Stormwater Runoff Water Quality Science/Engineering Newsletter Devoted to Urban Stormwater Runoff Water Quality Management Issues

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Background to this Newsletter

This Newsletter is the first issue of the 4th volume (year) of publishing the Stormwater Runoff Water Quality Science/Engineering Newsletter. The original motivation for developing this Newsletter was that, three years ago, it became clear that the approaches beginning to be used then for regulating the water quality impacts of chemical constituents and pathogen indicator organisms in urban area and highway stormwater runoff did not utilize the science/engineering that is readily available. Unfortunately, this situation has not changed in the past three years. Rather than focusing on toxic available forms of constituents in urban area and highway stormwater runoff, state and local regulatory agencies frequently ignore the fact that chemical constituents exist in natural waters in a variety of chemical forms, only some of which are toxic/available.

Further, the regulatory approaches that were beginning to be used then and are still being used today, ignored that the exceedance of US EPA water quality criteria and state standards based on these criteria, tend to overestimate the water quality impacts of potential pollutants in urban area and highway stormwater runoff. In addition to failing to focus on available toxic forms, the current regulatory approach frequently ignores the fact the US EPA's duration of exposure relationships incorporated into the implementation of their water quality criteria and NPDES permits, is not appropriate for the typical stormwater runoff event where aquatic life can receive only limited exposures to toxic available forms during the runoff event.

As has been discussed in previous Newsletters, the exceedance of a US EPA water quality criterion or a state standard based on these criteria, is not a reliable assessment of impaired water quality in the receiving waters for stormwater runoff. The technically valid reliable approach involves site specific investigations to determine where the exceedance of a criterion/standards represents a real impairment of the beneficial uses of the receiving waters for the stormwater runoff or is an "administrative" exceedance related to how the US EPA's national water quality criteria were developed and are being implemented.

Frequently, stormwater managers and consultants state that the US EPA national water quality criteria are not valid. The facts are that, with few exceptions, the US EPA criteria are valid for the protection of aquatic life and other beneficial uses of a waterbody under worst case based situations, i.e., those of potential pollutants being in a 100 % available forms and aquatic life in the receiving waters experiencing an extended exposure to these forms. The US EPA's national water quality criteria evolved from the US Congress Clean Water Act which required the Agency develop criteria that would be protective of the nation's waters. The Agency staff responsible for formulating this approach in the early 1980s understood that, if mechanically implemented in state standards, could readily lead to over regulation of chemical constituents in many waters as a result that most waters have detoxification/binding capacity for toxic

available forms causing them to become nontoxic nonavailable. In an effort to address this issue, the US EPA developed its "Water Quality Standards Handbook" which is now in its 2nd Edition (1994) which provides guidance on how the worst cased based national criteria should be adjusted for site specific conditions. There are a number of notable examples, such as for copper in New York Harbor and San Francisco Bay, where following this guidance with appropriate modifications, the exceedance of the worst case based criterion/standards disappears when the standard is adjusted for site specific conditions.

Unfortunately, urban and highway stormwater management agencies in many parts of the country have been reluctant to do the studies needed to demonstrate that the exceedance of worst case based criteria/standards in urban area and highway stormwater runoff is often an administrative exceedance that does not represent an impairment of the beneficial uses of the waters receiving the stormwater runoff. Until urban and highway stormwater management agencies conduct the necessary site specific studies to evaluate the real impacts of chemical constituents in urban area and highway stormwater runoff, there will continue to be considerable unreliable, typically overprotective approaches used to manage the real significant water quality impacts of urban area and highway stormwater runoff. Further, the current approach leads to the development of inappropriate, inadequate BMPs associated with managing urban area and highway stormwater runoff. These issues have been discussed in several of the Newsletters published over the past three years. Past issues of the Newsletter are available from www.gfredlee.com.

"National Water Quality Inventory US EPA 1998 Report to Congress"

In the fall 2000, the US EPA released its 1998 Report to Congress on the status of the nation's water quality. The official release date was June 2000, although it was not available in hard copy until recently. The US EPA states that the "National Water Quality Inventory 1988 Report to Congress" is the primary vehicle for informing Congress and the public about the quality of waters in the nation's rivers, streams, lakes, ponds, reservoirs, wetlands, estuaries and coastal waters. Previous issues of this Inventory have been instrumental in causing the US Congress to develop urban stormwater runoff water quality management programs based on the fact that urban area stormwater runoff was alleged to be a major cause of impairment of the nation's waters. The Inventory is part of the Clean Water Act 305(b) requirements, where states are required to provide the US EPA with information on the status of achieving water quality standards every two years. The state reports are then used by the US EPA to develop the Inventory.

In the past and currently, the US EPA has dictated, to a considerable extent, how the states are to assess water quality impairment, focusing primarily on violations of water quality standards. The violations of water quality standards become the basis for 303(d) listing and TMDL development. The National Water Quality Inventory is particularly important to urban stormwater runoff water quality managers since it has and continues to provide unreliable information on the adverse impacts of urban stormwater runoff on the beneficial uses of receiving waters, especially as it relates to potentially toxic constituents, such as certain heavy metals and organics. Overall, the 1998 Inventory continues to list urban stormwater runoff-associated constituents as a major cause of the nation's impaired waterbodies.

Attached are several pages from the "Inventory" which summarize the Agency's findings with respect to water quality use impairment and their causes. Only about 23 % of the river and stream miles of the US were assessed in the 1998 report, 42 % of the lakes, ponds and reservoirs and 32 % of the estuaries, while only 5 % of the nearshore marine waters were assessed. Therefore, at this time, some states, for some types of waters, are not evaluating/reporting the water quality of substantial parts of their waterbodies.

According to this report, the states have reported that, of those evaluated, 65 % of the river and stream miles, 55 % of the lake acreages and 56 % of the estuarine areas fully support water quality standards. Therefore, on the order of 40 to 50 % of the assessed waterbodies are "impaired" because of water quality standards violations. It is important to understand, however, that these standards violations are, in general, related to exceedances of US EPA-based water quality criteria, and, while not discussed by the US EPA in the Inventory, many of these exceedances are what we term "administrative" exceedances, which do not necessarily represent actual impairment of the beneficial uses of waterbodies. They, instead, reflect the overly protective worst-case nature of the US EPA national water quality criteria. This is especially true for potentially toxic constituents, such as heavy metals and some organics.

Until recently, there was little incentive for states and, especially, NPDES-permitted dischargers to perform any needed adjustment of the national criteria to consider how a particular waterbody detoxifies or immobilizes the potential pollutants, thereby making them unavailable to adversely impact aquatic life and many other beneficial uses of waterbodies. However, with the enforcement of TMDL requirements of the Clean Water Act, states and especially NPDES-permitted dischargers, are now beginning to implement the provisions of the Clean Water Act which allow adjustments of the US EPA national water quality criteria for site-specific conditions. As site-specific evaluations of water quality standards exceedances are properly conducted, it is likely to be found that many of the National Water Quality Inventory waterbodies listed as "impaired" will be removed from the list of impaired waterbodies since the water quality standards will be appropriately adjusted for site-specific conditions. This is especially true for nonpoint source discharges, such as runoff from agricultural lands, as well as urban stormwater runoff. Lee and Jones-Lee (1996) have previously reported on the unreliable information provided in the 1994 and 1996 US EPA "National Water Quality Inventory Report to Congress."

There are certain impairments – such as violation of contact recreation standards for bathing beaches, as well as excessive bioaccumulation of hazardous chemicals such as the organochlorine pesticides and PCBs in fish tissue which cause the fish to be considered unsafe for use as human food – that are real, significant water quality use impairments. However, the exceedance of heavy metals and some organics' water quality standards, where there is a mechanical comparison between the standard and the concentrations found in a waterbody, is not a reliable approach for informing Congress of the current state of impairment of the nation's waters. The proper approach for reliably

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EPA

Water Quality Conditions in the United States

A Profile from the 1998 National Water Quality Inventory Report to Congress

States, tribes, territories, and interstate commissions report that, in 1998, about 40% of U.S. streams, lakes, and estuaries that were assessed were not clean enough to support uses such as fishing and swimming. About 32% of U.S. waters were assessed for this national inventory of water quality. Leading pollutants in impaired waters include siltation, bacteria, nutrients, and metals. Runoff from agricultural lands and urban areas are the primary sources of these pollutants. Although the United States has made significant progress in cleaning up polluted waters over the past 30 years, much remains to be done to restore and protect the nation's waters.

Findings

Recent water quality data find that more than 291,000 miles of assessed rivers and streams do not meet water quality standards. Across all types of water-bodies, states, territories, tribes, and other jurisdictions report that poor water quality affects aquatic life, fish consumption, swimming, and drinking water. In their 1998 reports, states assessed 840,000 miles of rivers and 17.4 million acres of lakes, including 150,000 more river miles and 600,000 more lake acres than in their previous reports in 1996.

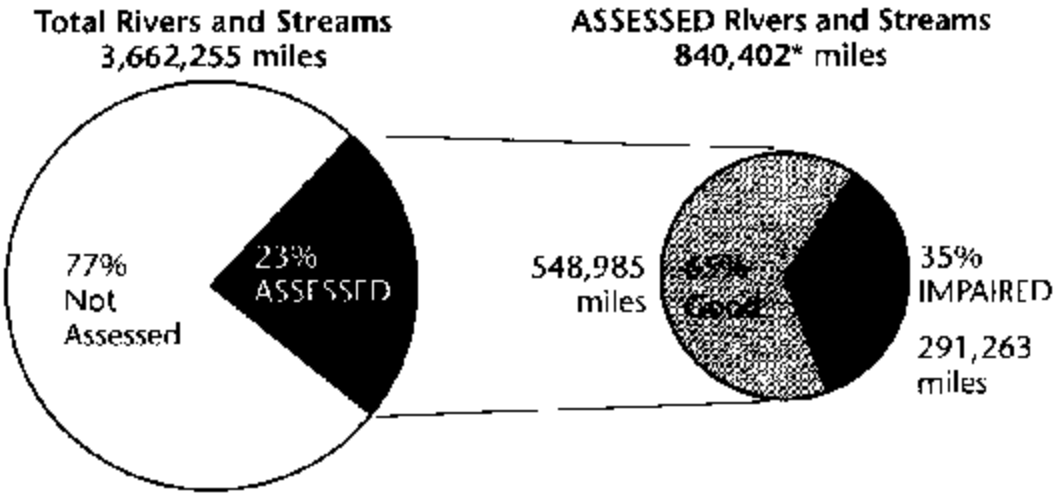
Of the assessed ocean shoreline miles, 12 % are impaired, primarily because of bacteria, turbidity and excess nutrients. Primary sources of pollution include urban runoff, storm sewers, and land disposal of wastes. States assessed only 5 % of the nation's ocean shoreline miles. States also found that 96 % of assessed Great Lakes shoreline miles are impaired, primarily due to pollutants in fish tissue at levels that exceed standards to protect human health. States assessed 90 % of Great Lakes shoreline miles.

Wetlands are being lost in the contiguous United States at a rate of about 100,000 acres per year. Eleven states and tribes listed sources of recent wetland loss; conversion for agricultural uses, road construction, and residential development are leading reasons for loss.

The states found that ground water quality is good and can support many different uses. However, measurable negative impacts have been detected and are commonly traced back to sources such as leaking underground storage tanks, septic systems, and landfills.

Figure 3-4

Leading POLLUTANTS in Impaired Rivers and Streams



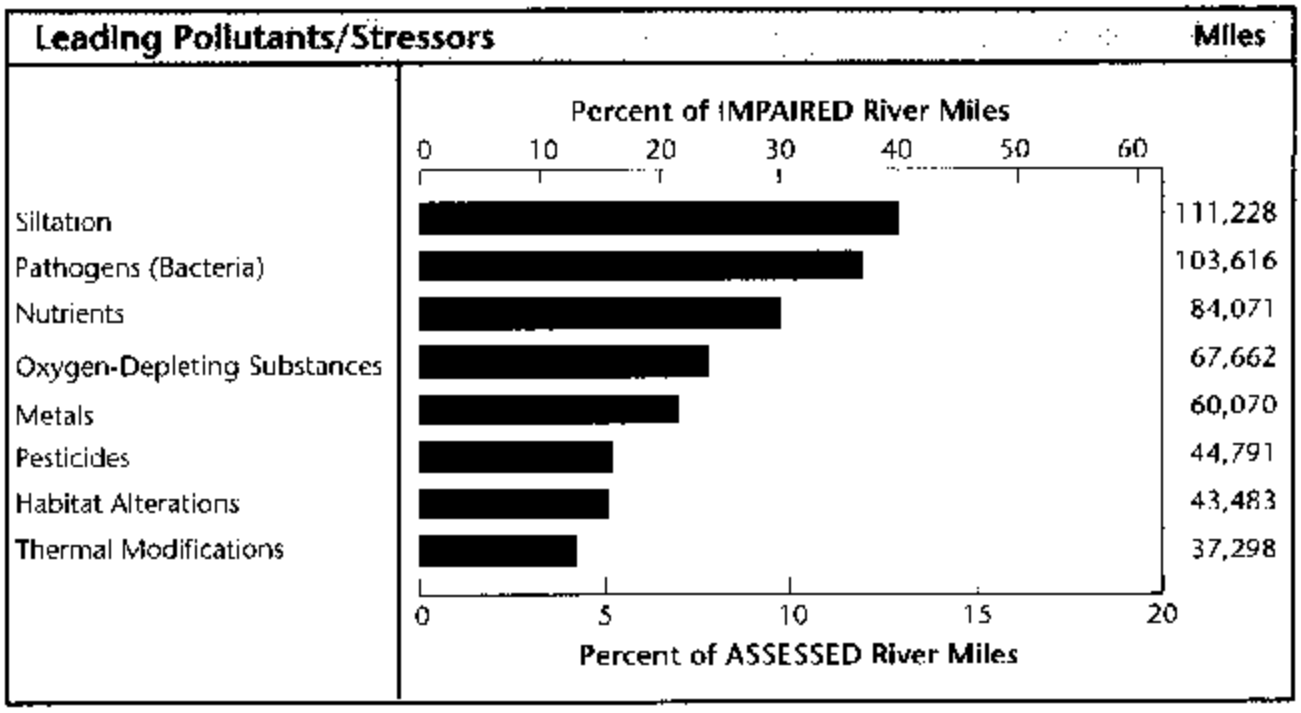
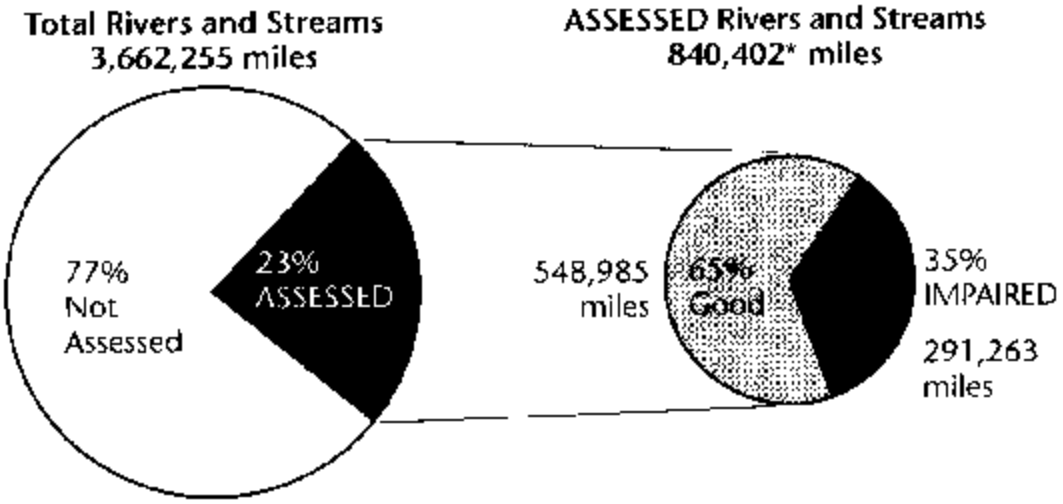


Figure 3 5

Leading SOURCES of River and Stream Impairment†



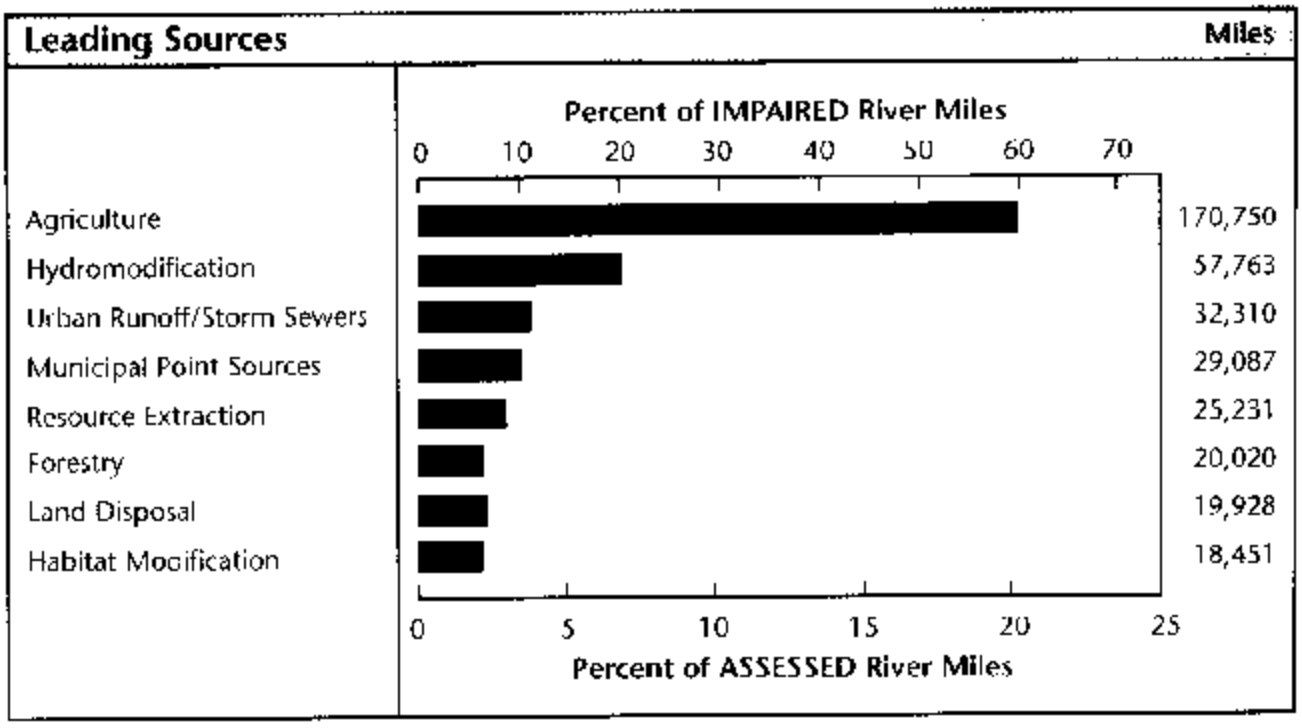
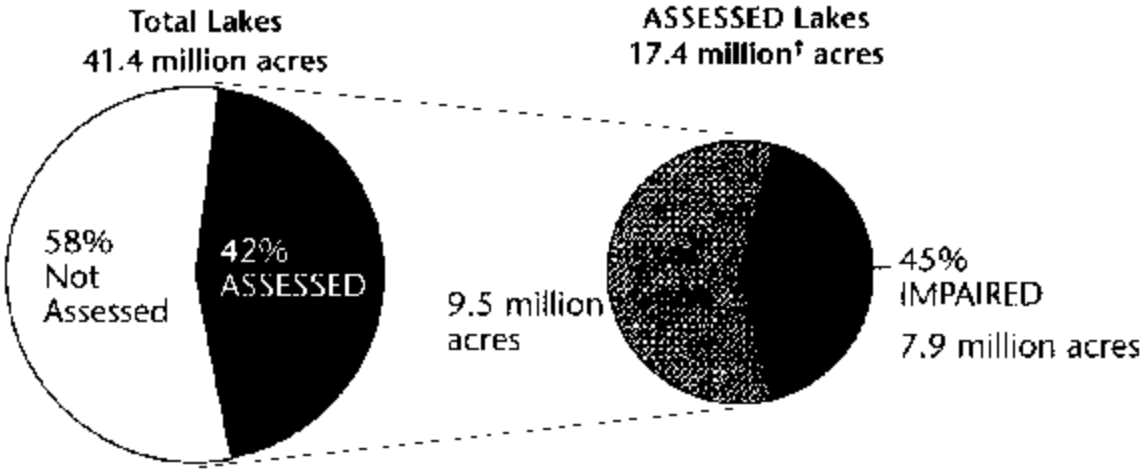


Figure 4-4

Leading POLLUTANTS in Impaired Lakes*



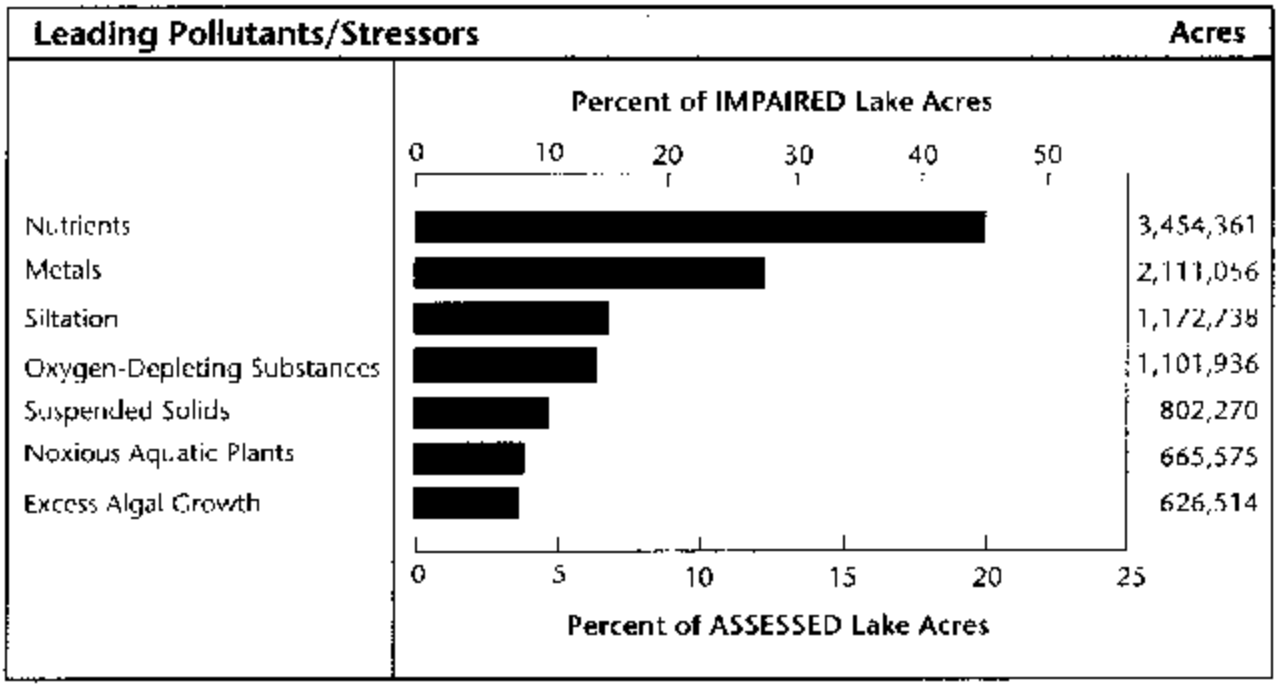
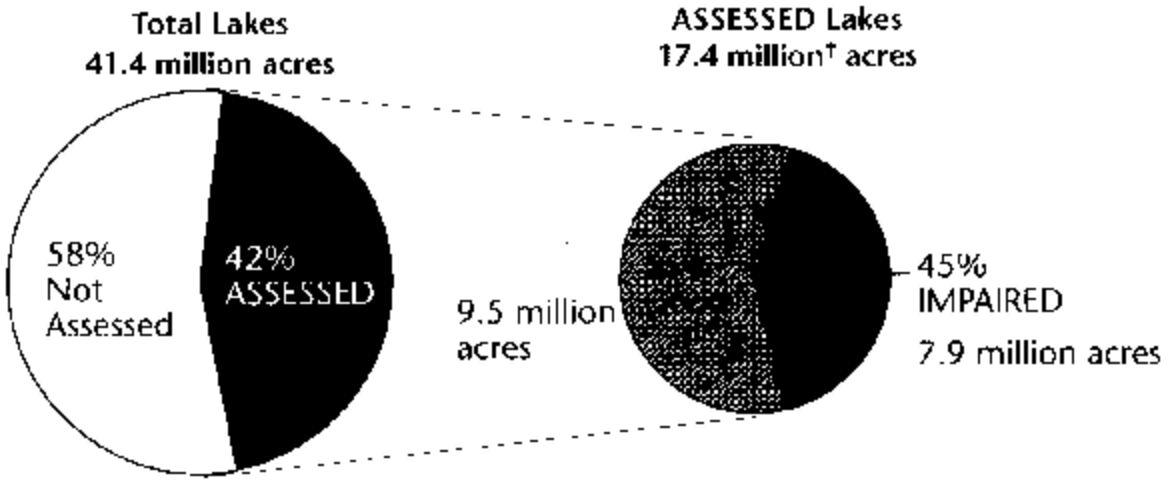
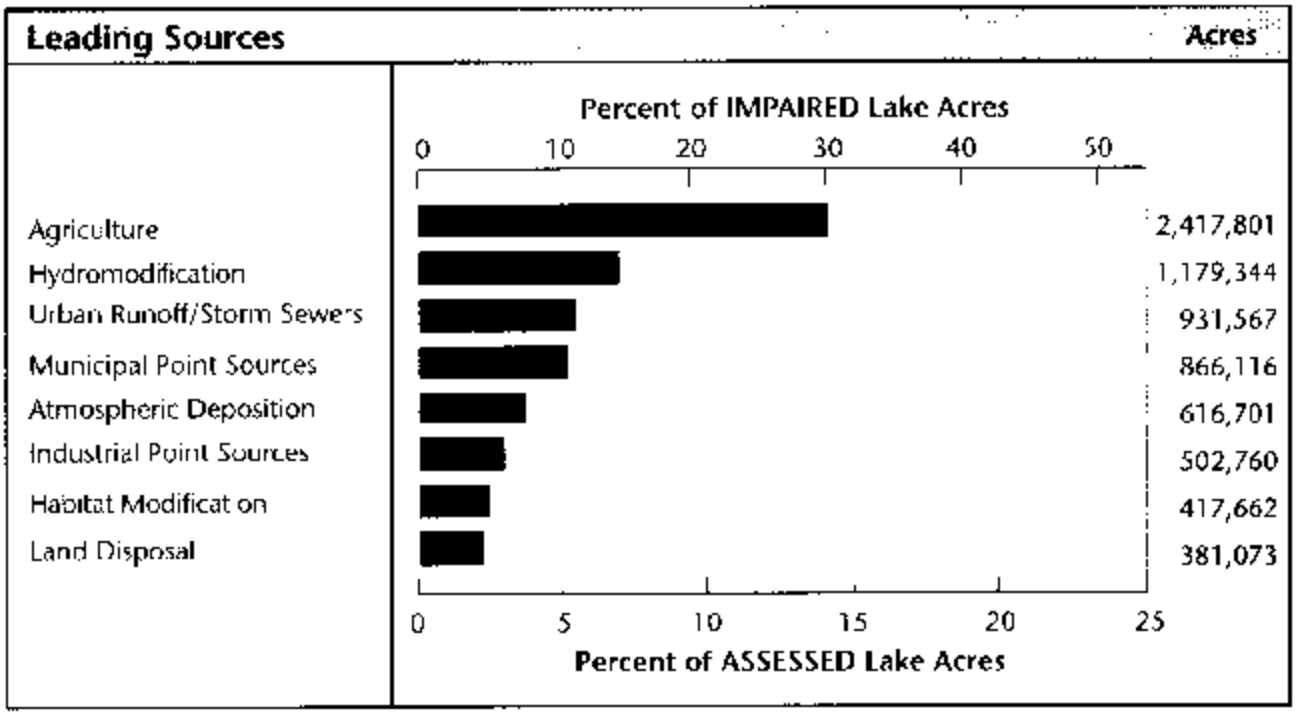


Figure 4-5

Leading SOURCES of Lake Impairment*‡





assessing whether potentially toxic constituents which exceed worst-case-based water quality standards represent impairments of beneficial uses is through organism assemblage information, where the numbers, types and characteristics of the aquatic life present in a waterbody are assessed relative to the habitat carrying capacity.

In time, the significant deficiencies in the approach used to report to Congress on the status of the nation's waters will be resolved as TMDLs are implemented, where, if properly implemented, the first step will be to assess the reliability of the exceedance of the water quality standard in representing a real, significant impairment of the beneficial uses of the waterbody.

This 413-page Inventory provides substantial information on each state's water quality assessments, as well as various programs that are underway in the US to control impairment of US waterbodies. Copies of this Inventory are available from the US EPA National Service Center for Environmental Publications, 1-800-490-9198. It is EPA-841-R-00-01.

Reference

Lee, G. F., and Jones-Lee, A., "Unreliable Reporting of Water Quality Impairment by the US EPA's National Water Quality Inventory," Report of G. Fred Lee & Associates, El Macero, CA, February (1996).

Stormwater Runoff Water Quality Short Course

Several years ago, Mr. Scott Taylor of RBF Consulting, Irvine, California, and Dr G. Fred Lee (the author of this Newsletter) developed a stormwater runoff water quality science and engineering short course. This is a two day course that was recently presented in Hong Kong to the Hong Kong Environmental Protection Department staff. It has previously been presented to the Orange County and Los Angeles County, California, NPDES stormwater permit co-permittees. The course is designed to provide a technical base of information to help stormwater management agencies and regulatory agency staff understand how urban area and highway stormwater runoff associated constituents should be evaluated with respect to their impact on receiving water quality/beneficial uses. The course also provides information on the characteristics and expected efficacy of best management practices (BMPs) that are frequently used to "treat" urban area and highway stormwater runoff in accord with current regulatory practices. However, as discussed in previous Newsletters, conventional BMPs such as detention basins, grassy swails, etc., are largely ineffective in producing a treated effluent/discharge that will meet worse cased based water quality standards.

The short course content is presented in Table 1. This course can be offered at any location by Mr. Taylor and Dr. Lee where there is a sponsor for local arrangements and there is funding to cover their time and expenses. The typical short course fees charged by professional organizations are sufficient so that governmental agency and urban and highway stormwater agency staff cannot attend. The course has been and will continue to be made available to stormwater management agencies and regulatory agency personnel at a cost far less than that typically charged for professional organization developed courses. The cost to present the course at a particular location will be the minimum necessary to cover expenses and presentation. Further information on the course and its presentation at a particular location is available from Dr. Lee at gfredlee@aol.com.

Course Outline
Urban Storm Water Runoff Water Quality Management: An Introduction to the Technical Basis for Assessing Impacts and Selection/Evaluating of BMPs

(The first day is taught by Dr. G. Fred Lee and the second day by Scott Taylor)

DAY 1 – Introduction and Course Outline/Overview

Course Objectives

Course Overview

Overview of Developing an Urban Stormwater Runoff Water Quality Management Program

Urban Stormwater Runoff vs CSOs and Domestic and Industrial Wastewater Discharges

Review of Water Quality Impact Assessment and Regulatory Approaches

Urban Area Stormwater Runoff as a Source of Potential Pollutants

Introduction - Overview of Issues

Overview of Urban Stormwater Runoff Related Water Quality Problems - Real and Perceived

Physical Impacts

Flow-Related Erosion

Altered Biological Habitat

Suspended Solids - Physical & Chemical

Abrasion, Deposition, Turbidity

Chemical Impacts

Heavy Metals (Cu, Cd, Pb, Zn, Hg)

Organics (PAHs, Petroleum Hydrocarbons, Pesticides, etc.)

Nutrients - N and P Compounds

Microorganisms - Sanitary Quality (Coliforms, etc.)

Human Health

Drinking Water and Contact Recreation

Litter

Trash

USA Potential Water Quality Standards Compliance Issues

Urban Stormwater Regulatory Requirements

Municipal and Highway NPDES-Permitted Runoff Regulatory Requirements

Control “Pollution” Using BMP to MEP

Application of Water Quality Standards to Stormwater Runoff

Overview of BMP Ratcheting Down Process To Achieve Water Quality Standards

Principles of Water Quality Evaluation

Basic Concepts

- Designated Beneficial Uses - Water Quality
- Water Quality Criteria and Standards/Objectives

Drinking Water MCLs

Primary and Secondary Standards
Chemical-Specific Toxicity-Based (Acute and Chronic)
Aquatic Life Criteria
Bioaccumulation of Hazardous Chemicals
Fish Advisories
Sanitary Quality
Domestic Water Supplies, Contact Recreation and
Shellfish Harvesting
Narrative Standards
Toxicity - WET
Toxicity Units
Extrapolation to Ambient Water Conditions
Nutrients N and P – Eutrophication, Red Tide
Nutrient Water Quality Criteria/Standards
Sediments - Turbidity - Habitat - Shoaling
Aesthetics
Biological Criteria
Numbers, Types and Characteristics of Aquatic Organisms Relative to Habitat Characteristics
Wildlife Standards
PCBs, Se, Hg
Biomarkers
Less than Whole Organism Responses
Compliance with Water Quality Standards/Objectives
Averaging Period and Occurrence Frequency
"Administrative Exceedances"
Adjustment of Water Quality Standards for Site Specific Conditions
California Toxics Rule
April 1999 Water Quality Criteria Update

What Makes a Chemical Hazardous to Aquatic Life

$ Overview of Principles of Aquatic Chemistry
Chemical Species - Toxic/Available
Soluble vs. Total Contaminants
Relationship Between Analytical Results for Specific Chemicals and Water Quality Toxicity Testing Methods used to Establish Criteria/Standards

$ Overview of Basic Principles of Aquatic Toxicology
Duration of Exposure
Sensitivity of Organisms

$ Chemical Constituents vs. Pollutants
The Characteristics of the Source and the Receiving Water Determines if a Chemical Constituent is a Pollutant

Characteristics of Urban Stormwater Runoff

- Elevated Concentrations of Unavailable/Non-Toxic Forms of Constituents
- Duration of Organism Exposure

Typically Short Durations of Exposure; Episodic Events

Overview of Principles of Aquatic Life Hazard/Risk Assessment

Tiered, Integrated Evaluation of

- Aquatic Chemistry (Constituent Fate & Transport), and
- Aquatic Toxicology (Constituent Availability, Duration of Exposure, Sensitivity/Types of Organisms), to Assess Potential Impairment of Designated Beneficial Uses by Particular Source/Discharge/Runoff

Monitoring Stormwater Runoff Water Quality Impacts

Problems with Conventional Runoff Compliance Monitoring

Focus on Chemical Concentrations

Evaluation Monitoring

Focus on Assessing Receiving Water Impacts on Beneficial Uses

Watershed-Based ,Technical Stakeholder Managed Consensus on Problems and Management Approaches

Monitoring Discharge/Runoff vs. Ambient Waters To Assess Impacts

Objectives of Water Pollution Control - Protect Designated Beneficial Uses

- •Numbers, Types, Character of Desirable Aquatic Organisms in Receiving Water
- Use of Water for Domestic Water Supplies
- Contact and other Recreation
- Runoff Testing as Measure of Potential Impact on Receiving Water Quality-Often Unreliable

Translation of Runoff Concentrations to Receiving Water Impacts

Water Quality Impairment

Exceedances of Water Quality Standards -

Adverse Impact on Designated Beneficial Uses

"Administrative Exceedance-Use Impairment"

"Administrative Exceedance" … "Beneficial Use Impairment"

Problems with Use of Exceedances of Water Quality Standards as Determiner of Water Quality Impairment

Chemical-Specific Objectives

Worst-Case Assumptions

Chemical Constituent Toxicity/Availability

Chronic Exposure Conditions

Organism Sensitivity

Criteria/Objectives: 1-hr Avg.; 4-day Avg.; 1 Exceedance/3 yrs

Overly-protective

Biological Impact Evaluation

Effluent/Discharge Aquatic Life Toxicity Test Limitations

- Toxicity Test Conditions More Severe Than Typically Occurs in Ambient Waters
- Runoff Toxicity Cannot Be Directly Translated to Receiving Water Toxicity

Biological Assessment

- Factors Affecting Numbers & Types of Organisms

Habitat • Natural Variability • Storms • Flows • Other Influences

Weight of Evidence BPJ Approach

- Toxicity, Aquatic Organism Assemblages and Chemical Information
  - Appropriate use of Chemical information

Aquatic Sediment Water Quality Impacts

- Particulates in Urban Stormwater Runoff
  - Assessing Water Quality Impacts
    - Chemical Approaches - Sediment Quality Guidelines
      - Co-Occurrence-Based Approaches
        - Long and Morgan Sediment Quality Guidelines-Unreliable
    - Biological Assessment
      - Toxicity and Bioaccumulation Potential

Blue Print for Urban Stormwater Runoff Water Quality Management

- Implementation of Evaluation Monitoring
- Appropriate Implementation of BMP Ratcheting-Down Process
  - Use US EPA Worst-Case-Based Water Quality Criteria Adjustment
  - Approaches to Develop Technically Valid, Cost-Effective Discharge Limits/Discharge Standards
    - Standards Adjustment for Site-Specific Conditions
    - Characteristics/Components of Site-Specific Studies
  - Variances
  - Use Attainability Analysis
  - Economic Feasibility

Evaluation of BMP Efficacy

- Focus on How BMP Impacts Receiving Water Beneficial Uses – Not Across BMP Unit Removal

DAY 2 –Urban Storm Water Management

- Introduction to Hydrology
  - Rational Method
    - Unit Hydrograph Method
  - Design Storm Determination
    - Design Storm Concept
    - Capture Volume
    - Recommended Design Storm
  - Source Control BMPs
    - Land planning
    - Urban design
      - Construction BMPs
      - Municipal activities
      - Public Education
      - Enforcement
      - General Introduction to Structural Controls
  - Structural Controls – Biofilters
    - Site selection
      - Design guidance
      - Case studies
    - O&M
      - Cost (construction and O&M)

- Performance
- Structural Controls – Detention Basins
  - Site selection
    - Design guidance
    - Case studies
  - O&M
    - Cost (construction and O&M)
    - Performance
- Structural Controls – Infiltration Devices
  - Site selection
    - Design guidance
    - Case studies
  - O&M
    - Cost (construction and O&M)
    - Performance
- Structural Controls – Media Filters
  - Site selection
    - Design guidance
    - Case studies
  - O&M
    - Cost (construction and O&M)
    - Performance
- Structural Controls – Drain Inlet Filters
  - Site selection
    - Design guidance
    - Case studies
  - O&M
    - Cost (construction and O&M)
    - Performance
- Erosion and Sedimentation
  - Erosion
    - Debris control
    - Channel erosion
      - Stable channel design
- Impacts of Urbanization
  - Freshwater plumes in marine bays and estuaries
  - Urbanization and the stream
    - Channel classification
    - Channel morphology
      - Impact of urbanization (flow)
    - Mitigation measures
      - Case Studies
    - References
- BMP Retrofit Evaluation – Case Study of Costs and Benefits

Comments and Closing

Course Evaluation and Closure