concentration is set at 1.5 mg/l.

3.5 The ammonia model is in the form: -

$$f = \frac{F\ (q - C)}{c - q}$$

where:- f = maximum allowable combined effluent flow
F = river flow
q = target maximum downstream quality
C = upstream river quality
c = combined effluent quality

3.6 The sewerage system normally operates with the penstock control in the fully open position. At the start of a storm the pumps on the seafront pump the increasing flows to the CIS. The sewage flows to the STW and when the peak flow to treatment is exceeded the storm tanks begin to fill. The model calculates the allowable combined flow to the river using the default combined effluent quality. When the storm tanks are 80% full the penstock from the CIS is lowered to restrict the flow arriving at the works to that allowed by the model. The storm tanks continue to fill at the reduced rate. When full they begin to spill and the model commences to use the measured effluent quality. As the values of the model parameters change during the storm the setting of the penstock is adjusted. The maximum flow allowed at the works inlet is around 6DWF.

3.7 When the penstock lowers to restrict the free flow from the CIS then the CIS begins to fill. When the sewage level measured at Shaft 4 reaches 7.1m ASD the Hengistbury Head PS shuts down. When the sewage level in the CIS reaches 9.0m ASD the Bournemouth No 1 PS shuts down. Iford and Boscombe pumping stations continue to pump in all storm events. The maximum storage in the CIS is 18.000 m3 to the 9.4m overflow level at Fishermans Walk.

3.8 At the end of a storm priority is given to draining down the CIS storage and restarting any stopped pumping stations. The storm tank contents are automatically returned to the flow for treatment when capacity is available.

3.9 The above is a summary of the main points of the operating procedure for the system. The problem faced by the NRA was to find a way to incorporate these requirements in a verifiable way within the discharge consents regime. The solution adopted was for the water company to produce a draft detailed operating procedure and proposed local control settings. This will be considered by the NRA and both parties will work through the procedures to ensure that they meet the objectives most effectively under all conditions. Both parties will sign off the procedures. The consent will then require compliance with the agreed procedures and will make provision for review of the procedures and agreed amendments. The procedures will also cover the monitoring and recording of information from the system. The consent will require reports on the operation of the system.

4. Conclusions

4.1 The above procedure is still being completed. It is seen as an ongoing process. The results of the first years monitoring are being assimilated and changes may be agreed in the procedures as a result. The key is cooperation between the regulator and the discharger. This is in both parties interests. The regulator because they can ensure compliance with objectives and the discharger because they can agree fine tuning of the system to minimise costs. If the discharger chooses not to cooperate then the regulator will impose requirements. which is likely to result in higher costs than a cooperatively developed solution.

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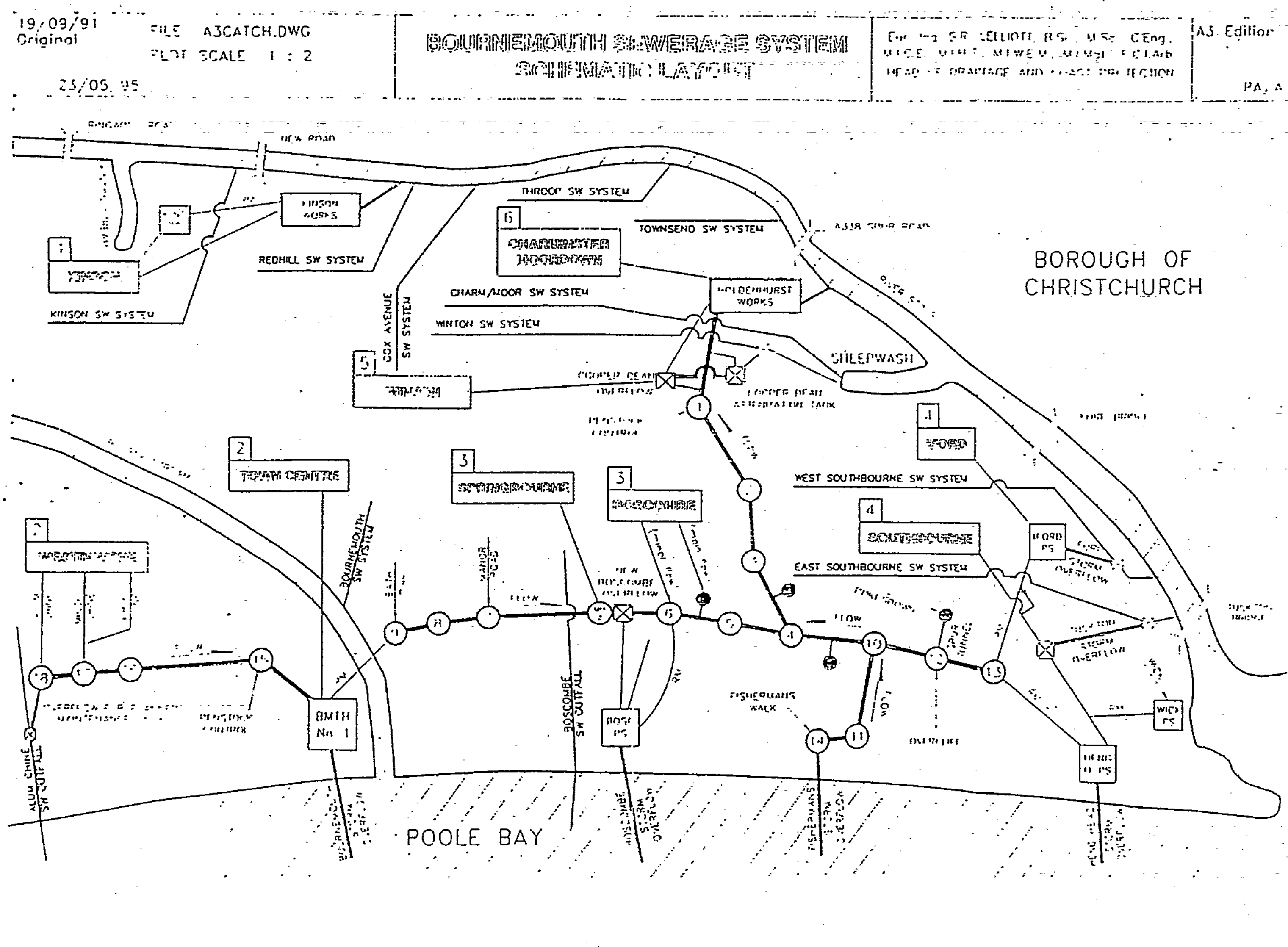

Development of Consent Control on an Active Storm Management System
R Saxon NRA

Question Dennis Dring Yorkshire Water
Have you had any operational problems using the interceptor as a storage tank ? i.e. sedimentation
Answer
Water Company has not reported problems. There was a problem with the 15 years of DWF profile balancing, over 500 tons of grit had to be removed. The company is monitoring the build up under the new operational regime. It should be OK as the system now runs free with no backing up.