Experience and Qualifications of Dr. G. Fred Lee and Dr. Anne Jones-Lee

Urban, Industrial, and Rural Stormwater Associated Contaminant Impact Evaluation, Monitoring, and Management

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Presented below is information on the experience and expertise of Drs. G. Fred Lee and Anne Jones-Lee in evaluating the water quality significance of stormwater runoff associated contaminants and in the development of monitoring and management programs for stormwater runoff associated contaminants.

Previous Stormwater Quality Runoff Evaluation and Management Experience

Dr. G. Fred Lee initiated studies on the amounts and water quality significance of chemical constituents in urban stormwater runoff in the 1960's as part of the International Biological Programs (IBP) Research Project. This work was done in Madison, Wisconsin while Dr. Lee held the position of Professor of Water Chemistry and Director of the Water Chemistry Program in the Department of Civil and Environmental Engineering at the University of Wisconsin, Madison. This study was concerned with the amounts of contaminants present in urban stormwater runoff from residential and commercial areas. It was the first study of its type undertaken on the amounts of urban stormwater runoff associated contaminants in which aerial loadings were defined. Aerial loadings of stormwater-derived chemical constituents are becoming increasingly recognized as major sources of some constituents for certain waterbodies. Recently, Drs. Lee and Jones-Lee have confirmed earlier findings that the deterioration of the water quality that is occurring in Lake Tahoe, California is derived from nitrogen input in atmospheric sources which are most likely derived from automobile, bus and truck exhaust NOx releases within the Lake Tahoe Basin (Lee and Jones-Lee, 1994a).

During the 1960's, Dr. Lee and his graduate students at the University of Wisconsin pioneered in developing nutrient export coefficients (grams of contaminant/square meter of source area/year) from various types of urban and rural land use activities. From these studies, he and his associates developed standardized nutrient export (N & P) coefficients from rural and urban sources that are now used to estimate the amount of nutrients derived from various types of land use (Rast and Lee, 1983).

In addition to establishing the amounts of nutrient and other chemical constituent concentrations and loads in the IBP studies, Dr. Lee and his graduate students did the first studies

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ever done on determining available forms of these contaminants. They modified algal laboratory culture methodology to assess available forms of contaminants. These studies showed that much of the phosphorus and part of the nitrogen present in urban stormwater runoff was not available to support algal growth in receiving waters for this runoff. Similar results were found for rural stormwater runoff. These studies were conducted in Madison, Wisconsin; Rochester, New York and several other US cities.

While the focus of the IBP in the 1960's at the University of Wisconsin, Madison was on nutrients, studies were also conducted on the availability of potentially toxic chemicals, such as heavy metals, organics, etc., in urban stormwater runoff to aquatic life. It was found that while high concentrations of some heavy metals such as lead were present in urban stormwater runoff, the chemical forms present were non-toxic to sensitive forms of aquatic life.

Several master's theses, Ph.D. dissertations, reports to contracting agencies, and professional papers were published from the IBP studies. A listing of these publications as well as other professional papers and reports on this topic are available upon request.

In the late 1970's and the early 1980's, while Drs. Lee and Jones-Lee held professorial positions at Colorado State University, they worked with several Colorado Front Range cities and governmental agencies as advisors on the urban stormwater runoff associated contaminant studies that were being undertaken as part of the US EPA's National Urban Runoff Program (NURP). This work also included studies specifically designed to evaluate the impact of urban stormwater runoff in Ft. Collins, Colorado on Spring Creek, a small trout stream that flows through Ft. Collins that receives much of the city's stormwater runoff. They found that even though high concentrations of heavy metals and several other constituents were present in Spring Creek during periods of stormwater runoff, a naturally reproducing trout population was present in the creek. They also investigated the impact of the runoff on an urban lake as well as downstream reservoirs and river. They served as advisors to the City/County of Denver NURP studies and were instrumental in having those conducting those studies add bioassays to the study program to evaluate available - toxic forms of contaminants in the urban stormwater runoff.

They tried to get those responsible for management of NURP within the US EPA Washington DC to expand the scope of these studies to include assessment of available forms of contaminants in all NURP studies across the country (Lee and Jones, 1981). Unfortunately, this effort was unsuccessful with the result that the US EPA's NURP studies were of limited value in defining the water quality significance of chemical constituents in urban stormwater runoff since they did not include reliable toxicity testing and other impact studies as part of the program. Without such testing, it is not possible to determine the potential impacts of stormwater associated contaminants on receiving water quality for the urban stormwater runoff.

In the early 1980's, Drs. Lee and Jones-Lee conducted studies on behalf of the City of Lubbock, Texas, on the impact of urban stormwater runoff on the Yellow House Canyon Lakes. These studies (Lee and Jones, 1991a) focused on evaluating the impact of stormwater runoff from Lubbock on water quality in these lakes. Particular concern was directed towards the sanitary

quality of these waters for contact and non-contact recreation, as well as their chemical quality for fish and aquatic life.

Water Quality Criteria and Standards Development

One of the key areas of concern in assessing the impacts of urban and rural stormwater associated contaminants is the basis of judging impacts. Frequently, federal water quality criteria and state standards based on these criteria are used for this purpose. However, as discussed below, such use is typically inappropriate. Throughout Drs. Lee's and Jones-Lee's professional careers, they have frequently served as advisors to governmental agencies, industry, and others on the development of water quality criteria, standards, and point source NPDES discharge limits. These efforts have ranged from criteria development for the Corps of Engineers and US EPA to specific review and development of site-specific criteria for a particular discharge into a particular waterbody.

In the 1960's, Dr. Lee served as an advisor to State of Wisconsin's Department of Natural Resources in developing water quality standards for that state. In the early 1970's, Dr. Lee served as a peer reviewer for the National Academies of Science and Engineering "Blue Book of Water Quality Criteria" released in 1973. In the late 1970's, Drs. Lee and Jones-Lee served as members of the American Fisheries Society's Water Quality Panel that reviewed the US EPA's "Red Book of Water Quality Criteria" that was released in 1976. In the early 1980's, Drs. Lee and Jones-Lee served as US EPA peer reviewers for the then-proposed approach for developing the current US EPA water quality criteria. They also served as members of peer review panels for several of the heavy metal criteria that were released in 1984 and that served as the basis for the US EPA's 1986 "Gold Book of Water Quality Criteria."

As part of the US EPA's proposed implementation of the National Toxics Rule, Drs. Lee and Jones provided detailed comments on the inappropriateness of the US EPA's proposed approach for managing toxics in point and nonpoint source discharges (Lee and Jones, 1991b). The Agency's approach has led to gross over-regulation of chemical constituents that are not toxic in the receiving waters from point and nonpoint source discharges. Drs. Lee and Jones-Lee (1994b) point out that the approach that is used by the US EPA in assessing the water quality significance of urban stormwater runoff is not technically valid where an exceedance of a water quality standard is determined to be an impairment of designated beneficial uses of a waterbody. This approach leads to the US EPA providing unreliable reports to Congress and the public on the national significance of urban stormwater as a cause of water quality impairment in the country (US EPA, 1994).

Recently, Drs. Lee and Jones-Lee (1994c,d,e,f) have discussed current problems with the US EPA's approaches of regulating chemical contaminants in ambient waters through the use of exceedances of water quality criteria and state standards based on these criteria as NPDES permit violations. The Agency's Independent Applicability Policy over-regulates discharges from point sources such as municipal and industrial wastewaters and urban, industrial and agricultural stormwater runoff. As discussed by Drs. Lee and Jones-Lee (1994f) it is important to distinguish

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between chemical constituents in stormwater runoff and pollutants, i.e. those constituents that impair the designated beneficial uses of waterbodies. Chemical-specific criteria and standards should be used as indicators of potential problems in receiving waters due to exceedances of the numeric criteria - standard values, not as permit violations as is being done today by federal and state regulatory agencies.

With increasing emphasis on the watershed approach and so-called pollutant trading among point and nonpoint source dischargers, it is important in developing the watershed approach that toxic - available forms of chemical constituents are used in evaluating discharge limits. Any trading of pollutants should be based on those constituents in the discharge (pollutants) that, in fact, adversely impact the designated beneficial uses of the waterbody receiving the discharge. These issues are discussed by Lee and Jones-Lee (1994g,h).

Since moving back to California in 1989, Drs. Lee and Jones-Lee have been active in reviewing the Water Resources Control Board's proposed water quality objectives that were adopted in April 1991. Since their adoption, Drs. Lee and Jones-Lee have worked with a number of governmental agencies and industries on problems with the use of these objectives as a basis for establishing NPDES permitted discharges from municipal, industrial, and rural sources.

Beginning in the 1970's and periodically since that time, Drs. Lee and Jones-Lee have published several professional papers and reports on the appropriate development and use of water quality criteria, standards, and objectives for judging the potential water quality impacts of contaminants from point and nonpoint sources. A list of their recent papers and reports on these topics is available upon request.

Drs. Lee's and Jones-Lee's publications on the use of water quality criteria and state standards - objectives based on these criteria to evaluate potential impacts of point and nonpoint source discharges discuss the inappropriateness of trying to use these criteria and standards - objectives for this purpose. As discussed in these publications, these criteria are typically based on worst-case or near worst-case assumptions in which essentially 100% of available forms of contaminants were used to evaluate under chronic exposure conditions the toxicity of the contaminant to highly sensitive forms of aquatic life. It is indeed rare, if ever, that urban and rural agricultural stormwater discharges - runoff impacts on beneficial uses of receiving waters can be judged by an exceedance of such criteria. Typically stormwater associated contaminants are present largely in non-toxic, unavailable forms. Further, the duration of exposure that aquatic organisms can obtain from stormwater discharges of potential significance to them is usually short compared to the chronic exposure conditions that were used to develop the criteria. While the US EPA and the State of California list one hour maximum values as criteria - objectives which are not to be exceeded more than once in three years, implying that they are applicable to short-term events, in fact, a review of how the one-hour values and frequency of exceedance value were developed shows that they are not reliable for that purpose.

Basically, the chemical approach involving comparison of stormwater runoff associated contaminant concentrations with US EPA criteria and/or water quality objectives that is being used

by the US EPA and the California State Water Resources Control Board to judge impacts of stormwater associated contaminants is technically invalid and overestimates the potential real water quality problems that would occur in receiving waters for such discharges as runoff. While both agencies claim that there are documented widespread occurrences of water quality problems associated with urban nonpoint source discharges, such assertions are technically invalid and unreliable since the basis for their assessment is the exceedance of US EPA water quality criteria and state standards at the point where the stormwater discharge enters the receiving waters. Based on over 20 years of work on evaluating the potential impacts of stormwater associated contaminants on receiving water quality, it has been found by Drs. Lee and Jones-Lee that there are no properly documented cases where urban stormwater associated contaminants from residential and commercial sources are having a significant adverse impact on the water quality of receiving waters as measured by an impairment of the designated beneficial uses for such waters due to toxic chemicals present in the discharges. There are demonstrated water quality problems with combined sewer overflows and with erosion from construction sites. There could be problems from illegal or illicit dumping or discharges of toxic chemicals to storm sewers by industrial and some commercial establishments. However, the typical street runoff from residential and commercial areas which represents a significant thrust of the US EPA's urban stormwater contaminant management program would not be expected to adversely affect the aquatic life and domestic water supply related beneficial uses of receiving waters for the stormwater runoff for those chemicals that would tend to be toxic to and bioaccumulate within aquatic life.

Urban Stormwater Runoff Impacts

As discussed by Lee and Jones (1991c), the focus for toxic chemicals of the federal and state stormwater contaminant control programs should be on the control of illicit and illegal discharges and dumping of contaminants to storm sewers. To require that all the people in the greater Sacramento area spend $27/month per household for the control of a few heavy metals that are primarily derived from street runoff in urban areas is highly inappropriate and a massive waste of public funds in the name of water pollution control which will have little or no benefit on improving the designated beneficial uses of the receiving waters for the stormwater discharges (see Lee and Jones, 1991d).

Based on Lee and Jones-Lee's experience and what would be expected, there are, however, potentially significant eutrophication-related water quality problems associated with stormwater runoff derived contaminants on urban lakes. The high concentrations of nitrogen and phosphorus in such runoff can in some waterbodies represent potentially significant sources of algal and other plant nutrients for small waterbodies that have as their primary source of water urban stormwater runoff. The work done by Dr. Lee and his associates in the 1960's demonstrated that while most of the phosphorus and some of the nitrogen in urban stormwater runoff is not available to support aquatic plant growth, there can be situations in which sufficient amounts are available to cause excessive fertilization of urban lakes. Lee and Jones (1980, 1988) and Jones and Lee (1986) have discussed an approach that can be used to evaluate whether the stormwater associated nutrients are the primary cause of excessive fertilization in an urban lake. These papers also discuss

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approaches that can be used to manage such problems.

Studies of the impacts of urban stormwater runoff on water quality have shown that frequently such runoff contains high concentrations of fecal coliforms arising from dogs and other domestic and wild animals and illegal connections between the sanitary sewers and the storm sewers. Such runoff can cause violations of contact recreation sanitary quality standards. Usually, however, within a few days to a week or two after the runoff event the sanitary quality of an impacted area returns to acceptable levels for contact and non-contact recreation (see Lee and Jones, 1991a).

Lee and Jones (1991d,1992a,b,c) have provided guidance on the approaches that should be used to evaluate the need to control toxic chemicals in urban stormwater runoff to protect designated beneficial uses of receiving waters. Lee and Jones (1991e,1992d) have discussed some of the highly significant problems with the approaches adopted by the State Water Resources Control Board in developing a monitoring program for stormwater discharges from industrial properties. Many of these same problems apply equally well to non-industrial areas.

While Drs. Lee and Jones-Lee advocate the use of bioassays - toxicity testing procedures to evaluate available forms of contaminants in urban stormwater runoff, they point out that the typical toxicity testing procedures used today by regulatory agencies significantly overestimate the real toxicity that will occur within receiving waters for stormwater runoff. As discussed by Drs. Lee and Jones (1991c, 1992a, Lee and Jones-Lee, 1993), it is important that toxicity tests that are used to evaluate potential water quality problems associated with a point or nonpoint source discharge properly mimic the conditions that actually exist for the discharge in the receiving waters. Failure to establish appropriate toxicity testing procedures can lead to the development of contaminant control programs that eliminate toxicity in the stormwater discharge but have no impact on the receiving water quality since the stormwater discharge measured toxicity was not manifested in the receiving waters due to differences in the test conditions compared to receiving water conditions.

Implementation of Stormwater Runoff BMP's

Many of the larger urban areas across the country are now reviewing the need for structural best management practices (BMP's) for urban runoff associated chemical constituents. Jones-Lee and Lee (1994) and Lee and Jones-Lee (1994i) have discussed the approach that should be followed in evaluating the appropriateness of constructing a structural BMP for stormwater runoff contaminant control. They point out that the first step in selecting a BMP should be the finding of a real water quality problem - use impairment associated with the current stormwater runoff. When a problem has been found, then the specific chemical(s) responsible for the use impairment should be determined and, if possible, controlled at the source. If this is not possible, then site-specific structural BMP's should be developed that are designed to remove the chemical(s) that cause the use impairment. It will generally be found that the structural BMP's that are frequently used today such as detention basins, grassy swales, etc. are not effective in developing technically valid, cost-effective approaches for managing real water quality problems

associated with urban stormwater runoff.

Monitoring Stormwater Runoff Quality

Lee and Jones-Lee (1994j) have discussed the inappropriateness of many of the urban stormwater runoff monitoring programs that are being used today in assessing water quality impacts of such discharges. Typically, in these programs a few grab samples of stormwater runoff are taken from a few storm events each year and analyzed for a limited number of potentially significant chemical constituents. This approach provides no reliable information on the impact of the chemical constituents in the stormwater runoff on receiving water quality. Similar problems exist with trying to monitor the efficacy of structural BMP's in which a few grab samples are taken from the influent and effluent of the BMP and the reduction of a chemical constituent(s) is evaluated. This approach is only reliable under conditions where it has been demonstrated on a site-specific basis that the parameters being monitored are, in fact, responsible for impairing the designated beneficial uses of the receiving waters for the discharge from the BMP. The monitoring of particulate contaminant removal in a detention basin is an example of the inappropriateness of current monitoring programs since the particulate forms of contaminants are well-known to be non-toxic and non-available in ambient waters.

A stormwater monitoring program should be based on a site-specific evaluation of the water quality problems associated with a particular runoff source. Lee and Jones-Lee (1992b) have provided guidance on developing site-specific stormwater runoff quality monitoring programs.

Additional information on the qualifications and experience of Drs. Lee and Jones-Lee pertinent to non-point source contaminant evaluation and management is available upon request. Copies of their publications on this topic are available from the authors.

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