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January 3, 1999

Rob Wood
W-98-01
WQS-ANPRM Comment Clerk
Water Docket, MC 4101
US EPA
401 M Street, Southwest
Washington, D.C. 20460

Dear Rob:

The 1987 reauthorization of the Clean Water Act (CWA) established the requirement that urban area and highway stormwater runoff be regulated under the NPDES permit system. In 1991 the US EPA promulgated urban area stormwater runoff water quality management regulations which require that NPDES-permitted stormwater runoff-caused pollution be controlled to the maximum extent practicable using best management practices (BMPs). Previously the US EPA, in an internal review, concluded that NPDES-permitted stormwater runoff must ultimately comply with CWA requirements of not causing or significantly contributing to violations of water quality standards. Since urban area and highway stormwater runoff is not provided with a mixing zone, this means that water quality standards will, under the current regulations, ultimately have to be met in the stormwater runoff discharged to the receiving waters.

The July 7, 1998 Federal Register published the US EPA's "Water Quality Standards Regulation Advance Notice of Proposed Rulemaking" (ANPRM). This Rulemaking, if appropriately conducted and implemented, will be important in correcting the significant regulatory problems that are currently beginning to occur for urban area and highway NPDES-permitted stormwater runoff-associated constituents. As it stands now under the current regulatory program, the public in NPDES-permitted stormwater runoff communities will ultimately be spending hundreds of billions of dollars controlling chemical constituents in stormwater runoff that occur at concentrations above US EPA water quality criteria/state standards. This expenditure will occur under conditions where there are significant questions about the improvement in the beneficial uses of the receiving waters for the regulated urban area and highway stormwater runoff. These comments present a discussion of significant deficiencies in the US EPA's implementation of the Clean Water Act when applied to urban area and highway stormwater runoff-associated constituents.

While the focus of these comments is the development of more appropriate urban area and highway stormwater runoff regulatory approaches, the problems discussed and suggested approaches for addressing them have applicability to many types of NPDES-permitted wastewater discharges. Further, they are applicable to now-unregulated nonpoint source discharges, such as runoff from agricultural and rural lands.

Justification for an Alternative Approach for Regulating Urban Area and Highway Stormwater Runoff Water Quality Impacts

An in-depth review of the characteristics of urban area and highway stormwater runoff relative to the current regulatory requirements where, through a BMP ratcheting-down process, NPDES-permitted stormwater runoff shall not cause or contribute to water quality standards violations shows that this approach could readily cause the US public to spend hundreds of billions of dollars with little in the way of improved beneficial uses of the receiving waters for the stormwater runoff. Under this approach ultimately within a few years urban area and highway stormwater management agencies will be spending large amounts of public funds treating stormwater runoff using advanced wastewater treatment technology to comply with the ultimate goal of the BMP ratcheting-down process, i.e. full compliance with water quality standards in the stormwater runoff. While there are real and potentially significant water quality problems associated with constituents in urban area and highway stormwater runoff, such as litter, increased fecal coliforms that cause closure of beaches, etc., there is increasing evidence that the water quality standards violations that are occurring are "administrative" related to how the US EPA implements it worst-case-based water quality criteria into local water quality standards and NPDES-permitted discharge limits.

Several of the US EPA current water pollution control program components need attention as part of the ANPRM in order to more appropriately regulate urban area and highway stormwater runoff constituents, than is beginning to occur today. Presented below is a discussion of several of these areas as they impact the regulation of urban area and highway stormwater runoff.

- **Independent Application Policy**. As part of the ANPRM, the US EPA should abandon the Independent Application Policy which allows overly-protective, worst-case-based water quality criteria and standards based on these criteria to determine the degree of treatment of urban area and highway stormwater runoff. Under current regulatory requirements, the Independent Application Policy is applied to situations where appropriately conducted studies show that the exceedance of these standards does not represent a significant adverse impact on the beneficial uses of the waterbody receiving the stormwater runoff. This leads to "administrative" exceedances of water quality standards that do not represent real water quality use impairments of concern to the public. These administrative exceedances can and should be addressed through the ANPRM to ensure that when the public spends funds for chemical constituent and pathogen indicator organism control in urban area and highway stormwater runoff, significant improvements in the designated beneficial uses of the receiving waters for the runoff occur. .

- **Mixing Zones.** The US EPA, as part of the ANPRM, should develop a national policy which allows for the development of mixing zones where water quality standards are applied at the edge of the mixing zone. Urban area stormwater runoff discharged to a waterbody that has concentrations of regulated constituents above water quality standards should be allowed a mixing zone for protection of the designated beneficial use of the waterbody without significant, unnecessary expenditures for constituent control.

- **Urban Creeks.** The US EPA ANPRM should give particular attention to developing regulatory approaches for urban creeks where the flow is dominated by urban area stormwater. Many urban creeks have become, through flood control management programs, channelized, armored conveyance structures for urban stormwater runoff. The beneficial uses of such waterbodies is severely limited by habitat characteristics. It is important that the stormwater runoff to stormwater-dominated urban creeks consider the magnitude of the improvement in the designated beneficial uses of the creek associated with the public spending large amounts of money to treat urban area and highway stormwater runoff so that the runoff does not cause violations of water quality standards in the stormwater flow-dominated urban creek.

- **Sanitary Quality.** Fecal coliforms are well known to be unreliable indicators of sanitary quality for contact recreation, yet fecal coliforms are used to regulate sanitary quality in urban area and highway stormwater runoff. As part of the ANPRM, the US EPA should develop approaches for requiring that domestic wastewater systems control the input of human fecal-derived coliforms to the stormwater system in order to reduce, if not eliminate, the risk of acquiring a disease associated with contact recreating in waters with elevated fecal coliforms derived from stormwater runoff. The US EPA should develop a substantial research program devoted to evaluating the human health risk associated with contact recreating in areas that are impacted by urban area and highway stormwater runoff fecal coliforms where the input of human-derived fecal coliforms is controlled to a high degree of reliability.

- **Use Attainability.** The US EPA ANPRM should devote particular attention to appropriately regulated urban area and highway stormwater runoff that will be protective of achievable aquatic life-related beneficial uses without significant unnecessary expenditures for stormwater runoff constituent control. Of particular concern are the urban streams which are basically stormwater flow conveyance structures that have aquatic life-related designated uses. The Agency should develop approaches where these uses can be modified to appropriately match the habitat characteristics of the waterbody. Of particular concern should be the development of subcategories of aquatic life uses for stormwater-dominated urban streams which properly reflect that the beneficial uses of these streams are controlled by habitat and not chemical constituents.

- **Impact of Stormwater Flow on Habitat.** The Agency, as part of developing a regulatory program for reducing the impact of urbanization on increasing stream flows during stormwater runoff events, should provide specific guidance on how urban area and highway

stormwater runoff management agencies should evaluate the impacts of flow vs. chemical constituents on the beneficial uses of urban creeks and other waterbodies.

- **Sediment Quality Criteria.** The US EPA should direct its sediment quality criteria development and implementation toward biological assessment procedures involving toxicity tests and bioaccumulation assessments, rather than the current, unreliable co-occurrence, chemically-based sediment quality guidelines. Further, the Agency should devote a substantial research effort to assessing the water quality significance of sediment toxicity as it may impact the higher trophic-level beneficial uses of a waterbody.

- **Nutrient Criteria.** The US EPA should abandon its proposed approach for developing chemical-specific, numeric nitrogen and phosphorus criteria as an approach for regulating the excessive fertilization of waterbodies. Instead, the Agency should focus on developing guidance for site-specific evaluation of appropriate nutrient load eutrophication response relationships that can be used to reliably predict the impact of controlling nutrients from various sources, including urban area and highway stormwater runoff, on the beneficial uses of waterbodies. It is essential that this guidance focus on available forms of nutrients that influence the excessive growth of aquatic plants and not on total concentrations.

- **Litter.** One of the significant adverse impacts of urban area and highway stormwater runoff is litter. Stormwater carried litter can be significantly detrimental to a waterbody's beneficial uses through affecting its aesthetic quality and aquatic life. The US EPA should help urban stormwater management agencies develop effective litter control programs that not only control litter at its source, but also help collect and treat stormwater runoff to remove litter.

- **Anti-Degradation.** The US EPA has indicated that it plans to clarify and strengthen the anti-degradation policy. It is important that, as part of this effort, the Agency properly focuses on assessing degradation based on beneficial use changes and not on changes in chemical constituent concentrations.

- **Economic Considerations.** The US EPA has been significantly deficient in reliably informing the public of the cost that the public will have to ultimately bear in treating urban area and highway stormwater runoff to meet water quality standards. The US EPA should, as part of the ANPRM, conduct an in-depth analysis of the current projected costs of compliance with water quality standards in urban area and highway stormwater runoff so that no regulated constituent or aquatic life toxicity causes violations of water quality standards by any amount more than once every three years.

  The Agency also needs to develop approaches that will enable the public to judge, on a site-specific basis, the magnitude of the water quality improvements that will accrue on the designated beneficial uses of the waterbody receiving the treated urban area and highway stormwater runoff.

- **Revisions of the Clean Water Act.** As part of conducting the ANPRM, the Agency should consider and report to Congress on any current Clean Water Act regulatory requirements which hinder the technically valid, cost-effective management of urban area and highway stormwater runoff-associated constituents. Further, the Agency should specifically delineate those areas where there is need for research results to develop urban area and highway stormwater runoff water quality management programs that will be appropriately protective of the beneficial uses of a waterbody without significant, unnecessary expenditures for runoff-associated constituent control. The US EPA should obtain funding from Congress to fill the information gaps prior to implementation of the BMP ratcheting-down process to ultimately achieve water quality standards in stormwater runoff.

- **Inappropriate Translation of US EPA Water Quality Criteria into State Standards and NPDES Discharge Limits.** The current approach used by the US EPA and states of mechanically translating US EPA worst-case-based national water quality criteria into state standards and NPDES discharge limits, which involve the use of a one-hour average and four-day average for acute and chronic standards that must be met with no more than one exceedance by any amount every three years, grossly over-regulates many urban area and highway stormwater runoff-associated constituents. As part of the ANPRM, the US EPA should develop technically valid averaging periods and frequency of exceedances that will protect the designated beneficial uses of the receiving waters for urban area and highway stormwater runoff, without significant unnecessary expenditures for runoff-associated constituent control.

Attached is a report that discusses these issues in greater detail. If there are questions about these comments on the ANPRM, please contact me. There is interest in working with the US EPA in developing appropriate regulatory programs for urban area and highway stormwater runoff that will ensure that the funds used to control constituent concentrations in this runoff are used in a technically valid, cost-effective manner.

Sincerely yours,

G. Fred Lee

G. Fred Lee, PhD, PE, DEE

COMMENTS ON US EPA 1998 ANPRM FOR THE WATER QUALITY STANDARDS REGULATIONS

Submitted by
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January 3, 1999

The July 7, 1998 Federal Register published the US EPA's "Water Quality Standards Regulation Advance Notice of Proposed Rulemaking" (ANPRM). This Rulemaking will be extremely important in correcting the significant regulatory problems that are currently beginning to occur for urban area and highway NPDES-permitted stormwater runoff-associated constituents. As it stands now under the current regulatory program, the public in NPDES-permitted stormwater runoff communities will ultimately be spending hundreds of billions of dollars controlling chemical constituents in stormwater runoff that occur at concentrations above US EPA worst-case-based water quality criteria/state standards. These expenditures will occur under conditions where there are significant questions about the improvement in the beneficial uses of the receiving waters for the regulated urban area and highway stormwater runoff. The following comments provide a discussion of significant deficiencies in the US EPA's implementation of the Clean Water Act (CWA) when applied to urban area and highway stormwater runoff-associated constituents.

Background

The 1987 reauthorization of the CWA established the requirement that urban area and highway stormwater runoff be regulated under the NPDES permit system. In 1991 the US EPA promulgated urban area stormwater runoff water quality management regulations which require that NPDES-permitted stormwater runoff-caused pollution be controlled to the maximum extent practicable using best management practices (BMPs). Previously the US EPA, in an internal review, concluded that NPDES-permitted stormwater runoff must ultimately comply with CWA requirements of not causing or significantly contributing to violations of water quality standards. Since urban area and highway stormwater runoff is not provided with a mixing zone, this means that water quality standards will, under the current regulations, ultimately have to be met in the stormwater runoff discharged to the receiving waters.

BMP Ratcheting-Down Process. The requirement of ultimately having to meet water quality standards in urban area and highway stormwater runoff was reaffirmed in January 1998 by the US EPA Region 9 and Washington, D.C. headquarters as part of commenting on the San Diego Regional Water Quality Control Board's revised NPDES-permit for part of the Orange County, California stormwater runoff. As it stands now, the agencies/entities holding NPDES permits for urban area and highway stormwater runoff are in a BMP ratcheting-down process in which violations of water quality standards for any constituent by any amount causes the permittee to have to review existing BMPs and to establish additional BMPs to ultimately control the water quality standards violations.

Timetable for Compliance with Water Quality Standards. While no timetable has been established governing the duration of the BMP ratcheting-down process, it could be limited to three to five years, where environmental groups would, through litigation, seek assistance from the courts in causing NPDES-permitted stormwater runoff from urban areas and highways to comply with meeting water quality standards in a shorter time than the ten or so years that are sometimes mentioned as the compliance period.

Potential Water Quality Standards Compliance Problems. Lee and Jones-Lee (1998a) conducted a critical review of the potential for noncompliance with water quality standards for urban area and highway stormwater runoff-associated constituents. Their review concludes that there are several heavy metals (copper, lead, and zinc) including their dissolved forms, PAHs and fecal coliforms that potentially can cause frequent exceedances of water quality standards in the stormwater runoff. Also, at least in California, some other areas of the US and possibly nationally, the presence of organophosphate pesticides - diazinon and chlorpyrifos - used in residential and commercial areas for structural and lawn and garden pest control cause urban area stormwater runoff to be toxic to *Ceriodaphnia* and some other zooplankton, such as mysids. This is a potential violation of both US EPA Clean Water Act and many state water pollution control regulations covering the presence of toxic constituents in toxic amounts.

Further, there are a number of site-specific situations where urban area and highway stormwater runoff is found to contain constituents at sufficient concentrations so that they would be regulated under a TMDL for nutrients (nitrogen and phosphorus compounds) as a contributor to excessive fertilization of a waterbody. There are also a number of other constituents in urban area and highway stormwater runoff that, with further study, may also be found to cause or contribute to worst-case-based water quality standards violations. Urban area and highway stormwater runoff water quality managers and water quality regulatory agencies will soon be aggressively pursuing, in a BMP ratcheting-down process, the development of approaches that will enable the NPDES permittees to comply with appropriate water quality standards in a technically valid, cost-effective manner.

One of the most significant problems that exists today in appropriately managing urban area and highway stormwater runoff is that many of those working in this field do not properly distinguish between chemical constituents that are pollutants, i.e. impair beneficial uses of waterbodies when discharged from certain types of sources into certain types of waterbodies and constituents that are not necessarily pollutants when present in urban area and highway stormwater runoff. Part of this problem arises from the US EPA's focus on chemical constituent concentrations, rather than chemical impacts. The US EPA's ANPRM should result in a redirection of the nation's water pollution control program to incorporate approaches that will enable the regulated community, regulatory agencies and the public to use a 1990s level of science and engineering in assessing the real significant water quality use impairments caused by chemical constituents in urban area and highway stormwater runoff. Further, the ANPRM should establish a framework for regulating urban area and highway stormwater runoff receiving water use impairments that will, to the extent practicable/affordable, protect the designated beneficial uses of the receiving waters for the stormwater runoff without significant,

unnecessary expenditures for constituent control. A key component of this program will be guidance on how to clearly distinguish between chemical constituents in stormwater runoff that are present without regard to any impacts on the beneficial uses of the receiving waters and pollutants which, on a site-specific basis, are causing an impairment of the beneficial uses of a waterbody.

Cost of Compliance. In connection with the situation of potential violations of water quality standards in NPDES-permitted stormwater runoff, several permittees have conducted reviews of the ability of nonstructural and conventional structural BMPs such as detention basins to control/treat urban area and highway stormwater runoff so that the constituents in the runoff do not cause or contribute to water quality standards violations in the runoff waters at the point of discharge more than once every three years. The conclusions from these studies is that with the possible exception of banning the use of the OP pesticides diazinon and chlorpyrifos in urban areas, it will not be possible to eliminate water quality standards violations through nonstructural BMPs. While a ban on the use of OP pesticides for termite and ant control, as well as lawn and garden pest control, could eliminate the aquatic life toxicity that is routinely present in urban stormwater runoff, there is no assurance that the pesticides that are used in their place will also not be toxic to aquatic life or have other significant public health and/or environmental impacts.

Several stormwater NPDES permittees have conducted reviews of the ability of conventional stormwater runoff water quality BMPs to treat stormwater runoff from urban area streets and highways sufficiently so that the treated waters will not cause or contribute to violations of water quality standards. The results of these reviews have shown that conventional stormwater BMPs are not effective in removing constituents such as dissolved heavy metals, certain organics (i.e. PAHs), OP pesticides, and fecal coliforms so that their concentrations after treatment of urban area and highway stormwater runoff do not cause water quality standards violations. It is typically being found that detention basins of the type normally used as stormwater runoff BMPs can remove about 40% of the particulate constituents in urban area and highway stormwater runoff. This level of removal will not normally enable compliance with water quality standards that focus on the control of particulate forms of potential pollutants.

Further, the cost of retrofitting conventional BMPs such as detention basins is projected to be from $1 to $3 per person per day over 20 years or more for the population served by the NPDES-permitted stormwater runoff management system. The majority of this cost is associated with the acquisition of land and the development of a stormwater conveyance system to transport the stormwater to detention basins. Therefore, under the current regulatory approach, the retrofitting of conventional BMPs is not a viable option from either the perspective of treating stormwater runoff to meet water quality standards or the economic affordability of their development and maintenance.

Jones-Lee and Lee (1998a) have reviewed the inability of conventional (traditional) BMPs of the type described in the WEF/ASCE Urban Runoff Quality Management Manual of Practice (1998) to treat urban area stormwater to comply with water quality standards. They have also discussed how stormwater management agencies as well as regulatory agencies and the public, should work together to develop technically valid, cost-effective watershed-based stormwater runoff

pollutant control programs that will protect the beneficial uses of waterbodies without significant unnecessary expenditures for runoff-associated constituent control. As they discuss, in order to fully comply with current water quality standards in urban area and highway stormwater runoff, it will be necessary to develop a stormwater collection system and treatment works that will provide advanced wastewater treatment such as disinfection, coagulation, filtration, ion exchange, reverse osmosis, activated carbon and other technologies. The projected costs for part of the City of Los Angeles for this type of treatment is in excess of $50 billion. Again, the primary costs are associated with land acquisition for the construction of the stormwater collection and treatment system. There will also be substantial operation and maintenance costs associated with these advanced wastewater technology-based stormwater treatment plants.

While many communities are implementing conventional BMPs such as detention basins and grassy swales in new developments as part of the cost of the development where the costs are passed on to the new property owners, there is no possibility that existing residential and commercial developments will develop and operate BMPs to treat urban area and highway stormwater runoff so that it does not cause or contribute to exceedance of US EPA worst-case-based or site-specific adjusted water quality standards violations. The costs of achieving this level of constituent control are clearly beyond economic affordability for the public. Further, even for new developments, conventional BMPs such as detention basins, grassy swales, etc., will not treat new development area stormwater runoff so that this runoff will meet water quality standards.

Lee (1997) has discussed a number of the deficiencies in the US EPA's proposed approach for the development of the California Toxics Rule (CTR), with particular emphasis on the use of the CTR criteria for regulating urban area and highway stormwater runoff. As Lee discusses, one of the most significant deficiencies in the US EPA's current water pollution control efforts is the failure of the Agency to conduct a proper economic analysis associated with the application of water quality criteria/standards to urban area and highway stormwater runoff. The Agency, as part of its 1995 efforts to promulgate the California Toxics Rule so that the state of California would have a basis for developing water quality standards, indicated that the California Toxics Rule criteria would be applicable to urban area and highway stormwater runoff, but failed to conduct the economic analysis of what the application of these criteria as standards to NPDES-permitted urban area and highway stormwater runoff in California would cost the public.

Similarly, as part of the US EPA's efforts to develop the Phase II stormwater runoff regulations in 1998, the Agency claimed in the regulations and through their spokespersons as part of public hearings on the regulations, that six nonstructural BMPs would enable urban area and highway stormwater runoff water quality management agencies to achieve water quality standards. However, as discussed by Lee and Jones-Lee (1998b), this claim was not based on an engineering analysis of what could be expected to be achieved by implementing the six nonstructural BMPs in reducing the concentrations of the constituents in urban area and highway stormwater runoff that will cause exceedances of worst-case-based water quality standards in the runoff waters. Further, the US EPA failed, as part of the development and now adoption of the Phase II regulations, to conduct an economic analysis of what the true costs of implementing Phase II requirements, which included

ultimately achieving water quality standards in stormwater runoff, would be to the public served by the stormwater management systems.

If the Agency had properly developed the California Toxics Rule criteria and the Phase II stormwater regulations where an appropriate economic analysis of the true costs of achieving water quality standards based on CTR criteria, which are an update of the 1987 Gold Book criteria, the Agency would have found, as have a number of NPDES-permitted stormwater management agencies, that the cost to the public represents, for large communities, billions of dollars, and to the nation, hundreds of billions of dollars. As part of the ANPRM, the US EPA should conduct a proper economic analysis of what it will cost the US public to treat urban area and highway stormwater runoff so that it will not cause or contribute to an exceedance of a water quality standard by any amount more than once every three years.

Need for Alternative Regulatory Approach. The inability of low-cost BMPs to enable urban area and highway stormwater runoff water quality management agencies to comply with water quality standards when applied to end-of-the-pipe, edge-of-the-pavement stormwater runoff is causing stormwater managers and the state of California Storm Water Quality Task Force to explore approaches for regulating urban area and highway stormwater runoff that will be appropriately protective of the designated beneficial uses of the receiving waters for the runoff without significant unnecessary expenditures for stormwater-associated constituent control. One of the areas of particular concern is the way in which the US EPA develops and, most importantly, implements water quality criteria and state standards based on these criteria as discharge limits for NPDES-permitted urban area and highway stormwater runoff. Lee and Jones-Lee (1998c) have discussed some of the problems associated with using current US EPA worst-case-based water quality criteria as state standards for regulating urban area and highway stormwater runoff water quality. A summary of these issues is presented herein.

Problems with Current Regulatory Approach. In the early 1980s the US EPA adopted a national water pollution control approach that focused on controlling chemical concentrations in an NPDES-permitted discharge if no mixing zone is allowed, and at the edge of a mixing zone where mixing zones are allowed. Basically, permitted dischargers and regulatory agencies utilize a mechanical approach of comparing the concentrations of regulated constituents in the discharge waters with appropriate allowance for a mixing zone, if allowed, to a numeric, chemical-specific water quality standard that is designed to be protective of the receiving water's beneficial uses under worst-case or near-worst-case conditions. With few exceptions, the worst-case-based US EPA national water quality criteria such as for heavy metals are used as water quality standards that are applicable to urban area and highway stormwater runoff. While the US EPA recommends that ambient water dissolved heavy metals be used for certain potentially toxic heavy metals, it is not clear that this approach is going to be adopted by all of the states. Further, with respect to urban area and highway stormwater runoff, the concentrations of certain dissolved heavy metals in stormwater runoff waters are sufficient to cause exceedances of worst-case-based water quality standards.

Sufficient information is now becoming available through studies on the impacts of urban area and highway stormwater runoff-associated constituents on the beneficial uses of various types of receiving waters for the runoff to question the appropriateness of using worst-case-based water quality standards for regulating NPDES-permitted stormwater runoff. There have been a number of studies at several locations in California in which the toxicity of the stormwater runoff from urban areas and highways has been measured. While the urban area stormwater runoff is frequently toxic to some forms of aquatic life, this toxicity is not due to heavy metals which are present at concentrations above worst-case-based water quality standards. Further, it has been found that using the US EPA's (1994) latest guidance for implementation of the water effects ratio for adjusting the US EPA national worst-case-based water quality criteria into site-specific standards, that the Agency's approach does not adequately address the fact that there can be significant exceedances of site-specific water quality standards corrected through the water effects ratio without toxicity to the same organisms that were used to establish the national criterion.

An example of this situation is copper in San Francisco Bay. As reviewed by Lee and Jones-Lee (1997), after several years of monitoring of the toxicity and copper concentrations in San Francisco Bay waters, it has been found that the dissolved copper in the Bay waters exceeds the site-specific water quality standard for copper, yet this water is not toxic to *Mytilus edulis*, which is the same organism that was primarily responsible for establishing the national criterion for copper in marine waters. The primary source of copper to San Francisco Bay waters today is urban area and highway stormwater runoff and copper re-suspended from the Bay sediments.

The US EPA's water effects ratio approach does not properly adjust for the forms of the copper that are used in the test (copper sulfate) relative to the forms that are present in the environment. In the case of copper from automobile brake pads, the copper found in stormwater runoff from highways is derived from either copper oxide or chipped brass. The aqueous environmental chemistry of these forms of copper and their toxicity will be significantly different than copper sulfate. This situation can lead to significant over-regulation of copper that could ultimately cost the public in the San Francisco Bay region on the order of $1 billion to treat urban area street and highway stormwater runoff so that it does not cause or contribute to exceedance of the site-specific copper standard more than once every three years. Such treatment, however, is questionable, since after extensive study, no beneficial use impairment of San Francisco Bay waters has been found due to the routine exceedances of the copper and, for that matter, other constituents' water quality standards.

The San Francisco Bay copper situation, where the urban area and highway stormwater runoff concentrations of copper are above the site-specific water quality standard (objective) developed for San Francisco Bay waters, is an area that needs US EPA attention under the ANPRM. It is now understood that even if all stormwater entering San Francisco Bay were treated so that the concentration of copper was less than the copper site-specific objective for the Bay, the Bay would still have excessive dissolved and total copper due to resuspension of copper into the water column associated with wind and wave action and stormwater flow suspending Bay sediments.

The situation in San Francisco Bay is not one where there has been sufficient pollution of the Bay by copper so that the sediments of the Bay contain greatly elevated concentrations of copper. In fact, the sediments of San Francisco Bay contain copper at concentrations below normal crustal abundance. Further, it seems, from the studies conducted by the San Francisco Estuary Institute, that the copper present in the sediments as well as suspended into the water column is in a non-toxic/ non-available form and, as far as anyone has been able to detect after a number of years of study, it is not having an adverse impact on the beneficial uses of the Bay. If there are adverse impacts of this elevated copper, they are subtle compared to the worst-case-based or site-specific-based water quality standard for copper.

It is under these conditions that it is recommended that the San Francisco Bay water quality stakeholders, including all stormwater and wastewater dischargers, regulatory agencies, those responsible for atmospheric deposition of constituents in the Bay, members of the public, environmental groups and others need to work together to define an ongoing research program designed to look for subtle, yet undetected, water quality - use impairment problems associated with exceedances of worst-case- or site-specific-based water quality standards. If this search for these problems finds an undetected or new problem, then appropriate regulatory action should be taken to implement TMDLs, etc. It is certainly inappropriate to mechanically follow the approach that is implemented now under the US EPA's current chemical concentration-based approach of independently applying the chemical concentration-based exceedance of a water quality standard to force the public to pay for urban area and highway stormwater runoff treatment to achieve water quality standards where appropriately conducted studies have shown that as far as anyone can find, the exceedances represent administrative exceedances and do not represent real water quality beneficial use impairments of concern to the public which should cause expenditure of funds for their control.

The situation in the San Francisco Bay region is not atypical of what is being found elsewhere. Similar results with respect to the lack of toxicity of heavy metals in urban area street stormwater runoff have been found by the Central Valley Regional Water Quality Control Board for the Sacramento and Stockton, California areas. Further, these same types of results are being found in the Orange County, California, Upper Newport Bay area (Lee *et al.*, (1999a). There is growing evidence that the exceedance of the US EPA worst-case or site-specific adjusted water quality standard associated with urban area and highway stormwater runoff-derived constituents is an "administrative" exceedance related to the overly protective approach that the US EPA adopted in the 1980s for implementing worst-case-based water quality criteria into NPDES-permitted wastewater discharges, and now urban area and highway stormwater runoff.

While the US EPA administration claims high degrees of success with its chemical concentration-based water pollution control program, a critical review of these claims will show that this "success" was associated with application of the chemical concentration approach to municipal and industrial wastewater discharges where, with few exceptions, there have been few attempts to examine the over-regulation that has been occurring associated with applying worst-case-based

criteria and standards to domestic and industrial wastewater discharges at the edge of a mixing zone for these discharges.

There are several significant differences associated with applying US EPA worst-case-based water quality criteria/standards to municipal and industrial wastewater discharges at the edge of the mixing zone and the situation that exists today governing urban area and highway stormwater runoff NPDES-permitted discharges. One of the most important factors is that urban area and highway stormwater runoff is not provided with mixing zones. Another is that domestic and industrial wastewater dischargers already have appreciable treatment works infrastructure in place that can be expanded to address new regulatory requirements. In addition and most important, public-owned treatment works have the ability to gain access to funds from the populations served through increases in the sewer bill. NPDES-permitted stormwater dischargers, on the other hand, have no treatment works infrastructure in place and have limited ability to tax their constituents to cover the costs of adding this infrastructure. A number of communities find that the cost for stormwater flood control and water quality management amounts to $1 to $2 per person, per year. To now implement the addition of from $1 to $10 per person, per day for the development, operation and maintenance of even conventional, much less advanced, wastewater treatment systems to treat urban area and highway stormwater runoff so it complies with current water quality standards is not feasible.

It is time, especially in light of the impossibility of NPDES-permitted urban area and highway stormwater management agencies complying with current water quality standards with no more than one exceedance of any magnitude of any standard every three years, and the questionable benefits in terms of improved water quality of receiving water beneficial uses for urban area and highway stormwater runoff, to critically review how US EPA worst-case-based water quality criteria and state standards based on these criteria are applied to regulate urban area and highway stormwater runoff. While some industrial and municipal wastewater discharges contain available forms of constituents at concentrations for a sufficient duration to be toxic/adverse to aquatic life-related beneficial uses of the receiving waters for the discharge, urban area and highway stormwater runoff has been found to contain regulated potential pollutants, such as heavy metals, in non-toxic/non-available forms. Further, even where there are high levels of toxicity associated with urban area stormwater runoff due to the organophosphate pesticides, the duration of exposure of zooplankton to these toxic conditions and the limited numbers and types of organisms potentially impacted raises serious questions about whether the potential toxicity, as well as the measured toxicity, is significantly adverse to the beneficial uses of the waterbody receiving the toxic stormwater runoff.

Need for ANPRM to Consider Appropriate Regulation of Urban Area Stormwater Runoff. The high costs of compliance with water quality standards, even when adjusted based on US EPA (1994) currently allowed recommended procedures such as those set forth in the 1994 revisions of the Water Quality Standards Handbook, 2nd Edition, and the questionable benefits in terms of improved beneficial uses of receiving waters that are potentially impacted by the urban area and highway stormwater runoff-associated constituents, requires that the US EPA, as part of the ANPRM, devote considerable attention to the urban area and highway stormwater runoff regulatory situation. The US EPA headquarters management has not perceived urban area and highway stormwater runoff as a

high-priority area for attention. This situation seems to evolve from the fact that many parts of the U.S. are five or more years behind the urban area and highway stormwater runoff water quality management situation that exists now in California. Many of the NPDES-permitted urban area and highway stormwater runoff management agencies in California are well into their second five-year permit cycle. Associated with the initiation of this cycle, action was taken by several environmental groups that has led to the current BMP ratcheting-down process that will ultimately result in urban area and highway stormwater runoff meeting appropriate water quality standards that will be protective of the beneficial uses of the receiving waters for the stormwater runoff, without significant unnecessary expenditures for chemical constituent control and pathogen indicator organism control in the stormwater runoff.

The lack of attention being given by the US EPA headquarters management to urban area and highway stormwater runoff regulatory problems that exist today is exemplified by the fact that the US EPA held a national Water Quality Standards workshop and a national ANPRM meeting during the last week of August 1998 in Philadelphia, PA, where the issue of urban area and highway stormwater runoff regulatory problems was not on the agenda. While the previous US EPA 1996 discussions in the ANPRM specifically addressed urban area and highway stormwater runoff regulatory issues, the July 7, 1998 ANPRM Federal Register fails to address these issues. This is a significant omission by the current US EPA administration. US EPA management does not consider the problems with the regulatory approaches for urban area and highway stormwater runoff to be a significant problem at this time, and ranks them as a low priority for attention. It is the author's finding that the US EPA management does not understand the high cost involved, or the fact that, through environmental group litigation, the current BMP ratcheting-down process could lead to the courts ordering urban area and highway stormwater runoff compliance with water quality standards within a few years, rather than some of the current administration's projections of ten or more years.

In 1995, through the efforts of a number of urban area stormwater management agencies, including the California Storm Water Quality Task Force, a consensus provision was to be included in the provisions of the then-proposed Clean Water Act which would have provided the US EPA with $100 million that was to be spent over a ten-year period to develop wet-weather water quality standards that could be used to more appropriately regulate urban area and highway stormwater runoff than is being done today. The US EPA management, as part of the initial responses to comments on the ANPRM, indicated that it was not in favor of wet weather standards, but suggested that the state of Maine's temporary variance approach is a possible alternative to addressing the over-regulation that is occurring with applying US EPA worst-case-based water quality criteria as state standards to urban area and highway stormwater runoff at the point where the runoff waters enter a receiving water.

Misguided Environmental Group Activities. More recently it appears that the US EPA headquarters administration has been listening to the wishes of environmental groups who are opposed to the Agency devoting efforts to try to develop a more appropriate regulatory approach for urban area and highway stormwater runoff than the current worst-case-based chemical approach. There are some environmental groups who openly oppose any efforts to adjust US EPA worst-case-based water

quality criteria for site-specific conditions, claiming that such adjustments represent a weakening of the Clean Water Act. The facts are that such adjustments are a key component of the Clean Water Act. The Clean Water Act defines pollution as an impairment of the designated beneficial uses of a waterbody. The US EPA regulations for managing urban area and highway stormwater runoff focus on pollution control, not chemical constituent control irrespective of whether the constituents are adverse to the beneficial uses of a waterbody.

As part of the ANPRM, the US EPA should redirect the national water pollution control program so that it focuses on chemical impacts, as opposed to chemical concentrations. As part of implementing the US EPA criteria into state standards that are applicable to urban area and highway stormwater runoff, as well as other discharges/runoff, the US EPA should revise its water quality standards implementation approach so that NPDES permittees can work with federal and state regulatory agencies and the public to develop technically valid, cost-effective **pollution** control programs that will protect the designated beneficial uses of waterbodies without significant unnecessary expenditures for constituent control. These programs will require the use of at least mid-1990s level science and engineering in assessing and managing the water quality impacts of constituents associated with urban area and highway stormwater runoff.

Several of the US EPA current water pollution control program components need urgent attention as part of the ANPRM in order to more appropriately regulate urban area and highway stormwater runoff constituents than is beginning to occur today. Presented below is a discussion of several of these areas as they impact the regulation of urban area and highway stormwater runoff.

Independent Application Policy

One of the most significant barriers to appropriately regulating urban area and highway stormwater runoff water quality impacts is the Agency's Independent Application Policy. This policy mandates that each type of water quality criteria, such as chemical-specific criteria, toxicity tests, and biological organism assemblage information - biocriteria, must be applied independently. This approach is contrary to appropriate scientific and engineering principles. There is widespread recognition that the appropriate approach to regulating chemical constituents and pathogen indicator organisms is a best professional judgment, non-numeric, interactive peer-reviewed consensus in which a panel of experts in a public forum reviews the technical information available on a particular water quality management situation and develops an assessment of the impacts occurring and the management program that should be implemented. This weight-of-evidence approach utilizes information based on aquatic life toxicity, excessive bioaccumulation, and aquatic organism assemblage information relative to habitat characteristics to assess the magnitude of the water quality use impairment that is occurring, its significance to the public, and the possible alternative approaches that could be used to manage this use impairment.

Chemical information is used in a best professional judgment weight-of-evidence approach to indicate potential water quality problems and, through appropriately conducted toxicity investigation evaluations (TIEs) and forensic studies, to determine the cause and the source of the constituents responsible for the use impairment. As discussed by Lee and Jones-Lee (1998d), and

Jones-Lee and Lee (1998b), this best professional judgment weight-of-evidence approach should be conducted on a watershed-based approach in which all potential stakeholders are provided the opportunity to be active in formulating and implementing the program. No single component of this approach, such as the exceedance of a worst-case-based water quality criterion/standard should have independent application. The exceedance of such a standard, including a site-specific standard, should be a trigger that can be used by the dischargers and the regulatory agencies to allow for comprehensive site-specific investigations to determine whether the exceedance of the standard represents a real, significant impairment of the designated beneficial uses of a waterbody. The appropriate approach for using US EPA water quality criteria in the nation's water pollution control program has been discussed by Lee and Jones-Lee (1996a).

As part of the ANPRM, the US EPA should abandon the Independent Application Policy in favor of a more technically valid, cost-effective approach, where there is an opportunity to use mid-1990s-level science and engineering in assessing whether the exceedance of a worst-case-based or site-specific water quality standard is an administrative exceedance or actually reflects a beneficial use impairment that is of sufficient magnitude and duration to cause the public to spend funds for its control. Additional information on the inappropriateness of continuing the Independent Application Policy is provided by Lee and Jones-Lee (1995). This policy is strongly contrary to the public's interest and can readily lead to massive inappropriate use of public funds in the name of water pollution control with limited improvements in the beneficial uses of waterbodies.

Mixing Zones

There are basically two types of situations governing the discharge of urban area and highway stormwater runoff where mixing zones or other policies need to be considered in order to avoid over-regulation of constituents in the stormwater runoff. One of these is the situation in which the runoff waters enter a large waterbody where the constituents in the runoff waters that are present in concentrations above water quality standards in the runoff are rapidly diluted in the receiving waters below water quality standards. This is similar to the typical municipal wastewater discharge situation. Normally, such situations allow for a mixing zone where water quality standards applicable to the receiving water are applied at the edge of this zone. Mixing zones have an important role to play in regulating urban area and highway stormwater runoff in order to protect the designated beneficial uses of the receiving waters for stormwater runoff without significant, unnecessary expenditures for chemical constituent and pathogen indicator organism control. It is important as part of the ANPRM and the US EPA's previously announced but not yet released "Mixing Zone Policy" to consider urban area and highway stormwater runoff as a source of constituents for which mixing zones should be applied under conditions where there is water available for mixing of the stormwater runoff with ambient waters.

The US EPA's Mixing Zone Policy for urban stormwater runoff that should be developed as part of the ANPRM should not involve a mechanical approach of arbitrarily sizing mixing zones based on some dilution ratio but should provide site-specific guidance on how to evaluate whether constituents that exceed water quality standards, including narrative standards in urban area and highway stormwater runoff, significantly impact the beneficial uses of the receiving waters for the

stormwater runoff. Consideration should include the presence of toxic/available forms vs. total recoverable forms for all constituents of concern, not just a few heavy metals.

Another important factor that should be considered in the mixing zone evaluation is the concentration/duration-of-exposure relationships that actually exist in a stormwater runoff event relative to the critical concentrations of available form/duration-of-exposure relationships that are adverse to aquatic life-related beneficial uses. Included within this consideration must be attention devoted to short-term, pulse-type toxicity to lower trophic-level organisms, such as zooplankton, like that associated with the organophosphate pesticides diazinon and chlorpyrifos present in urban stormwater runoff, as this toxicity may impact higher trophic-level organisms of concern to the public, such as those associated with warm water sports fisheries. Lee *et al.*, (1999a,b) have discussed many of the factors that need to be considered in evaluating the water quality significance of aquatic life toxicity in urban area stormwater runoff. There can be situations where OP pesticide toxicity to *ceriodaphnia* in urban area stormwater runoff may not cause significant higher trophic-level aquatic life impacts.

The OP pesticides, such as diazinon and chlorpyrifos, are toxic to a restricted group of forms of aquatic life, such as certain zooplankton, which are quite similar in their characteristics to the terrestrial insects that are the target organisms for the OP pesticides. There have been a number of studies which show that there are a number of zooplankton which are not affected by the OP pesticide toxicity and that those that are affected rapidly recover after the pulse of toxic water has passed through the area. Further, there are a number of situations where the urban stormwater with OP pesticide-caused toxicity to *Ceriodaphnia* rapidly becomes non-toxic in the receiving waters due to dilution. Further, in the case of discharges of urban stormwater to marine waters, the area of toxicity in the marine waters is represented by a relatively small lens of a mixture of fresh water and marine waters that lasts a day or so, where the toxic fresh water is mixed to a limited extent with the marine waters and marine zooplankton migrate into this mixture and stay in there for a sufficient period to experience a toxic exposure. The likelihood that this type of situation represents a significant adverse impact on the marine aquatic ecosystem is small.

Urban Creeks. Another common situation which the US EPA, as part of the ANPRM, needs to address in order to appropriately regulate urban area and highway stormwater runoff occurs with urban creeks which have little or no flow during dry weather conditions. Under wet weather conditions, the flow in the creek is dominated by urban stormwater runoff. This type of situation is similar to the POTW effluent-dominated system except that rather than the discharge being a domestic wastewater, it is composed primarily of urban stormwater runoff. Under the typical effluent-dominated stormwater runoff urban creek situation, there is no dilution water to dilute the concentrations of constituents present in urban area and highway stormwater runoff below worst-case-based water quality standards. The US EPA and the states have been struggling with the regulation of effluent-dominated systems for many years. It is clear that this type of system has to be regulated differently than the normal wastewater and stormwater discharge/runoff situation in order to avoid causing the public to spend large amounts of money treating urban stormwater runoff in order to achieve water quality standards in the stormwater-dominated urban creek.

A critical review of urban creek water quality situations shows that at many locations the characteristics of urban creeks are severely altered from the natural waterbody that existed prior to the urbanization of the area. In many situations, the urban creek has been channelized, frequently with armoring, to prevent erosion associated with the higher flows that exist in an urbanized area. There is increasing evidence developing that the primary effects on aquatic life of urbanization of a small creek's watershed are associated with the increased flow due to paving of the area and not due to the chemical constituents present in this flow at concentrations above worst-case-based water quality standards or unregulated constituents, such as the organophosphate pesticides that are frequently present at toxic concentrations in urban stormwater runoff.

The US EPA, as part of the Clean Water Action Plan implementation (US EPA 1998) is developing a "Water Quality Criteria and Standards Plan" for evaluating and managing the impact of increased flow associated with urbanization of an area. It is important in developing this program to clearly distinguish between the effects of urbanized area flow on aquatic life-related resources and those associated with increased concentrations of chemical constituents in this flow. Frequently, these increased concentrations of constituents are present in non-toxic/non-available forms and/or are present for short periods of time compared to the critical period that is needed to be adverse to the aquatic life-related beneficial uses of the urban creek.

The US EPA, as part of the ANPRM, should develop an approach for addressing the regulation of urban area stormwater runoff to urban creeks where the aquatic life-related beneficial uses of urban creeks are protected to the maximum extent practicable/affordable considering the high cost of controlling chemical constituents in urban area stormwater runoff so they do not exceed water quality standards in the runoff waters. At least temporarily, the Agency should consider implementation of its previously suggested temporary variance approach (US EPA, 1996), which would allow NPDES-permitted urban area and highway stormwater runoff water quality management agencies, regulatory agencies, and the public to work together to develop appropriate regulatory approaches for protecting the beneficial uses of urban creeks without significant unnecessary expenditures for constituent control.

While the variances allowed under the Clean Water Act implementation approach adopted by the US EPA are typically short-term, it is suggested that as part of the ANPRM, at least an initial ten-year period be allowed for the stakeholders in urban creek water quality to address this issue, where the stakeholders devote substantial resources to selected, site-specific studies to assess what benefits in the stormwater-dominated urban creek situation would likely accrue through causing the urban community to treat stormwater runoff to urban creeks so that the stormwater would not cause violations of water quality standards in the urban creek.

Sanitary Quality for Contact Recreation

One of the primary constituents of urban area and highway stormwater runoff that will initiate the BMP ratcheting-down process is the presence of high levels of fecal coliforms in the runoff waters. The fecal coliforms in these waters are derived from a variety of sources, including leaking domestic wastewater sewerage systems, blockage of lift stations for sewerage systems, pets and

wildlife, animal transportation vehicles, leaking RV tanks and, in some areas, the homeless. While there is a poor understanding of the sources of fecal coliforms in urban area and highway stormwater runoff, it is well known that such runoff contains sufficient concentration of fecal coliforms so that there can be violations of sanitary quality standards for contact recreation, shellfish harvesting and, in some instances, domestic water supplies.

There are several aspects of this situation that need to be evaluated, the most important of which is achieving a separation of domestic wastewaters/wastes from urban stormwater runoff. The managers of domestic wastewater sewerage systems should be required to develop programs that will greatly improve the reliability of the sewerage system with respect to leaks, spills, blockages and illicit connections that result in the release of untreated domestic wastewaters to a community's stormwater conveyance system..

The key component of managing urban area and highway stormwater runoff sanitary quality is the control of dry weather flow fecal coliforms. Such fecal coliforms are likely derived from domestic wastewater inputs through illegal connections, spills, blockage of the sanitary sewerage system, etc. Such sources of fecal indicator organisms can and should be controlled to a much higher degree of reliability than is typically done today. This will require that the managers of sanitary sewerage systems devote considerable attention and resources to preventing pollution of urban stormwater runoff through discharges of domestic wastewaters to the urban stormwater conveyance systems.

It is believed that if complete separation of domestic wastewaters/wastes from urban area street and highway stormwater runoff were achieved, then the exceedance of the fecal and total coliform standards that are used to regulate sanitary quality for contact recreation, shellfish harvesting and domestic water supply use would allow the exceedances to occur with minimal health risk to the public. There is evidence that animal-derived fecal coliforms are not reliable indicators of the public health risk associated with contact recreation in waters that are impacted by fecal coliforms in urban area and highway stormwater runoff. This is an area that the US EPA needs to aggressively pursue as part of its efforts in the "Water Quality Criteria and Standards Plan – Priorities for the Future" (US EPA 1998). While developing criteria for microbial pathogens to better protect human health during water contact recreation is an area of emphasis of this Plan, the basic issue that needs to be addressed from the urban stormwater runoff water quality management perspective is whether contact recreating in waters that contain elevated concentrations of fecal coliforms that are derived from urban and highway stormwater runoff where domestic wastewater inputs to this runoff are controlled, represents a significant health risk to the public.

A key component of this issue is the development and implementation of reliable sanitary quality indicators. While the Agency has targeted this area as part of its Water Quality Criteria and Standards Plan implementation, particular attention should be given to urban area street and highway stormwater runoff to determine whether there is need to disinfect this runoff for fecal and non-fecal bacteria, enteroviruses and protozoan parasitic cyst-forming organisms, such as *Cryptosporidium*,

in order to protect the contact recreation designated beneficial uses of a waterbody from a significant increase in contact recreation-associated diseases.

As it stands now, unless a better understanding of the sanitary quality issues related to urban area and highway stormwater runoff where there is control of the input of domestic wastewaters and wastes into the stormwater runoff conveyance system is achieved, the public in some areas where the stormwater runoff is a significant contributor to waterbodies that are used for contact recreation will find that it is spending large amounts of funds through the urban stormwater runoff BMP ratcheting-down process to achieve what are known to be unreliable sanitary quality indicators.

The US EPA should, as part of developing and implementing revised, more reliable, sanitary quality indicators, work with state and local health departments in not only adopting the new sanitary quality indicators, but also terminating the use of the well-known to be unreliable fecal and total coliforms as sanitary quality indicators. Simply adding additional indicators on top of the existing unreliable indicators is not in the public's best interest. Reliable sanitary quality indicators must be developed, evaluated, and fully implemented as part of appropriately managing the fecal coliform-related sanitary quality problems currently associated with urban area and highway stormwater runoff.

Since it is likely to take a number of years before the needed information is available, the US EPA should, as part of the ANPRM, develop a temporary (ten-year) variance program which will allow exceedance of the fecal coliform standards in urban area and highway stormwater runoff under conditions where there is a high degree of control of domestic wastewater/waste inputs into the stormwater conveyance system.. During this variance period, the US EPA should conduct comprehensive research at a number of locations to assess the real public health risk associated with contact recreating in waters that are impacted by urban area and highway stormwater runoff which do not have significant amounts of domestic wastewater-derived fecal coliforms in the runoff.

Typically, stormwater runoff-associated violations of fecal coliform-based sanitary quality standards are present for a few days in contact recreation areas following the stormwater runoff event. Until there is a better understanding of the real public heath hazards associated with contact recreation in waters with elevated fecal coliforms where it is possible that part of the fecal coliforms are derived from domestic wastewaters, it may be necessary to encourage the public to restrict contact recreation in waters that have the potential to be a source of organisms that cause human disease. The overall restrictions of use of an area for contact recreation for a few days following stormwater runoff events that cause increased fecal coliforms may be in the best interest of society to avoid spending large amounts of funds unnecessarily in attempting to disinfect stormwater runoff so that it does not cause or contribute to sanitary quality violations following stormwater runoff events.

Use Attainability

One of the approaches that has been formulated by the US EPA for developing appropriate water quality standards for a waterbody is through an assessment of the ability of a waterbody to achieve the designated beneficial uses. In the mid-1970s when the states and the US EPA were

adopting designated uses for waterbodies, little to no consideration was given to the potential significance of designating an urban stream's beneficial uses for propagation of fish and other aquatic life. There are numerous examples where urban streams/rivers carry such designations where the waterbody is basically a concrete channel whose primary use is conveyance of stormwater runoff so that it does not flood the community. To now attempt to achieve water quality standards for many urban streams that are dominated by stormwater runoff to require meeting worst-case-based standards with no more than one exceedance of any standard by any amount every three years is strongly contrary to wise and appropriate use of public funds. While as discussed elsewhere, it is possible to collect and treat urban stormwater so that it will meet water quality standards when discharged to an urban stream, the cost to the public for such treatment is tens to hundreds of millions of dollars for small to moderate sized communities. For the Los Angeles area, these costs have been estimated to be on the order of $50 billion.

A key issue that should be addressed is what improvements in the beneficial uses of urban streams–which are basically stormwater conveyance structures–will be achieved through the expenditure of the funds needed to treat urban area stormwater runoff so that it is in full compliance with worst-case-based or even site-specific-adjusted water quality standards. It would be indeed rare that such expenditures would result in the development of an urban stream aquatic habitat that would support a balanced aquatic ecosystem. Even if all of the regulated chemical constituents were controlled to meet water quality standards, there still would be significant impacts of the stormwater flow on the beneficial uses of the waterbody. While it is possible to control stormwater flow from new developments to pre-development conditions, it is certain that in many areas retrofitting of flow control systems into established urban areas will not be possible because of the high cost of land acquisition.

As part of the ANPRM, the US EPA needs to reconsider the issue of defining the aquatic life-related use attainability of urban streams so that the public does not get trapped into spending large amounts of funds trying to achieve unattainable uses as a result of inappropriate classification of uses for urban streams that occurred over 20 years ago. At that time, little regard was given to the costs that would be involved in treating urban area stormwater runoff so that it would be in full compliance with water quality standards. As part of this effort, the US EPA should incorporate the herein-discussed provisions for temporary (ten years or so) variances, as well as provisions to address the application of water quality standards to stormwater dominated urban streams. During this ten-year variance period, federal, state and local regulatory agencies, stormwater runoff water quality management agencies and the public should work together to develop an approach that appropriately defines the attainable uses of urban area and highway stormwater runoff impacted streams that will, where economically affordable, protect appropriate designated uses.

The US EPA, as part of the ANPRM, should develop an approach for designating beneficial uses associated with urban area and highway stormwater runoff that would allow subcategories of uses that are applicable to urban area and highway stormwater runoff-dominated systems, such as urban streams.

Impact of Stormwater Flow on Habitat

The current US EPA administration has recognized that one of the primary impacts of urbanization of an area is increased stormwater runoff. A component of the Agency's June 1998 Interim Final "Water Quality Criteria and Standards Plan – Priorities for the Future" (page 41) is the development of biocriteria and bioassessments to assess the impacts of flow alterations on the aquatic life-related beneficial uses of a waterbody. While the Agency in its writings on this topic seems to be headed toward adding additional regulatory requirements beyond meeting the worst-case-based water quality standards, the appropriate use of biocriteria and bioassessments would be in a best professional judgement, non-numeric, weight-of-evidence approach where appropriate consideration is given to the impacts of flow, channelization, etc. on the beneficial use of a waterbody which preclude the development of a balanced, unimpacted urban stream aquatic life environment.

Of particular concern is an assessment of the improvement in beneficial uses that would accrue in urban streams associated with treating urban area and highway runoff to meet water quality standards. It is likely that there will be few situations where the flow in an urban stream is due to urban stormwater runoff where the public who must pay for this level of control of chemical constituents in stormwater runoff would perceive a significant improvement in the beneficial uses of the waterbody as the result of the projected expenditures for chemical constituent control. As part of the ANPRM, the US EPA should broaden its scope of the evaluation of the impacts of flow to consider the interrelationship between flow-related impacts and chemical constituent-related impacts in order that the public will gain an understanding of the improvements of the beneficial uses of the urban stream or other waterbody that receives significant amounts of urban area and highway stormwater runoff.

Sediment Quality Criteria

An area of emerging concern to urban area and highway stormwater runoff water quality managers is the development of sediment quality criteria/guidelines that could be used to regulate urban area and highway stormwater runoff-associated particulate heavy metals and organics. There is a disturbing trend occurring where some parts of the US EPA, in an effort to try to short-cut reliable science, are attempting to use chemically-based, co-occurrence-derived, so-called sediment quality guidelines to estimate excessive concentrations of chemical constituents in aquatic sediments. Such estimates are well known to be unreliable for either predicting aquatic life toxicity or excessive bioaccumulation of sediment-derived constituents in edible aquatic organisms that are present in the waterbody containing these sediments with the elevated concentrations of constituents. The US EPA, NOAA and others have repeatedly demonstrated that co-occurrence-based approaches, such as the so-called Long and Morgan approach, are less reliable for predicting sediment toxicity than flipping a coin. Lee and Jones (1992/99), Lee and Jones-Lee (1993a, 1994 and 1996b) have discussed the problems with trying to develop reliable chemically-based sediment quality guidelines/criteria as well as the appropriate use of biological effects-based sediment quality criteria.

The Agency staff responsible for the development of sediment quality guidelines are attempting to contrive approaches that would improve the reliability of co-occurrence-based assessments. However, because of the fundamentally flawed nature of the co-occurrence-based

approach which involves the use of total concentrations of constituents as opposed to toxic/available forms, no amount of statistical manipulation of co-occurrence-based data will address the inherently flawed approach associated with measurements of the concentrations of the constituents in sediments as an indicator of the water quality impacts of these constituents on the beneficial uses of the waterbody.

Lee and Jones-Lee (1993b, 1996c) have discussed the danger of developing sediment quality guidelines even though they are qualified with respect to how they should be used. As they point out, state and local regulatory agencies typically have limited expertise and resources to evaluate the appropriate use of chemically-based sediment quality guidelines. Because of their ease of use, such guidelines have been and are continuing to be used as regulatory limits that can cause the public to have to spend large amounts of funds controlling particulate chemical constituents in urban area and highway stormwater runoff since the concentrations of constituents in sediments near the point where runoff occurs exceeds guideline values. This has already occurred in the Los Angeles Santa Monica Bay Restoration Project where the public in the Santa Monica Bay watershed is committed to spending 42 million dollars over five years to control heavy metals including particulate heavy metals in urban area and highway stormwater runoff based on the observation that some Santa Monica Bay sediments contain elevated concentrations of lead above Long and Morgan co-occurrence based values.

Lee, (1995, 1998) has pointed out that it was technically invalid to assume that elevated concentrations of lead in Santa Monica Bay sediments compared to Long and Morgan co-occurrence based values is sufficient justification to cause the public of that region to spend 42 million dollars in removing particulate heavy metals from urban area, street and highway stormwater runoff. This is a technically invalid approach associated with the use of chemically based sediment quality guidelines. Those responsible for providing technical guidance to the Santa Monica Bay Restoration Project failed to reliably inform the regulatory agencies and the public responsible for formulating the Santa Monica Bay Restoration Project Management Plan of the unreliability of co-occurrence based sediment quality guidelines in serving as a basis for developing water quality management programs. Lee (1995, 1998a) discussed the need to conduct sediment toxicity tests in order to determine whether the elevated lead in the sediments represented lead in a toxic form that was significantly adverse to the beneficial uses of Santa Monica Bay. Even today over four years after the Santa Monica Bay Restoration Project Management Plan was adopted by local, state and federal agencies, based primarily on elevated concentrations of lead in Santa Monica Bay sediments, there still has been no assessment of whether the elevated concentrations of lead are in toxic available forms.

The inappropriate use of sediment quality guidelines in the Los Angeles region continues today where the Regional Water Quality Control Board for the Los Angeles area used elevated concentrations of heavy metals and organics in area sediments as a basis for listing the water body in which the sediments are located on the 303(d) list of “impaired” water bodies. This listing was approved by the State Water Resources Control Board in June 1998 with a result that total maximum daily load (TMDLs) have to be developed in order to control the elevated concentrations of constituents in stormwater runoff and other sources of particulates to reduce their concentrations so

that sediments will ultimately have concentrations of constituents below the Long and Morgan co-occurrence based sediment quality guidelines. However, as has been discussed by Lee and Jones-Lee (1996b) and in references contained therein, the Long and Morgan co-occurrence based sediment quality guidelines are less reliable for predicting sediment toxicity than flipping a coin.

As part of the ANPRM, the US EPA should protect the public from state and local regulatory agencies in appropriately using the Agency-contrived, chemically-based sediment quality guidelines. The focus of regulating particulate constituents in urban area and highway stormwater runoff must be on biological impact assessments, such as toxicity tests and excessive bioaccumulation measurements. Where toxicity is found associated with urban area and highway stormwater runoff-derived particulates, site-specific investigations should be conducted to determine the cause of this toxicity and whether the toxic constituents are derived from urban area and highway stormwater runoff-associated constituents. The approach that is used by some regulatory agencies such as the California Water Resources Control Board in its Bay Protection and Toxic Hot Spot policy (WRCB 1998) of assuming that an elevated concentration of a particulate potential pollutant in runoff waters causes an impairment of the beneficial uses of the receiving waters is obviously technically invalid. This is especially true for urban area and highway stormwater runoff particulates (Lee 1998, b, c, d and Lee and Jones-Lee 1998e.). A number of studies have shown that particulates in urban area and highway stormwater runoff are non-toxic. Further, based on the aqueous environmental chemistry of stormwater runoff-associated constituents, it is unlikely than in most waterbodies that non-toxic constituents in the runoff waters would lead to toxic constituents in the receiving waters' water column or sediments.

The US EPA, as part of the ANPRM, should critically examine this situation and develop reliable approaches for evaluating whether urban area and highway stormwater runoff-associated constituents are causing significant beneficial use impairments of receiving waters for the runoff. Failure to adequately and reliably address this issue could result in the US public becoming trapped into spending large amounts of funds coagulating and filtering urban area stormwater runoff to remove finely divided particulate heavy metals and organics which are in non-toxic forms in the runoff waters as well as in the receiving water water column and sediments.

An area of particular concern that the US EPA has thus far failed to address in its attempts to develop chemically-based sediment quality criteria, is the water quality significance of sediment toxicity. While creation of a large biological desert in aquatic sediments is certainly detrimental to the beneficial uses of a waterbody, the nature of sediment toxicity as it is typically found is such that there are significant questions about what sediment toxicity to a particular test organism means to the beneficial uses of a waterbody of concern to the public. As discussed by Lee and Jones-Lee (1996b), there can be significant alterations in the numbers and types of aquatic life present in sediments due to natural and anthropogenically-derived constituents that cause sediments to be toxic. However, these same waterbodies that have high levels of naturally occurring sediment toxicity due to ammonia, hydrogen sulfide and low dissolved oxygen also have what are considered to be outstanding sports fisheries.

The US EPA, as part of the ANPRM and the Water Quality Criteria and Standards Plan, should address the issue of the water quality significance of sediment toxicity. Failure to do so could trap the public into spending large amounts of money controlling constituent inputs to waterbodies from urban area and highway stormwater runoff because the particulate constituents accumulate in sediments that have aquatic life toxicity with little or no improvement in the beneficial uses of waterbodies of concern to the public. Basically, the US EPA should devote a substantial research effort to understanding what sediment toxicity of various types means to the higher trophic level beneficial uses of a waterbody.

Nutrient Criteria

In June 1998, the US EPA announced that it plans to develop chemical-specific, regional water quality criteria for nitrogen and phosphorus compounds that would regulate their impacts on the excessive growths of algae and other aquatic plants in ambient waters. As discussed by several speakers at the US EPA August 1998 national Water Quality Standards meeting held in Philadelphia, as well as by Lee and Jones-Lee (1998f) the Agency's proposed approach could readily lead to inappropriate assessment of the impact of nutrients derived from various sources on the beneficial uses of a waterbody. The US EPA should abandon its efforts to try to develop chemical-specific, regional, nutrient criteria that would be implemented as water quality standards that are not to be exceeded by any amount more frequently than once every three years and focus its excessive fertilization control program on the impacts of nutrient-derived excessive aquatic plant growth on the beneficial uses of the waterbodies experiencing excessive fertilization.

A key component of an excessive fertilization control program is the determination of the nutrient loads that influence the excessive growth of algae and other aquatic plants where consideration is given to the hydrologic and morphologic characteristics of the waterbody that influence how nutrients added to it are used to stimulate the growth of algae, as well as the available forms of nutrients, especially phosphorus, that can be used by algae as a nutrient.

Appropriate Approaches for Developing State Water Quality Standards and NPDES-permitted Discharges from US EPA Water Quality Criteria.

At this time, with few exceptions, worst-case-based US EPA Water Quality Criteria are being mechanically implemented into state water quality standards that are used to assess violations of urban area and highway stormwater runoff-associated constituents. This approach ignores the fundamental differences between the condition for which the Agency's national water quality criteria were developed, and the conditions typically associated with urban area and highway stormwater runoff. The US EPA worst-case-based water quality criteria are directed toward the control of toxic, available forms of chemical constituents, such as those that were typically associated with some municipal and industrial wastewater discharges that were commonly present in the 1960s and 70s when the US EPA worst-case-based water quality criteria were first being formulated. Today, however, it is rare that the residual constituents in municipal and industrial wastewaters occur in toxic, available forms. Further, a number of studies (Lee, *et al.* 1999a) have shown that the regulated constituents, such as heavy metals, in urban area and highway stormwater runoff are in non-toxic, non-available forms. This leads to a situation where applying worst-case-based water quality criteria

to urban area and highway stormwater runoff-associated constituents can lead to significant over-regulation of heavy metals and many organics.

While the US EPA's adoption of ambient water dissolved heavy metals as the regulatory standard for certain heavy metals is a step in the right direction for addressing this over-regulation, it still does not eliminate the over-regulation of many other forms of particulate constituents present in urban area and highway stormwater runoff. Further, even the dissolved heavy metals in urban area and highway stormwater runoff will be over-regulated due to the fact that the dissolved heavy metals in this runoff have been found to be in non-toxic forms. A further discussions of these issues is provided by Lee *et al*. (1999a.) The US EPA should, as part of its ANPRM, develop regulatory approaches for constituents in urban area and highway stormwater runoff that are in toxic, available forms, and thereby could potentially be adverse to the beneficial uses of the receiving waters for the runoff.

The Agency needs to focus a substantial effort on developing more appropriate averaging periods for stormwater runoff-associated constituents and frequency of exceedance limitations than is currently being used. The current US EPA worst-case based water quality criteria implementation approach based on a one-hour average and four-day average acute and chronic criteria that cannot be exceeded by any amount more than once every three years was arbitrarily developed. This approach grossly over-regulates constituents in many point and non-point sources, especially when applied to urban area and highway stormwater runoff. The short-term nature of stormwater runoff events, coupled with the fact that the constituents in urban area and highway stormwater runoff are largely in non-toxic, non-available forms, provides considerable justification for significantly changing the regulatory approaches that are used to translate US EPA worst-case-based water quality criteria and state standards based on these criteria to NPDES-permitted discharge limits for urban area and highway stormwater runoff-associated constituents.

Litter

One of the significant adverse impacts of urban area and highway stormwater runoff is litter. Stormwater carried litter can be significantly detrimental to a waterbody's beneficial uses through affecting its aesthetic quality and aquatic life. The US EPA should help urban stormwater management agencies develop effective litter control programs that not only control litter at its source, but also help collect and treat stormwater runoff to remove litter.

Anti-Degradation

At the ANPRM August 1998 meeting in Philadelphia, one of the issues that was raised by the US EPA in the discussion of anti-degradation is the need for the anti-degradation policy to be clarified and strengthened, especially regarding its use in developing point-source control and non-point source BMPs. As part of clarifying the anti-degradation policy, the US EPA should address the chronic problem with the implementation of the anti-degradation components of the Clean Water Act which can significantly adversely impact the appropriate regulation for urban area and highway stormwater runoff. There is confusion between relating changes in the chemical concentrations of constituents to changes in the beneficial uses of a waterbody. Of particular concern

is how increases in the concentration of a constituent which are below concentrations that are adverse to the beneficial use of a waterbody are frequently considered to be "degradation" of the waterbody. As part of the ANPRM, the US EPA should establish an explicit anti-degradation policy that establishes that violations of the anti-degradation policy focus on assessing a beneficial use impairment and not necessarily a change in concentration of a constituent that may or may not cause a beneficial use impairment. An assessment of violations of anti-degradation policy should be based on beneficial use impairments and not changes in concentrations unless a site-specific evaluation has been made which shows that a change in concentration of a constituent is directly linked to an impairment of the beneficial uses. It is important as part of clarifying the anti-degradation policy not to try to simplify it to judging violations of this policy to be equivalent to increases in the concentrations of chemical constituents that at some locations from some sources causes pollution - impairment of uses.

The use of a temporary (ten-year or so) variance from meeting water quality standards associated with urban area and highway stormwater runoff should not be mechanically equated to a degradation of water quality. The development of the variance approach for regulating urban area and highway stormwater runoff-associated constituents is designed to provide the opportunity for the regulated community, the regulatory agencies and the public to work together to develop technically valid, cost-effective regulatory approaches that will protect the designated beneficial uses of waterbodies from chemical constituents and pathogen indicator organisms in urban area and highway stormwater runoff. The nature of urban area and highway stormwater runoff-associated regulated constituents largely being in non-toxic, non-available forms and where toxic/available forms were present for such a short period of time associated with the runoff event as to not cause a critical exposure of aquatic life to be significantly adverse to aquatic life/designated beneficial uses of the waterbody requires that these issues be properly assessed in any refinement of the anti-degradation policy.

Economic Considerations

As part of the current implementation of the Water Quality Standards Rule, the US EPA has been devoting some limited attention to assessing the economic impacts of requiring that various point and non-point source dischargers control the concentrations of constituents in the discharge/ runoff to meet water quality standards. While the Agency has applied its economic evaluation approach to CSOs, thus far the Agency has failed to meet its public obligation of reliably assessing the cost to the public of treating urban area and highway stormwater runoff so that it does not cause or contribute to water quality standards violations at the point where the runoff enters a receiving water. This is a significant deficiency with the US EPA's current water pollution control program.

To mislead the public, as it did in the implementation of the proposed stormwater Phase II Rule in January 1998, into believing that water quality standards can be achieved in urban area stormwater runoff using the six minimum control measures was irresponsible on the part of the Agency management. Those with an elementary understanding of the potential ability of the Agency's proposed six minimum control measures,

1. Public education and outreach on stormwater impacts

2. Public involvement/participation in developing stormwater management program.
3. Illicit discharge detection and elimination.
4. Construction site stormwater runoff control.
5. Post-construction of stormwater management in new development and re-development.
6. Pollution prevention/good housekeeping for municipal operations.

know that the implementation of these measures will not enable an NPDES-permitted stormwater management agency to achieve water quality standards in the stormwater runoff. (Lee, 1998b). Further, even the implementation of conventional BMPs, such as detention basins, which on a retrofit basis will cost the public in the retrofitted area $1 to $3 per person per day will not enable achievement of water quality standards in the conventional BMP-treated stormwater (Jones-Lee and Lee, 1998a). The Agency should, as part of the ANPRM, stop misleading the public with respect to the cost of its current regulatory program for urban area and highway stormwater runoff which involves ultimately having to treat this runoff to meet water quality standards.

The Agency claims that the public can afford 1% to 2% of the median household income devoted to pollution control efforts. Such claims ignore the fact that there are many demands in the pollution control field, as well as other societal needs where 1% to 2% of the median household income could and should be used to meet more important societal needs than to fund BMPs to control some ill-defined, non-detected potential problem associated with urban area and highway stormwater runoff-associated constituents. The public should know with a high degree of certainty the cost and the expected improvement in the designated beneficial uses of a waterbody associated with expenditures to control chemical constituents and pathogen indicator organisms in the stormwater runoff. This should be an integral part of the US EPA's ANPRM efforts to develop more technically valid, cost-effective approaches for implementation of the water pollution control programs of this country. Rather than proceeding as now, where the affordability of urban area and highway stormwater runoff is judged based on the 1% to 2% median household income guideline, the Agency should be providing guidelines on affordability of urban area and highway stormwater runoff relative to other pollution control needs and societal needs.

Revisions of the Clean Water Act

If the US EPA headquarters staff find that the current Clean Water Act requirements preclude technically valid, cost-effective regulation of urban area and highway stormwater runoff, then as part of reporting in the ANPRM, the US EPA should clearly delineate those parts of the Clean Water Act that are contrary to the public's interests in cost-effectively managing the real significant water quality impacts of urban area and highway stormwater runoff-associated constituents. Further, if the US EPA determines that there are major information gaps that need to be filled in order to develop technically valid, cost-effective management of urban area and highway stormwater runoff, then the Agency should define these gaps in the ANPRM and provide an estimate of the cost to address them. This, in turn, would lead to obtaining funding from Congress for the development of the information needed to appropriately regulate the real significant water quality use impairments caused by urban area and highway stormwater runoff-associated constituents.

REFERENCES

Jones-Lee, A. and Lee, G.F., "Stormwater Managers Beware of Snake-Oil BMPs for Water Quality Management," Report of G. Fred Lee and Associates, El Macero, CA, July (1998a). Available from http://members.aol.com/gfredlee/gfl.htm

Jones-Lee, A. and Lee, G.F., "Evaluation Monitoring as an Alternative to Conventional Water Quality Monitoring for Water Quality Characterization/Management," Proc. of the NWQMC National Conference *Monitoring: Critical Foundations to Protect Our Waters,* US Environmental Protection Agency, Washington, D.C., pp. 499-512, (1998b).

Lee, G.F., "Comments on 'The Santa Monica Bay Restoration Plan, September 1994' for Stormwater Runoff Water Quality Management," Report of G. Fred Lee & Associates, El Macero, CA, February (1995).

Lee, G.F., "Initial Comments on US EPA 40 CFR Part 131 Water Quality Standards for the State of California as Proposed on Tuesday, August 5, 1997," Report of G. Fred Lee & Associates, El Macero, CA, September (1997).

Lee, G.F., "Santa Monica Bay Stormwater Runoff Water Quality Impact Research Needs, Comments submitted to J. Dorsey, Chair, Santa Monica Bay Restoration Project Technical Advisory Committee, G. Fred Lee & Associates, El Macero, CA, June (1998a).

Lee, G.F., "Additional Comments on Technical Validity Issues for State Board Staff's Proposed Incorporation of Chemical Information into the Sediment Quality Triad for Designating, Ranking and Toxic Hot Spot Cleanup Plan Development and Implementation," Submitted to the State Water Quality Resources Control Board, G. Fred Lee & Associates, El Macero, CA, June (1998b).

Lee, G.F., "Additional Comments on Technical Deficiencies on the Guidance on the Development of Regional Toxic Hot Spot Cleanup Plans," Submitted to the State Water Resources Control Board, G. Fred Lee & Associates, El Macero, CA, September (1998c).

Lee, G.F. and Jones, R.A., "Water Quality Aspects of Dredging and Dredged Sediment Disposal," In: Handbook of Dredging Engineering, McGraw Hill pp. 9-23 to 9-59, (1992). An updated version of this chapter which will appear in the second edition of this handbook is available from http://members.aol.com/gfredlee/gfl.htm..

Lee, G.F. and Jones-Lee, A., "Sediment Quality Criteria: Numeric Chemical- vs. Biological Effects-Based Approaches," Proc. Water Environment Federation National Conference, Surface Water Quality & Ecology, pp. 389-400, (1993a).

Lee, G.F. and Jones-Lee, A., "Equilibrium Partitioning-Based Values: Are They Reliable for Screening Contaminated Sediment?" Letter to the editor of Environ. Sci. & Technol., 27:994 (1993b).

Lee, G.F. and Jones-Lee, A., "Contaminated Dredged Sediment Disposal Criteria," Proc. ASCE "Dredged 94" Second International Conference on Dredging and Dredged Materials Placement, Orlando, FL, pp. 121-130 (1994).

Lee, G.F. and Jones-Lee, A., "Independent Applicability of Chemical and Biological Criteria/Standards and Effluent Toxicity Testing," The National Environmental Journal, 5(1):60-63, (1995), Part II, "An Alternative Approach," 5(2):66-67 (1995).

Lee, G.F. and Jones-Lee, A., "Appropriate Use of Numeric Chemical Water Quality Criteria," Health and Ecological Risk Assessment, 1:5-11 (1995). Letter to the Editor, Supplemental Discussion, 2:233-234 (1996a).

Lee, G.F. and Jones-Lee, A., "Evaluation of the Water Quality Significance of the Chemical Constituents in Aquatic Sediments: Coupling Sediment Quality Evaluation Results to Significant Water Quality Impacts," In: WEFTEC '96, Surface Water Quality and Ecology I & II, Vol 4, pp 317-328, Proc. Water Environ. Fed. Annual Conference (1996b).

Lee, G.F. and Jones-Lee, A., "Can Chemically-Based Sediment Quality Criteria Be Used as Reliable Screening Tools for Water Quality Impacts?" Society of Environmental Toxicology and Chemistry News, 16(3):14-15 (1996c).

Lee, G.F. and Jones-Lee, A., “Regulating Copper in San Francisco Bay: Importance of Appropriate Use of Aquatic Chemistry and Toxicology,” Presented at the Fourth International Conference on the Biogeochemistry of Trace Elements, Berkeley, CA, June (1997).

Lee, G.F. and Jones-Lee, A., “Assessment of Potential Urban Area and Highway Stormwater Runoff Water Quality Standards Compliance Problems,” Report to the CA Stormwater Quality Task Force Stormwater Science Workgroup, December (1998a).
Available from http://members.aol.com/gfredlee/gfl.htm.

Lee, G.F. and Jones-Lee, A., “Comments on US EPA National Pollutant Discharge Elimination System–Proposed Regulations for Revision of the Water Pollution Control Program Addressing Storm Water Discharges; Proposed Rule, Federal Register, January 9, 1998,” Comments Submitted to US EPA Washington, D.C., April (1998b).

Lee, G.F. and Jones-Lee, A., “Appropriate Application of Water Quality Standards to Regulating Urban Stormwater Runoff,” Report of G. Fred Lee and Associates, El Macero, CA, July (1998c).
Available from http://members.aol.com/gfredlee/gfl.htm.

Lee, G.F. and Jones-Lee, A., "Urban Stormwater Runoff Water Quality Management: Challenge of the 2000's," Report of G. Fred Lee & Associates, El Macero, CA, September (1998d).

Lee, G.F. and Jones-Lee, A., "Comments on 'Draft Functional Equivalent Document Water Quality Control Policy for Guidance on the Development of Regional Toxic Hot Spot Cleanup Plans' Developed by Division of Water Quality, State Water Resources Control Board, March 1998," Submitted to the State Water Quality Resources Control Board, G. Fred Lee & Associates, El Macero, CA, May (1998e).

Lee, G.F. and Jones-Lee, A, "Comments on 'National Strategy for the Development of Regional Nutrient Criteria' Developed by the US EPA Office of Water, June 1998," Submitted to the US EPA, Washington, D.C., August (1998f).

Lee, G.F., Taylor, S., and Neiter, D., "Review of Existing Water Quality Characteristics of Upper Newport Bay, Orange County CA and its Watershed and Results of Aquatic Life Toxicity Studies Conducted during 1997-98 in the Upper Newport Bay Watershed," Report to the Santa Ana Regional Water Quality Control Board, the Orange County Public Facilities and Resources Department, and the US EPA, (1999a).

Lee, G.F., Taylor, S., and Neiter, D., "Evaluation of the Water Quality Significance of OP Pesticide Toxicity in Tributaries of Upper Newport Bay, Orange County, CA, to be presented at ASTM Symposium, Environmental Toxicology and Risk Assessment: Recent Achievements in Environmental Fate and Transport: Ninth Volume, STP 1381, (1999b).

US EPA, Water Quality Standards Handbook: Second Edition, United States Environmental Protection Agency Office of Water, EPA-823-B-94-005a, Washington, DC, August (1994).

US EPA, Draft "Advance Notice of Proposed Rulemaking on the Water Quality Standards Regulation at 40CFT 131 (ANPRM)", United States Environmental Protection Agency Office of Water, (1996).

US EPA, Water Quality Criteria and Standards Plan - Priorities for the Future, United States Environmental Protection Agency Office of Water, EPA-822-R-98-003, Washington, DC, June (1998).

WEF/ASCE, Urban Runoff Quality management Manual of Practice, Water Environmental Federation and American Society of Civil Engineers, Alexandria VA (1998).

WRCB, "Water Quality Control Policy for Guidance on Development of Regional Toxic Hot Spot Cleanup Plans," State Water Resources Control Board, Sacramento, September (1998).

Summary Biographical Information

G. Fred Lee, PhD, PE, DEE

Dr. G. Fred Lee is president of G. Fred Lee & Associates, an environmental consulting firm located in El Macero, California.

For 30 years Dr. Lee held university graduate-level teaching and research positions at several major US universities, including a Distinguished Professorship of Civil and Environmental Engineering at the New Jersey Institute of Technology. In 1989, he and Dr. Anne Jones-Lee (wife) assumed full-time consulting activities through G. Fred Lee & Associates which is located in El Macero, California.

Dr. Lee holds a PhD degree from Harvard University in Environmental Engineering and Environmental Sciences(1960) and a Master of Science in Public Health degree from the University of North Carolina. He obtained a bachelors degree from San Jose State University.

Dr. Lee has conducted over $5 million in research on various aspects of water quality and solid and hazardous waste management. He has published over 850 papers and reports on this work. He has served as an advisor to numerous governmental agencies and industries in the US and other countries on water quality and solid and hazardous waste management issues.

Dr. Lee has extensive experience in developing approaches that work toward protection of water quality without significant unnecessary expenditures for chemical constituent control. He has been active in developing technically-valid, cost-effective approaches for the evaluation and management of chemical constituents in domestic and industrial wastewater discharges and urban stormwater runoff since 1960.

Dr. Lee's work on urban stormwater quality impact evaluation and management began in the late 1960's while he was a professor at the University of Wisconsin-Madison. He and his graduate students did some of the first work done on this topic. He has been active in evaluating and developing management approaches for urban area, street and highway stormwater runoff water quality for over 30 years. He and Dr. Jones-Lee have published extensively on the approaches that should be used to develop technically-valid, cost-effective best management practices for urban area, street and highway stormwater runoff. Dr. G. F. Lee and A. Jones-Lee have established a web site, http://members.oal.com/gfredlee/gfl.htm, where they list and make available as downloadable files their recent papers and reports on stormwater runoff water quality impact evaluation and management as well as other areas in which they are active.

Drs. Lee and Jones-Lee have developed an email based Stormwater Runoff Water Quality Science/Engineering Newsletter that is issued about monthly. Those interested in receiving the newsletter should send a email note to Dr. Lee at gfredlee@aol.com. Past copies of this newsletter

are available from their web site. This Newsletter presents discussions on various aspects of stormwater runoff water quality management.

Dr. Lee's most recent work on stormwater runoff evaluation and management has been devoted to the development of the Evaluation Monitoring approach. This approach focuses on finding real water quality use impairments in receiving waters for stormwater runoff and then developing technically-valid, cost-effective BMP's to control the water quality impacts to the maximum extent practicable. Dr. Lee has been an active participant in the CA Stormwater Quality Task Force. He is currently chair of the Task Force Stormwater Science Work Group. Information on this Work Group is available from their web site.