

The Long Term Monitoring of Pollution from Highways Runoff

R&D Technical Summary P2-038/TS

Highway surface runoff discharges may contain pollutants that have accumulated on the carriageway, particularly following periods of dry weather. These pollutants can then be transported via the surface water drainage system to discharge to ground or receiving watercourses.

Previous studies have demonstrated that highway runoff affects the quality of waters and sediments. Increased concentrations of metals, hydrocarbons and anions are associated with changes in the structure and functioning of biological communities.

The Highways Agency has a duty to ensure that discharges from the trunk roads and motorways do not pollute receiving waters. Various treatment facilities have been designed and incorporated into recent trunk road and motorway construction but these designs are based on predicted pollutant concentrations. The Highways Agency in association with the Environment Agency commissioned this study to collect data to improve the understanding of contaminants in routine non urban highway runoff and to examine the treatment efficiency of drainage systems and drainage devices in the non urban environment. Many of these systems have been installed to provide environmental protection through hydraulic control, but the potential for additional treatment was recognised.

These data will be used to assess the impact of highway runoff on receiving waters in order to assist in the future design of highway drainage systems.

There were six objectives for the research:

1. To undertake a programme of data collection for non-urban highways under a range of site conditions.
2. To create a database of flows, pollutant loads, rainfall and site details obtained during the study.
3. To identify key determinands and their concentrations in non-urban highway runoff.

4. To establish any relationships between pollutant concentrations and traffic flows, pollutant concentrations and rainfall totals, rainfall intensity, rainfall duration and antecedent dry periods.
5. To identify the treatment efficiency of a number of specified highway drainage types or combinations of treatment devices or facilities.
6. To evaluate the chemical and biological impact of highway runoff on receiving water quality.

The study was carried out by WRc plc over a 5 year period from December 1997. This involved the instrumentation and monitoring of non urban highway surface water drainage and the receiving water at 6 sites. The sites selected were in central Southern England. All sites had a minimum Annual Average Daily Traffic (AADT) of 15,000 vehicles/day. The sites had the following drainage types or combinations of treatment facilities: untreated runoff; bypass oil interceptor and dry balancing pond; oil trap manhole and sedimentation tank; full retention oil trap and wet balancing pond; untreated runoff and filter drain; and, bypass oil interceptor and wet pond/surface flow wetland. Each site was monitored for a minimum of 1 year. Continuous flow monitoring of the watercourse upstream and downstream of the highway runoff discharge location and continuous monitoring of rainfall were undertaken. Water quality samples and in situ measurements were taken at quasi-monthly intervals. Sediment samples were taken at the beginning and end of the monitoring period from the drainage system and from the watercourse. Highway runoff was recorded and sampled for 10 wet weather events during the monitoring period at each site. Flow measurement was undertaken at the point of discharge from the carriageway and liquid samples were taken upstream and downstream of each runoff treatment device. In addition to flow measurement in

the watercourse, water quality probes were deployed at the upstream and downstream locations. Biological surveys were undertaken on three occasions at each site at selected locations upstream and downstream of the highway discharge. Highway runoff, the discharge to the watercourse and associated sediment samples were analysed for up to 40 determinands, including metals, herbicides, hydrocarbons, suspended solids, BOD, COD and Ammoniacal Nitrogen.

The data have been collated in to a database and used to identify ranges of pollutant concentrations in highway runoff; relationships between runoff concentrations/loads and highway/environmental factors; treatment efficiencies; and impacts on receiving waters. This database can be used to support further analysis, investigation and interpretation. While the overall quantity of runoff data is large, with 60 events captured, the number of event data sets collected at individual sites is relatively small taking into consideration the observed variability of the events, background environmental conditions and highway characteristics. This has limited the identification of relationships between event and site characteristics and the resulting runoff quality at individual sites. In addition, the number of highway variables between sites has limited the conclusions that may be drawn from inter site comparisons of runoff, treatment device efficiency and environmental impact in the receiving watercourse.

A number of determinands were not detected. However, the full range of characteristics across the highway network were not represented and these may, therefore, be identified elsewhere. A number of determinands were detected during all monitored rainfall events and at concentrations well above limits of detection. Some were also shown to have concentrations greater than prescribed maximum and annual average concentrations identified for Drinking Water and Freshwater Environmental Quality Standards. The range of observed event mean flow weighted pollutant concentrations is higher than those quoted in the Design Manual for Roads and Bridges, Volume 11, Section 3:10, Water Quality and Drainage. A number of possible relationships associated with highway runoff quality can be proposed. Determinand concentrations, and in particular metals, appear in higher concentrations following winter salting and a relationship may exist between runoff concentration and rainfall intensity.

Assessment of treatment efficiency indicates that there is a wide range of pollution removal efficiencies for the individual and combinations of treatment devices at the monitored sites. The greatest pollution removal efficiency was produced by a combination of a bypass oil separator and wet pond-surface flow wetland.

Event monitoring and background monitoring in the receiving waters at five sites where data could be collected showed no apparent impact of highway runoff over background conditions. Watercourse sediment analysis showed little significant accumulation of contaminated sediments downstream of highway runoff discharges. The drainage from these sites appears not to have adversely affected macro-invertebrate communities in the receiving waters.

A literature review was conducted at the beginning of the study. This outlined the results of studies that examined the effects of highway runoff on the quality of receiving waters and sediments and the effect on biological communities. The review showed that

previous studies identified elevated concentrations of metals and hydrocarbons in waters and sediments and that these elevations are associated with changes in the structure and functioning of biological communities. This review is available as an associated report.

Overall, the results from the study seem to differ from previous studies of runoff quality and receiving water impact, largely associated with urban highways, higher traffic densities and different regional climates and receiving water characteristics.

This R&D Technical Summary relates to information from R&D Project P2-038 in the following outputs:

- R&D Technical Report P2-038/TR1**
The Long term monitoring of highways surface water run-off: Final Report
ISBN: 1 844 32208 4 October 2003
- R&D Technical Report P2-038/TR2**
M4/Brinkworth Brook - Site report
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- R&D Technical Report P2-038/TR3**
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- R&D Technical Report P2-038/TR4**
M4/River Ray – Site Report
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- R&D Technical Report P2-038/TR5**
M40/Souldern Brook – Site Report
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- R&D Technical Report P2-038/TR6**
A34/Gallos Brook – Site Report
ISBN: 1 844 32213 0 October 2003
- R&D Technical Report P2-038/TR7**
A34 Newbury By-pass – Site Report
ISBN: 1 844 32214 9 October 2003
- CDRom containing all reports plus database and literature review.**
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Project Managers: Environment Agency - A Roe
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Research Contractor: WRc, Swindon

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