Stormwater Runoff Water Quality Newsletter
Devoted to Urban/Rural Stormwater Runoff
Water Quality Management Issues

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This issue of the Newsletter is devoted to a review of the **development of water quality criteria/standards for regulating urban area and highway stormwater runoff water quality impacts**. A review is presented of the issues that need to be considered in developing water quality criteria/standards for urban area and highway stormwater runoff relative to the ability of conventional "best management practices" (BMPs) to achieve compliance with water quality standards. Also, information is provided on a recently released report by an expert panel to the California State Water Resources Control Board (SWRCB) entitled, "The Feasibility of Numeric Effluent Limits Applicable to Discharges of Storm Water Associated with Municipal, Industrial and Construction Activities."

An issue of particular interest to those concerned about regulating urban area and highway stormwater runoff water quality impacts is the potential to apply numeric water quality criteria/standards to the discharges of stormwater runoff from urban areas and highways. This topic has been discussed in several of the past Newsletter issues. Of particular significance are NL 1-2, 1-3, 1-5, 1-6/7, 2-2, 5-4, 6-8, 6-9, 7-2, 7-3, 7-5 and 7-6/7. All of the Newsletters that have been published since it was initiated in July 1998 are available at http://www.gfredlee.com/newsindex.htm. An index is also provided at this location.

Background

The author (Dr. G. Fred Lee) has been involved in water quality criteria and standards development and implementation since the mid-1960s. This involvement has included being an invited peer reviewer for the National Academies of Science and Engineering "Blue Book" of Water Quality Criteria 1972, a member of the American Fisheries Society Water Quality Committee that reviewed the US EPA "Red Book" of Water Quality Criteria 1976, and a member of the US EPA peer review panel that developed the current water quality criteria development approach and the "Gold Book" of Quality Criteria for Water 1986 (US EPA 1987). The development approach adopted by the US EPA in 1986 is still being used today by the US EPA in their most recent update, "National Recommended Water Quality Criteria: 2002" (US EPA 2002).

Further, Dr. Lee has been involved in investigating the water quality impacts of urban area street and highway stormwater runoff since the mid-1960s. In his professional papers and in the Newsletter discussions of the application of water quality criteria/standards to urban area and highway stormwater runoff, he has discussed that the mechanical application of US EPA water quality criteria and state standards based on these criteria to the discharges of urban area and highway stormwater runoff would tend to significantly over-regulate chemical constituents in this runoff for which there are criteria/standards, and fail to regulate the vast arena of chemicals

in such runoff that do not have water quality criteria or are not measured in water quality investigations/evaluations. An example of this type of situation is the pyrethroid-based pesticides which are now being found in California to be a widespread cause of sediment toxicity to some benthic organisms (see Newsletter NL 8-5).

Problems with US EPA Water Quality Criteria/Standards

The basic problem with trying to use existing water quality criteria/standards for regulating urban area and highway stormwater runoff is that this runoff is episodic, of short duration. The US EPA water quality criteria development approach targeted regulating discharges from point sources that occur over an extended period of time, where the potential pollutants are largely in toxic available forms. In accord with the 1972 amendments to the "Clean Water Act," the US EPA water quality criteria are designed to be national criteria that would be applicable to essentially all waterbodies in the country, and therefore represent worst-case (most toxic) conditions for impacts on aquatic life. The conditions that exist in urban area and highway stormwater runoff are typically considerably different than those for which the national criteria were developed.

While the US EPA water quality criteria include an acute criterion based on a one-hour exposure, the approach used for developing this criterion was not technically valid. There can be significant exceedances of the acute criterion/standard without significant adverse effects on aquatic life and other beneficial uses of waterbodies. The US EPA has recognized the inappropriateness of mechanically applying the worst-case-based national criteria/standards to all discharges. They have developed a Water Quality Standards Handbook (US EPA 1994) which enables some adjustment of the worst-case criteria to site-specific conditions; however, the adjustment approach developed by the US EPA does not appropriately consider the conditions that exist in urban stormwater runoff situations.

Wet Weather Standards

As discussed in past issues of the Newsletter, previous US EPA administrations have acknowledged that there is need to develop water quality criteria/standards (wet weather standards) that would be applicable to stormwater runoff events, in order to more appropriately regulate the potential water quality impacts of the chemical constituents in such runoff. This approach, however, has been opposed by some environmental groups as a "weakening" of the Clean Water Act requirements. On the contrary, if properly developed, wet weather standards would more appropriately regulate the real significant water quality impacts associated with urban area and highway stormwater runoff without significant unnecessary expenditures for chemical constituent control.

Evaluation Monitoring

Dr. Lee has discussed the need for comprehensive water quality investigations to determine the real significant water quality impacts of chemical constituents which are potential pollutants in urban area and highway stormwater runoff. Many of his publications on this and other related issues are available from his website, www.gfredlee.com, in the "Surface Water Quality," "Urban Stormwater Runoff" section (http://gfredlee.com/pswqual2.htm#runoff). As part of his work on these issues, he and Dr. Jones-Lee have developed what they have called the "Evaluation Monitoring" approach (Jones-Lee and Lee 1998, Lee and Jones-Lee 1999). This

approach has been discussed in Newsletters NL 2-3, 6-1, 7-3 and 8-6. Basically, the approach focuses on site-specific studies that determine the real significant water quality use impairments that are occurring in a waterbody potentially impacted by urban area and highway stormwater runoff during and following a runoff event.

For example, rather than measuring copper concentrations in stormwater runoff from an urban area or highway, and then trying to extrapolate through the water quality criterion/standard to potential impacts in the receiving waters for the runoff, the focus of the Evaluation Monitoring studies would be on evaluating the impacts of copper and other heavy metals, as well as known and unrecognized pollutants in stormwater runoff that have the potential to be toxic to aquatic life in the water column and sediments of the receiving water for the runoff. If toxicity is found in the receiving waters associated with the runoff event that can be related to past runoff events, then toxicity identification evaluations (TIEs) and forensic studies would be conducted to determine the cause(s) of the toxicity and the source(s) of chemicals responsible for it.

An issue of particular importance in urban area stormwater runoff is the presence of chemicals in the runoff such as PCBs, dioxins, mercury, etc., that tend to bioaccumulate in the food web, leading to concentrations in edible fish and other organisms that are a threat to human health and wildlife. The conventional stormwater runoff monitoring approach focuses on measurement of the concentration of these chemicals in the runoff waters at the point of discharge. The concentrations found are then compared to worst-case-based water quality criteria/standards. Such a comparison, however, can be unreliable in determining whether there is a real significant bioaccumulation problem in the receiving waters for the stormwater runoff, since there are a variety of factors that influence the magnitude of bioaccumulation. The Evaluation Monitoring approach, which focuses on determining whether there are edible organisms in the receiving waters that have bioaccumulated excessive concentrations of the chemicals is a far more reliable approach for discerning whether there is a human health hazard associated with bioaccumulatable chemicals in stormwater runoff. If the fish and other edible organisms contain excessive concentrations of hazardous chemicals, then studies should be done to determine their source. It is important, in conducting these studies, to evaluate whether the stormwater runoff-associated sources of these chemicals contain the chemical in a bioavailable form. These studies could require laboratory-based incubation of the stormwater runoff in the presence of organisms that bioaccumulate chemicals from aquatic systems.

Since chemicals that tend to bioaccumulate to excessive levels in fish often are associated with suspended and/or bedded sediments, site-specific studies should be conducted to determine whether the areas in the waterbody where the stormwater runoff-associated sediments have accumulated are a significant source of the bioaccumulatable chemicals in the edible organisms. These same kinds of studies are needed to properly interpret the potential for bioaccumulatable chemicals in urban area stormwater runoff to cause excessive bioaccumulation in organisms in the waterbody receiving the runoff. In addition to considering the potential impacts of the bioaccumulatable chemicals on human health, attention needs to be given to adverse effects to higher trophic level organisms, such as fish-eating mammals and birds.

As part of conducting the Evaluation Monitoring of fish tissue to determine if excessive bioaccumulation of known hazardous chemicals is occurring, consideration needs to be given to

identifying the cause of unknown-caused "peaks" in the gas chromatograph or GCMS examination of the fish tissue. Adoption of this approach can lead to the identification of potentially hazardous chemicals that are bioaccumulating in edible fish to levels that are of potential concern with respect to adverse effects to humans and wildlife.

The results of the Evaluation Monitoring approach logically leads to the development of management practices for controlling the real significant water quality impacts of pollutants in urban area and highway stormwater runoff. As discussed below, these management practices, however, would not typically involve the use of the current BMPs (such as detention basins, grassy swales, etc.) that are used for urban area and highway stormwater runoff. They would focus on source control, in which sources of the real pollutants (i.e., those constituents which impair beneficial uses) are identified and controlled at their source.

For example, a stormwater runoff source control issue is the use of copper in some automobile brake pads. Some environmental groups have been advocating the elimination of copper in some manufacturers' automobile brake pads, since copper in urban area and highway stormwater runoff is typically elevated above worst-case-based water quality standards. However, through site-specific studies, such as in southern San Francisco Bay, it has been found that adjustment of the national water quality criterion for copper to site-specific conditions in the Bay waters eliminates the exceedance. The copper in southern San Francisco Bay waters from automobile brake pads and all other sources which is causing the exceedance of the worst-case-based water quality standard is in a nontoxic form. This type of evaluation should be made in all urban area and highway stormwater runoff potential pollutant source control programs to be certain that these efforts are directed to controlling sources of pollutants in urban area and highway stormwater runoff that are, in fact, adversely affecting the beneficial uses of the receiving waters for the runoff.

Inadequate BMPs

As discussed in past issues of the Newsletter (such as NL 3-2), the so-called "best management practices" (such as detention basins, grassy swales, etc.) that are being used today to "treat" urban area and highway stormwater runoff were not developed based on their ability to treat urban area and highway stormwater runoff to a sufficient degree to achieve compliance with existing water quality standards. These BMPs are largely based on hydraulic considerations of the structural unit, with little or no regard to water quality management issues.

Previous Newsletters have discussed the finding that, in order to achieve compliance with water quality standards in urban area and highway stormwater runoff so that there is no more than one exceedance for any regulated parameter by any amount in a three-year period (i.e., the conventional NPDES permit requirements), it would be necessary to construct, operate and maintain treatment works similar to those that are used in advanced wastewater treatment, because of the very high flows that can occur in urban area and highway stormwater runoff. These treatment works would have to be of very large size to store and/or treat the large volumes of stormwater runoff that can occur in a one-inch (or more) 24-hour storm. It was estimated by the Alameda County, California, stormwater management agency that, in order to collect for treatment the stormwater runoff from Alameda County to San Francisco Bay from a one-inch,

24-hour storm, about 50 storage systems the size of the Oakland Coliseum would have to be developed on the shoreline of the Bay.

Studies in the Sacramento, California, area have shown that, to apply conventional BMPs (such as detention basins, etc.) to all of the stormwater runoff from Sacramento on a retrofit basis would cost the residents of Sacramento one to two dollars per person per day over 20 years. The primary cost is the acquisition of the land on which the collection system and detention basins, etc., would be installed. This investment would not achieve compliance with water quality standards in the stormwater runoff, since conventional BMPs cannot achieve this degree of treatment.

It was further estimated that in the Los Angeles area Santa Monica Bay watershed, in order to achieve compliance with current worst-case-based water quality criteria/standards, the cost to construct, operate and maintain the advanced treatment works would be eight to 10 dollars per person per day for the population served by the stormwater collection system. These cost issues have been discussed in previous Newsletters.

Further, except during periods of bypass during high-flow events, infiltration basins can control pollutants in stormwater runoff from urban areas and highways; however, as discussed in Newsletters NL 1-4 and 3-3, there is the potential for infiltration of stormwater runoff to lead to pollution of groundwaters. This can be especially important for areas in which high infiltration rates are available, where there is little or no removal of pollutants by sorption on the aquifer solids. Lee et al. (1998) and Taylor and Lee (1998) have discussed the appropriate use of infiltration basins as a BMP for urban area and highway stormwater runoff. This use requires the development of comprehensive monitoring programs for groundwaters potentially polluted by infiltrating stormwater.

BMP Ratcheting Down

The current regulatory approach for urban area and highway stormwater runoff involves a BMP ratcheting-down process (see Newsletters NL 1-2, 1-3, 1-5, 5-3 and 7-6/7), where, in accord with current Clean Water Act requirements, urban area and highway NPDES-permitted stormwater runoff must, at some undefined time in the future, achieve compliance with water quality standards. As being implemented by several California Regional Water Quality Control Boards, stormwater management agencies are supposed to be demonstrating with each new renewal of their NPDES permit that the BMPs that they have implemented are becoming ever-increasingly effective in achieving compliance with water quality standards. However, it has been well demonstrated that conventional BMPs of the type being used today cannot achieve compliance with worst-case-based water quality standards so that there is no more than one exceedance by any amount in a three-year period. This leads to an impossible regulatory program, where, in accord with regulations, compliance is to be achieved, yet it cannot be achieved with the current BMP approach.

Environmental groups have been frustrated with this approach, where, as discussed in previous Newsletters, legal action has been taken in order to try to get the Court to require that stormwater management agencies develop BMPs that will achieve compliance with water quality standards. It has been determined by the Ninth Circuit Court (see NL 2-2) that, in accord with current Clean

Water Act requirements, NPDES permitted stormwater runoff from urban areas and highways must ultimately achieve compliance with water quality standards; however, the US EPA has discretionary powers to determine when the compliance must occur. It was subsequently ruled by the US EPA Environmental Appeals Board, Washington, D.C. (see NL 5-3), that compliance must be achieved, but no deadline for compliance was imposed.

Storm Water Panel Report

In an effort to get the California State Water Resources Control Board (SWRCB) to adopt regulations that would require urban area and highway stormwater runoff NPDES permittees to achieve compliance with water quality standards, several environmental groups caused the SWRCB to conduct a review of this issue. This resulted in the SWRCB appointing a "Storm Water Panel" of experts to conduct this review. This Panel has just released its report:

> Storm Water Panel, "The Feasibility of Numeric Effluent Limits Applicable to Discharges of Storm Water Associated with Municipal, Industrial and Construction Activities," Storm Water Panel Recommendations to the California State Water Resources Control Board, Sacramento, CA, June 19 (2006).
> http://www.swrcb.ca.gov/stormwtr/docs/swpanel_final_report.pdf

Except for one member, the Storm Water Panel consists of individuals with an engineering background who are active in the urban stormwater runoff water quality management arena. As discussed below, the approach taken by this Panel in addressing the feasibility of numeric effluent limits is an engineering approach, focusing on current BMPs, rather than the water quality management approach discussed above. The Panel's approach evolved out of the charge given the Panel by the SWRCB, where on page 3 of the report, it states that the Panel was asked to consider the following:

> *"Is it technically feasible to establish numeric effluent limitations, or some other quantifiable limit, for inclusion in storm water permits? How would such limitations or criteria be established, and what information and data would be required?*
>
> *The answers should address industrial general permits, construction general permits, and area-wide municipal permits. The answers should also address both technology-based limitations or criteria and water quality-based limitations or criteria. In evaluating establishment of any objective criteria, the panel should address all of the following:*
> *(1) The ability of the State Water Board to establish appropriate objective limitations or criteria; (2) how compliance determinations would be made; (3) the ability of dischargers and inspectors to monitor for compliance; and (4) the technical and financial ability of dischargers to comply with the limitations or criteria."*

Beginning on page 4 of the report are presented the *"Panel's Findings on Feasibility of Numeric Effluent Limits Applicable to Municipal Activities,"* which state,

"1. The current practice for permitting, designing, and maintaining municipal stormwater treatment facilities (called BMPs herein) on the urban landscape does not lend itself to reliable and efficient performance of the BMPs because:

- *Permitting agencies, including EPA, States, and local governments, have rarely developed BMP design requirements that consider the pollutants and/or parameters of concern, the form(s) that the pollutants or parameters are in, the hydrologic and hydraulic nature of how they* [sic] *pollutants and flow arrive, and then the resulting unit processes (treatment and/or flow management processes) that would be required to address these pollutants or parameters.*
- *The permitting agencies generally are not accountable for the performance of the BMP, and thus give much leeway to the developer with respect to the type of BMPs to be constructed, and to the details of the design, although some states do have detailed design standards and have conducted performance tests to identify acceptable devices for their area,*
- *The developer is not responsible in most all cases for the performance of the BMP, so the treatment facilities are designed to minimize the cost and/or area of the facility and/or ease of permitting, not maximize the pollutant removal efficiency and/or flow management of the BMP*
- *Because BMPs are not held to any, or very few, long-term performance criteria, they are typically not maintained except for aesthetic purposes. Very few stormwater agencies are responsible for BMP maintenance on private property, and public facilities are maintained mostly in response to clogging and/or resultant drainage or aesthetic problems. Even for stormwater agency facilities, maintenance is often limited."*

The Storm Water Panel's statement on page 4 of the report that,

> *"The California BMP Handbooks and other local requirements leave too much of the BMP selection and design to the discretion of the designer, and thus do not address many if not all of the receiving water quality issues"*

points to the most significant problem with respect to the current approach to developing BMPs for urban area and highway stormwater runoff water quality management.

While the author agrees with the Panel's above-quoted bulleted item assessment with respect to problems with current BMPs, an issue that needs to be considered is what is meant by "performance" of a BMP. Often, those taking an engineering approach discuss performance in terms of removal of a constituent across the BMP unit – i.e., percent removal of copper, coliforms, etc. However, from a water quality management perspective, performance of a BMP should be evaluated based on how the unit impacts either protection (for new units) or enhancement (for retrofitted units) of the water quality of the receiving water – i.e., if one of the purposes of the BMP is to remove potentially toxic constituents (such as copper, other heavy metals and organics), how well does the BMP reduce the magnitude and duration of toxicity in the receiving waters associated with a runoff event? Further, a proper evaluation of performance of a BMP from a water quality perspective should include translating the reduction in a toxic

plume to an improvement in the designated beneficial uses of a waterbody, such as the numbers, types and characteristics of desirable forms of aquatic life in the waterbody. Until such evaluations are made, the technical base for water quality management associated with urban area and highway stormwater runoff is superficial and largely without merit. As discussed in the Lee and Jones-Lee writings on these issues, the Evaluation Monitoring approach can and should be used to evaluate the performance of various management practices used to "treat" stormwater runoff.

Lee and Jones-Lee (2002) have discussed the evaluation of performance of management practices for controlling potential pollutant water quality impacts from irrigated agricultural stormwater runoff. These are the same issues that urban stormwater runoff water quality management agencies face.

Beginning on page 5, mid-page, the Panel discusses *"The Problem with Existing Effluent Limit Approaches,"* where it states,

> *"Effluent limit approaches usually focus only on conventional water quality constituents that may not be solely or at all responsible for the receiving water beneficial use impairments in urban receiving waters. The important stressors that affect many use impairments can include one or more of the following and may vary in importance from system to system:"*

The Panel lists as potentially important stressors increased flow, sediment contamination, impaired aesthetic value, unsafe conditions, dissolved and suspended pollutants that are bioavailable, and elevated temperatures. The Panel, however, did not list one of the most important deficiencies in current effluent limitations: the presence of new or unregulated chemicals in stormwater runoff from urban areas. Of particular concern in California and some other areas are the pesticides used on residential and commercial properties. Typically, water quality criteria/standards are not available for these chemicals, with the result that their presence in urban area stormwater runoff is unknown, since they are not monitored.

As discussed in previous Newsletters (see NL 8-1/2, 8-6, 9-3 and 9-4), the organophosphate pesticides (such as diazinon, chlorpyrifos, etc.) have been used for many years on residential properties, where the runoff from these properties is toxic to some forms of aquatic life. This problem was ultimately detected through toxicity measurements. With the US EPA restrictions on the use of the organophosphate-based pesticides in urban areas based on potential human health issues (not water quality issues), there has been a shift to pyrethroid-based pesticides for treating pest problems on urban properties. This has introduced a new problem of urban stream and waterbody sediment toxicity. One of the advantages of using the Evaluation Monitoring approach is that it specifically examines the receiving waters for water quality problems, such as toxicity, and then looks to identify the cause.

On page 6 of the report, at the end of the first full paragraph, the Panel states, *"Although expensive, comprehensive investigations such as these should be considered an investment to help minimize wasteful expenditures due to the application of inappropriate control practices in a watershed."* One of the basic problems with urban area stormwater runoff water quality

management is that those responsible for funding in this area have become accustomed to devoting little or no funding to critically evaluating the water quality impairment in the receiving waters for the stormwater runoff. This has led to the current situation of not having an adequate understanding of what the real significant water quality problems are that are caused by urban area and highway stormwater runoff. While devoting funds to this area will represent a significant new expenditure for urban stormwater runoff water quality management agencies compared to what they have been devoting to receiving water water quality evaluation, in the long term, properly conducted receiving water evaluations will save the public considerable funds by focusing pollutant control on constituents that are causing real significant water quality problems in the receiving waters, through source control efforts, rather than treatment works.

Storm Water Panel's Recommendations. Beginning on page 8, the Panel presents "Municipal Recommendations," where it concludes, *"It is not feasible at this time to set enforceable numeric effluent criteria for municipal BMPs and in particular urban discharges."* The Panel recommends that an "**Action Level**" interim approach be adopted that would work toward improving the efficacy of conventional BMPs. The Panel states,

> *"For the purposes of this document, we are calling this 'upset' value an Action Level because the water quality discharged from such locations are enough of a concern that most all could agree that some action should be taken. Action Levels could be developed using at least three different approaches. These approaches include: 1) consensus based approach; 2) ranked percentile distributions; 3) statistically-based population parameters.*
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> *The consensus-based approach would be to agree upon effluent concentrations that all parties feel are not acceptable. For example, most parties would likely agree that an average concentration of dissolved copper above 100 ug/I from an urban catchment would not be acceptable. This would be an Action Level value that would trigger an appropriate management response. This approach may not directly address the issue of establishing numeric effluent criteria and achieving desired effluent quality, but the consensus-based approach would ensure that the 'bad actor' watersheds received needed attention."*

The author is concerned that the Panel's "Action Level" approach for identifying so-called "bad actors" will divert attention away from what is really needed, which is focused studies on discerning receiving water beneficial use impairments. The various approaches that the Panel has recommended for establishing Action Levels are not necessarily based on water quality issues and could cause further expenditure of funds for control of "bad actors" based on a "consensus" on the potential impacts of an elevated concentration of a particular chemical constituent in urban area and highway stormwater runoff. The Panel's discussion of the need for improved conventional BMP design, monitoring and maintenance is appropriate; however, until such time as the regulatory agencies become serious about managing the water quality impacts of urban area and highway stormwater runoff based on properly conducted studies of receiving water beneficial use impairments, the management of water quality issues associated with urban area and highway stormwater runoff will continue to be largely superficial and misdirected. Adoption of the Action Level approach recommended by the Panel could readily cause water

quality management agencies to assert to city councils, boards of supervisors, etc., that there is no need for funding to begin to effectively investigate the real water quality impacts of urban area and highway stormwater runoff chemical constituents and pathogen-indicator organisms, since the management agency has implemented an Action Level approach. However, this Action Level approach could be more of the same kind of largely inadequate water quality impact management that has been adopted through the use of conventional BMPs.

The Panel in its report also provides a discussion of the feasibility of establishing numeric effluent limits applicable to construction activities and industrial activities. Those readers interested in these areas may wish to review the Panel's report on these issues.

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