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An Irish perspective on Storm Water Overflows amd their impact to Sensitive Waters

by

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An Irish Perspective on Storm Water Overflows with particular reference to Sensitive Areas

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Introduction

In preparing this paper I have chosen to consider the word "sensitive" in its broadest sense and not just to confine myself to the definition from the Urban Waste Water Treatment Directive. Consequently in addition to considering the effects of storm water or combined sewer overflows on such designated "sensitive areas", the problems associated with designated bathing and shellfish waters are also considered.

The Republic of Ireland has over 13,000 km of rivers with only 1% classified as be seriously polluted. In all 77.5% are classified as unpolluted with 12% slightly polluted and 9.5% moderately polluted. We have 124 locations designated under the EU Bathing Water Directive 76/160/EEC of which only 8 are inland waters. Some 66 of the designated bathing waters were Blue Flag beaches in 1996. In addition there are in excess of 30 designated shellfish waters around our coastline. All our designated bathing waters were fully compliant with the Mandatory Values in the Directive in 1995 and there was 89.8% compliance with the Guide Values.

Population distribution in Ireland is of particular relevance in that over 50% of the population reside in coastal towns/cities all of which would have designated bathing waters in the vicinity. As tourism is a major sector of economic growth, the general public are extremely aware of maintaining our green image and indeed improving the environment by seeking that the highest standards be met as far as sewage collection and disposal are concerned.

Existing Situation

Some 99% of urban areas in Ireland have a collection system, with between 60 and 80% being on the combined sewer system. Separate systems have been provided on practically all newer developments since 1970. It is estimated that there are between 800 and 900 combined sewer overflows or varying designs on the combined systems. Many are simply an overflow pipe or low side weir type. There would also be a relatively small number of high side weir or stilling pond type overflows where major improvements to the collection systems have been undertaken over the past twenty years. Generally there is no storm water storage provided at these overflows and no screening.

The normal CSO setting is the traditional 6 times Dry Weather Flow (DWF) with sewage treatment plants designed for 3 times DWF and typically storm water storage provided at the treatment plants for flows between 3 and 6 times DWF. In general, no monitoring of CSO performance is carried out. Notwithstanding this scenario, out of 82 fish kills in 1995, six were caused by sewage pollution and only 2 of these were attributable to CSOs.

Application of Relevant Standards

Where explicit guidance is not available in the relevant standards such as the Bathing Water, Shellfish Water or Urban Waste Water Treatment Directives, it is necessary to interpret the spirit and intent of these standards in endeavouring to set down design criteria for storm water overflows. These standards must comprise certain minimum criteria with additional requirements where environmental conditions warrant them.

The general criterion for the future design of storm water overflows is defined as an absence of visible signs of sewage derived debris (e.g. oil slicks, foaming etc.) and of deposits or algal growths caused by sewage discharge. This requires that the effects of organic/nutrient loads deposited in bed sediments must also be considered.

Formula A is now considered as the minimum overflow setting in all situations. In addition the following steps should also be applied:

subjective criteria should be applied to exclude spills to minor watercourses and small, relatively clean streams and such receiving waters should be deemed unsuitable for such discharges

(ii) storm overflow structures should be designed in accordance with the WRc publication ER304E with acceptable types of overflow structure limited to high side weir, stilling basin and vortex chamber overflows designed for efficient solids separation and retention.

(iii) outlet control should maximise the retained flow at a near constant rate within the system capacity.

(iv) such an overflow should be designed for effective ntainment of detritus and floating debris.

(v) overflow structures should be capable of being properly maintained with provision for adequate ventilation, safe access and lighting.

(vi) overflow discharge points should be discretely located and for coastal outfalls should be taken, where practical, to low water level.

(vii) traditional structures of the low side weir type and ad-hoc overflows of the hole-in-the-wall type should in time be replaced by properly designed overflows, rationalised where possible to a minimum number of overflow structures for each system.

In addition to the foregoing the preliminary assessment of each erflow should have regard to possible "first foul flush" effects. These will depend on the nature of the sewage, the nature of the sewers upstream and their gradients. Such flows have the potential for severe pollution due to extremely high BOD_5 levels, potentially toxic levels of ammonia and hydrogen sulphide and long term degradation associated with a high level of organic solids deposited on the bed of the receiving water which continue to depress dissolved oxygen levels and release nutrients.

Additional criteria may also apply for control of pollution from overflows depending on the water quality objectives for the receiving water. Such criteria may require the use of storage to reduce the spill volume or frequency and this application will now be considered.

Bathing and Shellfish Waters

The critical requirement for protection of bathing and shellfish waters is the prevention of bacteriological contamination. This requires restricted spill frequency and volume of storm water discharged. However, in the former case the restriction can be limited to the bathing season from May to October.

The use of Time Series Rainfall for storm events confined to these months allows the determination of frequency and volume of spill using the calibrated hydraulic model of the network with a marine dispersion model. Iterative use of the models with a variety of storage volumes will determine the solution to satisfy the limits adopted.

The current policy recommended is that developed by the National Rivers Authority (NRA) in the UK sets out standards for consenting storm water overflows into or in close proximity to bathing areas and water contact/recreational use waters.

The standards set down in that policy can be summarised as follows:

- The maximum number of independent storm events discharged via the CSO must not, on average, exceed 3 per bathing season for identified bathing waters unless it can be shown that the design will achieve the water quality standards of the Bathing Water Directive for at least 98.2% of the time.
- The maximum number of independent storm events discharging via storm water overflows affecting water contact/recreational use waters must not, on average, exceed 7 times per bathing season.
- The soffit level of the overflow outfall must be located below the level of the low water mark of mean spring tides (MLWS). Otherwise a spill frequency criterion of 1 spill in 5 bathing seasons will apply.

Normally the incoming flow must exceed that calculated from "Formula A" before the storm water overflow spills unless there are high dilutions available.

- Discharge flows are required to be screened to at least 10 mm and where the frequency of spill is greater than once per year, 80% of the volume should be screened to at least 6 mm.

Network models using the HYDROWORKS or other software package can be used to establish the storage volume requirements to meet the above criteria for potential CSO spills to the identified bathing waters and water contact/recreational use waters.

The type of screen recommended to achieve the above requirements is the screenings retention type and not of the removal type. That is, the screenings intercepted by the screen should be retained in the sewer system and not removed for separate disposal. This will reduce running and maintenance costs of screening at storm water overflows.

Sensitive Areas

Article 3 of the Urban Waste Water Treatment Directive requires that "For urban waste water discharging into receiving waters which are considered 'sensitive areas' as defined under Article 5, Member States shall ensure that collection systems are provided at the latest by 31st December 1998 for agglomerations of more than 10,000 p.e."

Article 5 (2) of the Directive requires that "Member States shall ensure that urban waste water entering collecting systems shall before discharge into sensitive areas be subject to more stringent treatment than that described in Article 4, by 31st December 1998 at the latest for all discharges from agglomerations of more than 10,000 p.e."

The criteria for the identification of "sensitive areas" for the purposes of the Directive are clearly set down in Annex II to the Directive. In Ireland we have designated six stretches of river and four lakes as being "sensitive areas" under the Directive. This has been done having regard to the size of population centre discharging to the receiving water at these locations.

The setting of standards for storm water overflow discharges to waters considered sensitive to comply with these requirements is extremely difficult. In the absence of a sewage quality model for the collection system, the following approach has been adopted. In Table 2 of Annex I to the Directive a minimum percentage reduction of at least 80% for total phosphorus and at least 70 - 80% for total nitrogen is considered an acceptable alternative to setting acceptable effluent concentrations for discharges to receiving waters in "sensitive areas". It is then considered reasonable that a volume reduction of storm water spill of this magnitude would also be a consistent standard to apply for these "sensitive areas". That is, the volume of overflow as a percentage of rainfall run-off volume to the sewer should be a maximum of 20%. This might be considered a conservative approach in that it is of course based on the assumption that the nutrient load is equally distributed throughout the flow in the sewer. However, it is believed that in the absence of a quality model this is an appropriate as a means of applying the precautionary principle.

This approach implies that a combination of storage and other sewerage improvements be considered to contain 80% of storm water run-off using Time Series Rainfall analysis in a hydraulic model for the contributing catchments. This level of containment (80%) might be considered a minimum value and should correspond to a proportionally higher containment of nutrients since part of the nutrient load is carried in suspended solids, retention of which would be maximised in the design of the overflow structures.

Planning Methodologies

The planning methodologies recommended are indeed very similar to the UPM manual with different approaches depending on the level of significance of the overflow. The

.ne criteria are used to assess whether an overflow is of low, medium of high significance.

The level of investment that should be put into the preparation of models should, of course, be assessed by taking into consideration, not alone the likely savings to be made in the short term by the construction of the more cost effective solutions that will be developed by their use, but also by the ongoing benefits such models will provide in assessing the performance of the augmented sewer network.

Storm Water Overflows - Summary of Design Criteria

The following is a summary of the design criteria for the rehabilitation of storm water overflows (CSOs):

- Selection of appropriate spill locations and general rationalisation of the high number of existing overflows in order to discharge to receiving waters of adequate capacity (i.e. excluding small streams).
- Consideration of the maximum downstream hydraulic capacity in the sewer system and how this can be best exploited during storm conditions.
- The efficient design of each CSO to ensure hydraulic control and the maximum separation of gross polluting matters.
- Normally a continuing flow equivalent to "Formula A" is recommended with particular consideration to containment of high strength industrial wastes where these are discharged to the sewer. This requirement might be modified for very high dilutions where there is no adverse environmental impact.
- For discharge to bathing waters or water contact/recreational use waters, a restricted spill frequency during the bathing season should apply based on analysis using time series rainfall or other equivalent approach (once per season or three spills per season, as appropriate), unless it can be shown that the design will achieve the water quality standards of the Bathing Water Directive for at least 98.2% of the time.
- In general, consideration is required to be given to the containment of the "first foul flush" discharges, particularly to sensitive waters using a critical rainfall approach and time of concentration calculation or other modelling approach.
- For discharges to sensitive coastal waters or fresh waters classified as clean or with that objective, a higher standard than "Formula A" should be considered with the QUALSOC approach used to set a maximum BOD_5 concentration for normal river low flows.
- For "sensitive areas", where eutrophication is a potential problem, an overall analysis to limit both the frequency and volume of discharge to the receiving waters is required and can be achieved using Time Series Rainfall in conjunction with a calibrated network model. This can be used to limit the percentage of run-off spilled at the overflow (say 20% max.). This will not necessarily ensure that the limit of 2 mg/l P will not be exceeded but will generally be consistent with an 80% reduction target which would be the minimum requirement for treated effluents.

Key Issues

Two issues are seen as having particular significance in an Irish context.

1. for the areas designated as "sensitive areas" under the UWWTD 91/271/EEC the need to develop quality models as well as hydraulic models for the collection system in order to more economically meet the regulatory requirements.
2. the ability to be able to model the bacteriological quality of overflows for input into a marine dispersion model is of vital importance given our large number of designated bathing and shellfish waters and the fact that the majority of our major towns and cities are located around the coast.