Environmental Justice?
An analysis of air pollution and power plants in California

by

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Introduction

Over the past twenty years the controversy over inequitable distributions of environmental risks and hazards, especially due to pollution caused by industrial facilities, has led to calls for environmental justice. Yet exactly what environmental justice does and should entail remains unclear. There are four main categories of justice presented in the discourse: distributive, procedural, corrective, and social justice (Rechtschaffen and Gauna 2002), each of which is subscribed to by a different segment of the environmental justice movement and each of which stipulates a different type of policy reform as a solution to the current inequities. The complexity of environmental injustices and the difficulty of determining the causes have led to extensive debates. Some members of the environmental justice movement believe injustices have arisen due to a lack of fair and equal participation whereas others believe they are due to failures on the part of the state in enforcement of regulations (Cole and Foster 2001, Rechtschaffen and Gauna 2002).

As there has already been a considerable, albeit inconclusive, debate over the different categories of justice, this analysis focuses instead on the methodological issues in just one of those categories, that of distributive justice. It is important to evaluate and understand the methods used within distributive justice analysis because it is the distributive justice framework which is most used by policy makers, judges, regulators and scientists when analyzing environmental justice. Furthermore, it is now clear that the "choice of research methodology [in analyzing distributive justice] may lead to dramatically different research results" (Liu 2000). This investigation aims to illustrate this point by comparing the results of analyses which use various methods to characterize the demographics of the population impacted by air pollution from power plants in California.

Environmental Justice

The United States Environmental Protection Agency (EPA) defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or a socioeconomic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies. Meaningful involvement means that: (1) potentially affected community residents have an appropriate opportunity to participate in decisions about a proposed activity that will affect their environment and/or health; (2) the public's contribution can influence the regulatory agency's decision; (3) the concerns of all participants involved will be considered in the decision making process; and (4) the decision makers seek out and facilitate the involvement of those potentially affected" (Environmental Protection Agency 2004).

The term 'environmental justice' is now used in place of the term environmental racism, which was coined to describe "race-based discrimination in environmental policymaking; race-based differential enforcement of environmental rules and regulations; the intentional targeting of minority communities for toxic waste disposal and transfer and for the siting of polluting industries; and the exclusion of people of color from public and private boards and commission, regulatory bodies, and environmental non-profit organizations"(Lester, Allen and Hill 2001). The term environmental justice is more inclusive than environmental racism because it includes the disparities in environmental burdens borne by the poor (Rechtschaffen and Gauna 2002).

As indicated by the expansive definition by the EPA, environmental justice can encompass more than fairness in the distribution of the risk and impacts of environmental hazards and policies. Environmental justice is also tied to concerns over about participatory, democracy, and social responsibility (Bowen 2002).

History of Environmental Justice

The relationship between the environment, minorities and the poor first was brought to national attention by the 1971 annual Council on Environmental Quality report, which observed that the poor are unable to improve the quality of their environment due to income inequalities(Lester, Allen and Hill 2001). However, it was not until 1978 that the first widely documented protests against environmental injustices were held. These protests were directed against the siting of a polychlorinated biphenyl dump in Warren County, North Carolina. (Brown 1995) Following those protests, several key reports investigated the issue of environmental justice. Two of the most renowned reports are the 1983 US General Accounting Office study and the 1987 United Church of Christ study. The General Accounting Office study concluded that the location of hazardous waste facilities were highly correlated with the presence of racial minorities and low-income populations in the eight states included in the study (General Accounting Office 1983). Similarly, the United Church of Christ report concluded that the communities surrounding commercial waste sites were more likely to be home to African Americans and Hispanics than Caucasians (Commission for Racial Justice 1987).

Concerns about environmental justice increased with the release of the 1984 report prepared by the California Waste Management Board. This report recommended that industry and government search for lower socioeconomic neighborhoods when siting waste facilities because those communities would be less likely to oppose the siting (Brown 1995). In response to this seemingly obvious and institutionalized discrimination and to an increased vocalization of concerns, the US Environmental Protection Agency established the Office of Environmental Equity in 1992 (Lester, Allen and Hill 2001).

In 1994, President Clinton issued Executive Order 12898 entitled Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. This order mandates that all federal agencies address the issue of environmental justice (Brown 1995). Executive Order 12898 both reinforces Title VI of the 1964 Civil Rights Act, which prohibits discriminatory practices in programs receiving federal funds, and highlights the National Environmental Policy Act (NEPA), which does not specifically target discrimination, but does set goals for protection and improvement of the environment (Bullard).

California followed the lead of the federal government and, in December of 1998, began the process of amending Senate Bill 89 (Legal Counsel State of California 2000a). Senate Bill 89 calls for the formation of a working group on environmental justice that would be responsible for developing and implementing environmental justice strategies. Senate Bill 89 was signed by the California governor in September 2000. Meanwhile, during October 1999, Senate Bill 115 was approved by the state senate and signed by the governor. This bill designated the California Environmental Protection Agency as the coordinating agency for environmental justice in California and required that the California Environmental Protection Agency take steps to include environmental justice in its daily activities (Legal Counsel State of California 2000b).

On March 1, 2004, the Office of the Inspector General published a report critiquing the US Environmental Protection Agency (EPA) for not consistently implementing Executive Order 12898. This report contends that because the EPA has not fully defined "environmental justice population" nor has it developed criteria for determining what a disproportionate impact entails, it has been unable to implement the mandate. Additionally, the report says that the policies and practices undertaken by EPA regional offices have been inconsistent. Furthermore, the EPA, by advocating and creating policies geared towards greater environmental protection for all, is ignoring the provision in Executive Order 12898 that makes specific reference to minority and low income groups (Office of Inspector General 2004). The ambiguity in the definitions of justice and in the specification of what constitutes an adverse impact and what methods should be used during analysis illustrates that environmental justice is a contentious and difficult issue to tackle.

Definitions of Justice

The environmental justice movement has gained immense momentum over the past few decades. This increased interest has acted as a double edged sword, augmenting the cause while concurrently increasing the discord within the movement. Disparate opinions within the movement have arisen in part because the environmental justice movement itself is formed by loose coalitions of groups which advocate greater grassroots democracy, broader social justice goals, collective power, and reallocation of resources (Rechtschaffen and Gauna 2002). Each contingent within the movement has a specific goal that it aims to achieve; yet the movement as a whole must agree on a few important issues to champion in order to maintain its potency.

One of the many inconsistencies in the environmental justice movement is the definition of justice. Theorists have divided the main paradigms of justice within the environmental justice movement into four main categories: distributive justice, procedural justice, corrective justice and social justice.

<u>Distributive Justice</u>

Distributive justice is perhaps the most commonly used concept for evaluating whether or not an environmental injustice exists. Scientists, lawyers, and policy makers frequently employ this paradigm when analyzing the relationship between an environmental hazard and the demographics of the population in proximity to or affected by that hazard.

Distributive justice refers to the fairness by which the risks of environmental hazards are distributed among the population. Although this could be interpreted as meaning that burdens should be apportioned in relationship to benefits, most commonly, distributive justice denotes "the right to equal treatment, that is the same distribution of goods and opportunities as anyone else has or is given" (Rechtschaffen and Gauna 2002). With respect to the environmental justice agenda, distributive justice refers to an "equal distribution of burdens resulting from environmentally threatening activities or of the environmental benefits of government and private sector programs" (Rechtschaffen and Gauna 2002).

Procedural Justice

The distribution of environmental hazards and risks is not the only method by which to evaluate environmental justice. In fact, many environmental justice activists are more concerned with the process by which decisions are made. This concern reflects the perception that outcomes are limited by the processes by which decisions are made (Frey and Oberholzer-Gee 1996).

Procedural justice refers to the fairness of the procedures. This requires equal concern and respect for individuals and groups in the political decision effecting how these goods and opportunities are to be distributed. An ex-ante analysis of procedural justice evaluates the fairness of a procedure in advance of its use. An ex-post analysis of procedural justice evaluates whether in retrospect the completed process did entail equal consideration of all the participants involved (Rechtschaffen and Gauna 2002). Within the procedural justice framework, the question arises as to whether or not a fair procedure will necessarily lead to a fair outcome, and if not, whether or not a fair process can override claims of injustice if a disproportionate outcome does indeed arise.

Exactly what qualifies as a fair procedure is subject to interpretation. Equal consideration of all stakeholders and the opportunities for stakeholders to voice their opinions and be heard are key qualifications. However, even after meeting these requirements, there can be considerable variation in the procedures followed. Bruno Frey, in an analysis of nuclear power plants in Switzerland, evaluated the acceptance of alternative siting processes. All of the scenarios he proposed involved just and equal concern for the communities involved, yet each followed a different process. He surveyed community members and asked which siting procedure they would prefer: one in which the location of a nuclear waste repository is determined by negotiations between federal government and prospective host communities, by foreign experts who are entrusted with making the decision, by a national referendum, by a lottery, or by various price mechanisms which involve bids from the prospective communities. Although Frey found that the use of negotiations was the preferred procedure, there was variation in the response he received, indicating the presence of discordant views of what constitutes a fair procedure (Frey and Oberholzer-Gee 1996).

Corrective Justice

Corrective justice is also referred to as retributive justice, restorative justice, or commutative justice. The corrective justice paradigm holds that justice involves more than simply ensuring that a new current policy or practice meets fairness standards. Corrective justice implies that damages inflicted on individuals and communities must be addressed. Thus if a facility creates an environmental risk, the institution which owns or manages that facility should be forced to compensate for the losses that it has inflicted upon those affected. This insinuates that not only must current risks be accounted for, but past pollution or hazards should be compensated.

Social Justice

The social justice framework calls for "a more just ordering of society such that members of every class have enough resources and enough power to live as befits human beings." The premise behind the social justice paradigm is that the problems and risks an individual faces do not occur in isolation, rather the "same underlying racial, economic and political factors that are responsible for environmental threats to the community also likely play a significant role in why the area may suffer from other problems" (Rechtschaffen and Gauna 2002). Thus, social justice calls for a holistic analysis which includes all of the factors leading up to the current hazards and inequitable distributions. For environmental justice to be achieved, all of the contributing factors must be addressed.

Environmental Justice Research

The paradigm by which justice is viewed is tied directly to the factors which are believed to be the underlying causes of environmental injustices. Explanations of the causes of environmental injustices range from explicit discrimination to structural economic inequities. If justice is viewed through a distributive or procedural framework, it is likely that environmental injustices will be blamed on discriminatory land use practices such as expulsive zoning, red lining, and urban renewal or on discriminatory practices which do not sufficiently inform the affected communities nor allow communities to voice their dissent. On the other hand, if justice is viewed through a corrective or social justice framework, environmental injustices may be explained by the residential location theories of push-pull, invasion succession and institutional neighborhood change as well as by market forces, politics, and power relationships (Liu 1997).

The environmental justice movement involves a diverse group of people. The experiences, education, and beliefs of each person will influence from which framework that person views environmental justice. Environmental justice activists tend to focus their arguments and actions on proving and rectifying what they see as the causes of environmental injustice. These people are likely to use participatory research techniques and focus their energies on taking action, changing procedures, and advocating for social justice. On the other hand, scientists and policy makers, who must by nature of their professions take a more neutral stance, have traditionally focused on distributive justice, using quantitative data to demonstrate whether or not the outcome of a specific policy or practice has led to a disproportionate impact on specific populations.

A review of environmental justice literature reveals that a variety of techniques have been used for analyzing environmental justice. Much of the early literature on environmental justice falls into the descriptive, case study category. Other studies are more normative, prescribing means by which disproportionate distributions can be equalized via grassroots and political campaigns. Another group of articles reviews and critiques existing methods and articles (Lester, Allen and Hill 2001). Recently there has been a shift towards quantitative studies focusing on both distribution outcomes and processes. These studies use empirical data, regression and other statistical measures to evaluate proximity to hazards, implementation of regulation and cleanup, and the health effects of various projects and policies (Brown 1995).

It is important to focus on these later studies because it is these studies which provide the quantitative justification that can most easily support policy changes. The essence of such distributive justice analysis studies has been to quantify, qualify and evaluate disproportionate impacts of environmental hazards. However, even within this realm, there are many permutations of analysis, and as such, different conclusions may be drawn from the same information. Before embarking upon a detailed exploration of the different methods which are used in quantitative distributive justice analyses, it is useful to review critiques of existing environmental justice studies.

One criticism of quantitative empirical studies of environmental justice is that they are often initiated by a researcher who already has a specific location and hazard in mind. Such studies do not create a larger framework from which a sample is taken. Thus it is difficult to generalize the results of those studies to the population of the US as a whole. The validity of such studies is even more questionable when the scale of the unit of analysis is large and thus includes populations and industries which are likely to have spatial correlations. For example, the majority of Latino immigrants are located in the south and the west. At the same time, much of the petroleum processing in the US also occurs in those locations (Lester, Allen and Hill 2001). Thus it is likely that a spurious correlation will occur between the location of Latino immigrants and petroleum industries.

Another critique of environmental justice studies is that most are undertaken ex-post. The demographics of a neighborhood may have changed significantly during the implementation and functioning of the project. Thus although the resulting analysis may be used to discuss the current affected population, depending upon the rate at which the demographics of that area have changed and the amount of time which has elapsed since the facility was sited, it cannot be used to prove discrimination which occurred during siting.

Additionally, data and time constraints limit the scope of environmental justice analyses. Most quantitative environmental justice studies only look at the impact of one hazard or one source or source class and its relationship to a specific population. However, in reality the population is exposed to multiple pollutants, which may or may not interact with each other. Furthermore, there are a fair number of other variables beyond race or income which may be key factors in explaining the spatial distribution of risks.

Methods for Distributive Justice Analysis
Many decisions must be made during the analysis process. Choices must be made regarding the unit of analysis; the hazard to be evaluated; the impact of and risk associated with the hazard evaluated; and which communities can be used for comparison.

Unit of Analysis
The first step in performing a distributive environmental justice analysis is the selection of the unit of analysis. Determining the unit of analysis involves defining both the geographical domain and the populations to be considered.

Environmental justice studies have used various geographic areas for the unit of analysis. Some have performed the analysis using areas as large as counties whereas others have looked at zip codes or census tracts. The scale of the unit of analysis affects the results. For instance, suppose a county, such as Contra Costa county, were used as the unit of analysis. Contra Costa county has a higher percentage of minority and low-income populations than most other counties in California. It is also home to eleven electricity generating facilities. While this indicates a correlation between minority or low income populations and major industrial facilities, it does not directly indicate that those facilities disproportionately impact the minority and low income residents of the county. The distribution of the minority population within the county relative to the geographical location of the power plants can only be understood by looking at a smaller scale. An analysis on the level of townships or cities within Contra Costa county would lead to a better understanding of the spatial relationship between power plants and minorities, and an analysis on a census tract or census block level would allow for even more detail.

The challenge that arises in determining the appropriate spatial unit of analysis, beyond that of obtaining sufficiently accurate and detailed data, is to understand and account for the assumptions that are implicit in the use of that spatial unit of analysis. For example, one assumption commonly made is that the distribution of the population within the unit of analysis chosen is homogenous. However, even within the smallest unit of analysis for which data are easily available, the census block group, there is may be variation in where certain groups of people live and in the concentrations or risks experienced by those people. Larger units of analysis, such as zip code or township, are likely to be even more heterogeneous than block groups.

Furthermore, pollution and hazards can migrate across the boundaries of the spatial units analyzed. Methods to account for cross boundary pollution and risk must be developed. If the geographic expanse of the analysis is limited to a certain radius around a facility, it is important to consider whether or not impacts of that facility extend beyond that radius.

Once the unit of analysis and geographic range has been determined, the population sub-groups that will be considered must be defined. Many environmental justice studies try to determine if minority and low income populations disproportionately experience environmental hazards. However, both the category of minority and the category of low income require interpretation.

To determine the percentage of the population that is minority requires information on both race and ethnicity. This is because the category of minority includes both those who are racial minorities and those who are ethnic minorities. The President's Council on Environmental Justice defines minority as all people who are American Indian or Alaska Native; Asian or Pacific Islander; Black not of Hispanic origin; or Hispanic. This definition requires the use of data that makes the distinction between race and ethnicity, as well as data that includes information on who can be classified as both a racial and an ethnic minority. Unfortunately, most data does not contain that much detail. For example, the US Census Bureau data lists race and ethnicity separately. Thus it is impossible to know if a person responding as Hispanic is Black, White, or of another race. If all of the people responding as Hispanic were to be added to the category of minority, some people would be double counted. This classification problem is complicated by the growing population of people of mixed racial and ethnic heritages. Furthermore, lumping all minorities into one category makes it difficult to determine if a specific minority population experiences more of the risk than another.

The category of low income, which is included in environmental justice analysis to account for marginalization of the poor, is equally complicated. Income may not be a good proxy for the degree of financial prosperity or for the entitlements of an individual. This is because income may be different than total assets, may be shared across varying numbers of population, and allows for different purchasing power depending on the cost of living in a particular geographic region.

Impact Considered

The next step in an environmental justice analysis is to decide which impact of a specific facility or policy will be evaluated. Locally unwanted land uses (LULU) have multiple impacts on neighboring communities. For example, although the most salient effect of an LULU may be air pollution, the facility may also contaminate the ground and surface waters nearby. That LULU may also increase the amount of traffic and noise levels in the community. As multi-faceted analyses are difficult and laborious to undertake, environmental analyses have typically focused on a single impact. Furthermore, studies have generally only looked at the effect of one specific facility on the community. However, communities may host more than one LULU. The cumulative impact of those facilities together is as much of a concern as the impact of each facility individually.

Estimation of Hazard

Measuring the risk or hazard associated with the impact to be evaluated is complex. For an apparently easily quantifiable impact such as air pollution, the impact can be evaluated in terms of the concentration of the pollutants, the population dose, intake fractions, or the health risk created. Other impacts, such as noise and traffic may be more difficult to quantify. Furthermore, the community affected may perceive the risks differently than the regulatory agency. To ignore risk perception would be to disregard the public participation aspect of the environmental justice movement.

Comparison Communities
Often environmental justice studies compare the demographics of the affected population and the risk or hazard that population experiences with the demographics of and risks experienced by another community. A useful illustration of the complexity in choosing the community to be used for a comparison can be found in the study performed by Coburn when he investigated the environmental justice impacts of the US Acid Rain Programme (ARP). As part of his study, Coburn compared the demographics of the population living in a close vicinity to the power plants participating in the ARP with the demographic averages from individual states, with the averages of all states that contain at least one power plant participating in the first phase of the ARP program, and with the averages all the counties that contain at least one power plant participating in the first phase of the ARP program. The use of multiple comparison communities is rare in the research; typically only one community is chosen for comparison and then that choice is justified (Coburn 2000).

California Energy Commission
Concerns about environmental justice are often most pronounced when a new LULU is being sited. Power plants, with their tall smoke stacks, vapor plumes, and noise are prototypical undesirable land uses. Power plants, due to the nature of electricity generation and transmission, must be sited in locations meeting specific requirements. New power plants must be geographically spaced so as to be able to provide electricity to the locations where it is demanded while concurrently finding a way to minimize congestion on transmission lines. Power plants must also be located in proximity to specific resources, such as water for cooling and access to fuel. The deregulation of the California electricity market, changing environmental regulations, and the dot com boom and bust have had a dramatic impact on the demand and supply for electricity in California.

The California Energy Commission (CEC) is the regulatory agency that oversees the permitting of all electric power plants over 50 MW in California (California Energy Commission http://www.energy.ca.gov/sitingcases/index.html). Four different types of power plant operating permits are provided: normal, peaking, expedited, and emergency. The process for obtaining a permit depends on the type of permit being sought. In general, the process requires the project developer to provide a report detailing the project engineering specifications, safety and environmental practices, and conformance to demand. The developer must also complete a study of the cultural and socio-economic aspects of the community in which the project is to be sited, along with an analysis of the expected impact of the project on the community and environment. Such an analysis must include not only a description of the current land uses and zoning trends, but also the expected impact of the project in terms of future air quality, services, taxes, transportation, noise, waste, and safety. The project must also be reviewed at a public hearing in which any member of the general public is given the opportunity to speak (California Energy Commission http://www.energy.ca.gov/sitingcases/index.html).

In April 2000, in accordance with Senate Bill 115 and Executive Order 12898, the California Energy Commission developed its "Staff Approach to Environmental Justice."

However, the steps involved in this approach have not always been applied. On December 31, 2001, due to the California electricity crisis, Governor Davis issued emergency orders that allowed for an expedited permitting process. Projects fitting into this emergency permitting process were exempted from the California Environmental Quality Act, were not required to undergo an environmental justice analysis before permitting, and had limited public hearings. Furthermore, Executive Order D-40-01 allowed natural gas-fired plants to operate even if they did not meet air quality regulations (Latino Issues Forum 2001). These emergency measures were in place for a limited time. Since then, new operating licenses have only been issued through a 12-month review process or the Small Power Plant Exemption process (California Energy Commission http://www.energy.ca.gov/sitingcases/index.html).

The CEC staff approach to environmental justice follows the EPA guidelines for incorporating environmental justice concerns by following three steps: demographic screening, public outreach, and impact assessment. The CEC demographic screening process analyzes the census block group demographics within a six-mile radius around the proposed site. The CEC then determines if the population within this radius can be considered an "environmental justice population," i.e., if within that radius the population is greater than fifty percent minority or low income. The guidelines also suggest that it would be appropriate to consider whether or not a pocket or cluster within that radius is greater than fifty percent minority or low income or if the percentage of minority or low income population within that radius is greater than the percentage of that population in the general population (California Energy Commission http://www.energy.ca.gov/env-justice/staff_env_justice_approach.html). The CEC uses the President's Council on Environmental Quality definitions of minority and low-income. Minority individuals are those who are American Indian or Alaskan Native, Asian or Pacific Islander, Black not of Hispanic origin, or Hispanic. Low income individuals are identified by poverty thresholds from the Census Bureau's Current Population Reports (California Energy Commission 2003a).

If an environmental justice population is identified, the effect of the power plant on that population is evaluated to determine if the power plant will cause a high and adverse impact and, if so, what possible mitigation mechanisms are available. Public participation is encouraged throughout the process and notices regarding the proposed project, hearings, and workshops are provided.

In California between 1996 and 2002, fifty-two permitting applications were filed for new or improved electricity generation. During this time period, 26, or 50% of power plant applications submitted to the commission were sited in communities with environmental justice populations. In comparison, of the power plants sited between 1979 and 1995, only 14.3% of applications submitted were sited in communities with environmental justice populations (California Energy Commission 2003a).

The Latino Issues Forum performed a study on the demographics of the population within a six mile radius from power plants that were recently brought on-line in California. The results from that study differ from the demographic results reported by the CEC during the siting process (Latino Issues Forum 2001). It is difficult to disentangle whether this discrepancy arises from the use of different data sets or different analysis methods. However, as is demonstrated by this current investigation, different methods for analyzing the distribution impacts can lead to disparate descriptions of the impacted population.

It is important to note that even if a demographic analysis indicates the presence of an environmental justice population, it does not necessarily indicate that there is an environmental justice issue. A high, adverse and disproportionate impact on the minority or low income populations needs to be demonstrated. At present, there has been no official recognition of environmental injustices in power plant siting. The proposed cogeneration facility at Bayview Hunter's Point has been the most controversial case in California; however, that facility was not developed, as the project developers could not obtain a lease. Only two of the other proposed power plants sited in communities with environmental justice populations have had environmental justice complaints filed against them: the Pittsburg plant, also known as Los Medanos, (98-AFC-1, certified on August 17, 1999) and Delta (98-AFC-3, certified on February 9, 2000). Both of these plants are located in Pittsburg, CA.

Objective of this Study

Although few power plant projects have had environmental justice complaints filed against them, it is likely that the relationship between environmental justice and power plants will be of increasing concern in the future. This is partly due to increased demand for electricity, the need to re-power older facilities, and the changing demographics of the California population. The CEC staff approach to environmental justice is still in its infant stage, having been implemented only within the past three years. Thus the process is still being developed and will be adapted and improved during the next few years of permitting requests. In addition, it is likely that the Office of the Inspector General report, which criticize the EPA for inconsistently implementing environmental justice analysis, will spark not only more concern regarding the issue, but also a push from within government agencies to ensure that environmental justice is evaluated appropriately.

The main objective of this investigation is to provide a larger look at environmental justice and the benchmarks and measures which are used to define it. This study aims to provide a greater understanding of how the assumptions inherent in those benchmarks and measures influence the results of environmental justice analysis. A greater understanding of those influences can lead to the creation of a more informed and consistent approach to environmental justice analysis. To achieve this goal, this study uses two different methods to analyze the three power plants that are located in communities with potential environmental justice concerns.

Methods Used in this Study

Power Plants Evaluated

The first plant analyzed in this study was El Segundo, which received a repowering permit in February 2001 to replace two of its existing units with natural gas fired combined cycle turbines. The El Segundo power plant is located in an area of Los Angeles known to be home to a substantial minority and low-income population. Los Angeles County is ranked as the 4th most polluted county in California with respect to criteria air pollutants and 3rd most polluted county in California with respect to hazardous air pollutants (Environmental Defense). The El Segundo power plant provides an interesting case study because it is located in a geographic region with a strong bimodal wind pattern. Thus it was expected that the impacted population would most likely be different when determined based on proximity to the plant than when determined based on the actual concentrations of air pollution (California Energy Commission 2000).

The Potrero power plant was also examined in this study. This facility is located quite close to Bayview Hunter's Point, where a proposed facility caused a large public outcry, bringing the concept of environmental justice to the attention of the San Francisco media. The existing Potrero plant has been criticized for its impacts on the neighboring communities. In September 1999 Mirant Corporation filed for a permit to re-power the existing facility, adding a 540 MW natural gas fired combined cycle generator (California Energy Commission 2003b). The final CEC staff assessment was filed February 14, 2002 (California Energy Commission 2002).

The third power plant evaluated was the Pittsburg District Energy Facility, now called the Los Medanos power plant. The Pittsburg facility was approved for permitting on August 17, 1999. This project added a natural gas combined cycle combustion turbine generator of 555 MW to the existing facility (California Energy Commission 1998b). The Pittsburg plant was chosen for this analysis because it is one of only two plants for which interveners have filed an environmental justice complaint. This complaint, filed by Californians for Renewable Energy Inc., claimed that the power plant would unduly impact low income children and minorities who already experience disproportionately high levels of air pollutants. The complaint compared the quantity of emissions in Contra Costa county with emissions in the primarily white and wealthier county of Marin (California Energy Commission 1998a).

The CEC staff assessment for each power plant, prepared during the siting process, includes a demographic analysis of the population surrounding the plant. The Pittsburg power plant was permitted before the CEC implemented its "staff approach to environmental justice," thus the methodology and data used for the staff assessment of that plant are different than for the other two plants. There are inconsistencies within and among the CEC documents that report the results of environmental justice analyses for each plant. Table 1 indicates the demographics of the population living within a 6-mile radius of each plant which were provided in the CEC 2003 Environmental Performance Report. For all three power plants, the CEC compared these percentages to a benchmark of 50% to determine if there was an environmental justice population.

Table 1: Minority and Low Income Populations within 6 Miles

	Minority	In Poverty
El Segundo	70%	8%
Potrero	54%	13%
Pittsburg	44%	12%

Source: California Energy Commission 2003 Environmental Performance Report Appendix G

Although the CEC 2003 Environmental Performance Report indicates that the population within 6 miles of the El Segundo plant is 70% minority, the final staff assessment of the facility, which was published in September 2002, cites a different figure. At various points in the final staff assessment, the population surrounding the plant is reported as 60.6% minority, 57.6% minority, and between 44.9% and 57.6% minority. The figures cited for the percentage of the population that is low-income are less divergent, ranging from 10.11% to 10.85%. The final staff assessment of the El Segundo power plant does not clearly explain the variation in these numbers, nor why within the same document it reports different numbers for the same measure. The differences in these numbers may originate from analyses using different data sets (1990 or 2000 census) or different radii around the plant.

There are also discrepancies between the 2003 Environmental Performance report and the CEC staff assessment of the Potrero power plant. However, the environmental justice assessment for the Potrero power plant, which is included in the staff assessment, is better documented than for El Segundo, as it indicates the percentage of the population that is minority or low-income within 1, 2, 4, and 6 mile radii calculated using 2000 census data. The final staff assessment of the Potrero power plant reports the population within a 6-mile radius of the plant as 57.6% minority and 12.3% low-income. These numbers are not dramatically different from the 54% minority and 13% low-income reported in the CEC 2003 Environmental Performance Report.

The results from the staff final assessment for the Pittsburg power plant cannot be directly compared to the CEC 2003 Environmental Performance Report because the methods used in the demographic analysis are not the same. The CEC had not yet implemented its approach to environmental justice when the final analysis of the Pittsburg power plant was performed. The analysis for the Pittsburg power plant defined the affected population to be those people living within a 1.5 mile radius from the plant. The analysis used 1990 census data, and, since the percentage of the population which was minority (44%) or low-income (12%) did not exceed 50%, the analysis concluded that there was not an environmental justice population. The report did concede that the 1990 data may not be representative of the population at the time of permitting.

Unit of Analysis

The unit of analysis used for this study on environmental justice, air pollution, and power plants in California is the census tract. Census tracts are spatial units defined by the US

Bureau of Census and “designed to be relatively homogeneous units with respect to population characteristics, economic status, and living conditions at the time of establishment” (US Census Bureau 2004). Nevertheless, there is inevitably some variation within each tract. For each census tract, the Census Bureau aggregates the results of the census with respect to population demographics including age, sex, and race. Economic information such as household income, housing characteristics, and employment is also collected. The census tract is a useful unit of analysis for environmental justice studies because it provides the most accurate and detailed information available regarding the population that lives within small geographical units covering the entire US. One drawback to using census data is that the national census is only taken every ten years, in between which the characteristics of the population living within each census tract is likely to change. Year 2000 census data was used to determine the demographics of the population impacted by the three power plants analyzed.

The analysis used the same demographic categories as used by the CEC and the President’s Council on Environmental Quality. Thus two main categories of people were defined: minority and low income. The minority population was determined by subtracting the white population from the total population. This method avoids double counting of members of the population that belong to more than on racial or ethnic class; however, it is likely to underestimate the number of minorities, as some people maybe both white and Hispanic.

The Census Bureau calculates a poverty threshold based on multiple factors including household income, family size and composition. The Census Bureau reports poverty statistics for each census tract as the number of individuals living at a set interval of percentages of the poverty level. The poverty threshold in 2002 for a family of four (two adults and two related children under 18) was $18,244 (California Energy Commission 2003a). For this analysis, any one living on an income equal to or lower that 125% of the poverty level was considered low income.

The Census Bureau does not determine a poverty status for people who are institutionalized, living in military quarters, in college dormitories, or unrelated individuals under 15 years old. Thus these groups are people are excluded from the analysis. To account for this, when calculating the percentage of low income and people in poverty, a different denominator was used than when calculating the percentage minority. This denominator was the total number of people for whom poverty status was determined rather than the total population.

Since the presence of an environmental justice population is determined based on the percentage of the population that is minority or low-income, it could be argued that the way to calculate this percentage is to sum the number of minority and the number of low-income people and divide by the total population. However, the categories of minority and low-income are not mutually exclusive; both characteristics may apply to a single individual. This simple summation method would then lead to double counting of some persons. Unfortunately, census data does not indicate which individuals fall into both categories. To account for this, rather than sum the two categories, this analysis considers minority and low-income populations separately. Relative to a method which jointly considers the presence of minority or low-income populations, this method will underestimate the presence of an environmental justice population.

Impact Evaluated

Power plants emit both criteria and hazardous air pollutants. Most power plants in California burn natural gas and, due to the nature of this fuel, emit fewer small particles and toxics than coal-fired power plants used in other parts of the country. However, natural-gas power plants are still a significant source of nitrogen monoxide, carbon monoxide, sulfur dioxide, and volatile organic compounds. Furthermore, as several communities in California already experience concentrations of pollutants that exceed the recommended air quality standards, even moderate emissions can present a significant hazard.

This analysis looks specifically at the concentration of nitrogen oxides (NO_x) in the regions surrounding each of the three power plants analyzed. The concentration of NO_x is considered, even though it is nitrogen oxide (NO) which is formed during the combustion process, for two main reasons. The first is that the emissions data for each of the three power plants were reported as total daily NO_x not total daily NO emissions. The second is that part of the emitted NO is oxidized to NO_2. The reactions and transformations of NO, NO_2 and other molecules are part of a detailed atmospheric chemistry process which is beyond the scope of this analysis. However, for the purposes of this environmental justice analysis, the category of NO_x, which includes all species of nitrogen oxides, can be used to sufficiently represent pollution dispersion (De Nevers 2000, Finlayson-Pitts 2000).

NO_x pollution causes a variety of human health and environmental hazards. It reacts with volatile organic compounds to promote the formation of ground-level ozone, which can be damaging to human lungs and vegetation. NO_x is also a key ingredient in the formation of nitric acid, which contributes to acid rain, and is a primary cause of nitrogen loading in water bodies. NO_x emissions are of special concern because unlike other criteria air pollutants, which have significantly decreased since 1970, NO_x emissions have increased (Environmental Protection Agency http://www.epa.gov/air/urbanair/nox/index.html).

Estimation of Hazard – Pollutant Concentrations

To determine whether or not the pollution caused by NO_x emissions causes an environmental injustice, the expected concentration and distribution of NO_x pollution was determined. The concentration and dispersion of air pollutants depends on many factors including the quantity and rate at which the pollutant is emitted, the effective stack height, the meteorological conditions, the topographical conditions, and the type of pollutant. A Gaussian plume model, which accounts for all of these factors, was used to determine the expected concentration of pollutants in the areas surrounding the power plant.

The Gaussian plume model is the standard model used in regulatory applications to predict pollution dispersion. The form of the model used for this analysis is applicable to continuous point sources emitting primary non-reactive pollutants (Seinfeld and Pandis 1998). The Gaussian plume model is intended to provide a close approximation to the expected pollution concentrations in the vicinity of the power plants. However, these approximations are not perfect. This is the case for all models, as simplifying assumptions must be made due to constrained availability of data, the inability of a model to capture all natural variations, and limitations on the scientific understanding of complex transport and transformation processes. In particular, this model makes several explicit assumptions which will cause the modeled concentrations to be different than actual experienced concentrations.

Use of the Gaussian plume model assumes conservation of mass in the plume, constant mean transport wind in the horizontal plane, no wind shear in the vertical, and strong enough winds to make turbulent diffusion in the direction of flow negligible in comparison to mean transport (Arya 1999). This implies that meteorological conditions are constant in the entire 30 km radius surrounding each plant. This assumption is unlikely, as small changes in topography may create wind tunnels, eddies, turbulence, and even temperature differentials. These minute forces will impact the pollutant dispersion patterns. Although in the case of a strong steady wind these variations might have less of an impact, this does indicate that there are likely to be small scale variations between the distribution and magnitude of modeled and actual concentrations.

The form of the Gaussian plume model used to calculate the dispersion and concentration of emissions from power plants included modifications to account for the effects of 20 reflections from the ground and from the mixing height boundary. The formula used is

$$C = \frac{E}{\pi \sigma_y \sigma_z U} \exp(-\frac{y^2}{2\sigma_y^2}) \left\{ \sum_{n=0}^{20} \exp\left[-\frac{(2nM - H_E)^2}{2\sigma_z^2}) \right] + \sum_{n=0}^{20} \exp\left[-\frac{(2nM + H_E)^2}{2\sigma_z^2}) \right] \right\}$$

for which C is the ground-level concentration (g/m^3), E is the steady state rate of emission from the source (g/s), U is the wind speed (m/s), σ_y and σ_z are the dispersion coefficients in the downwind and crosswind directions (m) as modeled based on the Pasquill Gifford parameters (Davidson 1990), H_E is the effective stack height of the emission source, M is the mixing height, and n is an index for the number of reflections (Heath, Hoats and Nazaroff 2003).

The Gaussian plume model predicts the expected concentration of pollution at a given location in the downwind and crosswind directions from the plant. The benefit of this model is that it yields a realistic dispersion profile for point source emissions and interacts well with the available wind data. This model was evaluated at 14641 locations uniformly distributed throughout a square centered on each plant. The points were spaced every half-kilometer extending thirty kilometers, or 18.6 miles in each of the four cardinal directions. The analysis was limited to this geographic expanse for a variety of reasons. First, the purpose of this investigation is to demonstrate variation in results caused by the use of different method for analysis and the 30 km limit is sufficient for demonstrating that variation. Additionally, more complex modeling techniques would be required to estimate concentrations at greater distances from the emissions source, as it cannot be assumed that meteorological conditions (particularly wind direction) and topographical conditions remain constant. Beyond 100 km it cannot be assumed that the empirically defined dispersion parameters of the Gaussian plume model are applicable (Arya 1999). Furthermore, this analysis is computationally demanding (computer memory and time) and thus it was expedient to limit the analysis to this geographical span.

The Gaussian plume model is used to determine air pollution dispersion and the ground level concentrations of pollutants based on the meteorological conditions near the site of emissions. Meteorological data for each power plant was obtained from the Typical Meteorological Year 2 (TMY2) dataset published by the National Renewable Energy Laboratory (National Renewable Energy Laboratory) and by the Environmental Protection Agency's Technology Transfer Support Network for Regulatory Air Models (Environmental Protection Agency http://www.epa.gov/scram001/tt24.htm). The TMY2 data set includes hourly meteorological conditions for a 1-year period for each of 239 National Weather Service Stations located throughout the USA. Ten of these stations are located in California. These data are calibrated to represent the typical conditions for each location over a long period of time and are based on actual measurements from 1961-1990. Data from the Los Angeles station was used for analysis of the El Segundo power plant, data from the San Francisco station was used for analysis of the Potrero power plant, and data from Sacramento station was used for analysis of the Pittsburg power plant.

Although the TMY2 data set provides information on hourly wind speeds and directions among other values, it does not contain information on atmospheric stability class or mixing heights. Stability classes, which influence the choice of dispersion parameters used in the Gaussian plume model, were determined from the TYM2 data by applying the Pasquill classification system using the same methods as the Heath et. al report to the California Air Resources Board.(Heath, Hoats and Nazaroff 2003) It is easiest to describe that method by quoting the report directly.

> "Atmospheric stability describes the relationship between mechanical turbulent mixing and the effect of buoyancy on an air parcel (Turner, 1994). "Unstable" conditions (Pasquill stability classes A through C) enhance vertical mixing while "stable" conditions (E and F) hinder it; D is the neutral condition…There was not a perfect match between all requirements of Pasquill's classification system and the TMY2 data. Consequently, we made the following translations. Where Turner reports that others have designated nighttime hours with winds less than 2 m/s as "G", we classify these hours as "F" since there are no dispersion parameters in Davidson (1990) or common texts for "G." Pasquill defines night as "the period 1 hour before sunset to 1 hour after sunrise" (Pasquill, 1961). The translation we use for the TMY2 data is one hour before

> “extraterrestrial horizontal radiation” is zero in evening and one hour after it is zero in the morning. To implement Pasquill’s requirement that "category D should be used, regardless of wind speed, for overcast conditions during day or night" (Pasquill, 1961), we defined overcast as when low clouds completely cover the sky (i.e., when "opaque sky cover" = 10 for the TMY2 data). Finally, for all cases where stability class is given as a range, we use the end of the range tending toward neutral conditions (e.g, for “A-B” we use “B”)” (Heath, Hoats and Nazaroff 2003).

The TMY2 data does not include information on mixing heights. This data was obtained from the EPA Support Center for Regulatory Air Models (Environmental Protection Agency http://www.epa.gov/scram001/tt24.htm). Unfortunately these are only available for the Oakland, California meteorological measuring station. Thus the Oakland data was used for all locations. Although Oakland mixing height data provides a useful approximation, mixing height values are likely to vary over the geographic range analyzed. It is unlikely that the mixing height in Los Angeles on any given day is the same as that in Oakland. Furthermore, mixing height values are not available for every hour of analyzed, rather the dataset only contains twice daily mixing heights for each day of the year for the years 1986 – 1991. A ‘typical’ mixing height for the morning and for the afternoon was developed by calculating the average am and average pm mixing height for each day of the year. The am mixing height was applied to all hours between 10 pm and 10 am and the pm mixing height was applied to all hours between 10 am and 10 pm.

Adjustments had to be made to the Gaussian plume model to account for various meteorological conditions. The wind direction for each hour determined the crosswind and downwind distances from the power plant of each point at which the concentration was evaluated. If, for a given hour, a point was located upwind from the plant, the concentration at that point was assumed to be zero. Additionally, if for a given hour the mixing height was lower than the effective stack height, then the concentration of pollution at all locations for that hour was recorded as zero. This assumption was made because if the mixing height is lower than the effective stack height, the pollution will not disperse through the mixing height region, and will instead be transported further away. Furthermore, if the wind speed was recorded as zero, the conditions were calm. The Gaussian plume model does not apply to calm conditions; thus all calm hours were omitted from the analysis. The number of calm hours experienced in a typical year at the locations of the El Segundo, Potrero, and Pittsburg power plants are 340, 412, and 1198 hours, respectively. The omission of calm hours will cause the model to underestimate the concentration of pollution in close vicinity to the stack. This is especially important for the Pittsburg plant, as approximately 14% of the hours are calm.

The steady state emissions rate used in this analysis was calculated using data from the EPA’s Technology Transfer Network Ozone Implementation (Environmental Protection Agency 1996). The information is based on the 1996 National Emissions Inventory and includes detailed information on plant emissions, locations, and emission release stack height. Emissions data were provided both as total annual emissions in tons per year and as daily emissions in tons per day. The geographic location, effective stack height, annual NO_x emissions, daily NO_x emissions, and calculated emissions rate for each plant are listed in Table 2.

Because a given plant is not in operation at full capacity every day of the year, the daily average emissions value was used. To calculate the equivalent steady state rate of emissions, the total daily emissions was divided by the number of seconds in a day. Although this is a practical estimate for baseload plants, for peak load generating facilities, this assumption will create some degree of error, as those plants are frequently ramping up and ramping down. Emissions rates are not constant while power plant output is varying. In California, NO_x emissions are monitored on a constant basis, thus the total emissions reported for NO_x are all inclusive. However, for other pollutants the reported total annual emissions rate does not necessarily include emissions during ramp up and down. Thus if this method were used for other pollutants, total annual emissions would be higher than reported. Furthermore, as power plants all ramp up to generate more electricity, the temperature of gaseous emissions will increase, raising the effective stack height. During those periods, the effective stack height will be lower that the effective stack height used in this analysis, leading to higher ground-level concentrations of pollution closer to the plant. Additionally, the Gaussian plume model used in this analysis also does not account for the possibility of down washing, which, if it occurs, will increase the concentration of pollution closer to the plant.

All three of the plants analyzed involve repowering or expanding an existing facility. The El Segundo and the Potrero plant improvements, which have recently been permitted, are not expected to be on-line until 2005. Thus actual emission data from those facilities under their repowered configuration does not exist. The Pittsburg plant improvements were completed in 2001. Nonetheless, data are available for the existing portions of those facilities. Thus, this analysis determines the concentration of pollution resulting from those power plants as they were operated in 1996. As meteorological conditions are expected to remain relatively constant, the geographic location of the population affected by the re-powered facilities will be similar to that affected by the facility as it existed in 1996.

Table 2: Power Plant Summary Information

Plant	Latitude (°W)	Longitude (°N)	Effective Stack Height (m)	Annual NOx Emissions (Tons)	Daily NOx Emissions (Tons)	Emissions (g/s)
El Segundo	**33.9**	**118.4**	**291**	**189**	**0.6**	**6**
Potrero	**37.8**	**122.4**	**212**	**696**	**2.1**	**22**
Pittsburg	**38.0**	**121.9**	**460**	**1676**	**8.6**	**90**

Source: Environmental Protection Agency Technology Transfer Network Ozone Implementation

Using these meteorological and emissions data, the model was then calculated for each hour in the year for each of the three plants. Thus 8760 modeled concentrations were created for each point in the three grids. The estimated annual average concentration at that point is the arithmetic mean of those concentrations.

Demographic Analysis

To determine how the concentrations of pollutants emitted by the power plants impact the nearby communities both geographically and demographically, the modeled grid of pollution concentration was imported into GIS and superimposed on a map of census tracts. Census tract shape files and demographic information from the 2000 census were downloaded from ESRI (ESRI Software 2004). These files were projected from North America Datum 1983 to the State Plane Coordinate System, using meters as the spatial unit. The files for the region surrounding the El Segundo power plant were projected into California State Plane Zone V and the files for the region surrounding the Potrero and Pittsburg power plants were projected into California State Plane Zone III. Census Summary File 1 and Summary File 3 demographic and economic data was joined to the shape files. The latitude and longitude of each power plant was projected into the same plane and the grid of concentrations centered at that location to ensure the superposition was correct.

The census tract shape files, which designate in GIS the boundaries of census tracts, extend the boundaries of the census tracts into the ocean, as technically speaking part of the coastline pertains to that county. However, it is unlikely that anyone would be living within this spot of submerged land. Thus the submerged sections of the census tract files were clipped to represent the true above sea-level boundaries.

The population impacted by emissions from power plants was determined using two different methods: proximity and concentration levels. Proximity is the measure most frequently used in environmental justice analysis, and, as mentioned previously, is the first step used by the CEC in its approach to environmental justice. The proximity method involves analyzing the characteristics of the population within a selected distance from the power plant. A circular buffer is drawn around the plant and the demographics of the population within that buffer determined. As it is quite possible that a buffer will bifurcate a census tract, the population of that census block must be allocated to those who live within and those who live outside the buffer. Since the census tract summary files do not include information on the distribution of the population within each census tract, the simplifying assumption was made that population density is constant across the entire census tract. Thus the population living within the buffer zone for census tracts which are split by the border of the buffer is assumed to be proportional to the area of that census tract that falls within the buffer. The demographics of the population living within 6 miles (the CEC standard) and 30 km (18.64 miles) were calculated for each power plant analyzed.

Another possible method for evaluating the impacted population is to determine the population that experiences certain concentrations of pollutants. This was achieved by superimposing the modeled pollution concentrations on census tract data. The demographics of the population that experiences greater than 90% and greater than 75% of the maximum pollution concentrations attributable to the power plant emissions were determined. These percentages were used to illustrate how depending on the cut-off limit chosen, different segments of the population are included in the analysis. Instead of using maximum concentrations, it might make sense to determine the population which experiences a certain percentage of pollution concentration which is permissible by regulatory standards. Using the regulatory standard as a benchmark would be instructive, in that it would allow for a comparison across plants of the demographics of the population that experiences the same concentration of pollution. However, as the concentration of pollution due to any one facility is usually much less than the ambient air quality regulatory standard, the percentage of the standard used would have to be quite low in order for any segment of the population to be included. Furthermore, as the purpose of this study is to determine if the impact of a specific facility disproportionately impacts one segment of the population, it makes sense to determine the cut-off relative to the magnitude of impact of that specific facility itself rather than relative to a pre-determined benchmark.

As with the proximity method, when using the concentration levels method for determining the impacted population, assumptions must be made regarding the distribution of the population within the census tract. The Census Bureau defines tracts in such a manner as to encompass similar groups of approximately 4,000 inhabitants. However, as different areas will have different spatial layouts and population densities, census tracts vary in size. As a result, the concentration of pollution is likely to vary across the tract. Furthermore, larger census tracts encompass more than one of the points for which the concentration of pollutants was modeled. To account for the variation in pollution levels across census tracts, each tract was assigned an average concentration level. This involved averaging the concentration of the modeled points that fall within the census tract. This method in effect assumes that the population is evenly distributed and the total overall impact is experienced equally by all inhabitants in that census tract. Unfortunately, due to limitations on the number of points for which the concentration could be evaluated, some of the very small tracts do not contain any of the modeled concentration points. However, all of the small tracts are within 250 m of a modeled concentration point and, as concentrations do not vary discontinuously, the expected concentrations of pollution in those small tracts can be interpolated. Thus when calculating the concentration experienced by the population living within a census tract, the average was taken of all modeled points within 250 m of the census tract boundary.

Analysis Results

Demographics

Table 3 presents a synopsis of the demographics of the impacted population determined for each of the three power plants analyzed. The results from the proximity method of analysis are included as the total population living within the buffer radius listed and the percentage of that population that is minority or low income. The table also lists the population within each buffer who live in a census tract experiencing an average concentration greater than 90% and greater than 75% of the maximum concentration attributable to the power plant emissions.

Table 3: Demographics of the Population Affected by Each Power Plant

	In Buffer			> 90% Max Concentration			> 75% Max Concentration		
	Population	Minority	Low Income	Population	Minority	Low Income	Population	Minority	Low Income
El Segundo									
6 mile radius	509507	47%	18%	19751	64%	26%	47584	66%	25%
30 km radius	5033960	56%	28%	21291	70%	26%	142030	74%	32%
Potrero									
6 mile radius	800387	47%	12%	12601	48%	13%	48875	59%	13%
30 km radius	2578530	49%	16%	12601	48%	13%	48875	59%	13%
Pittsburg									
6 mile radius	120215	48%	18%	14634	33%	14%	38072	36%	17%
30 km radius	854416	31%	9%	14634	33%	14%	38990	36%	13%

The two methods used for determining the population affected by power plant emissions use different parameters for measuring impact. The proximity method is based on the principle that impact is best defined by distance from the plant. The concentration levels method is based on the principle that impact is best defined based on air pollution concentrations caused by the plant. These methods might lead to two possible outcomes: the affected population as defined by each method might be the same, or the affected population as defined by each method may overlap only partially. In general, the proximity method includes a larger segment of the population than the concentration method; however, the degree of this difference depends in part on the choice of the percentage of the maximum concentration of pollutants which is used as a cut-off mark. The affected population is likely to be the same for both methods if the concentrations of pollution are experienced relatively evenly throughout the buffer. Even if the affected population as defined by each method is different, it is possible that the resulting demographic analysis will yield similar percentages of minority and low-income populations if those people are evenly distributed throughout the geographic domain.

For the El Segundo power plant, the demographics of the affected population as determined using the proximity method are quite different from the demographics of the affected population as determined using the concentration levels. Looking strictly at the population within a 6 mile radius from the plant, the population is 47% minority and 18% low income. Yet the population living within a 6 mile radius from the plant and within census tracts that experience an average NO_x concentration of greater than 90% of the maximum concentration attributable to the plant is 64% minority and 26% low income. The population living within a 6 mile radius from the plant and within census tracts that experience an average NO_x concentration greater than 75% of the maximum concentration of air pollution attributable to the plant is 66% minority and 25% low income. Similarly, within a 30 km radius, the percentage of the affected population who is a minority or low income is higher when determined using the concentration levels method than when using the proximity method. The total population living within a 30 km radius from the El Segundo power plant 56% minority and 28% low income. The population that lives within a 30 km radius and experiences greater than 90% of the maximum concentration of pollution attributable to the plant is 70% minority and 26% low income. The population that lives within a 30 km radius and experiences greater than 75% of the maximum concentration of pollution attributable to the plant is 74% minority and 32% low income.

The different results obtained from the proximity and the concentration levels method are attributable both to the meteorological conditions in the area and to the demographic layout of the community. The wind patterns in El Segundo are generally bi-modal, flowing northeast on land and southwest out to the ocean. Since a greater proportion of minorities live to the northeast of the power plant and since the landward wind disperses the pollution mainly in that direction, those people will experience higher concentrations of pollutants than those living in other directions but located at the same distance from the power plant. Color-coded graphics which illustrate the percentage of minority and percentage of low income inhabitants in each census tract as well as of the geographic distribution of the concentration of pollutants attributable to power plant emissions are included in the appendix.

For the Potrero power plant, the total population within a 6 mile radius from the power plant is 47% minority and 16% low income. The population within that radius and living in a census tract that experiences greater than 90% of the maximum concentration of pollutants is 48% minority and 13% low income. The population within a 6 mile radius and living in a census tract that experiences greater than 75% of the maximum concentration of pollutants is 59% minority and 13% low income. The results are similar for a 30 km radius. The difference between the demographics of the affected population as determined by the two different concentration level cut-offs, 90% and 75%, may be due to the nature of neighborhoods in San Francisco. San Francisco contains many distinct neighborhoods, which tend to be divided by social, ethnic, and class characteristics. Although the entire city is densely populated, minorities and lower income individuals tend to live in areas that are even more densely populated than the average. However, the neighborhoods are close together. Thus by decreasing the percentage of the maximum concentration considered, the impacted area shifts slightly, but significantly enough to incorporate segments of new neighborhoods. This might explain why considering an impact area that experiences 75% of the maximum concentration of pollutants or higher might cause only a small change the geography of the impact area but a large change in the demographics of the population.

Although the percentage of the impacted population that is minority was higher using the concentration levels method of analysis for both the El Segundo and the Potrero power plants, the opposite occurred for the Pittsburg power plant. This is because the minority population in the Pittsburg area is located primarily to the north and a bit to the west of the power plant whereas much of the pollution travels to the east of the power plant. On the other hand, the low income population lives to the east and is more likely to be impacted by the pollution. Forty-eight percent of the population living within six miles from the Pittsburg power plant is minority and 18% is low income. Yet only 33% of the population living in census tracts that experience greater than 90% of maximum concentration of pollutants and only 35% of the population living in census tracts that experience greater than 75% of the maximum concentration of pollutants is minority. The population experiencing greater than 90% and 75% of the maximum concentration is the same for both the 6 mile and the 30 km buffer zones because the majority of the pollution attributable to the Pittsburg power plant falls within the six mile radius.

Both the proximity and the concentration levels methods provide valuable information for environmental justice analysis. The proximity model can show at a glance who is likely to be the affected population. It requires little other data and few calculations. This method is especially useful when evaluating effects that are clearly tied to the vicinity of the plant, such as noise or visual impacts. The proximity method also provides a reasonable estimate of air pollution concentrations in areas with light winds.

The concentration levels method is useful because frequently it is not the impact of an individual facility which is a problem; rather it is the cumulative impact of that facility on top of pre-existing conditions. The concentration levels method provides information that can be useful in this type of analysis because it calculates the additional concentration of air pollutants that are attributable to the power plant. If this information is combined with data from all emissions sources in the area, the cumulative impact of the individual facility can be determined in context.

Furthermore, in an area where meteorological conditions are relatively stable and uni- or bi-directional, it makes sense to use the concentration levels method to determine the affected population because the impact of the facility is not experienced uniformly in a circle around the power plant.

County and Statewide Demographics

The CEC staff approach to environmental justice defines an environmental justice population as one in which greater than 50% of the affected areas general population is minority or low income, greater than 50% of a pocket or cluster within the affected area is minority or low income, or the percentage of minority or low income populations within the affected area are greater than that of the general population. This definition is vague, as what constitutes a pocket or cluster and who constitutes the ‘general population’ is not defined. In practice, at least with respect to the three plants analyzed, the CEC has performed its environmental analysis by comparing the percentage of minorities and low-income in the total population within a 6 mile radius from the plant to the 50% benchmark. The staff assessments of the three power plants analyzed do not discuss clusters and, only with respect to the Potrero power plant, do the staff assessments mention the demographics of the regional population.

A comparison of the demographics of the affected population with the demographics of the overall population is especially important in California, where there are a large number of minorities. It is expected that by the time of the next census, white non-Hispanics will no longer constitute the majority of the California population. If this is indeed the case, then it would be expected that the demographic analysis of any region in the state might contain a population is greater than 50% ’minority.’ Yet such an analysis would not necessarily indicate that non-whites were being disproportionately impacted. Furthermore, in regions with small low-income and minority populations, even if those populations are disproportionately impacted, the percentage of them in the impacted population may not exceed 50%. For this analysis of power plants in California, the demographic characteristics of the impacted populations surrounding each power plant were compared with the demographics of each of the counties located within 30 km of the three power plants. A summary of the demographics of each county and of the demographics of the impacted population disaggregated by county for each power plant is listed in Table 4. If the percentage of the affected population that is minority or low income exceeds the countywide demographics, that number is highlighted.

Table 4A: Demographics of the State of California and Selected Counties

	Population	Minority	Low Income
California	33,871,648	41%	19%
Alameda County	1,443,741	51%	14%
Contra Costa Costa	948,816	34%	10%
Los Angeles County	9,519,338	51%	24%
Marin County	247,289	16%	9%
Napa County	124,279	20%	12%
Sacramento County	1,223,499	36%	19%
San Francisco County	776,733	50%	15%
San Joaquin County	563,598	42%	23%
San Mateo County	707,161	41%	8%
Solano County	394,542	44%	11%

Source: US Census Bureau (2000)

Table 4B: Demographics of Population Affected by the El Segundo Power Plant

6 Mile Radius	Population	% Minority	% Low Income
Total	509,507	47%	18%
> 90% Max Concentration	19,751	64%	37%
> 75% Max Concentration	47,584	66%	34%
30 Kilometer Radius	**Population**	**% Minority**	**% Low Income**
Total	5,033,960	56%	28%
> 90% Max Concentration	21,291	70%	37%
> 75% Max Concentration	142,030	74%	42%

The El Segundo power plant and the area located within 30 km from the plant are all located within Los Angeles County. Los Angeles County is 51% minority and 24% low income. The percentage of the population living within 6 miles from the El Segundo power plant that is minority or low income is less than would be expected given countywide demographics. Conversely, the percentage of the population living within 30 km of the El Segundo power plant that is minority or low income is greater than would be expected given countywide demographics. The percentage of the population that is minority or low income and lives in census tracts experiencing 90% or 75% and greater of the maximum concentration of pollutants is higher than would be expected given countywide demographics. If a comparison with countywide demographics is the measure of the existence of an environmental justice population, this would lead to the conclusion that such a population does indeed surround the El Segundo power plant. However, whether or not this is an environmental justice issue can not be determined without further consideration of whether or not the impact of the power plant on that population is high and adverse.

Table 4C: Demographics of the Population Affected by the Potrero Power Plant

6 Mile Radius	Population	% Minority	% Low Income
Total	800,387	47%	16%
Alameda	16,322	51%	16%
San Francisco	740,270	45%	16%
San Mateo	43,794	77%	15%
> 90% Concentration: Total	12,601	48%	13%
Alameda	0	0%	0%
San Francisco	12,601	48%	13%
San Mateo	0	0%	0%
> 75% Concentration: Total	48,875	59%	13%
Alameda	0	0%	0%
San Francisco	48,875	59%	13%
San Mateo	0	0%	0%
30 Kilometer Radius	**Population**	**% Minority**	**% Low Income**
Total	2,578,530	49%	16%
Alameda	880,563	55%	19%
Contra Costa	277,804	50%	14%
Marin	141,588	17%	14%
San Francisco	776,733	50%	16%
San Mateo	501,843	44%	10%
> 90% Concentration: Total	12,601	48%	13%
Alameda	0	0%	0%
Contra Costa	0	0%	0%
Marin	0	0%	0%
San Francisco	12,601	48%	13%
San Mateo	0	0%	0%
> 75% Concentration: Total	48,875	59%	13%
Alameda	0	0%	0%
Contra Costa	0	0%	0%
Marin	0	0%	0%
San Francisco	48,875	59%	13%
San Mateo	0	0%	0%

A 6 mile or a 30 km radius surrounding the Potrero power plant encompasses more than one county. If the percentages of minority or low income people within those radii are compared to a 50% benchmark, it appears as though minorities and low income persons are not disproportionately located in close proximity to the power plant. However, the results obtained by disaggregating the population living near the power plant by county tell a different story. A 6 mile radius around the Potrero power plant includes census tracts located in three different counties. In two of the three counties, the percentage of the population that is minority and lives within 6 miles of the power plant exceeds average percentage of the population that is minority in that county. In all three counties, the percentage of those people who are low income and living within a 6 mile radius from the power plant is greater than the countywide average. A 30 km radius surrounding the Potrero power plant encompasses part of five counties. In four of those five counties, the percentage of those people who are minority and living within 30 km from the power plant is greater than the countywide average; and, in three of those five counties the percentage of those people who are low income and living within 30 km from the power plant is greater than the countywide average.

The population that lives in census tracts experiencing greater than 90% and greater than 75% of the maximum concentration of pollutants attributable to the power plant is located entirely within San Francisco county. For both a 6 mile radius and a 30 km radius surrounding the power plant, the percentage of the affected population that is minority, as determined using the concentration levels method, is greater than the countywide average.

Table 4D: Demographics of the Population Affected by the Pittsburg Power Plant

6 Mile Radius	Population	% Minority	% Low Income
Total	120,215	48%	18%
Contra Costa	118,127	48%	18%
Sacramento	588	49%	46%
Solano	1,500	48%	11%
> 90% Concentration: Total	14,634	33%	14%
Contra Costa	14,634	33%	14%
Sacramento	0	0%	0%
Solano	0	0%	0%
> 75% Concentration: Total	38,072	36%	18%
Contra Costa	37,728	37%	18%
Sacramento	0	0%	0%
Solano	344	17%	13%

30 Kilometer Radius	Population	% Minority	% Low Income
Total	854,416	31%	9%
Contra Costa	661,936	27%	9%
Napa	33	31%	22%
Sacramento	2,117	23%	45%
San Joaquin	103	49%	12%
Solano	190,227	47%	11%
> 90% Concentration: Total	14,634	33%	14%
Contra Costa	14,634	33%	14%
Napa	0	0%	0%
Sacramento	0	0%	0%
San Joaquin	0	0%	0%
Solano	0	0%	0%
> 75% Concentration: Total	38,990	36%	17%
Contra Costa	38,990	36%	17%
Napa	0	0%	0%
Sacramento	0	0%	0%
San Joaquin	0	0%	0%
Solano	0	0%	0%

As with the Potrero power plant, more than one county is located in close proximity to the Pittsburg power plant. A 6 mile radius around the Pittsburg power plant includes three counties. For each of the three counties, the percentage of the population that is minority and lives within 6 miles from the power plant is greater than the countywide average. For 2 of the 3 counties, the percentage of the population that is low income and lives within a 6 mile radius is greater than the countywide average for two of the three counties. A 30 km radius around the Pittsburg power plant includes five counties. For three of the five counties, the population living within 30 km from the power plant is comprised of a greater percentage of minorities than the corresponding county average. For two of those five counties, the population living within 30 km from the power plant is comprised of a greater percentage of low income inhabitants than the county average.

The population living within census tracts that experience greater than 75% of the maximum concentration of pollutants attributable to emissions from Pittsburg power plant is primarily located in Contra Costa county. When the geographic domain of the analysis is a 6 mile radius, a small number, 344, of those people, live within Solano county. The reason those people are not counted as experiencing greater than 75% of the maximum concentration of pollutants in the 30 km analysis is that those people live in a census tract which is large and extends quite a bit beyond the 6 mile point. Thus, as described in the methods section, this census tract was bifurcated during the 6 mile analysis and the concentration of pollutants assigned to that census tract was determined by averaging the point evaluations falling both within 6 miles from the power plant and within that census tract. The concentrations of pollutants in the more distant sections of the census tract are lower and thus, for the 30 km analysis, the average concentration experienced by entire non-bifurcated census tract is much lower. This fact serves to illustrate one of the drawbacks of using the census tract as the unit of analysis. If detailed information on population demographics were available at a smaller and more uniform scale, the results of the 6 mile and the 30 km radius would have been more consistent.

The population living within Contra Costa county and in census tracts that experience greater than 90% or greater than 75% of the maximum concentration of pollutants is of a higher percentage of low income inhabitants than the countywide average for both the 6 mile and the 30 km analysis. The population living within Contra Costa county and in census tracts that experience greater than 90% of the maximum concentration of pollutants attributable to the power plant is of a lower percentage of minorities than the countywide average. Yet the percentage of the population living within Contra Costa county and in census tracts that experience greater than 75% of the maximum concentration of pollutants attributable to the power plant is of a higher percentage of minorities than the countywide average.

Whether or not an environmental justice population exists in the areas surrounding the Pittsburg and the Potrero power plants is difficult to determine because those power plants impact more than one county. The percentage of the affected population that is minority or low income exceeds the countywide averages for some of those counties but not for all. Thus a judgment would have to be made regarding how to decide if the impacted population is an environmental justice population or not. One possibility would be to decide that an environmental justice population exists if the percentage of the affected population that is minority or low income exceeds the countywide average for the majority of the counties. However, the fact that the demographics of each county are quite different and yet the people affected by the power plant all live close together raises the larger question of the validity of using county demographics as the basis for comparison.

The validity of the radius used to delineate the analysis boundary is also of concern. The California Energy Commission staff approach uses a 6 mile radius around the power plant. For the El Segundo power plant, the maximum concentration of pollutants attributable to the power plant is experienced 3.5 km (2.2 miles) from the power plant; however, concentrations of pollutants up to 75% of the maximum are experienced as far as 15 km (or 9.3 miles) away from the power plant. For the Potrero power plant, the maximum concentration of pollutants attributable to the plant is experienced closer to the power plant, at approximately 3 km (or 1.8 miles). The higher concentrations of pollutants are located within 6 miles of the power plant. For the Pittsburg power plant, the maximum concentration of pollutants attributable to the power plant is experienced at 6.4 km (or 4 miles) from the power plant, yet concentrations of 75% of the maximum experienced are experienced as far away as 12 km (or 7.4 miles) from the power plant. The variation in the distance the pollutants travel is due to differences in the effective stack heights of the power plants and meteorological conditions. Thus for certain conditions a 6 mile radius around the power plant will encompass the majority of the impact zone and for others it will not. This fact indicates that a 6 mile radius may be an inappropriate measure to use for an environmental justice analysis. Rather than use a predetermined radius, it would be scientifically appropriate to set the geographic domain of the analysis based on the specific details of each facility.

Concentration of NO_x Attributable to the Power Plants

Once the presence of an environmental justice population has been established, it must be determined if the hazard being evaluated has a high and adverse impact on that population. For this analysis, the impact measured is the average expected concentration of NO_x pollution. The maximum concentrations of NO_x that are attributable to emissions from each power plant as it was operated in 1996 are listed in Table 5.

Table 5: Maximum Annual Average NO_x Concentration Attributable to Power Plant

Power Plant	NO_x Concentration (ug/m^3)
El Segundo	0.11
Potrero	0.37
Pittsburg	0.22

Two further caveats need to be mentioned with respect to the impact of the power plants evaluated. The first is that this study determines the expected ambient air concentration of pollutants. Ambient air concentration, although correlated with health impacts, is not the same as intake. Intake quantities will vary depending on the duration of exposure, the level of activity, and individual characteristics of the population exposed to the pollution. Furthermore, this study estimates the impacted population based on a census of the place of residence. It is quite likely that many residents spend little time near their residence, as they commute to other locations for work or for school. The reverse is also a possibility, especially if schools, playgrounds, or construction sites are located near the power plants. Thus exposure cannot be directly calculated from the concentrations of pollutants calculated and census data. A more detailed analysis of intake and health impacts would take into consideration land use and life-style patterns.

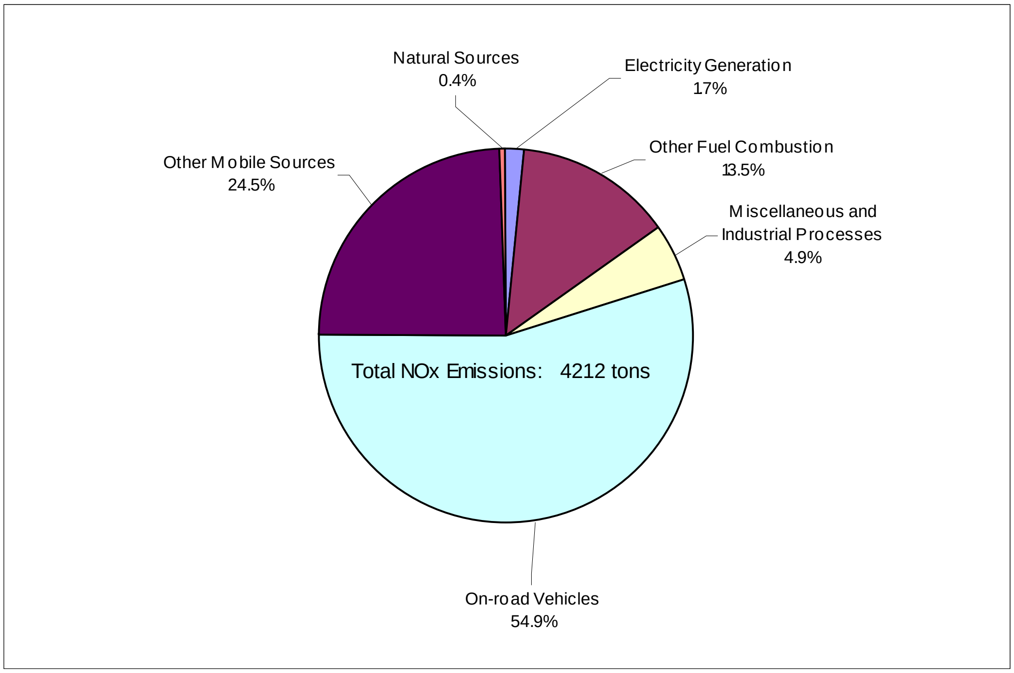
Air Quality Standards

Both the US EPA and the state of California have set ambient air quality standards for each of six criteria air pollutants. Although there is no standard for the general class of NO_x, two standards have been set for NO_2. The first is the EPA National Ambient Air Quality Standard (NAAQS), which states that the annual arithmetic mean of NO_2 concentration should not exceed 0.053 ppm or 100 $\mu g/m^3$. California has also set a one-hour standard of 0.25 ppm or 470 $\mu g/m^3$ (California Air Resources Board).

Even if the concentration of NO_x attributable to emissions from the power plants evaluated in this study were to be composed entirely of NO_2, those concentrations would be much lower than the standard. This result is not surprising, in that it would not be expected that the CEC would permit a power plant that would cause air pollution concentrations exceeding the legal health standards. However, it is instructive to look beyond the individual impact of a single plant at the regional cumulative concentrations of pollutants.

In 2002, California ranked worst as the state with the most number of person-days in exceedance of the NAAQs for all criteria air pollutants. (Environmental Defense) The statewide average measured ambient air concentration of nitrogen dioxide in California is approximately 40 $\mu g/m^3$. Actual concentrations of NO_2 range from a maximum of 79 $\mu g/m^3$, in Los Angeles county, to a minimum of 6 $\mu g/m^3$, in Mariposa county. (EPA AirData)   As indicated in Figure 1, power plants comprise only a small fraction (1.7%) of total NO_x emissions in the state; the majority of NO_x emissions in California originate from mobile sources, mostly on and off-road vehicles. In other states, the percentage of NO_x emissions due to power plants is higher, as electricity generation facilities in those states use coal. The percentage of NO_x emissions originating from electricity generation in California for each county located within 30 km from the three evaluated power plants is included in Table 6.

Figure 1: NO_x Emissions in California by Source Category



Source: California Air Resources Board

Table 6: NO_x Emissions and Ambient Air Concentrations by County

County	Daily NO_x Emissions from Power Plants (tons)	Total Daily NO_x Emissions (tons)	Percentage NO_x from Power Plants (%)
Alameda	0.0	149.0	0.0%
Contra Costa	7.8	155.2	5.0%
Los Angeles	16.6	900.7	1.8%
Marin	0.0	26.1	0.0%
Napa	0.1	14.5	0.5%
Sacramento	0.0	124.3	0.0%
San Francisco	3.6	89.6	4.1%
San Joaquin	0.7	99.7	0.7%
San Mateo	0.3	86.7	0.4%
Solano	0.0	56.1	0.0%

Source: California Air Resources Board

The portion of total NO_x emissions that is due to electricity generation and the contribution of those emissions to ambient air concentrations vary by county. Emissions from electricity generation in Los Angeles County comprise 1.8% of the NO_x emissions in that county; whereas in Contra Costa County, emissions electricity generation comprises 5.0% of the total NO_x emissions.

Unfortunately, data on the ambient air concentration of NO_x is unavailable for each county. However, the EPA does monitor ambient air concentrations of NO_2. The measured ambient air concentration of NO_2 for the county in which each power plant is located is presented in Table 7. This data can be used to make an order of magnitude estimate of the contribution of the emissions from each power plant to total ambient air concentrations of NO_2. A higher percentage (0.9%) of the ambient air concentration of NO_x is attributable to the Potrero plant in San Francisco county than is attributable to the Pittsburg Plant (0.6%) in Contra Costa county or the El Segundo Plant (0.1%) in Los Angeles county. These numbers indicate that power plants contribute more to NO_x concentrations in some areas than in others and that emissions must be considered in conjunction with dispersion patterns in order to accurately understand how they translate into ambient air concentrations.

Table 7: NO_x Concentration Attributable to Power Plant

Power Plant	**County**	**Maximum Annual NO_x Concentration Attributable to Plant (ug/m^3)**	**Measured Ambient NO_2 Concentration in County (ug/m^3)**	**Approximate Contribution of Plant Emissions**
El Segundo	Los Angeles	0.1	87	0.1%
Potrero	San Francisco	0.4	40	0.9%
Pittsburg	Contra Costa	0.2	36	0.6%

Source: California Air Resources Board and the US Environmental Protection Agency

To accurately measure the cumulative impact of each power plant, the dispersion of pollution from all sources in the vicinity would need to be modeled. Although the EPA has performed such analyses for hazardous air pollutants (Morello-Frosh, Pastor and Sadd 2001), it has not done so for criteria air pollutants. In the absence of such information, an estimate based on the regional ambient air concentrations of pollutants can be made. The worst case scenario would be if the concentration of NO_x attributable to each plant were composed entirely of NO_2. If that concentration is added to the measured ambient concentrations of NO_2 in the county, the total concentration of NO_2 would still be below the NAAQS.

Power Plants and Environmental Justice

Based on this small sample of three power plants a general conclusion cannot be made regarding whether or not power plant siting has systematically resulted in environmental injustice. Although for the El Segundo power plant, both the proximity and the concentration levels methods for determining the affected population indicates the presence of an environmental justice population, for both the Potrero and the Pittsburg plants, the results are mixed. Furthermore, this analysis only considered the impact of one pollutant, the concentration of which does not exceed air quality standards. However, the results do indicate one of the salient problems in distributive justice analysis; namely, that whether or not an environmental justice population exists depends on the analysis method used, the boundary of the analysis (the radius around the plant which is considered), the comparison communities, and the impact considered.

The three power plants picked for this study were specifically chosen because concerns about environmental injustices had been raised during the permitting process. The question which then arises is, if these plants do not represent a clear health risk to the community and do not clearly disproportionately affect minority or low income populations, then why has there been controversy over environmental justice and power plants?

There are multiple possible answers to this question. One explanation may be that community members may not agree with the analysis performed by the CEC. This appears to be the case with the Pittsburg power plant. The complaint against the permitting of that plant stems upon the argument that total emissions in Contra Costa county are greater than those in Marin, Napa, and Solano counties, three nearby counties which have much lower emissions rates. The complaint discusses emissions not concentrations of pollutants. It also does not compare the concentrations of pollutants with ambient air quality standards (California Energy Commission 1998a).

The fact that a complaint was filed may indicate that the community is more concerned with disproportionate impacts than with high and adverse impacts. Or it may indicate disparities between actual and perceived hazards. Perceptions of risk are related to a variety of issues which extend beyond an understanding of empirical data. With respect to power plants, risk perception and concerns about justice are tied to issues of visibility, scale, accessibility, and accountability.

Power plants are highly visible land uses. They are large, have industrial-style buildings and machinery, and tall smoke stacks which emit ominous plumes. Many people do not understand that the majority of the emissions emanating from smoke stacks are water vapor. Also, taller smoke stacks are more prominent, can be seen from a further distance, and may appear more threatening. Ironically, a taller stack height may increase the perceived risk when actually its serves to reduce the concentrations of pollutants experienced by the nearby community.

Public understanding and participation in the design, construction, and operation of power plants is limited. Power plants are technically complex and the decisions made regarding the design and siting of power plants are usually made by a few key actors, namely city officials, regulating agencies, and the power plant owners. Even when public participation is encouraged, individuals wishing to participate would need to much time and effort into understanding and participating in the process. Community reactions against the siting of locally undesirable land uses which arise during the permitting process may arise out of feelings of a lack of control over the nearby environment and a lack of understanding of the details involved.

The environmental justice movement may choose to focus on larger facilities such as power plants, even if those facilities do not represent the most significant environmental hazard to the community, because it is easier to influence decisions regarding centralized facilities. A power plant is generally owned and operated by a single entity, which receives permission to operate from a centralized regulatory agency. Thus calling for accountability of those agents is relatively straightforward. Other threats to the community and to the environment may not be so easy to identify and control. The main contributor to NO_x pollution in California is on and off-road vehicles. The largest contributions of passenger vehicle NO_x emissions are from older vehicles, which are more likely to be owned and operated by lower income people. Yet each vehicle is owned by a different individual. Attempting to reduce emissions from all vehicles would require the collaboration of a multitude of parties and a much more complicated regulatory framework.

Implications

The CEC staff approach to environmental justice does not address the issues of perceived risk, accountability and control. Rather the guidelines focus on determining whether or not there is an environmental justice population and if the impact of a power plant on that population is high and adverse. The results of CEC environmental justice analyses are influenced by several assumptions inherent in the method of evaluation used: the radius around the plant used in the analysis and the benchmark (50%) that is used to determine whether an environmental justice population exists.

This investigation expands upon the environmental justice analyses which have been performed by the CEC. Instead of defining the population affected by a power plant simply by proximity, the affected population is also defined by the impact itself. Furthermore, this study compares the demographics of the affected population with the overall demographics of the region rather than an arbitrary benchmark. These improvements to the analysis of distributive justice apply to more than power plant siting and air pollution.

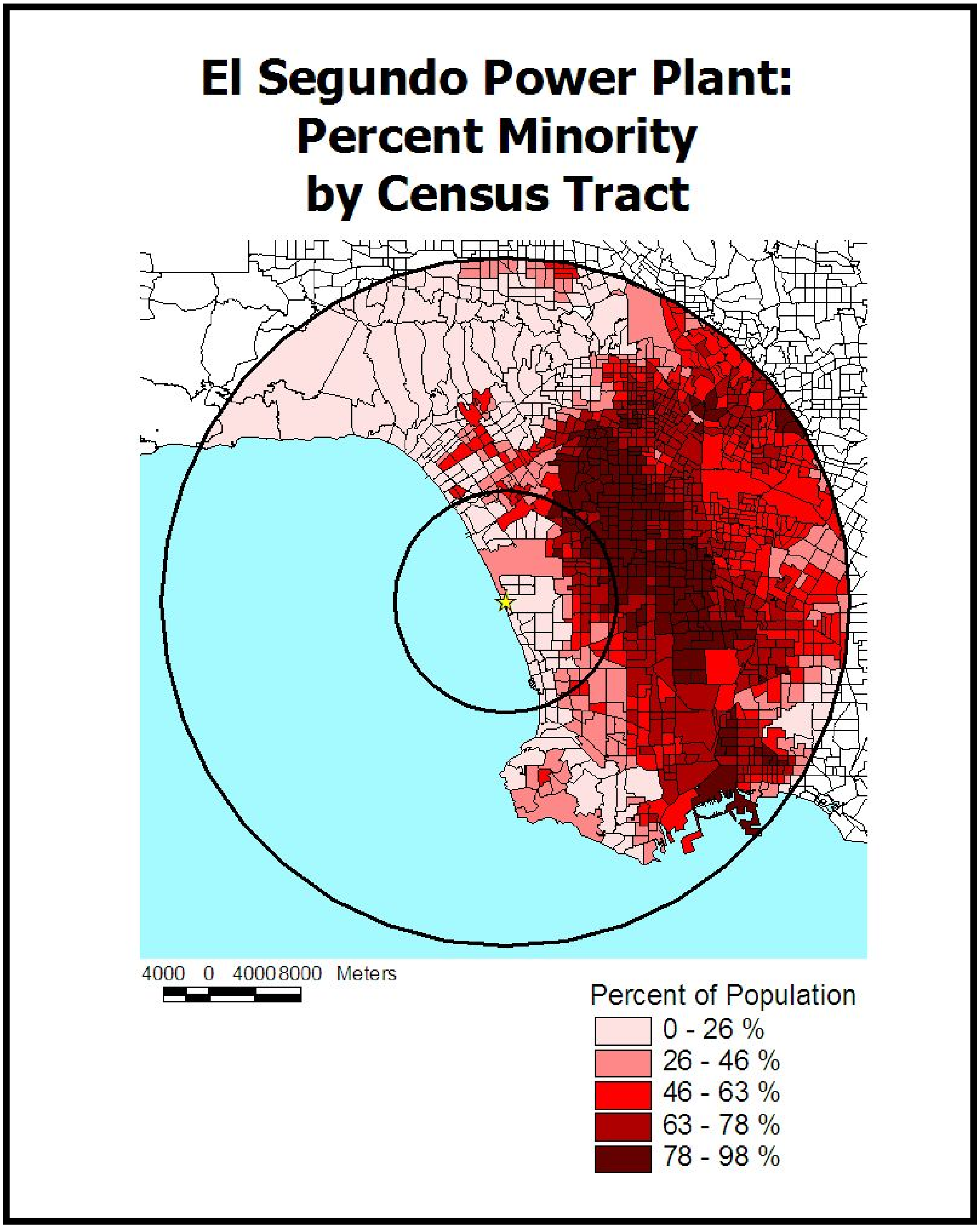
Power plants were used in this study as illustrative of a broader class, that of central release facilities. Large refineries, chemical processing plants, and other locally undesirable land uses are significant sources of both criteria and hazardous air pollutants. They are also sources of water pollution, noise, and other environmental insults. Similar to power plants, these facilities are regulated and must be permitted before construction and operation. The evaluation process for these facilities should provide a comprehensive look at the relative impacts of these facilities. This analysis of power plants provides an illustration of the complexity of the evaluation process and the effects that the methods and assumptions used in the analysis can have on the results. Clearly it is important to look not just at proximity, but the actual zone of the impact to better understand who is affected by the siting of a facility. In the case in which a facility has more than one negative effect, it is important to determine the population that experiences each impact separately. The population should be compared not just to a benchmark figure of 50%, but also to the demographics of the population within the region. The impacts should be considered both individually, cumulatively, and relative to the known risk such an impact will impose.

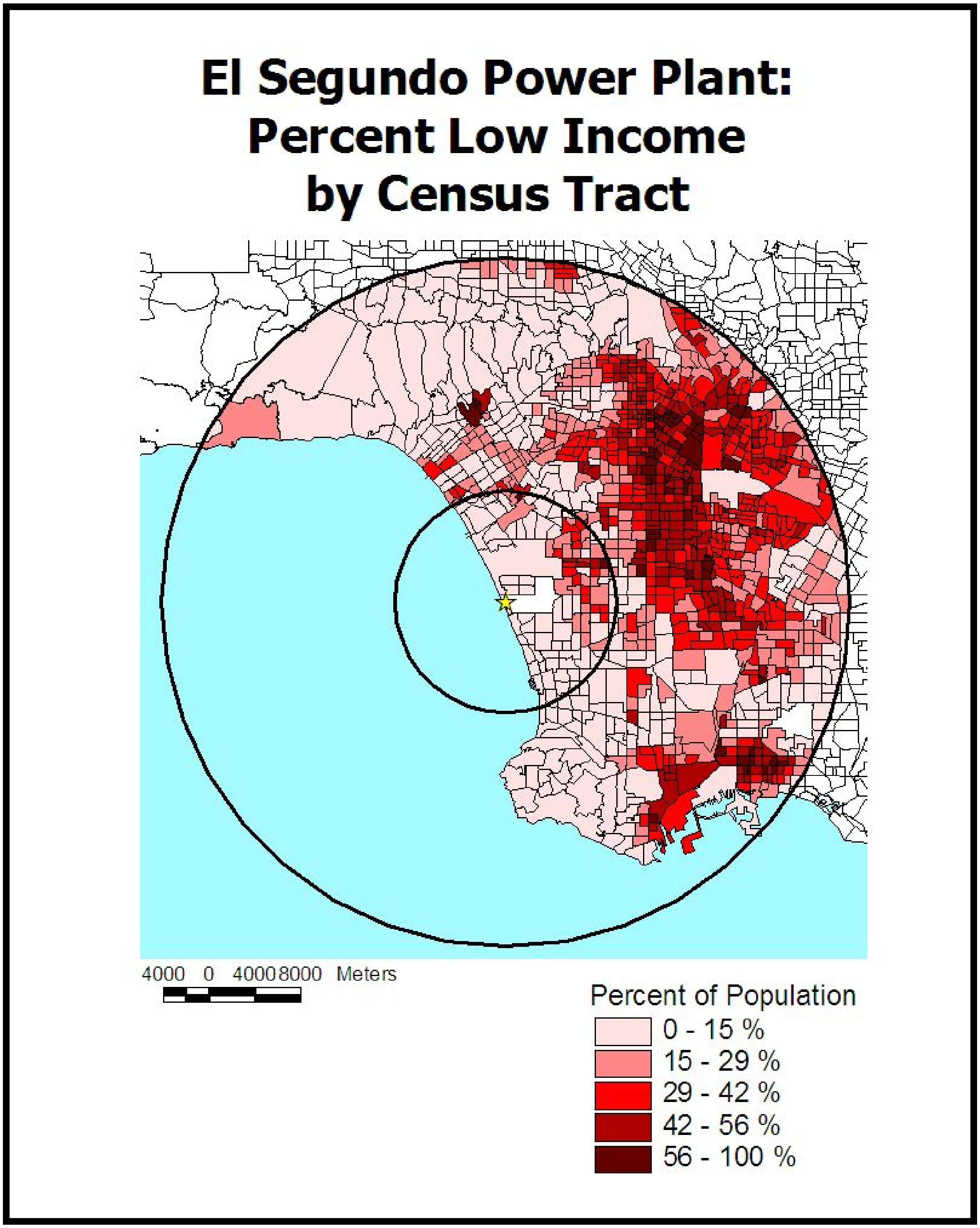
Conclusions

The original premise of this study was to create a better understanding of environmental justice by taking a closer look at distributive justice analyses. The logic behind this was that interest in environmental justice is growing but the field still lacks consistent mechanisms for evaluation. Yet despite this lack of consistency, decisions are being made in both the policy and legal realms. These decisions are predicated on results from distributive justice analysis because such analysis can provide empirical and quantitative numbers on which to base a decision. Thus the objective of this study was to understand how the choice of analysis methods and assumptions made can influence the analysis results. This paper accomplishes the goal to the extent that it indicates how there will be differences in the demographic results from an analysis based on proximity and an analysis based on a more detailed evaluation of the zone of impact.

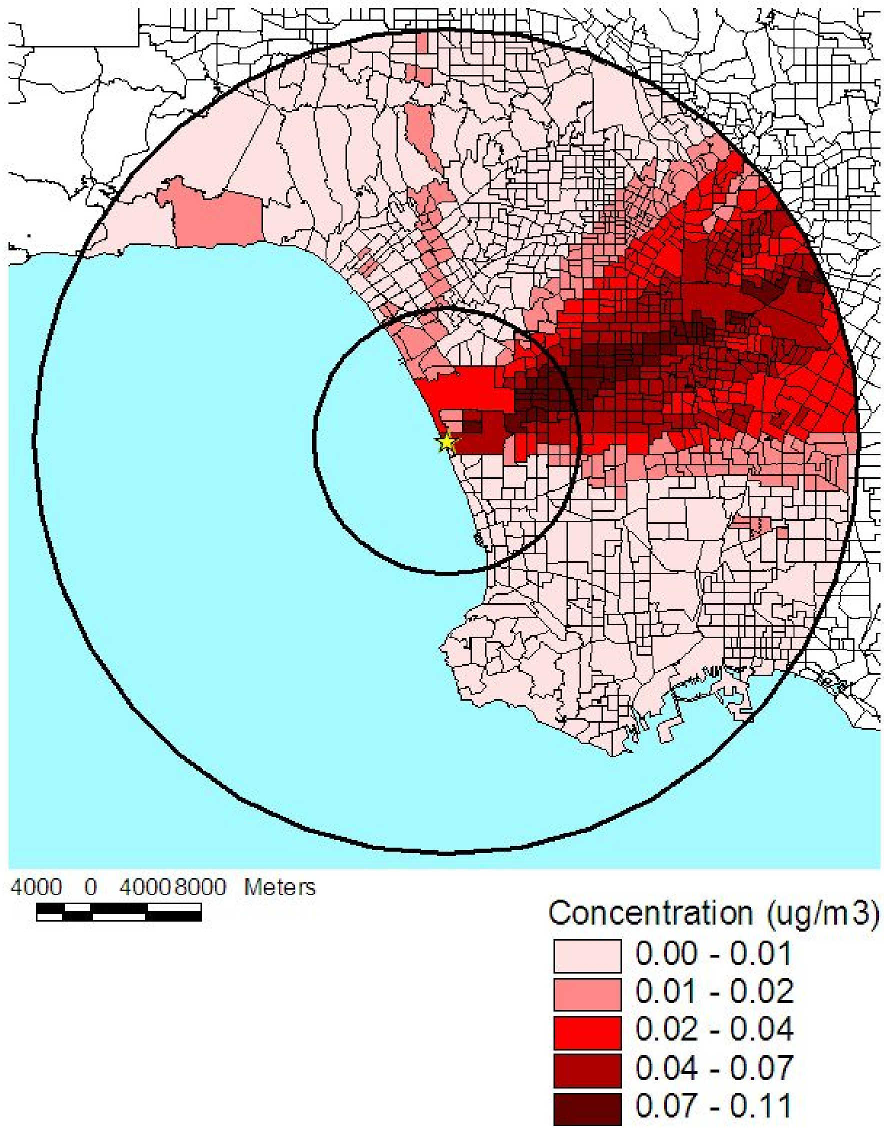
Although the focus of the study was on distributive justice, the findings indicate that the three power plants evaluated do not substantially contribute to the ambient air concentrations of one important class of pollutants, NO_x. However, depending on the method used for defining the affected population, the results indicate that minorities and low income populations may be disproportionately affected by air pollution from power plants. A further investigation is required to understand better the views of the public regarding environmental justice. It may be that procedural, corrective, and social justice concerns are just as important to the public as the distribution of the impact of a facility. Addressing the complexities of environmental justice is challenging, but important for gaining a full understanding of the issues at hand.

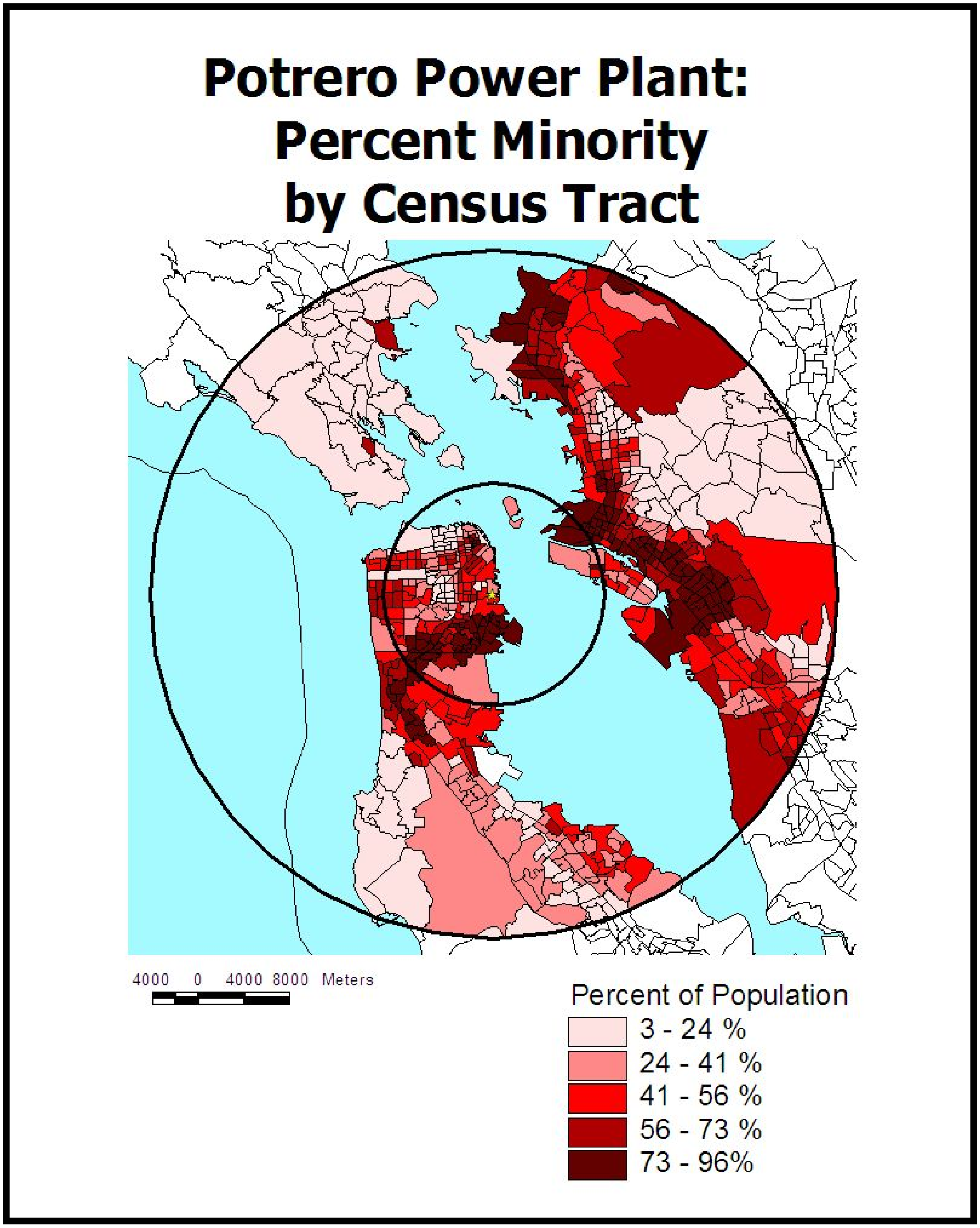
Appendix


El Segundo Power Plant:
Percent Minority
by Census Tract
4000 0 4000 8000 Meters
Percent of Population
0 - 26 %
26 - 46 %
46 - 63 %
63 - 78 %
78 - 98 %

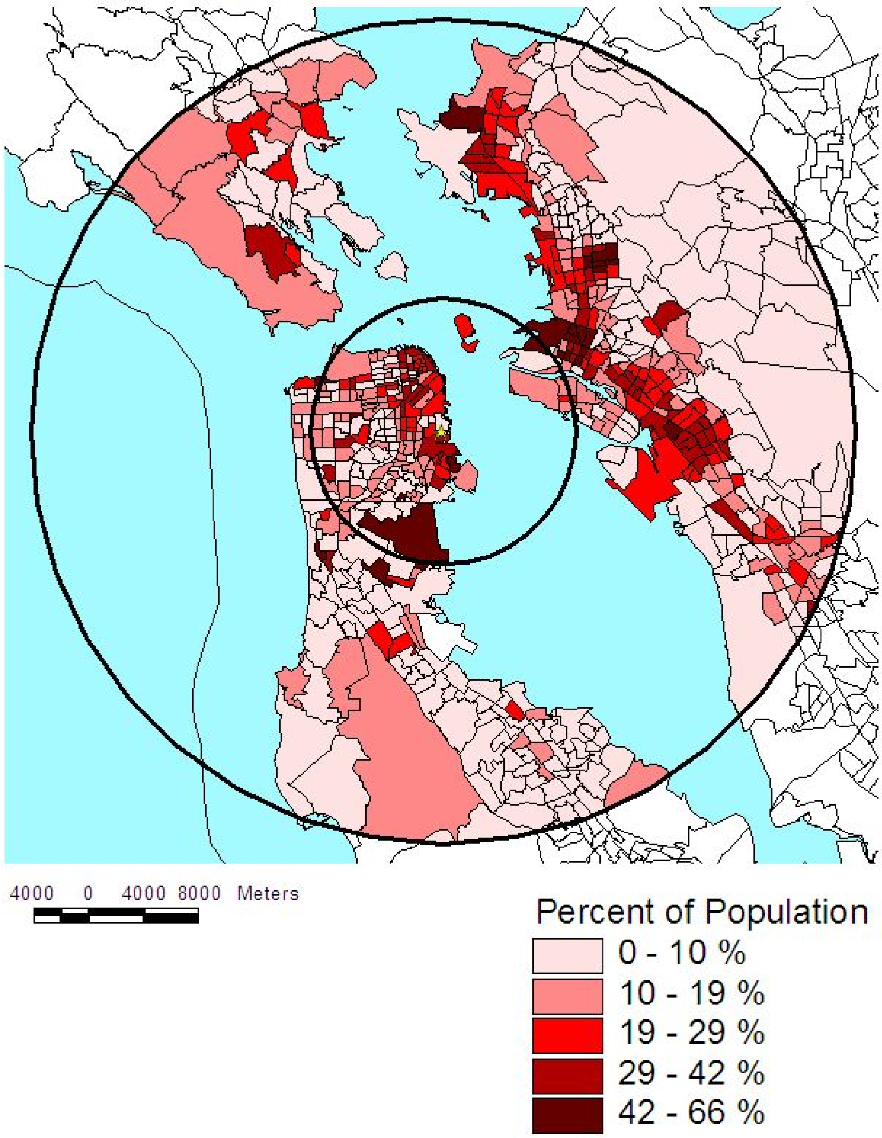

El Segundo Power Plant:
Percent Low Income
by Census Tract
4000 0 4000 8000 Meters
Percent of Population
0 - 15 %
15 - 29 %
29 - 42 %
42 - 56 %
56 - 100 %

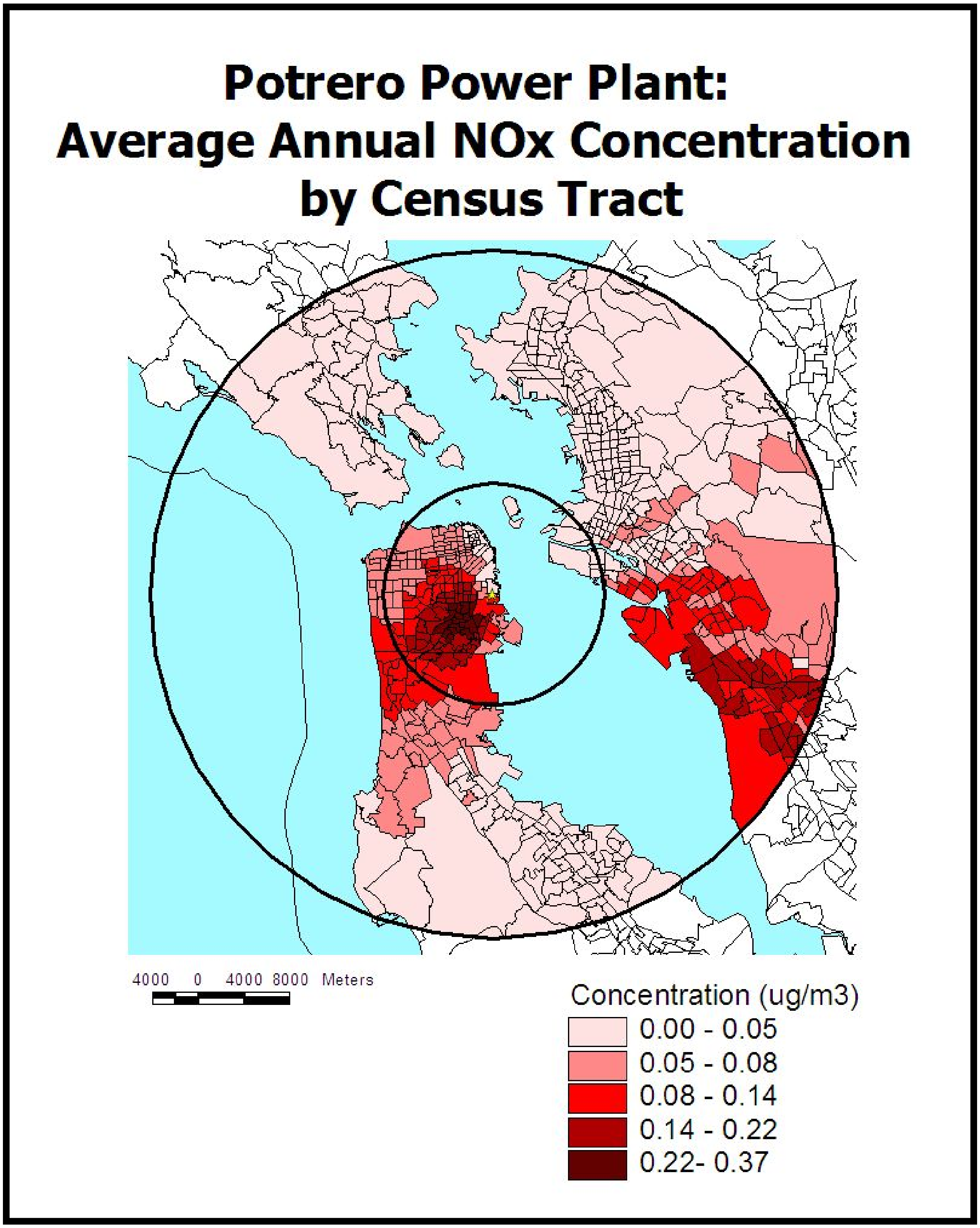
El Segundo Power Plant: Average Annual NOx Concentration by Census Tract



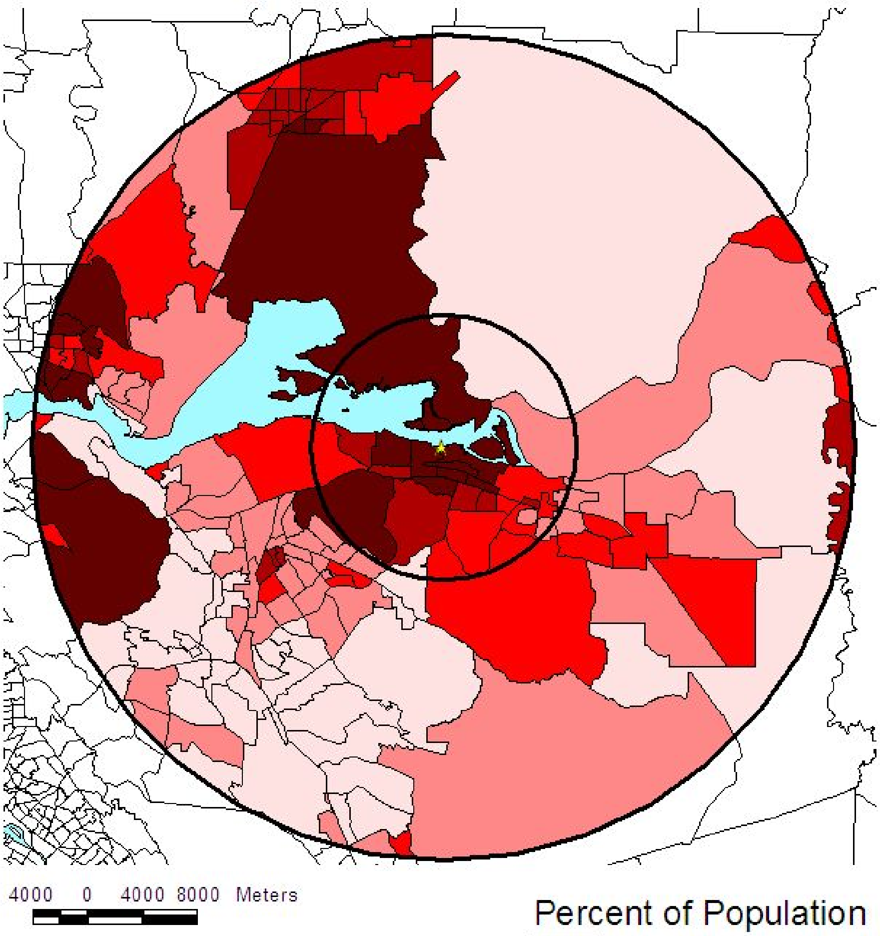

Potrero Power Plant:
Percent Minority
by Census Tract
4000 0 4000 8000 Meters
Percent of Population
3 - 24 %
24 - 41 %
41 - 56 %
56 - 73 %
73 - 96%

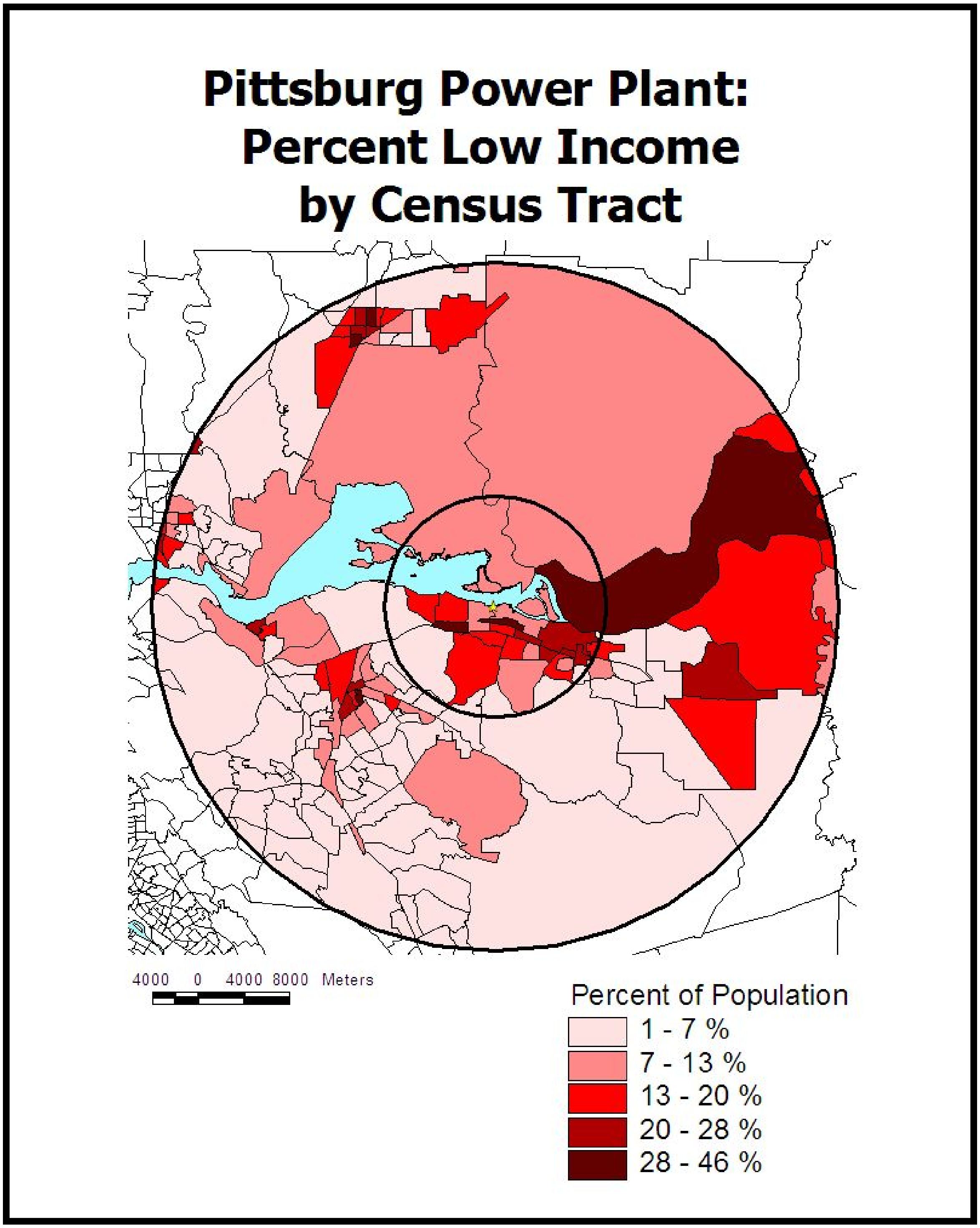
Potrero Power Plant: Percent Low-Income by Census Tract



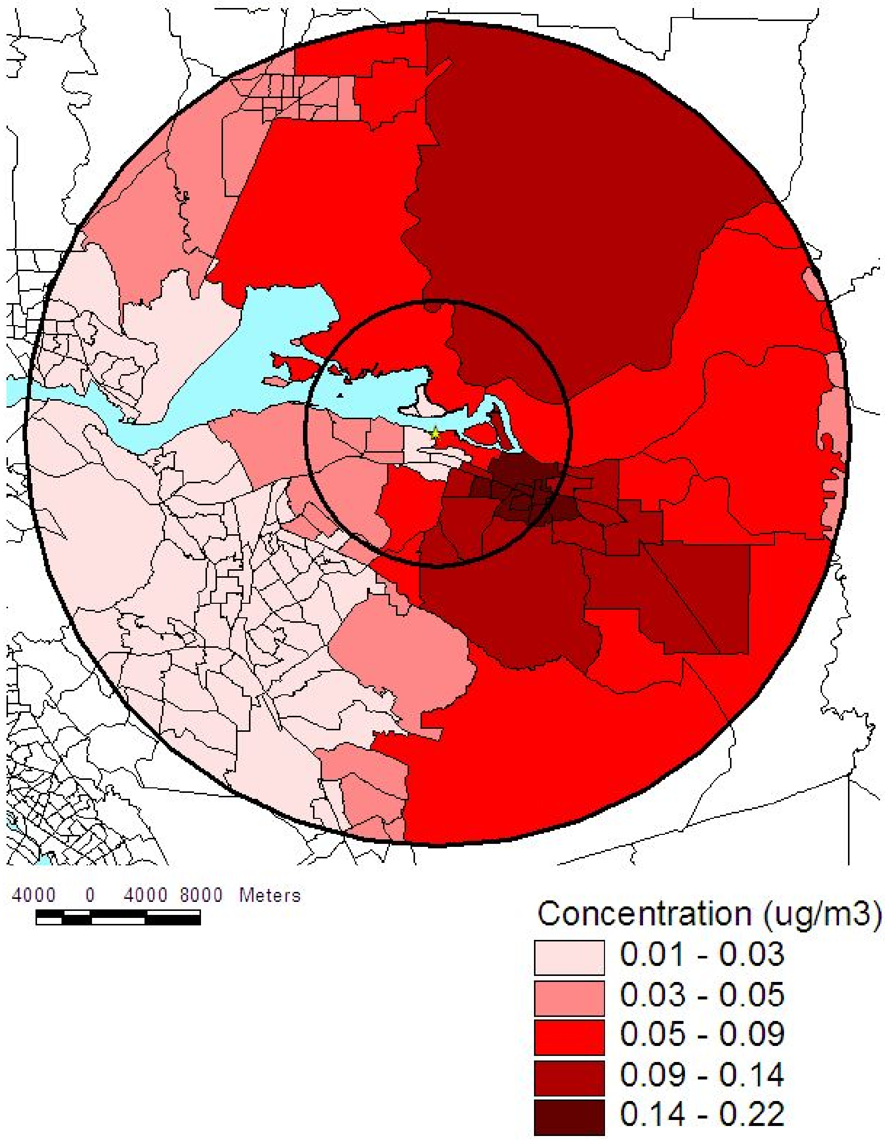

Potrero Power Plant:
Average Annual NOx Concentration
by Census Tract
4000 0 4000 8000 Meters
Concentration (ug/m3)
0.00 - 0.05
0.05 - 0.08
0.08 - 0.14
0.14 - 0.22
0.22- 0.37

Pittsburg Power Plant: Percent Minority by Census Tract




Pittsburg Power Plant:
Percent Low Income
by Census Tract
4000 0 4000 8000 Meters
Percent of Population
1 - 7 %
7 - 13 %
13 - 20 %
20 - 28 %
28 - 46 %

Pittsburg Power Plant: Average Annual NOx Concentration by Census Tract



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