Pollution from highway and surface water drainage systems

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Introduction

Urban drainage design and analysis has come a long way over the last 15 years. One of the most significant changes is the widespread consideration of water quality and the polluting effects of CSO discharges, and the launch of the UPM Manual late in 1994 will provide drainage engineers with the information needed to examine water quality issues at various levels of sophistication.

Discharges from surface water drainage systems have received less attention, even though it is recognised that they too can have a polluting effect on water quality. Highway drainage is a special case and in recognition of the need for information on which to base design decisions, the Highways Agency and NRA have jointly supported a project managed by CIRIA which has produced some simple guidelines for immediate use (CIRIA, 1994). The guidelines are explained here in terms of highway drainage but are equally applicable to other surface water drainage systems. The approach complements the UPM procedures.

The approach is based on better use of existing drainage techniques to control water quality without significantly increasing costs. Consideration of water quality at an early stage in design allows selection of drainage techniques which can remove pollution and meet quality standards in receiving waters.

The problem

Discharges from highway drainage systems fall into two broad categories:

- *routine* discharges due to rainfall washing off pollutants that have built up from everyday use of the road
- *accidental* discharges of pollutants from spillages, firefighting water, etc.

Control of pollution from these requires different approaches. Pollution from routine discharges can be controlled at source or in the drainage system itself - many drainage techniques have pollutant removal characteristics - whereas containment of spills to prevent pollution of the receiving water is the only satisfactory solution once an accident has occurred.

The scale of pollution from highway and surface water drainage systems is difficult to quantify but a good indication is given by the NRA (1994). In 1993, the NRA substantiated over 25,000 pollution incidents. The incidents were categorised by source, and the two sources of interest here are *Sewage and water industry* (which accounts for 25% of incidents) and *transport* (which accounts for 6%).

Of the transport incidents, about three-quarters are from roads and most of these were a result of traffic accidents. These are the accidental discharges referred to above.

Not surprisingly, CSOs account for the greatest proportion (21%) of sewage and water industry incidents. The second most important source of sewage incidents is water utility-owned surface water outfalls, which account for 16% of sewage-related incidents. Most of these systems carry road runoff.

The required river class to indicate the required quality of the river.

Simple tables then show whether there is a risk of problems from oil pollution, or from metal pollution.

For discharges which show a risk of pollution from metals the dilution calculations are repeated with more accuracy:

The daily traffic flow is used to calculate the amount of pollutants that will be deposited on the road surface and available to be washed off.

The background concentration of metals in the river is required. This is often available from the NRA.

The hardness of the river water is used together with the required river class, as this affects the permitted concentrations.

The concentration resulting from the dilution of the discharge by the river flow is then calculated and compared to the guideline concentrations. If the guidelines are exceeded then a drainage method which can remove pollutants should be chosen.

Drainage systems fall into two categories - surface and sub-surface. Some, such as filter drains, satisfy both functions. The components of highway drainage systems perform various functions:

- *collection* of water from the surface or sub-surface, e.g. kerbs and gullies
- *conveyance* of water to another part of the system, e.g. pipes
- *disposal* of water to watercourses or groundwater, e.g. infiltration basins
- *storage* of water to reduce peak flows, e.g. detention tanks
- *coarse sediment removal* to prevent blockages, e.g. sedimentation tanks
- *pollutant removal* to protect receiving waters, e.g. constructed wetlands.

Many components of drainage systems also remove pollutants - particularly those whose primary function is storage or sediment removal - but these effects are not currently taken into account.

The CIRIA report lists all common drainage techniques and quotes removal rates for fine sediments, metals, herbicides and organic pollutants. Information on costs, land take, operational and maintenance costs is also given, with guidance on the applicability of various systems to new and existing highways.

Derivation of the method

The method was derived by setting up a simple model of the build-up and washoff of pollutants on a road surface and running this for long rainfall timeseries from several parts of the country. The concentration that was exceeded for, on average, 15 days each year was calculated and the size of storms and amount of pollutant washoff that caused these conditions was identified. The variation in this storm for different river dilutions and traffic flows was investigated and was found not to be significant. The storms were then compared to the standard rainfall statistics for the locations and this comparison was used to derive the maps of rainfall depth for the whole country.

The method was tested on a range of schemes and found to give reasonable results.

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Question Dave Walters M W Barber Group

What is the difference between a grassed ditch and a polluted water course?

Answer

(a) You can't wash your hands in a grassed ditch.

(b) Grassed ditches are primarily for conveyance of runoff. They also provide storage and sometimes act as infiltration trenches. Some water quality improvement takes place due to particle settling and biofiltration: this would not happen in a river. Another obvious difference is that grassed ditches are dry between rainfall events.

Question Peter Whalley NRA

Problems of pollution derived from urban runoff are being more widely recognised. Did the study consider the wider aspects of surface runoff from the whole catchment?

Did the study consider other pollutants particularly nutrients such as total phosphate and total nitrogen which are major factors in environmental problems such as Eutrophication.

Answer

The original CIRIA proposal for the work was to study all urban runoff, not just highway runoff. Funding for the work was difficult to find, however, and when the Department of Transport offered to contribute we decided to concentrate on highway runoff. Highway drainage design is not as sophisticated as general urban drainage design, and most highway drainage engineers do not consider water quality issues at all. There was an opportunity, therefore, to make a significant contribution to highway drainage design by providing highway engineers with basic water quality information and tools. The work could easily and usefully be extended to make the guidance more generally applicable to non-highway situation.

Many pollutants were considered and details are given in the report. We focused on copper and zinc in the guidance because our work demonstrated that these are the metals in highway runoff most likely to cause a water quality standard failure.