Automobile Brake Pad Copper:
Is There a Real Water Quality Problem?

*An Example of an Inappropriate Approach for
Developing a Stormwater Runoff Source Control BMP*

G. Fred Lee, Ph.D, P.E., D.E.E. and Anne Jones-Lee, Ph.D.

Report of
G. Fred Lee & Associates
El Macero, CA 95618
(916) 753-9630 www.gfredlee.com

June 1996

With the implementation of the US EPA national NPDES urban stormwater runoff water quality management program in 1990, stormwater managers in urban areas in many parts of the US have begun to monitor urban area and highway stormwater runoff for a variety of chemical constituents and pathogenic organism indicators. These studies are confirming the findings of similar types of monitoring efforts that were conducted in the 1960's as well as the US EPA's National Urban Runoff Program (NURP) studies conducted in the late 1970's and early 1980's that urban stormwater runoff contains elevated concentrations of a variety of chemical constituents that are of potential concern because of toxicity to aquatic life.

It has been known since the 1960's that several heavy metals, such as copper, lead, zinc and cadmium, are present in urban area street and highway runoff at concentrations that exceed US EPA water quality criteria/state standards in the runoff waters. These exceedances, therefore, could be considered "water quality impairments" under current federal and state regulatory requirements where the exceedance of a water quality standard in ambient waters for an NPDES permitted discharge is labeled, albeit inappropriately, a "use impairment" that requires control.

In the early 1990's, the state of California Water Resources Control Board and its regional water quality control boards worked with major urban stormwater dischargers (with populations greater than 100,000) to develop early, compared to most of the rest of the country, stormwater runoff NPDES permits. This situation has led to the development of data from a number of stormwater runoff monitoring programs. These programs have demonstrated that copper and several other chemical constituents are present in urban and highway stormwater runoff at concentrations above water quality standards in the South San Francisco Bay area. The Bay has been found to contain both total and dissolved copper concentrations above the site-specific copper standard (called "objective" in California) developed by the San Francisco Bay Regional Water Quality Control Board. This situation has led to the Bay being classified as "water quality limited" and has, in accord with current regulations, caused the regulatory agencies to develop the wasteload allocation for copper and Total Maximum Daily Loads (TMDL's) for the various sources of copper to the Bay.

All of this was done without determining whether the copper in the stormwater runoff, wastewater discharges and other sources are in toxic - available forms, i.e. could impair the aquatic life-related beneficial uses of the San Francisco Bay waters due to the toxicity of copper which the

water quality criterion/standard is designed to protect. Those familiar with the elements of aquatic chemistry, aquatic toxicology and water quality know, however, that it is highly unreliable to assume, as was done in the South San Francisco Bay TMDL development, that all sources of copper are in toxic forms and that these toxic forms from each of the sources remain toxic in South San Francisco Bay waters. Such an assumption ignores what has been well-known about the chemistry and toxicology of copper since the 1960's, namely that copper and many other potentially toxic chemical constituents exist in ambient waters in a variety of chemical forms, only some of which are toxic - available and therefore could impact water quality-related beneficial uses of a waterbody.

When the exceedance of the copper standard was found in South San Francisco Bay, those responsible for the POTW's which discharged to South San Francisco Bay pooled their resources to develop a site-specific water quality copper standard (objective) for the Bay. Also, the San Francisco Regional Water Quality Control Board (SFRWQCB) independently developed a site-specific water quality standard (objective) for copper. Both groups used the guidance provided by the US EPA involving the development of a water effects ratio for copper in a toxicity test using a reference solution. This was compared to the toxicity of a toxic - available form of copper added to San Francisco Bay Waters that was used in a toxicity test. The ratio of the toxicity found in the reference solution was compared to the toxicity found in San Francisco Bay waters. This ratio then was used to adjust the national water quality criterion for copper of 2.9 μg/L to develop a site-specific water quality objective for copper.

The dischargers' site-specific standard was judged to be unreliable by the regulatory agencies since they had chosen to use insensitive aquatic organisms for the testing. The Regional Board's site-specific standard raised the standard from 2.9 μg/L to 4.9 μg/L. However, both the total and dissolved copper in South San Francisco Bay routinely exceed the 4.9 μg/L site-specific standard. It is not uncommon to have concentrations of 10 to 15 μg/L total and sometimes dissolved copper based on the methods used for measurement of dissolved copper which typically measure some of the particulate forms of copper present in the water.

The basic problem with the attempt to develop a reliable site-specific water quality criterion for copper is that the US EPA's water effects ratio adjustment of the national water quality criterion does not properly account for the aquatic chemistry of copper from various types of sources and their respective toxicologies. This results in a situation where the water effects ratio does not adequately and reliably adjust for the aqueous environmental chemistry of copper. Further, it assumes that equilibration takes place between the copper added in a highly toxic form in the test system and what has occurred and will occur in South San Francisco Bay waters over extended periods of time. Such equilibration will not occur except possibly after very long periods of time.

In accord with the wasteload allocation and TMDL's, the urban stormwater dischargers of copper were required to reduce the copper loads of their runoff discharge waters by 20%. This requirement has led to the stormwater dischargers to the Bay conducting studies to determine the sources of the copper in the urban stormwater runoff. Woodward-Clyde Consultants in 1994 conducted a study of heavy metals in stormwater runoff for the Santa Clara Valley Nonpoint Source Pollution Control Program where it found that some automobile brake pads contained high

concentrations of copper. It is estimated today that about 35% of the total copper in stormwater runoff from urban streets and highways in the South San Francisco Bay region is derived from automobile brake pads.

Common Ground for the Environment in Palo Alto, California has recently initiated an effort to "voluntarily" have the auto brake pad manufacturers and users terminate the use of copper in their brake pads. Common Ground for the Environment is part of Sustainable Conservation of San Francisco. This organization has as its stated objective the development of voluntary partnership between industry and public agencies for addressing environmental problems of this type. Common Ground for the Environment and the City of Palo Alto, California have developed a "briefing packet" (Common Ground, 1996) which is purported to provide background information on the copper brake pad water quality of South San Francisco Bay issues. Appended to these comments are comments specifically addressing parts of the briefing packet that do not adequately or reliably provide appropriate information on the automobile brake pad copper water quality problems in South San Francisco Bay.

A review of this briefing packet shows that its authors assumed, without proper evaluation, that there is a real, significant water quality problem in South San Francisco Bay due to concentrations of copper above the water quality standard (objective) and that this problem could, in some way, be addressed by having the automobile brake pad manufacturers and users terminate the use of brake pads that contain copper. While Sustainable Conservation and Common Ground for the Environment seem to have appropriate objectives in mind in terms of having industry and others work cooperatively to address real water quality environmental problems associated with the development and use of products, the basic premise underlying their brake pad copper control efforts is flawed in that it assumes that an exceedance of a water quality standard represents a real, significant water quality use impairment that requires correction through the control of copper input to the Bay.

Water Quality Considerations

Thus far, the advocates of curtailing the use of copper in auto brake pads have failed to conduct a critical, reliable assessment of the real water quality problems caused by copper in brake pads. Those who understand aquatic chemistry, toxicology and how the water quality criteria for copper were developed and implemented know that in many, if not most, marine situations copper in urban area street and highway stormwater runoff is in a non-toxic form, and it remains non-toxic in the ambient waters receiving the runoff. The same applies to POTW discharges of copper under conditions where the large-scale dumping of copper to the sewerage system by industry is under control through the pre-treatment program. It is highly unlikely under those conditions that the residual copper derived from such sources as its use in domestic water supply reservoirs for algae control, corrosion of copper pipes in municipal water supply systems and other sources that can cause copper to be present in low concentrations in treated domestic wastewaters would result in copper being in a chemical form in the wastewater discharges that are significantly toxic to aquatic life in South San Francisco Bay or similar situations. This conclusion has been borne out by studies that have been conducted on the toxicity of South San Francisco Bay waters by the San Francisco Estuary Institute of Richmond, California (1994, 1995). The briefing packet which Common Ground for the

Environment and the City of Palo Alto prepared on the copper brake pad issue failed to mention and discuss these studies, much less consider them in their assessment of the copper problem in South San Francisco Bay.

After three years of extensive monitoring of the South Bay for ambient water toxicity using several highly sensitive forms of aquatic life including the larval forms of *Mytilus edulis* it has been found that these waters are non-toxic. The lack of toxicity to *Mytilus* larvae is particular significant since it was this organism that was primarily responsible for establishing the US EPA national water quality criterion for copper at 2.9 µg/L. This situation raises the question of where is the problem that is caused by the exceedance of the copper site-specific water quality objective in the Bay waters? Since using several highly sensitive aquatic organisms in toxicity tests reveals no toxicity, it has to be concluded that the problem is "administrative" related to the approach that has been adopted by the US EPA and the state of California in administering the water quality criteria/standards program.

Of particular concern is the US EPA Independent Applicability Policy which requires that the chemical-specific water quality criterion/standard must be met for potentially toxic chemicals even when it is adequately demonstrated that the ambient waters are non-toxic. As discussed by Lee and Jones-Lee (1995a,b) this policy was adopted without adequate public review to ease implementation of the water quality criteria for potentially toxic chemicals. It is obviously technically invalid. It also reflects the fact that the US EPA's water effects ratio correction/adjustment approach does not adequately account for the aqueous environmental chemistry of copper and, for that matter, other constituents in ambient waters.

Need to Remove Copper in Auto Brake Pads

The results of the toxicity testing of South San Francisco Bay waters are expected, i.e. no toxicity, based on the aqueous environmental chemistry of copper in stormwater runoff and Bay waters. This copper would not be expected to be toxic. Also, the copper in auto brake pads would not be expected to be in a toxic form and would not be expected to become toxic in estuarine and marine waters or in their sediments. Copper, like many other metals and some other chemicals, exist in aquatic system sources and ambient waters in non-toxic, non-available forms and would not be converted to toxic, available forms in the environment under the conditions that exist in South San Francisco Bay. Estuarine and marine waters are well-known to have significant abilities to detoxify copper should it enter these waters in a toxic form or to detoxify any copper that is converted from non-toxic to toxic forms through precipitation, adsorption and complexation reactions. The authors have conducted a comprehensive review of the literature on the chemistry and toxicology of copper in estuarine and marine waters and sediments and found that it is indeed rare that significant toxicity occurs due to elevated concentrations of copper in such waters (Lee and Jones, 1991).

Redirected Efforts

Common Ground for the Environment, the City of Palo Alto and Sustainable Conservation are involved in a misdirected effort that is based on a flawed evaluation of the water quality significance of copper in urban stormwater runoff. Rather than continuing to try to have auto brake

pad manufacturers and users remove copper from the brake pads, Common Ground for the Environment *et al.* should direct their resources, energy and efforts to controlling real water quality problems - use impairments that are not now being controlled. An example of a problem of this type is the aquatic life toxicity caused by organophosphorus pesticides, such as diazinon and chlorpyrifos.

Urban stormwater dischargers as well as others such as the Central Valley Regional Water Quality Control Board's staff (C. Foe and V. Connor) in Sacramento, California have found that stormwater runoff from many urban areas in California and some other parts of the US contain diazinon at sufficient concentrations to be toxic to zooplankton. Further, for several weeks each year stormwater runoff from large areas of northern California is highly toxic to zooplankton due to diazinon and chlorpyrifos. This toxicity is associated with the use of these chemicals as a dormant spray in orchards where, in addition to stormwater runoff from these areas, there is significant atmospheric transport for considerable distances of the applied organophosphorus pesticides which becomes incorporated into rainfall and fogfall which causes runoff waters from large areas at considerable distances from where the pesticides are applied to be toxic.

Kuivila and Foe (1995) have reported pulses of high levels of acute toxicity and diazinon that have been traced through the Sacramento - San Joaquin River system and the Sacramento - San Joaquin Delta into upper San Francisco Bay. The amount of toxicity is such to be significantly adverse to zooplankton and epibenthic organisms which, in turn, would be adverse to fish and other forms of aquatic life which utilize these organisms as a source of food. 1995 studies by the San Francisco Estuary Institute have independently found diazinon toxicity in the upper parts of San Francisco Bay that is apparently related to the use of diazinon as a dormant spray in orchards during the winter.

For political reasons, water quality criteria - standards for diazinon have not been developed by the US EPA and state of California, despite the fact that the information necessary for developing such criteria - standards has been available for a number of years. Agricultural interests are sufficiently powerful to cause the federal and state administrations to not proceed with developing effective regulatory approaches for the control of the use of these chemicals, even though there is ample evidence that they are highly adversely significant to aquatic life in northern California and possibly elsewhere. The Sacramento - San Joaquin Delta system has listed endangered fish species and several others that are in the process of being listed due to their low populations. It is possible that the endangered species are being adversely impacted by the diazinon, chlorpyrifos and other organophosphorus pesticides that are present in tributaries to and within the Delta waters.

The magnitude of the toxicity that is being found in urban stormwater runoff and in the ambient waters of northern California each winter and spring is such that if it was associated with a discharge by a POTW, the owner-operator of the POTW would be fined and possibly incarcerated for violating water pollution control regulations set forth in an NPDES permit. However, agricultural interests have been able to block legislation at the federal and state levels from developing approaches for controlling the pollution of the environment, both surface and groundwaters, from agricultural use of chemicals and activities, with the result that agriculture is largely exempt from water pollution control. Agricultural activities can and do discharge large amounts of toxic materials to surface

waters and groundwaters without being regulated other than through the registration of the chemicals at the federal and state levels. This registration process, however, falls far short of adequately and reliably evaluating the potential environmental impacts of chemicals on surface water and groundwater beneficial uses.

While there is no question that the use of diazinon and other organophosphorus pesticides on agricultural fields has, for over 30 years, been causing and continues to cause widespread aquatic life toxicity that is detrimental to aquatic life populations, the urban use of diazinon in and around homes which results in aquatic life toxicity in the runoff water has not been found to generally cause significant water quality problems in the receiving waters. In many situations, the urban-derived diazinon would be rapidly diluted in the receiving waters and could result in a dissipation of the toxicity near the point of discharge. An exception to this would be in urban creeks or lakes where the flow into them during a runoff event is predominantly stormwater runoff. Under this condition, the diazinon toxicity found in stormwater runoff could be adverse to aquatic life in the creek or other urban or near-urban waterway or waterbody. There are situations of this type in the San Francisco Bay area (Alameda County) that could require the control of urban use of diazinon because of its toxicity to aquatic life.

Common Ground for the Environment and Sustainable Conservation could and should redirect its efforts to the organophosphorus pesticide problems where there are well-documented adverse impacts of agricultural chemicals and pesticides used in urban areas on aquatic life. Such a redirected effort would result in these organizations directing their efforts to the solution of real water quality problems, rather than the copper problem which is an administrative problem related to how the water quality criterion and standard for copper is developed and implemented.

Removal of Copper from Brake Pads as a Pollution Prevention Activity

While some may argue that copper in brake pads should be removed even if no real water quality use impairment can be found or is expected, as part of a pollution prevention effort in order to reduce the copper content of stormwater runoff. It is possible that there may be some yet unidentified water quality problem due to copper present in stormwater runoff which in the future would require controlling copper inputs to San Francisco Bay. The adoption of this approach would necessitate the development of a significantly different water pollution control program than exists in the US today. Instead of basing water pollution control programs on protection of designated beneficial uses through achieving appropriately developed water quality standards in the ambient waters, the development of a water pollution control program based on the fact that every chemical in stormwater runoff and wastewater discharges is potentially adverse because of some unknown impact that has not now been identified would be directed toward zero chemical constituent discharge rather than zero pollutant discharge. Pollutants are recognized as those constituents that impair the designated beneficial uses of waterbodies. The basis of the current US water pollution control program is the control of **pollutants**, not the control of all chemical constituents, irrespective of whether there is an adverse impact in the receiving waters for the discharges. Developing water pollution control programs based on the control of chemical constituents because they might cause some yet unidentified problem

would assume that there is no safe concentration of chemicals in ambient waters and that every chemical present in any amount in waters would be a threat to water quality that should be controlled.

Zero chemical discharge, if achieved, would result in distilled water being discharged to the nation's waters. The nation's water pollution resources would be directed under the distilled water discharge scenario to regulating all the regulated and many thousands of unregulated chemicals that could at some time in the future be found to be adverse to aquatic life or some of the other uses of water. It is important to understand that the closer that a distilled water discharge from stormwater runoff would be achieved, the closer a highly toxic environment would be created. Distilled water itself would be highly toxic to many forms of aquatic life. Aquatic life needs small concentrations of many chemicals for their survival. Obviously, this country's water pollution control programs should be based on the best possible science and appropriate goals where the funds available for water pollution control focus on utilizing today's information on aquatic chemistry and toxicology to define what is a real toxicant that is significantly adverse to the beneficial uses of waterbodies.

With the limited financial resources available today, it is mandatory that these funds be used to control real water pollution that causes discernible use impairment of the highest priority to the public. The "do-gooder" approach such as those of Common Ground for the Environment and Sustainable Conservation with respect to the copper brake pad stormwater runoff issues should not be implemented. If this group is seriously concerned about water quality issues associated with stormwater runoff, then it should devote its energies and resources to trying to find real water quality use impairments in waterbodies, such as South San Francisco Bay, that would be considered significant to the beneficial uses of the Bay's waters for aquatic life propagation and other purposes.

Implementation of Technically Valid Stormwater Runoff Water Quality BMP's

The Common Ground for the Environment, Sustainable Conservation, City of Palo Alto copper brake pad water quality situation is an example of a stormwater runoff water quality source control BMP gone awry. It is now becoming more widely recognized that many of the BMP's that are in the various BMP manuals for so-called stormwater quality management are not real BMP's, i.e. approaches that control water quality in the receiving waters for the stormwater runoff. Real water quality should be tied to the beneficial uses of a waterbody of concern to the public who must ultimately pay for their implementation and maintenance.

Since there are significant limitations on the amount of funds that the public will spend in water pollution control efforts, it is essential that the most significant, real water quality use impairment be addressed first with the funds available. Unfortunately, as with the case of diazinon, political considerations, such as the agricultural lobby, are able to disrupt a technically valid approach for prioritization of water quality use impairments. Groups like Common Ground for the Environment and Sustainable Conservation should use their energy and resources to eliminate the ability of groups like agricultural interests to avoid the regulation of toxicants in agricultural runoff and groundwater infiltration. Adopting this approach could, in the long run, be a highly significant step towards addressing real water quality use impairments that are not now being addressed in stormwater runoff.

At this time, major efforts are being made in the US at the federal, state and local levels to implement at watershed-based water quality management program where water pollution would be controlled throughout the watershed. These efforts will fail in those watersheds where there is any significant agriculture as long as agricultural interests are able to effectively block regulating the discharge of toxic or otherwise deleterious chemicals to the atmosphere, surface runoff and to groundwaters.

Today's laundry lists of BMP's for stormwater runoff include such approaches as detention basins, filters, grassy swales, etc. A critical review of the ability of these systems to cause an improvement in the real water quality of the receiving waters for stormwater runoff shows that they, in many instances, are of limited to no benefit in addressing real water quality use impairments (Jones-Lee and Lee, 1994 and Lee and Jones-Lee, 1995c).

Control of Particulate Forms of Copper in Stormwater Runoff

The standard practice that has been followed for a number of years since stormwater runoff water quality issues have begun to be addressed is to construct a detention basin to remove constituents from the runoff waters. A critical review of detention basins, however, shows that they remove some of the particulates in stormwater runoff. As discussed by Lee and Jones-Lee (1996) who have recently reviewed the validity of using detention basins as a stormwater runoff water quality BMP, detention basins could be an appropriate BMP if siltation, i.e. accumulation of sediment, in the receiving waters is a major water quality use impairment in the waterbody. It is rare, however, that siltation is a significant water quality problem from established areas, i.e. those that are not rapidly eroding, such as existing highways, urban area streets, etc. However, to justify construction and operation of a detention basin for removal of particulate heavy metals and organics is highly inappropriate since the particulate forms of these constituents are in non-toxic, non-available forms and are likely to remain so in the receiving water for the stormwater runoff (Jones-Lee and Lee, 1994).

Similar situations exist with respect to various types of filters which are designed to remove particulates. Unless the particulates they are removing cause real, significant water quality problems in the receiving waters for the runoff, then filters are not a real BMP for stormwater runoff, but simply an expensive approach that misdirects (wastes) public and private funds that fails to address the real problems associated with stormwater runoff that may be occurring in an area. These problems will be due, in most cases, to chemicals in dissolved forms. Even dissolved forms must be in a toxic - available form in order to be adverse to aquatic life-related beneficial uses.

Particulate forms of constituents such as particulate copper that accumulate in receiving water sediments should be regulated based on sediment quality evaluations (Lee & Jones-Lee, 1993). It is inappropriate to try to regulate these forms based on their presence in runoff waters unless it has been demonstrated on a site-specific basis that they do, in fact, cause adverse impacts on the receiving waters due to the presence of chemicals associated with the particulates.

Control of Unknown Problems Due to Copper

There are some in the San Francisco Bay region who claim that they are finding adverse effects of copper to some forms of aquatic organisms that inhabit San Francisco Bay sediments. However, this information has been reviewed by the regulatory agencies and others and is not adequate to justify the development of a program to control copper based on it.

An issue of particular concern in this regard is copper in sediments of San Francisco Bay. Studies by the SFRWQCB (1994) have investigated the copper concentrations in the sediments of the Bay and the associated toxicity. From the information available, it was found that the copper concentrations in San Francisco Bay sediments are typically less than crustal abundance. Further, the studies on the toxicity of the sediments do not indicate that copper present in the sediments is the cause of the toxicity where it is found. San Francisco Bay and neighboring bays' sediments, like many aquatic sediments, have been found to be toxic to aquatic life. This toxicity is due to a variety of constituents, some of which are of natural origin such as low dissolved oxygen, hydrogen sulfide and ammonia. Further, there is toxicity in sediments of the Bay region which are in "pristine" reference areas. This pristine area toxicity is certainly not due to copper; its cause is unknown at this time.

Another factor to consider is that copper in San Francisco Bay sediments would not be expected to be toxic. Particulate copper in sediments is well-known to be highly detoxified by a variety of chemical reactions. Therefore, at this time after fairly intensive study, it can be concluded that there is no justification for controlling copper in stormwater runoff arising from brake pads or, for that matter, other sources based on the accumulation of copper in the South San Francisco Bay or other receiving water sediments.

There may be situations such as in low alkalinity fresh waters that have a low pH where copper in stormwater runoff and from other sources would be adverse to aquatic life through toxicity. These are waters and sediments which have a low ability to detoxify copper. They are certainly not marine waters nor would they be expected to be hard water - freshwater systems. They would also be waters that have very low organic content.

Development of Stormwater Runoff BMP's

Because of the very high cost of properly treating stormwater runoff from urban areas and highways to remove dissolved forms of constituents where they are found to cause real water quality use impairments in the receiving waters for the stormwater runoff, it is likely that the BMP's that will be developed for urban area and highway stormwater runoff as well as rural stormwater runoff will be devoted to developing controls for the use of the chemicals (source control) responsible for the dissolved form. Again, it is important not to mechanically assume, as is sometimes being done today, that all sources of copper or, for that matter, other constituents cause or lead to toxic - available forms. Each source likely contributes the toxic - available form to a different degree than other sources. Therefore, even in source control it is important to understand the aquatic chemistry and toxicology

of the constituents in the source that can lead to the toxic forms in the receiving waters for the runoff that significantly impair the use of these waters.

It is important not to make the mistake that was made by Common Ground for the Environment, Sustainable Conservation and the City of Palo Alto in attempting to develop a source control BMP for copper in stormwater runoff, which assumed that the copper in the runoff that arises from its use in automobile brake pads is a significant cause of real water quality use impairment of concern to the public who must ultimately pay for the substitution of copper by another material and potentially experience the adverse impacts of this substitution. Common Ground for the Environment *et al.* argue in their briefing packet that since other automobile brake pad manufacturers are able to develop brake pads without copper and have them function satisfactorily in providing braking action for automobiles, that copper can be removed from brake pads without adverse impacts on the environment. This approach is naive and reflects a lack of knowledge of the current understanding of the water quality impacts of non-copper chemical constituents in brake pads.

The composition of brake pads either in the original materials or in the form that would be deposited in highways due to braking action after being heated to significantly elevated temperatures is largely unknown. Further, the aquatic chemistry - toxicology and therefore water quality impacts of these materials is also unknown. Today, only about 100 to 200 chemicals out of the 60,000 chemicals that are in commerce are regulated to any significant degree. There are many thousands of chemicals that could be present in brake pads originally and after use that could be deposited on the highway or street where either alone or in combination with other constituents could be adverse to aquatic life or other beneficial uses of a waterbody. Who can be certain that there is not a new unknown "dioxin" in the materials that wear from brake pads that would be a significant threat to public health and the environment? The removal of copper from brake pads could readily result in increasing the concentrations of the new "dioxin" and thereby, in the long-run, be strongly detrimental to public health and the environment. Dioxin is used here as an example of a chemical that has been present in the environment for very long periods of time from natural as well as anthropogenic sources. This chemical is known to be highly hazardous to aquatic life and man. It is now well-recognized that dioxins are formed through combustion processes such as lightning-caused forest fires.

Caution must be exercised in recommending that one product which has been studied extensively (copper) and at least in the South San Francisco Bay situation has not been found to be adverse to the beneficial uses of the Bay waters be replaced by a chemical or group of chemicals that substitute for copper that have not been evaluated with respect to their full range of potential impacts on public health and the environment. Such attempts to tinker with the environment through substituting other chemicals for copper in brake pads should only be done after real water quality problems have been identified in the receiving waters for the runoff due to the use of copper in brake pads and it has been found that products that are being used to replace copper are, after careful evaluation, are safe for the environment and the public.

Conclusions

Common Ground for the Environment, Sustainable Conservation and the City of Palo Alto have developed a "Brake Pad Partnership" that would involve having those automobile brake pad manufacturers and users "voluntarily" remove copper from the brake pads. While the program is now indicated as voluntary, there is little doubt that if manufacturers are not coerced into removing copper from their brake pads that they would be forced to do so through legislation. This program, however, is based on a fundamentally flawed approach of assuming that the copper in automobile brake pads is significantly adverse to the designated beneficial uses of South San Francisco Bay waters, and for that matter, the country as a whole. However, Common Ground *et al.* have failed to become familiar with and/or reliably report on the extensive toxicity studies that have been conducted on South San Francisco Bay which show that the exceedance of the water quality standard (objective) for copper does not represent the development of aquatic life toxicity to the larval forms of the aquatic organisms that were primarily used to establish the copper national water quality criterion/standard.

The facts are that there is no aquatic life toxicity problem in South San Francisco Bay that at this time would justify further control of copper or, for that matter, any other chemical constituents entering the Bay that are potentially toxic to aquatic life. The excessive concentrations of copper in South San Francisco Bay are due to "administrative" exceedances of the overly-protective water quality criterion/standard (objective) that has been developed by the US EPA and the state regulatory agencies. There is an urgent need for the US EPA to abandon the ill-conceived Independent Applicability Policy which mandates that copper loads to San Francisco Bay must be reduced to achieve the water quality standard/objective for the Bay for a potentially toxic chemical, such as copper, even though appropriately conducted toxicity tests show that the copper is in a non-toxic, non-available form.

The removal of copper from automobile brake pads could be adverse to the environment through the introduction of substitute materials. At this time, it is not possible to rule out that the non-copper components of brake pads are adverse to aquatic life and public health through some yet unidentified component. At least with copper, its impacts have been fairly intensively studied. For the other components of brake pads, there have been no studies to specifically address whether these components, after being eroded from brake pads through braking action, cause adverse effects to aquatic life and terrestrial life, including humans.

Common Ground for the Environment and Sustainable Conservation should direct their efforts to controlling real water quality problems to those situations where such problems have been found. There are such problems in the San Francisco Estuary (Sacramento - San Joaquin River system and the upper parts of the Bay) where real, significant water quality, aquatic life toxicity problems occur every winter due to the use of organophosphorus pesticides as a dormant spray in orchards. While these problems have been known for many years, for political reasons related to the power of the agricultural lobby, ineffective regulatory approaches have been adopted at the federal and state levels which would control the significant aquatic life toxicity associated with the current use of organophosphorus pesticides. This is an area that Common Ground *et al.* should address.

If Common Ground *et al.* wish to persist with their auto brake pad copper water quality program, they should redirect this program to finding real, significant widespread water quality problems that are directly attributable to copper in auto brake pads. If such problems are, in fact, found, then, and only then, should efforts be made to replace the copper in the brake pads with some other material. This replacement should only occur after it has been adequately and reliably evaluated to be certain that it does not cause significant water quality problems in the nation's waters, otherwise, the unintentional impacts of the product substitution could be adverse to the public's interests.

Acknowledgements

The authors wish to acknowledge the assistance of Richard Watson of Richard Watson Associates of Mission Viejo, California and Scott Taylor of Silverado-RBF of Irvine, California for their review and comments on this paper.

References

Common Ground for the Environment and City of Palo Alto, "Copper, Brake Pads, & Water Quality: Briefing Packet," Sustainable Conservation, San Francisco, CA (1996).

Jones-Lee, A., and Lee, G. F., "Achieving Adequate BMP's for Stormwater Quality Management," Proc. 1994 National Conference on Environmental Engineering, "Critical Issues in Water and Wastewater Treatment," American Society of Civil Engineers, New York, NY, pp. 524-531, July (1994).

Kuivila, K.M and Foe, C.G., "Concentrations, Transport and Biological Effects of Dormant Spray Pesticides in the San Francisco Estuary, California," Environmental Toxicology and Chemistry, 14(7):1141-1150 (1995).

Lee, G.F. and Jones, R.A., "Overview Aquatic Life Risk Assessment Copper-Contaminated Sediments at National City Marine Terminal," Submitted to San Diego Unified Port District, San Diego, CA 8pp, July (1991).

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, (1993).

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 (1995a).

Lee, G.F. and Jones-Lee, A., "Appropriate Use of Numeric Chemical Water Quality Criteria," Health and Ecological Risk Assessment, 1:5-11 (1995b).

Lee, G. F., and Jones-Lee, A., "Stormwater Runoff Management: Are Real Water Quality Problems Being Addressed by Current Structural Best Management Practices? Part 1," Public Works, 125:53-57,70-72 (1994). Part Two, 126:54-56 (1995c).

Lee, G.F. and Jones-Lee, A., "Evaluation of the Water Quality Significance of Eroded Suspended Sediment-Associated Constituents," Land and Water, 40:19-23 (1996).

San Francisco Estuary Regional Monitoring Program, "San Francisco Estuary Regional Monitoring Program for Trace Substances, 1993 Annual Report," San Francisco Estuary Institute, Richmond, CA (1994).

San Francisco Estuary Regional Monitoring Program, "San Francisco Estuary Regional Monitoring Program for Trace Substances, 1994 Annual Report," San Francisco Estuary Institute, Richmond, CA (1995).

SFRWQCB, "San Francisco Estuary Pilot Regional Monitoring Program: Sediment Studies," San Francisco Bay Regional Water Quality Control Board, Final Report, July (1994).

Comments on
Common Ground for the Environment - Sustainable Conservation - City of Palo Alto "Briefing Packet" Devoted to Brake Pad Copper Issues in South San Francisco Bay

G. Fred Lee, Ph.D, P.E., D.E.E. and Anne Jones-Lee, Ph.D.

In the cover letter for the "Briefing Packet," Common Ground for the Environment states in the first paragraph, *"In the 1980's, the U.S. Environmental Protection Agency and state agencies across the nation began to address water pollution from copper and other toxic metals as a top priority."* Actually, the issue of water pollution from metals began to be addressed as a top priority in the 1960's. The National Academies of Science and Engineering, as part of developing their "Blue Book of Water Quality Criteria" released in 1973, specifically addressed the issue of toxicity of metals and how to properly regulate metal discharges. NAS/NAE reported then that these discharges should be regulated based on toxicity, not chemical concentrations. The US EPA, in the early 1980's, chose to ignore the recommendation of the Academies' expert panels and changed its regulatory program to focus on the total concentrations of metals rather than on the toxic - available forms, even though it was well-known ten years earlier that total concentrations are not reliable predictors of potential water quality impacts, such as aquatic life toxicity.

In this same paragraph, Common Ground states, *"To realize further significant gains in water quality, regulatory agencies, industry, and environmental organizations are broadening their attention to water pollution from nonpoint sources."* First, from a regulatory perspective, stormwater runoff from urban areas and highways is treated as a point source, not a nonpoint source. Second, the words, "water quality" quoted above, should be replaced by "water quality objective." There are significant problems with trying to relate exceedance of water quality objectives to real water quality issues - use impairments of concern to the public.

The statement is made in the second paragraph, *"Copper pollution is a nationally significant problem occurring in major water bodies such as: the Chesapeake Bay, the Delaware Estuary, New York-New Jersey Harbor, and the San Diego Bay."* This statement is a significant distortion of the real situation. The authors have worked on several of these bays and are familiar with the real situation; copper is not a water quality problem in these bays which adversely impacts the beneficial uses of the waterbodies.

In the third paragraph, it states,

> *"Common Ground for the Environment is requesting your support and participation in convening a national Brake Pad Partnership. The goal of the Partnership is to identify and implement a voluntary, business solution to reduce the levels of copper entering water bodies from brake pads."*

The basic problem is that Common Ground has relied on inappropriate information in assessing the water quality significance of copper from urban stormwater runoff as well as brake pads.

In the "Briefing Packet" section labeled, "Why Is Copper a Problem?" the authors of this section have failed to properly distinguish between "pollutant" and "chemical constituent." "Pollutants" are constituents that impair beneficial uses. There is no evidence after extensive study that copper in urban stormwater runoff, and certainly not in San Francisco Bay, is a pollutant. If Common Ground *et al.* had properly evaluated this issue, they would have found that toxicity tests using algae and shellfish larvae, which they claim are extremely sensitive to small concentrations, has shown that copper and all other constituents in South San Francisco Bay are in a non-toxic form.

In the second paragraph of this section, the authors have misused the word, "standard." The US EPA develops "criteria," not "standards." Standards are developed at the state level. The US EPA criteria are guideline values that indicate potential problems under worst-case conditions; they should not be used as an absolute concentration maximum above which there is harm. Those who understand how criteria - standards are developed and implemented know that they tend to grossly over-regulate copper since only a small part of the copper in total as well as dissolved forms is actually toxic. This issue has recently been discussed by Lee and Jones-Lee (1995b).

With respect to the third paragraph in this section, it is stated that the San Francisco Regional Water Quality Control Board has adopted a requirement that all dischargers reduce their copper discharge to the Bay by an average of 20%. Common Ground *et al.* should have checked into the technical basis for that 20%. It was not developed based on a finding that a 20% reduction would achieve the water quality objective for copper in San Francisco Bay. It has no relationship to any real water quality use impairment problems due to the copper in the Bay.

In the section, "Report Summary," it is indicated that Woodward-Clyde Consultants (1994) in a study conducted for the Santa Clara Valley Nonpoint Source Pollution Control Program found that copper is present in some automobile brake pads and that this could lead to on the order of 35 percent of the copper in urban stormwater runoff. This means that most of the copper in urban stormwater runoff is from other sources.

If there was a real water quality problem due to copper in urban stormwater runoff, it would be appropriate to find out where most of the copper is coming from rather than focusing only on auto brake pads as a cause of copper-related water quality problems in the Bay. Further, in making this evaluation it would be very important to determine whether there are significant differences in the toxic - available forms of copper from the various sources. It is highly likely that this will be the case. The focus on auto brake pads should only be done after it has been found that the copper derived from this source is in a toxic - available form that adversely affects the designated beneficial uses of the Bay waters. It could readily be that even if there were a copper toxicity problem in South San Francisco Bay that auto brake pad-derived copper does not contribute to this problem.

In the "Briefing Packet" component labeled, "How Can We Reduce the Amount of Copper in Brake Pads?" it is stated in the second paragraph, *"The Brake Pad Partnership can become a model for addressing other pollutants identified through regulatory programs."* Hopefully, this prediction will not be fulfilled. The Brake Pad Partnership is not based on a proper evaluation of the water

quality problems that are caused by copper from brake pads. The first step in developing a technically valid program for control of a pollutant is to find out what problem is to be solved. If the problem is excessive concentrations of copper based on overly-restrictive water quality standards (objectives), then this is an administrative problem that can best be solved by correcting the inappropriate regulatory approach rather than as Common Ground *et al.* are pursuing, supporting an inappropriate approach which can readily lead to a waste of public and private funds and possibly lead to an impaired environment.

On the second page of this section, in the last bulleted item, it states as an objective,

"Improve understanding of the relationship of copper released from brake pads to toxicity in aquatic ecosystems. Past, current, and future studies can provide a more detailed understanding of the relationship of brake pad copper releases to water quality and effects on aquatic ecosystems."

This is one of the action items listed by Common Ground *et al.* in its "Briefing Packet." This activity should have been the first phase of the current program rather than adopting a program that calls for the removal of copper from auto brake pads before a real water quality problem has been found due to this copper.

The logical approach that should be followed in a situation like this is to find a real water quality use impairment in the receiving waters for the discharge, determine the specific cause of the use impairment, i.e. what chemical and what forms are responsible for it, and determine the specific sources of those forms of the chemicals responsible. Then develop a control program for the specific constituents that cause the problem. The mechanical, brute force approach that is being used by Common Ground *et al.* is a very poor example of how this process should be implemented.

In the "Briefing Packet" component labeled "Chronology: Water Pollution and Brake Pads," there are a number of aspects of the bulleted items in this so-called chronology that need to be explained. For example, in the first bulleted item, where it states, *"The California State Water Resources Control Board lists South San Francisco Bay as an impaired water body, under Section 304 (l) of the Clean Water Act..."* this listing is a mechanical listing arising from the fact that the concentrations of certain constituents such as copper exceed water quality standards. This listing does not mean that the exceedances cause real water quality use impairments which are of concern to the public.

Under "January 1996" on the first page of this chronology, it mentions that the copper levels in San Francisco Bay were found to exceed the US EPA water quality criterion for dissolved copper at 29 of 40 stations. Why did not Common Ground *et al.* also indicate from apparently the same monitoring program that there was no toxicity in the samples taken based on using highly sensitive organisms to copper toxicity? This represents inadequate and unreliable reporting of issues in an effort to try to "prove" a previously adopted point that is not supported by the facts available.

In a "Briefing Packet" component labeled, "Brake Pads and San Francisco Bay Questions and Answers," it states in the first paragraph, *"Copper and other toxic metals threaten the health of many wildlife species in San Francisco Bay."* There is no support for that statement. After extensive studies, there is no evidence that copper is adverse to wildlife in the Bay or associated with it.

It states in the next paragraph, under "What's the Problem?," *"Copper and other heavy metals are a problem for San Francisco Bay."* The problem is an administrative exceedance problem of overly-protective water quality objectives; it is not a water quality problem that can be solved by eliminating the copper from brake pads or, for that matter, any other source.

It is also stated in the same paragraph that copper and other heavy metals are toxic to aquatic life in very low concentrations. Those familiar with the toxicity of copper know that this is an appropriate statement only under very limited conditions. In most conditions, and especially estuarine conditions, copper is not particularly toxic; it is rapidly detoxified.

On the second page, first paragraph of this section, it states, *"About 35 percent of the total amount of copper...comes from vehicle disc brake pads."* and that *"...disc brake pads are one of the largest sources of copper discharge to the Bay, and a significant contributor to the Bay's copper problem."* The Bay's copper problem relates to an inappropriate regulatory approach, not a real water quality problem.

On page 4 of this section, under "Do Brake Pads Cause Problems for Other Water Bodies?" it states, *"While the relationship between water pollution and brake pads has not been studied in other parts of the country, many other rivers, lakes, and bays...have copper problems."* Those familiar with the situation know that these so-called copper problems are often due to analytical problems related to using sample handling techniques that contaminate the samples. They do not represent toxicity to aquatic life.

The statement is made in this same section under "What Can Be Done?" in the second paragraph, *"In conjunction with other copper pollution prevention efforts, a reduction of this magnitude might be enough to get the Bay close to or even in compliance with water quality standards."* That statement represents a lack of proper evaluation of the situation. The water quality standards will be exceeded more than once in three years even if all external sources of copper were eliminated. While the copper concentrations in sediments are not particularly high, they are sufficient to lead to excessive concentrations in the water column when they are stirred into the column by storms. These exceedances would also be measured as dissolved copper based on the procedures used.

Overall, the "Briefing Packet," prepared by Common Ground for the Environment, Sustainable Conservation and the City of Palo Alto is not a factual statement of what has been and is well-known today. It is a document designed to present support for an ill-conceived action.