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URBAN NONPOINT SOURCE / STORMWATER MANAGEMENT

EPA

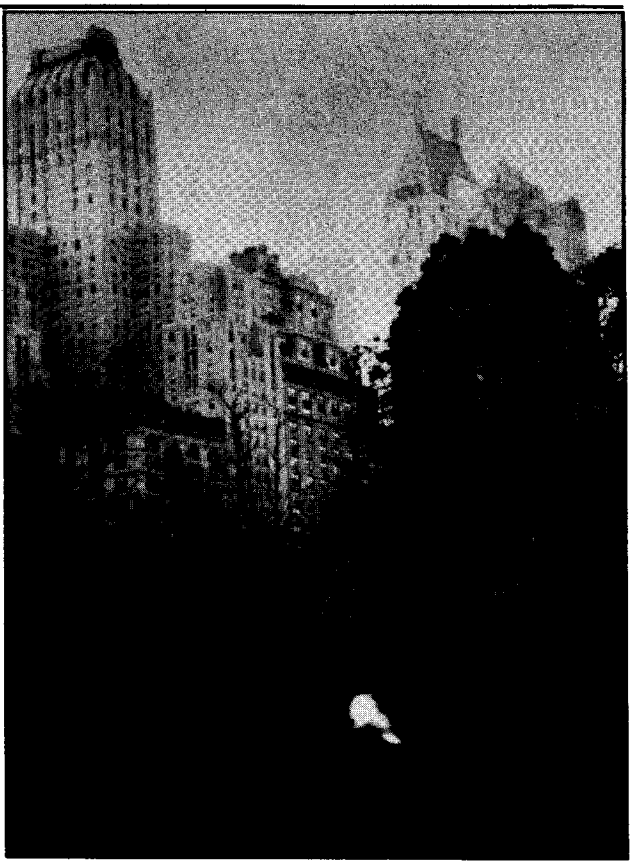
# Urban Runoff Impacts to Receiving Waters

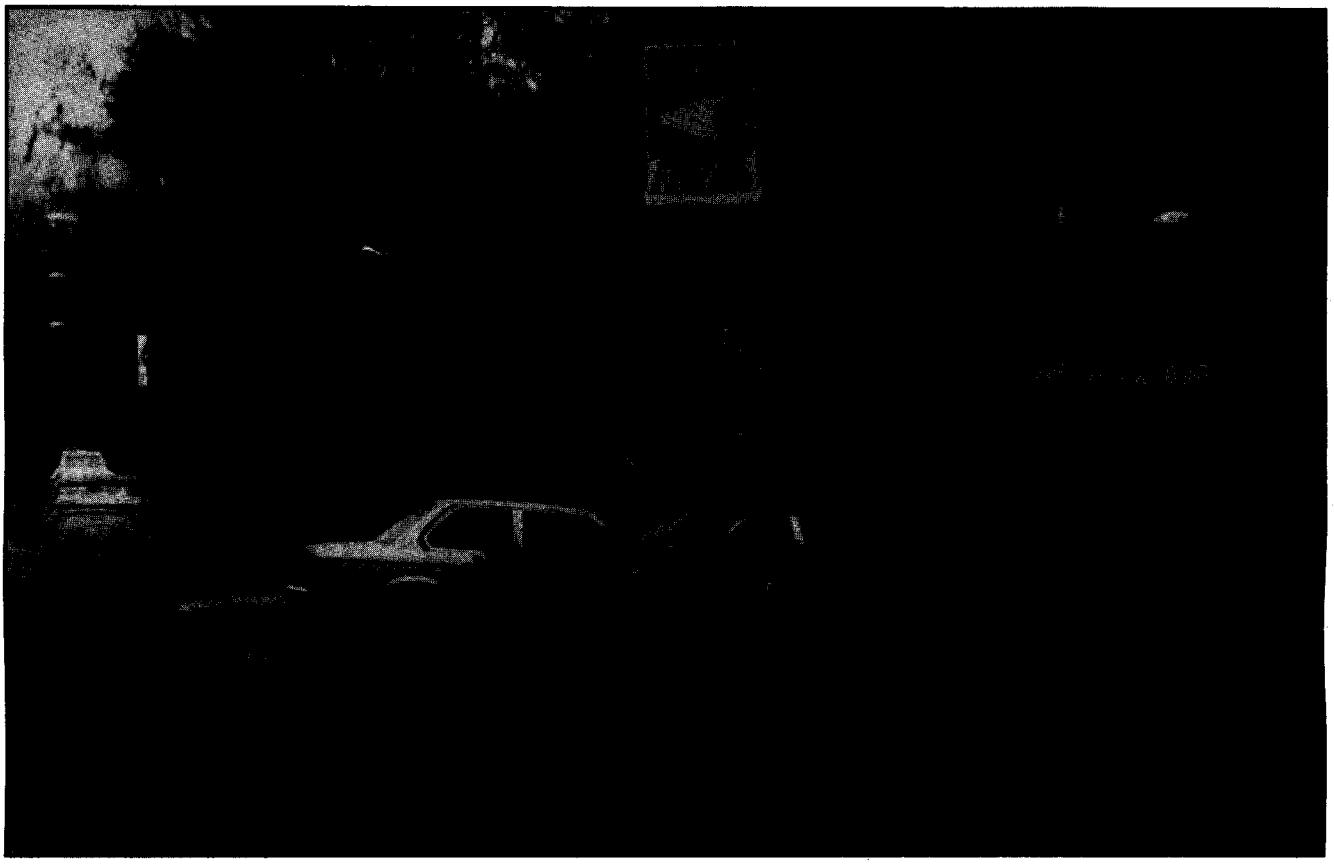
## Introduction

The EPA-sponsored National Urban Runoff Program (NURP) identified the potential of stormwater to adversely affect receiving waters and aquatic biota through increased frequency and duration of peak flow rates, erosion/sedimentation, eutrophication, or toxic impact. Assessments completed under state clean lakes and nonpoint source programs have identified the extent to which urban runoff is impairing water use.

## Stormwater Contaminants

The state assessments identified several categories of potential urban stormwater pollutants: suspended solids, nutrients, bacteria, oils/grease, toxic organics, and toxic inorganics (heavy metals). Critical pollutants were identified by: (1) frequency of occurrence within the stormwater database, and (2) high concentrations relative to the EPA water quality criteria. An additional consideration was the degree to which urbanized stormflow hydrology alone impacted biota in natural stream courses. Potential impacts resulting from the presence of the above pollutants include: (1) physical impairment or habitat disruption to biota, (2) enrichment and subsequent eutrophication of receiving waters, and (3) exposure and physiological response to toxic substances by aquatic biota. The presence of such impacts are considered an impairment of the receiving water resource.





**Automobile traffic is a major source of pollutants resulting from urban stormwater runoff.**

## *High Flows/Erosion/ Suspended Solids*

Various urban runoff studies have effectively demonstrated the impacts of high flows, erosion, and deposition on urban streams and other sensitive receiving waters. Increased frequency and duration of high flows result in increased erosion-related impacts to (1) eroded sites, (2) conveyance systems including streams, and (3) sites of deposition. In-stream impacts are related to increased streambank erosion during high flows, increased turbidity and suspended solids concentrations, scouring habitat, and downstream depositional impacts that degrade habitat and reduce hydraulic channel capacities. Increased suspended solids concentrations and turbidity in streams can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, and reproduction. The deposition of relatively fine-grained sediments in stream beds can dramatically reduce their value for insect production and fish spawning. Erosion/ sedimentation impacts can be costly, requiring removal of deposited materials to restore water supply storage, flood control, habitat, and recreational benefits of impacted resources.

## *Nutrients*

Increased nutrient (phosphorus, nitrogen) concentrations in stormwater have been shown to result in greater nutrient enrichment and associated algal productivity in lakes, embayments, and other quiescent receiving waters, often creating undesirable excessive growth conditions. Phosphorus is often emphasized as the nutrient controlling algal growth; phosphorus loading rates from urban areas have been determined to be three to seven times greater than undeveloped woodland. However, a preponderance of stormwater inflow has been demonstrated to inhibit algal growth as a result of the presence of toxic substances, despite elevated nutrient concentrations.

### *Toxic Organics*

Toxic organic pollutants that are prevalent in urban runoff include pesticides, phenols, phthalates, and polynuclear aromatic hydrocarbons (PAHs). While some exceedances of EPA freshwater chronic water quality criteria have been reported, concentrations in general are sufficiently low to preclude significant impacts to aquatic biota. However, their potential for bioaccumulation and status as human carcinogens warrants continued consideration as pollutants of concern.

### *Toxic Metals*

Toxic metals are the pollutants of greatest concern in urban runoff. Lead, zinc, copper, and cadmium have both a high frequency of occurrence and high absolute concentrations in stormwater; numerous exceedances of water quality criteria for these metals have been reported. Metals have the potential to bioaccumulate and persist in the environment.

EPA water quality criteria have been developed for both acute and chronic toxicity values from bioassays on representative biota; criteria are designed to protect 95 percent of aquatic species. Physiological effects of metals exposure include algal growth inhibition and zooplankton/fish mortality through gill adsorption and respiratory impairment.

## Uncertainties of Toxic Impacts

While stormwater impacts related to aesthetics, hydrologic changes to stream habitat, elevated fecal coliform counts, and eutrophication have been adequately demonstrated, the adverse effects of toxicants have been more difficult to establish. Although some water quality degradation may be occurring, such degradation has generally not been perceived to result in significant impairment to aquatic biota. For example, of over 10,000 fish kills investigated by EPA during the period 1970-1979, less than 150 were attributable to urban runoff. If present, potential toxic impacts have been more subtle and more easily overshadowed by larger, definite impacts associated with scour and sedimentation. Other sources of uncertainty regarding toxic pollutant impacts include the following:

1. Water quality metals criteria and most stormwater analyses are based on total concentrations, whereas only the smaller dissolved fraction is directly related to toxicity. Criteria are therefore conservative as they also assume dissolution of the inert particulate fraction.

2. Criteria are based on continuous bioassays for the defined exposure period. In reality, stormwater toxic exposure is intermittent and of short duration, whereupon receiving waters recover to relatively acceptable quality. These are recognized by EPA under the term "Estimated Effect Levels for Intermittent Exposure."

3. Bioassays and water quality criteria are based upon end-of-pipe stormwater concentrations. Criteria therefore do not assume dilution capability by the receiving water.

4. Pollutant forms and concentrations are dynamic relative to product and use trends. For example, lead concentrations in stormwater have declined in recent years with the progressive conversion of the motor vehicle fleet to lead-free combustion engines. Similarly, some pesticide products are being retired in favor of new products being introduced to the market.

# Summary Assessment of Urban Runoff Impacts

The majority of pollutant loading attributed to urban stormwater originates from endemic sources such as motor vehicle traffic and atmospheric fallout. While toxic metal criteria established from continuous exposure bioassays are regularly exceeded in stormwater, receiving water resources and local perception often do not reflect a corresponding beneficial use impairment of the resource. Possible reasons for this disparity are due to the conservative nature of water quality criteria designations and the complexity of biochemical cause and effect relationships. Instead, perceived or documented impairments focus on aesthetics from oil and floatable debris, species displacement from erosion/sedimentation in conveyance streams, and enhanced eutrophication potential from nutrient enrichment.

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