Still Toxic After All These Years

Air Quality and Environmental Justice in the San Francisco Bay Area

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Foreword

In the last several decades, policy makers have paid increasing attention to issues of environmental justice – the idea that the health burdens and risks of poor air quality and proximity to hazards are inequitably distributed by race and income. In 1994, for example, the Clinton administration adopted an executive order that made environmental justice a lens through which all federal environmental policy was to be assessed. The state of California took up the banner in 1999, with legislation that directed the state's environmental agencies to develop environmental justice policies and strategies.

This shift in public sector attention has not been due to a sudden burst of goodwill on the part of regulators. Rather, public pressure by vibrant community-based groups coupled with mounting evidence compiled by academic researchers have both made the case clear and changed the political calculus. This winning combination of community voice and careful research has created examples of change across the country, and more groups have sought to develop partnerships that would generate both the scientific platform and the organizing energy to protect community health.

This report emerges from one such partnership: the Bay Area Environmental Health Collaborative (BAEHC). With support from the San Francisco Foundation, some of the Bay Area's leading environmental justice and community health organizations came together with researchers from the Center for Justice, Tolerance and Community of UC Santa Cruz (CJTC) to help document the state of environmental disparity in the Bay Area. The results, as detailed in the report, are clear: environmental inequality is unfortunately alive and well, a fact that threatens the wellness of the most affected communities.

The issue, of course, is what should be done to reduce disparities and improve environmental quality for everyone in the Bay Area. At the end of this report, we offer some possible policy directions but we realize that these are merely a start to a longer conversation between community, business and regulatory leaders. Our only insistence is that such a dialogue be initiated: as we witnessed in the Hurricane Katrina disaster of 2005, leaving some of us less protected ultimately poses environmental risks and costs for everyone.

For supporting this project, including its community outreach component, we thank The California Endowment, the California Wellness Foundation, the San Francisco Foundation, and the W. K. Kellogg Foundation. For providing careful data analysis, we thank Justin Scoggins and Bill Jesdale. And for inspiring us with their energy, enthusiasm and commitment to this important work, we thank the activists and leaders involved in the Bay Area Environmental Health Collaborative.

- Manuel Pastor, James Sadd, Rachel Morello-Frosch, January 2007

Introduction

On May 15, 2006, residents in Bayview Hunters Point, a mostly minority low-income community nestled at the bottom edge of San Francisco, celebrated a stunning victory: after nearly a quarter century of organizing, protests, and civil disobedience, they convinced Pacific Gas and Electric to finally shutter one of California's oldest and dirtiest power plants. In an area already saturated with toxic sites and high pollution emissions, community members had long blamed the plant for elevated levels of asthma, cancer, and other health ailments – and local resident Tessie Ester seemed to express the general sentiment when she commented: "When I look over at those stacks, and there is nothing coming out, I can't help but cry."

Bayview Hunters Point community residents and Greenaction for Health and Environmental Justice blockaded the gates of PG&E's Hunter's Point power plant. State and PG&E officials announced the closure of the plant just weeks after this protest.

Just a month earlier, activists from Richmond, a largely minority inner-ring suburb dotted with petrochemical facilities, managed to persuade the Bay Area Air Quality Management District (BAAQMD) to tighten up regulations on a practice called "flaring". Flaring occurs when refinery operators attempt burn off gas build-ups; while refineries argue that this is safer than releasing the gases, those living along the fencelines of such operations have long worried about the health impacts. Once again, the victory was sweet but long in coming: activists in Richmond have been fighting for flare control for over twenty years. And they know that they will have to continue to struggle – the devil is ultimately in the details of the BAAQMD's actual implementation of the new flare rules.

Meanwhile, the Oakland-based "Ditching Dirty Diesel" collaborative has, over the past few years, been recognized by both foes and friends for its efforts to curtail truck and school bus emissions in minority and low-income neighborhoods. The community-based campaign, in which activists reached out to both business owners and affected residents, has been credited with influencing the state's Air Resources Board to adopt a rule that will require all diesel trucks to have a device that will automatically shut engines off after five minutes of idling. This, too, has been long in the making: activists in West Oakland have been complaining for years that they face a per capita level of toxic diesel particulates that is seven times that for the rest of Alameda County.

While these recent environmental justice victories are heartening, the length of time it has taken to address these problems is not. Moreover, the commonality of disparity – in which communities with lower incomes and higher proportions of minority residents are more often the subject of regulatory neglect – has led some to argue for a more comprehensive and precautionary approach, one that would both prevent or reduce exposures and health risks before they occur and reduce persistent inequalities.

This report seeks to contribute to that task by both documenting environmental disparity in the Bay Area and offering some principles for new strategies. We begin by discussing the data we use to look at disproportionate environmental exposures, and then highlight the patterns revealed by several types of quantitative analysis. The main point we make is simple: even after controlling for income, land use and other variables that are frequently used to explain away disparate patterns of exposure, we still find a separate and independent effect of race on estimated pollution burdens. Communities of color, who often feel they may be they are disparately impacted by undesirable land uses, indeed have reason to be concerned.

This presents an opportunity as well as a challenge: surely Bay Area leaders, who often pride themselves on their devotion to environmental preservation and protection, can develop an environmental justice policy which leads the state and its regions.

To do so will require both adding real force to the current set of rules as well as developing new regulatory strategies. It will require a cumulative approach that considers multiple sources of air pollution, a precautionary strategy that puts health before economic interests, and a social overlay that accounts for disparities and vulnerabilities due to poverty and psycho-social stressors. And it will require turning rhetoric into reality in terms of community engagement and neighborhood protection.

The focus in this report might seem specific – how best to insure that current disparities will be reduced. But such an effort can serve a broader purpose. Researchers are beginning to find that where health and environmental disparities are greatest, overall health and environmental outcomes are worse for everyone. Protecting the most vulnerable populations can lead to better environmental protection for all of us – and it can only be done if we examine the patterns of disparity honestly and work together for a better future.

Understanding the Stakes

Despite the history of activism and action around environmental justice issues in the Bay Area, the literature shows a surprising gap: there have been no published analyses of the overall state of environmental disparity in the region.

This is not to say that there has not been a wealth of studies focused on particular pollutants or particular communities. Recent exemplary studies include the Pacific Institute's 2003 publication *Clearing the Air* (which focused on diesel pollution in West Oakland) as well as its 2006 publication *Paying With Our Health* (which focused on the impacts of the goods transport industry on several Bay Area and California neighborhoods); also both important and path-breaking was *Breathing Fire*, a 2005 publication about flaring released by the West County Toxics Coalition and Global Community Monitor. Academics have also been busy, with a slew of excellent academic articles and books produced by distinguished researchers such as Dara O'Rourke from UC Berkeley, Andrew Szasz from UC Santa Cruz, David Pellow from UC San Diego, and Michael Lipsett from the Environmental Health Investigations Branch of the Department of Health Services, among others.

Most of this literature, however, has not offered a quantitative assessment of the overall environmental disparity in the region. This may seem a minor gap: after all, polls from the Public Policy Institute of California suggest that Californians from all ethnic groups agree that environmental "bads", like toxic wastes, are more likely to be in minority communities while environmental "goods", such as open space and parks, are less likely to be found in those neighborhoods.

But public perceptions of inequality and social science research are not always in line. After a pioneering study on environmental disparity issued by the United Church of Christ twenty years ago helped to launch a wave of activism and policy concern, a subsequent set of studies conducted by researchers at the University of Massachusetts in the mid-1990s argued that environmental inequality did not hold across the country and further suggested that income differentials explained most observed racial disparities in the siting of environmental hazards.

Since then, the empirical debate has raged on, with methodological disputes centered on both statistical techniques and the scale of analysis. On the scale issue, new studies have indicated that disparities should be assessed on a regional basis since this reflects the reality of economic geographies – furniture factories in Los Angeles are not likely to move to Seattle and software developers in Seattle were not like to head south, and so inequality has to be considered in the context of the industrial clusters, economic development, and traffic patterns that exist in any particular metro area. When this approach is taken, disparities by race show up consistently and while income does seem to matter, controlling for it does not always eliminate the racial gap.

The stress in the research literature on the role of race is not simply a function of civil rights concerns. Rather it is deeply connected to understanding and weighing the merits of three

In July of 2005, PODER and the Mission Anti Displacement Coalition organized a grassroots forum to bring together young people, families, and elders in our community to learn how to leverage strong community benefits from the proposed land use changes in their neighborhood.

strands of explanation for the location of both hazards and emissions: those that focus on land use, those that emphasize the importance of income, and those that lift up the dynamics of power.

The land use perspective suggests that hazards are located where complementary land uses, such as industrial facilities or traffic arteries, are clustered; therefore, any correlation of environmental "bads" with race is viewed as an unfortunate byproduct of economic geography. The income view sees the role of property values as key: more hazardous land uses tend to be where income levels and property values are low, and co-location of the poor and toxics simply reflects the normal workings of the market system. In both perspectives, while health impacts could remain significant, environmental disparities are basically benign in intent – the association of particular neighborhoods and particular hazards is seen as a matter of accident or choice.

The power perspective suggests that hazard location and poor air quality depends on a community's ability – or inability – to resist placement of undesirable land uses in their neighborhood. In this view, discriminatory practices and/or power differentials are largely responsible for the patterns of environmental disparities that are frequently observed. And since race and power are so highly intertwined in our society, patterns of difference by race are suggestive of patterns of difference by power.

In the real world, all three of these factors – land use, income and power– are inextricably linked. Communities with less political voice may be less able to contest incompatible land uses, and income is not just a reflection of a market system but also a marker of influence in the decision-making process. Still, if race still matters once land use and income levels are accounted for, this suggests that differential access to political power and policy voice may be important to consider and address in the regulatory process.

Of course, another reason to be worried about racial difference in hazard location is simple because of the potential impacts on the health and well-being of different ethnic communities. At stake in the empirical debate, then, are both theories of causation and strategies for improving public health. In this light, a broad empirical study of the Bay Area is essential for understanding whether the voiced concerns of diverse communities are specific and isolated cases or part of a broader regional pattern that regulatory agencies should address.

Such studies have been done in other parts of California. In a series of analyses, we examined the situation in the Los Angeles metropolitan area from several different vantage points: the distribution of treatment, storage, and disposal facilities and transfer sites, the allocation of large industrial facilities that are known to release large amounts of hazardous air pollutants, and the distribution of cancer and non-cancer health risks associated with air toxics emissions from mobile and stationary emission sources. We have also assessed environmental inequalities and their impacts on school children, both in terms of disparate exposures and the potential effect on asthma hospitalizations and academic performance.

Along every dimension, there is persistent and strong empirical evidence of environmental inequality in Southern California. It is, therefore, no surprise that many effective community-based groups have emerged, making the region a hotspot of environmental justice organizing and the origin of groundbreaking state legislation on environmental equity sponsored by L.A.-area State Senators and Assembly Members.

What about the Bay Area? Are there also general patterns of environmental inequality? Are these patterns related to land use, income, or race – or all three? And if disparities exist, are there any nuances in the pattern that can help us understand how best to protect communities and their health?

Understanding the Data

To get at these issues, we considered several different databases on toxic air emissions and concentrations, and combined these with neighborhood demographic characteristics available from the 2000 Census, including income levels, ethnicity, and language fluency. The environmental databases included:

• the U.S. EPA's Toxic Release Inventory (TRI) for 2003, a collection of self-reported toxic air emissions data from large industrial facilities;

• the 2001 Community Health Air Pollution Information System (CHAPIS) from the California Air Resources Board, an emissions inventory from both mobile and stationary sources, based on emissions inventory information from both the state and some regional air boards;

• the 1999 National Air Toxics Assessment (NATA), a dataset developed by U.S. EPA that estimates annual average ambient air toxics exposures from both mobile and stationary emission sources that can be utilized to estimate potential cancer risk and respiratory hazard at the neighborhood level and on emissions toxic air concentrations; and

• a set of ambient air toxics concentration and health risk estimates generated by the California Air Resources Board using the statewide emissions inventory CIEDARS.

This report focuses on study results from our analysis of the TRI and NATA. The decision to use these two federal datasets is partly because they have been used more widely in the academic and popular literature and this facilitates comparability to other regions and other studies; we would also note that the California EPA's air toxics risk data is only available to the public as a set of web-based images of grids that translate poorly into the neighborhood-level detail needed for this exercise. Future research could and should use the California-generated data, as well as to incorporate community-level estimates of health risks from exposure to outdoor toxic air that are now becoming available under the BAAQMD's Community Air Risk Evaluation (CARE) project. Improvements in data accuracy and availability for future research assessments are among the many things we call for at the end of this report.

What is in the TRI? Mandated under the Emergency Planning and Community Right-to-Know (EPCRA) provisions of the Superfund Amendments and Reauthorization Act (SARA) of 1986, the Toxic Release Inventory requires certain industrial and commercial facilities, as well as federal facilities, to report to the U.S. EPA on annual releases and transfers of nearly 650 toxic compounds. There are inherent limitations to the TRI data: emissions are self-reported estimates and not actual measures of releases; small area emissions sources, such as chrome platers, auto body paint shops and dry cleaners are not required to report; and the TRI does not include releases from mobile sources which are known to significantly contribute to pollution levels and health risks.

Despite its limitations, most of the literature on environmental justice has taken this database as a starting point in asking questions about the proximity of certain communities to potential hazards. We follow that strategy here, first calculating proximity using a complicated process of geocoding and double-checking facility location, and then drawing a circle around each facility to assess whether a significant percent of nearby or adjoining neighborhoods fall within a specified distance range. This approach is superior to simply asking whether a facility is located within a neighborhood or census tract, since many facilities tend to be on major thoroughfares that border communities and thus can affect more than one area.

Our second set of environmental health indicators, the U.S. EPA's National Air Toxics Assessment (NATA) for 1999, is built upon an underlying inventory of air toxics emissions that includes both stationary and mobile sources. The inventory is derived from five primary sources, including state and local air quality regulatory agencies, EPA's own air toxics regulatory program and its TRI database, mobile source emissions estimates developed by EPA's Office of Transportation and Air Quality, and other emission estimates generated from activity data (such as off-road sources). Using the emissions data as inputs, an air dispersion "fate and transport" model that accounts for movement and atmospheric chemistry of pollutants (due to the effect of winds, temperature, and atmospheric stability) is used to estimate the concentration of each air pollutant for each census tract in the continental United States.

The NATA data generated by this process includes tract-level concentration estimates for diesel particulates and 177 of the 187 air toxics listed under the 1990 Clean Air Act Amendments. The U.S. EPA also reports figures on cancer risk and respiratory hazard but these risk estimates do not include diesel and some other air toxics. In our analysis, we combined cancer potency values and respiratory hazards values from U.S. EPA as well as from the California EPA to estimate cumulative lifetime cancer and respiratory risks associated with ambient air toxics exposure. This process enabled us to include contributions from as many pollutants as possible, including the significant effect of diesel. Specific details on how we calculated cumulative risk estimates appear in the Appendix.

A few caveats about these cancer and respiratory hazard estimates are in order. First, these risks are calculated based on assumptions about ambient exposures and toxicity and do not represent actual cancer or respiratory cases. The latter are typical of epidemiological studies; the risk estimates we derive are instead ecological measures that characterize a census tract and essentially ask what would be the cumulative impact if a resident lived in the neighborhood for their whole life. In reality, people constantly move across diverse environments in a single day – traveling from where they live to where they work to where they go to school to where they worship, etc. – and they also move their households over time from neighborhood to neighborhood. Despite this, these risk estimates are useful for comparing the overall pollution burdens between neighborhoods and clarifying what the implications may be for residents' health.

A second caveat is that these modeled estimates account for ongoing and sustained exposures for both stationary and mobile sources – but they do not capture what might be termed "episodic" incidents. Such "episodes" could range from occasional flaring at refineries to longer-term air toxic concentrations that can be generated by, say, off-road diesel equipment during a multi-year construction project. These exposures are important to the local communities but cannot be fully captured or modeled by the approach taken here. Future studies might seek to model these effects, particularly to guide remediation activities.

Finally, we also utilize land use information from the 2001 U.S. Geologic Survey (USGS) Land Cover Characterization Program, an effort that makes use of aerial photo and satellite imagery interpretation to classify land use at a spatial resolution of 30 meters. Unfortunately, the results combine industrial, commercial, and transportation land uses together; while this is appropriate for a broad emissions database like NATA, it is less clear that it is appropriate for the TRI's facilities-based estimates – for which industry is the driving land use. In the TRI analysis, we therefore use a proxy based on more readily available census data, the percent of area employees in manufacturing; for further technical details on choices re variables, techniques, and other matters, please see the Appendix to this report.

Toxic Releases and Geographic Proximity

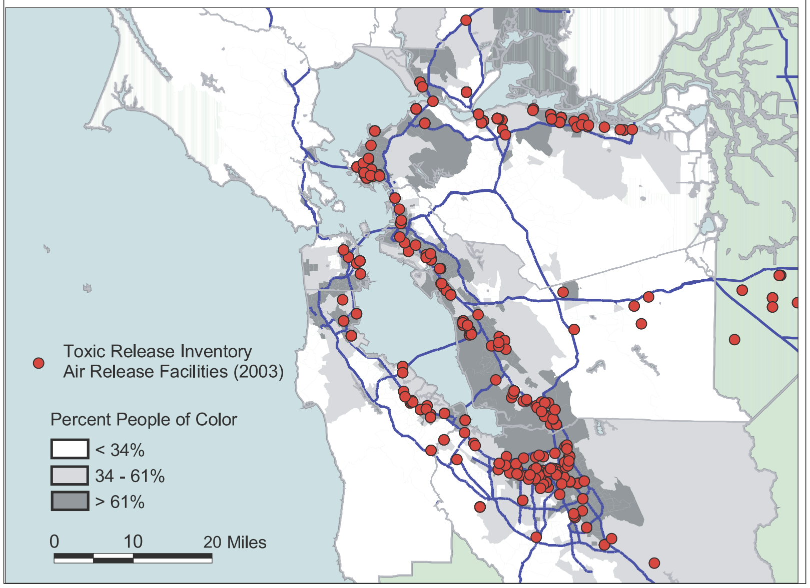
The easiest way to examine disparities is to assess visual patterns – that is, to map the locations of TRI facilities in comparison to underlying neighborhood demographics. We do this in Figure 1, comparing the locations of facilities with active air releases as recorded in the TRI relative to 2000 census tracts in the Bay Area ranked by percent people of color. The Bay Area in this case refers to the nine counties covered by both the Association of Bay Area Governments (ABAG) and the Bay Area AQMD; for ease, we focus the map on the more populated sections of the region which include the larger cities of San Francisco, Oakland, and San Jose.

The visual correlation between the percentage people of color and TRI location is striking. But since appearances might be deceiving, Figure 2 provides a demographic breakdown of the populations by proximity to a TRI release. The three population groups we examine are: those communities within one mile of a TRI facility, those between one and two and a half miles from a TRI facility, and those located further than two and a half miles from a TRI facility with active releases.

As can be seen, the percent Anglo in a tract declines at closer proximity to a TRI facility. By contrast, African Americans are three times more likely to live within one mile of a TRI as they are to live more than two and a half miles away from a TRI. Using the same geographic comparison, Latinos are twice as likely and Asians are about sixty percent more likely to be living with one mile of a TRI.

Is this pattern just a function of income, land use, or other factors? Table 1 shows the breakdown

Figure 1: Locations of Facilities with Air Releases (as Recorded in the Toxic Release Inventory or TRI) Relative to Neighborhood Demographics in the 9-County Bay Area



for our three proximity categories for a number of variables, including the poverty rate, per capita income, the level of home ownership, the percent of land devoted to industrial, commercial, and transportation uses, and population density. We also include two other demographic variables: the percent of local employees employed in manufacturing and the percent of recent immigrants.

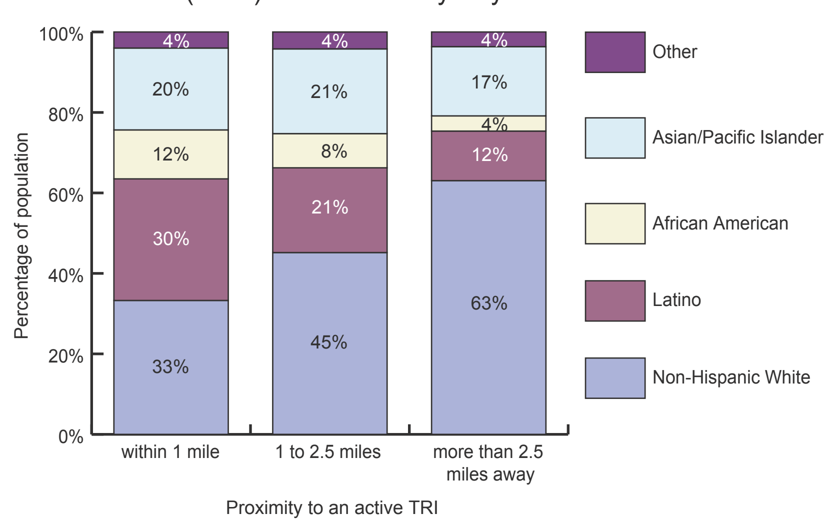
As can be discerned from the table, there is an income gradient, with increased proximity and lower incomes highly correlated. Likewise, home ownership, a standard measure of wealth, is lower in the more proximate neighborhoods. Nearer to TRIs, a greater percentage of land tends to be devoted to commercial, industrial, and transportation uses and the percent of the local labor force engaged in manufacturing, an indirect indicator of industrial land use frequently employed in the research literature, tends to be higher as well. Population density is lower in neighborhoods that are closer to TRI facilities, something that is partly a function of the fact that in neighborhoods hosting the type of industrial facilities that report to the TRI, some land is devoted to non-residential uses. Finally, figures for immigrants who arrived in the 1980s and 1990s indicate that they are twice as likely to live within one mile of a TRI as to live more than 2.5 miles away, suggesting that part of the ethnic disparity for Latinos and Asians might be connected to immigration status, language fluency, and other factors.

The major question addressed in the research literature, however, is whether the racial disparities depicted in Figure 2 disappear once researchers control for income. Figure 3 shows that they do not: using the one mile break and plotting the income levels of groups, we see that the likelihood of being near a TRI facility declines as income rises (and so does the disparity between groups). However, there is a racial disparity in proximity at each and every level of income.

One way to consider the separate impacts of the various factors – income, land use, population density, race, etc. – is through what is termed multivariate statistical analysis. Such an approach helps to isolate whether increases in one measure, holding all the others constant, affects the probability of a neighborhood being proximate to a TRI. We do this, taking into account homeownership, income, percentage of manufacturing employees, population density, and racial composition of the neighborhood.

One caveat is in order. The land use measure we have available for the Bay Area is imperfect as it combines commercial and transportation land uses with industrial uses, and does not distinguish their relative percentages. While the inclusion of commercial and transportation work

Figure 2: People by Race/Ethnicity (2000) and Proximity to an Active Toxic Release (2003) in the 9-County Bay Area



well for pollution burden measures that include mobile and stationary sources, it is problematic for the more industrial uses associated with TRI's. In our Los Angeles studies, we were able to utilize more precise measures of land use and so could separate and test industrial land use on its own; here, we are forced instead to use a standard indirect measure, the percent of the local labor force that is employed in manufacturing.

Table 1: Demographic and Land Use Characteristics of Tracts (2000) in Relation to Proximity to an Active TRI Facility (2003) in the 9-County Bay Area

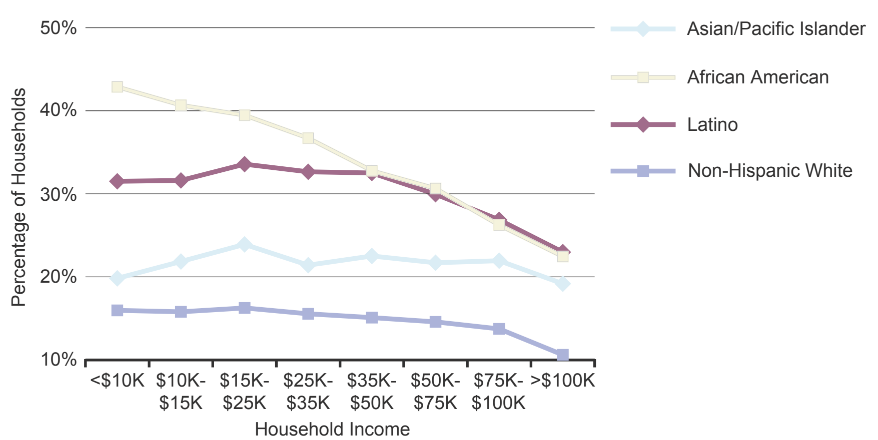
	TRI Proximity		
	Less than 1 mile	*Between 1 mile and 2.5 miles*	*More than 2.5 miles away*
Percent persons in poverty	12%	9%	6%
Median per capita income	$19,702	$25,140	$34,187
Percent home owner	52%	57%	61%
Percent industrial, commercial and transportation land use	17%	9%	5%
Population density (persons per square mile)	9,202	10,107	9,748
Percent employed in manufacturing	19%	16%	12%
Percent recent immigrants (1980s and later)	26%	21%	15%

The results are shown in Table 2. To simplify matters, the table displays the sign of the relationship between the demographic and land use variables on one hand and TRI facility proximity on the other. The asterisks indicate whether results are statistically significant (more asterisks indicate higher significance and statistical significance, as usual, is measured as the likelihood that the reported signs are in error – hence, the "lower" the significance threshold, the better). As can be seen in the first column, the pattern revealed by the simple comparisons in Figure 2 and Table 1 generally hold in a multivariate analysis: home ownership, income, and population density are negatively correlated with proximity to a TRI facility, while our proxy for industrial land use is positively associated with proximity to such a facility. Even controlling for all these factors, African Americans and Latinos are significantly more likely to be near a TRI; Asians are not, although the result is not statistically significant.

Given the patterns on immigration observed earlier, we were curious whether more recent migrants were more or less likely to be proximate to TRI releases once we controlled for other factors. Since the percent immigrant is highly correlated with percent Latino and Asian, we decided to separate out what might be a more meaningful measure in terms of communication: "linguistic isolation." Linguistic isolation is a measure developed by the Census by which a household is designated isolated if no household member older than 14 speaks English "very well." In the second column of Table 2, we see that linguistic isolation does matter – that is, there is an effect of limited English language capacity even when controlling for all other variables. Moreover, the statistical significance of percent Latino falls somewhat when controlling for language, suggesting that outreach to this group in a native language might be especially important for both conveying information and allowing groups to mobilize to have their concerns expressed.

However, the bottom line is that the race effect does not disappear – accounting for income and other factors does not eliminate the pattern of disparity for African American and Latino households. Still, this analysis only covers the sort of stationary sources recorded in the TRI – ones that have been important to community groups like the West County Toxics Coalition, Communities for a Better Environment and others which have struggled to clean up the activities of local refineries. What about the truck and other traffic emission sources that have given rise to deep concern in neighborhoods like West Oakland, San Leandro, the Mission District of San Francisco, and elsewhere in the Bay?

Figure 3: Percentage Households within One Mile of an Active TRI (2003) by Income and Race/Ethnicity in the 9-County Bay Area



Ambient Air Toxics and Estimated Health Effects

To look at this, we turn to the National Air Toxics Assessment (NATA). As noted above, NATA includes ambient air toxics concentration estimates from large industrial facilities as well as smaller area and mobile emission sources. This is important because the largest proportion of estimated cancer risk from ambient air toxics – over 70% in the Bay Area – are related to mobile emissions. Of course, this fact does not diminish the need to address stationary sources: as the previous section shows, facility-based emissions are unevenly distributed and can be the main environmental health concern in certain communities. Still, the NATA data on underlying emissions allows us to offer a more complete picture of both cancer risks and respiratory hazard.

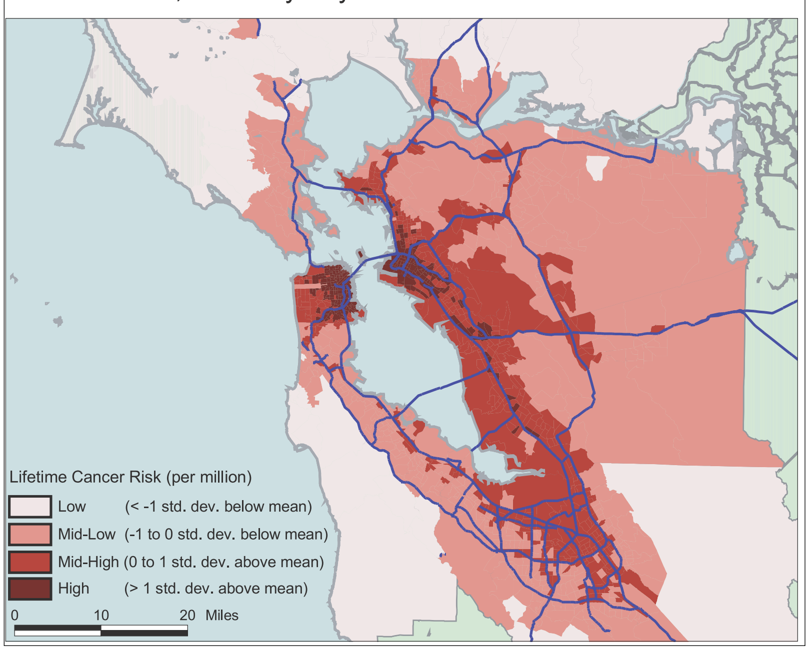
Table 2: Multivariate Correlates of Neighborhood Proximity to an Active Toxic Release in the 9-County Bay Area (Proximate = Within 1 Mile)

Model variables	*Coeff. Sign*	*Stat. Sig.*	*Coeff. Sign*	*Stat. Sig.*
% owner occupied housing units	-	**	-	
ln(per capita income)	-	***	-	***
ln(population density)	-	**	-	**
% manufacturing employment	+	***	+	***
% African American	+	***	+	***
% Latino	+	***	+	**
% Asian/Pacific Islander	-		-	
% linguistically isolated households			+	*
* indicates significance at the .10 level; ** indicates significance at the .05 level; *** indicates significance at the .01 level	N = 1,403		N = 1,403	

Visually understanding the pattern of this data with respect to race is more challenging than with the TRI – we cannot plot single facility points against demographic breaks since we are also breaking the neighborhoods up in groups ranging from those least-affected to those most-affected. Because of this, we simply show a Bay Area map of excess cancer risks from ambient air toxics that can be compared to our earlier map of demographics (Figure 1).

The observant reader will note that air toxic risk does not seem to be an equal opportunity affair: there are higher levels of risk in Richmond and West Oakland, as well as parts of San Francisco and East San Jose, all heavily minority areas. Still, air quality is a challenge confronting the whole Bay Area: even the so-called "low" risk areas have an average level of estimated cancer risk which is an order of magnitude above the goal of ten cancers in a million used by BAAQMD in regulating new facilities. This suggests the general importance of a cumulative approach: a little risk here, a little risk there, and soon you have health risks that are well above those benchmarks that trigger regulatory concern.

Figure 4: 1999 NATA Estimated Cancer Risk (All Sources) by 2000 Census Tracts, 9-County Bay Area



Once again, we dig deeper into the distribution of burdens by breaking up Bay Area neighborhoods (or census tracts) by their degree of both cancer risk and respiratory hazard; following the general breaks in the map, we designate "least risk" areas as those that are more than one standard deviation lower than the Bay Area average, and "most risk" areas as those that are more than a standard deviation above this average. We then compare demographic, income, and

Table 3: Demographic and Land Use Characteristics of Census Tracts by Estimated Cancer and Non-Cancer Risk Category

	Cancer Risk			Respiratory Hazard		
	Least risk	*Middle range*	*Most risk*	*Lowest hazard ratio*	*Middle range*	*Highest hazard ratio*
Percent Anglo	68%	48%	39%	66%	49%	33%
Percent African American	4%	7%	16%	5%	6%	16%
Percent Latino	17%	20%	17%	18%	19%	24%
Percent Asian Pacific Islander	7%	21%	24%	7%	22%	23%
Percent Other	4%	4%	4%	4%	4%	4%
Percent home owner	70%	61%	28%	71%	59%	34%
Median per capita income	$28,231	$28,187	$22,973	$27,137	$29,329	$20,487
Percent persons in poverty	7%	8%	15%	7%	8%	15%
Population density (persons per square mile)	2,929	8,175	24,194	2,603	9,346	19,425
Percent industrial, commercial and transportation land use	3%	8%	17%	4%	8%	20%
Percent recent immigrants (1980s and later)	10%	21%	24%	10%	21%	26%

other characteristics, for the communities that fall into each of these categories in Table 2.

The table indicates that the higher risk areas have higher proportions of minority and immigrant residents. They have a higher percentage of land devoted to industrial, commercial, and transportation land uses, and have a lower level of home ownership. Poverty rises slightly as we go from the "least risk" to the middle range areas and then skyrockets in the "most risk" areas; median per capita income follows a similar trajectory and is much lower in the "most risk" areas. This suggests that the "least risk" areas are not necessarily the most affluent in the Bay Area, but one should note that they are more stable, with relatively high rates of home ownership.

As before, a full consideration of the importance of various measures requires that we do a multivariate analysis. The specification for this is quite similar to what we used when examining the TRI pattern, but with a few modifications. First, we enter income with two effects: an *initial positive effect* at the very lowest levels of income in which we expect that as income rises, cancer risk and respiratory hazard from ambient air toxics will also rise, mostly because it is associated with more economic activity; and a *subsequent negative effect* in which higher incomes eventually provide a defense, either economically or politically against higher levels of pollution (this is the pattern indicated in the broad breaks in Table 3 and it technically means that the second variable is entered as a square of the first). Second, because ambient air toxics are related to all of the various industrial, commercial, and transportation uses, we can utilize that land use variable in this exercise. Third, because we assume that since transit uses and commercial activity rise with population, population density is assumed to be positively correlated with ambient air toxics.

The results are shown in Table 4. Again, even after controlling for income and other factors, race seems to matter both for our measures of cancer risk and our measure of respiratory hazard. In the analysis in which we add linguistic isolation, we find it to be important for the cancer risk variable, but very insignificant – indeed, the effect is as nearly close to zero as is possible in such tests – for respiratory hazards, partly because it is so highly correlated with percent Latino and percent Asian.

Table 4: Multivariate Correlates of Estimated Cancer and Non-Cancer Risk in the 9-County Bay Area

	Cancer Risk				Respiratory Hazard			
Model variables	*Coeff. Sign*	*Stat. Sig.*	*Coeff. Sign*	*Stat. Sig.*	*Coeff. Sign*	*Stat. Sig.*	*Coeff. Sign*	*Stat. Sig.*
% owner occupied housing units	-	***	-	***	-	***	-	***
relative per capita income (tract/state)	+	***	+	***	+	***	+	***
relative per capita income squared	-	***	-	***	-	***	-	***
ln(population density)	+	***	+	***	+	***	+	***
% industrial/commercial/transportation land use	+	***	+	***	+	***	+	***
% African American	+	***	+	***	+	***	+	***
% Latino	+	***	+	**	+	***	+	***
% Asian/Pacific Islander	+	***	+	***	+	***	+	***
% linguistically isolated households			+	***			-	
* indicates significance at the .10 level; ** indicates significance at the .05 level; *** indicates significance at the .01 level	N = 1,402		N = 1,402		N = 1,402		N = 1,402	

The bottom line is simple. Considering either the hazard from exposure to nearby TRI toxic air releases, or the level of estimated cancer risk and respiratory hazard from air toxics concentrations estimated in the NATA data, there is a general pattern of environmental inequity in the Bay Area: densely populated communities of color characterized by relatively low wealth and income and a larger share of immigrants, disproportionately bear the hazard and risk burden for the region.

Potential Policy Implications

Although it is important to examine and document environmental disparities, the true challenge facing the Bay Area is developing and implementing strategies to minimize inequalities and decrease exposures to potential environmental hazards for all residents.

Fortunately, there are numerous community groups engaged in discussions and debates with regulators, business leaders, and others about adopting more health-protective approaches. For example, thanks to the persistent advocacy efforts of several Bay Area environmental justice advocacy organizations, the Bay Area Air Quality Management District passed a flare control rule for refinery operations. This rule prohibits routine flaring by refineries and requires them to prepare Flare Management Plans for each flare at their facilities that specifically outlines steps they have taken and can take to reduce the frequency and duration of flaring events. Reduction of air toxics emissions from these large refineries due to flaring will directly benefit the region, particularly fenceline communities living next to these facilities.

Similarly, advocacy and organizing efforts have been successful at drawing attention and support from unions and the public about the need to reduce diesel emissions from trucks idling at the Port of Oakland. In San Francisco, adoption of the precautionary principle has helped to encourage initiatives that promote toxics use reduction, environmental health assessments in impacted communities, and localized interventions to reduce emissions from problematic large and small area sources.

In thinking through additional new approaches for addressing environmental inequalities in the Bay Area, we would suggest several guiding principles.

The first is the need to consider *cumulative impacts*. In the analysis above, we first overlaid one set of hazards, the location of the Toxic Release Inventory facilities, and found inequities by race and income. We then took a more comprehensive database that includes mobile sources and health risk estimates, the National Air Toxics Assessment, and found a similar pattern. Further analysis with state of California data charting the location of chrome platers, hazardous waste sites, and other locally undesirable land uses, although not shown in this report, produces a fuller picture and conveys same message: environmental inequity is alive and well in the Bay Area.

Communities are not simply impacted by one set of air releases or one type of hazard, but by several, and some of these may accumulate and interact to impact community health in ways that are poorly understood. While our traditional approach to regulating air quality still tends to be site-by-site and source-by-source, mounting evidence strongly suggests that it is time for a more comprehensive neighborhood-based approach to cumulative impact and community vulnerability assessment that considers all pollution sources when permitting new facilities or deciding where to focus resources on environmental remediation and emissions reduction efforts. The failure to consider in permitting decisions the cumulative impacts from multiple sources and the factors that enhance community vulnerability to the adverse effects of pollution exposures may undermine the fundamental regulatory mission to protect public health.

While a cumulative approach to regulatory decision-making might seem abstract and untried, it is quite relevant to the contemporary challenges facing the state. Both Southern and Northern California are facing environmental pressures as a result of state and regional decisions to pursue economic revitalization through the rapid expansion of the goods movement – the logistics of shipping products to and from our ports and sending them via rail and truck to the rest of the country. While this business strategy might ensure the Bay Area's preeminent position in a globalized

Chinese & Latino youth from southeast San Francisco work with PODER and the Chinese Progressive Association to organize a community media event that highlighted the results of a community survey and grassroots community planning process.

economy and the role of Los Angeles as an entry for U.S. trade, it creates the real possibility for worsening air quality and community environmental health risks in places like West Oakland in the north and the Alameda Corridor in the south. Regulating as though all neighborhoods mattered would encourage a search for alternatives to diesel fuels, stricter regulations on truck and train idling, and remediation of local point sources as major transportation corridors experience increases in truck traffic volume.

A second guiding principle involves the need to consider *social vulnerability*. The analysis above suggests that environmental hazards have over time tended to gravitate to places with the least economic, social and political power. This is the most striking of contradictions from a health perspective: those residents least likely to have access to adequate health care because of income shortfalls, language barriers, and other impediments are finding themselves confronted with the worst environmental conditions in the region. And the health consequences are quite real: in a separate analysis, we have found that the respiratory hazards we have modeled are highly correlated with hospitalization for asthma, even after controlling for the other factors.

Taking social vulnerability and cumulative exposures into account could mean developing strategies for determining which neighborhoods might need special outreach, regulatory protection, or engagement in the policy and rule-making process. For example, regulatory strategies such as targeted air quality monitoring could be enhanced in segregated neighborhoods where poor air quality is a particular concern. Similarly, this information could help communities and local agencies understand how to target their efforts to reduce emissions from major sources. These targeted monitoring and emission source reduction strategies would have to be done in partnership with communities who would play a critical role in helping to identify smaller emissions sources that typically fall below the regulatory radar screen but that may be located near sensitive receptors (e.g., residential communities or schools). Communities can also help agencies balance the need for more effective regulation with the promotion of economic opportunities within a region. Previous agency/community collaborations of this sort include monitoring and source reduction efforts conducted by the California Air Resources Board and the communities of Barrio Logan in San Diego, and Wilmington in the Los Angeles area.

Some might worry that paying attention to both cumulative exposures and social conditions would essentially become a red light for economic activity in the region. But this view oversimplifies perceived tradeoffs between environmental integrity and business vitality, and promotes an outdated understanding of the sophistication of community-based organizations. Indeed, special attention to environmental and social justice can actually help the economy: a landmark community benefits agreement around the expansion of the Los Angeles International Airport set aside $500 million for noise abatement for homes and schools and provided job training for local residents even as it facilitated a go-ahead for the project. The point of addressing environmental inequities is not to stop economic growth but rather to balance costs and benefits in ways that work best for all affected communities within a region.

A third guiding principle should be promoting *meaningful community participation*. Such participation means involving communities and their representatives at appropriate points in research and decision-making. It means understanding that capacities are uneven, and that community groups may need additional technical training, information, and partners to insure that their views on environmental health issues are articulated and understood. And it means reaching out in languages that are accessible: not only Spanish, Chinese, Laotian, and other tongues, but also by translating and communicating scientific information and research results in formats that community organizations can leverage and disseminate to their constituents.

The Bay Area Air Quality Management District has stated their commitment to community participation and environmental justice but community activists remain skeptical. They argue that information and outreach in multiple languages is available only under political pressure and not as a matter of course. And they suggest that the recent modeling of air toxics under the District's Community Air Risk Evaluation (CARE) program will not provide enough details for neighborhood-level analysis of environmental exposures and inequities.

The distance between the stated intentions of the AQMD and the views of activist residents points to a gulf that needs to be overcome. Getting to common ground will require more discussions and more collaborations. One way that might help would be the development of real community-based participatory research projects. While the AQMD has been crafting new databases of modeled emissions, communities have been out trying to collect ground-level data on the conditions in their neighborhoods. Surely these efforts can be brought together, a process that would generate more trust in both the data and the good will of policy makers.

A final guiding principle should be *meaningful action*. Perhaps the most important frustration expressed by community members is simple: discussions of community engagement and the need for better data collection drag on while their children remain at risk from toxic air and local health hazards. There is a need for better data, better science, and better methods to document disparities – and we hope that this report will contribute to a discussion about these issues. How the regulatory community should address fundamental socioeconomic drivers of environmental health also remains an open question. Finally, the capacity of environmental and public health agencies to proactively engage with these issues is somewhat constrained by legislative mandates that structure the priorities of their research, regulatory, and enforcement activities.

Yet agencies that conduct research can begin to grapple with how to integrate place-based inequality measures and neighborhood-level indicators of socioeconomic status (SES) with the individual-level factors that have traditionally commanded regulatory attention. Moreover, although causally linking the presence of environmental pollution with potentially adverse health effects is an ongoing challenge, particularly in situations where diverse populations are chronically exposed to complex chemical mixtures from various sources, the ongoing quest for better data and unequivocal proof of cause and effect should not make us lose sight of a basic public health principle— namely, the importance of disease prevention. This requires regulatory and land use planning agencies to work proactively with communities to constantly seek and develop opportunities for emissions source reduction that can improve air quality for specific neighborhoods and the region as a whole.

BAAQMD could make significant steps toward embracing the three principles we outline above by implementing some very specific short- and long-term regulatory initiatives. In the short-term, the air district can proactively facilitate more open access to critical data sets and emissions inventories that enable communities to assess environmental health issues as well as identify potentially problematic emissions sources that require community and regulatory intervention. Even more important, the BAAQMD could collaborate more with cities, counties and public stakeholders to expand its inventories to include unregulated sources that may be contributing significantly to local cumulative environmental health risks.

Critical to this process will be efforts to identify the advantages and limitations of all emissions inventories and data sets that AQMD develops and disseminates. For example, most inventories are based on estimates of emissions and not actual measurements, and they tend to only capture pollution emissions from "normal operating" conditions and not episodic events that may occur due to industrial accidents, or an unusual ramping up of activity due to construction or the expansion of an existing facility. Moreover, it will be important to consider emissions from "magnet" sources (e.g. ports and terminals), grandfathered sources, and uncontrolled emissions sources that could be either permanent or temporary (such as construction activities). In this way, communities can work more closely with the air district to identify activities that may fall below the "regulatory radar" and not get captured in existing inventories but that may actually contribute significantly to local pollution burdens.

Over the longer term the air district should develop a cumulative impact approach in its regulatory activities and permitting decisions. This will require rethinking traditional risk assessment in ways that take into account emissions multiple pollutants coming from multiple sources that can have both localized and regional impacts. Similarly, the air district will have to develop a more open, and deliberative process to develop measures of vulnerability that are broader than traditional indicators of "sensitive receptors" (i.e. children and the elderly). These measures should include socioeconomic status, access to health services, community capacity for civic engagement, and information on the incidence of health outcomes that are linked to both the social and physical environment of neighborhoods. Community participation in this process will be critical to the development of policy-relevant and transparent indicators of vulnerability and cumulative impact.

Effective regulatory and policy initiatives that advance environmental justice will require combining local and regional approaches to data collection, air quality monitoring, analysis, dissemination of results, and, most important, regulatory intervention. In some instances regional activities aimed at emission source reduction can result in significant decreases in certain pollutant burdens. But this regional work must be complemented by local initiatives that combine emissions reduction incentives and in some cases outright caps in those neighborhoods that are already severely affected by high pollution levels from myriad mobile and stationary sources. These localized regulatory activities can be leveraged through collaboration with other agencies to problem-solve environmental health issues associated with land use, industrial development and zoning decisions.

Finally, as the Bay Area undergoes an impressive development and construction boom in what were once low income communities, the issue of gentrification will have to be forthrightly addressed. On the one hand, environmental clean-up and exposure reduction activities should not simply be targeted toward so-called "up and coming" neighborhoods, but aimed at improving environmental quality for all residents in the Bay Area. On the other hand, proactive measures will need to be taken to insure that any increase in area attractiveness because of environmental remediation – which is likely through this to raise property values – does not wind up producing a displacement of the residents whose concern and activism prompted the clean-up. Those who have suffered through the toxic soup for many years should be among those to reap the rewards from a new commitment to the environmental quality in general and environmental justice in particular.

On October 18 2005 the Bay Area Ditching Dirty Diesel Collaborative distributed more than 8,000 informational anti-idling fliers to diesel truck and bus drivers, as well as local residents. loophole The California Air Resources Board (CARB) held a hearing two days later in which they closed a loophole that allowed truckers with sleeper cabs to idle their vehicles overnight, effective 2008.

Looking Forward

The Bay Area has often prided itself on leading the state on environmental issues. When the state passed a Global Warming Solutions Act in September 2006, the signing ceremony was staged on Treasure Island. When the state authorized a new biomonitoring program in the same month – an approach that will allow us to know rather than guess about pollutant exposures – Bay Area legislators were at the forefront.

Yet this study demonstrates that the Bay Area is also characterized by an unequal distribution of our environmental burdens and opportunities – and no amount of sophisticated statistical attempts to control for other factors seems to erase the stain of racial and economic inequality.

We can and should do better.

We enjoy, after all, the presence of some of the country's most vibrant and creative community-based environmental organizations, groups that have generated their own research efforts and continue to press for cleaner air for all the region's residents. We are host to some of the country's most dynamic companies, firms rooted in the new economy and therefore aware that improving the environment represents not a business drag but a business opportunity. And we have among us some of the country's best researchers and scientists, people who can bring data and tools from our academic and public sector institutions to analyze problems and suggest solutions.

The task is to marshal these resources for a new direction and new partnerships that will take social equity as a serious prism for understanding and improving the environment. The challenge is to consider cumulative impacts in a new regulatory approach, building on the wisdom of communities who know that it is not just one sort of hazard or release that threatens their health. And while we fully understand the need to deepen the research and consider the complexities, the time for action is now.

Technical Appendix

In order to have the bulk of this report as accessible as possible, we have chosen to confine certain technical details to this appendix. Here, we discuss in more detail datasets and variables as well as techniques.

In our consideration of facilities listed in the Toxic Release Inventory (TRI), we examined only those with active air releases; the TRI itself includes numerous facilities that are not currently generating air emissions and we exclude these. Active facilities were located using address-matching (geocoding) of the street address reported to EPA against the address ranges in high quality spatial data sets recording roads and street statewide. To check for location accuracy and possible errors, each facility address was located using current versions of two different street databases, one from TeleAtlas and one from Geographic Data Technology, two of the most reliable data providers available.

The basic unit for neighborhood analysis for both the TRI and NATA analysis (see below) was the census tract, a standard in both demographic and environmental analysis. To determine which tracts were proximate, we drew, as noted in the text, various radii; if half of a tract's population fell within each resulting circle, as measured by the populations of the census blocks that fell within the circle, we considered that tract to be affected. This procedure is a slight modification of the best practices in the case of stationary sources as laid out in a recent article by Mohai and Saha (2006). The radii utilized were one mile and two and a half miles; we also tightened the focus to look at the area within one half mile of a TRI but the results were quite similar to the demographics for the one mile radius, and so we present just the three breaks (with one mile, between one and two and a half miles, and beyond) in the text.

The National Air Toxics Assessment data is briefly explained in the text and more on the 1999 iteration can be found at http://www.epa.gov/ttn/atw/nata1999/. To calculate cancer risk, we combined air toxics concentration estimates with inhalation unit risk estimates for each carcinogenic compound to estimate overall cancer risks. Estimated cancer risks for each pollutant in each census tract were derived with the formula

$$R_{ij} = C_{ij} \text{ x } IUR_j,$$

where R_{ij} is the estimate of individual lifetime cancer risk from pollutant j in census tract i, C_{ij} is the concentration in micrograms of pollutant per cubic meter of air (µg/m^3) of the air toxic j in census tract i, and IUR_j is the inhalation unit risk estimate for pollutant j. In accordance with California's AB2588 "Hot Spots" Guidelines (OEHHA 2003) and EPA's cancer risk guidelines (U.S. EPA 1986; U.S. EPA 1990), cancer risks of each pollutant were assumed to be additive and were summed together in each tract to derive a total individual lifetime cancer risk.

Respiratory hazard was derived by comparing each pollutant concentration estimate by its corresponding Reference Concentration (RfC) to derive a hazard ratio. An RfC for chronic respiratory effects is defined as the amount of toxicant below which long-term exposure to the general population of humans, including sensitive subgroups, is not anticipated to result in any adverse effects. The actual respiratory hazard ratios for each pollutant in each census tract were calculated using the following formula:

$$HR_{ij} = C_{ij}/RfC_j$$

where HR_{ij} is the hazard ratio for pollutant j in tract i, C_{ij} is the concentration in *ug*/m^3 of pollutant j in census tract i, and RfC_j is the reference concentration for pollutant j in *ug*/m^3. An indicator of total respiratory hazard was calculated by summing together the hazard ratios for each pollutant in order to derive a total respiratory hazard index:

$$HI_i = \Sigma_j HR_{ij}$$

where HI_i is the sum of the hazard ratios for all pollutants (j) in census tract i.

For all of the analysis presented above we used estimates of cancer risk and respiratory hazard that were based on the Hazardous Air Pollutant Exposure Model (HAPEM). HAPEM integrates ambient concentration estimates with information on indoor/outdoor microenvironment concentrations, penetration of outdoor pollutants into indoor environments, local populations, and individual-level activity patterns to generate an expected range of inhalation exposure concentrations for each census tract before applying the inhalation unit risk estimates and reference concentrations for each pollutant to obtain the final estimates. HAPEM tries to take into account more realistic scenarios of people's day-to-day activities and the fact that they tend to move across various locations (e.g., from home to work, or home to school) and spend a majority of their time in indoor environments (e.g., the home, workplace, school, or commuting in a car). While our analytical results are nearly identical when the basic concentration-based estimates are used, we applied the HAPEM-based exposure results to derive our cancer and non-cancer risk estimates since this modeling approach takes into account differences in estimated population exposures, related to human activity patterns in different microenvironments.

As noted in the text, these are modeled cancer risks and respiratory hazards. Still, we should stress that in a set of multivariate regressions separate from the current analysis, a significant relationship was found between the respiratory hazard ratio described above and age-adjusted asthma hospitalization rates (taken as three year averages over the years 1998 through 2000) that were made available to us by Community Action to Fight Asthma (CAFA). Although the analysis was carried out at the Zip Code Tabulation Area (ZCTA) – the level of geography at which the asthma data was made available and one that is far less detailed than the census tract – the significance of the relationship, even when controlling for several measures that would seem to explain both the incidence of asthma and the event of hospitalization for the condition, lends some degree of confidence to the respiratory hazard ratio we have developed as a measure of health impacts.

While most of the data comparisons are quite clear in the text, it is useful to mention several things. First, in the simple comparisons of tracts by degree of cancer risk or respiratory hazard, we talk about breaking the data by standard deviations from the mean. The cancer risk and respiratory hazard measures, however, are not normally distributed; by contrast, the natural logs of these values seem to be close to a normal distribution. Because of this, we use the logged value as the dependent in our regressions and also in determining the "most" and "least" affected tracts for the comparison in Table 3, as well as in the map that comprises Figure . This is an approach we have used before in several different pieces, including most recently in Pastor et al. (2005). We should also note that the statistics reported for the comparisons drawn in Tables 1 and 3 are weighted means of each variable across all tracts falling into each category, applying the appropriate weight, with the exception of population density and the share of land devoted industrial, commercial and transportation uses, for which unweighted means are reported. This is done because the variation in land area of census tracts (which would be the appropriate weight for the two variables mentioned above) is so great that applying such a weight would greatly distort the view of a typical census tract falling into each category. Such a distortion by the use of population or household weights does not occur for the other variables.

For the multivariate analysis of TRI location, we used a logit regression; this is an appropriate strategy for a case where the dependent variable consists of two possibilities, either being proximate (say, less than one mile away) or not being proximate (say, further than one mile away) to a TRI. For the NATA analysis, we utilized straightforward ordinary least squares regressions techniques.

Since for clarity of presentation, we report just signs and coefficient levels, some might wonder just how close to significance some of those variables that do obtain traditional significance levels might be. In the TRI logistic regression in the first column of Table 2, the negative sign for the percent Asian and Pacific Islander has a significance level of .864, meaning that it is virtually certain that the real value is zero. In the second column, it appears that housing ownership has slipped in significance but only to the .125 level (meaning that there is nearly a ninety percent chance that the real effect is negative). The inclusion of the statistically significant measure for linguistic isolation raises the significance of the negative sign for Asian Pacifics, implying that for this population, linguistic isolation is especially important. Finally, in the NATA regressions in Table 4, readers might be struck by the negative sign for linguistic isolation. However, with a significance level of .904, again, it is virtually certain that the real effect is null rather than negative. While this is still of interest, a better reading and maybe even presentation of that sign would be as a question mark.

Though also not reported in the tables, the model fit as measured by the reported Nagelkerke R Square values for the TRI regressions ranged from 0.2581 to 0.2616; these might seem to be low but the figures are actually quite good for this type of regression. The fit for the NATA regressions as measured by the reported Adjusted R Square values ranged from 0.5632 to 0.5721, which is a very good performance. In both the TRI and

NATA analysis, population density is entered as a log on the grounds that its effect diminishes at higher values; in the TRI analysis, we entered per capita income as a log for the same reason. In the NATA analysis, however, we utilize per capita income in a U shaped formula – that is, we enter the normalized value of per capita income (relative to the state value) and the square of that value – because of our assumptions about the shape of the relationship at lower and higher levels of income. There was no attempt to control for spatial autocorrelation although we intend to do that in future analyses.

Finally, regarding the two maps presented, we should note that because HAPEM estimates of cancer risk and respiratory hazard are only made for census tracts in which people reside, and there is one tract in the Bay Area that contains no people (the San Francisco International Airport) and hence has no available cancer risk estimate to include in Figure 4, rather than dropping it from the map we assigned to it the distributional category it would receive under the basic concentration-based cancer risk estimate, which does require people to be in a tract in order to generate a risk estimate. Similarly, for the same tract in the Figure 2, we assigned to it the percent people of color category that best reflected the surrounding neighborhoods. Also in Figure 2, the demographic breaks were derived by ranking all Bay Area tracts into thirds according to the percentage people of color. Thus, the numbers reported in the legend are tertiles, and they have been rounded to the nearest whole percentage point for convenience.

For those interested in more detail on these various techniques, we recommend our various analyses of Southern California, especially Sadd, et al. (1999) and Morello-Frosch, et al. (2002, 2001). For those interested in the general empirical debate about environmental justice disparities, we suggest United Church of Christ (1987), Anderton, et al. (1994), Lester et al. (2001), and Ash and Fetter (2004).

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Selected Web Resources

- American Lung Association (ALA). The ALA is the oldest voluntary health organization in the United States, with a National Office and constituent and affiliate associations around the country; it fights lung disease in all its forms, with special emphasis on asthma, tobacco control and environmental health. See http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=22542

- Bay Area Air Quality Management District (BAAQMD). BAAQMD is charged with regulating to achieve clean air to protect the public's health and the environment in the San Francisco Bay region. See http://www.baaqmd.gov/

- Berkeley Center for Environmental Public Health Tracking (BCEPHT). BCEPHT works to advance a nationwide Environmental Public Health Tracking (EPHT) network that provides and communicates information about relationships between environmental factors and health to all relevant audiences, including policy-makers and community stakeholders. See http://ehtracking.berkeley.edu/

- California Air Resources Board (CARB). CARB is responsible for promoting and protecting public health, welfare and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the state. See http://www.arb.ca.gov/homepage.htm

- California Environmental Health Tracking Program (CEHTP). CEHTP is a multi-agency collaborative seeking to develop a comprehensive standards-based, coordinated, and integrated system, at the state level, that enables public health actions through linkage, monitoring, reporting, and communication of health effects and environmental hazards and exposure data). See http://www.catracking.com

- California Environmental Protection Agency (Cal/EPA). Cal/EPA has as its mission restoring, protecting and enhancing the environment, to ensure public health, environmental quality and economic vitality. To see the strategies for environmental justice in the state, including recommendations for state agencies, go to: http://www.calepa.ca.gov/EnvJustice

- Center for Community Action and Environmental Justice (CCAEJ). The goal of this center is to build a strong movement for change that recognizes the connections between environmental and worker exploitation, and oppression on the basis of race, gender, sexual orientation and class, and incorporates that connection in its primary activities. See http://www.ccaej.org/

- Center for Health, Environment and Justice (CHEJ). This organization works to level the playing field by allowing communities members to have a say in the environmental policies and decisions that affect their health and well-being. By organizing one school, one neighborhood, one community at a time, CHEJ is making the world cleaner and healthier for all of us. See http://www.chej.org/index.htm

- Communities for a Better Environment (CBE). CBE is an environmental health and justice non-profit organization, whose unique three-part strategy provides grassroots activism, environmental research and legal assistance within underserved urban communities. See http://www.cbecal.org

- Community Action to Fight Asthma (CAFA). CAFA is a network of asthma coalitions in California working to shape local, regional and state policies to reduce the environmental triggers of asthma for school-aged children where they live, learn, and play.). See http://www.calasthma.org

- Environmental Health Coalition (EHC). Dedicated to achieving environmental and social justice, this coalition believes that justice is accomplished by empowered communities acting together to make social change, and supports broad efforts that create a just society which fosters a healthy and sustainable quality of life. See http://www.environmentalhealth.org/

- Environmental Inequality (This site contains a report detailing environmental injustices in Silicon Valley and Santa Clara County. Refer to the maps comparing toxic sites with income level and racial compositions.): http://www.mapcruzin.com/EI/

- Golden Gate University Environmental Justice and Law Clinic. In 1994, Golden Gate was one of the first law schools in the country to establish an environmental justice clinic. Working under the close supervision of two full-time professors, students directly represent environmental organizations and community groups in low-income and minority communities in real-life public health, toxics, and environmental justice matters.). See http://www.ggu.edu/school_of_law/academic_law_programs/jd_program/environmental_law/environmental_law_justice_clinic

- Greenaction for Health and Environmental Justice (Greenaction). Greenaction mobilizes community power to win victories that change government and corporate policies and practices to protect health and to promote environmental justice. See http://www.greenaction.org/

- National Resource Defense Council (NRDC). NRDC works to foster the fundamental right of all people to have a voice in decisions that affect their environment. See http://www.nrdc.org/

- Pacific Institute. The Pacific Institute is an independent, nonpartisan think-tank studying issues at the intersection of development, environment, and security. Some of its recent work includes pioneering studies of environmental disparities, particularly using community-based participatory research. See http://www.pacinst.org/

- Silicon Valley Toxics Coalition (SVTC). This diverse organization is engaged in research, advocacy, and grassroots organizing to promote human health and environmental justice in response to the rapid growth of the high-tech industry. See http://svtc.etoxics.org/

- Students for Environmental Action at Stanford (SEAS). This group of activists at Stanford is dedicated to fighting for environmental and social justice on campus, in the surrounding communities, and beyond. See http://seas.stanford.edu/

- The San Francisco Foundation. The Foundation seeks to mobilize resources and act as a catalyst for change to build strong communities, foster civic leadership, and promote philanthropy. It has had special interests in the area of environmental justice. See http://www.sff.org/grantmaking/enviro_ehji.html

- Transportation and Land Use Coalition (TALC). TALC is a partnership of over 90 groups working for a sustainable and socially just Bay Area with a focus on analyzing county and regional policies, and working with community groups to develop alternatives. See http://www.transcoalition.org/

- Urban Habitat (UH). UH builds power in low-income communities and communities of color by combining education, advocacy, research and coalition building to advance environmental, economic and social justice in the Bay Area. See http://urbanhabitat.org/

- US EPA's 1999 National Air Toxics Assessment (NATA) website can be found at: http://www.epa.gov/ttn/atw/nata1999/

- US EPA's 2003 Toxic Release Inventory Program can be accessed at:http://www.epa.gov/tri/tridata/tri03/index.htm

Bay Area Environmental Health Collaborative

The Bay Area Environmental Health Collaborative (BAEHC) is a multi-year partnership among six broad coalitions and numerous organizations working for the adoption of specific measures to protect public health in communities that are heavily impacted by air pollution. BAEHC's diverse membership includes community representatives, environmental health and justice advocates, scientific and technical experts and public health professionals.

The goal of BAEHC is to assure better health outcomes for local residents by improving Bay Area air quality through community capacity and the establishment of protective public policy measures that reduce the cumulative effects of air pollution and ensure public access to decision-making processes, particularly in highly impacted areas.

Environmental Justice Air Quality Coalition

- Greenaction for Environmental Health & Justice
- Communities for a Better Environment
- West County Toxics Coalition
- Youth Unitited for Community Action
- Hunters View Mothers Committee
- Healthy San Leandro Collaborative

Immigrant Power for Environment Health and Justice

- Chinese Progressive Association
- People United to Demand Environmental and Economic Rights
- Environmental Law and Justice Clinic

Bay Area Clean Air Task Force

- American Lung Association of California
- Bayview Hunters Point Commujnity Adcocates
- Bluewater Network
- Breathe California, Golden Gate Partnership
- Natural Resources Defensive Council
- Our Children's Earth Foundation
- Regional Aswthma Management and Prevention Initiative
- Sierra Club
- Union of Concerned Scientists
- TRANSDEF
- West Oakland Environmental Indicators Project
- Contra Costa Asthma Coalition
- American Lung Association of California
- Asthma Community Advocates
- Communities for a Better Environment
- Community Action to Fight Asthma
- Community Clinic Consortium of Contra Costa
- Community Focus
- Community Health Initiative
- Concerned residents of Contra Costa County
- Contra Costa Child Care Council
- Contra Costa Community Services
- Contra Costa Council
- Contra Costa Health Services
- John Muir Health
- Kaiser Permanente
- La Clinica de La Raza
- Martinez Unified School District
- Mt. Diablo Unified School District
- Neighborhood Houst of North Richmond
- Parents for a Safer Environment
- Shields-Reid Community Center
- West County Toxics Coalition

Ditching Dirty Diesel Collaborative

- Bayview Hunters' Point Community Advocates
- Center for Community Action and Environmental Justice
- Coalition for Clean Air
- Communities for a Better Environment
- Healthy San Leandro Collaborative
- International Longshore and Warehouse Union, Local 10
- Natural Resources Defense Council
- Neighborhood House of North Richmond
- Pacific Institute
- Regional Asthma Management and Prevention Initiative
- West Oakland Environmental Indicators Project

Regional Asthma Management Prevention Initiative

- Oakland-Berkeley Community Action to Fight Asthma
- Ethnic Health Institute
- San Francisco Department of Public Health
- San Francisco Asthma Task Force

Environmental Law and Justice Clinic

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