

Results of Survey on Water Quality Problems  
Caused by Urban and Highway Stormwater Runoff

G. Fred Lee, Ph.D., P.E., D.E.E. and Anne Jones-Lee, Ph.D.  
G. Fred Lee & Associates  
El Macero, California

1996

The US EPA (1995) in their 1994 Report to Congress on the water quality status of the US waterbodies claims as they have in previous biennial reports to Congress that urban area and highway stormwater runoff is one of the major causes of water quality impairment in the US. It appears that the US EPA's claim is based largely on the way the agencies and the states assessed water quality impacts in the National Water Quality Inventory in which they assumed that any exceedance of a water quality standard by any amount and duration represented a "use impairment." However, those familiar with how the US EPA water quality criteria and state standards based on these criteria are developed know that considerable exceedance of these standards can occur for potentially toxic chemicals, such as heavy metals and organics, without adversely impacting the real aquatic life-related beneficial uses of the waterbody receiving the stormwater runoff (Lee and Jones-Lee, 1995). There is, therefore, considerable controversy as to what real water quality - use impairment problems are caused by highway and urban area street stormwater runoff-associated chemical constituents.

Are the water quality problems that the US EPA has cited largely administrative, related to the use of overly-protective water quality criteria and state standards or are there significant adverse impacts on the numbers, types and characteristics of desirable forms of aquatic life in the nation's waters due to the presence of elevated concentrations of heavy metals and other potentially toxic constituents in urban area and highway stormwater runoff? This issue is of considerable importance to the national as well as state and local stormwater runoff water quality management programs that are currently being formulated across the country since it will determine the need for non-structural and structural best management practices (BMP's).

The US EPA's national urban area and highway stormwater quality management program (US EPA, 1990) requires stormwater managers to control pollution of the receiving waters for the stormwater runoff to the maximum extent practicable (MEP) using BMP's. The key issue that has to be defined in developing technically valid, cost-effective stormwater management programs is what constituents in stormwater runoff cause pollution (impairment of uses) of the receiving waters for the runoff. This issue has to be assessed on a site-specific basis.

It is the authors' experience, having worked in this topic area over the past 30 years, that it is indeed rare that chemical constituents in urban and highway stormwater runoff cause real water quality use impairments in the receiving waters for the runoff. This would be expected based on the chemical nature of many of the constituents in urban and highway stormwater runoff since they are in non-toxic, non-available forms, and runoff events are of a short-term, episodic nature thereby allowing higher concentrations of toxic-available forms to be present in runoff waters without adverse impact on the beneficial uses of the receiving waters.

In an effort to try to gain as wide a variety of stormwater runoff water quality impact experience as possible, a survey has been conducted through several national magazines and journals, professional groups, governmental agencies and others for the purpose of finding documented cases of real water quality use impairments associated with urban and highway stormwater runoff. This survey has included a review of the technical literature on stormwater runoff water quality impact studies. Presented below is a synopsis of the results of this survey. It also presents information developed from the authors' work over the past 30 years devoted to evaluating the water quality impacts of urban area and highway stormwater runoff-associated constituents on the beneficial uses of the receiving waters for this runoff.

It is concluded that:

- Urban and highway stormwater runoff contains a number of potentially toxic or otherwise adverse chemical constituents which at the point of runoff exceed the US EPA water quality criteria/state standards.
- There are few documented cases where urban stormwater runoff has caused real water quality use impairments of the receiving waters for the runoff due to toxic or bioaccumulatable chemicals.
- The aquatic life toxicity present in urban stormwater runoff has not been found to be due to the regulated chemicals such as heavy metals or "traditional" organics, but is due to the unregulated chemicals such as the organophosphorus pesticides, principally diazinon. While diazinon and other organophosphorus pesticides found in urban stormwater runoff at sufficient concentrations to be toxic to aquatic life are derived from urban household and commercial use, in some areas, such as Northern California, there is also long-distance atmospheric transport of organophosphorus pesticides from agricultural use that causes aquatic life toxicity in urban area and highway stormwater runoff due to precipitation scrubbing (washout) of diazinon from the atmosphere.

In most situations where the urban stormwater discharges occur to large waterbodies, diazinon-associated toxicity in the discharge likely has limited impact on the receiving water water quality due to the rapid dilution of the stormwater runoff discharge with the receiving waters. However, for small urban creeks where the stormwater runoff could become the dominant flow for a sufficient period of time to be toxic to aquatic life, the diazinon-caused toxicity could be significantly adverse to the beneficial uses of these types of waterbodies.

- It should not be assumed that exceedance of a water quality criterion or state standard causes a real water quality use impairment of the designated beneficial uses of the receiving waters for the urban stormwater runoff. Many of the constituents in urban stormwater runoff are in particulate, non-toxic forms and therefore do not adversely impact the designated beneficial uses of the receiving waters for the runoff.
- Conventional "BMP's," such as detention basins, often advocated for use in connection with urban area and highway stormwater runoff are not effective in controlling toxic forms of chemical constituents. The toxic forms occur in a dissolved state while detention basins, filters and many other conventional BMP's remove particulate forms of

constituents which have been recognized for over 25 years as being non-toxic. Regulatory agencies and others are now beginning to recognize in the implementation of water pollution control programs that particulate heavy metals and other particulate constituents are in non-toxic forms and remain in these forms in the receiving waters for the stormwater runoff.

- Because of the high cost of real structural BMP's for removal of true pollutants (typically dissolved chemical species) and the ineffectiveness of conventional structural BMP's in controlling real pollutants, source control BMP's will likely be the primary method used for the control of real water pollution-use impairment caused by chemical constituents in highway, and urban area stormwater runoff. Caution must be exercised, however, in developing a source control BMP to be certain that the control of constituents from a source addresses real pollutants i.e., those constituents that significantly adversely impact the beneficial uses of the receiving waters for the stormwater runoff.
- Stormwater runoff BMP's involving infiltration of stormwater into the groundwater system can lead to pollution of groundwaters by chemical constituents in the stormwater runoff. This could more readily occur in sandy areas.
- Current water quality monitoring of stormwater runoff is of limited reliability in assessing the potential water quality impacts - water quality impairments of the beneficial uses of waterbodies. There is need to shift emphasis from end-of-the-pipe - pavement or property monitoring to receiving water evaluation to determine on a site-specific basis what, if any, real water quality use impairments are caused by urban area and highway stormwater runoff.
- Aquatic plant nutrients (phosphorus and nitrogen) in urban stormwater runoff can cause significant water quality deterioration - excessive fertilization (eutrophication) in urban streams and especially small urban lakes whose makeup water is principally urban stormwater.
- It should not be assumed that all nitrogen and phosphorus in urban stormwater runoff, whether derived from terrestrial vegetation or fertilizers applied to lawns and shrubbery, cause excessive fertilization in waterbodies receiving the runoff. Site-specific investigations of the receiving waters for stormwater runoff must be conducted to determine whether the aquatic plant nutrients (phosphorus and/or nitrogen) cause excessive fertilization in a particular waterbody and thereby require control in the stormwater runoff.
- Urban and highway stormwater runoff often contains significantly elevated concentrations of fecal indicator organisms which can be detrimental to contact recreation and shellfish harvesting in the receiving waters for the runoff. It is unclear at this time whether urban and highway stormwater runoff contains potentially significant numbers of the enteroviruses and cyst-forming protozoans such as *Cryptosporidium* and *Giardia* which have recently become recognized as significant potential threats for domestic water supply as well as contact recreation water quality.

- There are situations particularly associated with new developments and agricultural runoff where inadequate control of erosion can lead to adverse impacts on receiving water beneficial uses through excessive turbidity and siltation that is adverse to aquatic life habitat and can cause shoaling. These problems are due to the presence of suspended and/or bedded sediments. They are largely independent of the chemical characteristics of the sediments. It is situations such as these where inadequate erosion control at the source can lead to the need for appropriately designed detention basins (desilting basins) to control the excessive suspended sediments present in the runoff.
- The management of urban stormwater runoff often involves significant aquatic life habitat alteration as part of improving stormwater conveyance in order to avoid flooding. This, in turn, often significantly degrades (alters) the aquatic life populations in an area. Such degradation should be recognized as separate and distinct from the potential impacts of chemical contaminants in stormwater runoff.

### **Request for Additional Information**

The authors are interested in continuing this survey and request that any instances of documented cases of urban area, residential and commercial streets and highway stormwater runoff has, in fact, caused aquatic life toxicity or adverse impacts in receiving waters that are detrimental to the designated beneficial uses of these waters, be brought to their attention. These adverse impacts should be manifested in terms of altered numbers, types and characteristics of desirable forms of aquatic life or excessive bioaccumulation of constituents in tissue that renders the aquatic life hazardous in terms of exceedance of a health advisory for consumption by humans or wildlife. In making this assessment, it is important to distinguish between altered habitat characteristics associated with stormwater conveyance systems and the presence of toxic forms of hazardous or deleterious chemicals which would require their control in stormwater runoff.

### **Acknowledgements**

The authors thank all of those who participated in this survey. They also thank S. Taylor of Silverado - RBF, Irvine, California and Richard Watson of Richard Watson and Associates, Mission Viejo, California for review of this paper.

### **References**

Lee G.F., and Jones-Lee, A., "Stormwater Runoff Management: Are Real Water Quality Problems Being Addressed by Current Structural Best Management Practices? Part 1," Public Works, 125:53-57,70-72 (1994). Part Two, 126:54-56 (1995).

US EPA, "National Pollutant Discharge Elimination System Permit Application Regulations for Stormwater Discharges; Final Rule," 40 CFR Parts 122, 123, and 124, Federal Register 55(222):47990-48091, November 16 (1990).

US EPA, "National Water Quality Inventory 1994 Report to Congress: Individual State and Territorial Summaries," US Environmental Protection Agency, Office of Water, Washington, D.C., December (1995).

-----

Prepared as a report by G. Fred Lee & Associates, El Macero, CA, June 1996.

Published as: Lee, G. F. and Jones-Lee, A. "Survey Results: Stormwater Runoff," *Runoff Report* 5(4):3 (1996).