
RC 2004
Southern California Environmental Report Card 2004
UCLA INSTITUTE OF THE ENVIRONMENT

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RC 2004

From the Director

Mary Nichols, J.D.
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Each year the UCLA Southern California Environmental Report Card examines four important environmental topics, bringing together faculty experts from a wide variety of disciplines to analyze and grade the condition of our region's environment and the performance of the public agencies charged with protecting it. For the 2004 Seventh Annual Report Card, editors Ann Carlson and Arthur M. Winer have tapped authors from public health, law and public policy to address persistent problems of air and water pollution from new angles, and to examine an old enemy—the illegal dumping of trash and toxic wastes—from the perspective of California's first residents, the Native tribes.

There is good news (the improved performance of water quality regulators) and bad news: despite great progress in meeting national air quality standards, mainly attributable to cleaner cars and improved fuels, continued rapid population growth and even faster growth in vehicle miles traveled threaten those gains. While traffic congestion is not a major cause of pollution, drivers stuck in traffic or children playing outdoors near clogged freeways are being exposed to excessive levels of toxic air contaminants. As the essay on congestion shows, our intractable traffic problems also take a heavy toll on the economy of the region. Most disturbing is the mixed news from the front lines of environmental health research: as our ability to measure individual exposure to air pollution advances, we now are learning that a Los Angeles child's daily round trip on a diesel-fueled school bus during rush hour can be riskier than playing outside during a smog alert. As always, the Report Card presents scientific data and objective analysis in a format that is useful to the general public. The focus is on linking the science to policies which could improve the state of our environment, like congestion pricing, in the hope that we can stimulate widespread debate.

This year, one inescapable conclusion emerges from the studies. As a region, we have yet to come to grips with the immense impact our transportation system is having on the environment and public health. Whether it's the piles of used tires on Indian lands, or the pollutant-loaded road dust washing into the creeks and storm drains and out onto the beaches, or the exhaust that is assaulting our lungs as we sit in traffic with the windows rolled up and the air conditioner on, we can't seem to break out of the trap of dependence on petroleum-fueled vehicles. The dream of a non-polluting vehicle, currently focused on hydrogen, seems to be always just over the horizon, and even if the tailpipe emissions are cleaner than the air coming into the engine, continued dramatic growth in the number of vehicles means we may be losing the effort to

Beyond its immediate objectives, the Report Card sends a message about what is important and what should be measured. We hope to build on the University's existing base of expertise to become the leading repository of environmental information about the Los Angeles region.

reduce air pollution. By definition, the status quo is not sustainable.

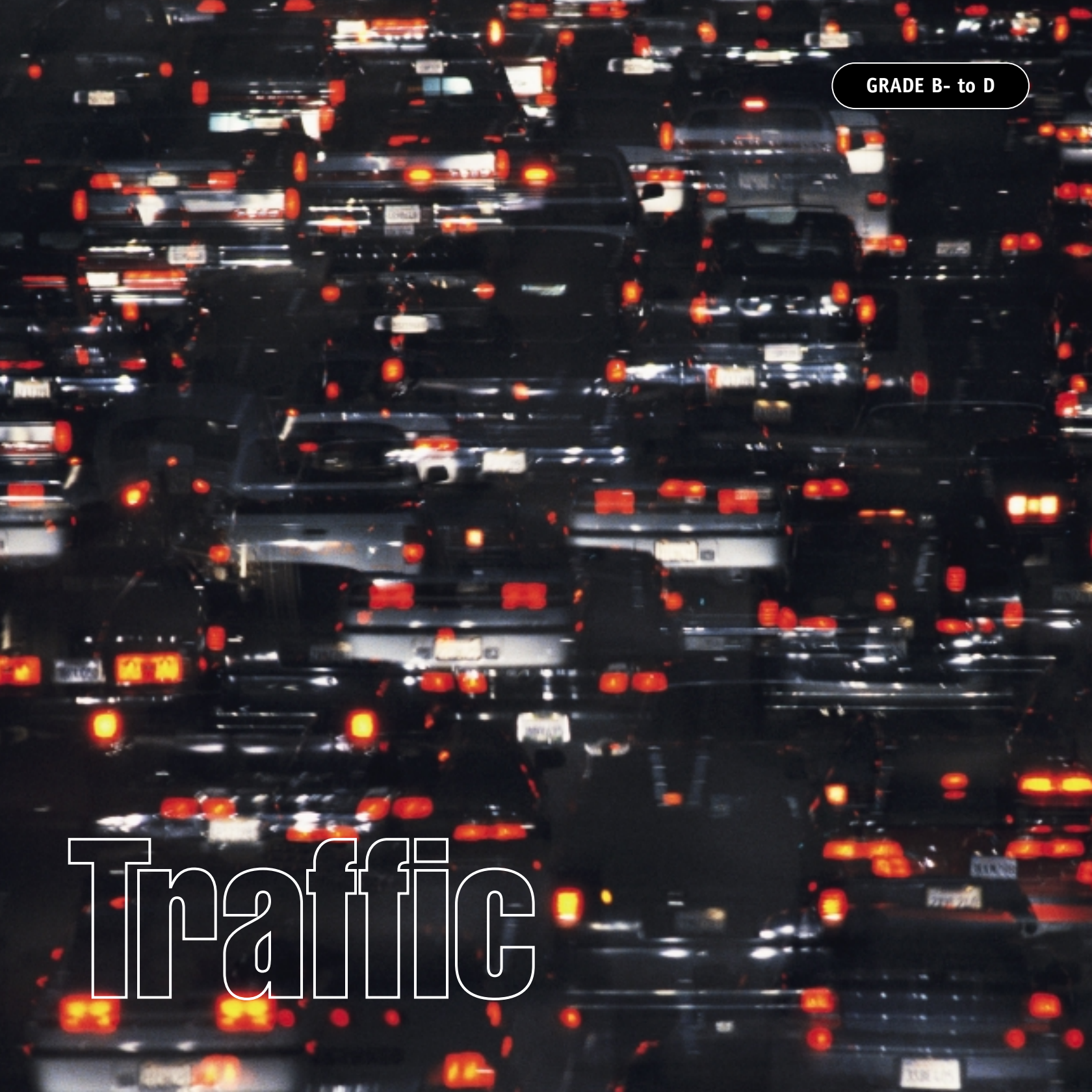
As the new Director of UCLA's Institute of the Environment, I want to take advantage of the editors' invitation to use this space to add some thoughts about the future of this Report Card and how it relates to the future of the Institute. Under the leadership of its first director, Prof. Richard P. Turco, the IoE faculty created the Report Card as a tool for engaging academic research directly with the community. Teachers know that students pay attention to grades. Over the years, the Report Card has become a widely read and frequently cited document. It is the Institute's signature publication.

Beyond its immediate objectives, the Report Card sends a message about what is important and what should be measured. We are looking at ways to expand this concept by creating new indicators of environmental health that can be tracked over time and lead to improved forecasts. These indicators need to be tailored to our dynamic regional environment. As we seek to define the conditions for a healthy and sustainable urban environment in the setting of one of the most biologically diverse regions on earth, new kinds of information will be needed. We hope to build on the University's existing base of expertise to become the leading repository of environmental information about the Los Angeles region. Making use of improved tools for combining and mapping different types of environmental data, we could produce more frequent statistical reports and make the indicators available to land use planners, community groups and businesses seeking to build or expand facilities in the region.

As California's Secretary for Resources, I came to UCLA last October for the release of the 2003 Annual Report Card. I told an audience of administrators, staff, students and friends of the Institute that the Report Card is a highly sophisticated and relevant document for state and national policy, providing a unique opportunity for the University to engage in conversation about the future of the region. I also challenged the audience to move beyond the current high level of analysis toward indicators of environmental sustainability that would be as widely accepted as the Anderson School Economic Survey.

Within a few months, I was invited to join the faculty of the UCLA School of Law as a Professor in Residence, and to lead the Institute of the Environment. It is now my privilege to send the 2004 edition of the Report Card into the world, and to take up the challenge of moving it to the next level. California's lingering economic woes and harsh budget climate for the University make it more difficult to launch new projects at this time. I believe more strongly than ever that we need to deploy the enormous intellectual resources of the University—only a small sample of which are on display in the pages that follow—if we are to fulfill our obligations as stewards of Southern California's precious natural resources.

I invite your ideas and support for this effort. For further information about the UCLA Institute of the Environment and our plans for the future, please turn to the back of the book.



GRADE B- to D

Traffic

by Randall Crane, Ph.D. and Paul Ong, Ph.D., Director, Lewis Center for Regional Policy Studies
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INTRODUCTION

Almost everyone complains about the traffic in Los Angeles, and for good reason. We hold the dubious honor of being the most congested and polluted region in the country. Pollution follows partly from congestion since cars, trucks, and buses are the primary sources of many air pollutants and gridlock exacerbates pollution by causing higher exhaust emissions than free-flowing roadways. In addition, our dependence on cars is said to isolate transit-oriented neighborhoods, rob us of exercise and time, and weaken social ties.

How did we get into this mess and what, if anything, can be done? The short answer is that the region's economic success results in lots of people with lots to do. And, like people pretty much everywhere, they mostly do it by car. Southern California has the 10th largest economy in the world, containing 54% of California's jobs. On the other hand, the state has less road capacity than all but 2 of the 65 largest U.S. regions. Absent more roads, this strained capacity can be relieved only by substantially less driving per person, many fewer drivers, or both.

Either solution would be a neat trick. Traffic is the product of complex interactions involving the level of economic activity, the region's spatial structure, the design of the transportation network, and the choices facing individual travelers. As a result, there is no silver bullet for any one of the associated problems, however much we might wish otherwise.

We cannot do away with traffic and traffic problems altogether, but we can manage them better. So, while it is easy to complain, point fingers, and make promises, it is more useful to clarify our circumstances and opportunities, modest though they may be. To show this, we first look at how this region is performing comparatively, then discuss the policy options and, finally, grade the region's progress in managing traffic problems.

COMPARED TO WHAT?

Table 1 presents recent urban form and transportation data on four U.S. regions. New York and Chicago are comparable to Los Angeles in population size, while Houston has at times been ranked as the region with the worst air pollution, briefly replacing Los Angeles for this dubious distinction.

To begin, note that the reputation of Los Angeles as having extreme low-density sprawl is an urban myth. Los Angeles has a form typical of metropolitan areas that matured during the latter half of the twentieth century. Population density measured in persons per square mile here is low for the metropolitan area as a whole, particularly compared to the New York metropolitan area. Chicago, however, has a lower population density despite being an older region. And the density in Houston is only one-third of that for Los Angeles. When non-urban areas are excluded from the calculations for the larger urbanized complex, Los Angeles is actually more densely settled than the other three, including New York.

Another urban legend is that Los Angeles is disproportionately automobile-dominated. Although the number of personal vehicles per household in Los Angeles is twice as large as in New York, Houston has more cars per person and Chicago is close behind. Moreover, one in eight L.A. households does not own a vehicle. Indisputably, New Yorkers are in

Table 1. Key indicators for metropolitan areas (2000)

	Los Angeles	Houston	Chicago	New York
Urban Form				
Housing Characteristics				
1,000 units per sq. mile, metro area	0.81	0.27	0.62	3.22
1,000 units per sq. mile, urbanized area	2.40	1.11	1.49	2.04
% of units in 10+ Bldg	25%	23%	19%	50%
Highway Roadway				
Lane Miles per 100 Households	1.64	3.50	2.01	0.74
Average number of lanes per direction	2.42	2.24	2.21	2.24
Travel Patterns				
Work Commute				
Car Pool	15.1%	14.2%	11.0%	8.3%
Transit	6.6%	3.3%	12.5%	47.0%
Avg. Time (minutes)	29	29	31	39
Trip Characteristics				
Percent of VMT on Freeway	45%	42%	30%	36%
Congested Peak Vehicle-Miles	89%	68%	80%	69%

Sources: U.S. Bureau of the Census, U.S. Bureau of Transportation Statistics, and the Texas Transportation Institute.

a league of their own when it comes to shunning a car, and this is consistent with their extraordinary reliance on public transit. New York has a transit system that is a quantum leap more extensive than in any other metropolitan area in the U.S. Removing New York from the comparison changes the relative performance of Los Angeles. A respectable number of Angeleno workers share a ride in either a car pool or on public transit, for a combined rate that is similar to that for Houston and Chicago. The number of vehicle miles per person also indicates that Los Angeles is not at the extreme.

Finally, the Texas Transportation Institute consistently ranks Los Angeles as having the worst traffic congestion in the nation, but average commute time for its residents is considerably shorter than for New Yorkers, and roughly comparable to Chicago and Houston.

Despite the mixed results in the comparison of urban form and travel patterns, there is no disputing the air pollution problem in Los Angeles, which the EPA rates as the worst in the nation. Table 2 provides comparative statistics. In 2000, Los Angeles had 88 days of unhealthy levels of air pollution. While this is a dramatic improvement over 1993 (137 unhealthy days), Angelenos suffered noticeably more unhealthy days than their counterparts in the other three regions.

The reputation of Los Angeles as having extreme low-density sprawl is an urban myth.

Mobile sources are a major contributor to air pollution, as the statistics for carbon monoxide (CO) emissions indicate, and cars contribute more to air pollution in Los Angeles than in the other three regions. The amount of CO produced by passenger cars per household in New York is the lowest because a smaller percent of New Yorkers own a car; but interestingly, the emissions per vehicle are the highest for New York, perhaps due to the way New Yorkers drive and/or higher emissions per vehicle. For the other three regions, this indicator is roughly comparable, with Houston faring the worst by a small margin.

Our comparison of urban form and travel patterns indicates that the severity of traffic and pollution problems in Los Angeles is not determined solely by population density or high car use. Other factors such as the physical geography contribute to the problems.

PLANNING PROBLEMS

Transportation planning used to be pretty easy, even in LA. The task was mainly to design streets and highways connecting

Another urban legend is that Los Angeles is disproportionately automobile-dominated.

Table 2. Air pollution indicators for metropolitan areas

	Los Angeles	Houston	Chicago	New York
Air Quality				
Unhealthy days	88	53	16	22
CO dominant days	32	1	1	1
Source of CO Emissions				
Onroad Vehicles	84%	62%	65%	69%
Passenger Vehicles	43%	33%	35%	38%
Passenger Car CO Emissions				
Annual Tons Per Household	0.26	0.30	0.26	0.17
Annual Tons Per Personal Vehicle	0.16	0.18	0.17	0.22

Sources: U.S. Environmental Protection Agency, Air Quality System Database and National Emission Inventory, 2004.

concentrations of people (emerging towns) to where they wanted to go (jobs and commerce). In much earlier times, fixed rail and bus transit played dominant roles in these designs. However, the primary, almost exclusive, focus during the post-World War II era was to build street and highway systems to accommodate the most flexible and convenient mode, the car.

In doing so, planners reinforced patterns of urban and regional development that moved millions of residents and jobs away from the urban core to emerging centers throughout the region. It would be wrong to argue that freeways created the suburbs, but they worked hand in hand with a decentralized economic base, the rapid increase in women in the workforce (which complicates family commuting patterns and increases income availability for larger houses), the tax subsidy for home ownership, and the desire for a single-family home with a backyard.

Moreover, there seemed to be no downside to automobile dependence. Initially, the car was a huge environmental improvement over its predecessor, the horse, until air quality problems were conclusively linked to automobile travel in the 1950s. The displacement of residential neighborhoods and the impact on habitat were at best secondary concerns—at least in the public eye—until the 1960s.

We all know the urban population in Southern California rose rapidly through the last century, but urban travel grew even faster. In the last two decades, total region-wide "vehicle miles traveled" (VMT) nearly doubled while the population rose 44 percent. Capacity grew even less, with arterial and local lane-miles increasing by only 20 percent. Why? Key trends behind travel demand include the steady increase in women in the work force, leading to more drivers per household; the growth in real incomes that raised car ownership levels and lowered the importance of transportation costs in choosing where to live; and the rising proportion of nonwork-related trips (now over 60% of all trips). On the supply side, California highway building became increasingly subject to a fiscal squeeze after the 1960s. Construction costs climbed, driven by escalating urban land prices, while real revenues fell as gasoline tax revenues failed to keep pace with VMT or even inflation.

As the gap between travel demand and roadway construction grew, so did regional congestion. Congestion cost Americans an estimated $70 billion in 2001, from lost time and extra fuel consumption. Public opinion polls show traffic congestion is often cited as one of the most pressing urban policy problems.

In addition to all these demand and supply factors, which often reflect larger demographic and economic trends, we as a society fail to hold individuals responsible for the traffic costs they impose on others. Both air pollution and congestion

We all know the urban population in Southern California rose rapidly through the last century, but urban travel grew even faster.

Traffic congestion is not new,

are classic cases of market failures that create social cost for others, often known formally as *externalities*.

The costs of automobile emissions include the impact on the health of those along the roadways, in the region, and ultimately throughout the world. The cost of congestion is more localized to the extra time that others must spend on the road. Each additional car slows traffic, and while the impact on any one other car is tiny, it adds up when summed across thousands or millions of delayed travelers. All of us ignore how much we slow other cars down, which is at the heart of the problem.

To summarize, pollution is explained by the amount and congestion of traffic. Volume growth is explained by demographic and lifestyle changes and economic development. Congestion, in turn, is both a capacity and an incentive problem. In particular, while we should expect some congestion as evidence of a successful economy, there will always be *too much* when individual drivers ignore the costs they impose on society.

POLICY STRATEGIES

Solving our traffic problems is difficult because they are nuanced, moving targets. One should be leery of simplistic solutions. When stuck in traffic, for example, the knee-jerk reaction is to argue for more road capacity. While understandable in light of the regions' low road and highway investments in recent decades, finding funds for new construction is extremely problematic. Moreover, more capacity will not by itself substantially reduce congestion. Urbanist Anthony Downs once famously stated that travel demand on freeways rises to meet capacity. If new lanes are added, congestion problems might be lessened in the short run. But that reduced congestion will attract drivers who previously used other routes, traveled at different times of the day, used other modes, or drove less or not at all. New roads and lanes do provide additional mobility and other transportation benefits, but increased road capacity provides less congestion relief than one might expect.

Policymakers must perform a balancing act, addressing air and other environmental concerns without excessively sacrificing the ability to get where we need and want to go. Ideally, achieving one of the objectives should not come at the expense of the other. Feasible approaches include increasing carpooling (including vanpooling), shifting trips to mass transit, adopting efficient pricing, and altering land-use.

"Travel demand management" is one attempt to increase the number of passengers per car. One notable experiment in this vein is the trip reduction policy of the South Coast Air Quality Management District (SCAQMD), adopted in the late 1980s. The initial attempt to increase ridesharing was controversial because many firms argued the regulatory burden was unjustifiably burdensome

and continues to vex policymakers today.

and expensive. Moreover, only small driving reductions were credited to the early years of the program, which is now voluntary. An alternative strategy is rewarding carpooling by establishing high-occupancy-vehicle (HOV) lanes, which allow eligible vehicles to travel at higher speeds. The hope is that people will respond to the time savings by forming more carpools. Unfortunately, the evidence suggests that dedicated lanes for car-poolers stimulate only a small increase in ride sharing. The average number of occupants per vehicle (about 1.2) is little more than it was twenty-five years ago, before the widespread introduction of HOV lanes.

A second major strategy is to shift trips to mass transit. Intuition suggests that better routes and more comfortable trains and buses will encourage more transit use, thus getting drivers out of their cars. The question here is not the absolute benefits of transit investments, but identifying the most effective use of public funds. In a select few Los Angeles corridors, where the density of both population and destinations assures high ridership, providing heavily subsidized rail transit trips is reasonable in comparison to other congestion-relief and mobility programs. It is wishful thinking, however, to believe this is true for much of the region because most parts of L.A. do not have the density to support rail transit. More sensibly, Los Angeles should enhance its bus service, including express buses, modernizing and expanding the bus fleet, improving the management of the numerous transit systems, and coordinating services across agencies.

For most economists, the Holy Grail for traffic-related problems is charging drivers the costs (externalities) they impose on others. When forced to pay the real price of travel, some individuals would reduce their driving, share the cost through carpooling, and find other means of making trips. Unfortunately, imposing such a charge has not been politically feasible because drivers vehemently oppose paying for previously un-priced travel. With minimal popular support, the pricing solution has been tried in a very limited fashion to address congestion but not environmental externalities. Despite the limited application, the results are revealing.

One example of congestion pricing is the establishment of toll lanes down the median of State Route 91 in Orange County. The franchise for this venture was granted to a private contractor, and the current tolls vary by time of day according to demand. This application of congestion pricing never met with serious opposition because the toll lanes provided new capacity immediately adjacent to existing free lanes. Travel time in the free lanes dropped by as much as twenty minutes as some traffic diverted to the new capacity. This project demonstrates two important points: (1) In a highly congested corridor, people will pay to reduce their travel time, and (2) Even those who do not wish to pay are made

Policymakers must perform a balancing act, addressing air and other environmental concerns without excessively sacrificing the ability to get where we need and want to go.

Randall Crane studies travel behavior, the causes and impacts of sprawl, housing markets, the public finances of developing countries, and environmental governance initiatives such as smart growth. His most recent book is, "Travel by Design: The Influence of Urban Form on Travel," Oxford, coauthored with Marlon Boarnet. He also serves on a National Academy of Sciences panel of experts looking at how the built environment influences travel and public health.

At UCLA, Crane is professor of urban planning, associate director of the Institute of Transportation Studies, and director of undergraduate programs in the School of Public Affairs. He teaches courses on environmental policy, transportation policy, sprawl, and cities in developing countries. Abroad, he has consulted for the World Bank, USAID, and the governments of Guyana, Indonesia, Kenya, Mexico, Thailand, and Yemen. Crane's Ph.D. is from M.I.T.

better off by the toll facility when traffic is diverted from existing free lanes.

There are two other promising ideas. The first is creating high occupancy toll (HOT) lanes. Because the high occupancy vehicle lanes on the Interstate 15 north of San Diego had been underused, local officials allowed single occupancy vehicles to "buy into" the carpool lanes, initially with the purchase of a monthly pass. The revenues from this project are used, in part, to finance express bus service along the corridor, thus alleviating some of the concern that pricing projects inherently favor upper income individuals who can afford to pay for faster travel. The other promising idea comes from abroad. Singapore and London have implemented congestion pricing—charging more for driving at peak hours—for their central business districts, and this has produced popular results in relieving downtown and regional congestion, and generating revenue for public transit.

Finally, many planners promote various urban design strategies to reduce car use, alternatively known as the New Urbanism, Transit-Oriented Planning, or Smart Growth (see RC 2003 article). These vary in their details, but the idea is that denser and more-mixed use urban development, especially if focused around transit systems and stations, will both reduce VMT and increase walking and transit use. However, these proposals face two uncertainties: the best recent research does not consistently support either claim, and the higher densities could generate yet more congestion. Nonetheless, some project details hold promise, and may well deliver benefits in certain cases.

Each of the above strategies provides only partial solutions. The lesson is that policy responses should be multifaceted because there is no monolithic monster to blame for our traffic ills. More effective use of road pricing can better align individual behaviors with the social costs of traffic, as can more strategic investment in road capacity and express bus systems. The benefits from these actions can be enhanced through better land-use planning and urban design.

Policy responses should be multifaceted because there is no monolithic monster to blame for our traffic ills.

GRADING

Investment in road capacity: The road network has not kept pace with growth, leaving the region with close to the least capacity per driver in the nation. **Grade: D**

Investment in and management of transit: Unproven and expensive rail investments have been at the expense of proven bus service. The good news is that Los Angeles now has more express bus routes with dedicated lanes, and is purchasing more buses, albeit under court order. **Grade: C-**

Pricing: California is experimenting with congestion pricing on freeways, but its application is extremely limited and mostly outside of this region. **Grade: D+**

Land use planning: Los Angeles works reasonably well as a car-based system of relatively dense subcenters. Sprawl complaints lack hard evidence, and the region compares well by national standards. The challenge is balancing high-density in-fill, such as Playa Vista, with mixed uses while conserving open space and managing congestion. **Grade: B-**

ACKNOWLEDGEMENTS

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DATA SOURCES

American Public Transportation Association, Public Transportation Fact Book

Texas Transportation Institute, 2003 Urban Mobility Study

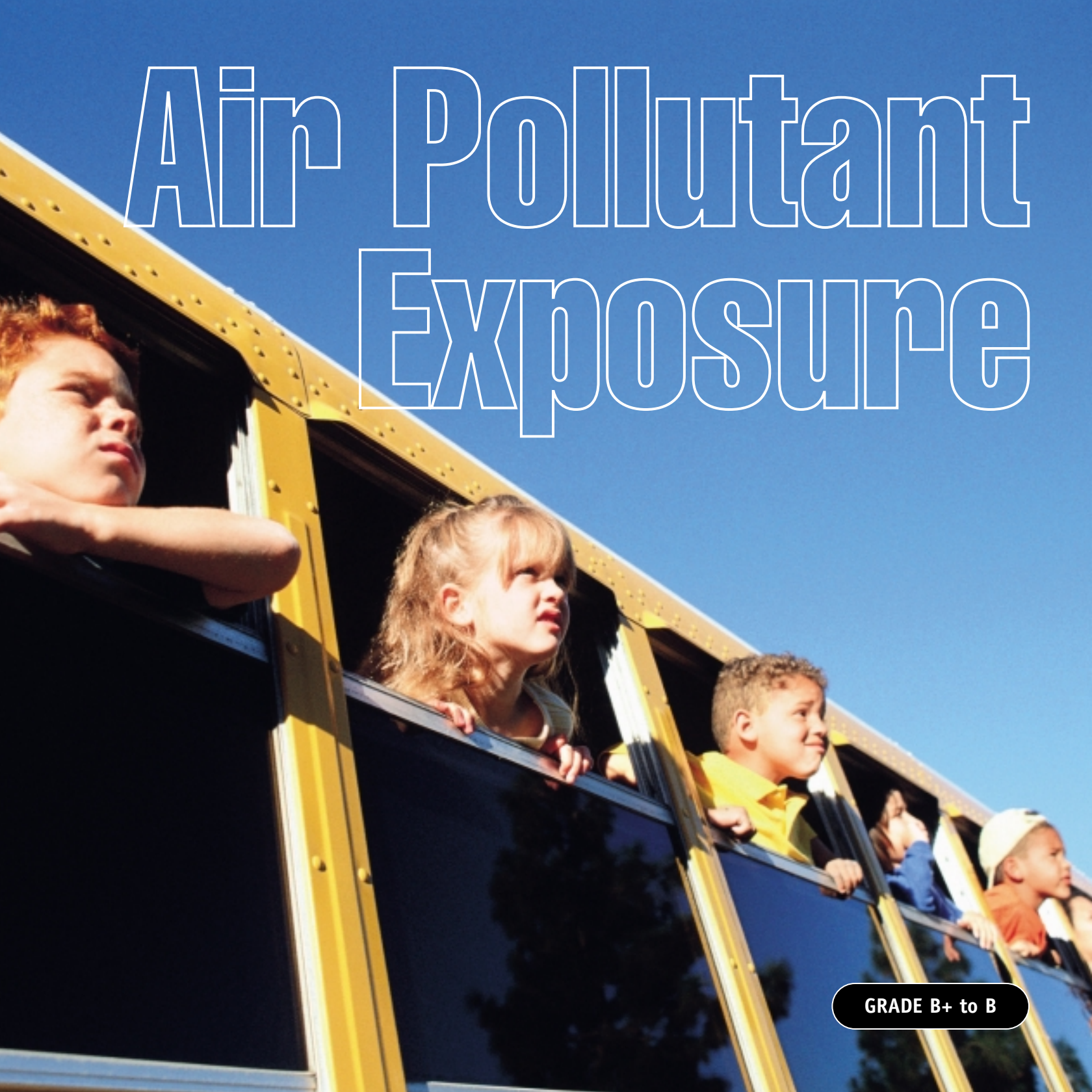
U.S. Bureau of the Census, 2000 Census Data.

U.S. Bureau of Transportation Studies, Highway Performance Monitoring System (HPMS)

U.S. EPA, Air Quality System and National Emission Inventory

Paul M. Ong is Professor at UCLA's School of Public Affairs, affiliated faculty with Asian American Studies, and the Director of UCLA's Ralph and Goldy Lewis Center for Regional Policy Studies. He has a master's degree in urban planning from the University of Washington and a doctorate in economics from the University of California, Berkeley. He has done research on urban and regional spatial structures, transportation and job access, and environmental justice. His publications include "An Unnatural Trade-Off: Latinos and Environmental Justice," "Impacts of Affirmative Action: Policies and Consequences in California," and "Locational Adjustments to Pollution Regulations." He has worked with numerous community organizations and has served on advisory committees for the U.S. Bureau of the Census, the National Research Council and Transportation Research Board, and the South Coast Air Quality Management District.

Air Pollutant Exposure



GRADE B+ to B

by Arthur M. Winer, Ph.D.

Professor of Environmental Health Sciences, School of Public Health

INTRODUCTION

Where we live, work, attend school, recreate, or drive—the places we spend our time, and how much time we spend there—determine the concentrations of a given air pollutant to which we are exposed, and the amount of that pollutant we inhale in the course of a day. Yet, traditionally, we have measured our progress in cleaning up the air through long-term monitoring of *outdoor* air pollution levels, rather than what any individual or population actually breathes on a day to day basis. Although long-term measurements of atmospheric concentrations by even a few air monitoring stations can tell us whether emissions of air pollutants are increasing or decreasing, when our focus is on human health effects and what people are actually breathing, data from a handful of widely separated air monitoring stations are less useful. As Kirk Smith, a UC Berkeley Professor of Environmental Health Sciences, is fond of saying, "The place makes the poison," and most of us spend less than 10% of our time outdoors on a typical weekday.

This article focuses on the relatively young science of air pollution exposure assessment, which attempts to accurately characterize which pollutants (and their concentrations) adults or children are breathing in the specific places, or "microenvironments," where they spend most of their time. Over the past two decades a paradigm shift has occurred in exposure studies, moving us away from a reliance on a scattered network of outdoor air monitors measuring only a few pollutants, and toward the measurement of a much wider range of species in homes, schools, motor vehicles and work environments—the places where people typically spend 90% of their time. As a result, we now understand that high concentrations of certain air pollutants in these microenvironments, plus the large amount of time people spend there, can lead to *much higher* exposures than indicated by outdoor concentrations measured at distant sites. The most dramatic evidence shows, for example, that the time someone spends in the microenvironment of their vehicle each day is typically the most important factor in their overall exposure to diesel particulate matter. Thus, reducing traffic congestion, as suggested in the previous article, could have significant public health benefits, in addition to economic and quality of life benefits.

The paradigm shift in how we measure air pollution exposure, together with new measurement tools and sophisticated models, has dramatically improved our ability to quantify the exposure of adults and children to a wide range of air pollutants. With improved understanding of exposure, the results of epidemiological studies of air pollutant health effects are also improving.

While in a few cases these powerful new studies have provided some reassurance about human exposures, other cases unfortunately have served to heighten our concerns, particularly about the exposures of children and other vulnerable populations to a wide range of hazardous air pollutants, both gaseous and particulate.

This article, using recent and ongoing studies in Southern California, summarizes the current state of the art in air pollutant exposure assessment. The article differs from four previous Report

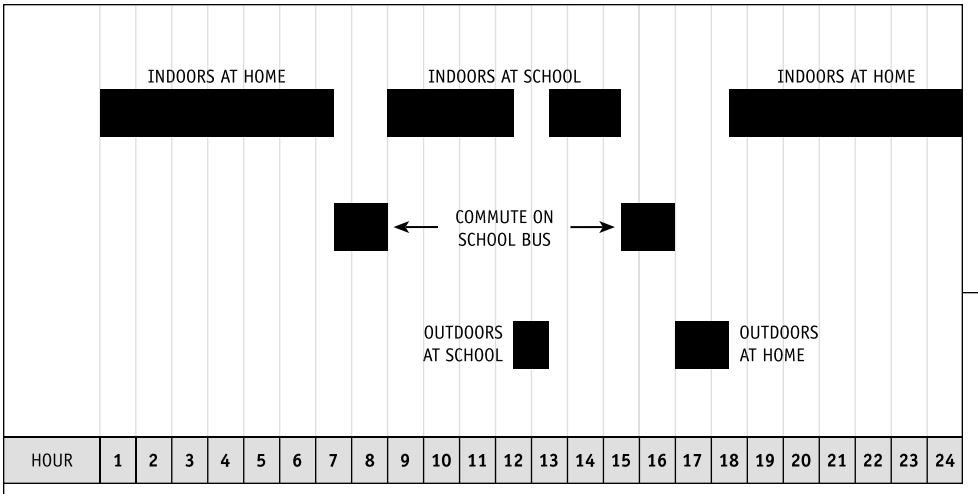


Figure 1. Time-activity pattern for a child on a school day

Almost all adults and children spend more than 90% of their time each weekday indoors or in a vehicle.

Card articles on air pollution that focused primarily on levels of pollution in outdoor air (RC 1998, 2000, 2001, 2003), and illustrates the new paradigm of microenvironmental measurement and modeling that the air pollution community is practicing here in Southern California and throughout the world. The article attempts to answer the question: How well do we understand the amounts and kinds of air pollutants adults and children are breathing in Southern California? It also provides recommendations for reducing the exposure of vulnerable populations, especially children, to hazardous air pollutants, based on new information provided by recent exposure assessment studies.

HUMAN TIME-ACTIVITY PATTERNS

One important impetus for new approaches to air pollutant exposure assessment has been the development of quantitative information about how people spend their time during a typical day. Through the use of carefully designed "time-activity" diaries distributed to relatively large numbers of participants, researchers have collected detailed data on how much time adults and children spend in their homes, vehicles, schools and workplaces, at recreational facilities, and outdoors, on an average weekday or weekend day. Time-activity diaries can also be used to estimate the breathing rates of individuals, by keeping track of their exercise states such as sleeping, at rest, and light or heavy exercise. The combination of exercise state or breathing rate, the time spent in a microenvironment, and the pollutant concentration in that microenvironment determines the specific dose of a pollutant received. And through the use of appropriate models, scientists can extend data collected for a few hundred or a few thousand individuals to the overall population of a region.

Figure 1 shows a time-activity pattern on a school day for a child who commutes on a school bus from south central Los Angeles to a magnet school on the Westside. In this case the child spends about twelve hours indoors at home, a surprising three hours commuting on a diesel school bus, about seven hours inside school buildings, and the balance of only about two hours outdoors. As this time-activity pattern illustrates, whereas assessment of exposure by traditional air monitoring networks corresponds to, in effect, everyone spending 24 hours a day outside, right next to a monitoring station, in reality almost all adults and children spend more than 90% of their time each weekday indoors or in a vehicle.

Note that in each of the different microenvironments described in Figure 1, different pollutants may be present in differing amounts, including significant differences in air quality between the home location and school location. Given knowledge of time-activity patterns and breathing rates, the remaining informa-

Our ability to quantify the exposure of adults and children to a wide range of air pollutants has dramatically improved.

tion needed to characterize exposure is the specific concentrations of the relevant pollutants in a given microenvironment. The following sections provide examples of how scientists have conducted sophisticated measurements to determine the concentrations of key pollutants in homes, vehicles, schools and other important microenvironments.

Figure 2. Subject wearing personal monitor for measurement of air pollutant concentrations in her personal breathing space.

EXPOSURE MEASUREMENTS

Homes and Personal Monitoring The "gold standard" and ultimate extension of the new paradigm in air pollutant exposure assessment is the measurement of personal breathing space over an extended period (e.g., several days). Such measurements are costly and laborious since they require the recruitment of individual subjects willing to wear a portable air sampling system capable of being taken everywhere throughout a typical day.

Figure 2 shows an example of such a "personal monitoring" system being worn by an adult woman. Inside the backpack is a special pump that can pull air through a set of devices designed to collect samples of particles and gases from the area of the nose and mouth of the person wearing the pack. The pump operates off a battery capable of running at least 48 hours without recharging.

As part of a multi-center study, UCLA researchers conducted a study of indoor, outdoor and personal breathing space in about 100 homes in four southern California communities. Confirming earlier studies of this kind, results showed higher concentrations of fine particles and certain air toxics in personal breathing air than in average indoor air. This corresponds in part to exposures from the "personal cloud" of particles created by activities such as cooking and vacuuming, and the tendency for activities to bring a person in close proximity to indoor sources, where indoor concentrations are highest. Indoor concentrations measured in this research, and similar studies in Los Angeles and other cities, were also higher than outdoor concentrations for pollutants with indoor sources. Such pollutants include chlorinated compounds in air fresheners, cleaning products and moth cakes; aromatic compounds emitted from paints, solvents and building supplies; and aldehydes emitted from consumer products, plywoods and particle boards, or from reactions of ozone with various indoor surfaces.

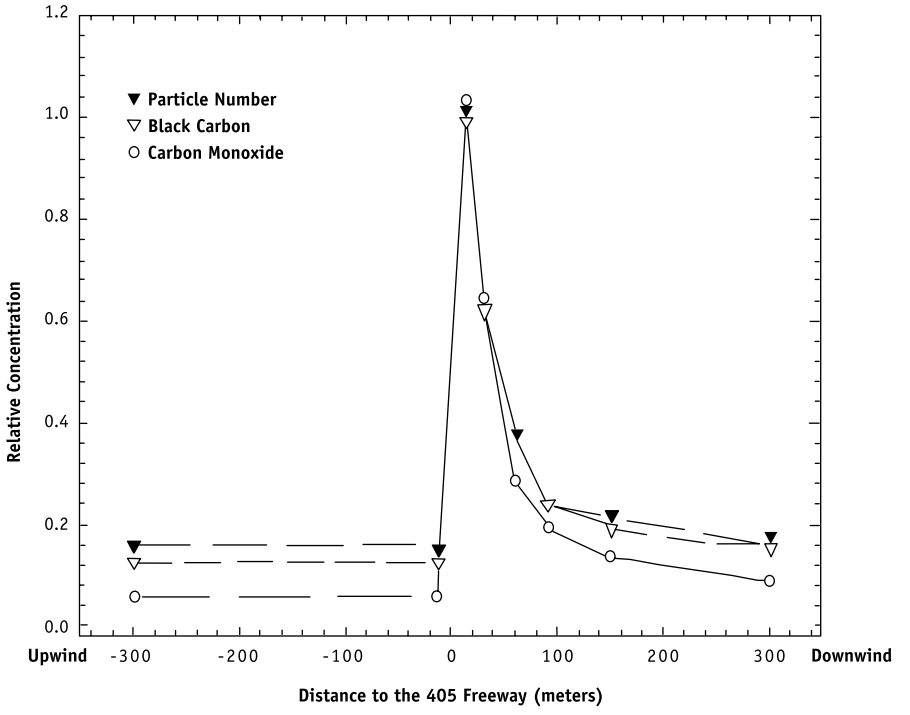


Figure 3. Relative concentrations of black carbon and carbon monoxide, and particle counts, upwind and downwind of the I-405 freeway in west Los Angeles. (Zhu, Hinds, Kim, Siotas, 2002)

Portable Classrooms One-third, or two million, children in California's schools are currently educated in portable classrooms. Both teachers and students have complained about respiratory problems after spending many hours each school day in portables. Studies conducted initially by UCLA researchers, and subsequently by state health agencies, in portable classrooms indicate these complaints arise primarily from poor ventilation, rather than from elevated air toxics concentrations.

Researchers have found that ventilation systems for portable classrooms are poorly maintained, sometimes not properly operated by teachers (or turned off to reduce noise), and are often undersized. In addition, teachers often seal windows with teaching materials or student's assignments and keep doors closed for long periods of time. These factors lead to stagnant air and elevated levels of carbon dioxide from human breath, which in turn can lead to complaints of fatigue and respiratory problems. School

Although the average person in California spends about 1.5 hours (or 6% of a day) driving, this time spent in vehicles will typically be the most

administrators, teachers and custodians need to be educated about the importance of proper ventilation in portable classrooms if portables are to be an effective teaching environment.

Near Roadway Exposure Recent studies by UCLA/USC researchers showed (Figure 3) a large spike in concentrations of vehicle exhaust pollutants immediately adjacent to and downwind of the 405 and 710 freeways, with a rapid fall off in concentration on the downwind side of the freeways to near background levels within about 500 feet. These results show that building homes, schools or other structures within about 500 feet of major roadways such as freeways will lead to elevated exposures to deleterious particles and gases for "downwind" occupants. Partly in recognition of these new findings, the legislature recently passed regulations preventing the siting of schools in California any closer than 500 feet of a freeway.

Passenger Cars Using a "chase" car, several studies have investigated in-vehicle exposure to a wide range of

important factor in their overall daily exposure to diesel particulate matter, a key toxic air contaminant.

Table 1. Black carbon concentrations measured inside a passenger car while following various vehicles in Los Angeles. (Fruin, Winer, Rodes, 2004)

Vehicle Followed	Black Carbon Concentration Inside Passenger Car (µg/m³)
Gasoline Passenger Car	~5
Tractor Trailer (Semi) Truck with High Exhaust	13
Delivery Truck with Low Exhaust	21
Diesel Transit Bus with Low Exhaust	90

particles and gases, especially when following diesel vehicles. One of these studies has shown highly elevated levels (compared to background) of ultrafine particles within the cabin of the chase car while driving on congested roadways. Concern about ultrafine particles (smaller than 100 nanometers in diameter) is growing in the health effects community as evidence accumulates that such particles can penetrate cell membranes, including the blood-brain barrier, and may be contributing significantly to the elevated morbidity and mortality observed in vulnerable populations following high exposures to particulate matter.

A recent analysis of the experimental data from one chase car study, by a UCLA doctoral student, indicates that although the average person in California spends about 1.5 hours (or 6% of a day) driving, this time spent in vehicles will typically be the most important factor in their overall daily exposure to diesel particulate matter, a key toxic air contaminant. Table 1 shows the average concentrations of black carbon, a marker of diesel exhaust particulate matter, experienced by a passenger car occupant following different vehicles and exhaust configurations. The clear message is to avoid following diesel vehicles closely, especially those with low exhaust (and especially those emitting black smoke).

Diesel School Buses In the past five years, scientists have conducted two studies of children's exposure in diesel school buses in Southern California. The most recent and comprehensive of these studies, conducted by UCLA/UC Riverside researchers, investigated not only the school bus microenvironment but also bus stops and a school loading/unloading zone. As illustrated in Figure 4, these scientists measured a wide range of particle and gaseous pollutants using real-time instruments to capture the dynamic behavior of the exhaust from nearby vehicles, as well as of the moving bus platform itself. A range of buses was studied, including high-emitting as well as more representative conventional diesel buses, a diesel bus with a particle trap, and a bus fueled with compressed natural gas (CNG). Researchers videotaped surrounding traffic on each run and, as shown in Figure 5, later correlated spikes in concentrations of black carbon and other key pollutants with the emissions of other diesel vehicles in close proximity to the school bus, including other caravanning school buses and diesel trucks traveling immediately ahead of, or alongside, the instrumented school bus. As shown in Fig. 5, spikes in black carbon concentrations aboard the school buses studied exceeded 40 to 50 µg/m³, far higher than ambient concentrations of black carbon in Los Angeles away from traffic, typically in the range of 1 or 2 µg/m³.

The bus route chosen for most attention originated in south central Los Angeles and traveled about half the time on highly congested freeways and half the time on surface streets, to the

Figure 4. UCLA graduate student operating instruments on diesel school bus. (Fitz, Winer, Colome, 2003)

Spikes in black carbon concentrations aboard school buses exceeded 40 to 50 µg/m^3, far higher than ambient concentrations of black carbon in Los Angeles away from traffic.

Brentwood Science Magnet School on the Westside. Remarkably, the child who boarded first on this route, at about 6:05 a.m., spent three hours commuting round trip, and did not leave the returning bus until nearly 5:00 p.m.

Using an inert "tracer" gas injected into the exhaust pipe, this research demonstrated for the first time that all of the buses in this study experienced "self pollution." That is, a portion of the exhaust from the school bus itself entered the cabin, a phenomenon generally not observed in vehicles such as passenger cars. How to minimize or eliminate self-pollution is the subject of on-going research.

Average concentrations of key pollutants were significantly higher aboard the school buses than at bus stops or the school loading/unloading zone, and children spent much more time aboard the buses than at the other two microenvironments. Hence, children's exposure during bus commutes is of greater concern than exposure at bus stops or school loading/unloading zones. Clearly, reducing children's pollutant exposure during bus commutes is an effective way to protect their health, and at the end of this article we suggest strategies for achieving such reductions based on the results of this study.

EXPOSURE MODELS

Scientists have developed a new generation of exposure models in recent years to exploit the data generated in measurement projects like those described above. Because such field studies are expensive and can only investigate a relatively small number of subjects, it is important to build models that can extend these results to larger numbers of susceptible individuals, and even to the entire regional population.

UCLA researchers have developed an individual exposure model (IEM), designed to improve the exposure assessment for thousands of children enrolled in the University of Southern California's long-term longitudinal Children's Health Study (CHS), conducted in twelve communities in California with differing air quality. Due to resource limitations, the CHS assigned the same exposure to every child in a given community, based on a single central monitoring site. By using the IEM to model the exposure of each individual child retrospectively, UCLA School of Public Health researchers were able to estimate the variability in children's exposure within each community, and make this information available to the CHS epidemiologists to improve estimates of health impacts.

UCLA researchers have also recently applied the Regional Human Exposure (REHEX) model to estimate the exposure of the entire regional population to naphthalene, a prototypical polycyclic aromatic hydrocarbon that is a suspected human carcinogen emitted from fuel evaporation, vehicle exhaust and indoor sources. The REHEX model showed that popula-

tions near major roadways experienced the highest exposures to naphthalene, with about one million residents experiencing estimated exposures greater than 1000 nanograms per cubic meter.

REDUCING EXPOSURE

Diesel Exhaust Exposures Recently the California Air Resources Board sent the mitigation measures recommended to reduce children's exposure during diesel school bus commutes by the UCLA/UCR school bus study investigators to all 1700 school districts in California, in both English and Spanish. Parents are encouraged to make certain school boards are implementing these measures, particularly those that can be carried out at no cost to the schools. These include placing the buses with the cleanest exhaust on the longest routes; encouraging children to sit in the forward part of the bus when the bus is not full; making sure drivers do not caravan one bus directly behind the other; and making bus drivers turn off their engines immediately upon arriving at a school and only turn their engines on when all students are loaded and the buses are ready to depart. The most important additional measure school boards can take is to require their own bus maintenance mechanics, or mechanics at companies hired to maintain buses, to properly maintain school bus engines to eliminate visible smoke under all operating conditions. Of course all school districts should be encouraged to transition from polluting conventional diesel school buses to cleaner fuel buses and/or buses equipped with particulate trap technologies as soon as possible.

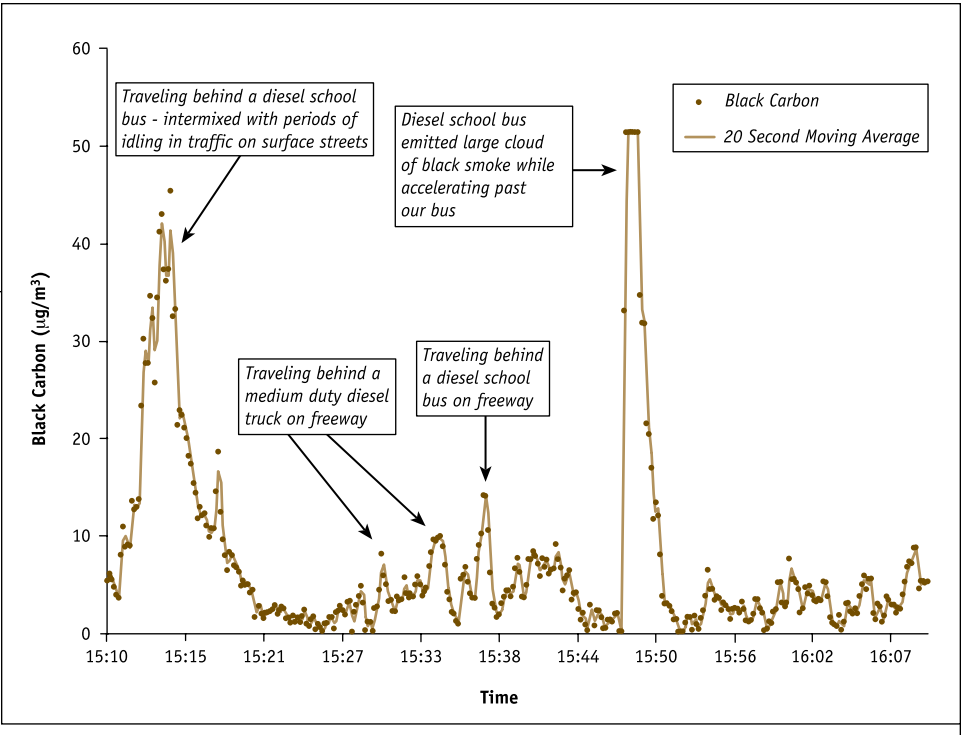


Figure 5. Agreement between videotaped encounters with diesel vehicles and spikes in black carbon concentrations measured on a commuting school bus. (Fitz, Winer, Colome, 2003)

Passenger car occupants can reduce their exposure to diesel exhaust by minimizing, as much as possible, driving behind diesel vehicles, especially diesel school buses and trucks that have low exhausts. Particularly avoid any vehicle emitting visible smoke.

Home Exposures Reducing air pollutants in the home is important because the majority of most people's time is spent there, and many potent sources of indoor pollution are commonly taken for granted. Volatile chemicals are frequently emitted from products such as cleaning agents, solvents, paints, air fresheners, etc., and their use (as well as storage)

Figure 6. Child wearing personal monitor with separate sampler (left) for in-home monitoring of air toxics and fine particles.

should be minimized, and only under conditions of good ventilation.

An important source of coarse particulate matter exposure in the home is house dust, which may be enriched in toxic metals and pesticides. Housekeeping measures such as door mats, removing shoes, keeping floors clean, and minimizing the use of carpeting are effective at reducing indoor dust levels. In addition, avoiding the use of pesticides on pets or lawns removes a major source of pesticide exposure (often a more important route of exposure than food residues). The major source of fine particles and nitrogen dioxide is combustion, so activities such as cooking, especially with natural gas, should be performed with adequate ventilation. Second-hand tobacco smoke should never be allowed in the home.

FUTURE DEVELOPMENTS

Two main areas need further development to advance air pollutant exposure assessment capabilities. First, more attention needs to be given to gases and particles that have been inadequately measured in personal breathing space or key microenvironments. These include ultrafine particles, polycyclic aromatic hydrocarbons—many of which are particle-bound and are known mutagens or carcinogens—and oxygenated compounds—especially aldehydes that are suspected carcinogens. Second, the development of compact, light-weight, and relatively inexpensive "real-time" samplers—the size of a cell phone, for example—equipped with real-time telemetry capability, remains the ultimate goal of personal monitoring for air pollutants. Replacement of the current expensive, heavy and obtrusive "back-pack" monitoring systems, would facilitate the recruitment of much larger numbers of participants, and the acquisition of more accurate and representative data. Nanotechnology, and continued development of innovative and minaturized pollutant monitors, offer a path to reach this goal.

GRADES

Exposure Assessment Researchers Consistent with the severity of the air pollution problem in Southern California, the region has one of the highest concentrations in the world of researchers concerned with air quality, including various aspects of pollutant exposure assessment. As a result, a substantial number of specialized monitoring and exposure studies have been conducted over the past decade. This research, which has led not only to a better understanding of human exposure to air pollutants but also initial policy recommendations and regulations for reducing such exposures, merits a good grade. However, as noted above, additional studies are needed for non-

School districts should be encouraged to transition from polluting conventional diesel school buses to cleaner fuel buses and/or buses equipped with particulate trap technologies as soon as possible

conventional pollutants such as ultrafine particles and certain toxic chemicals that have not been adequately studied. **Grade B+**.

Agencies The various regulatory agencies, including the California Air Resources Board, U.S. EPA, and South Coast Air Quality Management District, deserve substantial credit for supporting the exposure assessment research described above and for implementing initial exposure reduction measures. However, these agencies could do more to implement specific policies to reduce the most important indoor exposures to toxic air pollutants, especially pollutants not regulated under the Clean Air Act but identified as of concern by health effects researchers. **Grade B**

ACKNOWLEDGEMENTS

The author thanks Scott Fruin and Eduardo Behrentz for helpful comments.

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Illegal Dumping In Indian Country

GRADE C

by Carole Goldberg, J.D.

Professor of Law and Director, Joint Degree Program in Law and American Indian Studies, UCLA

The biggest environmental story in Indian country today isn't tribal casino development. Rather, it's the historic and ongoing damage that non-Indian development has inflicted on Native lands, water, air, and cultural resources. Numerous important environmental issues face Indian tribes in California, including harm to cultural resources, both on and off reservations, as well as the environmental contaminants that urban and suburban development have brought to southern California reservations. This article zeroes in on a particularly grievous problem these tribal communities face—non-residents dumping vast amounts of solid and hazardous waste on their lands.

ILLEGAL DUMPING OF SOLID AND HAZARDOUS WASTE

An oddly prosaic environmental problem preoccupies southern California Indian nations—waste disposal. Sometimes nonmembers from outside the community dump their waste along the roadside or in more hidden locations on reservations. In other cases, individual tribal members holding allotments[1] illegally lease land within reservation boundaries to nonmembers, who then run unpermitted dump sites or landfill operations for profit. A third variation is when nonmembers live on privately owned land within reservation boundaries and draw income from the same types of illegal dumping.

How serious is the problem among southern California tribes? A survey of their environmental concerns, conducted by the California Water Resources Control Board, put illegal dumping at the top of their lists. And the waste afflicting southern California reservations is far from innocuous. Construction and demolition debris (including concrete, asphalt, wood, metals, dry wall, and roofing materials) from city development projects outside the reservation often finds its way into the hands of private disposal companies that dump the waste illegally on tribal land, sometimes into illegally run landfills or unauthorized dumpsites. This practice can be very profitable, because the disposal companies avoid paying landfill charges. Roadside dumping of household hazardous waste (such as used household cleaners, latex and oil based paints, and dry cell batteries) occurs on reservations in rural areas where highways bisect reservations. Individuals enter the reservation, often at night, dispose of their goods, and save themselves a costly trip to the landfill.

Abandoned methamphetamine and other drug labs are another source of illegal waste. Materials used in the manufacture of methamphetamine, or "speed," include solvents, explosives, metals, salts, and medical waste, such as needles. Fire and serious health hazards result from exposure and these labs are often left booby-trapped to protect their former operators from detection.

Tire dumping is another severe problem on southern California reservations. Discarded tires have an uncanny way of attracting others of their type. The resulting piles pose serious fire hazards and are a breeding ground for mosquitoes. Unusable and old vehicle dump sites also pose a threat due to hazardous wastes such as oils, antifreeze, gasoline, and wet cell batteries which contain dangerous acids and electrolytes.

Discarded household appliances are also dumped with a higher frequency on

This map shows the Indian reservations in Southern California.

A combination of geographic and legal conditions has made Southern California reservations ground zero for illegal dumping.

Indian reservations than the immediately surrounding non-reservation areas. Washers, dryers, refrigerators, and microwaves all contain hazardous wastes such as polychlorinated biphenyls or PCBs.

A combination of geographic and legal conditions has made the southern California reservations ground zero for illegal dumping. Geographically, these reservations are relatively isolated tracts, at least by California standards. Simultaneously, they are in the path of rapidly growing communities. Two reservations—Pala in San Diego County and Torres-Martinez in Riverside/ Imperial Counties—illustrate the magnitude, complexity, and intractability of the illegal dumping problem.

Pala is located on 12,000 acres of mountain and inland valley country, approximately 40 miles northeast of the city of San Diego. Interstate 15, a major route between Los Angeles and San Diego, runs approximately six miles west of the center of the reservation. The tribe has a seven-person Environmental Protection Agency, but no tribal law enforcement and no tribal court.

On the southern end of the Pala reservation, on a road that winds in and out of the Tribe's territory and beside a tributary of the San Luis Rey River, lies one of the largest illegal dump sites in San Diego County. Tribal members have found dead animals, drums, appliances, meth lab waste, and household garbage at this site. The Tribe has also discovered the operation of a junk yard on allotted land under an unauthorized lease. The operator of this dump site is a nonmember who leased the land from an allottee without the requisite approval of the Bureau of Indian Affairs (BIA). As many as 1,000 non-operational automobiles have littered this site, leaking oil, antifreeze, and other contaminants. And on private land owned by a nonmember within the reservation, immigrant workers are housed illegally in shacks and shabby trailers, without safe drinking water, trash disposal, or proper sewage. Not only is reservation land contaminated by the raw sewage, but in 1999 a toddler died when she fell into an open concrete septic tank filled with sewer water, metal rebar, and other debris.

The Torres-Martinez Reservation offers a similar story. Located on 24,000 acres in the Coachella Valley, one of the fastest growing regions in the United States, and surrounded by upscale golf courses and country clubs, this impoverished community is like a rock in an onrushing stream of development. The Tribe has a small environmental protection office and has even adopted a solid waste management code, but it has no tribal police force, no functioning tribal court, and no economic development that might help to fund monitoring or clean-up.

For some time the Torres-Martinez reservation has been a magnet for mas-

Discarded appliances, used tires, and junked cars are some of the items found at an illegal dumpsite on the Torres-Martinez Reservation.

sive illegal dumping. Currently, the Tribe is struggling with an invasion of construction debris from off-reservation development and green waste from the scores of surrounding golf courses. Developers in nearby cities are hiring independent disposal companies to pick up their waste, and these companies are unloading their trucks at one of several illegal dump sites on allotted land under lease by nonmembers. One of these landfills is one-quarter mile square and consists of 500,000 tons of debris, in close proximity to a public school. Torres-Martinez is also site of a mobile home "park" operated by tribal members on allotted trust land for several hundred very low-wage workers. As low income housing is scarce in the Coachella Valley, and the growth of the region demands labor, workers desperately need affordable housing. Without sewage systems, running water, or systems of waste disposal, these mobile home parks have become a severe environmental hazard.

Law and government have been wholly inadequate to the task of solving these problems at Pala, Torres-Martinez, and other southern California reservations. The laws pertaining to illegal dumping on reservations are so complex and deficient that reservations are perceived as a kind of legal no-man's land. Even where legal authority clearly exists, inadequate government support and infrastructure makes enforcement unlikely or nonexistent. Federal, state, and tribal governments all play Hamlet in this environmental tragedy.

Under federal law, namely the Resource Conservation and Recovery Act (RCRA), EPA has no routine regulatory responsibility for illegal dumping of solid waste on or off reservations. It may step in only in the event of an "imminent" and "substantial" threat to human health or the environment; but its regulatory apparatus is unprepared even for that type of intervention on a regular basis. Only when the local school district adjacent to the Torres-Martinez dump site complained about burning and other forms of contamination did Region IX EPA show any interest.

The federal government also has responsibilities as the trustee of tribal lands and individual trust allotments. Illegal dumping is a form of trespass, and the trustee can and should bring suit against any perpetrators who can be identified. Allottees who lease their lands without federal and tribal approval, setting up unpermitted businesses, are inviting trespasses as well. In the past, the Bureau of Indian Affairs and U.S. Attorneys have been slow to respond.

Containers of used oil dumped on the Pala Reservation.

The laws pertaining to illegal dumping on reservations are so complex and deficient that reservations are perceived as a kind of legal no-man's land.

At Pala, where the auto junk yard was operated without an approved lease, the Tribe sought the assistance of the BIA, which issued a cease and desist order. When one of the lessees refused to leave, the BIA suggested that the Tribe adopt the BIA trespass code and serve the occupant an order of trespass. The Tribe did adopt an eviction ordinance and serve the lessee; but without tribal police or a tribal court, eviction was infeasible. In March 2004, while the BIA's order was under appeal, the frustrated Tribe finally blocked access to the property from reservation roads and sent in a car crusher. With revenue from casino gaming, the Tribe could finally afford to protect its environment.

Historically, the BIA has been no more effective at Torres-Martinez, despite signs of a new era of collaboration between that federal agency and the tribal government. In at least one instance, the BIA approved the lease of an allotment to a nonmember known for inviting use of land for illegal disposal. When the allotment owner discovered the massive dump site, he secured a cease and desist order from the BIA. But the Department of the Interior left the dumpsite in place for an intolerably extended period despite a BIA public notice indicating that it is investigating those responsible for illegal dumping and unapproved businesses on the Torres-Martinez Reservation. To date, no legal action has been brought.[2] Because the BIA has never been robustly funded in California,[3] it is difficult for that agency to curtail illegal dumping on the dozens of southern California reservations. But in a recent encounter between Torres-Martinez officals and haulers who were illegally dumping green waste and landscaping debris on the reservation, the BIA backed up the Tribe when it confiscated $100,000 worth of the haulers' equipment. The BIA's support reassured the local county sheriff and facilitated an acknowledgement of guilt on the part of the haulers.

States normally have little authority over illegal dumping, or anything else for that matter, within Indian country. But state power over reservation waste disposal in California is particularly difficult to grasp. Federal law confers no authority on states to regulate solid waste disposal on tribal lands or allotted lands held by the federal government in trust for individual Indians. Although legal authority is unclear on this point, RCRA probably also grants states no power over fee lands owned by nonmembers within reservations.[4]

Limited state authority may exist on reservations, but even that is far from certain. Some court decisions uphold state criminal jurisdiction over so-called victimless crimes committed by non-Indians within Indian country.[5] But whether dumping on tribal lands should be treated as "victimless," when tribal lands and other resources are harmed, is unclear. Given that the kinds of illegal dumping described above include extremely hazardous substances that endanger drinking water supplies and other water sources, state authority may not prevail. At Pala, for example, where

The tribes themselves are left as the major force to repel illegal dumping.

"No Dumping" signs posted by the County of San Diego are no deterrent to illegal dumping of dead animals, appliances,and household garbage on a road through the Pala Reservation.

the little girl died in an open sewage pit on private land, the county sent the Tribe a letter stating that they did not have jurisdiction on the property, and the only agency willing to take jurisdiction was U.S. EPA. But the only authority EPA claimed was over safe drinking water; the sewage problem was outside their jurisdiction, they said, because there was no threat to waters of the United States. Although EPA eventually brought suit, and in 2000 secured an order requiring the property owner to provide safe drinking water to the residents, the property owner has yet to comply.

The tribes themselves are left as the major force to repel illegal dumping. Yet, the United States Supreme Court has partially tied their hands through a ruling that denies tribes criminal jurisdiction over non-Indians. It has also impeded tribal control of the reservation environment by its complex rules limiting tribal civil jurisdiction on nonmember-owned lands within reservations. Such limitations make the exercise of tribal jurisdiction on private land an invitation to a lawsuit.

Despite these limitations, tribes may still institute civil penalty actions, seizure and forfeiture of vehicles involved in illegal dumping activities, exclusion orders, and civil injunction and damages suits, at least on tribal or trust lands. Some tribes outside California have used these tools effectively against illegal dumpers. But that kind of enforcement activity requires tribal solid waste codes, well developed environmental regulatory bodies, law enforcement agencies, and tribal courts—institutions that are rarely found among southern California tribes. For instance, fewer than ten of the 35 southern California tribes have solid waste management codes. And even where codes exist, the absence of tribal law enforcement and justice systems makes implementing them nearly impossible. For example, Torres-Martinez was relatively helpless in the face of the unauthorized mobile home park, even after it enacted a solid waste ordinance, because it has no tribal police force or tribal court to assist with enforcement. More recently, Torres-Martinez has enacted laws prohibiting illegal dumping. And while the enforcement apparatus is not fully in place, the Tribe has begun confiscating vehicles of haulers caught in the act.

It is not the California tribes' fault that they lag behind Indian nations elsewhere in the United States in the development of legal institutions. Ever since statehood, Congress and the Department of the Interior have systematically shortchanged California tribes. When the federal government began supporting tribal self-determination in the 1970's, funding tribal police forces and court systems, California tribes received almost nothing. Over the past decade, EPA and the U.S. Department of Justice (DOJ) have begun to fill that void. EPA's GAP program has provided start-up funding for small tribal environmental protection agencies, and 32 southern

California tribes currently benefit from such grants. The Bureau of Justice Assistance in DOJ has established competitive grants for individual tribes and consortia to receive funds for tribal court development and enhancement. Two southern California tribes have individual grants for these purposes, and another 18 participate in consortia that have secured such grants. In addition, six southern California tribes are currently recipients of COPS funds from DOJ to support acquisition of equipment and training for tribal law enforcement. Finally, adoption of tribal solid waste codes in Southern California has received a boost from programs funded by the Indian Health Service, EPA, and the Administration for Native Americans within the U.S. Department of Health and Human Services, often with assistance from UCLA School of Law's own Tribal Legal Development Clinic. Several tribes are nearly ready to enact such laws.

Under these circumstances, further federal support for California tribal legal systems, aimed at overcoming the systematic denial of funds to those tribes over decades, can facilitate tribal initiatives against illegal dumping. A Congressionally established commission, the Advisory Council on California Indian Policy, recommended just such compensatory funding in its final report, issued in 2001. Congress has yet to respond.

Apart from tribal funding, greater cooperation between federal, state, local, and tribal governments can help address the dangerous waste disposal problems in Southern California. There are some promising experiments in such cooperation underway.

- The San Luis Rey Watershed Council, a partnership of local San Diego County landowners, agricultural growers, Indian nations, community and environmental organizations, government agencies, and special districts with ties to that watershed, has been working to assess, clean up, and prevent illegal trash dumping on a road adjacent to the reservation. Funding has come from U.S. EPA, the Farm and Ranch Solid Waste Cleanup and Abatement Grant Program operated by the California Integrated Waste Management Board (CIWMB), and the Pala Tribe.
- In response to the problem of independent disposal companies dumping off-reservation waste at Torres-Martinez, the Tribe approached one of the local cities granting permits to a developer whose debris ended up on the reservation, and requested increased oversight of the developer's activities. While the negotiations are still underway, and the cities may be reluctant to impose further obligations on developers, the BIA's notice to cities of its intent to take corrective measures to protect the health and safety of people residing at Torres-Martinez may move this process forward.
- To foster better understanding and cooperation between Indian nations and local enforcement agencies, CIWMB has funded UCLA School of Law's Tribal Legal Development Clinic to conduct joint trainings aimed at developing solutions to the problem of illegal dumping.

Stemming the onslaught of illegal dumping in southern California Indian country will require many more such cooperative endeavors, and a much

The sprawling, noxious, and unsightly dumpsites in Indian country bespeak failure.

higher level of support for tribal environmental agencies.

Grading the full array of environmental performance by federal, tribal, and state agencies regarding Native resources in Southern California would encompass so much as to be meaningless. A more focused assessment of these governments' responses to illegal dumping produces a mediocre grade at best. The sprawling, noxious, and unsightly dumpsites themselves bespeak failure. The law addressing illegal dumping in Indian country is a mess as well. But the stirrings of mutual support and cooperative action among tribal governments, EPA, the Bureau of Indian Affairs, and California's Integrated Waste Management Board are enough to warrant a modest passing grade.

GRADE: C

NOTES

1. Allotments are parcels of land, normally but not always within a reservation, that the United States holds in trust for an individual tribal member. Allotments are the result of a federal policy, begun in the nineteenth century, to divide collectively-owned tribal lands and distribute them to tribal members, in order to facilitate policies of forced assimilation.

2. The BIA has initiated an action to shut down the Torres-Martinez mobile home park. The focus there, however, is the illegal leasing and business, not specifically illegal dumping.

3. Carole Goldberg and Duane Champagne, A Second Century of Dishonor: Federal Inequities and California Tribes (Report to the Advisory Council on California Indian Policy, 1996), available at: www.sscnet.ucla.edu/Indians/ca/tribes.htm.

4. Such lands can be found on several southern California reservations because of a federal policy, known as allotment, which divided up reservation lands among tribal members, and lifted federal restrictions on transfer of those divided lands. On some reservations, the allotments are still held in trust for individual tribal members. See note 1, above.

5. "Indian country" is a technical legal term under federal law (18 U.S.C. § 1151), which refers to all land within reservation boundaries and all trust allotments, whether within or outside reservation boundaries.

Carole Goldberg is a professor at UCLA School of Law, Director of UCLA's Joint Degree Program in Law and American Indian Studies, and faculty chair of the law school's Native Nations Law and Policy Center. She teaches in the areas of Federal Indian Law and Tribal Legal Systems, and founded the law school's Tribal Legal Development Clinic, which provides legislative drafting and judicial development services to Indian nations. She has lectured widely on problems of illegal dumping in Indian country. Goldberg's scholarly interests center on conflicts among tribes, the federal government, and the states over control of conduct and resources within Indian territory, with a specific focus on the historic and contemporary legal problems confronting California's Native peoples. She is co-author of American Indian Law: Native Nations and the Federal System (2004), and she is co-editor and co-author of the Felix Cohen's Handbook of Federal Indian Law (1982 ed. and forthcoming 3d ed.) Her current research explores the background and implications of an important 19th century legal case involving a clash between tribal and federal authority in California. Professor Goldberg holds a B.A. magna cum laude from Smith College and a J.D. from Stanford Law School.


GRADE A to B-
Stormwater
Regulation

by Sean B. Hecht, J.D.

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Polluted runoff is the major problem facing Southern California's rivers, lakes, and coasts today. Runoff includes rainwater as well as the water used to irrigate our yards and wash our cars. In urban areas, this runoff flows over concrete and asphalt surfaces laden with tire shavings, motor oil, exhaust residue, dog feces, fertilizer and pesticides, home improvement project waste, cleaning products, trash, and other contaminants. It then makes its way into stormwater channels and eventually arrives untreated in rivers and the ocean.

Polluted runoff contains pathogens, toxic substances, and floatable debris that can endanger public health and the environment. Studies have found that swimming near storm drains in Santa Monica Bay increases the risk of acute health problems such as colds and gastrointestinal illness. The City of Los Angeles advises people to stay out of the ocean for 72 hours after rainstorms because of stormwater's health impacts. Too often, bacteria from stormwater have caused beach closures. And polluted runoff can harm marine ecosystems by injuring wildlife and plants and degrading their habitat.

Discharge of pollutants into stormwater is governed by a system of laws and regulations that provide the main source of hope for a clean future for Santa Monica Bay. But efforts to ensure that polluted urban runoff does not impair our waters were, until recently, slow and uneven. Lack of political will to design and implement the programs necessary to address polluted runoff, the difficulty of designing and enforcing runoff restrictions on literally millions of contributors, and legal wrangling have left the coastal waters of Southern California in a precarious condition as we enter the 21st century. The picture is improving dramatically, however. Leadership by regulatory agencies, innovative efforts by some local governments, and the work of leaders in the environmental community bring hope for the future.

Previous Report Card articles have discussed stormwater pollution, coastal water quality in Southern California, and the efforts made by Los Angeles-area households to change their behavior to reduce stormwater pollution from their activities. (See RC 1999, 2000, 2001.) In the time since those articles first appeared, several important developments have occurred. The landmark settlement, in 1999, of a lawsuit brought by a coalition of environmental groups has resulted in the development of legally-binding plans that will further clean up the region's impaired waterways. In 2001, the Los Angeles Regional Water Quality Control Board issued a new county-wide permit that requires local governments to take stronger action to ensure that stormwater from their communities is clean. In response to these developments, many local governments have been developing technology, infrastructure, and other means to ensure the effects of polluted runoff decline over time. Nonetheless, some local governments have challenged the new requirements in court, seeking to invalidate the ever more stringent rules. The remainder of this article discusses the ways that urban runoff is regulated in California, details recent developments in runoff regulation, and evaluates the effectiveness and promise of current regulatory efforts.

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URBAN RUNOFF REGULATION IN CALIFORNIA

Under the federal Clean Water Act, the United States Environmental Protection Agency ("U.S. EPA") is charged with protecting the nation's water quality, in partnership with state and local governments. In California, state agencies do most of the regulatory work to protect water quality. The State Water Resources Control Board ("State Board") sets statewide policies that address water quality, and state agencies called regional water quality control boards are charged with preserving and enhancing water quality in each part of the state. The Los Angeles Regional Water Quality Control Board ("Regional Board") is our regional water quality agency.

The Regional Board regulates stormwater—runoff that is channeled into a storm sewer and sent to a waterway such as the Santa Monica Bay—through special permits under the Clean Water Act's National Pollutant Discharge Elimination System ("NPDES") program. The number of potential polluters and the variety of processes that generate pollution make the problem a challenge to manage. Development and implementation of "best management practices" ("BMPs") to control stormwater pollution have been crucial to the management effort, as has the power of the Regional Board under the NPDES permit program to make sure these practices are being implemented. Some BMPs—such as not pouring motor oil or industrial chemicals into gutters or onto concrete or asphalt surfaces that drain into storm sewers—have focused on changing the behavior of ordinary citizens and businesses. Other BMPs—such as cleaning catch basins and installing devices to block trash from entering storm sewers—are implemented by local governments. BMPs that reduce stormwater at the source, by creating mechanisms to recapture rainwater and other runoff sources before they enter storm sewers, also create benefits for communities by allowing reuse of the water.

The Total Maximum Daily Load ("TMDL") program mandated by the federal Clean Water Act steps in where other efforts don't succeed. Under the TMDL program, the state and federal governments must take specific steps to reduce pollution to the levels necessary to promote and sustain healthy ecosystems and safe recreational use of our waters.

STORMWATER

In Los Angeles County, municipal stormwater—all the runoff from industrial, residential, and public lands that finds its way into storm drains—is collected in a system separate from the collection system for sewage. And unlike sewage, municipal stormwater usually goes straight into rivers and the ocean without treatment. Stormwater accounts for approximately 100 million gallons of runoff each day into Santa Monica Bay in dry weather, and up to 10 billion gallons a day in rainy weather.[1]

Through a special permit called a Municipal Separate Storm Sewer System ("MS4") permit, the L.A. Regional Board requires cities to ensure that stormwater coming from within their boundaries is as clean as practicable before it makes its way into the Los Angeles River, Ballona Creek, and other waterways, and ultimately the ocean. And the Regional Board also issues industrial and construc-

Unlike sewage, municipal stormwater usually goes straight into rivers and the ocean without treatment.

Pollution from storm drains has led to beach closures in Southern California, especially in wet weather conditions.

tion permits for particular businesses' stormwater, in order to ensure that storm sewers don't carry industrial wastes. The first MS4 permit in Los Angeles County was issued in 1990 and was revised in 1996. On December 13, 2001, the Regional Board adopted a new MS4 permit for 84 municipalities within Los Angeles County, and for most unincorporated areas governed directly by Los Angeles County.[2]

The 2001 MS4 permit is innovative in requiring municipalities to take direct responsibility for many aspects of stormwater pollution prevention. The permit requires municipalities to implement BMPs to reduce stormwater pollution from sources within their boundaries, including private sources. The permit retains and expands on several important features of the 1996 permit, such as implementation of plans that designate best management practices to control polluted runoff from new development projects. And it steps up the powers of the Regional Board to require local governments to do their part in reducing stormwater pollution. Its requirements include the following:

1. Local and state governments must inspect industrial and commercial facilities to verify that those facilities are implementing the required "best management practices" to prevent pollutants from entering the collection system. These inspections, which must be conducted at least twice in five years, will make it less likely that businesses will release pollutants into storm drains.
2. Where water quality standards aren't being met, cities must identify and implement best management practices to reduce stormwater pollution, and then improve the practices if they don't work. This provision allows cities to try innovative approaches to solving stormwater pollution in good faith, and penalizes them if they stop trying before the problem is solved.
3. Cities have to inspect and clean their storm drains on a regular basis in order to make sure that improper maintenance of the drains doesn't make pollution worse.
4. Cities are required to track down and eliminate illegal storm sewer connections, which allow untreated

Trash in Ballona Creek and other local waterways will decline as regulatory measures are implemented.

Most municipalities in Southern California are now working to develop and implement best management practices to clean up their stormwater.

sewage and industrial waste to flow untreated into Santa Monica Bay.

Most municipalities in Southern California are now working to develop and implement best management practices to clean up their stormwater. And some local governments have been leaders in solving the problem. The City of Santa Monica, for example, has been active in eliminating illicit connections, inspecting businesses for stormwater compliance, and implementing BMPs such as covering storm drain openings in dry weather.

Some municipalities have taken a less constructive approach, however. A group of municipalities calling itself the Coalition for Practical Regulation ("CPR") has challenged the 2001 MS4 permit in court and attacked it in the media. CPR contends that the permit's costs to governments and businesses will far outweigh its environmental benefits. According to the group, the permit's provisions will not improve water quality for 20 years, will cost tens of billions of dollars to implement, and will deter businesses from operating in the area. State regulators and environmental advocates counter that water quality improvements will be significant and that CPR's cost estimates are wildly inflated and based on "worst-case" projections. CPR's court challenge to the permit is still pending. Nonetheless, the permit's provisions are legally sound and appropriately protective of the environment. The court has already upheld key permit terms and has found that the Regional Board's analysis and justification of those terms were legally sound. The resources these municipalities are diverting to fighting the new regulations could be used more constructively to develop and implement the programs necessary to comply with the permit. Setting a good example is the City of Los Angeles, which had originally challenged the MS4 permit along with CPR. The City, which has been working hard to implement solutions to stormwater pollution, dismissed its lawsuit in late 2003 and is now working constructively with the Regional Board.

The Regional Board also recognizes that stormwater control will often serve other needs. As Regional Board member Susan Cloke notes, "Water quality and water quantity are inter-related issues. Through a variety of design approaches, we can divert runoff for landscape. By so doing we reduce the amount of stormwater that reaches the ocean, the natural infiltration process allows for safe groundwater recharge, and we reduce our demand on imported water." This type of thinking will serve the region's needs well over the coming years.

Some municipalities have taken a less constructive approach.

A Santa Monica storm drain opening captures street litter, preventing trash from reaching the ocean.

TMDLS

In a critical component of the overall plan to reduce polluted runoff, California's State Board and Regional Boards, in cooperation with the U.S. EPA, have recently begun to develop and implement the Total Maximum Daily Load (TMDL) program, which forces local governments to reduce stormwater pollution where MS4 permits have not succeeded.

A TMDL is a written plan that, if properly designed and implemented, will make sure a particular pollutant doesn't enter a waterway in unsafe quantities. A TMDL describes how much of a particular pollutant a particular waterway can be expected to absorb safely, and creates a plan for guaranteeing the pollutant doesn't enter that waterway in excess of the safe amount. A TMDL for a given pollutant includes a measurable numeric target for the pollutant, a description of what needs to be done to attain the target level, and an allocation of responsibility among the various dischargers. A TMDL is implemented by using permits or other regulatory tools to ensure each discharger's contribution to the pollution is appropriately limited to meet the target.

TMDLs must be developed for "impaired" waterways—waterways that are not safe for recreation and sustaining aquatic life. Unfortunately, this means TMDLs are required for every major waterway in Los Angeles County, for pollutants ranging from trash to bacteria to toxic metals to the nutrients in commercial fertilizers.

Although the TMDL program is over 30 years old, regulators have only recently begun to develop the program under court order. For years, no TMDLs were developed at all. But that began to change with litigation brought by the Natural Resources Defense Council, representing advocacy organizations including Santa Monica BayKeeper and Heal the Bay. The lawsuit led in 1999 to a consent decree with the U.S. EPA that required state and federal agencies to develop and implement TMDLs for impaired waterbodies in Southern California on a specific timetable. Since then, the Regional and State Boards have devoted considerable resources to devel-

Santa Monica Bay attracts tens of millions of visitors annually and supports a diverse array of marine life.

oping the plans. So far, the regulatory agencies have issued TMDLs to limit trash on a number of waterways, to limit bacteria from wet weather flows into Santa Monica Bay, and to control nitrogen compounds (from fertilizer runoff).

TMDLs have met resistance at the local level. Some municipal engineers remain skeptical of the TMDL consent decree timetable, contending it requires TMDLs to be set too quickly. And some local governments have complained TMDL development doesn't adequately take into account the feasibility of implementing the TMDLs, or the costs that will be borne by state and local agencies.

These complaints have made their way into hard-fought litigation over the future of the TMDL program. For example, the local-government coalition CPR has successfully sued to require the Regional Board to reconsider the Trash TMDL. The court in that case found that in setting an ultimate target of zero for trash in the Los Angeles River, the Regional Board had not adequately considered economic factors, had not justified the lack of certain scientific studies, and had not completed a proper study of environmental impacts. At the same time, the court rejected several other arguments made by the local governments, holding the Regional Board was correct in imposing numeric pollution limits necessary to implement water quality standards rather than looser limits reflecting "practicability."

Despite this court ruling, the zero-trash standard, which is supported by ample analysis, is still ultimately likely to be implemented. The court's decision is currently on appeal, as the State Board and Regional Board contend persuasively that the Trash TMDL and other TMDLs should be developed to a health-based standard and not limited by the costs to local governments.

The TMDL program represents a huge step forward in ensuring the future health of our beaches and other coastal resources. While court challenges make the timetable and form of some TMDLs less certain, there is reason to be optimistic that polluted runoff will decrease significantly as TMDLs are developed and implemented.

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CONCLUSION

Over the past five years, we have seen unprecedented progress to clean up our region's stormwater. This progress would not have happened without the efforts of environmental advocacy groups and a forward-thinking Regional Board. The Regional Board is now on track to use the MS4 permitting program and the TMDL program to protect water quality in a meaningful way. And other innovations designed to reduce stormwater quantity while benefiting local communities are on the horizon.

Spurred by the Regional Board's leadership, local governments are increasingly doing what is necessary to protect the state's waters. There is still much room for improvement. Some municipalities still go to court to fight every attempt at regulation. All in all, though, the region is poised to make great strides in improving the health of our waterways.

GRADES

A for the Regional Board. This agency deserves credit for its work to solve the region's stormwater problem over the past five years, including diligent efforts to develop, implement, and defend in court the 2001 MS4 permit and TMDLs.

B- for local governments. Since it is impractical to provide separate grades for each of the dozens of jurisdictions, this grade reflects a compromise. A growing number of cities, including Santa Monica and, more recently, Los Angeles, have embraced the challenge of dealing with polluted stormwater. Others have pursued a litigation and public-relations strategy that threatens to impede progress. Overall, however, the trend is positive.

NOTES

1. See Stormwater Impact, RC 1999, for a comprehensive discussion of where stormwater comes from and goes, as well as the difference between dry and wet weather stormwater flows.

2. Long Beach is the one city in Los Angeles County for which the Regional Board has adopted a separate MS4 permit.

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Before coming to UCLA, Hecht practiced law at the firm Strumwasser & Woocher and served as a Deputy Attorney General in the Environment Section of the California Department of Justice. He received a B.A. *cum laude* from Yale University in anthropology and environmental studies and a J.D. *cum laude* from the University of Michigan, and served as law clerk for Hon. Laughlin E. Waters of the United States District Court for the Central District of California. He is a member of the Executive Committee of the Environmental Law Section of the State Bar of California.

About the UCLA Institute of the Environment

The IOE was founded as a new UCLA organization in 1997 with three primary goals: (1) Develop a world-class interdisciplinary academic program spanning the full breadth of environmental studies; (2) Support and augment existing environment-related activities at UCLA, and provide opportunities for the coordination and expansion of such programs, both on and off campus; (3) Place UCLA in a leadership position in environmental problem-solving for the twenty-first century. These lofty goals were supported by an allocation of 7 full time faculty positions, including an executive director, and complementary support staff.

In its first five years, the IOE developed an extensive portfolio of interdisciplinary research, created a popular undergraduate course called Global Environment, and brought environmental science into K-12 classrooms around Los Angeles with its Globe in the City program. The research vessel Sea World UCLA, owned by the IoE's Coastal Center, took hundreds of school children and their teachers on educational voyages in Santa Monica Bay. The Center for Tropical Research, also a project of IoE, expanded its operations and collaborated actively with international conservation groups and local universities in Ecuador and Cameroon.

When Founding Director and internationally known atmospheric scientist Richard Turco decided to step down from his administrative post and return to research and building the IOE Air Pollution Center, members of the faculty approached Vice Chancellor for Research Roberto Peccei about recruiting a nationally known environmental leader to lead the effort to develop the Institute to its full potential. The IoE is extremely fortunate to have hired Mary D. Nichols as its new Executive Director. Nichols, a Yale educated lawyer, most recently served as California Secretary for Resources, following her tenure as the head of the Environmental Protection Agency's Air Program. Her involvement in environmental policymaking spans three decades beginning in the mid-1970s when she chaired California's Air Resources Board. Nichols has also served as a lawyer for several non-profit organizations, headed an environmental foundation and counseled private clients on environmental compliance issues. In addition to heading the IoE, she has a joint appointment with the UCLA School of Law.

Nichols took charge of the IoE in January 2004, with a commitment to complete an external review of the program within the first six months. The Ad Hoc Review Committee submitted a highly supportive report in June 2004. Two strong recommendations stand out: that IOE expand its role in undergraduate education by creating a new environmental major, and for IOE to develop an LA-focused research agenda.

The IOE is rapidly moving to implement both recommendations. Building on existing faculty research and a history of public service, we are developing new projects addressing the coastal watersheds of Southern California and the region's overwhelming need to assure a safe, reliable water supply for the growing population while confronting the challenge of global climate change. We are studying the complex interrelationships of land use and water pollution, changes in ocean temperature and marine life. We seek to expand on the air pollution human exposure research reported on in this issue of the Report Card, in order to directly address concerns about threats to children's health and environmental justice. California's most endangered habitat type, the oak woodlands, is the subject of extensive study to develop plans for assuring its long-term survival.

Meanwhile, a small faculty working group has been meeting to produce a draft curriculum for a new major to be administered by IOE in cooperation with several departments and professional schools that will develop courses for this program. We hope to make the program available on an informal basis beginning in the Spring 2005.

The goal is to give students a truly interdisciplinary experience with a strong grounding in the tools of environmental science and policy.

To make these new programs successful, to recruit top flight students and faculty to the effort, IOE needs to build an external advisory committee and raise private funds. We will receive an enormous boost when the Institute moves to the "greenest" building on the UCLA campus. LaKretz Hall opens in winter 2004-5. The new classroom and lecture hall facility is topped by a 5,500 square foot floor dedicated to IOE offices and conference rooms and will be a visible symbol of UCLA's commitment to operate an energy-efficient, environmentally friendly campus.

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