Aquatic Chemistry/Toxicology in Watershed-Based Water Quality Management Programs

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G. Fred Lee, Ph.D, P.E., D.E.E. and Anne Jones-Lee, Ph.D.
G. Fred Lee & Associates
El Macero, CA 95618

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There is considerable discussion today about implementing the "watershed approach" for point and nonpoint sources of pollutants in a region. There is, however, considerable confusion about what is meant by the "watershed approach" in water quality management. There is even greater confusion on how the watershed approach should be implemented. U.S. EPA (Perciasepe, 1994) has adopted a Watershed Protection Approach which purports to promote integration of water quality problem solutions in surface waters, ground waters and habitats of concern on a watershed basis. According to Perciasepe, the Watershed Protection Approach is an essential priority for U.S. EPA's Water Program, however little guidance is given on how this approach is to be implemented so that it properly addresses the management of real water quality problems-designated use impairment within a watershed without significant waste of public and private funds controlling chemical constituents from point and nonpoint sources that have little or no impact on the designated beneficial uses of waters.

Some point source dischargers who advocate the watershed approach do so with the hope that they will receive relief from having to achieve stricter discharge limits associated with achieving the requirements of U.S. EPA's National Toxics Rule for potentially toxic chemicals. They claim that since nonpoint source dischargers are not being required to meet water quality standards in the receiving waters, further restricting the discharges of point source dischargers should not be required until the nonpoint source dischargers come into compliance with achieving water quality standards. Such an argument would be valid if the impact of the chemical constituents in point and nonpoint source discharges were the same for the total chemical constituents of a type in a discharge. However, as discussed below, this is rarely the case. This paper summarizes some of the issues that need to be considered in developing a technically valid, cost-effective watershed approach for managing water quality in a region focusing on the importance of properly incorporating aquatic chemistry and aquatic toxicology of chemical constituents that are to be managed in a watershed-based approach.

Implementation of the Watershed Approach

A watershed approach should be adopted where both point and nonpoint source dischargers work with the regulatory agencies to evaluate the real water quality problems in a particular waterbody. After the real water quality problems-use impairment have been identified then the specific source(s) of the specific pollutant form(s) that is responsible for use impairment should be required to control the input of the pollutants to the degree necessary to protect the designated beneficial uses of the waterbody independent of the nature of the source, i.e. point or nonpoint, agriculture, industry or urban, etc.

As discussed by Lee and Jones-Lee (1995a,b), in assessing water quality use impairment it is important not to assume that an exceedance of a water quality criterion or standard represents such a use impairment. U.S. EPA water quality criteria and state standards based on these criteria are designed to protect aquatic life and other beneficial uses under plausible worst-case or near worst-case conditions. It is indeed rare that those conditions occur. This leads to "administrative exceedances" of water quality standards that do not represent real use impairments but instead reflect the inability of the regulatory agencies to develop and implement water quality criteria and standards that will protect uses without significant over-regulation of the chemical constituents in a watershed.

It is important that those responsible for implementing the watershed approach recognize that all sources of a particular type of chemical constituent, such as copper or phosphorus, do not contribute that chemical constituent to the waterbody that impacts designated beneficial uses to the same degree per unit total concentration. Copper from automobile brake linings/pads in urban storm water runoff will be significantly different in its potential impact on receiving water quality than copper from copper sulfate used to control algae in a water supply reservoir or the copper that is used to kill roots that have penetrated a sanitary sewer system. In one case (the brake linings/pads) the copper originates as a metallic element that is unavailable and non-toxic to aquatic life. In the other cases, the specific form of copper (copper sulfate) is designed to be highly toxic to plant life. Before it is assumed that all sources of copper to a waterbody have equal adverse impacts on the beneficial uses of the waterbody proportional to the total concentration of chemical constituents, site-specific studies should be conducted to determine whether this unexpected situation is occurring. These studies would focus on the use of aquatic life toxicity testing using organisms that are known to be highly sensitive to copper.

The assumption that all sources of copper or other chemical constituents are of equal adverse impact is strongly contrary to aquatic chemistry and aquatic toxicology. Based on the authors' experience it will be indeed rare, if ever, that all sources of copper, phosphorus, or for that matter other chemical constituents, will have equal adverse impact per unit total concentration of a chemical constituent on the designated beneficial uses of a waterbody. It is, therefore, important in developing a watershed approach for water quality management to focus pollutant control on those chemical constituents that are actually significantly impairing the designated beneficial uses of the waterbody(s) within and downstream of the watershed. This is the technically valid, cost-effective approach that should be followed in implementing the watershed approach.

Pollutant Versus Chemical Constituent

Significant problems exist today in the water quality management field because of a failure to recognize the difference between *pollutants* and *chemical constituents*. Chemical constituents are any chemicals added to water, irrespective of the impact. Pollutants by tradition and national regulations are those constituents that are present in a water in sufficient concentrations of available/toxic forms for a sufficient duration to adversely impact the designated beneficial uses of the waterbody.

To assume that pollutants and chemical constituents are the same, as is sometimes done, can be and usually is highly wasteful of public and private funds in "water pollution" management programs. This will be especially true as attempts are made to control pollutants from nonpoint sources. In order to determine whether a chemical constituent is a pollutant it is necessary to develop a site-specific understanding of the aquatic chemistry and aquatic toxicology of the chemical constituent of concern as well as the key components of the designated beneficial uses of a waterbody.

Lee and Jones-Lee (1995c) have discussed that every chemical is toxic to aquatic life and man at some concentration and duration of exposure. The primary issue in water *pollution* control from various point and nonpoint sources in a particular watershed is the evaluation of the concentrations of the chemical constituents in the discharge/runoff that are, because of their chemical forms, significantly impacting the designated beneficial uses of the receiving waters for the discharge/runoff. Paulson and Amy (1993) have suggested that thermodynamic models, such as U.S. EPA's MINTEQ model, can be used to determine the toxic forms of chemical constituents in urban storm water runoff. However, such an approach is not technically valid and will, in general, greatly over-estimate the toxic forms of chemical constituents, such as heavy metals, in storm water runoff.

Pollutant Trading

As part of developing the watershed approach there is discussion of "pollutant" trading, where one source of pollutants in a watershed could be controlled to a greater degree at less cost than required based on allowed total maximum daily loads (TMDL), thereby enabling another source of the same chemical constituent in the same watershed to control the chemical constituent to a lesser degree. There are a number of examples of watershed-based nutrient trading programs that have been and/or are being developed today that have significant technical problems with the way in which the "pollutant" (nutrient) trading has been established.

Hall and Howett (1994) have discussed "pollutant" (nutrient) trading in the Tar-Pamlico River Basin of North Carolina. They point out that rather than requiring point source dischargers to remove nutrients to a greater degree than currently being achieved, that the use of the funds that could be devoted to nutrient control for point source discharges could be used more effectively to control nutrients from nonpoint discharges. However, the Hall and Howett discussion fails to address one of the most important issues in eutrophication management, namely that various sources of nutrients, especially phosphorus from POTWs and agricultural land runoff, contribute algal available phosphorus to a waterbody to a significantly different degree per unit total phosphorus concentration.

This is a common, widespread problem that is occurring today with the implementation of the watershed approach where those responsible for developing such programs fail to properly incorporate reliable evaluation of the aquatic chemistry and aquatic toxicology of the chemical constituents of concern from various sources in a watershed. As discussed by Lee and Jones-Lee (1992), pollutant trading programs should be implemented where it can be shown that each of the sources of chemical constituents which are to be traded contribute chemical constituents in the same specific chemical forms and amounts to the overall waterbody of concern and thereby enable an improvement in the designated beneficial uses to develop to the same degree based on the control of the pollutant of concern from either source to the same degree. This situation will almost never occur for potentially toxic chemical constituents such as heavy metals, organics, nutrients, and other chemical constituents from point and nonpoint sources. It is highly unlikely that it will ever be possible to reliably trade pollution loads between point and nonpoint sources because of the differences in the chemical forms/impacts of most chemical constituents from these two types of sources without extensive pre-trade evaluation of the actual amounts and impacts of chemical constituents from each source of potential concern.

Another potentially significant problem with pollutant trading is that pollutants may adversely impact waterbodies in two overall ways; near the discharge and in the overall waterbody. Pollutant trading, as it is being discussed today, does not adequately consider localized adverse impacts near the discharge point on the beneficial uses of the waterbody. Local impacts on large waterbodies can be quite significant to the public that utilizes the beneficial uses of the waters near the point of discharge. This point is discussed further by Lee and Jones-Lee (1994a) in evaluating the economic aspects of pollutant trading.

San Francisco Bay Copper Management

One of the prime examples of an inappropriate regulatory approach for point and nonpoint sources of a chemical constituent in a watershed is occurring today for the regulation of copper inputs to San Francisco Bay. The San Francisco Bay Regional Water Quality Control Board with the concurrence of U.S. EPA Region IX has potentially locked the people of northern California into a massive waste of public and private funds in excess of $1 billion for the control of copper from point and nonpoint sources within the San Francisco Bay watershed. The San Francisco Bay Regional Water Quality Control Board or others have yet to find, after extensive investigation, a real water quality problem in San Francisco Bay that is associated with the current copper discharges to the Bay. However, there are "administrative" exceedances of the highly over-protective water quality objective (standard) that was adopted by the State Water Resources Control Board in April 1991 and the Water-Effect Ratio-based, site-specific water quality objective developed for San Francisco Bay by the San Francisco Bay Regional Water Quality Control Board in 1993.

The SF Regional Board followed U.S. EPA Water-Effect Ratio guidance which does not account for the most important reason (source chemical forms) for the need to develop site-specific water quality criteria and standards. The approach used assumes that all forms of chemical constituents, such as copper, are present in each of the sources of copper for the waterbody in the most toxic available form, i.e. the form that was used in the Water-Effect Ratio toxicity testing. This assumption would not be valid for any waterbody with multiple sources of a chemical constituent or for any single source over a period of time. U.S. EPA's current approach, including the recently adopted revised Water-Effect Ratio (U.S. EPA, 1994), falls far short of what is needed to develop reliable, site-specific chemical constituent loads/concentrations for waterbodies such as San Francisco Bay. The use of this approach can waste large amounts of funds. For San Francisco Bay the amount will be in excess of $1 billion unless the current approach adopted by the SF Regional Board is amended to more properly reflect the information available on aquatic chemistry and aquatic toxicology for copper from each source and within the Bay waters and sediments.

The inappropriateness of U.S. EPA's approach for developing site-specific water quality criteria based on Water-Effect Ratio adjustments of the national criteria is demonstrated for copper in San Francisco Bay by extensive studies using toxicity testing of Bay waters with the same organism as was used by U.S. EPA to establish the Agency's national criterion for copper. Repeatedly, over several years, no toxicity to this and other sensitive organisms was found in the water column even though the total copper frequently exceeded the national criterion and site-specific criterion by a factor of two to four. Obviously, since the reason for concern about copper in San Francisco Bay is its potential toxicity to aquatic life, if no toxicity is found to sensitive forms of aquatic life, then the exceedance of the water quality criterion-standard is an "administrative" exceedance that does not reflect a real use impairment. Lee and Jones-Lee (1995b) have recently discussed the highly significant problems that are arising out of U.S. EPA's Independent Applicability Policy where exceedances of chemical-specific standards are arbitrarily defined by U.S. EPA as "impaired" waters even though biological effects assessments, such as toxicity tests, show that there is no impairment of the beneficial uses of the waters associated with the exceedances.

Rather than addressing the fundamental problem of the use of inappropriate standards (objectives) for copper in San Francisco Bay, the San Francisco Bay Regional Water Quality Control Board chose to adopt *arbitrary* TMDLs for copper from all point and nonpoint sources in the San Francisco Bay watershed, including the riverine source of the Sacramento River and its tributaries. The Regional Board acknowledges that it does not understand the relationship between the copper loads to San Francisco Bay from various sources and the administrative exceedances of the copper concentrations in the San Francisco Bay waters. It is the Board's position with U.S. EPA's support that if the initial TMDLs do not achieve the water quality objectives within a specified time period, more restrictive TMDLs will be adopted where all dischargers will face a ratcheting down of their copper loads to the Bay.

This Board, however, has chosen to ignore the fact that the sediments in San Francisco Bay contain sufficient copper so that during storms when the sediments are stirred into the water column there will still be administrative exceedances of the water quality objective that has been adopted by the Board for the Bay waters. These exceedances will occur in perpetuity even if all external sources of copper for the Bay were eliminated. Stormwater dischargers to the Bay face spending over $1 billion in copper control programs which after they are spent will have no impact on the designated beneficial uses of San Francisco Bay waters. The watershed approach that has been adopted for copper in San Francisco Bay is obviously a failed approach that can readily result in massive waste of public and private funds controlling forms of chemical constituents that do not adversely impact real water quality issues (use impairments) of Bay waters.

Santa Monica Bay

The Santa Monica Bay Restoration Project has proposed a Plan of Actions for Bay Restoration that includes spending $42 million over the next five years to control a group of conventional chemical constituents, such as copper, in the Santa Monica Bay watershed stormwater runoff (SMBRP, 1994). A watershed mass emission strategy approach has been adopted by those responsible for conducting the Santa Monica Bay Restoration Project where persistent chemicals, such as heavy metals, are to be controlled in stormwater runoff by BMPs. However, a review of the information on water quality impairment that is currently occurring in Santa Monica Bay shows that there is no information that demonstrates that many of the chemical constituents singled out for control under this strategy are having a significant real adverse impact on the designated beneficial uses of Santa Monica Bay waters.

The reason that copper and other chemical constituents were selected for control was because these chemical constituents are "persistent" and accumulate in Santa Monica Bay sediments. However, there is no evidence that such accumulation arising from current stormwater inputs to Santa Monica Bay is adversely affecting the designated beneficial uses of Santa Monica Bay waters. In fact, it is unlikely that such adverse impacts are occurring. The proposed Plan for Action involving the expenditure of $42 million over the next five years for the development of BMPs to control stormwater runoff-associated chemical constituents has been developed without proper definition of a real water quality problem associated with the current stormwater discharges.

Obviously, before a watershed approach is adopted that calls for largescale expenditures of funds to control chemical constituents from point and nonpoint sources, real significant water quality problems should be identified within the waterbodies impacted by the watershed-derived chemical constituents. Further, associated with any watershed or other area-source that is proposed for implementation for the control of chemical constituents from point and nonpoint sources, a reliable understanding of the benefits in terms of improved designated beneficial uses that will accrue for the expenditures for chemical constituent control should be available. The shortage of funds available for water pollution control programs requires that the funds used in such programs be directed toward solving real significant water quality problems. The Santa Monica Bay Restoration Project has yet to properly define the water quality problems that it intends to solve and the improvement of the designated beneficial uses that will accrue from spending $42 million over the next five years to implement BMPs for stormwater runoff to Santa Monica Bay.

Control of Chemical Constituents at Source-Pollution Prevention

One of the frequently advocated components of a watershed management approach is pollution prevention, i.e. the control of chemical constituents at their source. One of the major areas of concern in regulating urban storm water runoff and other sources of chemical constituents for a waterbody is the presence of elevated concentrations of a number of heavy metals and other chemical constituents in the storm water runoff/discharges that are potentially controllable at the source. Copper is one of the elements of greatest concern in urban storm water runoff. Copper and many other heavy metals are present in urban storm water runoff at concentrations considerably above U.S. EPA water quality criteria. It has been found that one of the principal sources of copper is its use in brake linings/pads for some types of automobiles. This has led some to call for copper source control by requiring that the manufacturers of brake linings/pads stop using copper where some other material would be substituted for the copper that is being used today. Numerous studies have shown, however, that the heavy metals, including copper, in urban storm water runoff are not a source of toxicity to aquatic life (see Mangarella, 1992).

There are significant questions, therefore, about whether voluntary or imposed national or regional bans on the use of copper in brake linings/pads is an appropriate best management practice (BMP) for storm water runoff water pollution control. While adoption of this approach would likely reduce some of the administrative exceedances of copper at some locations, such as for San Francisco Bay, it would not likely address any real water quality problems (use impairment) associated with the presence of copper in storm water runoff to the Bay or its tributaries. Further, since some other material will have to be substituted for copper, concern should be raised on the potential public health and environmental impact of the substitute material.

In formulating a point and nonpoint source chemical constituent control program, it is important to reliably evaluate the aquatic chemistry and aquatic toxicology of the chemical constituents that are to be controlled through BMPs. It is also important to understand that the current suite of structural BMPs, such as detention basins, grassy swales, etc., were not based on a technically valid assessment and that their implementation would solve real water quality problems (Lee and Jones-Lee, 1996). An example of this situation is the use of detention basins where low flow storm waters are retained in a basin for a period of time where large particulate forms of chemical constituents settle out. However, particulate forms of chemical constituents are generally non-toxic and non-available to aquatic life. Detention basins typically do not remove the soluble/toxic forms of chemical constituents. Lee and Jones-Lee (1995c) have discussed the importance of properly selecting BMPs for chemical constituent control in a watershed, including control at the source, so that the control focuses on addressing real water quality problems rather than wasting public and private funds controlling chemical constituents which have little or no impact on the beneficial uses of the waters in the watershed.

Conclusion

Water pollution control programs should be based on a watershed management-based control program in which all chemical constituent sources to a waterbody are reliably evaluated as to their potential impact on the designated beneficial uses of a waterbody. The focus of the watershed approach should be on protection and, where degraded, enhancement of the designated beneficial uses of the waterbody. For aquatic life-related uses, the focus should be on the numbers, types, and characteristics of desirable aquatic organisms. The mechanical approach that is being adopted today in some watershed approaches for water quality management of considering all chemical constituents from all sources of equal impact on the designated beneficial uses per unit total chemical constituent concentration derived from the source is technically invalid. In implementing the watershed approach, proper evaluation of the chemical constituent aquatic chemistry and aquatic toxicology as it may impact the designated beneficial uses of a waterbody must be made in order to avoid waste of public and private funds in controlling chemical constituent inputs that are not adversely impacting water quality within the watershed and downstream thereof.

Pollutant trading should be based on the trading of real pollutants, i.e., those that impact designated beneficial uses at a particular location in a waterbody. Consideration should be given to waterbody-wide effects as well as those that can occur near the point of discharge/runoff.

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Presentation Slides Follow:

Aquatic Chemistry/Toxicology in Watershed-Based Water Quality Management Programs

G. Fred Lee, PhD, PE, DEE and Anne Jones-Lee, PhD
G. Fred Lee & Associates
El Macero, California

Watershed Approach for Water Quality Management

What Should a Watershed Based Water Quality Management Approach Involve?

All Stakeholders Working Together to Identify, Prioritize and Manage All Significant Water Quality Problems in a Waterbody and Its Tributaries

Broaden the Scope of Water Pollution Control to Address All Impairment of Uses and All Sources of Pollutants that Impair Uses

Ag No Longer Exempt from Practicing Full Water Pollution Control

Consider Both Near-Field (Near Point of Discharge-Runoff) and

Far-Field (Waterbody-Wide) Impacts

Definitions

Water Quality - Impairment of Designated Beneficial Uses: Fish and Aquatic Life, Domestic Water Supply, Wildlife Habitat, Contact Recreation, Etc.

Chemical Constituent - A Chemical Added to or Present Within Water

Pollutant - A Chemical Constituent That Impairs the Beneficial Uses of a Waterbody

Chemical Constituent does not equal Pollutant

Most Chemicals Exist in a Variety of Chemical Forms, Only Some of Which Are Toxic - Available to Impact Water Quality

Waterbody - Water Column Including the Sediments

Watershed is the Area That Contributes Water to a Waterbody; Includes Airshed - Atmosphere and Groundwater

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Deficiencies in Current Watershed-Based Water Quality Management

Current Watershed Approach for Water Quality Management Largely Ignores Aquatic Chemistry and Toxicology - Real Water Quality Issues

Brute Force Approach

Assumes That All Forms of Chemical Constituents Equally Important

All Copper, Mercury, Other Heavy Metals, Pesticides, PCBs, Phosphate Are in Forms That Adversely Impact Water Quality

Well Known Not To Be True

Assumes All Aquatic Organism Exposure a Chronic Exposure

Aquatic Toxicology - Adverse Impacts Such as Toxicity, Excessive Bioaccumulation, Tumors, Etc.

Aquatic Chemistry - Chemical Transformations; Kinetics (Rates) and Thermodynamics (Energy - Equilibrium)

Technically Appropriate Use of Water Quality Criteria and Standards

US EPA Water Quality Criteria and State Standards Numerically Equal To These Criteria Are Based On Worst-Case or Near Worst-Case Assumptions With Respect To Impacts On Aquatic Organisms

Chronic Exposure to 100% Available Forms

Rarely Will These Conditions Occur

Not To Be Exceeded For More Than Once In Three Years At the Edge Of Mixing Zone

Leads to Significant Over-Estimation of Both Near-Field and Far-Field Impacts

Chemical Specific Water Quality Criteria and State Standards Should Be Used to Indicate Potential Adverse Impacts

Allow Discharger and the Public To Determine If Exceedance Of Standards Represents a Real Impairment of Water Quality

Impairment of Uses or an Administrative Exceedance

Inappropriate Regulatory Approaches

US EPA Independent Applicability Policy

Contrived to Ease Administration of Water Quality Standards

Technically Invalid

Requires Compliance With Chemical Specific Standards For Potentially Toxic or Bioaccumulatable Chemicals Even if Site-Specific Investigations Show That the Constituents Of Concern Are in Non-Toxic Forms and Excess Bioaccumulation is Not Occurring

Leads to Gross Over-Regulation and Potentially Massive Waste of Public Funds in Regulating Urban Area, Highway and Rural Stormwater Runoff

Must Focus Watershed Approach for Water Quality Management On Toxic Available Forms Where Toxicity and Actual Bioaccumulation Are the Primary Tools Used for Defining Water Quality Impacts

Independent Applicability Policy Should Be Terminated

Watershed Approach for Managing San Francisco Bay Copper
A Watershed Approach Gone Awry

Exceedance of National Copper Water Quality Standard - 2.9 ug/L

Developed Site-Specific Standard Based on Water Effect Ratio Approach - 4.9 ug/L

Find 10 to 15 ug/L Soluble Copper in San Francisco Bay Waters

Because of Independent Applicability Must Develop Waste Load Allocation and Total Maximum Daily Loads (TMDLs)

"Phased Approach" Adopted Because of a Lack of Understanding of the Relationship Between Copper Loads and Copper Concentrations in Bay Waters

Phase I - All Dischargers Reduce Total Copper Loads by 20%

Copper Sources For South San Francisco Bay: Treated Wastewaters 15%, Auto Brakepads 35%, Other Runoff Sources - Urban and Highway Stormwater and Mine Waste 50%

Each Source of Copper Must Reduce Copper Input to Achieve TMDLs

All Sources of Copper Considered Equally Harmful

Ignored the Role of Bay Sediments as a Source of Copper to the Water Column During Storms

If All Copper Inputs From the Watershed Terminated, the Soluble Copper Concentrations in the Bay Will Be Exceeded for More Than Once in Three Years, i.e., Will Still Have Exceedance of Water Quality Standards

Phased Approach Technically Invalid Must Have an Understanding of the Relationship Between Copper Loads and the Resultant Concentrations Also Must Consider Sediments in Evaluating Exceedance of Water Quality Standards

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All Sources of Copper Are Not of Equally Toxicity

Cu - Metal - Some Auto Breakpads

Cu^{2+}, $Cu(H_2O)_6^{2+}$

$CuOH^+$, $Cu(OH)_2$, $CuCO_3$

CuO, $CuCO_{3s}$

Cu organic, Cu-humates, Cu-EDTA, Etc.

Models - MINTEQ Not Reliable to Predict Toxic Forms

Soluble Copper - Some Non-Toxic

Must Use Toxicity Measurements and TIEs To Determine If Copper In a Water Sample Is Toxic

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Watershed Approach for Managing San Francisco Bay Copper Where Is The Problem?

Extensive Toxicity Measurements of San Francisco Bay Waters Over Three Years Have Shown No Toxicity Due to Copper or Other Constituents to Several Highly Sensitive Aquatic Organisms

Used the Same Organism and Test as Was Used to Establish the Water Quality Criterion - No Toxicity Found

Exceedance of the Water Quality Standard is an Administrative Exceedance Due to Overly Protective Standard (Worst-Case) and Inappropriate Regulatory Approach (Independent Applicability)

Could Cause Stormwater Dischargers (Municipalities) to Spend Over One Billion Dollars Treating Urban Area and Highway Stormwater Runoff to Achieve Copper Water Quality Standard in Bay Waters

No Beneficial Uses of the Bay are Expected to Result From Such Expenditures

Example of Inappropriate Watershed Approach That Fails to Properly Incorporate Aquatic Chemistry and Toxicology

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Santa Monica Bay Stormwater Runoff

Santa Monica Bay Restoration Project Adopted the Watershed Approach for Managing 22 Chemicals That are Transported into Santa Monica Bay in Stormwater Runoff

Heavy Metals Focal Point of Attention

Mass Load Emission Strategy Adopted

All Stormwater Runoff Sources of Metals Considered Toxic and Available - No Measurements Made to Verify Assumptions

Heavy Metals Accumulate in Near-Shore Sediments of Santa Monica Bay - Assumed That Elevated Concentrations of Heavy Metals in Sediments Represents Significant Adverse Impacts to Beneficial Uses of Santa Monica Bay Due to Aquatic Life Toxicity

No Toxicity Measurements Made

Require Expenditure of $42 Million Over Five Years to Control Heavy Metal and Other Constituent Inputs to Santa Monica Bay From Watershed (Including City of Los Angeles and Surrounding Communities)

Implementation of Stormwater "BMPs"

Assume That Any Approach That Removes Heavy Metals in Stormwater Runoff is a BMP for Protection of Santa Monica Bay

Technically Invalid Approach

A BMP for Stormwater Runoff is Valid if it Improved Beneficial Uses of Receiving Waters

Heavy Metals in Stormwater Runoff from Urban Areas and Highways Are in Non-Toxic, Non-Available Forms Also Rarely Will Heavy Metals From These Areas Be Adverse to Aquatic Life When They Accumulate in Receiving Water Sediments

Pollutant Trading

Under TMDL Situations, Dischargers Are Required to Control a "Pollutant" to a Specified Load

Some Sources Can Control the Pollutant at Less Cost Per Unit Mass of Pollutant Removed Than Others

The Discharger Which Can Most Cost-Effectively Remove Pollutants Do So and Thereby Allow Another Discharger to Remove Less of Their Pollutant Load

In a True Pollutant Trading Situation Must Trade Pollutants That Impact Water Quality Not Chemical Constituents Irrespective of Their Impact

Consider Near-Field and Far-Field Effects

Evaluate Toxic-Available Forms

Pollutant Trading For Control of Toxicity

Metals and Some Organics Are Of Concern Because of Potential Toxicity or Bioaccumulation

Should Trade Toxic Units Not Total Metals or Even Dissolved Metals

Should Trade Bioaccumulatable Forms Not Total Concentrations

Technically Valid Pollutant Trading Will Require Site-Specific Evaluation of Each Major Source of Constituents of Concern To Determine the Pollutant Content

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Management of Eutrophication

Eutrophication - Excessive Fertilization One of the Most Important Causes of Water Quality - Use Impairment in the US

Excessive Growth of Algae and Other Aquatic Plants

Most Freshwater Waterbodies Algal Growth Controlled by Phosphorus

Nitrogen Important For Most Estuarine and Marine Systems and Some Freshwater Systems Especially on the West Coast

Watershed Approach to Eutrophication Management Focusing on Controlling Limiting Nutrient Input Often Technically Invalid

Ignores the Aqueous Environmental Chemistry of Phosphorus

The Total Phosphorus Load From Some Sources is a Poor Predictor of Algal Available Phosphorus

Only About 20% of the Particulate Phosphorus in Urban Area and Rural Runoff Available to Grow Algae

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Pollutant Trading For Eutrophication Control

Phosphate From Non-Point and Point Sources Are Not Pollutants To the Same Degree

POTW Residual Phosphorus May or May Not Be Available to Support Algal Growth

Aluminum and Iron Treatment For Phosphate Removal Produces Particulate Iron or Aluminum Phosphates

Filter Effluent to Further Remove Particulates

Removing Non-Algal Available Phosphorus

Non-Point Sources - 80% of the Particulate Phosphorus Non-Available to Support Algal Growth

Must Trade Algal Available Phosphorus Not Total Phosphorus

Evaluation Monitoring For Implementation of a Watershed Based Water Quality Management Program

Current Water Quality Monitoring Programs are Largely End-of-the-Pipe Edge-of-the-Pavement/Property "Compliance" Monitoring

Provide Little to No Useful Information on the Real Water Quality Use Impairments That Are Occurring in the Receiving Waters For the Discharge - Runoff

Evaluation Monitoring Developed to Use Monitoring Funds More Appropriately to Define Real Water Quality Use Impairments in the Receiving Waters For the Discharge - Runoff

Shift Monitoring Emphasis From Discharge - Runoff to Receiving Waters

All Dischargers, Regulatory Agencies and the Public Work Together to Use Monitoring Funds Available to Find Real Water Quality Use Impairments in a Waterbody

Where Such Use Impairments Are Found, Assess and Prioritize Their Significance

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Potential Water Quality Problems That Should Be Considered in a Watershed Based Water Quality Management Program

- Aquatic Life Toxicity
- Excessive Bioaccumulation of Hazardous Chemicals
- Domestic Water Supply for Surface and Groundwaters
- Sanitary Quality - Contact Recreation and Shellfish Harvesting
- Eutrophication
- Petroleum Hydrocarbons - Oil and Grease
- Aquatic Sediment As a Cause of Toxicity and Excessive Bioaccumulation
- Aquatic Life Carcinogens
- Oxygen Demand
- Litter and Debris

Evaluation Monitoring Approach

Problem Definition and Control

Determine the Cause and the Source of Constituents Responsible for the Use Impairment

Develop Site-Specific Programs That Will Control the Use Impairment to the Maximum Extent Practicable

Repeat Evaluation Monitoring Program Evaluation of Each Potential Water Quality Use Impairment Every Five Years to Detect Changes in Activities Within the Watershed That Are or Could Be Adverse to the Waterbodies Water Quality

Also to Detect New or Increased Use of Constituents That Impair the Beneficial Uses of a Waterbody Introduced Into the Watershed

Overall, Evaluation Monitoring Focuses on Finding a Real Water Quality Problem in a Waterbody, Determining Its Cause and Significance and Developing Control Programs For Controlling the Input of Pollutants at the Source

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Development of Technically Valid Watershed Approach for Water Quality Management

Organize All Stakeholders (Dischargers, Water Users, Interested Parties, Regulatory Agencies, Etc.) to Develop Watershed Based Water Quality Management Approach

Appoint a Stakeholders Technical Advisory Committee That Includes Several Individuals Knowledgeable in Aquatic Chemistry, Aquatic Toxicology and Water Quality

For Each Potential Type of Water Quality Use Impairment Within the Waterbody of Concern, Assess What is Known About Its Magnitude and Significance Within the Waterbody and Downstream Thereof

Develop a Data-Information Gathering Program to Fill Data Gaps on Current Water Quality Problems Within the Waterbody

Is There Aquatic Life Toxicity in the Ambient Waters?

Do Fish and Other Aquatic Life Have Excessive Concentrations of Bioaccumulatable Chemicals?

Is There an Impairment of Contact Recreation or Shellfish Harvesting Due to Excessive Concentrations of Fecal Indicator Organisms?

Is The Use of Water For Domestic Water Supply Purposes Impaired? - Consider Both Surface and Groundwater

Is There Excessive Growth of Algae and Other Aquatic Plants?

Are the Sediments Toxic to Aquatic Life?

Do the Sediments Serve as a Source of Bioaccumulatable Chemicals That Impair the Beneficial Uses of the Waterbody?

Do Low Dissolved Oxygen Conditions Exist in the Waterbody?

Is There Excessive Trash and Other Debris, Oil and Grease, Etc.?

The Stakeholders - the Public Should Prioritize the Water Quality Use Impairments Within the Waterbody In Terms of Their Importance to the Public Considering Any Legal or Other Constraints That Exist on Water Quality Management Approaches Within the Watershed

The Proper Prioritization of Both Near-Field and Far-Field Water Quality Impacts Within a Watershed May Require Acquisition of Additional Information That May Not Be Available

The Prioritization Should Be Reexamined Every Few Years, i.e., Five Years to Incorporate New Information That Has Been Developed and Changes in Use of the Waters Within a Watershed

Assess the Current Information on the Causes of Water Quality Use Impairments Within the Waterbody

If There is Aquatic Life Toxicity, What Constituent(s) is Responsible For It?

Do Not Assume That Exceedance of Water Quality Criteria - Standards For Potentially Toxic Chemicals Represents a Real Water Quality Use Impairment - Use Toxicity Tests and TIEs

Through Forensic Analysis, Determine the Specific Sources of the Pollutants That Cause Water Quality Use Impairments Within the Watershed That Are of Sufficient Magnitude to Require Control

Develop and Implement Site-Specific Control Programs For Each of the Sources of Pollutants That Significantly Impairs the Near-Field or Far-Field Uses of the Waterbody

Focus Control Programs on Sources Rather Than Trying to Treat Stormwater Runoff From Urban Areas, Highways and Rural Areas

Implement Pollution Prevention Program Designed to Detect Potentially Emerging Problems

Focus Pollution Prevention on Control of Pollutants Not Chemical Constituents Irrespective of Whether They Are Potentially Adverse to Water Quality

Repeat the Evaluation Monitoring Approach for Each Potentially Significant Water Quality Problem Every Five Years

Overall, Approach Is Technically Valid and Cost-Effective

Utilizes Current Understanding of Factors Influencing the Water Quality Significance of Chemical Constituents in Aquatic Systems

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Supplemental Information

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