SUMMARY OF ANALYSIS OF CALTRANS FREEWAY RETROFIT

COST-BENEFIT ANALYSIS

LOS ANGELES AREA (DISTRICT 7)

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Introduction

I have reviewed two interwoven studies that attempt to define the scope of benefit-cost assessment and the method of estimating benefits of controlling pollution in surface water run-off (storm water) from California Department of Transportation (CalTrans) facilities in the Los Angeles region, referred to by CalTrans as District 7. These studies are, respectively, *Storm Water Facilities Retrofit Evaluation*, Brown and Caldwell (1996), and *Preliminary Economic Valuation of Stormwater Quality Improvement for Ballona Creek*, Wilchfort, Lund, and Lew (1996). In this report, I refer to the first study as "Brown and Caldwell" and the second as "Wilchfort, Lund, and Lew."

I do not address in my evaluation whether a cost-benefit analysis of any sort is appropriate under the Clean Water Act prior to installing treatment device to control storm water pollution, as this matter is outside the scope of my review. Rather, I have reviewed and analyzed the Brown and Caldwell, and Wilchfort, Lund, and Lew reports in terms of their adequacy as objective cost-benefit analyses. I have been guided not only by my own professional experience and expertise, but by assumptions and methods widely accepted in the economic field and that are found in the peer-reviewed literature.

My conclusions include the following. Both studies are fundamentally inadequate to support their conclusions. The benefit method relied upon is not among any recognized and peer reviewed approach to cost-benefit analysis or benefit estimation of improving environmental quality. The benefit estimates of retrofiting CalTrans' facilities are unreliable. The methods used are not appropriate for estimating the increase in economic benefits from controlling water pollution. The studies systematically omit benefit categories. More generally, a pattern emerges in the studies whereby analytic decisions consistently are made that have the effect overstating the costs and understating the benefits of freeway retrofit to control storm water pollution. The method for benefit estimation is theoretically invalid, arbitrarily unreliable, and biased. These studies do not aid good decision-making.

Discussion

A. The Structure of Each Study Diverts and Narrows Focus

The objective of benefit-cost analysis is to quantify all the benefits and costs of alternatives in a circumstance and to calculate the net benefits (benefits minus costs) of the alternatives in a single unit of measure – dollars. The purpose is to assist good decision-making in a circumstance. These two studies purport

purport to address the circumstance of surface water run-off to waterways (including storm drains, rivers, and streams) and their receiving reaches (including Santa Monica Bay, San Pedro Bay, and the Pacific Ocean). Analysis of the title and overall structure of each study alone reveals much about each effort. The titles and focus of each of these two studies are verisimilitudes that divert and narrow focus from the circumstance, from the objective, and from the purpose of benefit-cost analysis.

The title of the study by Brown and Caldwell (<u>CalTrans Storm Water Facilities Retrofit Evaluation</u>) diverts and narrows focus from surface water run-off to storm water run-off, excluding all benefits except benefits that accrue during 40 storm days of the 365 day year. The title also narrows alternatives to CalTrans-only storm drain retrofit options that fail to take advantage of economies of scale of treating all surface water run-off jointly with other agencies, affecting the cost calculations and the effectiveness, and thereby the benefits.

The title of the study by Wilchfort, Lund, and Lew (<u>Preliminary Economic Valuation of Stormwater Quality Improvement for Ballona Creek</u>) diverts and narrows focus from surface water run-off to storm-water run-off, similarly omitting benefits except those that accrue during 40 storm days of the 365 day year. Their title also diverts and narrows the focus to Ballona Creek, omitting benefits to the receiving waters (Santa Monica Bay). Their title further diverts focus from quantifying benefits and costs to presenting a method for "preliminary economic valuation". There is nothing preliminary about their conclusions that would excuse CalTrans from an analysis of all the benefits and costs of promising alternatives with economies of scale.

Both reports shift focus from the purpose of benefit-cost analysis. By shifting and narrowing focus to partial benefit calculations, and to alternatives that fail to take advantage of economies of scale, these studies do not assist good decision-making nor support their conclusions.

B. Evaluation of the Content of the Studies

This report evaluates the adequacy of the benefit-cost analyses by Brown and Caldwell (1996) and Wilchfort, Lund, and Lew (1996) , studies that state that they have the purpose of concluding whether there are control options to reduce pollution in surface water run-off in CalTrans District 7 that have benefits high enough to justify the cost. This report is critical of the approach and recommends that results of these two benefit-cost analyses not be accepted because of the significant flaws contained in each. This report presents the reasons why the method for benefit estimation proposed in these two interwoven reports should be rejected as invalid, unreliable, and biased.

1. Overview of Approach

By way of summary, there are six key components to a benefit-cost analysis under the circumstances. First is the selection of the geographical region under consideration and the time frame for analysis. Second is establishing the baseline of pollution without treatment. Third is the selection of treatment options that determine the cost of treatment and the amount of pollution reduction. Fourth is identification of the benefits that are adversely affected by pollution in the surface water run-off. Fifth is the method used to link changes in pollution to changes in benefits. Sixth is the assignment of dollar values to changes in benefits.

2. Temporal and Geographical Scope of Analysis

Brown and Caldwell and Wilchfort, Lund, and Lew bias their analyses by geographically and temporally circumscribing the benefits and costs of pollution control.

a. <u>Geographical Scope</u>

There are five ways the geographical scope of the analysis can bias benefit and cost estimates: (1) Selecting the Watershed for Analysis; (2) Omitting Areas that Receive Waters in the Watershed; (3) Economies of Scale in Cost Estimates from Omitting Pollution Sources within a Watershed; (4) Benefit Transfer: Omitting Classes of Benefits; and (5) Benefit Transfer: Incorrectly Estimating the Value of Benefits.

(1) Selecting the Watershed for Analysis

Even if the benefit-cost analysis by Brown and Caldwell (1996) were reliable for the Santa Monica Bay region, which it is not, the results would be inapplicable to the watersheds in CalTrans District 7 and their reaches, or to other areas in the State of California. Pollution levels and categories of economic benefits are significantly different between Santa Monica Bay watersheds and the rest of District 7 where pollution levels may be significantly higher.

Brown and Caldwell and Wilchfort, Lund, and Lew omit categories of benefits which would accrue due to structural retrofit to control storm water pollution from Caltrans facilities because of the geographic scope of their analyses. Neither study considered benefits of pollution control in the major watersheds of District 7: the Los Angeles River, the San Gabriel River, the Dominguez Channel, nor the Los Cerritos Channel. The Los Angeles River plus the San Gabriel River have a factor of 10 times the mass emissions as Ballona Creek does.

The Los Angeles and Long Beach international harbors are critical centers of economic activity for Southern California. The Brown and Caldwell study is unable to include any comparable harbor in the geographical region they consider. Consequently, any conclusion they reach regarding the benefits and costs of pollution control is inapplicable to the majority of the land area and watersheds affected by pollution in CalTrans District 7.

(2) Omitting Areas that Receive Waters in the Watershed:

Both studies omit geographical areas and receiving waters *within their own watershed study areas* where benefits occur from the pollution reduction, biasing downward the benefit estimates for those watersheds. Wilchfort, Lund, and Lew omit from their benefit calculations areas including the adjacent Ballona Wetlands, Ballona Lagoon, Venice canals, Dockweiler Beach, and the adjacent beaches along the Santa Monica Bay. Wilchfort, Lund, and Lew exclude areas including the inland reaches of Ballona Creek. Brown and Caldwell (1996) only consider a small portion of the Ballona Wetlands in their computations of the benefits of controlling CalTrans-only pollution within the Santa Monica Bay watershed. Brown and Caldwell also omit the Malibu Lagoon in their benefit analysis of the Santa Monica Bay watershed. *These two omissions alone would almost double Brown and Caldwell's benefit estimation associated with pollution control, had they been included.*

(3) Economies of Scale in Cost Estimates from Omitting Pollution Sources within a Watershed:

The third type of bias occurs when cost estimates are based upon more expensive, selective treatment of just some pollution sources. There are economies of scale if a facility can be designed to treat pollution from several sources rather than just one source. Efficient engineering requires consideration of design options that account for geographical connections in a watershed which typically result in surface water pollution run-off from many sources. Treatment designs that just treat CalTrans-only pollution may not be efficient because economies of scale are lost.

Brown and Caldwell acknowledge that there are economies of scale for joint treatment of all water in a watershed. Yet they do not present a benefit-cost analysis for joint treatment of all water that reaches the Santa Monica Bay; their benefit-cost analysis is for water from CalTrans-only. They do not compare benefits and costs of other obvious options such as detention ponds with groundwater recharge, other "low-tech" BMPs, water reclamation projects jointly built and operated with water districts, water agencies, cities, and other agencies, or diverting water run-off to Publicly Owned Treatment Works (POTWs) by way of existing sanitary sewers, and seasonally shut off the diversion during heavy rains to avoid overflow to the sewage treatment facilities. Wilchfort Lund and Lew dismiss a water reclamation option without correctly analyzing the benefits.

(4) Benefit Transfer -- Omitting Classes of Benefits

Bias can occur when benefit estimates from a study of one geographical region are transferred to another region without sufficient care; this can occur in two ways. The fourth type of bias is when pollution reduction can affect beneficial uses, some of which may be present in one geographical region but not in another. Wilchfort, Lund and Lew bias their benefit estimate downward by confining the study area, thereby omitting classes of benefits in the method they propose. Brown and Caldwell use Wilchfort, Lund, and Lew's method, omitting a class of benefits in their analysis of a larger geographical area.

Wilchfort, Lund, and Lew omit the benefits from preserving and enhancing ecosystems such as the Ballona Wetlands. They also omit health benefits to swimmers at Dockweiler Beach. Wilchfort, Lund, and Lew (Appendix C, p.5) categorize "preservation value, intrinsic value, bequest value, option value, and existence value" as "nonuse values … not included in the analysis of Ballona Creek." Wilchfort, Lund, and Lew do not extend the method they propose to ecosystem or health benefits and so omit these important classes of benefits. Brown and Caldwell apply the method of Wilchfort, Lund, and Lew to the entire Santa Monica Bay. Because the method they use does not consider ecosystem or health benefits, they omit these classes of benefits.

(5) Benefit Transfer -- Incorrectly Estimating the Value of Benefits

If the dollar value of a beneficial use is lower in one geographical region than another, transferring the value from the former geographical region to the latter region biases downward the benefit estimate of pollution reduction; this is what Wilchfort, Lund, and Lew do, and Brown and Caldwell follow their example. Wilchfort, Lund, and Lew, use forest service studies from the 1980s to establish a value for outdoor recreation at Southern California beaches. Brown and Caldwell then apply those estimates to the Santa Monica Bay watershed.

b. Temporal Scope

Both the analyses by Brown and Caldwell and by Wilchfort, Lund, and Lew confine the temporal scope of analysis, biasing downward the benefit estimates. Benefit estimates are biased downward because they only calculate benefits of pollution control for 40 days out of the year. Both studies ignore the economic and population growth in the region, both of which will result in increases in pollution and increases in benefits from pollution reduction over the relevant period. Both of these biases result in benefit estimates that are lower than they should be.

The method proposed by Wilchfort, Lund, and Lew assumes that pollution emissions do not have random fluctuations. Brown and Caldwell use the method proposed by Wilchfort, Lund, and Lew. In fact, "a uniform storm water quality has been assumed for all CalTrans runoff" (Brown and Caldwell, p.iv). To the contrary, between wet years and dry years pollution emissions vary considerably.

3. Chapter 3: The Baseline Level of Pollution

The baseline level of pollution run-off has two parts: (i) the current amount of surface water run-off – without treatment, and (ii) the future level of pollution run-off without treatment during the period relevant to the proposed treatment options. In order to estimate the benefits of pollution control, it is necessary to establish the baseline of pollution prior to control, and the level of benefits corresponding to that amount of pollution. The treatment options determine how much reduction in pollution is possible and at what cost. The level of pollution after treatment is integral to the new level of benefits. The benefit-cost test compares the increase in benefits to the treatment cost.

In order to accurately assess the benefits, it is necessary to accurately measure the baseline. The baseline used by CalTrans only contains the first part – the current condition – and omits the expected increase of pollution in the future. In the absence of treatment, increases in population and economic activity will likely increase pollution emissions over the next 20 years. Some of the literature reviewed in Appendix 3.1 of Brown and Caldwell could be helpful in estimating the increase in pollution. Brown and Caldwell do not do so.

Irrespective of the original source of pollution, all reductions in pollution that are provided by treatment affect the benefit calculus. If pollutants that would be controlled are omitted from the analysis because they are not considered when establishing the baseline, then the benefits of treatment are biased downward. Brown and Caldwell omit numerous pollutants that typically are found in CalTrans run-off, and they omit pollutants from sources other than CalTrans that would be controlled by joint pollution control measures. Wilchfort, Lund, and Lew establish their baseline for analysis from information obtained from Brown and Caldwell, so both analyses have this bias.

Compared to the 53 types or measures of pollutants identified in a study for CalTrans by Dammel (1997) and the additional pollutants given by the LARWCQB (1997), the treatment options considered by Brown and Caldwell include only 15 pollutants on the list that defines the current condition. By restricting the number of pollutants, Brown and Caldwell ignore benefits of pollution control.

Wilchfort, Lund, and Lew propose a method to estimate benefits of treatment, a method upon which Brown and Caldwell rely and to which Brown and Caldwell contribute. In their method, as described in the section on Chapter 4 below, page __, they propose a range given by an upper bound and a lower bound for concentration of each pollutant. For the treatment measures that they consider, if the baseline is outside the range they propose and if the pollution reduction does not result in a concentration within the range, then they propose *omitting* the pollutant from the analysis and setting any derivative benefits equal to *zero*. In this way, their method *eliminates* benefits of pollution control from the benefit estimate. Also in their method, if the baseline they use in their analysis places a pollutant below the range they propose, then they omit any benefits from controlling that pollutant. For many pollutants Brown and Caldwell analyze, their baseline is a constant value below the range they propose. To the contrary, the actual level of pollution randomly varies geographically and over time, so that the method proposed by Wilchfort, Lund, and Lew arbitrarily omits benefits of pollution control. The variation in pollution run-off from CalTrans roads and highways is typically higher than the baseline established by Brown and Caldwell for most pollutants.

4. Chapter 4: Treatment Options and Pollution Reduction

The goal of a benefit-cost test is to measure the economic value of a change in environmental quality. Having established the reference or baseline condition, it is then necessary to determine the expected concentrations of the pollutants after the implementation of the appropriate treatments. Those estimates are then projected over the relevant time period such that the expected and baseline conditions could be compared in each year. Although there are numerous treatment options, the pollution reduction potential of the various treatment options should be well understood, and estimates should therefore be made with a considerable degree of certainty.

The importance of selecting the most efficient treatment option for a given situation cannot be overstated. The efficient option is that which achieves the desired result at the minimum cost. This definition is not theoretical: successful firms continually strive to improve the quality of their output while reducing production costs. Failure to do so would compromise the long term performance of the firm by eliminating the profits that would have been earned as a result of cost reductions. The same logic applies to the problem of pollution control: the analysis must make every effort to include the most efficient treatment options so that estimates will reflect the optimal results of treatment.

Selecting the treatment option may determine whether the benefits of treatment are greater than the cost. The treatment option determines treatment costs and the reduction in pollution concentrations in surface water run-off. The reduction in pollution can be subtracted from the baseline to estimate the expected level of pollution concentration in surface water run-off after treatment, and so affect the benefits from treatment.

Economies of scale occur when the average cost of treatment falls with the amount of treatment. This chapter establishes that Brown and Caldwell are aware of economies of scale in treatment options for surface water run-off. Yet, for the benefit-cost test by Brown and Caldwell, the three levels of treatment they consider are for only one treatment option, the option with the least economies of scale. Indeed, watersheds exist in District 7 with potential for economies of scale, but Brown and Caldwell did not select those watersheds for the study site. Within the Brown and Caldwell study site, treatment options exist with potential for economies of scale, but again these options are not selected by Brown and Caldwell for analysis. Finally, for the treatment options common to both studies, discrepancies exist in treatment effectiveness between Brown and Caldwell and Wilchfort, Lund, and Lew, further diminishing the utility of these studies.

The treatment option Brown and Caldwell analyze for the Santa Monica Bay region is CalTrans-only roads. For the Ballona Creek watershed, Brown and Caldwell analyze CalTrans-only treatment and joint treatment of all roads. Appendix 4A reveals that Brown and Caldwell believe that CalTrans-only treatment results in controlling 3% of the pollution in the surface water run-off. Since the analysis is confined to 40 out of 365 days in the year, this amount is further reduced to a small fraction of the 3%.

5. *Chapter 5: Identification of Benefits*

An economic valuation of the benefits of controlling surface water run-off will produce estimates that are biased downward if the analysis excludes categories of benefits. Each study omits benefit categories contained in the other, even though the two studies both include the Ballona Creek watershed. Comparing categories of benefits identified by the LARWQCB(1997) and the Santa Monica Bay Restoration Project (1994) with the benefit categories identified and included in the studies by Brown and Caldwell and Wilchfort, Lund, and Lew chapter shows that the latter studies exclude categories of benefits.

In their study of the benefits of the Ballona Creek watershed, Wilchfort, Lund, and Lew actually count only four benefits for only forty days of the year: 1) UCLA team rowing in the mouth of Ballona Creek, 2) bicycling along the edge of Ballona Creek, 3) 200 sailboats that dock in Marina del Rey, and 4) 12 commercial vessels docked in the marina that engage in shellfishing and dinner cruises. Although they discuss many other benefits, none are part of their benefit estimate that they ultimately compare against costs. This contrasts with 14 existing and 2 potential beneficial use categories for the Ballona Creek watershed, according to the Los Angeles Regional Water Quality Control Board (1997).

In their study of the benefits of the Santa Monica Bay watershed, Brown and Caldwell actually only count one benefit for only forty days of the year: habitat. They simply calculate the distance (omitting distances along concrete lined drainage channels) of each creek from a CalTrans freeway or highway to the Santa Monica Bay. They multiply this distance times a 50 foot stretch on each side of the center line of the creek to obtain wildlife habitat [Brown and Caldwell, p. 8-22]. Although they discuss other benefits, none are part of their benefit estimate that they ultimately compare against costs. This contrasts with 20 beneficial use categories that exist for the Santa Monica Bay, according to the Los Angeles Regional Water Quality Control Board (1997).

Ballona Creek is within the Santa Monica Bay watershed. Brown and Caldwell count wildlife habitat along Ballona Creek in their computations, a benefit ignored by Wilchfort, Lund, and Lew. Wilchfort, Lund, and Lew count team rowing, bicycling, sailing, and commercial vessels as benefits in their computations, benefits ignored by Brown and Caldwell. These contradictions result in both studies omitting benefit categories that the other includes, biasing downward their benefit estimates. Further, the inconsistencies between these studies demonstrates the arbitrary nature of the approach in each study.

Brown and Caldwell decide not to calculate any benefit for the use of Dockweiler Beach, although the 75,000 to 600,000 people who engage in Water Contact Recreation there on a daily basis (Wilchfort, Lund, and Lew 1996: pg. 24) are much more than "potential," the status given by Brown and Caldwell and which is inconsistent with the LARWQCB. Brown and Caldwell exclude Commercial and Sport Fishing and Shellfish Harvesting from any of the receiving waters of Ballona Creek or Malibu Creek, shown in Table 5-4, but these are common and valuable activities all along the Southern California coast, and this exclusion is inconsistent with the LARWQCB (1997, pp. 75, 103). Also shown in Table 5-4, Brown and Caldwell assume that the receiving waters from either Malibu Creek or Ballona Creek exclude Marine Habitat, or Rare-Threatened-Endangered Species, contrary to the LARWQCB (1997, pp.75, 103). The LARWQCB (1997, p.103) lists the nearshore and the offshore zones as receiving reaches of Ballona Creek. For Ballona Creek, the LARWQCB lists Estuarine Habitat, Preservation of Biological Habitat, Migration of Aquatic Organisms, Spawning-Reproduction-Development, and Wetland Habitat as benefits, all omitted by Brown and Caldwell.

Brown and Caldwell ignore navigation, inconsistent with both the LARWQCB and with Wilchfort, Lund, and Lew, especially since Brown and Caldwell incorporate the latter report by reference.

For Ballona Creek, Brown and Caldwell ascribe only two existing beneficial uses compared to 14 existing uses identified by the LARWQCB, and compared to 12 initially identified by Wilchfort, Lund, and Lew. The latter study pares their initial list to 8 existing beneficial uses after a site visit, inconsistent with Brown and Caldwell.

Of the 20 benefit categories listed by the LARWQCB, in their final analysis comparing benefits to costs for the Santa Monica Bay watershed, Brown and Caldwell (p.8-21) only count Freshwater Habitat in their actual benefit calculation. Through similar logic that is critiqued in the section on Chapter 6 below, page __, Wilchfort, Lund, and Lew eliminate all but four benefit categories for computation of benefits for the Ballona Creek watershed: 1) UCLA team rowing in the mouth of Ballona Creek, 2) bicycling along the edge of Ballona Creek, 3) 200 sailboats that dock in Marina del Rey, and 4) 12 commercial vessels docked in the marina that engage in shellfishing and dinner cruises. The rest of the benefit categories are missing in the numerical comparison with cost.

Brown and Caldwell (p. 8-20) decide to ignore the commercial boating harmed by trash and debris that were identified by Wilchfort, Lund, and Lew, and only consider private pleasure boats. Because "there is insufficient data at present to estimate the value of shellfishing in Santa Monica Bay" (Brown and Caldwell, p.21), that aspect of commercial boats moored in the Marina at Ballona Creek is ignored. Since Brown and Caldwell determine that treatment of CalTrans facilities alone would not substantially reduce trash and debris, they decide that the value of control to private pleasure boats is not worth calculating.

Viewed as a whole, the pattern of omitting benefit categories is extensive, permeating both analyses. These omissions range across the spectrum, geographically, temporally, and categorically. Here are some major benefit categories that are either omitted wholesale from both studies (Brown and Caldwell, 1996, and Wilchfort, Lund, and Lew, 1996) or major portions of the categories are omitted:

1. <u>Geographic Categories</u>
    a. The majority of CalTrans District 7
    b. Benefits from controlling all pollutants in the watersheds

2. <u>Temporal Categories</u>
    a. Year round benefits
    b. Future increases of benefits

3. <u>Water reclamation</u>

4. <u>Primary and Secondary Income</u>
    a. Dredging in LA and Long Beach Harbors, releasing heavy metals
    b. Dredging in Marina del Rey and King Harbor
    c. Regional economic impacts

5. <u>Property values</u>

6. <u>Health effects</u>

7. <u>Recreation</u>
    a. Contact recreation, particularly at the beach year round
    b. Non-contact recreation
    c. Fishing
    d. Boating

8. <u>Nonuse Benefits</u>

9. <u>Ecosystems</u>

6. *Chapter 6: Method for Relating Changes in Pollution to Changes in Benefits*

The report by Brown and Caldwell displays a number of pollutants and a list of beneficial uses in their analysis of Santa Monica Bay, and yet in their actual computations count only one beneficial use – wildlife habitat. Further, in Brown and Caldwell's analysis, only one pollutant – copper – is included in the actual benefit computation for pollution control (Brown and Caldwell, Table 8.13, p.8-25).

Wilchfort, Lund, and Lew (1996) also consider a list of beneficial uses in their analysis of Ballona Creek, and yet in their actual computations count only five beneficial uses – UCLA's team rowing in the mouth of Ballona Creek, bicycling along Ballona creek, pleasure boating from the Marina, and commercial vessels for dinner cruises and commercial vessels for shellfishing. Since Wilchfort, Lund, and Lew only consider five pollutants at the outset of their analysis, it is less surprising that only four pollutants – oil and grease, fecal coliform, lead, and debris – are included in the actual benefit computation for pollution control (Wilchfort, Lund, and Lew Tables 11 and 12, pp. 26-27).

There are six concepts key to the elimination of benefits and pollutants in the method for estimating benefits proposed and applied by Wilchfort, Lund, and Lew and applied by Brown and Caldwell. Two concepts are general and four are specific. Each is invalid.

One general concept is the selection of the pollutants and the increment of pollution reduction for the benefit computation. The correct way would have been to determine the pollutants and their reduction by the context in which particular pollution control options are considered; for examples, (i) pollution control by CalTrans alone of just CalTrans facilities, (ii) pollution control by CalTrans of CalTrans facilities simultaneously with pollution control by other permit holders, or (iii) joint agency pollution control. A second general concept is diminishing marginal utility.

Four concepts are specific to the method by Wilchfort, Lund, and Lew, which was adopted by Brown and Caldwell: pollution thresholds, linearity of changes in benefits to changes in pollution, legal standards (unrelated to economic benefits) that determine economic benefits and confine links among specific pollutants to specific benefits, and the assumption that the current condition describing the pollution concentration is the same constant everywhere and every time, rather than randomly varying over time and geographically across water reaches.

These matters and their impact on the studies are discussed below.

a. The Increment of Pollution Reduction Determined by the Treatment Option

The size of pollution reduction is a basic consideration. The context in which particular pollution control options are considered includes the "water quality goals … derived from the Clean Water Act of fishable, swimmable waters and a California goal that all fresh water be a potential drinking water source" (Brown and Caldwell, p.iv). Brown and Caldwell acknowledge that the language of the permit explicitly states that water quality control efforts are "… to be evaluated by the total efforts of all the permittees, not on an individual basis" (pg. 8-5). Hence, actions by CalTrans must not be considered in isolation from other efforts to reduce pollution. Consequently, the appropriate levels of pollution reduction should be considered in the context of simultaneous or joint actions with other agencies, whichever of these two is the most cost effective.

In their comparison of the benefits and costs of pollution control for Santa Monica Bay, Brown and Caldwell evaluate the benefits and costs on an individual basis rather than the total efforts of all the permittees. Thus, their analysis violates the language of their permit, but it minimizes the reduction in pollution and so minimizes the benefit.

b. Diminishing Marginal Utility

It is standard economic analysis to apply the concept of diminishing marginal utility to the relationship between pollution reduction and increase in benefits. Diminishing marginal utility is among the most fundamental notions in economic analysis, which states that in any endeavor the largest increase in benefits is derived from the initial amounts, and incrementally less benefit is received from subsequent equal amounts.

The method proposed by Wilchfort, Lund, and Lew is inconsistent with diminishing marginal utility. Wilchfort, Lund, and Lew assume two types of pollution thresholds: the putrid threshold and the noisome threshold. Their reasoning is as follows: the initial reduction in pollution may reap no benefit if the current level of pollution is so putrid that no benefit can be obtained. For pollution reduction in between their putrid threshold and the noisome threshold, their assumption is as follows: as the resource becomes progressively cleaner, equal changes in pollutant concentration yield the same change in benefits. For pollution reduction below the noisome threshold, Wilchfort, Lund, and Lew assume that there is no benefit. Their assumption is that there is equivalency between the noisome threshold and a "pristine" environment. All three levels of pollution – above the putrid threshold, between the thresholds, and below the noisome threshold, are in opposition to the fundamental principle of diminishing marginal utility.

c. Eliminating Pollutants: Inappropriate Use of Legal Standards to Establish Economic Benefit Thresholds, and Arbitrarily Selected Constant Values for the Current Condition

Wilchfort, Lund, and Lew's method eliminates pollutants from the analysis. First, pollutants are eliminated for which the existing level is at or below the noisome threshold. Second, pollutants are eliminated if the existing level is above the putrid threshold and if the reduction in pollution is so small that the expected pollution concentration remains above the putrid threshold.

Brown and Caldwell and Wilchfort, Lund, and Lew also eliminate pollutants from the analysis in three more cases. One is if they cannot establish the pollution concentration. Two is if they cannot find an existing legal standard to establish an economic threshold. Three is if more than one pollutant in a category of pollutants falls in between the two thresholds, and the analysis can be "simplified" by just focusing on one pollutant, ignoring the other pollutants in that category.

Brown and Caldwell begin their analysis by considering only 29 out of 53 pollutants in CalTrans run-off. In their application of the Wilchfort, Lund, and Lew method, Brown and Caldwell next eliminated most of their 27 pollutants from the analysis after selecting among alternative legal standards, and arbitrarily picking constant values for the current condition that fall below the noisome thresholds. Next, Brown and Caldwell ignored pollutants for which they found no legal standard, irrespective of the impact on human health or the ecosystem. They additionally ignored pollutants for which they were not able to determine the current condition.

In their benefit analyses of Ballona Creek, Wilchfort, Lund, and Lew rely on Brown and Caldwell's arbitrary specification of a constant current condition, on Brown and Caldwell's selection of legal standards for economic benefit thresholds, on Brown and Caldwell's elimination of pollutants for which there was no legal standard to establish economic thresholds, on Brown and Caldwell's elimination of pollutants for which they were not able to identify the current condition, and on elimination of pollutants within a category of pollutants. Consequently, Wilchfort, Lund, and Lew only consider five pollutants at the outset of their analysis, which they pare to four.

Brown and Caldwell's constant values for the pollution concentration are arbitrary because they bear no meaningful statistical relationship to the sampled data: they consider only four observations (four storms), their numbers are not estimates of averages, nor do their numbers reflect the variation of the reported actual sampled values.

Consider the following seven ways in which the benefit calculations are minimized. First, Brown and Caldwell consider the 29 pollutants, and ignore the other 24 pollutants identified in CalTrans reports. Second, Wilchfort, Lund, and Lew name the lower threshold the "Unimpaired Use Concentration," implying that the environment is pristine for pollution concentrations below this level. If it is pristine below the standards and the current condition can be found to fall in that category, then they assign zero benefit for further pollution reduction. Third, Brown and Caldwell select from among myriad alternative pollution criteria and standards, choosing the ones that are high rather than low (for example, acute toxicity instead of chronic toxicity). Fourth, Brown and Caldwell choose the current pollution concentration levels from selected samples and reports of water quality for which the concentrations are in the low end of the typical range reported in CalTrans studies. Fifth, Brown and Caldwell eliminate pollutants for which the assumed current condition is lower than the selected standards. Sixth, Brown and Caldwell eliminate from the analysis pollutants for which there are standards but for which no value is presented for the current condition, even though there are procedures for sampling and even though samples and studies exists with values for those pollutants. Seventh, Brown and Caldwell eliminate from the analysis pollutants for which no standard is presented. Then most pollutants are ignored in the calculation of the benefits of pollution control. In fact, at this stage of their analysis, the only candidates are Total Suspended Solids, Oil & Grease, Total Coliform, Fecal Coliform, Antimony, Copper, Lead, and Zinc.

Brown and Caldwell next eliminate antimony and zinc from their analysis. Brown and Caldwell do not explicitly explain why they eliminate antimony and zinc from the analysis. They also eliminate Total Suspended Solids, but add tons of debris. Brown and Caldwell (p.8-15, Table 8.4) thereby pare the analysis down to only consider Debris, Oil and Grease, Total Coliform, Fecal Coliform, Copper, and Lead.

At this point, the analyses of Wilchfort, Lund, and Lew and Brown and Caldwell slightly diverge. Wilchfort, Lund, and Lew only specify upper and lower thresholds for Debris, Oil & Grease, Fecal Coliform, and Lead; they do not explain why they ignore total coliform or copper. Brown and Caldwell only specify upper and lower thresholds for Debris, Oil & Grease, Fecal Coliform, Copper and Lead; they do not explain why they ignore total coliform.

Thresholds selected by Brown and Caldwell are not consistent with legal standards nor consistent with thresholds selected by Wilchfort, Lund, and Lew. The lower threshold for fecal coliform has been doubled from the legal standard, and that the lower thresholds for lead and copper do not match the legal standards. The upper thresholds for the effect of oil and grease on Navigation do not match when comparing the study by Brown and Caldwell to the study by Wilchfort, Lund, and Lew. Brown and Caldwell simply ignore the impacts of debris, oil and grease, and lead on recreation, while Wilchfort, Lund, and Lew do not.

Setting thresholds for economic benefits on the basis of legal or quasi-legal mandates is arbitrary and inappropriate. There is no basis in economics, public health, law, or common sense to accept the fiction that economic benefits of pollution control are zero when pollution is reduced below legal standards. Some standards are mandated strictly by health risks, while others pass a benefit-cost test. A standard that passes a benefit-cost test does not give the pollution level where benefits are zero; it may give the level where the additional benefits equal the additional costs. For the category of metals, EPA has protocols for measurement and ambient water quality criteria for acute and chronic toxicity an for human health for antimony (Sb), arsenic (As), cadmium (Cd), trivalent chromium (Cr III), hexavalent chromium (Cr IV), copper (Cu), lead (Pb), mercury (lig), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), and zinc (Zn). The standards for acute toxicity are not the same as those for chronic toxicity. In these cases there are a plethora of alternatives from which a threshold could be chosen for these pollutant, using the method by Wilchfort, Lund, and Lew. The method by Wilchfort, Lund, and Lew gives no guidance to relate these standards to economic value, and so there is no basis for selecting among the alternatives. This is yet another example of the arbitrariness of the method proposed by Brown and Caldwell, and Wilchfort, Lund, and Lew.

Some of the thresholds are simply made up. Wilchfort, Lund, and Lew admit as much.

d. <u>Eliminating Benefits by Confining Benefits to Water Pollution Standards</u>

Having winnowed the list of pollutants to a handful, Wilchfort, Lund, and Lew's method for benefit estimation confines the types of beneficial uses to pollutants for which a water quality standard is specified to protect a particular beneficial use. There is no basis in economic theory for this elimination of benefits. Tables 6-7 and 6-8 also highlight this assumption in the method. For example, neither study considers the impact of fecal coliform, debris, or oil and grease on habitat, nor the impact of debris on contact recreation. Wilchfort, Lund, and Lew do not consider the impact of oil and grease on shellfish.

There are 20 beneficial uses given in Table 5-6, but Table 6-3 shows that Brown and Caldwell present legal standards that relate pollutants to only five columns that represent beneficial use impacts. The fifth column is labeled "other" but this column only has six entries. Most beneficial uses are omitted because there is no legal standard to artificially create an economic threshold. Thus, the method proposed by Wilchfort, Lund, and Lew, and Brown and Caldwell, simply assumes that reducing most pollutants has zero economic benefit. This is another example of the bias inherent in their proposed method for benefit estimation.

Of the 20 beneficial uses listed by the LARWQCB (see Table 5-7 above) for Santa Monica Bay, Brown and Caldwell omit 12 beneficial uses because they have no threshold.

e. Brown and Caldwell's Changes in Benefits from Changes in Pollution Concentration for Treating CalTrans-Only Facilities in the Santa Monica Bay Watershed

Wilchfort, Lund, and Lew's method proposes to calculate the increase in benefits due to a decrease in pollution. They propose to multiply the dollar value of the beneficial use that would exist if the environment were pristine times a benefit fraction. The numerator of the benefit fraction is the reduction of pollution concentration between the thresholds that occurs from water treatment. The denominator is the difference between the upper and lower thresholds. Therefore, the fraction is smaller if only a small amount of the storm water runoff is treated, or if the treatment reduces the pollution concentration outside the thresholds. The fraction is also smaller if the thresholds are chosen so that the difference between the thresholds is large.

Therefore, if only CalTrans sources are treated, without considering treatment of other sources of storm water run-off, then the analytical method pre-determines that the benefits will be relatively smaller. If the existing pollution concentration is selected such that it falls near the selected upper or lower bound, then it is more likely that treatment reduces pollution concentration outside the thresholds, and the benefits are smaller. Finally, if treatment reduces the pollution concentration within the thresholds, then both increasing the upper threshold or lowering the lower threshold will lower the benefits. *Again, the analytical method pre-determines that the benefits will be smaller.*

In order to calculate the reduction in pollution from treating CalTrans facilities alone, Brown and Caldwell distinguish between the pollution concentration from CalTrans facilities and the pollution concentration in storm water run-off to calculate the current condition. They do this in low density urban watersheds and in high density urban watersheds for four pollutants: debris, fecal coliform, lead, and copper. This is summarized in Table 6-9.

Based on the thresholds, and current and expected pollutant concentrations, Brown and Caldwell estimate the changes in benefits as a result of CalTrans storm water treatment. Brown and Caldwell find that the removal of CalTrans debris from runoff does not render the creeks and harbors useful during storm events, and the value of treatment to Navigation is therefore also zero (B&C, 1996, p.8-24). Similarly, they find that CalTrans storm water treatment would not reduce fecal coliform levels below the 5000 MPN/100mL threshold, so the value of improved water quality to Contact and Non-Contact Recreation is zero (B&C, 1996, p.8-24). According to Brown and Caldwell, only Habitat will enjoy a 4% increase in benefit value as a result of CalTrans storm water treatment since current concentrations of copper and lead are below the upper thresholds. They calculate the benefit from copper reduction and omit the calculation for lead.

f. Wilchfort, Lund, and Lew's Changes in Benefits from Changes in Pollution Concentration for the Ballona Creek Watershed

Wilchfort, Lund, and Lew present two benefit calculations for the Ballona Creek Watershed. One is the benefit of CalTrans-only treatment facilities. The second is the benefit of jointly treating the watershed at the mouth of the creek.

For both benefit calculations, Wilchfort, Lund, and Lew eliminate categories of effects of pollutants on beneficial uses. They eliminate the impact of lead on water contact recreation by establishing a threshold for lead in sediment that is higher than the selected value describing the current concentration (prior to treatment). Since lead is the "representative pollutant" in the metals category, they assume that no other metal affects water contact recreation. They eliminate the impact of fecal coliform on shell fishing by establishing a threshold that is lower than the treated water condition. Since fecal coliform is the "representative pollutant" in the biological pollutant category, they assume that no other biological pollutant affects shell fishing.

For the CalTrans only benefit calculation, Wilchfort, Lund, and Lew eliminate the impact of fecal coliform on water contact recreation and the impact of debris on navigation. Elimination of these beneficial uses are on the grounds that the pollution levels are above the putrid thresholds after treatment. Even with their method of analysis, this result should not hold for their benefit calculation of joint treatment, because joint treatment would reduce the pollution by a much greater amount to a level below their putrid threshold; but Wilchfort, Lund, and Lew do not consider any benefits in their joint treatment analysis that they eliminate by their CalTrans only analysis. As representative pollutants, they assume that no other pollutants in those categories affect those beneficial uses.

After this winnowing process, for the analysis of CalTrans only treatment, only three pollutants actually enter the benefit calculation: oil and grease, lead, and debris. Oil and grease affects pleasure sailboats, the UCLA rowing team, and bicycling. Lead affects commercial vessels that take passengers shell fishing. Debris affects bicycling.

They confine benefits to the wet season. They only count the Winter months when the number of visitors are smaller than Summer, and only for 40 days out of the year for visits, so the benefit estimate is artificially lower. This is yet another example of the bias inherent in their method for benefit estimation.

For the joint pollution control benefit calculation, Wilchfort, Lund, and Lew's approach to benefit estimation contains three critical assumptions. First, they assume that pollution control at the mouth of Ballona Creek will not control any pollutants except those that would be controlled in the CalTrans-only analysis. Second, they assume that the only beneficial uses that will benefit from pollution control are those that were considered in the CalTrans-only analysis. Third, they assume that joint control will not reduce pollution during the dry seasons. The first two assumptions confine the analysis to the same pollutants and beneficial uses as the CalTrans-only analysis. The third assumption restricts the increase in benefits to 40 days in the year and reduces the number of people to smaller Wintertime use numbers.

Even though treatment level 3 eliminates between 95% and 100% of all pollutants, it is claimed that the benefit fractions for level 3 treatment are only 4% for oil and grease, 5% for lead that affects shellfish, and 10% for debris that affects non-contact water recreation. For oil and grease, and for debris, the reason is that the putrid thresholds are extremely high relative to the single numbers representing pollution concentrations prior to treatment; hence the denominator of the fraction is large. For lead, the reason is that the single number representing pollution concentration prior to treatment is just slightly above the legal standard.

While level 3 treatment removes almost all pollutants, the only pollutants that have significant "benefit multipliers" are for the effect of fecal coliform on water contact recreation, and the effect of debris on navigation. But the only water contact recreation considered by Wilchfort, Lund, and Lew is the UCLA rowing team, so the increase in benefit is confined to a small number of beneficial users.

Moreover, eliminating debris only provides small changes in benefits to those who sail pleasure boats and to navigation by commercial vessels. The reason for these results is that Wilchfort, Lund, and Lew's method proposes two alternative means for calculating benefits when more than one pollutant affects a beneficial use. One method is to select the smallest "benefit multiplier" from among the pollutants and use it. Since oil and grease also affects pleasure boating, and the benefit multiplier for oil and grease is 4%, that small percentage – rather than the 94% multiplier for debris on navigation – is the one they propose to use. Since fecal coliform and lead also affect shellfish, and their benefit multipliers are 0% and 5% respectively, then the smallest benefit multiplier is zero, so the benefit to shell fishing is zero. The second method uses an average of the "benefit multipliers". For this method, when two out of three of the multipliers are close to zero, the average cannot be very large.

g. Multiple Pollutants Affecting One Beneficial Use

For beneficial uses that several pollutants affect, Wilchfort, Lund, and Lew use two alternative methods to select the benefit multiplier: the "Limiting Pollutant Method" (LPM) and the "Averaging Method" (AM). Neither the LPM nor the AM account for synergistic effects of multiple pollutants, nor the cumulative impact of multiple toxins, each of which may be below some threshold.

When discussing their relative merits, at first Wilchfort, Lund, and Lew state: the LPM "assumes that the benefit value of management measure is limited by the pollutant that has the most adverse impact on the beneficial use" (Wilchfort, Lund, and Lew Appendix B, p.8). One might assume that this means to use the multiplier of the pollutant that does the most damage. For example, toxins are a threat to health for water contact recreation, while turbidity affects the visual ascetics. Yet in just this type of example, Wilchfort, Lund, and Lew select the multiplier for turbidity rather than the multiplier for toxins in an example to illustrate their method (Example A.4, p.8, Appendix B, Wilchfort, Lund, and Lew). The LPM actually means: *use the smallest from among all the pollutant multipliers that apply to a beneficial use.*

Wilchfort, Lund, and Lew do not use the LPM method for the "bottom line" calculation for comparing benefits and costs (Wilchfort, Lund, and Lew, Tables 15 and 16, pp.28, 30). Instead, they use the "Averaging Method" (AM). The AM, however, is nearly as erroneous.

For example, suppose that three pollutants, A, B, and C all affect a beneficial use but in unrelated ways. Further suppose that the pollution concentration of A is so high that, by itself, it would eliminate 100% of the value of the beneficial use. Further suppose that the pollution concentration of B is so low that, by itself, it would only eliminate 5% of the value of the beneficial use. Finally, suppose the analyst can identify a pollutant C that is defined as doing no damage because the noisome threshold is selected to be higher than the constant value selected to represent the pollution concentration prior to treatment. Suppose that treatment is 100% effective for all three pollutants, resulting in restoration of 100% of the value of the beneficial use.

In this example, the separate benefit fractions for pollutants A, B, and C are 100%, 5%, and 0%. The AM procedure calculates a simple average (100+5+0)/3 = 35%. Even though treatment changes the benefit from 0% to

100%, only 35% of the value of the beneficial use is permitted in the Wilchfort, Lund, and Lew AM procedure.

The reader may say, surely no method for calculating benefits would simply add pollutants to the analysis and average zeros into a benefit multiplier, lowering the number. Because of the inherent bias, certainly no such method would be acceptable to a genuine peer-review process. In the Wilchfort, Lund, and Lew method, the calculation of the beneficial use of commercial vessels for joint treatment of water at the mouth of Ballona Creek does just that. In that calculation by Wilchfort, Lund, and Lew, the separate benefit fractions for fecal coliform, lead and debris are 0%, 5%, and 94%, and the average is 33%, the benefit multiplier they used for commercial vessels.

h. The Size of the Decrement Under Consideration: CalTrans Only Treatment vs. Simultaneous or Joint Treatment as the Basis for Selecting the Decrement of Pollution Concentration

Wilchfort, Lund, and Lew recognize that the benefit-cost comparison should include a joint treatment option. They perform a benefit cost calculation for joint control of pollution at the mouth of Ballona Creek. Brown and Caldwell only analyze the benefit-cost trade-off for CalTrans-Only Treatment in the Santa Monica Bay watershed.

The Maximum Extent Practicable (MEP) standard places on the storm water discharge permit applicant the responsibility to prove that any best management practices (BMPs) eliminated or not considered were indeed less effective and less efficient than the option selected. The definition of MEP requires that the selection of BMPs be a thorough and comparative effort. This view is supported and expanded upon by the language of the Los Angeles County 1996 NPDES Permit (8.1.4, pg. 8-5). It states that "… permittees are required to implement a comprehensive pollution prevention and management program [which]… consist[s] of a combination of best management practices, control techniques, system design and engineering methods" (LA Storm Water Permit 1996b, quoted in Brown and Caldwell 1996, pg. 8-5).

The marginal analysis by Brown and Caldwell is surprising since they acknowledge that they are legally obligated to consider best management practices that treat all sources of pollution, not just pollution from CalTrans sources. They also acknowledge that they are legally obligated to consider regional solutions, such as water reclamation and treatment. Brown and Caldwell acknowledge that the language of the permit explicitly states that water quality control efforts are "… to be evaluated by the total efforts of all the permittees, not on an individual basis" (pg. 8-5). It is then clear that proper usage of a maximum extent practicable standard goes well beyond the isolated efforts of a single entity and must instead be a function of the collaborative efforts of all polluters discharging in a given region. This again refers to the MEP definition and the responsibility to explore all available combinations of options on widely applied basis.

Wilchfort, Lund, and Lew use marginal analysis to estimate the benefit of pollution control from CalTrans roads and facilities only. They also marginalize the analysis by considering the incremental reduction in pollution from Level 1 treatment, then the additional incremental reduction in pollution by going from Level 1 to Level 2 treatment, then the additional incremental reduction in pollution by going from Level 2 to Level 3 treatment. Brown and Caldwell estimate that the pollution flowing into Ballona Creek from CalTrans roads and facilities is a small portion of the total pollution concentration flowing from Ballona Creek into Santa Monica Bay. This small reduction in pollution is made smaller by increments from one treatment Level to another.

Consequently, by marginally decreasing pollution only from CalTrans roads and facilities, one level at a time, most benefit from pollution control is zero: either the pollution concentration exceeds the "fully impaired threshold" or falls below the "unimpaired threshold". These thresholds result in what is technically called non-convexity.

In his undergraduate textbook, Goodstein (1995, pp. 529-538) explains that "when nonconvexities are present, … marginal analysis will no longer provide a reliable guide to the efficient level of pollution control" (p.531). This is a well-known result. The non-convexity in the Wilchfort, Lund, and Lew methodology is caused by their establishment of unimpaired and fully impaired use thresholds. In essence, they assume that small amounts of pollution, below the "unimpaired threshold", are harmless, and that there is no benefit from reducing excessive pollution beyond the "fully impaired threshold" because the environment has no use value if polluted that much. The non-convexity assumption is shown in Figure 6-2. Figure 6-2 corresponds with Figure T1.1C of Goodstein (1995).

The method proposed by Wilchfort, Lund, and Lew cannot be used to correctly estimate small changes in pollution unless it drops the assumptions of thresholds, or the incremental analysis of benefits and costs. As Goodstein (1995) wrote, "when nonconvexities are present, … marginal analysis will no longer provide a reliable guide to the efficient level of pollution control" (p.531).

The criticism of this section also applies to Brown and Caldwell (1996). They apply incremental analysis of treating only CalTrans runoff to Santa

Monica Bay, at increments of Level 1 treatment, the incremental difference between Level 1 and Level 2 treatment, and the incremental difference between Level 2 and Level 3 treatment. They use the non-convexity approach of Wilchfort, Lund, and Lew (1996), based upon "unimpaired thresholds" and "fully impaired thresholds". They also fail to consider a regional treatment option, a source of non-convexity in costs with a level of benefits that they do not estimate. Because their analysis combines non-convexity in benefits with incremental analysis of CalTrans pollution control only, and incremental treatment levels, their analysis "will no longer provide a reliable guide to the efficient level of pollution control" (Goodstein, 1995).

7. Assigning of Dollar Values to Benefits and Literature Review

The method for estimating the benefit of reducing pollution in surface water run-off proposed by Wilchfort, Lund, and Lew and adopted by Brown and Caldwell is not an established method that is accepted in the peer review literature. The existing literature does include methods to estimate benefit categories omitted by these two studies (Brown and Caldwell, 1996, and Wilchfort, Lund, and Lew, 1996). This chapter reviews estimates of benefits that could be transferred and applied to the study areas of these two studies. Finally, this chapter reviews methods and complementary data applicable to the study areas that could be used to estimate benefits omitted by the two studies.

A review of the literature establishes:

- The method proposed by Wilchfort, Lund, and Lew , and relied upon by Brown and Caldwell, does not exist in the peer-reviewed literature.

- Established methods do exist to value recreational use benefits of improving water quality.

- A recently developed method and its variants (contingent valuation and contingent ranking) can be used to value ecosystems and non-use benefits of improved water quality.

- The contingent valuation method took several decades to develop and mature in the peer-review literature, culminating in acceptance by a panel of eminent economists, including Nobel Laureates, and continues to be refined in the literature today.

- Use of contingent valuation in legal proceedings has passed legal tests, including formal acceptance by the courts and acceptance by several government agencies in adopted regulations.

- The method proposed by Wilchfort, Lund, and Lew should not be relied upon. The method is not accepted by economists as a valid method of estimating benefits.

Literature Review

A literature review identifies four approaches for valuing environmental quality: the use of averting behavior, weak complements, hedonic market methods, and contingent valuation. The first three methods are indirect market methods (sometimes called revealed preference methods) in that they use information about market decisions to avoid damage from pollution (weak substitutes), or market decisions to buy complements to environmental quality (trips for recreation, for example). The earliest of these approaches was developed in the 1950's, and these approaches have been used to value the recreational benefits of improved water quality since 1978, with literally hundreds of peer review articles and books. The method proposed by Wilchfort, Lund, and Lew is not among these four approaches.

The most recently developed method has been refined for over two decades in the peer review literature, reviewed and accepted by government agencies, reviewed by a panel of distinguished economists, and accepted by the courts. The method proposed by Wilchfort, Lund, and Lew has only been reviewed once, and this is that review.

In 1989 the District of Columbia Court of Appeal (Ohio v. The United States Department of Interior) accepted the inclusion of nonuse value as part of the benefits to be measured under *CERCLA* (*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 U.S.C. 9601-9675). Under the Oil Pollution Act of 1990, NOAA (1994) issued regulations accepting CV as a method to measure the benefits from environmental amenities. The contingent valuation (CV) method is used to estimate nonuse values.

A panel of experts convened by NOAA (1994), including two Nobel Laureates, Kenneth Arrow and Robert Solow (Arrow, et al., 1993), designed protocols for Contingent Valuation (CV) studies that are strict enough to be able to replicate results, "estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive use values" (Arrow et al., 1993).

The literature review establishes categories of benefits that are omitted by Brown and Caldwell and Wilchfort, Lund, and Lew . General categories of benefits include secondary income, property values, recreation, nonuse values, and values of ecosystems. First, some comments apply to all the categories of benefits.

a. <u>Year-Round Benefits</u>

Wilchfort, Lund, and Lew and Brown and Caldwell assume that benefits from pollution control occur in 40 out of 365 days, and assign zero benefits to the other 325 days. In this review of the literature, no other study has done so.

b. <u>Water Reclamation</u>

Wilchfort, Lund, and Lew discard water reclamation as an option. Brown and Caldwell ignore it. Wilchfort, Lund, and Lew ignore the possible beneficial use of reclaimed water on specious grounds. They omit the value of additional water.

c. <u>Secondary Economic Effects</u>

Pollution generally makes an area less desirable. There will be secondary economic effects on local businesses whose success is closely tied to the quality of the area. The demand for recreation is a function of the environmental quality. Visits to the beach, harbor, and wetlands, are a function of the level of pollution. These visits bring business to the local economy, and the reduction of visits from pollution is harmful to the local economy. Wilchfort, Lund, and Lew and Brown and Caldwell excluded an estimate of the secondary economic effects.

d. <u>Property Values</u>

Beneficial uses such as cycling, fishing and boating are adversely affected by pollution, and so too are property values in the surrounding areas. The number of homes and commercial establishments near the Ballona Wetlands (and other areas impacted by pollution), the distance to the wetlands, and the present property values could be ascertained. The increase in property values from improving the wetlands and other impacted areas could be inferred from the literature if site specific estimates are deemed too expensive. Wilchfort, Lund, and Lew (1996) and Brown and Caldwell (1996) exclude the impact of changes in property values.

e. <u>Health Effects</u>

Ill-health effects avoided are additional benefits of pollution control. The level of pollution affects the value per hour of recreational experiences, and the frequency and duration of visits, all of which affect the benefit of recreational use. In addition, if we have ill effects from exposure to pollution, ill effects that can be avoided or reduced by pollution reduction, those are additional benefits. Haile, et al.(1996) estimate the frequency of illnesses that occur to swimmers. The amount that we are willing to pay to avoid the symptoms of ill-health is a topic covered in the literature (Hall et al., 1992 and references therein). Wilchfort, Lund, and Lew and Brown and Caldwell omit the economic value of ill-health effects avoided by pollution reduction.

f. Recreation Demand

One error in the method proposed for benefit estimation by Wilchfort, Lund, and Lew is that the demand for recreation visits does not depend on the level of pollution. A second error is their assumption that the marginal utility of benefits is linear. A third error is their transfer of benefit estimates between dissimilar recreation activities and dissimilar locations. A fourth error is the omission of categories of recreation benefits. The methods in the literature do not make these errors.

(1) Approach of Wilchfort, Lund, and Lew

Wilchfort, Lund, and Lew derive the marginal benefit of improvements in water quality and compare them with the marginal costs. Their first step was to list recreation activities and define the pollutants which affect those activities. For each benefit, they select pollution thresholds at which beneficial uses would be "unimpaired" and "fully impaired". For small reductions in pollution, they calculate a "benefit multiplier" that is a fraction less than one. For a pollution treatment option, pollution falls from the present level to a marginally cleaner level. The fraction used as a benefit multiplier equals the portion of pollution reduction that falls within the "unimpaired and "fully impaired" thresholds. They multiply this fraction times their estimate of "unimpaired" recreation benefits. Thus, they assume a linear relationship between pollution emissions and the percentage of unimpaired beneficial value available (benefit multiplier).

Wilchfort, Lund, and Lew derive multipliers for each pollutant. When, in their judgment, a form of recreation is affected by more than one pollutant, they propose an average to derive a composite multiplier for the type of recreation.

Wilchfort, Lund, and Lew refer to some literature to justify an hourly benefit of recreation. They multiply their hourly benefit times their estimate of the number of hours of recreation in a visit to obtain the benefit of a visit, and multiply this times the number of visits during the 40 rainy days in the year:

Benefit/Hour x Hours/Visit x #Visits/40 storm days = Total "Unimpaired" Benefits

Wilchfort, Lund, and Lew multiply their estimate of the unimpaired beneficial use value times the fractional benefit multiplier to estimate the marginal benefit from the incremental changes in water quality:

Marginal Benefit = "Unimpaired Benefit x fractional benefit multiplier

This multiplication is where Wilchfort, Lund, and Lew implicitly assume constant marginal utility of recreation.

As pointed out in the previous chapter, for most recreation categories neither Brown and Caldwell nor Wilchfort, Lund, and Lew have a benefit multiplier (for example, if they assume no effect from pollutants); in those cases they set the multiplier equal to zero and ignore the benefit. For those categories of recreation where the reduction in pollutants falls outside the thresholds, the fractional benefit multiplier is set to zero and those benefits are ignored. For any remaining categories of recreation, the size of the fractional multiplier reduces their estimate of 40 storm days of beneficial losses to a fraction of their estimated "unimpaired" benefits.

Compare the approach by Wilchfort, Lund, and Lew to the calculations by Hanemann. Hanemann identifies three forms of losses to recreators due to pollution: (i) losses from trips not taken, (ii) losses from trips taken to other, less desirable sites, and (iii) losses from trips taken to the site, but with diminished value because of the pollution. Wilchfort, Lund, and Lew's method at best incorrectly accounts only for the third item in Hanemann's list of benefits.

(2) Number of Visits Depends on the Amount of Pollution

One of the assumptions by Wilchfort, Lund, and Lew (1996) is that the number of visits to a recreation site is independent of the amount of pollution. This assumption is inconsistent with the literature.

In calculating the unimpaired benefit value, it is essential to understand that the quantity demanded of beneficial uses is a function of the level of pollution. A cleaner area will attract more people, thereby increasing the number of visits, and therefore the total benefit value. This is a basic point in the literature survey by Cropper and Oates (1992).

Since the quantity demanded for recreation depends on the pollution concentration, pollution emissions can affect the use. For their method, Wilchfort, Lund, and Lew state in Appendix B that incorrectly using the impaired benefit instead of the unimpaired benefit will bias their benefit estimates downward. But that is precisely what they do since they assume that the number of visits and hours per visit are invariant with the level of pollution.

(3) Diminishing Marginal Utility of Recreation Benefits

An implicit assumption of the method by Wilchfort, Lund, and Lew is constant marginal utility, an assumption inconsistent with economic analysis. For example, Parsons and Kealy's (1995) model assumes diminishing marginal utility: net utility and the marginal utility of the recreation dollar (a) diminish as the number of trips taken (T) increases.

(4) Benefit Transfer

Wilchfort, Lund, and Lew value four beneficial uses of Ballona Creek and its reaches. Their terminology and the actual use are presented in Table 7.15, as well as the value per unit of recreation which they state is from a literature review, and a value per unit of recreation they call the "Upper Bound" which they state is a "conservative" number.

In Appendix B, however, Wilchfort, Lund, and Lew provide a reason for using the "upper bound," to avoid an error that their approach may cause. On page 3 of Appendix B, they acknowledge that their estimates could be 75% lower than the those that are internally consistent with their method, unless the use value is adjusted upward to account for the "unimpaired value". If that is so, the upward adjustment may not be "conservative".

In Appendix C, Wilchfort, Lund, and Lew distinguish between the willingness-to-pay (WTP) and consumer surplus (CS). They refer to the WTP as the total value under the demand curve, while the CS is the WTP minus the cost of recreation, typically parking and other user fees but omitting travel cost. They call the cost of recreation "the market clearing price (MCP)", which they arbitrarily set equal to 55% or 45% of the *average* WTP, depending on the recreational activity. The *average* WTP is the WTP divided by a the number of recreation visitors. The *average* CS is simply the *average* WTP times .55 (or .45). They use benefit numbers from the Forest Service Handbook, and divide by 12 hours to get an hourly value. They could get lower values if they divided by, say, 16 hours, or higher hourly values by dividing by 8 hours/day. Their report states, "A RVD is defined as 12 hours of a recreational activity" (Appendix C, p.2). They do not state who defined a RVD. They state that they use the *average* WTP rather than the lower *average* CS because they want to be conservative, and because the Forest Service percentages of 45% or 55% may not be accurate (Appendix C, p.3).

In order to consider whether the values transferred from forest service studies to marine recreation by Wilchfort, Lund, and Lew are reasonable, note that the WTP must be larger than the cost of recreation, since the difference must be positive or the consumer would not engage in the recreation. That is, the consumer surplus can not be negative. Consider the value of pleasure boating which Wilchfort, Lund, and Lew believe equals $1.90/hour. One telephone call provided an estimate of the cost of a dock from one of the yacht clubs at Marina del Rey. Guest docks cost $0.50/foot-day, and the median boat is 33 feet, for a total of $16.50/day. Assuming the vessel costs $100,000, lasts for 20 years, and the interest rate is 7%, then the daily capital cost is $25.86. Add a maintenance and repair cost, plus a travel demand cost, equal to 50% of the capital cost, and sum to get $55.29/day. The weekly cost is $387, a cost that must be lower than the weekly WTP. At $1.90/hour, 6 people per vessel, 8 hours of recreation per trip, and three trips per week, the weekly WTP equals $274, a clearly inconsistent result. From this comparison, the value for boating presented by Wilchfort, Lund, and Lew, from forest service studies of boating in mountain lakes, is not representative of the value of ocean marina recreation in Southern California.

For further comparison, Wilchfort, Lund, and Lew base their value of boating on old forest service numbers which they report in their Table 2, Appendix C, p. 4, giving the WTP for a day of recreation in 1989 $ equal to $18 for non-motorized boating and $13 per person-day for motorized boating. Compared to the values in Tables 7.8 and 7.9, Wilchfort, Lund, and Lew have underestimated the value of pleasure boating. Based upon the estimate by Hanemann (1997) of $87/person-day, Wilchfort, Lund, and Lew (1996) have under-estimated the value by five hundred percent. Hanemann's (1994, 1996, 1997) estimates were presented on behalf of the State of California in the *American Trader* Oil Spill case.

(5) Omitted Categories of Impacted Recreation Demand

The analysis by Wilchfort, Lund, and Lew limits benefits to four recreational activities, with benefits adversely affected by only five pollutants. Motor boats and sail boats in Marina del Rey are adversely affected by debris, and oil and grease. Team rowing at the mouth of Ballona Creek is affected by oil and grease, fecal coliform, and lead. Bicycling along Ballona Creek is affected visually by debris, and oil and grease floating in the creek. Twelve commercial boats docked in the Marina that take visitors on dinner cruises, and sport fishers on day trips, are adversely affected by debris that closes the Marina and by shell fish with lead and fecal coliform.

For any method of pollution control, all the benefits of pollution control need to be considered when comparing benefits to costs, not just a subset of benefits. Omitted recreation benefits include year-round benefits, beach visits without water contact, water contact beach visits such as surfing, bird and wildlife viewing, shoreline fishing, and boating (including avoiding closure of Marina del Rey due to polluted silt). Other benefits include higher property values for property adjacent to creeks and wetlands, secondary economic effects, reduced ill-health effects from water contact recreation in the Santa Monica Bay, and cleaner ecosystems with benefits to fisheries, aquatic and wildlife habitat, nonuse values, and the value of reclaimed water.

g. Nonuse Values

The method proposed by Wilchfort, Lund, and Lew, and relied upon by Brown and Caldwell, does not permit the calculation of benefits from non-use values. Consequently, both studies omit all benefits related to non-use values, causing the benefit estimates to be biased downward.

h. Brown and Caldwell's Valuation of Changes in Benefits

Having eliminated from their analysis the vast majority of all available or potential benefits, the change in benefit value is easy to calculate. Based upon the method of Wilchfort, Lund, and Lew, Brown and Caldwell determined that of all potential benefits, the only benefit category that would benefit from pollution control is riparian habitat because the concentrations of lead and copper were in between the "unimpaired" and "fully impaired" thresholds. Brown and Caldwell assume that the benefit of pollution reduction to all other categories zero.

C. Concluding Remarks

A pattern emerges for the studies by Brown and Caldwell and Wilchfort, Lund, and Lew of omitting benefit categories. These omissions permeate their approach to benefit-cost analysis and are the object of their proposed method for estimating benefits.

The geographic and temporal scope the their analyses omits benefits, and inflates costs per unit of treatment. They leave out receiving reaches of the watersheds in their study areas, omitting benefits. They only account for benefits in 40 out of the 365 day year. They fail to account for changes in benefits over time as population and the economy grow.

The CalTrans-only treatment option ensures that relatively less improvement will result for pollution concentration. In their comparison of the benefits and costs of pollution control for Santa Monica Bay, Brown and Caldwell evaluate the benefits and costs of CalTrans-only treatment rather than joint treatment by all the permittees. Thus, their analysis violates the language of their permit.

The benefit estimate by Brown and Caldwell is unreliable. They use the method by Wilchfort, Lund, and Lew which omits nonuse values and most benefit values unrelated to recreation. Their method eliminates most categories of recreation.

The method proposed by Wilchfort, Lund, and Lew, adopted by Brown and Caldwell, and applied by both groups, is not appropriate for analyzing the increase in economic benefits from controlling water pollution. The method is baseless in both economic theory and econometric theory. It requires arbitrary assumptions. It leads to the omission of harmful pollutants from the analysis. It requires the omission of beneficial uses from the analysis. It ignores the variation in pollution concentration over time and watershed. It requires arbitrary choices for computation of benefits – the selection of the benefit multiplier for a beneficial use affected by multiple pollutants.

Their conclusion is that the costs outweigh the benefits of pollution control. Their conclusion hinges on having a low benefit estimate (by ignoring benefits), a high cost estimate (by only considering the most expensive control measures with no economies of scale or scope) and by confining their analysis to CalTrans-only treatment, contrary to law. Their conclusion relies on a method for benefit-cost analysis that does not exist in the peer-reviewed literature.