Assessment of Diesel Pollution in Inner West Contra Costa County

Technical Support Report

By the Pacific Institute
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INTRODUCTION

In 2003, the Community Health Initiative and the West County Asthma and Diesel Committee began working on assessing the impact of and strategies for reducing diesel pollution in West Contra Costa County. Diesel pollution, and its links to health effects including asthma, was a key concern identified by the community through a series of community meetings on air pollution and health.

The West County Asthma and Diesel Committee is a collaborative effort joining community groups from West Contra Costa County, Contra Costa Health Services, and regional non-profits. The Asthma and Diesel Committee originated out of community residents' concern about health and air pollution identified at a November 2003 Air Pollution Town Hall meeting organized by the Community Health Initiative. The town hall meeting was one of a series of events funded by a Partnership for Public Health grant from the California Endowment. The Community Health Initiative is a partnership of 14 community-based organizations that had been working together informally for nearly ten years to address the health needs of communities in West Contra Costa County. The Partnership for Public Health grant formalized the coalition linking these groups.

One of major issues of community concern is the link between diesel pollution and the region's asthma epidemic. There are numerous sources of diesel pollution in West Contra Costa County including diesel truck traffic on the major freeways surrounding the communities, rail yards near residential areas, and a major bulk cargo port on Richmond Harbor. The goal of the Asthma and Diesel Committee is to identify and help implement strategies to reduce diesel pollution in West Contra Costa County. Table i-1 is a complete list of the organizations that have attended committee meetings.

Table i-1 Asthma and Diesel Committee Meeting Participants

Organization Type	Organization Name
Community-Based Organizations	Community Health Initiative: - Neighborhood House of North Richmond - Asian Family Resource Center - Baptist Ministers Association - North Richmond Ministerial Council - Exchange Works - North Richmond Municipal Advisory Board - Greater Richmond Inter-Faith Neighborhood Council - Ma'at Youth Academy - West County Toxics Coalition - National Association for the Advancement of Colored People - Robinson-Weeks-Robinson Scholarship Fund Neighborhood House of North Richmond West County Toxics Coalition
County Agencies	Contra Costa Health Services West Contra Costa County Asthma Advocates Contra Costa Community Development Department Contra Costa County Public Works Department West Contra Costa County Transportation Advisory Committee
Regional and State Agencies	Metropolitan Transportation Commission
Regional Non-Profit Organization	Pacific Institute Regional Asthma Management and Prevention Initiative

The activities of the Asthma and Diesel Committee are organized around a three-part work plan (see Appendix A). The first task is to identify community questions related to asthma and diesel pollution. The second task is to conduct research in order to answer community questions. The third task is to identify potential solutions and work together to implement them. This study is part of the second task and is carried out by the Pacific Institute's Community Strategies for Sustainability and Justice (CSSJ) program. The CCSJ program activities are aimed at integrating the Pacific Institute's research skills with the strengths of community-based groups; an approach that meets the Asthma and Diesel Committee's goals.

This report serves as a technical support document to the Asthma and Diesel Committee's future campaigns. The study provides general information on diesel pollution, especially diesel particulate matter pollution in Section I as a background for the rest of the report. Section I also presents the geographic boundaries of the study area and describes the demographic, economic, and health characteristics of the study area. In Section II, the last decade of ambient air particulate matter measurements are analyzed and crucial data gaps are identified. Existing studies describing the sources of diesel pollution in West Contra Costa County are summarized in Section III. Section IV draws on the data presented in Section III to create an estimate of the emissions of diesel pollution in the West Contra Costa County study area. This emissions inventory is compared to the official county and state's emission inventory estimates in order to compare the burden of diesel pollution on residents of the study area c to residents in other parts of the County and State. Section V describes the implementation and results of an indoor air quality monitoring project focusing on black carbon, a surrogate for diesel particulate matter.

SECTION I: PROJECT BACKGROUND

A. DIESEL POLLUTION: SOURCES AND EFFECTS

a. What is diesel pollution?

Diesel emissions result from the combustion of diesel fuel inside a compression ignition engine. The exhaust consists of gaseous, liquid and solid components. The exhaust contains mostly carbon dioxide (CO_2) and water vapor but also criteria air pollutants and toxic air contaminants. A criteria pollutant is a pollutant for which a standard has been established based on a determined acceptable level of exposure.[1] The criteria pollutants in diesel exhaust are primarily oxides of nitrogen (NOx), carbon monoxide (CO), hydrocarbons (HC), particulate matter (PM) and oxides of sulfur (SOx). NOx and HC contribute to the formation of ground level ozone also known as urban smog. PM is composed of solid or liquid particles of a wide array of sizes. Other chemical substances are present on these particles' surfaces. Toxic air contaminants are pollutants for which no lower exposure limit has been established.[2] These substances, which include formaldehyde, acetaldehyde, acrolein, and benzene, are toxic at very low concentrations, and can be found on the surface of emitted particles. According to the State of California, over 40 toxic air contaminants are present in diesel exhaust as well as attached to diesel particulate matter.[3] Diesel PM, the particulate matter from the exhaust of diesel engines was designated a toxic air contaminant in 1998 by the California Air Resources Board (ARB). This designation triggered the development and implementation of a plan to reduce the risk associated with exposure to diesel particulate matter throughout the state. Diesel PM is only a small subset of PM from all sources.

b. What is diesel particulate matter?

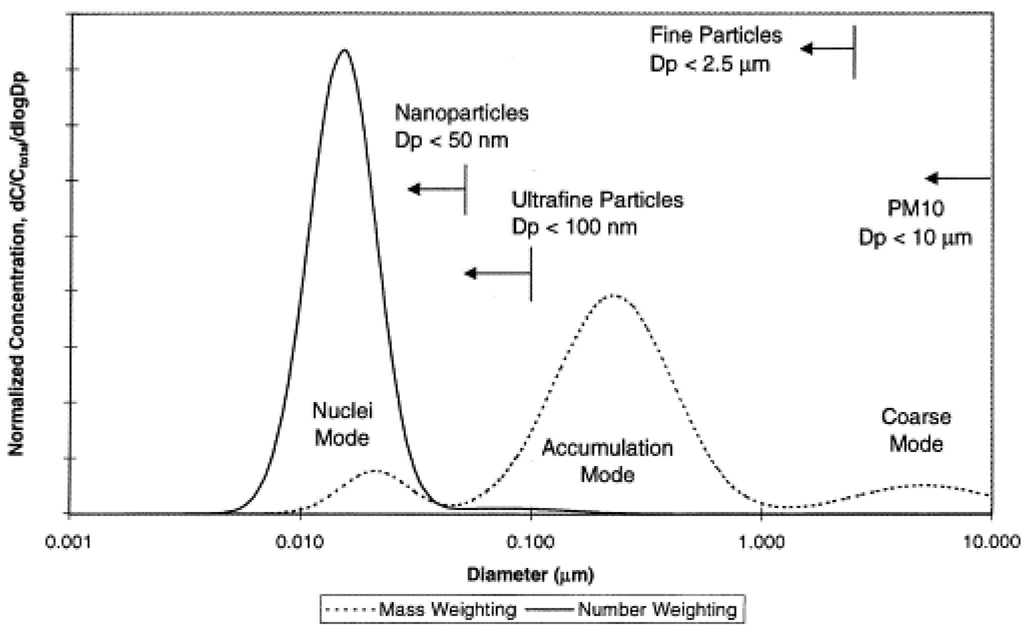
As mentioned above, diesel PM was designated by ARB as a toxic air contaminant. This designation differentiates diesel PM from particles of other origins. The term particulate matter refers to all solid or liquid particles suspended in the air originating from a variety of sources. The particle's origin influences its size, shape, and chemical composition and therefore its impact on the environment and human health. Table I-1 summarizes some basic information on particulate matter. The particle size categories described in the table are ultra fine or nuclei (<0.1 µm), accumulation (0.1 to 2 µm), and coarse (> 2µm). As a product of combustion, most diesel particles are ultra fine, that is smaller than 0.1 µm in diameter or about 1/100 the size of a human hair. [4]

Table I-1 Particulate Matter Size and Source[5]

Common Name	Ultra fine or nuclei	Accumulation	Coarse
Particle Size (diameter)	Smaller than 0.1 µm	0.1 µm to 2 µm	Greater than 2 µm
Typical Source	Combustion	Secondary formation in atmosphere	Grinding, abrasion
Composition	Carbon, metals, condensed gases	Organic compounds, salts, water	Soil, salts
Duration of life in the atmosphere	Days	Weeks	Hours

Particulate matter emitted from most sources, including diesel engines, contains particles of a range of sizes. Figure I-1 is a graph of typical diesel exhaust particle size distribution with a normalized number of particles per volume of air on the left axis. The size and composition of particles can change once they are emitted in the atmosphere. For example, two particles can collide and stick to each other thus forming a larger particle. The mass distribution is also represented in Figure I-1. As smaller particles have very little mass, most of the PM mass is contained in the larger particles in the accumulation or coarse size range.

Figure I-1. Diesel PM Typical Size and Mass Distribution[6]



To describe the mass concentration of particles by size, the common notation is to put the maximum size of the particle in micrometers (or microns) after the acronym PM. For example, PM10 refers to particles 10 µm or below in diameter. A majority of the mass concentration of PM10 particles will consist of, in many cases, the mass of the larger particles. The PM2.5 category, which consists of particles 2.5 µm and below in diameter, is a closer approximation of the smaller particles that result from combustion. Current Federal and State air quality standards set limits on the concentration of PM10 and PM2.5 in ambient air. These standards set limits on the allowed mass concentration of PM10 and PM2.5 in a given volume of air.

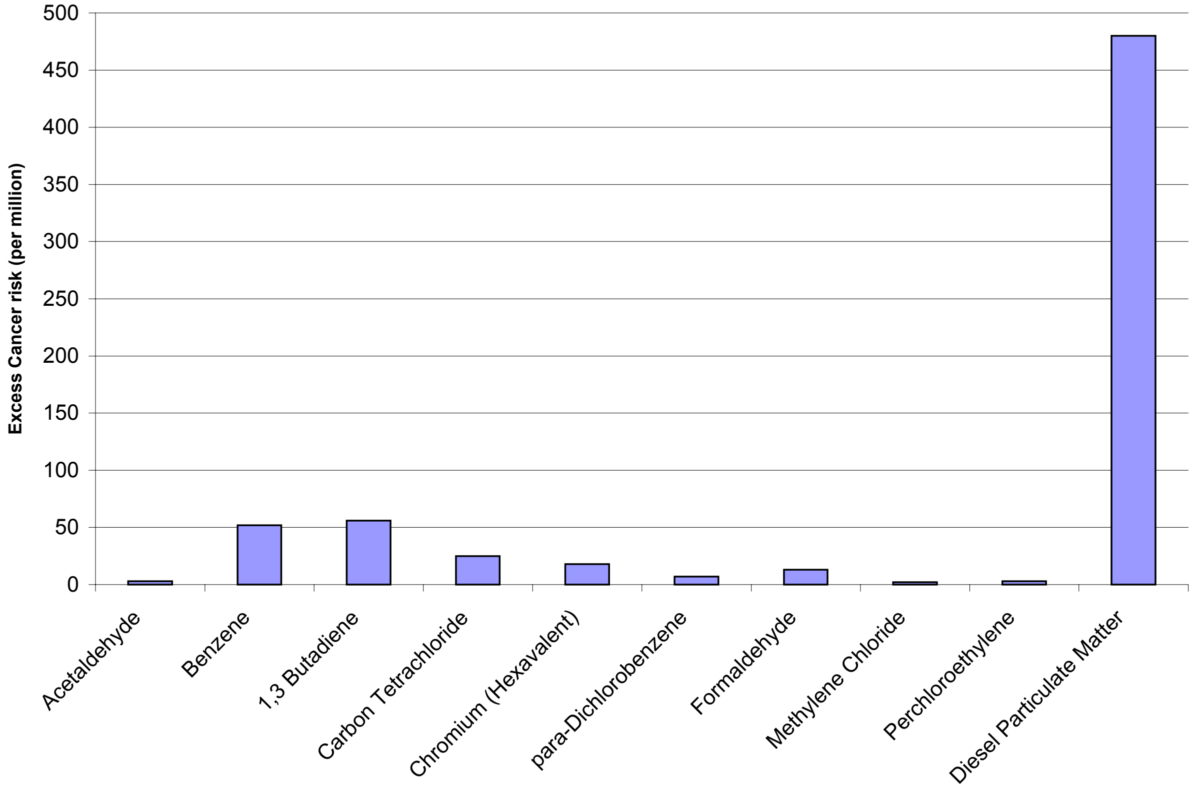
Diesel PM is therefore a subset of the total amount of particulate matter present in the atmosphere. Currently, there are no direct techniques for distinguishing diesel combustion borne particles from all other particles. The absence of a diesel "fingerprint" has made it difficult to directly assess the concentration of diesel PM in the air that humans breathe. Some indirect techniques rely on the high amount of carbon present in diesel particles and measure black carbon (BC) or elemental carbon (EC) concentration as a surrogate for diesel PM. Black carbon is commonly referred to as soot.[7] Particles from other sources, such as those emitted while cooking or burning candles, can also have a high black carbon content which can limit the assessment of diesel PM concentrations when other black carbon sources are also predominant. It is however possible to design controlled indoor and outdoor experiments where the largest sources of black carbon is diesel PM.[8]

c. What are the health effects of diesel exhaust and diesel PM?[9]

Exposure to the mixture of gases and solids that compose diesel exhaust has been shown to result in serious health effects. Diesel exhaust has been linked to diseases such as cancer, respiratory illnesses, and asthma symptom aggravation. High levels of particulate matter exposure have been connected to premature death.

Numerous studies have linked long-term exposure to diesel exhaust with cell mutations and DNA damage, the precursors to cancer.[10] The California EPA Office of Environmental Health Hazard Assessment has deemed diesel exhaust to pose the highest cancer risk of all evaluated air contaminants. This is not because diesel is the most toxic chemical but because it is present in higher concentration in the air than other toxics. Figure I-2 shows the excess cancer risk per million for 10 toxic air contaminants in the San Francisco Bay Area based on year 2000 average concentrations.[11] The risk associated with diesel particulate matter is over 8 times greater than the toxic with the second highest risk, 1,3 butadiene.

Figure I-2. Excess Cancer Risk due to Toxic Air Contaminants in the San Francisco Bay Area Basin (2000)



This claim has been further substantiated by the South Coast Air Quality Management District, which estimates that about 70% of all cancer risk from air pollution in California comes from breathing diesel exhaust.[12] This is not because diesel PM is the most toxic of air contaminants but because it is present in high concentrations in ambient air, increasing daily exposure. Over 30 reports have examined persons (such as truckers and railroad workers) who have worked for more than a decade in close proximity to high levels of diesel exhaust. Consistently, workers have displayed a high risk of lung cancer.[13] Despite these findings, this data remains incomplete. The occupational studies have failed to produce a standard methodology for exposure measurement, conclusive data on the exposure level that leads to cancer, and the particular components of diesel exhaust that pose the greatest threats. Nonetheless, based on the available evidence, the California EPA, the National Institute for Occupational Safety and Health, and the International Agency for Research on Cancer have all identified diesel exhaust as carcinogenic.

Short-term exposure to diesel exhaust has been known to create eye, nose, throat, and lung irritation, as well as aggravated chronic respiratory and pulmonary disorders.[14] A recent study explored the hypotheses that diesel exposure could cause asthma in otherwise healthy subjects and concluded that it was biologically possible for diesel exposure to cause asthma.[15] Diesel PM exposure could have the triple effects of causing asthma, triggering asthma attacks, and worsening the intensity of an asthma attack.

In addition to aggravating respiratory ailments, diesel pollution may also exacerbate heart disease. In a recent study conducted at the National Public Health Institute of Finland, scientists discovered that patients with heart disease who were exposed to diesel and smoke stack pollution were approximately three times more likely to have decreased blood flow and oxygen supply to their hearts during exercise. Inhaled particles they will stay in the body for hours, enter the blood stream and tighten arteries, interfere with heart rhythm, consequentially increasing the risks for heart attacks and strokes.[16]

A number of studies led by the USEPA have examined many U.S. cities and the state of California to understand how air pollution contributes to premature deaths. These studies suggest thousands of lives in each state are lost every year due to pollution's exacerbation of normally non-terminal illnesses such as bronchitis, emphysema, and asthma. In the early 1990's it was estimated that 60,000 people die each year in the United States from particulate air pollution.[17]

There is currently no consensus on whether health effects are related to mass concentration or number concentration of particles. However, smaller particles with a diameter smaller than 0.1 μm have been shown to be more toxic than larger particles with the same chemical composition and mass concentration.[18] The reasons for the increased toxicity may be their relative small size compared to the lung's cellular structure and their extensive surface area. These features could allow more efficient penetration of particles and delivery of toxic substances.

The sum of the evidence linking diesel exhaust and particulate pollution to heath effects led the California Air Resources Board to declare diesel particulate matter a toxic air contaminant (TAC). To be listed as a TAC, a substance must "cause or contribute to an increase in mortality or in serious illness, or which may pose a present or potential hazard to human health."[19] This designation was not extended to diesel exhaust in general because exhaust contains several nontoxic substances such as water vapor.

Those most threatened by these health effects are the old and the young. The elderly are more likely to have weak immune systems, as well as chronic respiratory and pulmonary problems, making them more vulnerable to a polluted environment. In numerous community studies, diesel exposure has been linked to increased hospital and emergency room visits, asthma attacks, and premature deaths among those suffering from these preexisting ailments.[20]

For children, the risk associated with this pollution is also quite high. Generally, children breathe much more rapidly than adults, and through their mouths, bypassing the filtering effects of the nose and taking many more toxic pollutants directly into their lungs. This exposure is magnified because children are the population most likely to be outside participating in vigorous exercise and taking in large doses of pollutants. Children's developing respiratory systems are much more sensitive to invasive particles. Inflammation and irritation may obstruct the narrow passageways of the lungs, increasing the risk for asthma attacks and respiratory illness. It has been argued that chronic pollution exposure in childhood may in fact create damage to the respiratory, nerve, endocrine, and immune systems, as well as increase the risk of cancer later in life.[21]

In addition to the young and the old, low-income and communities of color also face disproportionate health risks from diesel particulate matter pollution. Sources of diesel exhaust are typically found where commercial and industrial activities are concentrated. These include areas surrounding highways, ports, and rail yards. A recent study focusing on schools in Alameda County found a correlation between asthma and bronchitis symptoms in school children and schools' proximity to transportation corridors.[22] These results are similar to those obtained in other US-based and European studies. [23] Many of these areas are low-income communities and communities of color. These are also the communities that are the most affected by asthma and other air quality related ailments. In the US, African American children are four times more likely to die from asthma than white children.[24] Latino children are 2.5 times more likely than white children and 1.5 times more likely than African-American children to develop asthma.[25] Low income and people of color communities bear the brunt of pollutants; they may often not have access to regular health care, where early intervention may avoid the exacerbation of diesel-related health risks.

d. What are the major sources of diesel pollution?

Diesel fuel is primarily used in the United States in heavy-duty applications such as trucks, generators, and construction equipment. Diesel engines have the advantage of being more fuel efficient per unit load than spark ignited gasoline engines. Diesel engines are typically more efficient than gasoline engines in part because of their higher compression ratios. Diesel vehicles and equipment are therefore used in commercial and industrial applications where fuel cost savings provide a competitive advantage, including for the transportation of goods. Unlike in Europe, diesel fuel is not widely used in passenger cars in the United States due to a combination of customer preference and stringent passenger car emission standards.

Table I-1 shows the contribution of diesel vehicles and equipment to the California PM emission inventory. Most of the diesel PM emissions are from mobile sources. Other non-diesel PM emissions are mostly due to area-wide sources such as road and construction dust and stationary sources such as natural gas power plants. As seen in Table I-2, Diesel PM only account for 2% of all PM emissions. In contrast, diesel engines are responsible for over 50% of all NOx emissions. The discrepancy between proportion of NOx and PM from diesel sources occurs because NOx is primarily produced by combustion sources (of which diesel fuel accounts for a large proportion) whereas PM can be produced by a number of very different sources, including non-fuel based sources such as road dust. Table I-3 shows the contribution of diesel vehicles and equipment to the California NOx emission inventory.

Table I-2 California PM Inventory by Source[26]

Source	PM Emission Source Type (tons/day)		Total	Diesel PM Percent of Total
	From Diesel Combustion	All Others		
Mobile Total	70	58	130	55%
On-road	*17*	*33*	*50*	*34%*
Off-road	*53*	*25*	*77*	*69%*
Stationary	4	200	200	2%
Area-wide	0	3,400	3,400	0%
Natural	0	100	100	0%
Total	73	3,700	3,800	2%

Table I-3 California NOx Inventory by Source[27]

Source	NOx Emission Source Type (tons/day)		Total	Diesel NOx Percent of Total
	Diesel	All Others		
Mobile	1,700	1,000	2,700	61%
On-road	*800*	*880*	*1,700*	*48%*
Off-road	*900*	*160*	*1,000*	*84%*
Stationary	56	460	500	11%
Area-wide	0	92	92	0%
Natural	0	21	21	0%
Total	1,700	1,600	3,300	52%

e. How is diesel pollution regulated?

The Clean Air Act confers the authority to the United States Environmental Protection Agency to set emission standards for diesel engines. In addition, the California Air Resources Board also has the authority to set emission standards for certain diesel engines purchased in California, as long as the California standards are at least as or more stringent than the federal standards. Local air quality agencies have authority over diesel engines in stationary applications that require an air quality permit in order to operate, such as large back-up generators.

US EPA set the first on-road diesel engine standard for new engines in the late 1980's. Figure I-3 illustrates how the particulate matter standard has evolved since the first regulated model year in 1988. California introduced the first California diesel PM standard a model year earlier in 1987. For the subsequent model years, the California and US EPA PM standards were the same. The standards are expressed in mass of pollutant diesel PM emitted (grams) per unit of fuel energy produced (horsepower-hour). By 2007, it is expected that new heavy-duty vehicles will emit 0.01 grams PM/bhp-hr of diesel PM, about 2% of the 1988 standard.

Figure I-4 shows the Federal and California NOx emission standards for diesel on-road engine emissions. ARB introduced the 6 grams NOx/bhp-hr standard three years earlier than US EPA. The 2007 standard is also 2% of the first heavy-duty diesel NOx standard.

Figure I-3 Federal PM On-Road Heavy-Duty Diesel Engine Standards by Model Year[28]

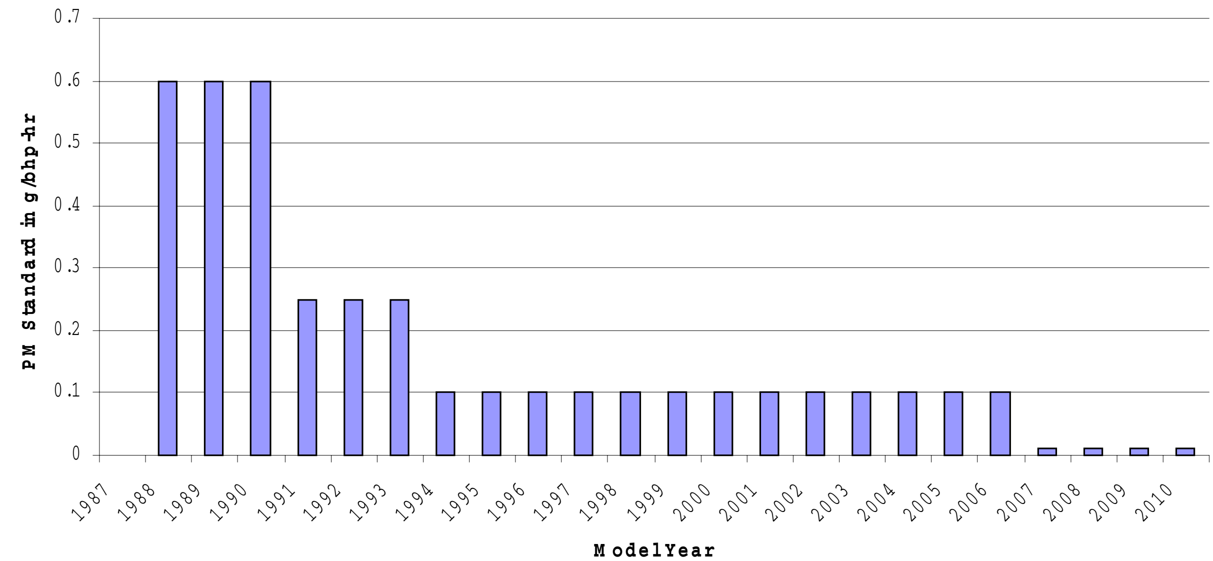
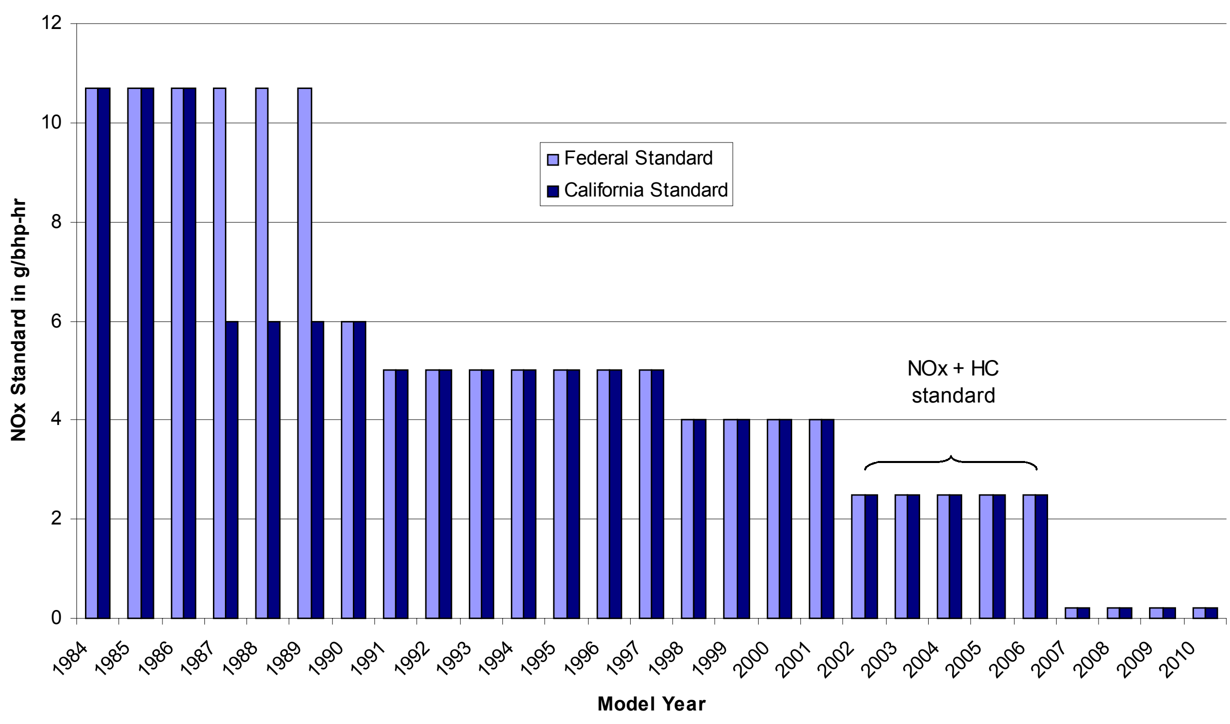
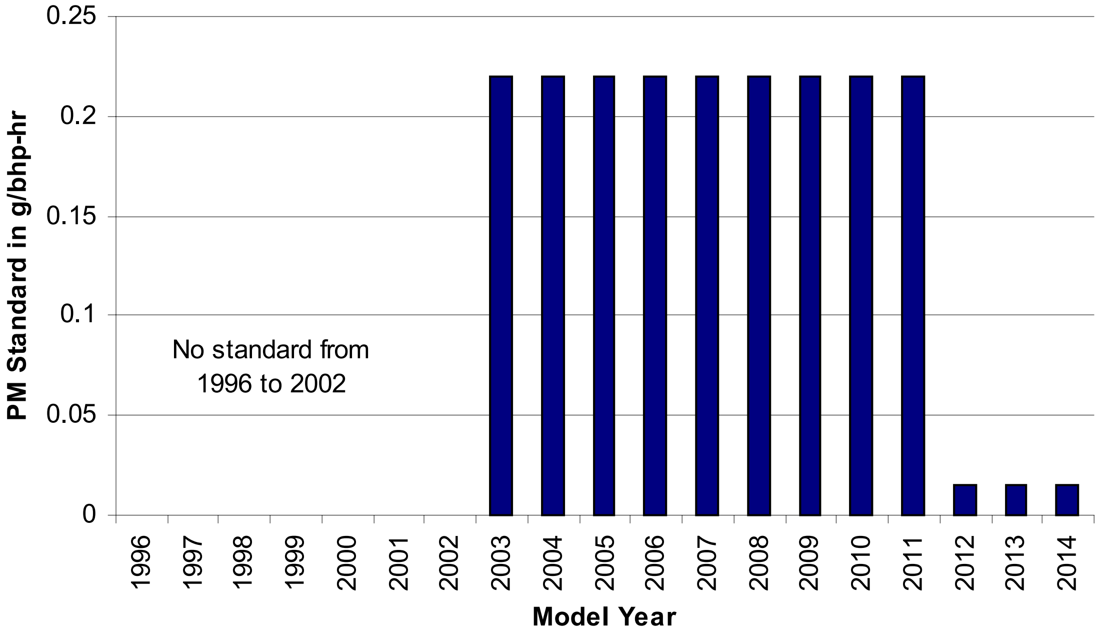


Figure I-4 Federal and California NOx On-Road Heavy-Duty Diesel Engine Standards by Model Year[29]



In 1996, off-road diesel engines had to comply for the first time with federal emissions standards. These standards varied by engine horsepower category. ARB has limited authority to set emission standards for off-road equipment. The state agency cannot establish emission standards for agricultural or construction equipment under 175 horsepower. Figure I-3 illustrates the federal emission PM standards for an off-road diesel engine between 100 and 175 horsepower. Even though the first standards were implemented in 1996, many engine sizes were not regulated until much later. The example engine used in Figure I-5 did not need to comply with emission standards until 2003.

Figure I-5 Federal PM Off-Road Diesel Engine Standards for a 100-175 HP Engine by Model Year[30]



Although the adoption of emission standards leads to a progressive improvement of the vehicle and equipment fleet emissions, these standards only apply to new vehicles and equipment in the year they are purchased. The extent to which emissions standards are an effective emissions reduction measure is directly related to how long vehicles and equipment are used. Diesel engines are especially long lived. For example, ARB estimates the average life of a diesel engine in an on-road application is 15 years and can be up to 30 years in some off-road applications. [31] There are therefore still a large number of unregulated vehicles and equipment operating today. The full benefits of emission standards are incurred only after the older and dirtier vehicles are removed from service.

Emissions from older vehicles and equipment are regulated through inspection and maintenance programs such as the Heavy Duty Vehicle Inspection Program launched in 1998 by ARB. Owners of heavy-duty vehicles and buses must annually inspect their vehicle's exhaust for excessive smoke and make appropriate repairs. Vehicles can also be randomly inspected by ARB at weight stations, on roadsides, and at the fleet facility at any time. This inspection and maintenance program does not apply to off-road equipment.

Federal, state and local agencies also fund voluntary programs that provide incentives for the reduction of diesel pollution from mobile sources. Voluntary programs are open to all vehicle and equipment that meet program requirements as determined through an application process.

One of these programs, ARB's Carl Moyer Program, has provided incentives to fleet and equipment owners to purchase alternative fuel vehicles and repower engines in existing equipment. This program has funded about 146 tons/year of diesel PM reductions after 3 years of implementation from 1998 to 2001.[32]

In addressing diesel PM, California has gone further than most states and the US EPA by implementing a Diesel Risk Reduction Program. The program led by ARB is expected to reduce diesel PM emissions by 75% in 2010.[33] The first Air Toxic Control Measure (ATCM) to be implemented was the transit bus fleet rule in 2000. The rule was followed by control measures for school bus idling, waste collection trucks, stationary and portable engines, as well as transportation refrigeration units. Unlike voluntary programs, the ATCMs are mandatory and all vehicle and equipment covered in the regulation must comply with the emission reductions prescribed by the measure.

f. Summary and Conclusion

Diesel exhaust in general, and diesel PM in particular, were not regulated in the United States until the late 1980's, much later than most major pollution sources such as gasoline engines and stationary sources. This has resulted in a fleet composed of a large fraction of unregulated diesel engines. Scientific research in the last decade has shown the significant role of diesel exhaust and diesel PM in the overall exposure to toxic air pollutants in this country. Moreover, those most sensitive to diesel exhaust exposure are those most likely not to have the resources or power to prevent or alleviate the health effects.

Most of the current regulatory efforts at the federal and state level focus on reducing emissions from new equipment. New engine emission standards are positive steps towards reducing exposure to diesel PM in the long term, however they do not address emissions from vehicles already in use. Although the California Air Resources Board has committed to implement significant reductions of diesel PM emissions from in-use vehicles and equipment by 2010, the control measures are dependent on technological advances such as the availability of diesel particulate matter filters and new lower emitting engine replacements for a wide variety of engines types. Furthermore, the ARB rulemaking process has focused to date on source categories such as transit buses, waste collection vehicles, and stationary engines that only account for a small portion of the state's diesel PM inventory. Finally, ARB's strategies are implemented on a statewide basis and do not directly target sources operating in the communities that are most impacted by diesel pollution, thus fail to address hotspots of diesel pollution in a more integrated fashion.. The communities most affected by diesel PM pollution may not necessarily benefit the most from ARB's adopted and future measures. Thus, it is important for these communities to understand the characteristics of diesel PM pollution on a regional and local level. From this basis, it is possible to develop strategies and advocate for solutions that take into account local social and economic factors. The following section provides an overview of this study's regional focus, West Contra Costa County.

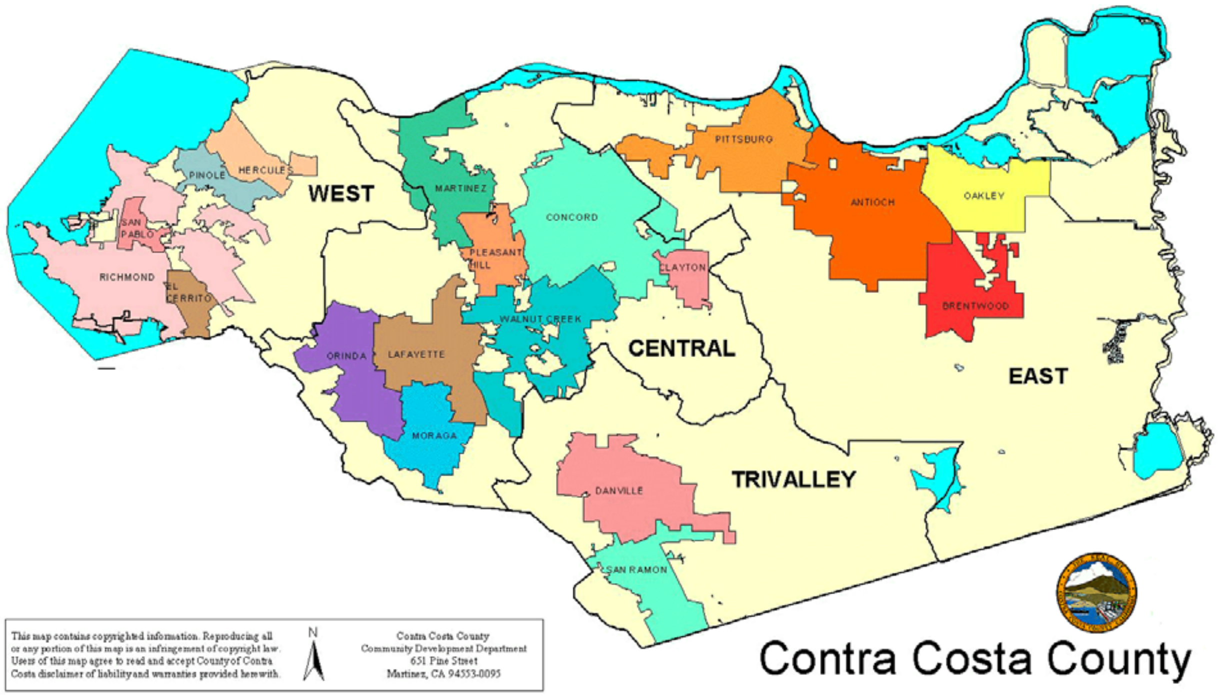
B. WEST CONTRA COSTA COUNTY AND THE STUDY AREA

a. Study Area Geography

West Contra Costa (WCC) consists of 5 cities (Richmond, El Cerrito, San Pablo, Pinole and Hercules) as well as the unincorporated portions of the western half of Contra Costa County including North Richmond. Figure I-6 shows where Contra Costa County is situated in the San Francisco Bay Area. WCC is a geographic subdivision with an administrative function. It defines the jurisdiction of a school district, a transportation planning agency, and a waste management agency. Figure I-7 illustrates the subdivisions of Contra Costa County including West Contra Costa County. WCC has developed its own regional identity apart from the rest of Contra Costa County because of its industrial economic base and its racially and socially diverse population. The region has been shaped by successive waves of migration against the backdrop of great changes in the local economy from the rise and fall of World War II shipyards to today's sprawling petro-chemical complexes. WCC has long been considered an environmental justice area because of the prevalence of industrial sources of pollution in proximity to low-income communities of color.

Figure I-6 Contra Costa County in the San Francisco Bay Area[34]

Figure I-7 Map of Contra Costa County[35]



The area identified for this study includes the communities that have traditionally been most affected by toxic pollution in the region, as decided by the Community Health Initiative and the West Contra Costa Asthma and Diesel Committee. The study area includes the communities of Iron Triangle, San Pablo, North Richmond, and Parchester Village, which are all part of the service area of the North Richmond Center for Health. The study area is thus defined as the portion of West Contra Costa County most closely abutting the San Francisco Bay, and mostly bounded by 23rd Street, including the part of the city of San Pablo east of 23rd Street and a northern census tract (3650.01) containing the Hilltop Shopping Center. San Pablo is an incorporated city. Iron Triangle and Parchester Village are part of the City of Richmond whereas North Richmond is an unincorporated part of Contra Costa County. Figure I-8 is a map highlighting the census tracts that form the study area.

Figure I-8 Map of the Study Area[a] [36]

[a] Study Area Census 2000 Tracts: 3650.01, 3650.02, 3660.01, 3660,02, 3680, 3690.01, 3730, 3750, 3760, 37,80, 3790, 3800

The study area is framed by two major highway, Interstate 580 and 80 and traversed by a major thoroughfare, the Richmond Parkway. In addition railroad tracks operated by Burlington Northern Santa Fe, Union Pacific, and the Richmond Pacific Railroad run through the study area. The Burlington Northern Santa Fe Railway also operates a rail yard in the study area. Petrochemical and other industrial complexes dot the region's coastline, many of them near the Port of Richmond located on Richmond Harbor.

b. Study Area Demographic and Economic Characteristics

Table I-4 provides the population in the study area and other larger geographic divisions within which the study area is contained based on the 2000 Census data. The Study Area is significantly more racially diverse than the rest of the county and the entire San Francisco Bay Area Air Basin, with 85% of its population composed of people of color.

Table I-4 Population by Race by Geographic Boundary [37]

	Study Area		West Contra Costa County		Contra Costa County		San Francisco Bay Area Air Basin	
American Indian and Alaska Native alone	300	0.4%	900	0.4%	4,000	0.4%	24,000	0.4%
Asian alone	8,000	11%	38,000	16%	102,000	11%	1,300,000	19%
Black or African American alone	23,000	31%	54,000	23%	87,000	9%	480,000	7%
Hispanic or Latino	29,000	39%	55,0000	24%	170,000	18%	1,300,000	19%
Native Hawaiian and Other Pacific Islander alone	400	0.5%	1,000	0.4%	3,000	0.3%	33,000	0.5%
White alone	11,,000	15%	74,000	32%	550,000	58%	3,300,000	50%
Some other race alone	300	0.4%	1.,000	0.4%	3,000	0.3%	18,000	0.3%
Population of two or more races:	2,000	3%	9,000	4%	33,000	3%	220,000	3%
Total:	74,000		230,000		950,000		6,600,000	
Percentage of People of color	85%		68%		42%		50%	

Table I-5 shows the percentage of households that are linguistically isolated. A linguistically isolated household is one in which no household member older than 14 speaks English well according to the census definition. The census data shows that the proportion of linguistically isolated households in the study area is close to three times the proportion in the county as a whole. Table I-5 also shows that in the study area a larger percentage of Latino households in are linguistically isolated than in Contra Costa County in average.

Table I-5 Language Ability by Households[38]

Language Indicator	Study Area	Contra Costa County
Percentage of Linguistically Isolated Households	14%	5%
Percentage of Latino Linguistically Isolated Households	37%	21%

Figure I-9 illustrates the disparities in family income distribution between the study area and Contra Costa County. Over half the families living in the study area have an income below $35,000 whereas only a quarter of the families in Contra Costa County earn below this amount each year.

Figure I-9 1999 Family Income Distribution [39]

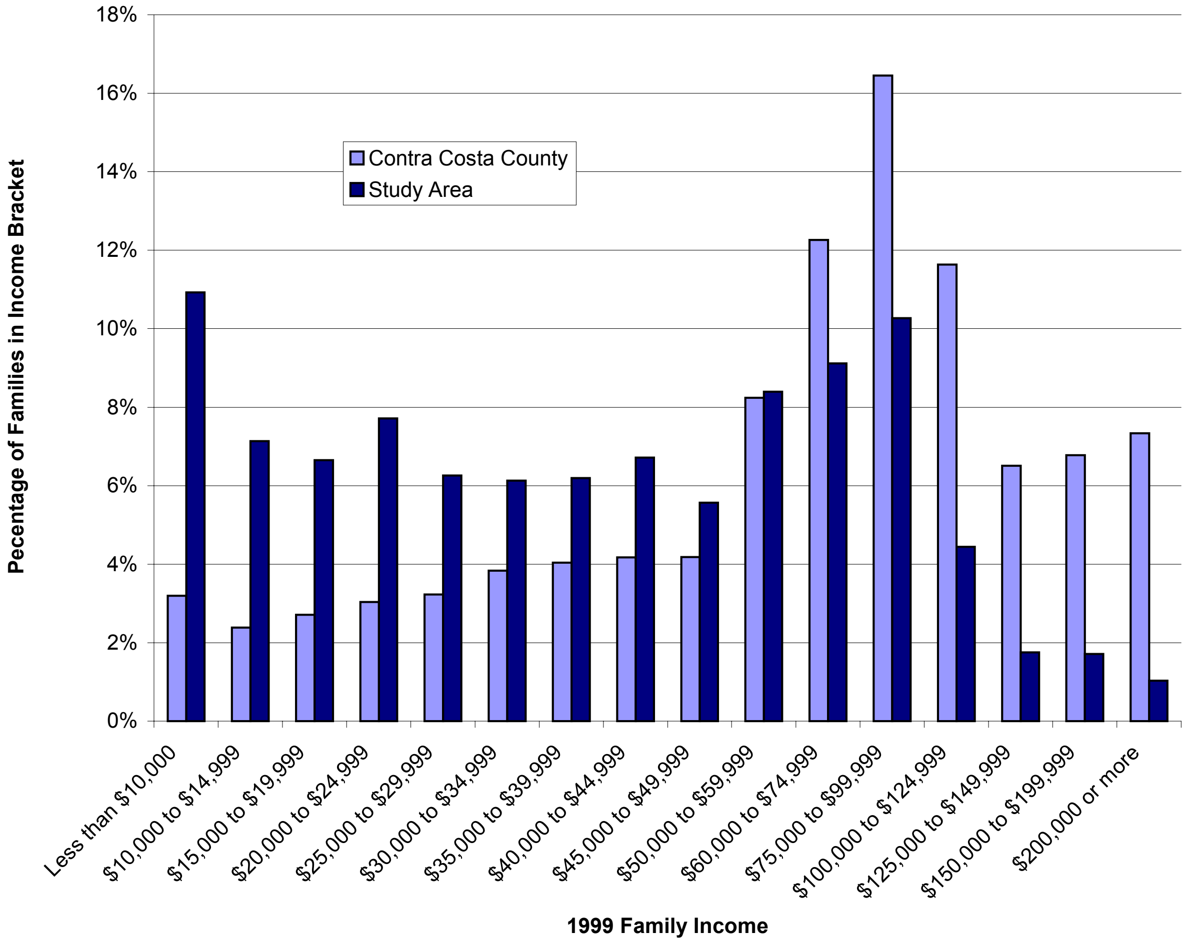


Table I-6 summarizes several economic indicators, which demonstrate the extent to which the average family in the study area is economically disadvantaged compared to the average family in Contra Costa County. The difference between the two geographic areas is provided in the last column.

Table I-6 Economic Indicators based on 1999 Income[40]

Economic Indicator	Study Area	Contra Costa County	Difference
Median 1999 Family Income	$38,500[a]	$73,000	-$34,500
Per Capita 1999 Income	$16,000[b]	$30,600	-$14,600
Percentage of Population with 1999 Incomes below Poverty Level	22%	8%	x 2.9

[a] Median of study area census tracts' median income

[b] Population weighted average of the income for each census tract

c. Study Area Health Statistics

The disparities between the study area and Contra Costa County extend to health issues. For example, the rate of asthma related hospitalizations of children 14 and younger in the study area is nearly twice the average rate for children in the county and the state of California. This disparity is illustrated in Figure I-10, which reports the age-adjusted rates of asthma hospitalizations among children for the three zip codes that cover the study area. Figures I-11 and I-12 show that the differences in asthma hospitalization rates extend to all age groups at the same magnitude. The asthma hospitalization rates are well above the state *Healthy People 2010* target rates.[41]

Figure I-10. Children Ages 0-14 Annual Age-Adjusted Asthma Hospitalization Rates (1998-2000) [42]

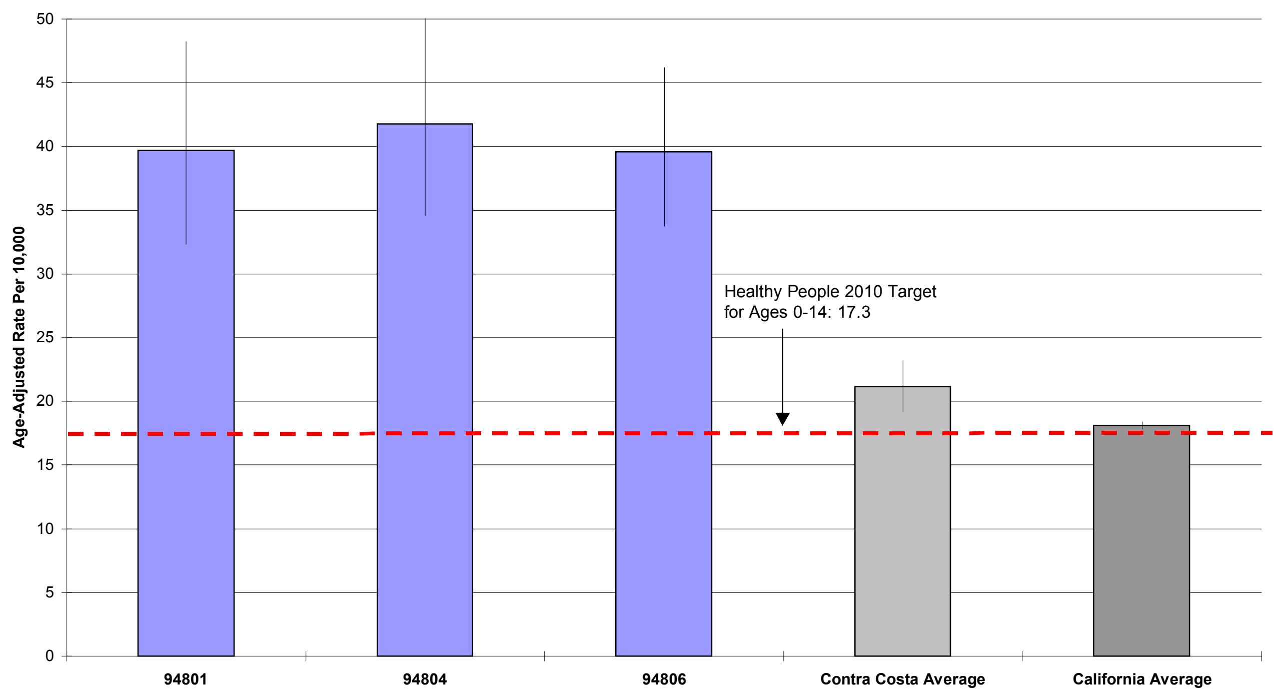


Figure I-11 All Ages Annual Age-Adjusted Asthma Hospitalization Rates (1998-2000)[43]

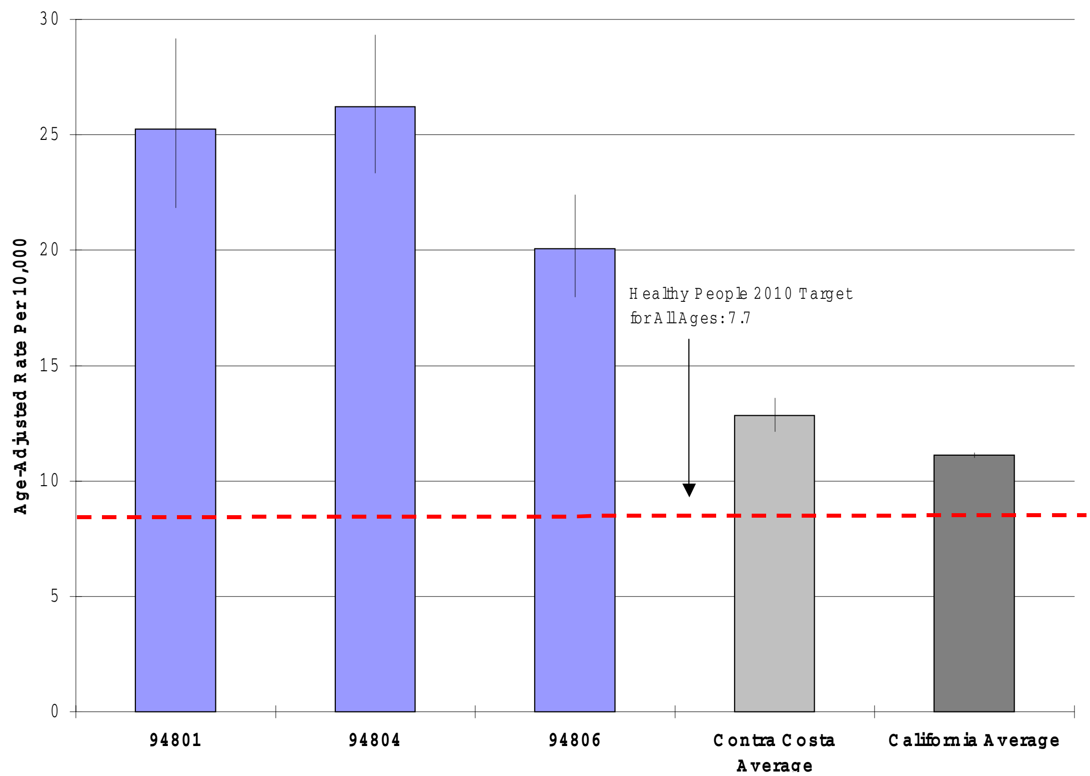
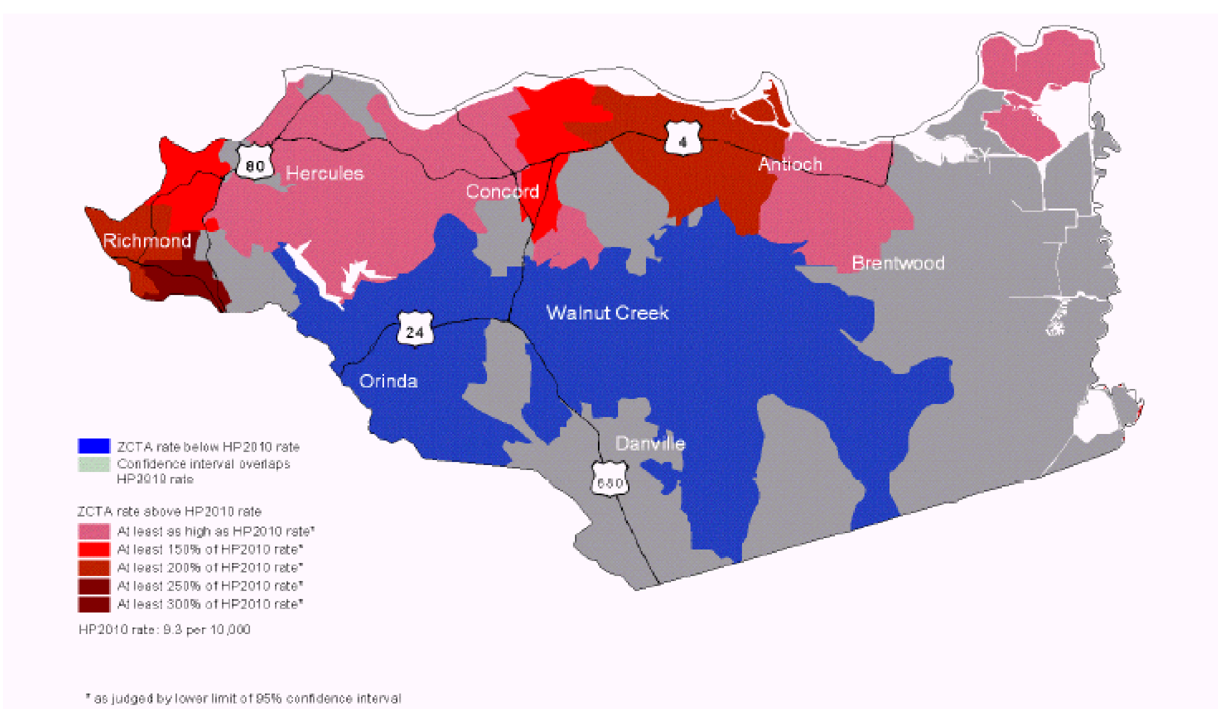


Figure I-12 Contra Costa County Asthma Hospitalization Rates for All Ages[44]



d. Conclusion

The study area is characterized by a significant number of major sources of diesel PM in a concentrated geographic area: two major highways (I-80 and I-580), a truck traffic thoroughfare (Richmond Parkway), an important bulk port, two rail yards serving several miles of train tracks, as well as diesel truck trip generators such as a refinery and other industrial complexes. The study area demographic and economic profile is markedly different than the Contra Costa County or the San Francisco Bay Area average. The study area's population consists mostly of low-income communities and people of color in a relatively more affluent and less racially diverse county. In addition, the asthma hospitalization rates indicate that the study area's population is more impacted by asthma than the rest of the county. Within this context it is important to better assess the extent to which diesel pollution is contributing to bad air quality and poor health outcomes in the region. The next section will examine ambient air PM concentration data in the study area collected by air quality agencies and determine its relevance towards understanding diesel PM pollution in the study area.

SECTION II: AIR QUALITY MONITORING

A. MONITORING PROGRAM DESCRIPTION

Both the California Air Resources Board (ARB) and regional air districts are required by law to monitor air quality for certain pollutants in their jurisdictions. The network of state and regional monitoring stations measure the concentrations of pollutants in outdoor air throughout the state. The measurements are analyzed to determine each region's status in meeting federal and state air quality standards. Air monitoring is especially important because over 90 percent of Californians breathe unhealthy levels of one or more air pollutants during some part of the year.[45]

Federal and state air quality standards exist for criteria pollutants. Criteria pollutants are pollutants for which an acceptable level of exposure has been determined on the basis of their effects on human health and the environment.[46] The criteria pollutants include ozone (O_3), respirable particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$), carbon monoxide (CO), nitrogen dioxide (N_2O), and sulfur dioxide (SO_2), and lead (Pb).

A number of California ambient air monitoring stations also measure the ambient concentrations of certain Toxic Air Contaminants (TACs), which are chemicals that have been found to cause serious health effects such as cancer, birth defects, nervous system damage, and death at very low levels of exposure.[47] As of December 1999 when it was last updated, the California TAC list included 244 chemicals.[48] Only a few of these pollutants such as acetaldehyde, benzene, and toluene are actively monitored at 36 out of the 277 monitoring stations.[49]

Monitoring station locations are determined through a process that takes into account factors such as regulatory requirements and logistical constraints. Federal regulation requires that the ambient air monitoring station network should include stations that can monitor the highest pollutant concentrations, others that monitor concentrations in densely populated areas, others that focus on the impact of major emission sources, and finally stations that provide measurements of the background pollutant levels.[50] Other factors that are taken into account are the available monitoring technology and programmatic concerns including budgets. Input from federal, state, and local agencies inform the final location of a station. While these general guidelines exist, there is no formal process by which ARB ensures that these numerous goals are being met through the siting of monitoring stations.[51] ARB annually updates the *California State and Local Air Monitoring Network Plan* describing the monitoring network and the data collected.

The following sections will examine the locations of monitoring stations in the study area described in Section I –B, the pollutants monitored at these stations, and the monitoring technologies used to measure PM concentrations.

a. Monitoring Station Locations in the Study Area

Figure II-1 is an overview of the network of 37 active monitoring stations in the San Francisco Bay Area. Figure II-2 focuses on the 10 stations in Contra Costa County that are part of the State and Local Air Monitoring System (SLAMS) Network. Three of these ten stations are in the study area.

Figure II-1. 2001-2003 California State and Local Air Monitoring System (SLAMS) San Francisco Bay Area Monitoring Sites[52]

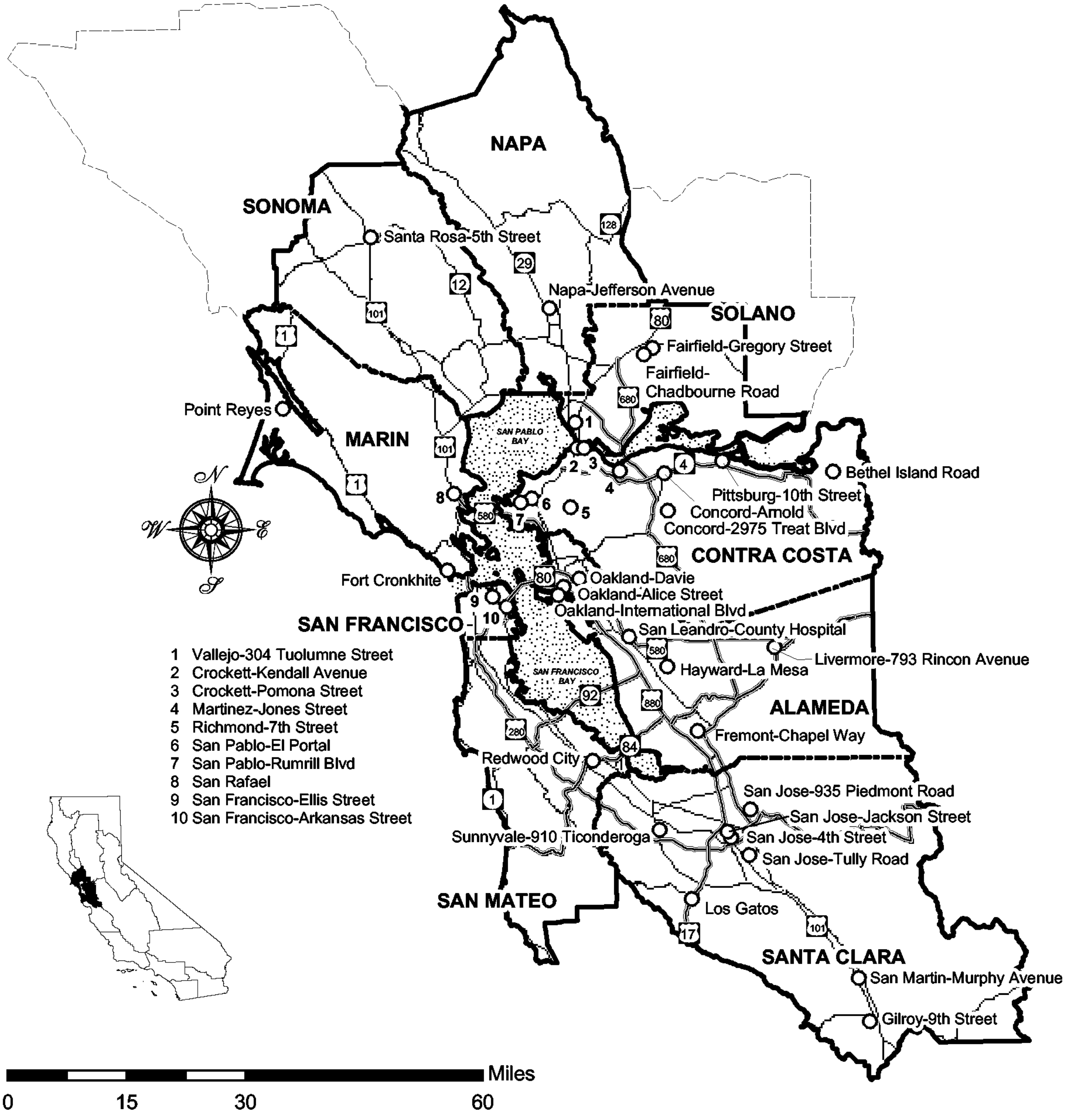
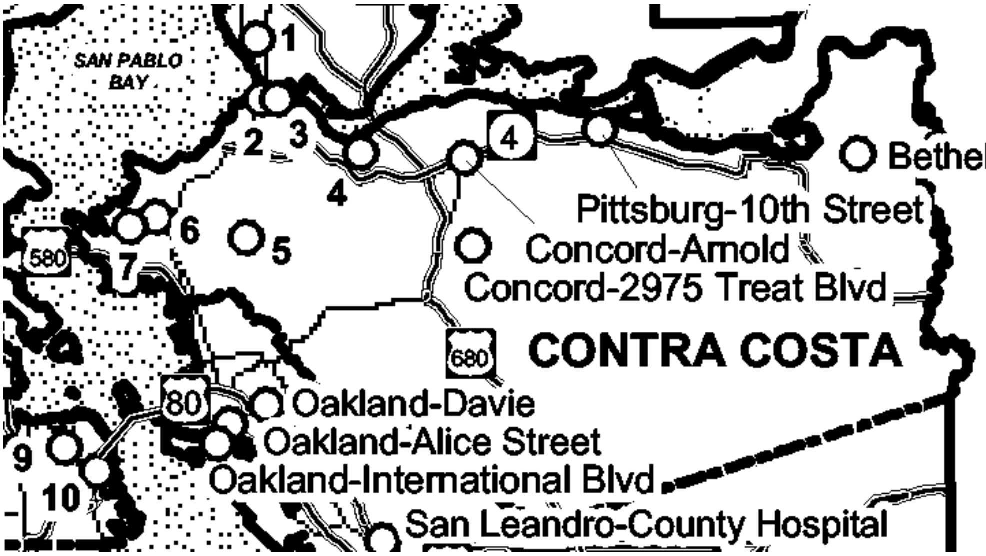


Figure II- 2. 2001-2003 Contra Costa Air Quality Monitoring System[53]



1. Vallejo (Solano County)
2. Crockett-Kendall Avenue
3. Crockett- Pomona Street
4. Martinez- Jones Street
5. Richmond- 7th Street
6. San Pablo- El Portal
7. San Pablo- Rumrill Boulevard

Two additional stations to the 10 in the SLAMS network are operated in Contra Costa County by BAAQMD and monitor hydrogen sulfide (H_2S). They are located in Rodeo on 3rd Street and in Point Richmond on West Richmond Avenue. At the spatial resolution offered by Figure II-2, the monitoring stations appear located along major transportation corridors such as Interstate 580 and in the vicinity of major stationary sources such as the refineries in Richmond and Martinez. As mentioned previously, three monitoring stations are located in the study area: on 7th Street in Richmond (5 on the map), on Rumrill Boulevard in San Pablo (7 on the map), and on El Portal in San Pablo (6 on the map). The following section provides additional information on the monitoring activities in the study area.

b. Pollutants Monitored in Study Area

In addition to the three SLAMS monitoring stations and the BAAQMD H_2S station, one more location has been used in the recent past to monitor ambient air quality in the study area. Table II-1 provides details about the current and past station locations in the study area including the pollutants monitored. Station locations are also presented on a map in Figure II-3. Out of the 5 sites, three are currently active.

Table II-1. Active and Inactive Monitoring Station Locations in the Study Area[54]

Monitor Location City (Street)	Monitoring Agency	Monitoring Period	Current Activity Status	Pollutants Monitored	Monitoring Height[55]
Richmond (1065, 7th Street)	BAAQMD	1980-present	Active	SO_2	11 meters (roof top)
Richmond (1144, 13th Street)	ARB/BAAQMD	1972-1997	Inactive	Ozone, CO, NO_2, SO_2, PM_{10}, Lead, Toxics	N/A
San Pablo (1865 Rumrill Boulevard)	BAAQMD	2002- present	Active	Ozone, CO, NO_2, SO_2, $PM_{10,}$ Toxics	N/A
San Pablo (El Portal Center, Unit 759)	ARB/BAAQMD	1997-2002	Inactive	Ozone, CO, NO_2, SO_2, PM10, Lead, Toxics	N/A
Point Richmond-Richmond	BAAQMD	N/A	Active	H_2S	N/A

Figure II-3. Active and Inactive Monitoring Locations in Study Area. The red symbols identify the inactive stations and the green the active station.[56]

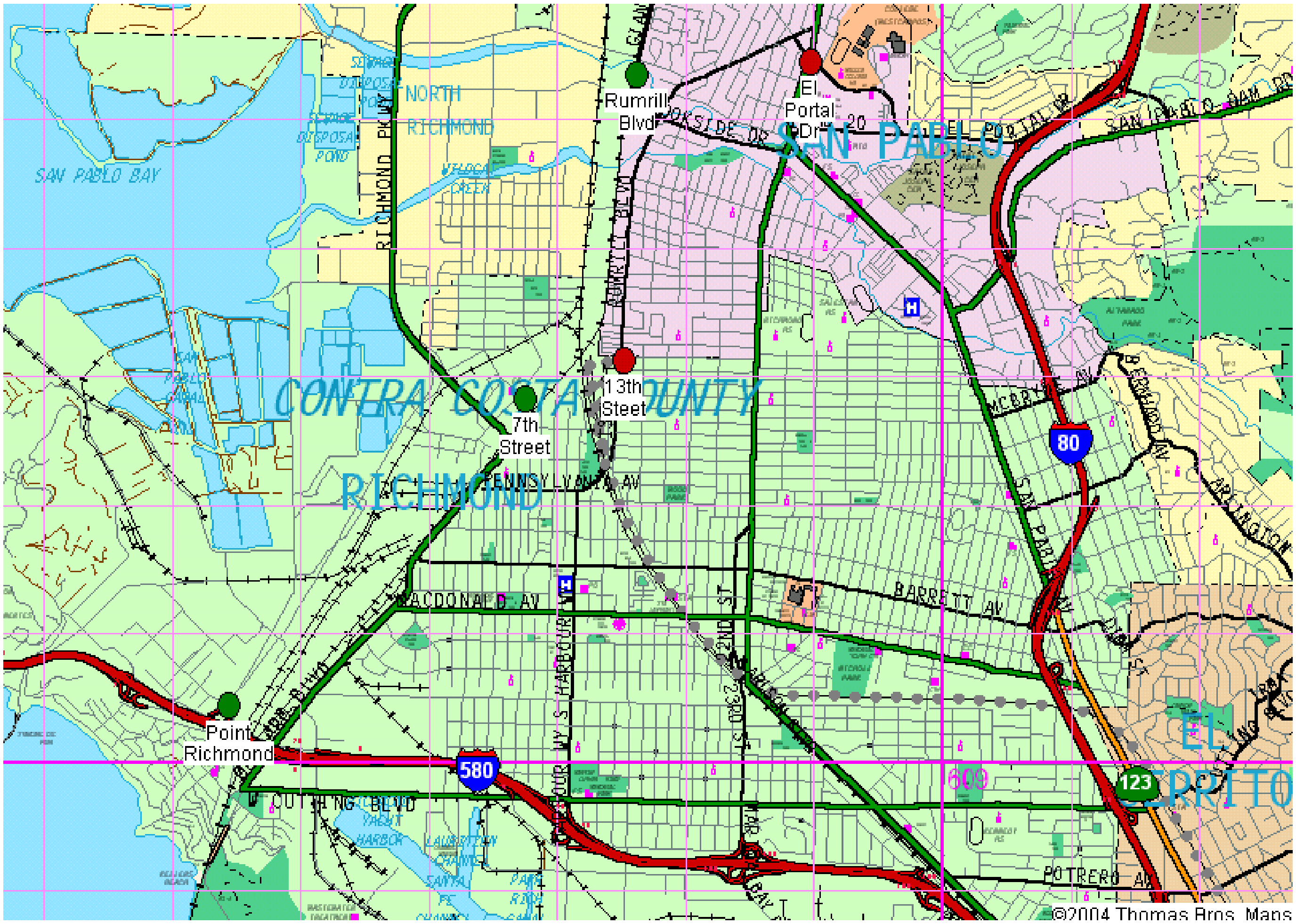


Figure II-4 Probe at the Richmond 7th Street Monitoring Station [57]

Only one currently active station monitors PM_{10} concentrations. $PM_{2.5}$ is not currently monitored in the study area and there are no plans to install monitoring in this area as part of the deployment of the new PM2.5 monitoring network.[58] The closest PM 2.5 monitors are located in Crockett on Pomona Avenue, Concord on Treat Boulevard, and in Oakland on International Boulevard.

c. PM Monitoring Technology

PM monitoring equipment is standardized and equipment-specific guidelines are developed by ARB's Monitoring and Laboratory Division. Two instrument types, the tapered element oscillating microbalance and the beta attenuation mass monitor, are used to measure concentrations of particles below a pre-selected size either 10 microns or 2.5 microns. Both measurement technologies use very sensitive instrumentation to measure concentration on the order of several $\mu g/m^3$. PM10 is sampled continuously over 24 hours every 6 days. PM2.5 is monitored both continuously year round and for 24 hours every 3 days depending on the site. Federal law requires monitoring of PM 2.5 composition including elemental analyses by X-Ray Fluorescence, ion analyses (nitrate, sulfate, ammonium, potassium, and sodium), and elemental / organic carbon composition analyses.[59] The first and second procedures occur in a laboratory using particulate matter accumulated on a filter. The third can occur at the sampling location using a continuous black carbon measurement technology such as an aethalometer.

d. How has the recently adopted PM 2.5 standard and diesel TAC determination affected the monitoring program?

ARB and the air districts began developing a PM2.5 monitoring network shortly after the US EPA issued the new standards in 1997. The agencies provide US EPA an annual report of their implementation efforts.[60] The PM2.5 24-hr sampling mass monitoring network, which assesses compliance to state and federal standards, is currently fully deployed with most of its stations operating since 1999. Continuous monitoring stations, which help understand the daily and episodic behavior of fine particles, are currently operating in Livermore, Oakland, Point Reyes, San Francisco, and San Jose. The only continuous speciation station in the BAAQMD is located in San Jose.

In 1998, ARB declared Diesel PM a toxic air contaminant, which triggered the development of a risk reduction plan to reduce Californian's exposure to diesel particulate matter.[61] The diesel risk reduction plan does not include any proposal to monitor ambient diesel PM. One of the constraints identified by ARB staff is the lack of field-tested technologies that can isolate diesel PM from particulate matter from other sources.[62] According to staff, the agency is sponsoring research activities to determine a diesel "fingerprint" that would enable its detection through speciated monitoring.[63]

B. RESULT SUMMARY

The following figures and tables summarize the available data for PM ambient concentrations in the study area. Figure II-5 charts the maximum 24-hour average concentration at the monitoring sites in the study area from 1989 to 2002.

As shown in Figure II-5, no data points are available for the years 1999 through 2001. For most of the years that data is available, the 24-hr maximum is higher than the state standard of 50 µg/m3. It is also important to note the significant difference between the 1997 maximums at the two monitoring stations in the study area. While the Richmond-13th Street measurement exceeds the state standard, the San Pablo-El Portal measurement is well below the standard. Looking at the map of monitoring station location in the study area (Figure II-3) the El Portal station location is not as close as the 13th Street station to important sources of PM. The El Portal station is not situated as close to the train tracks, the Port of Richmond, the Richmond Parkway, and Interstate 580 as the Richmond-13th Street monitor. The El Portal Station is however closer to Interstate 80 than the 13th Street station. The difference in location may explain the discrepancy in the 1997 measurements. Overall, the uncertainty surrounding the impact of the changes in monitoring locations added to the missing data over the 15-year record makes it difficult to conclusively establish a trend of PM10 maximum concentration in the study area.

Figure II-6 compares the maximum concentrations measured at the study area monitoring stations to the maximum concentrations in Contra Costa County and the San Francisco Bay Area Air Basin. The study area maximum 24-hr PM10 concentrations were the highest in the county two years, 1989 and 1997, of the eleven years data is available. In those same eleven years, the study area maximum values were never the basin maximum values. The county and basin maximum values are determined by assigning the value of the monitoring station with the highest recorded measurements in the geographic area of concern. In the last few years, San Jose in Santa Clara County, San Francisco in San Francisco County, and Napa in Napa County have shown some of the highest average annual measurements and some of the highest 24-hr maximum peaks.

Figure II-5: Maximum 24-Hour Average PM10 Concentration μg/m^3 by Monitoring Station and Year in Study Area[64]

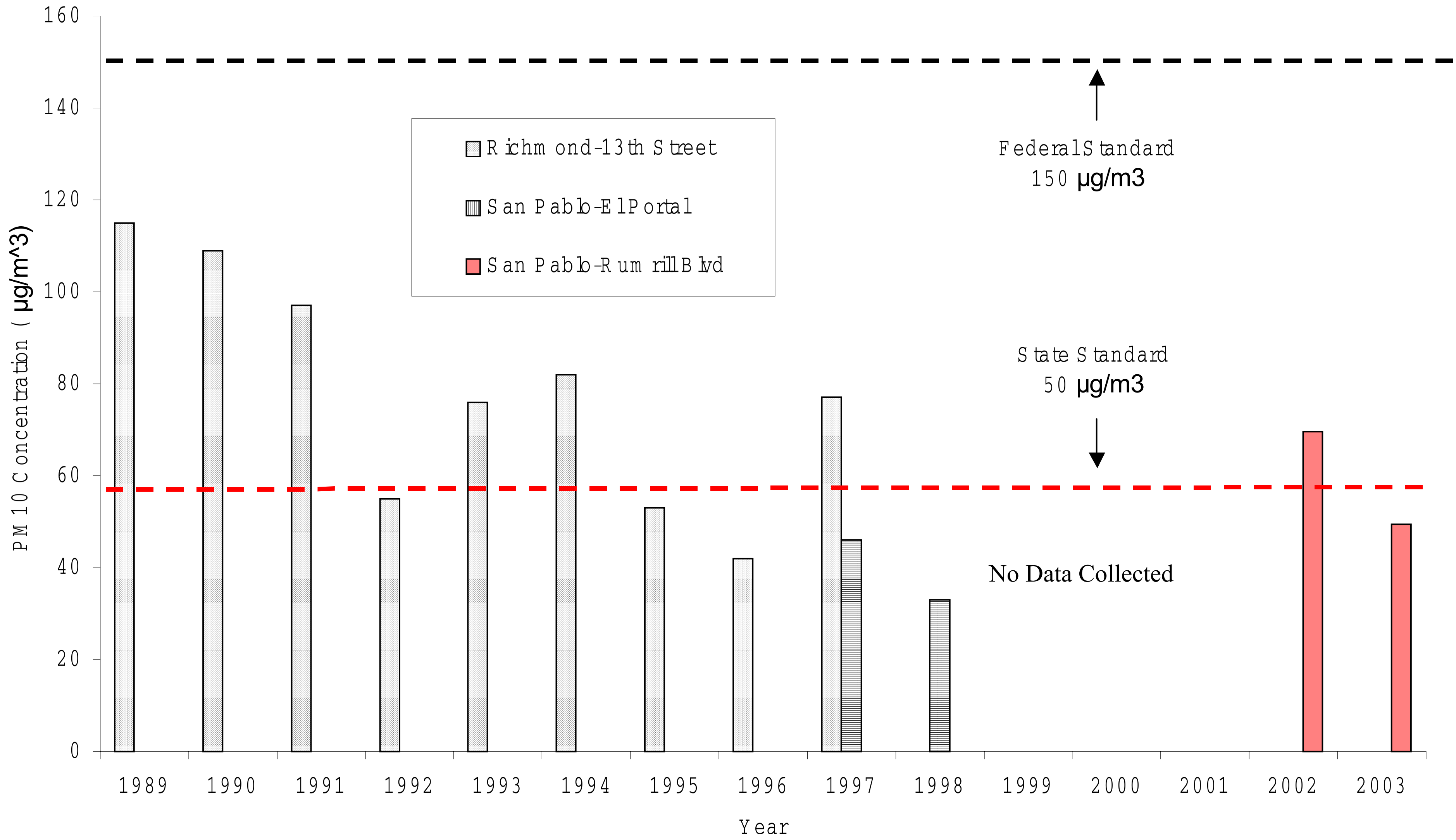


Figure II-6. Maximum 24-Hour Average PM10 Concentration in μg/m^3 by Monitoring Station and Year in Bay Area[65]

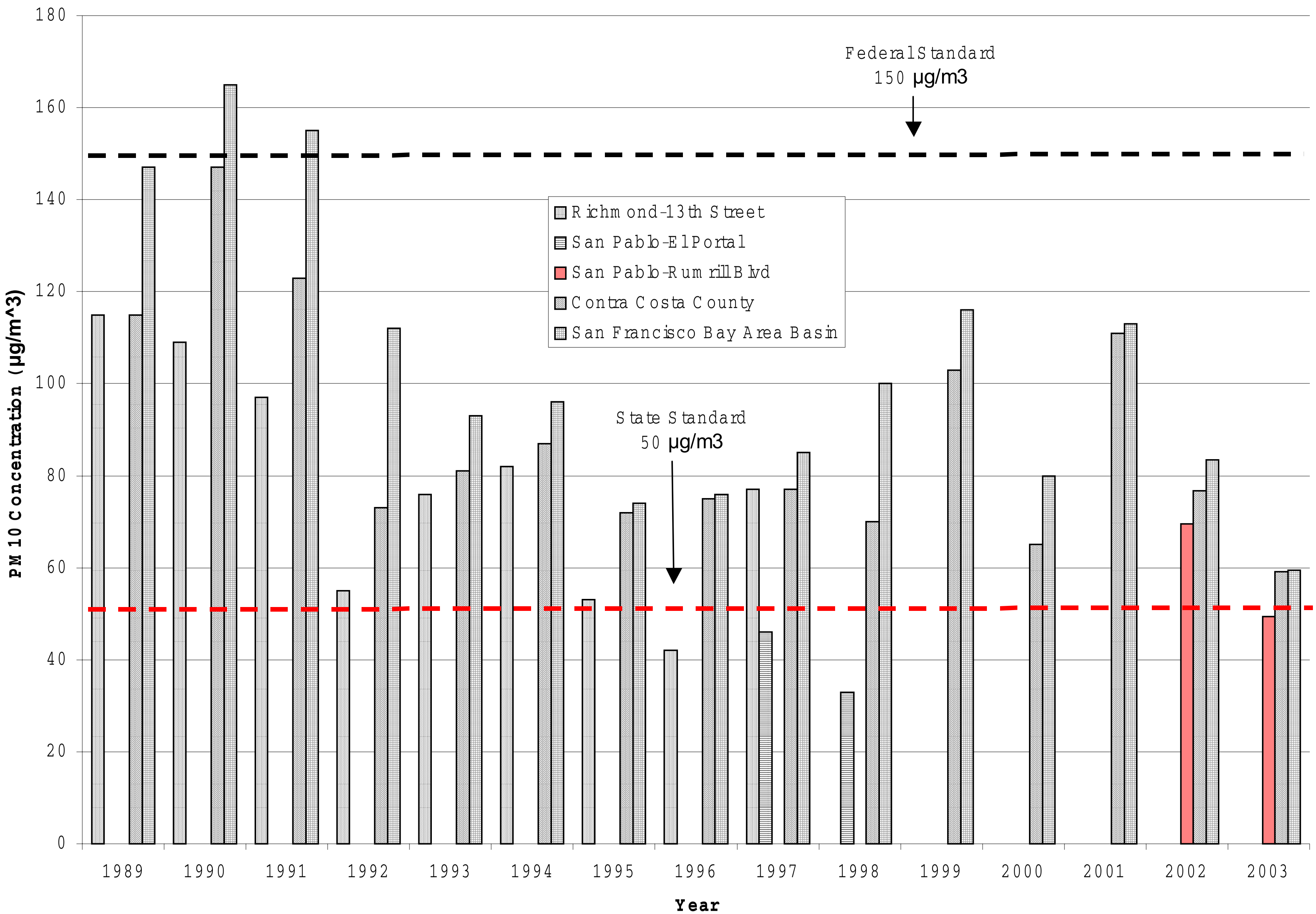
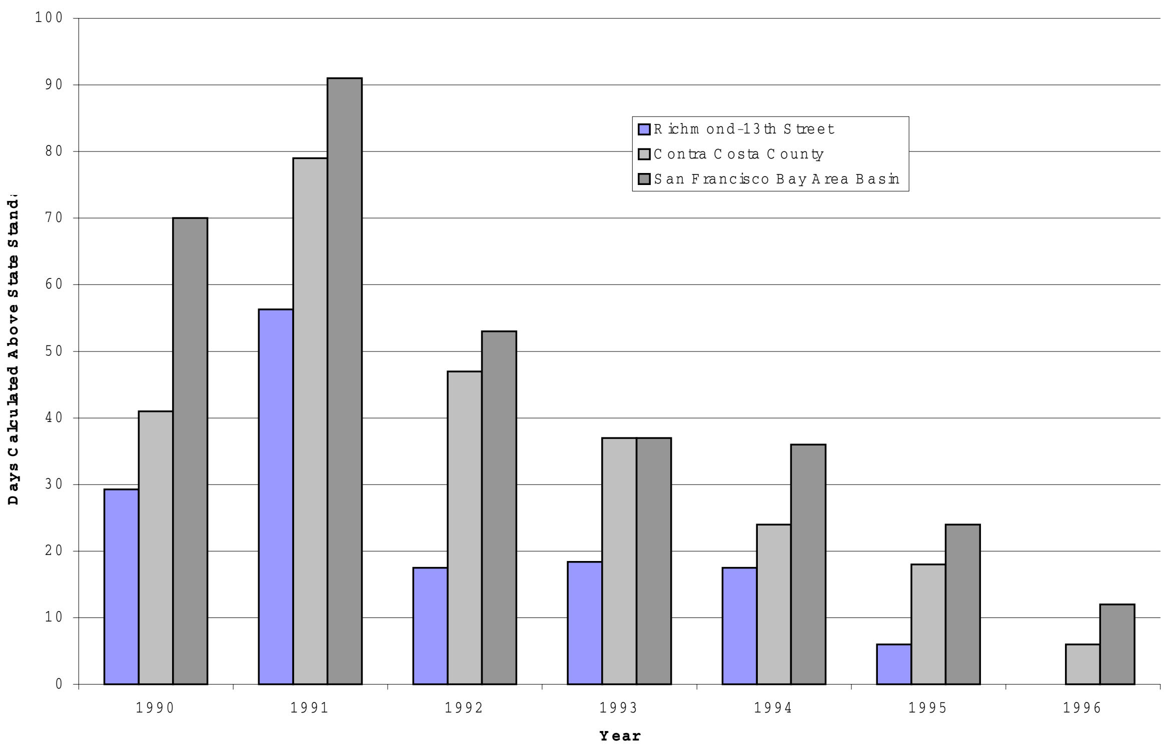


Figure II-7 is a chart of the calculated days above the California PM10 standard between 1990 and 1996 based on the Richmond-13th Street station records. The calculated days above standards are an estimate of the actual number of days residents are breathing air that is above the health-based standards. They are calculated using the measured concentrations and the meteorological conditions on the days between measurements. The calculated number of days of exceedances is therefore typically greater than the number of days for which exceedances are measured. In 1996, no exceedances were measured at the Richmond-13th Street station and therefore the estimate was zero days above the standard. Since 1996, no estimates of days above the standard have been made for the monitoring stations representing air quality in the study area. This is another large air quality data gap for the study area.

Figure II-7. Calculated Days Above State Standards in the Study Area, Contra Costa County and the San Francisco Bay Area Basin[66]



The county and basin data presented in Figure II-7 is not the sum of all the calculated days at each station in the region but the number of days calculated at the monitoring station that yielded the highest number of exceedances in the area. Because of the lack of data after 1996, it is difficult to make any conclusions about the trends or compare the total number of exceedances in the study area versus the county or basin as a whole.

C. DATA GAPS AND DISCUSSION

A significant number of data gaps were made evident in reviewing the data collected by ARB and BAAQMD to represent the status of the selected study area towards the attainment of the

PM10 standards. To date PM data collection efforts have been inconsistent. The measurements that were performed do not allow establishing a clear trend as to how the concentration of particulate matter the study area population is exposed is changing over time. Finally, agencies plans for future monitoring in the study area do not include the improvements in PM pollution data collection efforts that are being deployed elsewhere in the state such as PM2.5 and diesel PM monitoring.

The inconsistency of the PM data collection effort is in part due to the years where either no monitoring was performed or no analysis of the data collected was performed to determine the calculated number of days above the state standard. The inconsistency is also in part due to the change of monitoring station location to a location that seemingly represents lower concentrations. This is especially problematic because the 1998 maximum value at San Pablo-El Portal is the lowest of all maximum measurements in the study area. The uncertainty around how representative the new monitoring station location is extends to the measurements performed at this location.

In addition to the lack of consistent PM10 data, neither ARB nor BAAQMD is monitoring PM2.5 and diesel PM in the study area. Considering the link between PM 2.5 and diesel PM to combustion sources as well as the significant presence of these combustion sources in the study area, it is not possible to accurately assess exposure to particulate matter in the study area without a good understanding of the PM2.5 and diesel PM concentrations in ambient air. Even though diesel PM monitoring methods are not fully proven in field applications, environmental justice areas such as the study area should be selected as test sites for monitoring technology development. The fact that PM2.5 and diesel PM monitoring stations are not slated to be installed in the near future in the study area is also a source of concern. This would mean that regional data would not take into account the effect of concentrated sources of combustion PM in the study area. This also means that regional decision-making about reducing PM2.5 regionally will not take into account the characteristics of fine particulate pollution in the study area. Finally, as the study area continues to be developed as a mix of closely located industrial, commercial, and residential uses, the impact of new sources of PM2.5 and diesel pollution will remain unmonitored.

SECTION III: EXISTING DIESEL EMISSION SOURCES STUDIES

In addition to its ambient pollutant concentration monitoring activities, the California Air Resources Board, in collaboration with local agencies, develops an annual inventory of the sources of air pollutants in the state and their corresponding emissions. The Contra Costa County emission inventory prepared by ARB is a useful starting point for this study's objective of understanding the sources of diesel PM in the study area and the resulting air quality burden on the study area residents. Figure III-1 through Figure III-5 and Tables III-1 and III-2 are summaries of the ARB emissions inventory for Contra Costa County in 2003.[67]

Figure III-1 is a breakdown of all PM10 emissions in the county according to major inventory categories. Stationary sources are fixed emissions sources such as factories and power plants. Mobile emission sources include all sources that can move either on their own or attached to a moving source. Mobile sources range from cars to tractor-trailers to lawnmowers and handheld gardening tools. Area-wide sources have emissions that are distributed over a large area, such as fireplaces, and construction, road, and agricultural dust. Figure III-2 provides the breakdown of PM2.5 emissions. Mobile and stationary sources make up a larger portion of the PM2.5 emissions as combustion generated PM tends to be smaller in size.

Figure III-1 Contra Costa County Total PM10 Emission by Major Inventory Category[68]

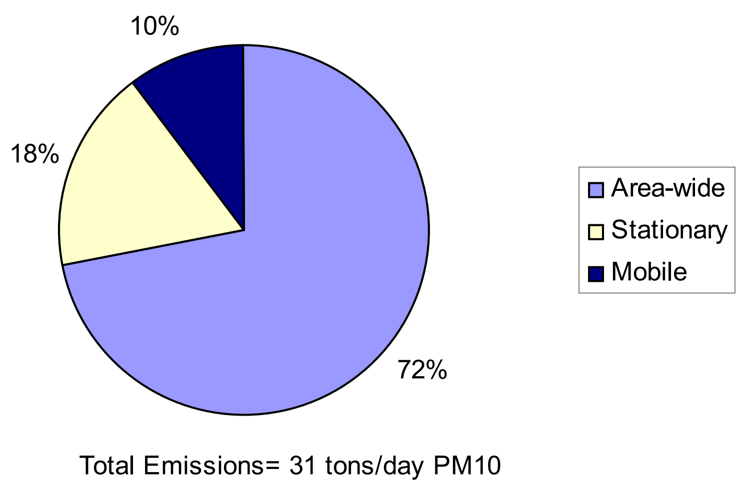


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Figure III-2 Contra Costa County Total PM2.5 Emissions by General Source Type[69]

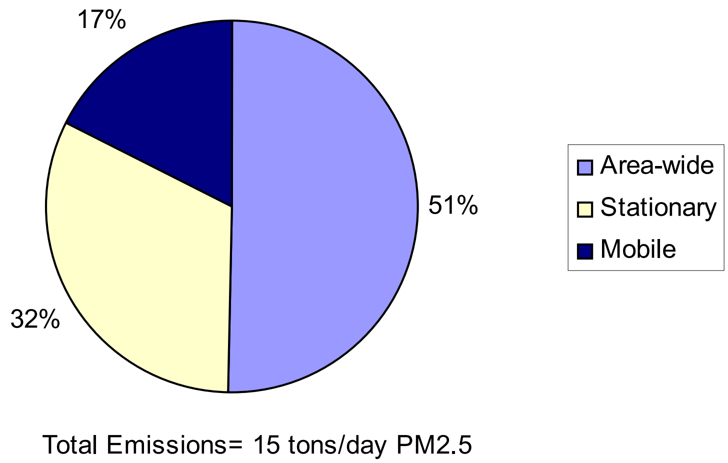


Figure III-3 and Table III-1 focus on the sources of particulate matter from diesel fuel combustion. The overwhelming majority of the diesel particulate matter is emitted from mobile sources. As shown in Table III-1, most of the diesel PM by mass is PM2.5 because diesel PM is mostly composed of particles smaller than 1 µm.

Figure III-3. Contra Costa County Diesel PM10 and PM2.5 by General Source Type. PM2.5 emissions represent over 90% of the PM10 emissions.[70]

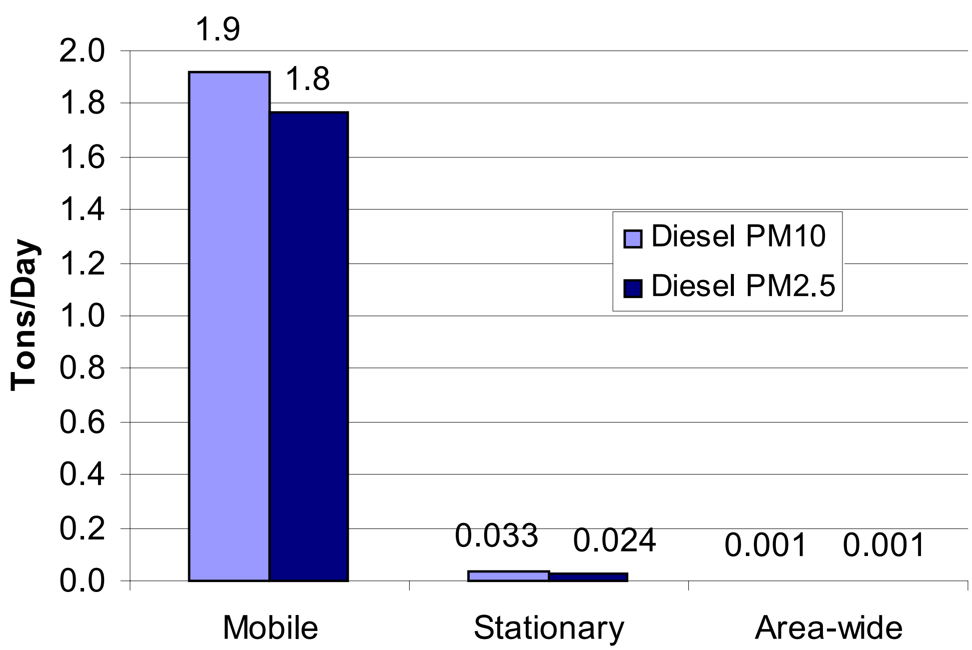


Table III-1. Contra Costa County Diesel PM by General Source Type[71]

Sources	Diesel PM10 (tons/day)	Diesel PM2.5 (tons/day)
Mobile	1.9	1.8
Stationary	0.03	0.02
Area-wide	0.001	0.001
Total	2	1.8

Mobile sources comprise very diverse groups of sources. Table III-2 presents the mobile source sub-categories and their relative contribution to diesel PM in Contra Costa County. The main contributors are off-road equipment, ships and commercial boats, heavy heavy-duty diesel trucks, and trains. Off-road equipment refers to mobile sources not requiring on-road registration. The off-road category specifically excludes ships, recreational boats, trains, and aircraft. Off-road equipment includes agricultural equipment and construction equipment. Heavy-duty vehicles are vehicles with a gross vehicle weight rating above 8,500 lbs. The gross vehicle weight rating is the weight of the vehicle and of its maximum passenger and cargo load. Heavy-duty vehicles are further classified as light 1, light 2, medium, and heavy according to their gross vehicle weight rating. For example, heavy heavy-duty vehicle refers to a vehicle with a gross vehicles weight rating greater than 33,000 lbs. Most container trucks would be considered heavy heavy-duty vehicles. The diesel PM10 results in Table III-2 are illustrated in Figure III-4. In Figure III-4, the heavy-duty vehicle categories are combined under the heading Heavy-Duty Diesel Trucks.

Table III-2. Contra Costa Mobile Source Diesel PM by Specific Sources[72]

Mobile Source Category	Diesel PM10 (tons/day)	Diesel PM2.5 (tons/day)
Off Road Equipment	1.1	1.1
Ships and Commercial Boats	0.2	0.2
Heavy Heavy-Duty Diesel Trucks	0.22	0.20
Trains	0.10	0.09
Medium Heavy-Duty Diesel Trucks	0.07	0.06
Farm Equipment	0.06	0.05
School Buses	0.04	0.04
Heavy Duty Diesel Urban Buses	0.02	0.017
Light Duty Passenger (Car)	0.01	0.010
Light Duty Trucks 1	0.01	0.006
Light Heavy Duty Truck 1	0.01	0.005
Light Heavy Duty Truck 2	0.01	0.005
Medium Duty Truck	0.004	0.004
Light Duty Truck 2	0.003	0.003
Motor Homes	0.002	0.002
Recreational Boats	0.002	0.002
Total	1.9	1.8

Figure III-4. Contra Costa Mobile Diesel PM10 by Specific Source Type (Total Emissions=1.9 tons/day)[73]

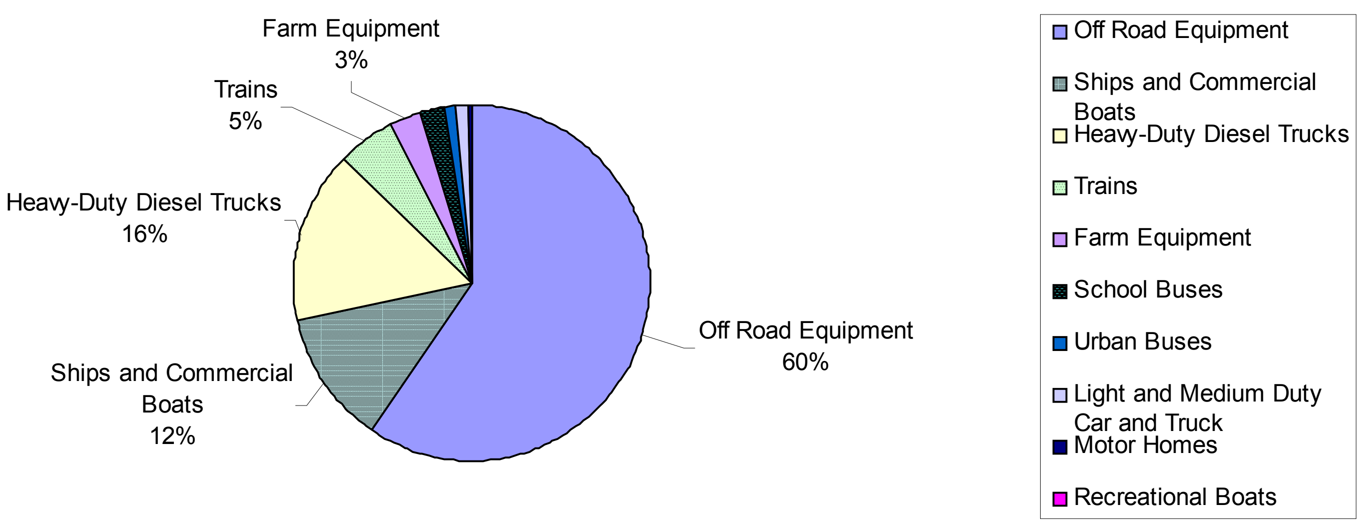
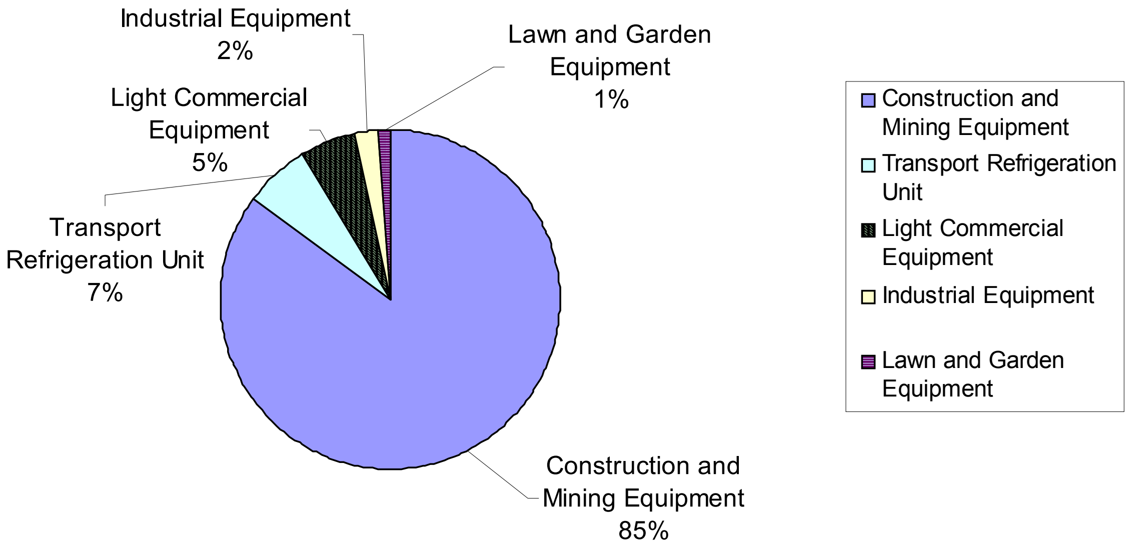


Figure III-5 provides details on the types of off-road equipment that contribute to diesel PM10 emissions in Contra Costa County. The "Construction and Mining" inventory category t represent 85% of the off road diesel PM10 emissions. In Contra Costa County, this category consists mainly of construction equipment.

Figure III-5. Contra Costa Off-Road Mobile Diesel PM10 by Specific Source Type (Total Emissions=1.1 tons/day)[74]



As a result of this analysis of sources of diesel PM in Contra Costa County, the estimate of sources in the study area focuses on the categories in the ARB county inventory that add up to the majority of diesel PM emissions in the county. These sources are heavy heavy-duty vehicles, ships and commercial vessels, trains, and construction equipment.

In order to estimate the contributions of these sources in the study area, existing studies that provide additional details on these sources in the geographic region of interest were reviewed. Following are summaries of the most relevant existing studies identified for this purpose. In some instances the studies provide evaluation of the sources' activities, in others of their air quality impacts. These studies help to provide a quantitative and qualitative basis for the study area inventory that follows in Section IV.

A. HEAVY HEAVY-DUTY VEHICLES

a. California Department of Transportation (Caltrans), Traffic and Vehicle Data Systems Unit. February 2004. *2002 Annual Average Daily Trucks Traffic on the California State Highway System*.

1. Study Purpose

Every year the California Department of Transportation (Caltrans) conducts traffic counts on about one sixth of a network of traffic counting locations along the routes of the State Highway System. During these traffic counts, Caltrans staff separately tracks truck traffic. The data collected during these annual counts helps the agency determine the State Highway System's operational characteristics and informs its infrastructure maintenance, planning and design activities.

2. Study Methods

Caltrans utilizes a combination of partial day, 24-hour, 7-day, and continuous sampling to determine annual average daily traffic counts. The agency defines trucks as vehicles of gross vehicle weight rating greater than 3,000 lbs with 2 or more total axles. This definition excludes pickup trucks and vans with only four tires and is roughly equivalent with ARB's heavy-duty truck definition. Each count location is identified by a post mile marker indicating its distance to the county line along the route.

3. Study Findings

The Caltrans report provides truck counts by number of axles. Heavy heavy-duty vehicles are best represented by the Caltrans 5 or more axle category shown in Figure III-6. The annual average daily truck traffic for these trucks in the vicinity of the study area is presented in the following tables (Table III-3 through III-7). The State Highways that frame the study area as shown in Section I are Route 80 and Route 123 on the East, and Route 580 on the South. North of the study area, Route 4 connects to Route 80. West of the study area, Route 101 junctions with Route 580. These freeway and the count locations are shown in Figure III-7.

Figure III-6 Typical 5-Axle Tractor-Trailer

Figure III-7. Location of Caltrans Truck Counts[75]

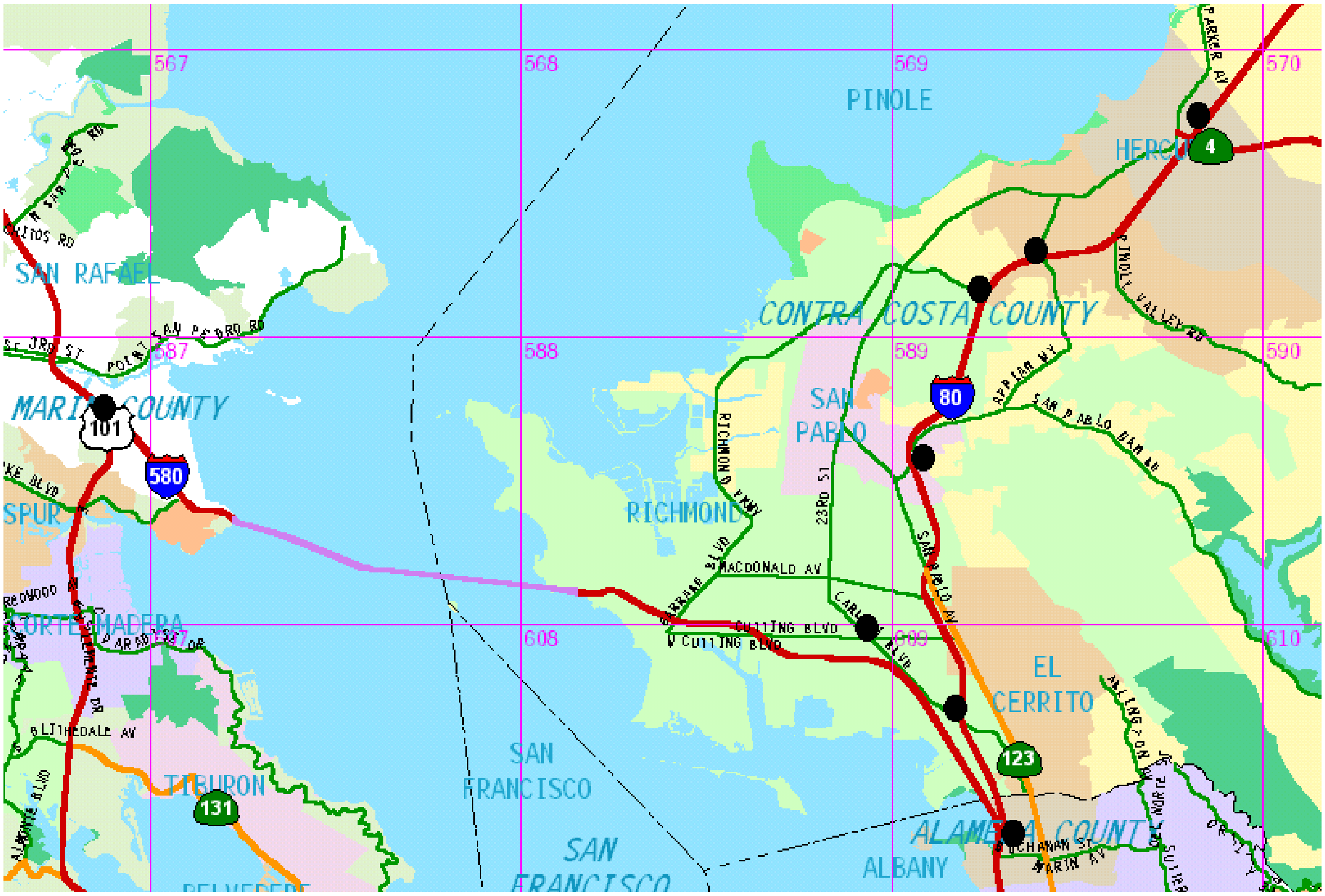


Table III-3. Annual Average Daily Traffic (AADT) on Route 4[76]

Location	All Trucks AADT	Truck AADT % of all Vehicles AADT	5+ Axle Truck AADT	5+ Axle Truck AADT % of all Trucks AADT
Junction 80 (After)	1962	6.23%	1005	51.22%

Table III-4. Annual Average Daily Traffic (AADT) on Route 80[77]

Location	All Trucks AADT	Truck AADT % of all Vehicles AADT	5+ Axle Truck AADT	5+ Axle Truck AADT % of all Trucks AADT
Junction 580 (Before)	11,655	4.50%	6,294	54.00%
Junction 580 (After)	8,010	4.50%	4,494	56.10%
Junction Route 123 South (Before)	5,664	3.20%	2,838	50.10%
Junction Route 123 South (After)	6,432	3.20%	3,358	52.20%
San Pablo Dam Road (Before)	6,415	3.24%	3,383	52.74%
San Pablo Dam Road (After)	7,064	3.28%	3,610	51.10%
Hilltop Drive (Before)	8,040	4%	4,020	50%
Appian Way (Both)	8,041	4.37%	4,731	58.84%
Junction Route 4 East (Before)	8,080	5.05%	4,509	55.81%
Junction Route 4 East (After)	6,420	5.35%	3,990	62.15%

Table III-5. Annual Average Daily Traffic (AADT) on Route 123[78]

Location	All Trucks AADT	Truck AADT % of all Vehicles AADT	5+ Axle Truck AADT	5+ Axle Truck AADT % of all Trucks AADT
Cutting Blvd	537	1.47%	39	7.25%
Junction 80 (Before)	314	0.98%	60	19.11%

Table III-6 Annual Average Daily Traffic (AADT) on Route 580[79]

Location	All Trucks AADT	Truck AADT % of all Vehicles AADT	5+ Axle Truck AADT	5+ Axle Truck AADT % of all Trucks AADT
Junction 80	6148	6.54%	2928	47.62%
Junction 101	4140	6.90%	1544	37.30%

Table III-7 Annual Average Daily Traffic (AADT) on Route 101 (Marin)[80]

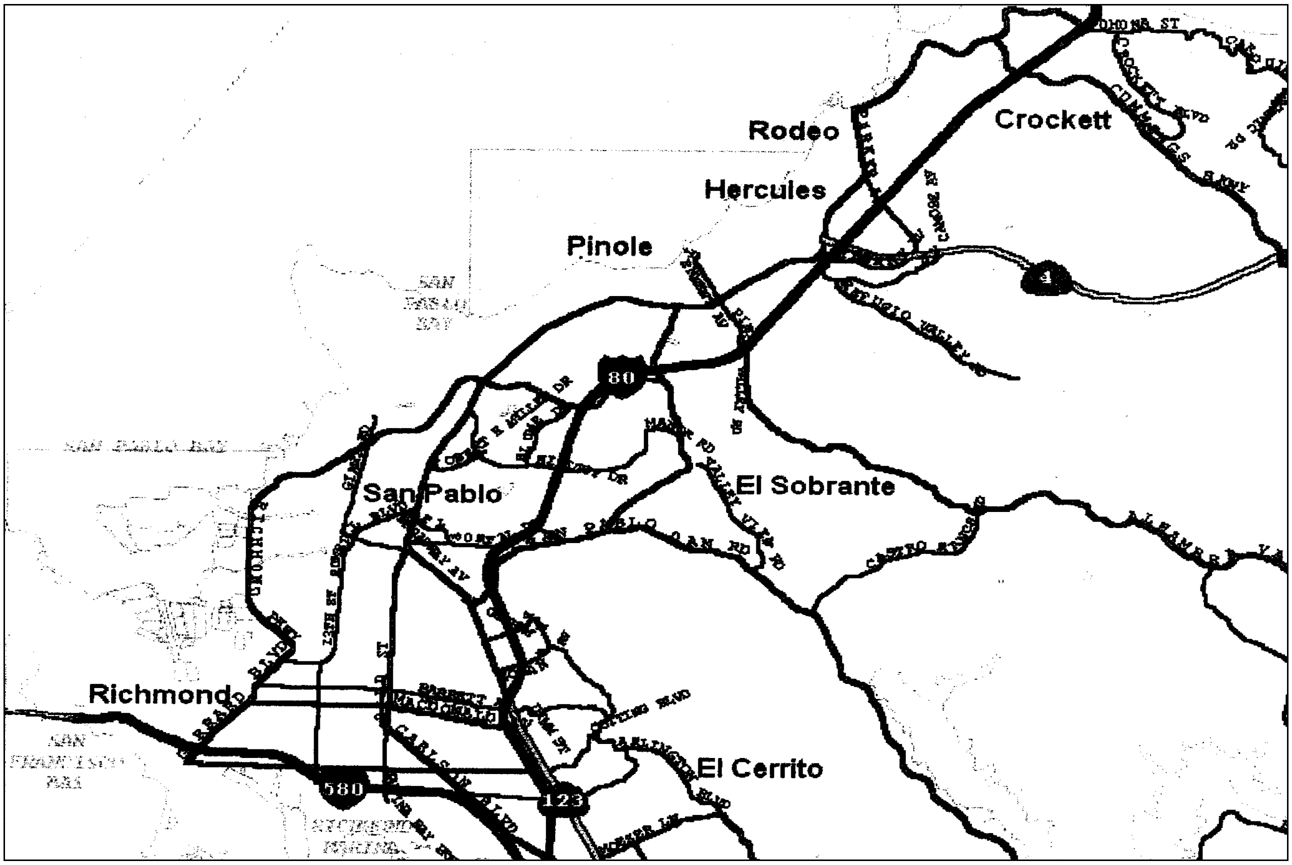
Location	All Trucks AADT	Truck AADT %	5+ Axle Truck AADT	5+ Axle Truck AADT %
Junction 80 (Before)	3711	1.54%	1060	28.57%
Junction 80 (After)	14828	1.70%	261	18.30%

b. Dowling Associates for the West Contra Costa County Transportation Advisory Committee (WCCTAC). December 2001. *Truck Route/Weight Limitation Survey for West Contra Costa County*.

1. Study Purpose

The truck route and weight limitation survey was commissioned by WCCTAC and the City of Richmond in order to inform decisions about regional truck traffic while addressing potential negative impacts on the communities where trucks circulate. The study area consists of all of West Contra Costa County as shown below (Figure III-8). The report's audience is not only the region's local governments but also truck operators and affected communities.

Figure III-8 WCCTAC Study Area[81]



2. Study Methods

Dowling Associates compiled existing information and performed a survey of truck related businesses in order to assess changes required to improve truck circulation in the region. They identified all designated truck routes and associated weight limits. The consultant surveyed 134 businesses identified as truck generators. The survey results provided an estimate of number of truck trips generated in the region and the spatial distribution of major truck generators as well as their access routes to the highways. Dowling Associates also summarized previous studies on truck counts in the region. They identified trucks routes that were close to sensitive land uses such as schools, bus lines, and bicycle paths. Finally, they identified the main infrastructure and operational issues needing resolution.

3. Study Findings

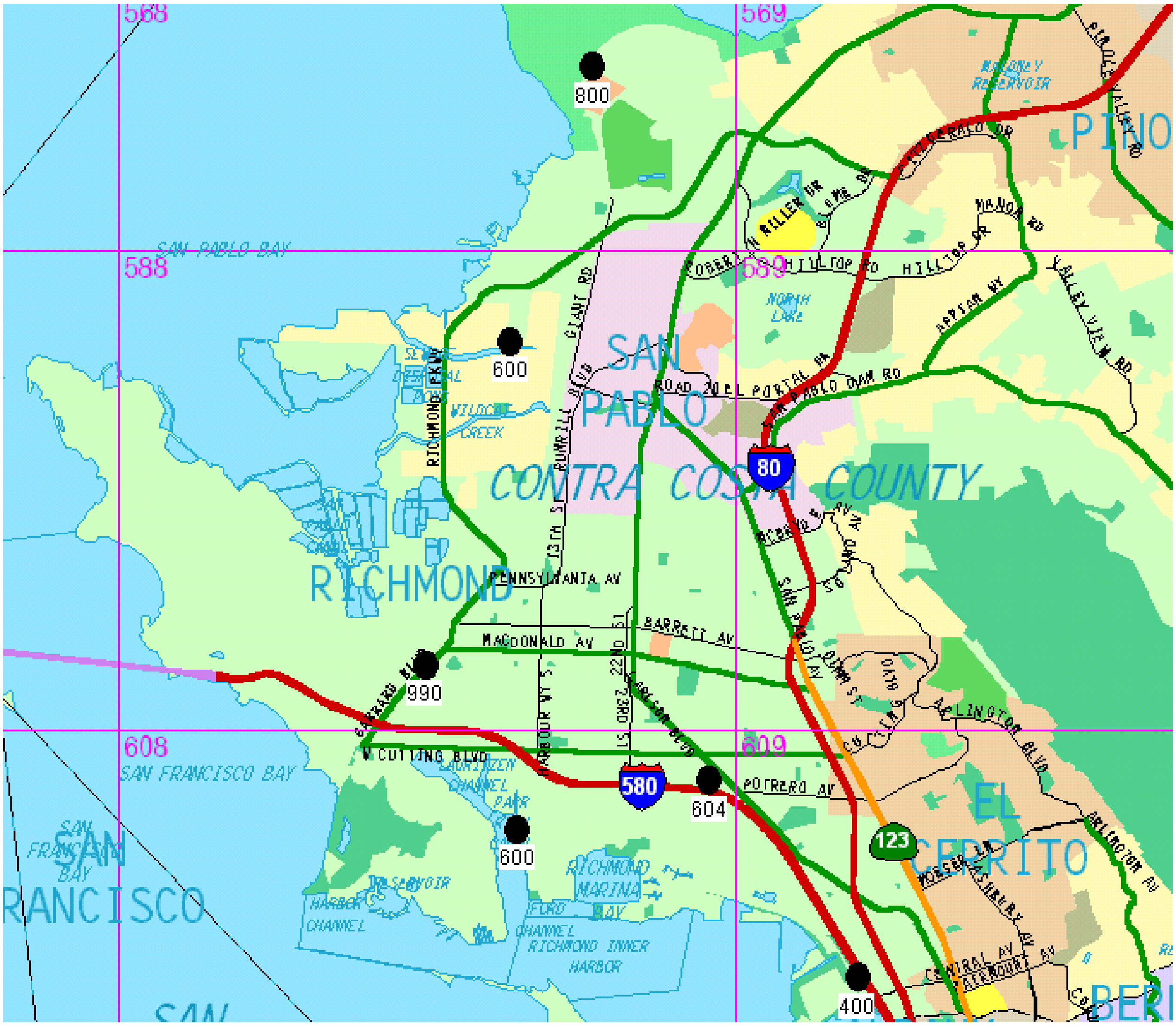
The major study findings are summarized in Table III-8 and Figure III-9. Table III-8 lists the number of daily truck trips by the route used to access the highway. Survey respondents accounted for over 90% of all truck trips in the West Contra Costa County region. The most common access routes to the highways are Richmond Parkway, South Garrard Boulevard, and Atlas road. Combined these routes account for a third of all trips.

Table III-8. Daily Truck Trips by Highway Access Route for Surveyed Truck Generators[82]

Street	Daily Truck Trips	Percentage of all Truck Trips
Richmond Parkway	2,772	18%
S Garrard Blvd.	1,094	7%
Atlas Rd.	1,040	7%
Parr Blvd.	936	6%
Harbour Way South	930	6%
Wright Ave.	890	6%
San Pablo Ave.	670	5%
Central Ave.	624	4%
Erlandson St.	612	4%
State Route 4	438	3%
Rydin Rd.	400	3%
Chevron Way	370	3%
Canal Blvd	344	2%
Appian Way	222	2%
Blume Dr.	220	2%
Loring Ave.	210	1%
Rolph Ave.	210	1%
Ponoma St.	210	1%
Franklin Canyon	184	1%
Protero Ave.	180	1%
Hensley St.	170	1%
W. Cutting Blvd.	170	1%
Regatta Blvd.	154	1%
Cutting Blvd.	144	1%
Hilltop Dr.	140	0.9%
Giant Rd.	120	0.8%
Garden Tract	100	0.7%
Marina Bay Parkway	100	0.7%
Total	**13,654**	**91%**

Figure III-9 maps the top 6 truck trip generators in the WCCTAC region. Each dot on the map marks the location of the truck trip generators identified in the survey as well the number of daily truck trips the facility generates. These truck trip generators are responsible for close to 60% of all truck trips generated in the WCCTAC jurisdiction. All these 6 truck trip generators are either located in the City of Richmond or in unincorporated North Richmond.

Figure III-9. Locations of Top 6 Truck Trip Generators in WCCTAC[83]



4. Study Recommendations

The report recommends additions to the truck route system in Richmond to improve access of major truck generators to Route 580. The report further recommends the use of traffic calming measures on routes near school sites. Truck hotspots identified by truck drivers were included in the recommendation. These hotspots focus on road geometry and conditions (flooding, potholes). Finally, the report suggests that local truck restrictions pertaining to cut-through trucks be clarified to truck trip generators located on restricted roads. The report also highlights the need for access to the Richmond Parkway from North Richmond without having to drive through residential areas, as is currently the case.

c. Fehr & Peers for the City of Richmond. July 2003. *Macdonald Avenue Existing Transportation Documentation*.

1. Study Purpose

The study summarizes information on Macdonald Avenue in Richmond collected by Fehr & Peers to inform the Macdonald Avenue Corridor Revitalization Study. The study describes the infrastructure (signals, crosswalks, transit stops, and parking) and the level of use by reporting daily traffic volumes. Also included in the study was an assessment of traffic accidents.

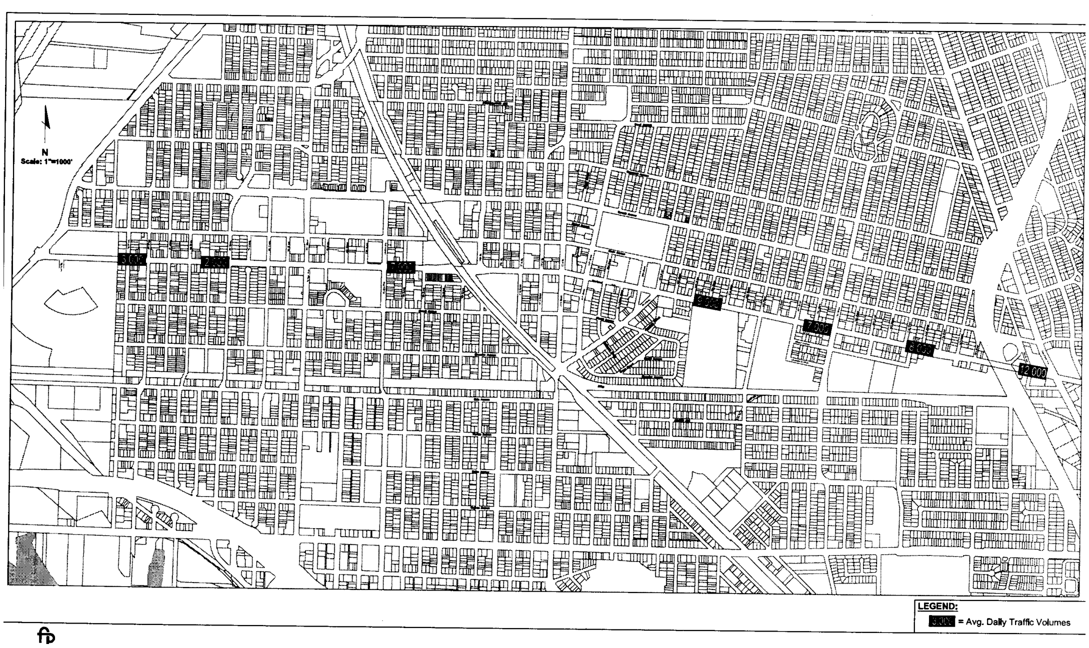
2. Study Methods

Traffic counts were performed at seven locations along Macdonald Avenue between Garrard Boulevard and San Pablo Avenue. No distinction was made between truck and passenger car traffic.

3. Study Findings

Figure III-10 shows the range in two-way average daily traffic. The highest traffic volume is found near San Pablo Avenue, which is also located near the Route 80 highway.

Figure III-10 Macdonald Avenue Annual Average Daily Traffic Count[84]



d. Environmental Impact Reports

The California Environmental Quality Act (CEQA) requires all public agencies to perform an environmental impact report for all projects that are expected to have significant impacts. The significance of the impacts is compared to the lead agency's specific threshold of significance. Thresholds of significance can project characteristics such as location or a quantitative limit such as an emission rate in tons per day. If a project's impact surpasses the threshold of significance, then mitigation measures are required.

Traffic impacts are often compared to the threshold of significance established by the local land-use planning agency such as city or county planning and community development departments. These agencies can, for example, determine a Level of Service (LOS) for an intersection below which mitigation measures must be adopted. The Level of Service is a letter grade rating from A to F used to qualitatively describe traffic flow at an intersection. The City of Richmond considers a traffic impact significant if there is a decrease of level of service from a LOS A, B or C to a LOS of E or F.

Air quality impacts of significance are determined by the jurisdiction's air quality agency. In the San Francisco Bay Area, the Bay Area Air Quality Management District (BAAQMD) is responsible for determining the level of emissions above which the project impacts must be mitigated. The agency does not require project proponents to quantify particulate matter construction emissions.[85] Instead, the district has identified a number of PM mitigation measures all new construction projects must implement based on their size. These PM mitigation measures focus on reducing dust from construction activities. This means that project proponents are not required to estimate or to mitigate emissions from construction equipment and vehicles. The BAAQMD thresholds of significance for a project's operation emissions are presented below in Table III-9.

Table III-9 BAAQMD Project Operation Emissions Threshold of Significance[86]

Pollutant	Threshold of Significance		
	Tons/year	Pounds/day	Kilogram/day
Reactive Organic Gases (ROG)	15	80	36
Oxides of Nitrogen (NOx)	15	80	36
Particulate Matter (PM10)	15	80	36

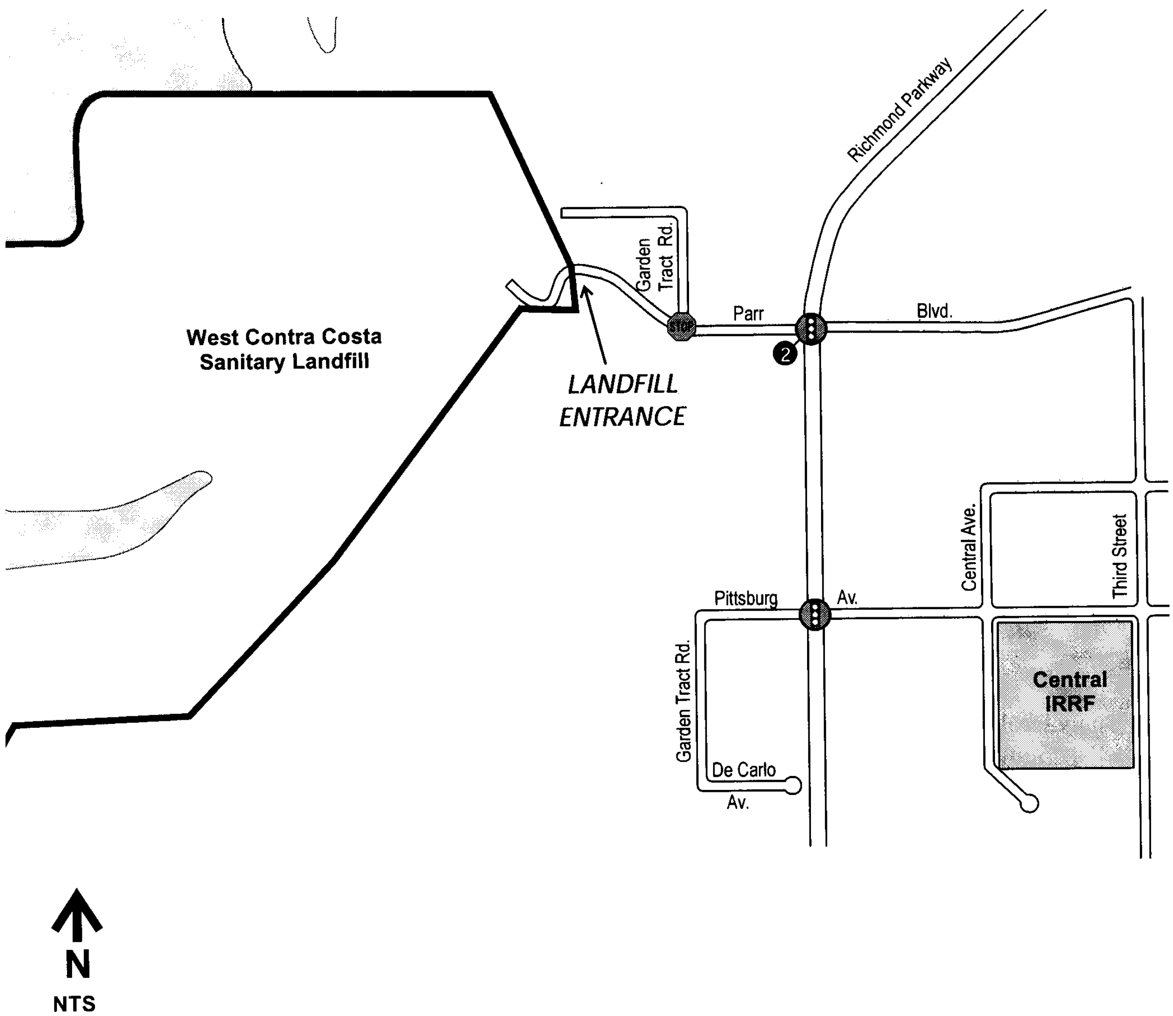
The following sections are summaries of Environmental Impact Reports (EIR) and Draft EIRs prepared for projects located in the study area. The summaries below only focus on the quantification and evaluation of air quality and traffic impacts relevant to this study.

a. **Contra Costa County. July 2004. *West Contra Costa Sanitary Landfill Bulk Materials Processing Center and Related Actions Final Environmental Impact Report.***

1. Study Purpose

The Environmental Impact Report (EIR) presents the potential impact of expanding bulk material processing activities at the Class II West Contra Costa Sanitary Landfill (WCCSL). Among the proposed changes are the construction and operation of a Waste Recycling Center and expanded facility hours. Bulk material processing at this facility includes composting, soil remediation and processing construction materials such as concrete and asphalt. These activities will replace traditional waste disposal. Part of the WCCSL is located on unincorporated land while most of the facility is under the jurisdiction of the City of Richmond (Figure III-11). Under the California Environmental Quality Act the EIR's lead agency is Contra Costa County Community Development Department. The project impacts relevant to this study are increased traffic and deteriorated circulation, the analyses of which are presented in the EIR's Chapter 8 as well as related air quality impacts presented in the EIR's Chapter 10. The final EIR was certified in 2004 by the Contra Costa County Board of Supervisors.

Figure III-11 West Contra Costa Sanitary Landfill Project Location[87]



2. Study Methods

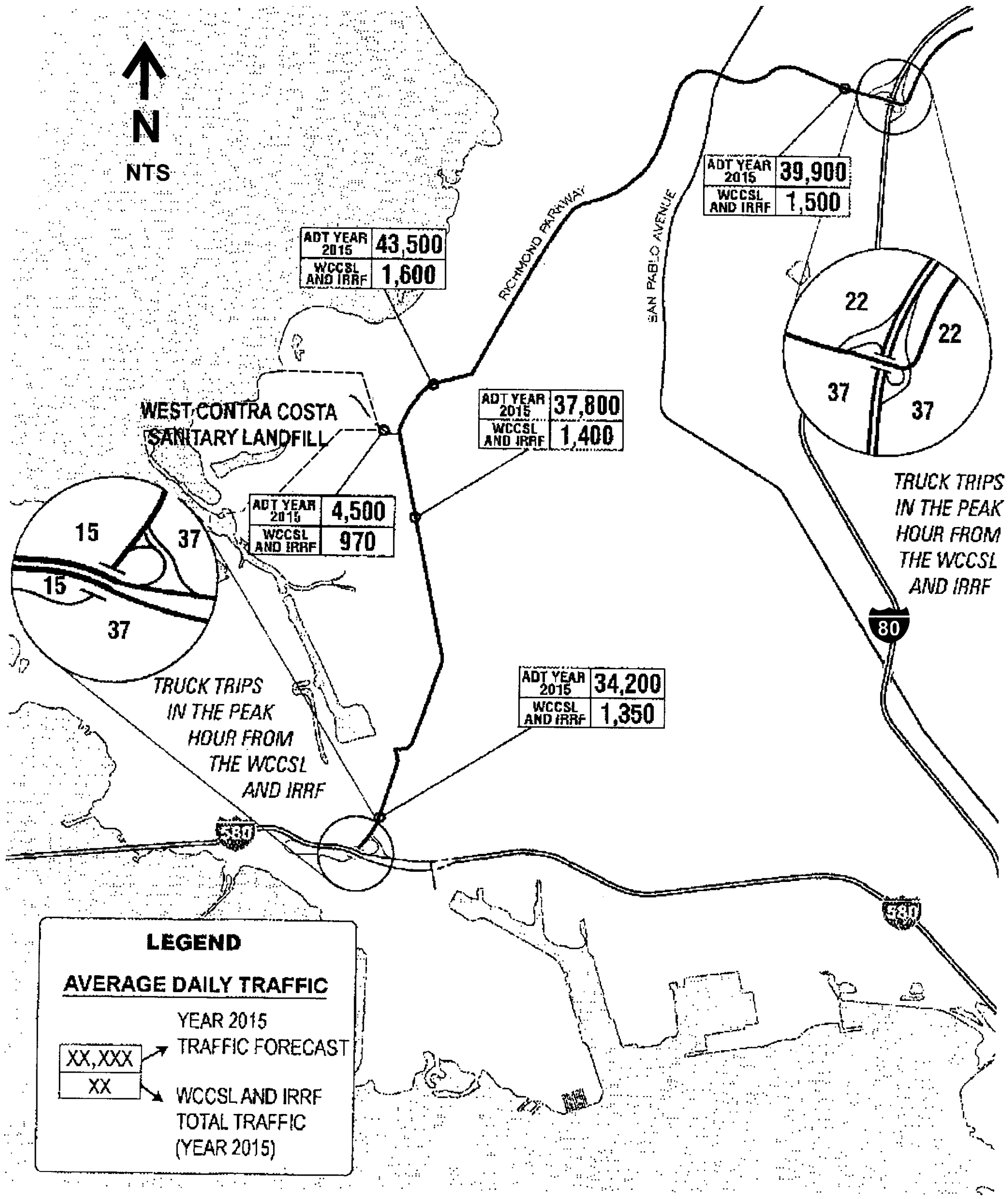
The traffic and circulation impacts of the proposed project were determined by performing peak and daily traffic counts at two intersections on Parr Boulevard, the road leading to the landfill entrance. The existing counts were compared to estimates for 2008 and 2015. Cumulative impacts incorporated the traffic effects of the nearby Central Integrated Resource Recovery Facility operating at its permitted capacity as well as increased traffic on the neighboring highways (Route 580 and 80) and the Richmond Parkway.

The proposed facility expansion's air quality impacts include changes in process, vehicle, and equipment related emissions. These impacts were estimated by applying emission factors to estimates of activity levels such as number of vehicles entering and exiting the facility and their average total trip length in the region (10 to 20 miles). The EIR also includes an assessment of diesel health risks to two residential areas bordering Richmond Parkway. Cumulative impacts include an evaluation of the diesel health risk due to all traffic near the two neighborhoods.

3. Study Findings

Figure III-12 and Table III-10 present the cumulative (existing and proposed) traffic impacts of the project by 2015. It is important to note that the traffic counts in the figure include all vehicle types. However it is expected that most of the WCCSL and IRRF traffic will consist of medium- to heavy-duty trucks.

Figure III-12 2015 Cumulative Traffic Impacts[88]



Source: Abrams Associates, August 2003

Table III-10 2015 Cumulative Traffic Impacts[89]

	Existing Conditions	2015				
Location	ADT (Veh/day)	ADT Estimates	WCCSL ADT Increase	IRRF ADT Increase	Total ADT	% ADT Increase
Parr Boulevard (west of Richmond Pkwy)	2,500	4,500	970	0	5,470	119%
Pittsburg Ave (East of Richmond Pkwy)	-	2,800	0	2,200	5,000	n/a
Richmond Parkway (south of Parr Blvd)	32,000	37,800	450	950	39,200	23%
Richmond Parkway (north of Parr Blvd)	32,000	43,500	500	1,050	45,050	41%
Castro Road At 580	-	34,200	400	950	35,550	n/a
Richmond Parkway at 80	-	39,900	450	1,050	41,400	n/a

The EIR found that overall ROG and NOx emissions will decrease with the implementation of the project because of a reduction in combustion of landfill gas and improved vehicle emissions due to standard implementation. However, PM10 emissions will increase significantly because of the dust created by bulk material processing. Diesel PM emissions due to offsite truck traffic delivering bulk materials and recyclables are expected to increase while diesel emissions from equipment formerly used in the landfill operations such as grader and loaders. However, the decrease of onsite emissions do not offset the increase in offsite emissions resulting in a net increase in diesel PM emissions overall. Calculated cancer risk to residential communities located at Richmond Parkway and Gertrude Avenue and at Richmond Parkway and Hilltop Drive are well below the BAAQMD threshold of 10 in one million. Cumulative risks of truck traffic are up to 4 times higher than the risk from the project by itself at these two locations but still below the air district threshold. These risk calculations only include PM emissions from truck traffic on the Richmond Parkway and do not include other local major sources of diesel PM such as trains and ships.

4. Study Recommendations

The impacts on roadway and intersection capacity are judged less than significant in comparison to the expected non-project related growth in traffic. Recommendations were made to shift peak landfill traffic to off-peak roadway traffic hours.

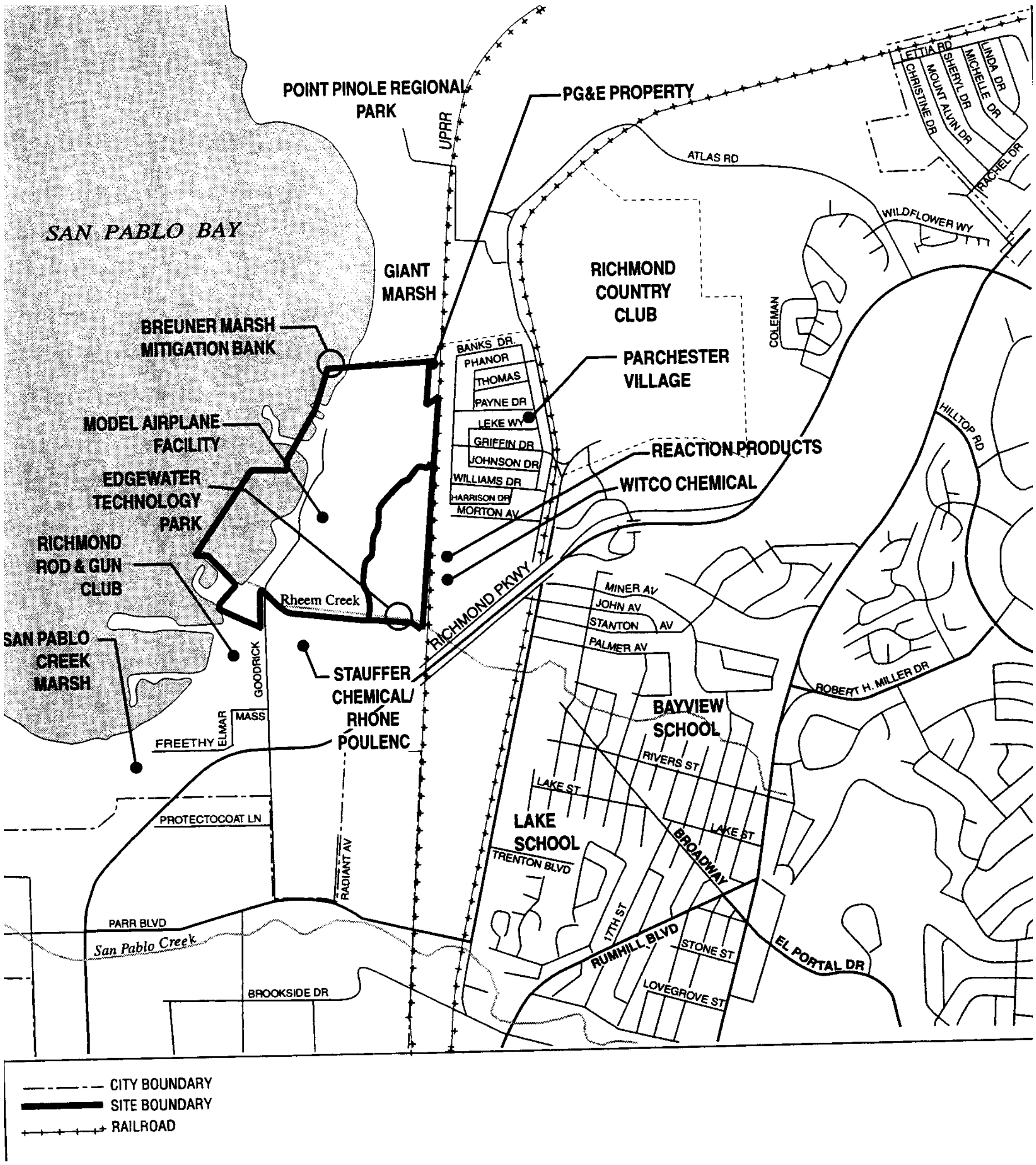
Construction emission impacts are considered potentially significant. However mitigation measures only address dust emissions and not diesel equipment emissions. Operation emission mitigation also focuses on reducing dust emissions. Additional traffic emission impacts are considered less than significant and no mitigation is proposed.

b. Impact Sciences. June 2002. *Edgewater Technology Park/Breuner Marsh Mitigation Bank Draft Environmental Impact Report.*

1. Study Purpose

The EIR analyzes the impacts of two adjacent proposed projects. The first project is the construction and operation of a business campus, the Edgewater Technology Park. The Second project, the Breuner Marsh Mitigation Bank, is a habitat preserve that will generate credits to offset wetland development in the Bay Area. Figure III-13 is a map of the proposed projects' location. The EIR's lead agency is the City of Richmond. Relevant impacts include increased traffic (Section 4.2) and air quality impacts (Section 4.9). The Richmond City Council denied the certification of this project's final EIR in 2003, which was subsequently abandoned by the developer.[90] However, a residential developer is currently considering purchasing the property.

Figure III-13 Edgewater Technology Park/Breuner Marsh Mitigation Bank Project Location[91]



2. Study Methods

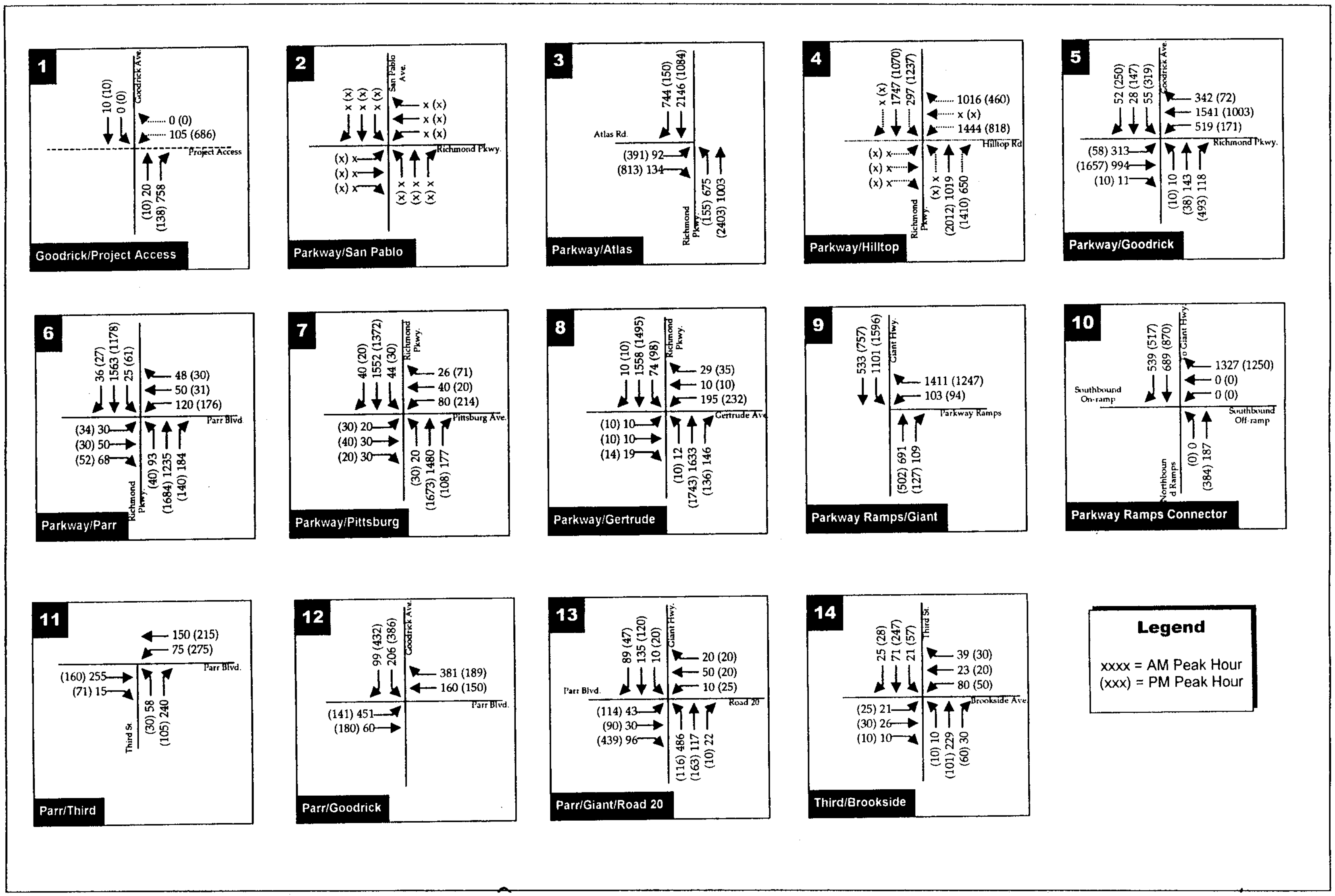
Peak traffic counts at 14 intersections surrounding the project were performed by a consultant, Dowling Associates. The traffic counts did not include average daily traffic and did not isolate truck traffic counts. Most of the intersections surveyed are along the Richmond Parkway. Traffic counts were used to determine peak level of service ratings.

Construction emissions were not calculated because their assessment is not required by the BAAQMD. Operation emissions were estimated based on anticipated direct stationary sources such as heating systems and indirect mobile sources such as vehicle traffic. The mobile source emissions were estimated using EMFAC7G. At the time the study, the California Air Resources Board had already revised the model twice because it underestimated emission from heavy-duty vehicles. As a consequence, the emission estimates provided in this draft EIR should be considered underestimates of actual emissions. The EIR also provides estimates of CO concentrations at the intersection where the level of service is below the BAAQMD threshold of significance. The estimates are performed using Caltrans' model CALINE4.

3. Study Findings

Only two intersections, Richmond Parkway and Goodrick Avenue and Richmond Parkway (an existing intersection) and San Pablo Avenue (a planned intersection), were found to have an unavoidable reduction in level of service under the cumulative impact scenario (Figure III-14). The project emission calculations show that both NOx and ROG emissions are estimated to exceed the threshold of significance. The PM10 emissions are not estimated to exceed their threshold. Project and cumulative CO concentrations at the two impacted intersections were estimated not to exceed state and federal standards under worst-case conditions.

Figure III-14 Cumulative Projects Traffic Impact[92]



SOURCE:Dowling Associates Inc.

4. Study Recommendations

The EIR proposes several mitigation measures to address the reduction in level of service at the two intersections on Richmond Parkway. These include changing the intersection configuration and adding lanes to increase the intersection capacities.

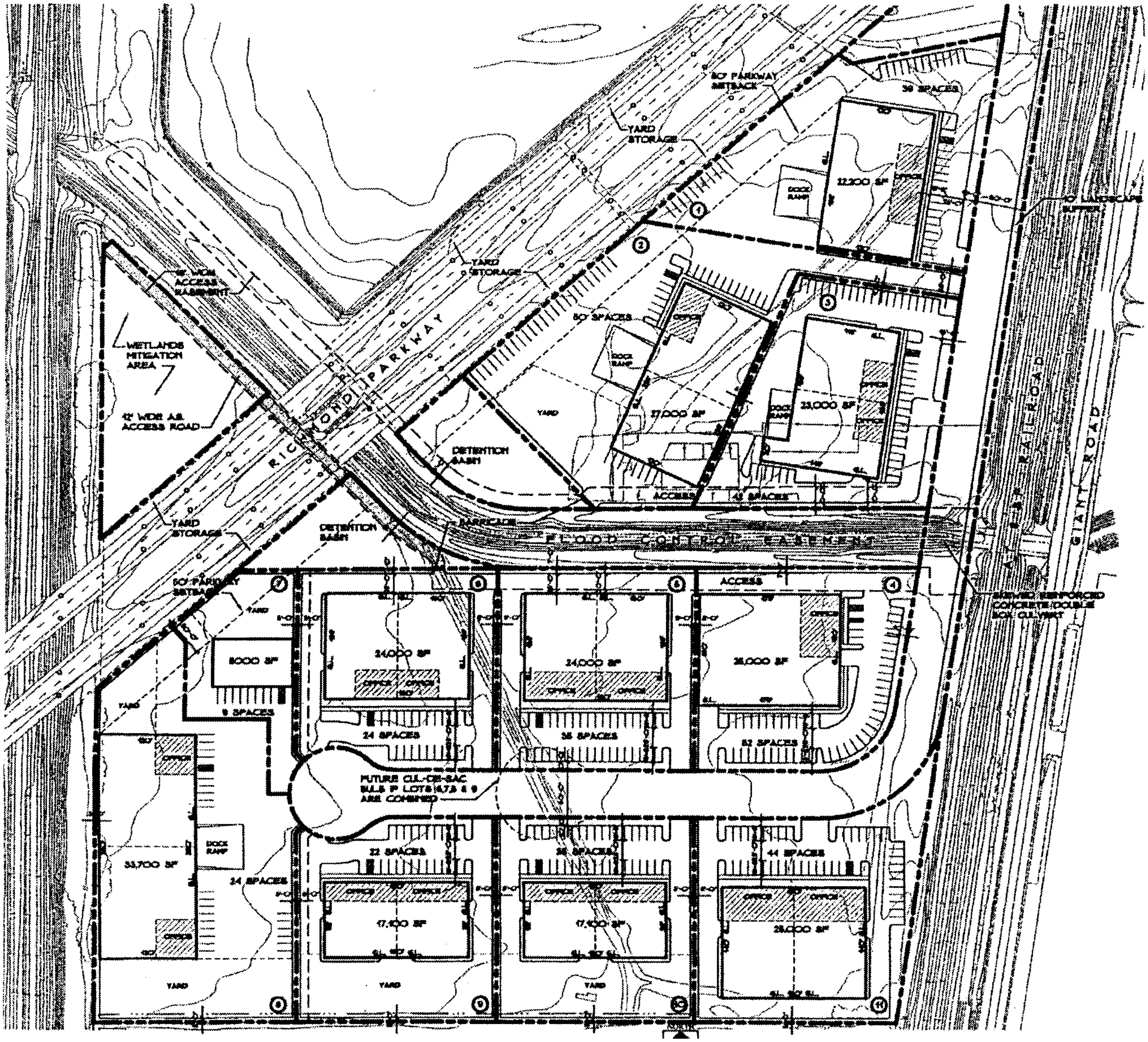
Construction dust emissions are expected to be mitigated by implementing the required BAAQMD measures. The construction emissions from off-road diesel equipment are not required to be assessed or mitigated by the BAAQMD. Increased NOx and ROG emissions are to be mitigated by a combination of voluntary carpool and shuttle programs, parking fees and restrictions, and biking infrastructure. These measures all apply to passenger vehicle emissions. The EIR states that emission reduction through these mitigation measures are not guaranteed due to their voluntary nature. The estimated NOx and ROG emissions will therefore remain largely un-mitigated.

c. Environmental Science Associates. September 2003. *Parkway Commerce Center Draft Environmental Impact Report* and Environmental Science Associates. July 2004. *Parkway Commerce Center Final Environmental Impact Report*.

1. Study Purpose

This EIR provides an analysis of the impact of developing an industrial park, the Parkway Commerce Center located near the intersection of Richmond Parkway and Giant Road in the north of the City of Richmond. Figure III-15 is an overall map of the proposed project. The lead agency for this EIR is the City of Richmond. The project's anticipated air quality impacts are discussed in Section IV.B. Traffic impacts are addressed in Section IV.K. The final EIR is to be submitted for certification in September 2004.

Figure III-15 Parkway Commerce Center Project Location[93]



2. Study methods

The EIR examines the potential impact of both construction and operational emissions. Following the BAAQMD guidelines, construction emissions are not estimates. Operational emissions are estimated using URBEMIS 2002 and compared to the air district's threshold of significance.

Traffic counts were performed at 11 intersections around the proposed project site. The baseline counts were used to assess the impact of the project on the intersection level of service.

3. Study Findings

The EIR found that neither the construction nor the operation emissions would have significant air quality impacts. The evaluation of operation emissions was limited by the uncertainty related to the facility's actual use. The Parkway Commerce Center is proposed to house both commercial and light industrial activities, however the tenants have yet to be selected. Estimates of emissions due to traffic generated by the facility were found to be under the threshold of significance.

Level of service analyses showed that the project would not significantly affect traffic volumes at intersections. However, the traffic generated by the facility may impact traffic flow around the facility. The impacts are amplified by the fact that the site access is restricted by train crossings. The EIR found that no significant cut-through traffic could be observed from San Pablo Avenue.

4. Study Recommendation

Construction dust will be mitigated using the BAAQMD recommended construction practices. Stationary sources installed at the facility are required to obtain air district permits; but the EIR assumes that this would ensure the facility remains under the thresholds.

Re-striping part of Giant Road to change lane patterns is expected to alleviate the traffic on that road. The EIR also recommends other infrastructure improvements to increase the facility accessibility and to mitigate cumulative effects of this and other approved projects.

B. SHIPS AND COMMERCIAL VESSELS

Institute for Water Resources, Department of the Army Corps of Engineers. 2003. *Waterborne Commerce of the United States-Calendar Year 2002, Part 4-Waterways and Harbors Pacific Coast, Alaska and Hawaii*.

1. Study Purpose

The Department of the Army Corps of Engineers publishes the Waterborne Commerce of the United States report on an annual basis. The report provides detailed data on the quantity and types of goods traded in the country's waterways and harbors. Data on the Port of Richmond can be found in Part 4 of the report.

2. Study Methods

The Army Corps of Engineers' authority to collect data on waterborne commerce was conferred by Congress through the Rivers and Harbors Appropriation Act of 1922[94]. Domestic vessel owners and operators are required to submit a form once the cargo is delivered. The data set is completed with data on foreign waterborne trade purchased from the Journal of Commerce.

3. Study Findings

There are two ports in Contra Costa County: the Port of Richmond located in the Richmond Harbor and the port along the Carquinez Straight. The Port of Richmond is located in the study area while the Carquinez Straight Port is outside the study area. The Port of Richmond was ranked 32nd in 2002 in trade by cargo weight evaluated in tons. In contrast the Port of Oakland was ranked 47th by weight in 2002. This is mainly due to the fact that the Port of Richmond is essentially a bulk cargo port and the Port of Oakland is a container port. Table III-11 provides the weight of freight traded at Contra Costa County ports in tons per year. The percent in the study area is the fraction represented by the Port of Richmond.

Table III-11. Annual Tons of Freight Traded at Contra Costa County Ports (tons/year)[95]

Year	Richmond Harbor	Carquinez Strait	Total	Percent in Study Area
1993	24,570,000	26,046,000	50,616,000	49%
1994	24,094,000	26,118,000	50,212,000	48%
1995	20,839,000	26,931,000	47,770,000	44%
1996	21,803,000	24,841,000	46,644,000	47%
1997	21,706,000	20,421,000	42,127,000	52%
1998	19,020,000	19,539,000	38,559,000	49%
1999	22,356,000	17,388,000	39,744,000	56%
2000	19,388,000	18,435,000	37,823,000	51%
2001	21,220,000	20,203,000	41,423,000	51%
2002	21,901,000	21,948,000	43,849,000	50%

Petroleum and petroleum products make up 90% of the volume traded at the Port of Richmond. The majority of these petroleum products are the crude oil supply for the nearby refineries. Table III-12 presents a detailed list of the commodities traded at the Port of Richmond.

Table III-12 Commodities Traded at Port of Richmond in 2002[96]

Commodity	Foreign	Domestic	Total
Petroleum and Petroleum Products (crude, gasoline, residual fuel oil)	8,646,000	11,142,000	19,788,000
Chemicals and Related Products (benzene, organic compounds)	713,000	150,000	863,000
Crude Materials (sand, gravel, ore)	618,000	276,000	894,000
Primary Manufactured Goods (paper, lime, glass, steel)	49,000	19,000	68,000
Food and Farm Products (rice, oilseeds, oils)	226,000	-	226,000
Manufactured Equipment, Machinery and Products	1,000	-	1,000
Unknown or Other	59,000	-	59,000
Total	10,313,000	11,588,000	21,901,000

Table III-13 shows the number of vessel trips to and from Contra Costa Ports from 1998 to 2002. The vessel trips considered in the study area are the fraction representing the Port of Richmond.

Table III-13 Annual Number of Vessel Trips to and from Contra Costa County Ports (Number per Year) [97]

Year	Richmond Harbor	Carquinez Strait	Grand Total Trips/Year	Percent in Study Area
1998	6,643	4,250	10,893	61%
1999	9,522	4,249	13,771	69%
2000	11,161	4,833	15,994	70%
2001	9,810	4,680	14,490	68%
2002	13,096	5,593	18,689	70%

C. LOCOMOTIVE

Booz-Allen & Hamilton, Inc for the California Air Resources Board. 1991. *Locomotive Emission Study*.

1. Study Purpose

This study of locomotive emissions in California was requested by the state legislature in late 1987. It is the most recent study of its kind. The report was prepared with the collaboration of the California railroad industry. It presents an inventory by basin of the emissions resulting from locomotive operation. It also provides a detailed inventory of the routes operated by each of the rail companies.

2. Study Methods

The study utilizes locomotive fleet inventory, activity data, and locomotive engine emission characteristics gathered from railroad companies to build an air basin emission inventory. The inventory is based on calendar year 1987 data. The report also identifies emission reduction strategies for locomotives.

3. Study Findings

At the time the report was prepared there were four railroad companies operating in Contra Costa County: Atchison, Topeka and Santa Fe Railway Company, Southern Pacific Transportation Company, Union Pacific Rail Road, and Amtrak. As a consequence of industry wide mergers and acquisitions in the 1990's railroad track operators have changed since the report's publication. For example the Southern Pacific Transportation Company operations were taken over by Union Pacific Railroad Company. Atchison, Topeka and Santa Fe Railway Company is now Burlington Northern Santa Fe Railroad Company. Finally, the Richmond Pacific Railroad operates the switching operations at the Port of Richmond. These changes in ownership may have significantly affected the activities on the routes upon which the emission inventory is based. However, this report is the only comprehensive source of locomotive activities in the study area and the basis of the current Air Resources Board emission inventory for locomotives. The study findings are therefore relevant in comparing the Bay Area and Contra Costa County inventory to the study area inventory.

Table III-14 is a summary of the locomotive emissions in the Bay Area by locomotive type. Passenger trains are high-speed trains dedicated to transporting passengers such as those operated by Amtrak throughout the Bay Area and Caltrans in the Peninsula. Intermodal Freight trains typically transport containers. Mixed freight trains are defined in the report as "point-to-point trains which carry all types of equipment, tank cars, box cars, gondolas, etc." Yard trains operate only in rail yards and are used to switch trains onto different tracks. Local trains function as combinations of yard trains and mixed freight trains over short distances. The last row of Table III-14 provides ARB's Bay Area 2003 inventory as a comparison. It is important to note that the figures are only slightly higher almost two decades later. This could mean that activity and fleet emissions have not changed very much over the last 17 years or that increases in activity have been offset by decreases in fleet emissions.

Table III-14 1987 Bay Area Locomotive 1987 Emission Inventory (tons/day)[98]

Locomotive Type	HC	CO	NOx	SOx	PM 10
Mixed Freight	0.11	0.34	2.60	0.19	0.06
Intermodal Freight	0.11	0.35	2.40	0.18	0.05
Local Trains	0.19	0.60	4.20	0.32	0.09
Yard Operations	0.13	0.32	2.20	0.12	0.05
Passenger Trains	0.03	0.07	1.00	0.09	0.02
Total 1987	0.56	1.68	12.33	0.89	0.27
Total 2003 (ARB)	0.55	2.11	13.02	1.15	0.31

Table III-15 provides the routes within the San Francisco Bay Area Air Basin (SFBAB) for mixed freight trains.

Table III-15 Mixed Freight Train Route Segments in the San Francisco Bay Area Air Basin [99]

Train Type	Segment		Direction	Average Miles Traveled Per Train in SFBAB
Mixed	Midway	Milpitas	West	55
Mixed	Oakland	Midway	East	55
Mixed	Fairfield	Oakland/Bethany	West	105
Mixed	Orwood	Richmond	East	54
Mixed	Warm Springs	Oakland	East	32
Mixed	Orwood	Richmond	West	54
Mixed	Bethany	Oakland	East	61
Mixed	Fairfield	Oakland/Gilroy	West	118
Mixed	Warm Springs	Oakland	West	32
Mixed	Bethany	Oakland	West	61
Mixed	Fairfield	Oakland	West	44
Mixed	Fairfield	Oakland/Gilroy	East	118
Mixed	Fairfield	Oakland	East	44
Mixed	Fairfield	Oakland/Bethany	East	105
Mixed	Midway	Oakland	West	55
Mixed	Gilroy	Oakland	East	74
Mixed	Gilroy	Oakland	West	74

D. CONSTRUCTION EQUIPMENT

The following table, Table III-16 provides an inventory of construction equipment operating in Contra Costa County and the Bay Area by fuel type. These tables are results from ARB's OFFROAD model, which is used to estimate emissions from off-road equipment. Table III-17 is a list of the diesel equipment types included in the ARB OFFROAD model.

Table III-16 Number of Construction Equipment Operating in Contra Costa County and the Bay Area [100]

Fuel	Contra Costa County	San Francisco Bay Area
Diesel	7,878	46,642
Gasoline- 2 Stroke	157	959
Gasoline- 4 Stroke	3,818	23,301
Total	11,854	70,902

Table III-17 Diesel Equipment Types in ARB OFFROAD Model[101]

Bore/Drill Rigs	Paving Equipment
Concrete/Industrial Saws	Rollers
Cranes	Rough Terrain Forklifts
Crawler Tractors	Rubber Tired Dozers
Crushing/Proc. Equipment	Rubber Tired Loaders
Excavators	Scrapers
Graders	Signal Boards
Off-Highway Tractors	Skid Steer Loaders
Off-Highway Trucks	Surfacing Equipment
Other Construction Equipment	Tractors/Loaders/Backhoes
Pavers	Trenchers

E. DATA GAPS

The review of documents pertaining to the sources of diesel particulate matter pollution in the study area reveals a number of data gaps. The following paragraphs will assess the major gaps in how sources of diesel particulate matter emissions are characterized in existing studies.

Heavy Duty Trucks:

The data collected to date does not provide a direct estimate of the number of trucks passing through the study area and affecting the area's air quality. Specifically, most of the traffic counts do not differentiate trucks from other vehicles. Other studies focus on only several intersections in the study area and fail to provide an overall picture of truck traffic in the area. In addition, the truck counts performed by Caltrans provide data for only two points within the study area. However, it is possible to bound the estimate with a lower limit of the number of trucks generated in the study area and a higher limit of the number of trucks traveling on the highways surrounding the study area.

Nevertheless, the range between the low and high estimate is wide, which strongly supports the need to collect truck travel data within the study area. This data can be collected by implementing truck counts at strategically chosen locations in the study area. It is also important to better understand truck traffic patterns on neighborhood streets. The documents reviewed do not provide a sense of how many trucks are traveling through or parking and idling in residential areas. Emissions from trucks that operate close to where people live impose a greater burden due to their proximity.

Ships and Commercial Vessels:
The current evaluation of ship and commercial vessel activity in the study area, doesn't include information about the vessels' stay in the port. Namely we do not know how long vessels stay in the port and whether they are idling on bunker diesel fuel the entire time they are at dock, or only a portion of that time. Also unknown are the vessel operation requirements at the Port of Richmond. These operation requirements include restrictions on maneuvering speed and idling time.

Locomotives:
The information collected on the impact of locomotive activities on the air quality in Contra Costa County is both outdated and incomplete. The most comprehensive existing study reports 17-year old data that does not reflect the dramatic changes in the railroad industry that occurred in the 1990's. The ARB county emission inventory presented in this section's introduction does not include idling emissions even though two rail yards are located in the county.

It is unclear whether the data presented in this report understates or overstates emissions from locomotives. For example, the fleet emission rate reflects older locomotive technology that may have been phased out over 17 years and replaced with cleaner locomotives. In this case, the data would overstate the emissions if locomotive activity has not changed. However, activity along the routes could have changed significantly in the last two decades, especially considering the growth in container freight traffic at the nearby Port of Oakland. In this case, the data would understate the emissions assuming the average emission rate has not changed. The uncertainty surrounding locomotive activities and related emissions remains great and extends to the inventory data the Air Resources Board uses as a basis for policy making. It is therefore important that a study similar to the report described in Section C be undertaken to update the current estimates of the impact of locomotives on air quality in California.

In general, there is a great need to accurately characterize vehicle and equipment activities at inter-modal facilities such as the Port of Richmond. ARB's current regulatory effort on this front may result in better inventories of inter-modal facilities and the impact of the port, rail, and truck terminal combined activities on a region's air quality.

Construction Equipment:
This study is lacking data on construction activity specific to the study area as well as data for the rest of the county. Useful data could be construction permits issued by the county government and the incorporated cities in the county.

SECTION IV: STUDY AREA DIESEL EMISSION INVENTORY

A. OBJECTIVES

This section presents an inventory of emissions of diesel particulate matter in the study area prepared using the information compiled to date and presented in the previous sections. Inventory data from the California Air Resources Board is only available at the state, air basin or county level and not at city or neighborhood level. The following study area inventory provides an estimate of the extent to which sources of diesel PM pollution that affect the entire county are concentrated in the study area. This inventory will also help determine how much each source type contributes to the amount of diesel PM emitted each day. The key reasons for understanding the sources and amount of diesel PM is being released in the study area is to identify solutions to reduce diesel pollution from the sources that are of the most concern to the residents in the study area either because of their size or because of their proximity to residential areas. The study area diesel PM inventory will also help assess whether current strategies in place to mitigate diesel pollution are appropriate.

The study's methodology for each source type is described in Section B. The references of the data used are provided for each source. An explanation for why certain data sources were not used is provided in the appendix (Appendix B). The results are presented in Section C.

B. METHODOLOGY

In this section, a review of the relevant data is provided for each diesel PM source. Also provided is the rationale behind the inventory calculation methodology choices. An assessment of the accuracy of the estimate is also made.

a. Heavy Heavy-Duty Trucks

Table IV-1 presents the data sources used in estimating the daily contribution of heavy heavy-duty trucks to the study area's diesel PM inventory. Explanations as to why some data sources identified in Section III were not used in the preparation of the inventory can be found in this study's appendix (Appendix B).

Table IV-1 Data Used in Preparing the Heavy Heavy-Duty Truck Inventory

Author/Source	Title	Data Used and Why
Caltrans	2002 Annual Average Daily Truck Traffic on the California State Highway System	Used: Number of heavy heavy-duty trucks traveling south and north of the study area on Interstate 80 and 580 Why: Provides an upper limit of the number of trucks traveling through the study area coming from or going to the Interstates.
Dowling for WCCTAC	Truck Route/Weight Limitations Survey for West Contra Costa Study	Used: Number of heavy heavy-duty trucks whose trips are generated within the study area Why: Provides a lower limit of the number trucks traveling through the study area that are generated within the study area.
California Air Resources Board	EMFAC2002 Emission Factor Model	Used: - Heavy heavy-duty truck mileage in Contra Costa County - Heavy heavy-duty truck age profile in Contra Costa County - Heavy heavy-duty truck age adjusted PM10 and PM2.5 emission factors Why: EMFAC2002 provides the most up to date data on truck use and emissions in California
Census 2000	American FactFinder	Used: Study area and county surface area based on census tract areas Why: Study area surface is used as a scaling factor for the mileage driven in the study area

The study area heavy heavy-duty truck inventory is estimated in four steps. First, the upper and lower estimates of the number of trucks traveling through the study area are extracted from the Caltrans and the Dowling/WCCTAC reports. These truck estimates are provided in Table IV-2. Table IV-2 also includes, for comparison purposes, the total number of trucks (2 to 5+ axles) and estimates for the corresponding amount of truck trips in the study area. The number of trucks generated in the study area is considered the lower limit because there can not be any fewer trucks traveling through the study area than those going to or coming from destinations within the study area.

Second, the number of miles traveled in the study area is estimated by scaling the number of miles traveled by heavy heavy-duty trucks in Contra Costa County provided by EMFAC2002 with the ratio of the study area surface to the county surface (Table IV-3). Third, age adjusted PM10 and PM2.5 emission factors for each model year obtained using EMFAC2002 documentation are multiplied by the percentage of the trucks operating in Contra Costa County of that model year. The age profile of heavy-heavy duty trucks in Contra Costa County is provided in Figure IV-1. The results of the multiplication are an age and population adjusted emission factor in mass per mile traveled for each pollutant. The emission factor can then be multiplied by the number of vehicles and the daily mileage to obtain the amount of pollutant emitted each day by the heavy heavy-duty trucks traveling through and around the study area.

Table IV-2 Estimates of Trucks Traveling through Study Area

Estimate Type	Number of 5+ Axle Trucks	Number of 5+ Axles Truck Trips	Total Number of Trucks (2 to 5+ Axles)	Total Number of Truck Trips (2 to 5+ Axles)
Lower Limit (trucks and truck trips generated in study area)	3,577	7,154	N/A	N/A
Upper Limit (trucks traveling on I-80 and I-580)	6,275 (North of study area) 7,422 (South of study area) Average: 6,849	6,275 (North of study area) 7,422 (South of study area) Average: 6,849	12,181 (North of study area) 14,158(South of study area) Average: 13,170	12,181 (North of study area) 14,158(South of study area) Average: 13,170

Table IV-3 Surface Area Scaling Factor[102]

	Contra Costa	Study Area	Scaling Factor
Surface	720	20	3%

Figure IV-1 Heavy Heavy-Duty Truck Age Profile in Contra Costa County, San Francisco Bay Area and California[103]

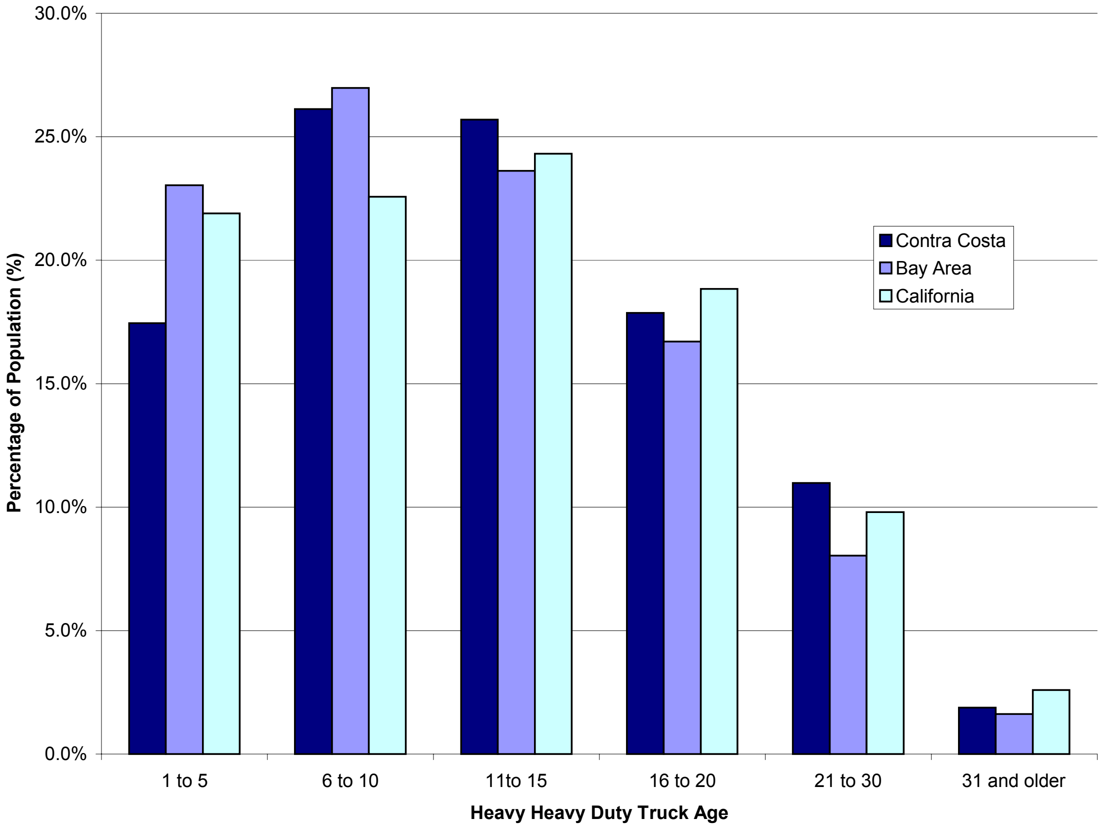
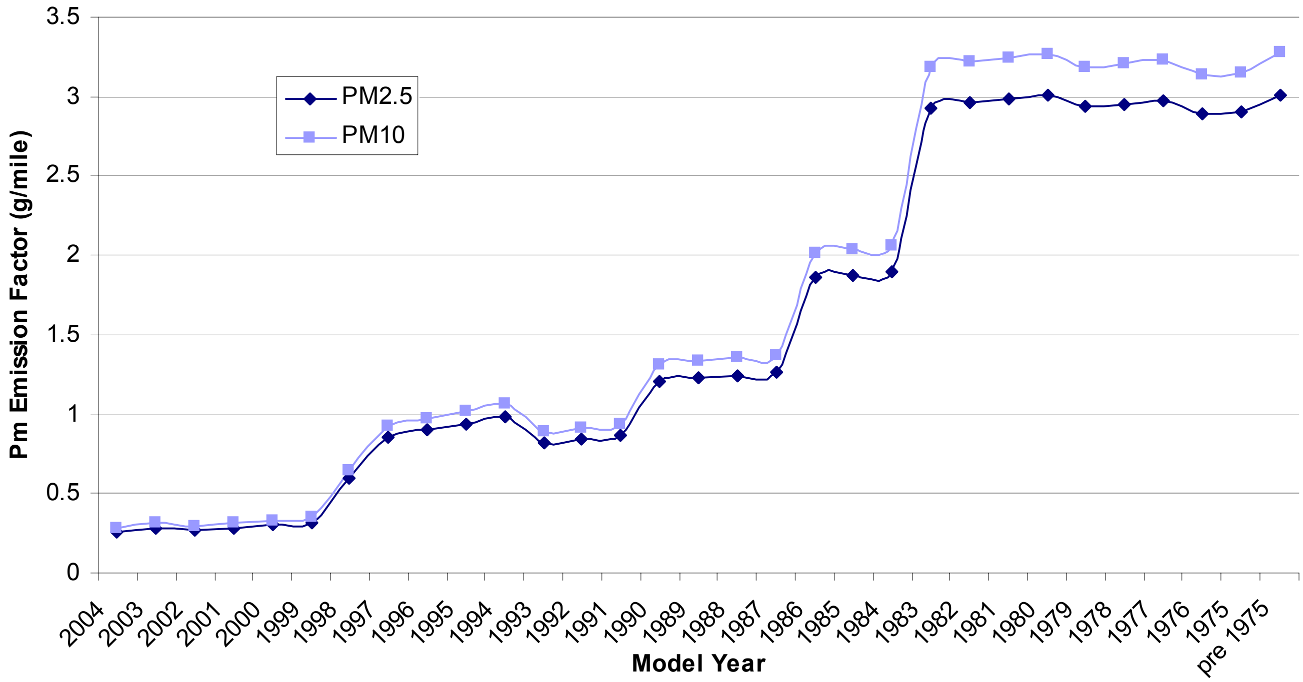


Figure IV-1 shows that trucks operating in Contra Costa County tend to be on average older than the average truck operating in the Bay Area. The average heavy heavy-duty truck in Contra Costa County is about 12 years old whereas the average heavy heavy-duty truck in the Bay Area is 11 years old. An older vehicle tends to be dirtier than a newer vehicle as can be seen in Figure IV-2, which provides this study's emission factor by model year based on ARB methodology. A pre-1980 vehicle emits as much as 11 times more PM per mile than a model year 2004 vehicle.

Figure IV-2 Heavy Heavy-Duty PM Emission Factor By Model Year[104]



b. Ships and Commercial Vessels

Table IV-4 summarizes the data used to estimate the study area's ship and commercial vessel emissions. ARB's annual emission inventory provides an estimate of the ship and commercial vessel emissions from transit, maneuvering and berthing. This study's assumption is that the emissions from ship activities at the Port of Richmond represent the contribution from the Port of Richmond to the study area's inventory. Assuming that emissions are on average proportional to the number of vessels calling to a port, the study area's inventory was estimated by applying to the county inventory the ratio of ships calling to the Port of Richmond to the number of vessels calling to Contra Costa County Ports. However this is a definite underestimate, because many of the ships calling to ports other than the Port of Richmond in Contra Costa County will pass by the Port Richmond on the way to their port of call. The emissions from the transit of these ships through the study area was not calculated, although it is a potentially important source.

Table IV-4 Data Used in Preparing the Ship and Commercial Vessel Inventory

Author/Source	Title	Data Used and Why
California Air Resources Board	2003 Emission Inventory	Used: Ship and commercial vessel emission inventory for Contra Costa County Why: Provides the basis of the analysis
Department of the Army Corps of Engineers	Waterborne Commerce of the United States-Calendar Year 2002	Used: Number of vessels calling annually to the Port of Richmond and the Carquinez Port Why: Provides a ratio used to scale ship and commercial vessel emissions

c. Locomotives

Table IV-5 provides a summary of the data utilized in preparing an estimate of the locomotive emission inventory in the study areas.

Table IV-5 Data Used in Preparing the Locomotive Inventory

Author/Source	Title	Data Used and Why
Booz-Allen & Hamilton for California Air Resources Board	Locomotive Emission Study	Used: Locomotive activity and fleet emission rate for San Francisco Bay Area Why: Provides the basis of the analysis
California Air Resources Board	2003 Emission Inventory	Used: 2003 Bay Area and Contra Costa locomotive emission inventory Why: Provides a ratio to scale the 1987 emissions to 2003 estimates

The Contra Costa County and study area inventories based on the air basin inventory were estimated in five steps. The first step consisted of estimating the number of miles traveled and average load carried by each line haul locomotive type within the geographic boundaries of the county and the study area. This was done by mapping each route segment in a Geographic Information System software.[105] The softwares estimated the length of the route within the specified geographic boundaries. The second step estimated the number of yard and local locomotives operating in the rail yards in Contra Costa County. As the basin inventory report only provides the total number of the locomotive type for the Bay Area, it was assumed that these locomotives were distributed evenly among rail yards. For example, AT Santa Fe is reported to operate 5 to 7 yard trains in 2 rail yards, one in Oakland and the other in Richmond. It was then assumed that half of these railroad company's yard trains are operated in Richmond.

Once the number and activity of the locomotives in the county and study area are established, the third step was to estimate their associated emission factors. The Booz-Allen report provides emission inventory in tons per year for the Bay Area. These values were divided by the ton-miles per year reported in the Bay Area for line haul locomotives to obtain an emission factor in tons of pollutant per ton-mile of activity. For the yard trains, the emission inventory estimate was divided by the number of yard trains in the Bay Area to obtain an emission factor in tons of pollutant per train. This methodology allowed for the conservation of the inventory study's assumptions about the technology makeup of the fleet operating in the Bay Area. In the fourth step, the emission factors were multiplied by the activity estimates to obtain the emission inventory for the county and the study area. The final step consisted in scaling the 1987 estimate to the 2003 estimates by assuming that the study area's proportion of the Contra Costa County's inventory remains constant at 51% (Tables IV-6 and Table IV-10). Although the Booz-Allen & Hamilton report only provides PM10 estimates, the 2003 ARB inventory can be used to determine the ratio of PM2.5 to PM 10 . This ratio of 92% was applied to the PM10 1987 and 2003 estimates for the study area (Table IV-10).

Tables IV-6 through IV-10 provide some of the intermediary and final results obtained by implementing this methodology.

Table IV-6 Estimates of Average Locomotive Trip Length in Contra Costa County and the Study Area[106]

Train Type	Segment		Direction	Average Miles Traveled Per Train in SFBAB	*Est. Avg. Miles in Contra Costa County*	*Est. Avg. Miles in Study Area*	Number of Trains	Average Trailing Tons
Mixed	Midway	Milpitas	West	55	29	15	494	4608
Mixed	Oakland	Midway	East	55	29	15	341	2041
Mixed	Fairfield	Oakland/Bethany	West	105	29	15	146	5500
Mixed	Orwood	Richmond	East	54	54	15	851	2010
Mixed	Warm Springs	Oakland	East	32	0	0	313	5500
Mixed	Orwood	Richmond	West	54	54	15	1134	3711
Mixed	Bethany	Oakland	East	61	0	0	279	5500
Mixed	Fairfield	Oakland/Gilroy	West	118	29	15	426	5500
Mixed	Warm Springs	Oakland	West	32	0	0	316	5500
Mixed	Bethany	Oakland	West	61	0	0	286	5500
Mixed	Fairfield	Oakland	West	44	29	15	135	5500
Mixed	Fairfield	Oakland/Gilroy	East	118	29	15	352	5500
Mixed	Fairfield	Oakland	East	44	29	15	395	5500
Mixed	Fairfield	Oakland/Bethany	East	105	29	15	37	5500
Mixed	Midway	Oakland	West	55	29	15	22	3636
Mixed	Gilroy	Oakland	East	74	0	0	159	5500
Mixed	Gilroy	Oakland	West	74	0	0	11	5500

Table IV-7 Total Ton-Miles Estimates in the San Francisco Bay Area, Contra Costa County and the Study Area

Train Type	Total Ton-Miles in Bay Area	Ton-Miles in Contra Costa County	Ton-Miles in Study Area
Mixed Freight	1,595,808,211	645,946,261	257,574,135
Intermodal Freight	1,157,371,443	603,406,081	253,059,585
Local Trains	1,376,645,550	37,634,940	37,634,940
Yard Operations	N/A	N/A	N/A
Passenger Trains	127,190,400	62,910,400	26,040,000
Bulk	37,314,860	19,675,108	10,176,780
Total	4,294,330,464	1,369,572,790	584,485,440

Table IV-8 Estimates of Number of Yard Trains Operating in Contra Costa County and the Study Area

	Total Yard Trains in Bay Area	*Est. Total Yard Trains in Contra Costa County*	*Est. Total Yard Trains in Study Area*
Yard Operations	12,294	*3,016*	*3,016*
Percentage of Total		*25%*	*25%*

Table IV-9 PM10 Locomotive Emission Inventory

	PM10 (tons/day)		
	Bay Area	Contra Costa County	Study Area
1987 Booz-Allen & Hamilton and Estimated Inventory	0.27	*0.08*	*0.04*
% of Bay Area		*28%*	*15%*
% of Contra Costa County			*52%*
2003 ARB and Estimated Inventory	0.31	0.10	*0.05*
% of Bay Area		32%	*17%*
% of Contra Costa County			*52%*

Table IV-10 PM2.5 Locomotive Emission Inventory

	PM2.5 (tons/day)		
	Bay Area	Contra Costa County	Study Area
1987 Booz-Allen & Hamilton and Estimated Inventory	0.25	*0.07*	*0.04*
% of Bay Area		*28%*	*15%*
% of Contra Costa County			*52%*
2003 ARB and Estimated Inventory	0.28	0.09	*0.05*
% of Bay Area		32%	*17%*
% of Contra Costa County			*52%*

d. Construction Equipment

The data sources and data used in preparing the study area's construction equipment inventory are presented in Table IV-11. Data collected but not used is provided in the appendix (Appendix B). Members of the Diesel and Asthma Committee of West Contra Costa County estimated that construction activities were evenly distributed throughout the county. The study area emission inventory due to construction equipment is therefore the county inventory scaled to the study area's urbanized surface area.

Table IV-11 Data Used in Preparing the Construction Equipment Inventory

Author/Source	Title	Data Used and Why
California Air Resources Board	2003 Emission Inventory	Used: Construction equipment emission inventory for Contra Costa County Why: Provides the basis of the analysis
Census 2000	American FactFinder	Used: Study area and county surface area based on census tract areas Why: Study area surface is used as a scaling factor for the construction activity in the study area

C. RESULTS

The results of the methodologies described in Section B are presented in Tables IV-12and IV-13 and Figure IV-3. Every day heavy heavy-duty trucks, ships, locomotives, and construction equipment operating in the study area emit nearly 0.26 tons of PM10 and 0.25 tons of PM2.5. These amounts represent between 17% and 18% of the county's diesel PM emissions concentrated on 3% of the county's surface. The discrepancies in distribution are further highlighted by the per capita and per square mile estimates in Table IV-14 and Figures IV-4 and IV-5. This study estimated that more than twice as much diesel PM10 and PM2.5 is emitted per resident per year in the study area than per resident in Contra Costa County. The ratio increases drastically to 6 times more emissions per square mile in the study area than the county average and about 40 times more emission per square mile in the study area than the state average. The study area is potentially overburdened by diesel PM emission in comparison to the county, air basin, and state averages.

Table IV-12 Study Area Diesel PM10 Inventory

	Study Area Inventory (tons/day)		Partial Contra Costa Inventory (tons/day)	Partial Bay Area Inventory (tons/day)	Partial California Inventory (tons/day)
Inventory Category	Lower Limit	Upper Limit			
Heavy Heavy-Duty Trucks	0.018	0.035	0.22	1.7	10.4
Ships and Commercial Vessels	0.16		0.24	1.1	10.2
Locomotives	0.05		0.10	0.3	5.1
Construction Equipment	0.027		0.97	5.3	20.5
Total PM10	0.26	0.27	1.53	8.4	46.3

Table IV-13 Study Area Diesel PM2.5 Inventory

	Study Area Inventory (tons/day)		Partial Contra Costa Inventory (tons/day)	Partial Bay Area Inventory (tons/day)	Partial California Inventory (tons/day)
Inventory Category	Lower Limit	Upper Limit			
Heavy Heavy-Duty Trucks	0.017	0.032	0.20	1.6	9.6
Ships and Commercial Vessels	0.15		0.22	1.0	9.4
Locomotives	0.05		0.09	0.3	4.7
Construction Equipment	0.025		0.89	4.9	18.9
Total PM2.5	0.24	0.25	1.41	7.7	42.6

Figure IV-3 PM10 Study Area Diesel PM10 Emission Inventory

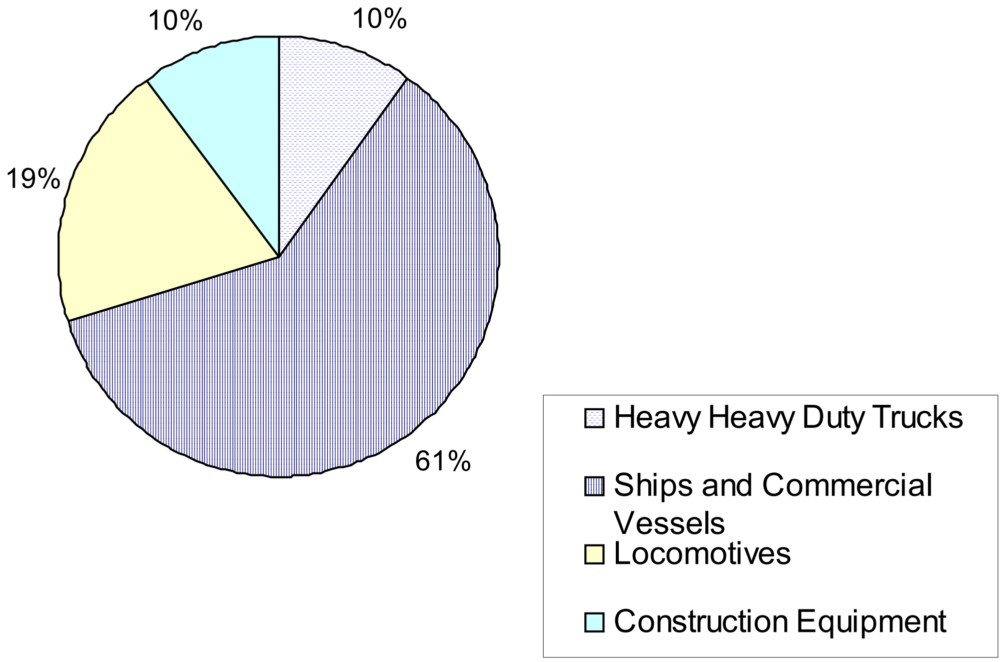


Table IV-11 Inventory Distribution Metric

	Study Area (lbs/year/pers or tons/year/sq mile)		Contra Costa County (lbs/year/pers or tons/year/sq mile)	Bay Area (lbs/year/pers or tons/year/sq mile)	California (lbs/year/pers or tons/year/sq mile)
	Lower Limit	Upper Limit			
PM10 Per Capita	2.8	2.9	1.2	0.9	1.00
PM2.5 Per Capita	2.6	2.7	1.1	0.8	0.9
PM10 Per Sq Mile	5.1	5.5	0.8	0.6	0.11
PM2.5 Per Sq Mile	4.7	5.0	0.7	0.5	0.10
PM10 Per Sq Mile Urban[a]	7.4	7.8	2.1	N/A	2.1
PM2.5 Per Sq Mile Urban[a]	6.8	7.2	2.0	N/A	2.0

[a] Urbanized area based on definition by Census 2000.

Figure IV-4 PM Emission Per Capita in the Study Area, Contra Costa County, the Bay Area, and California

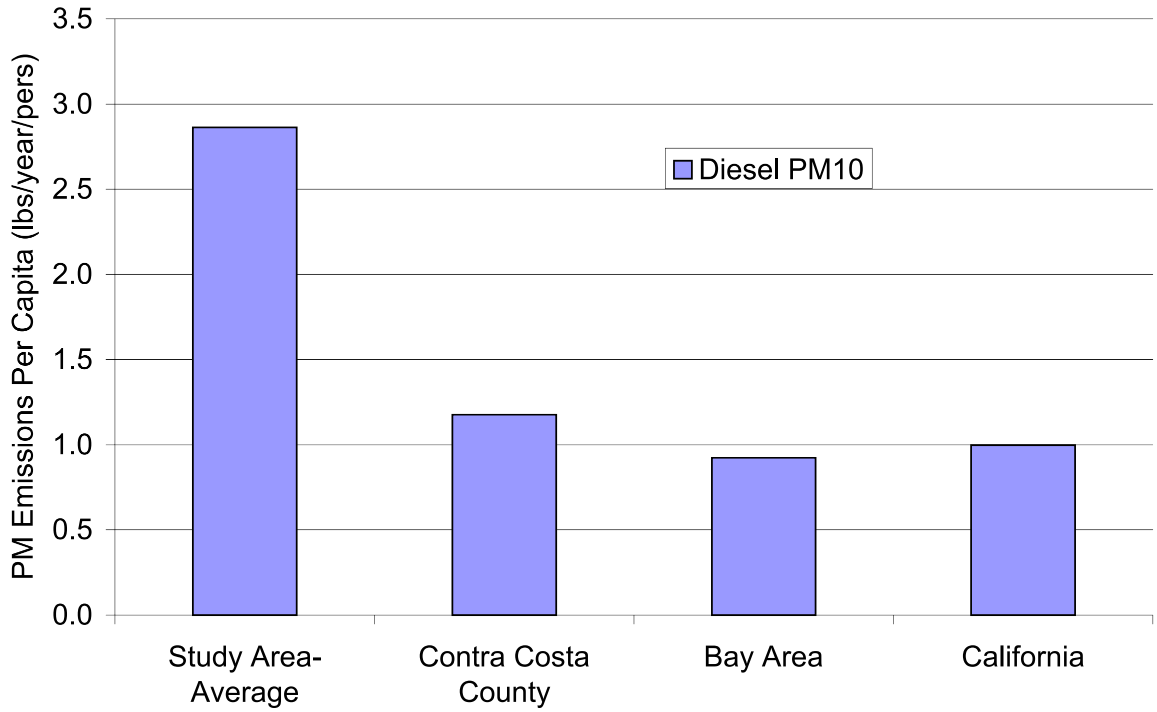
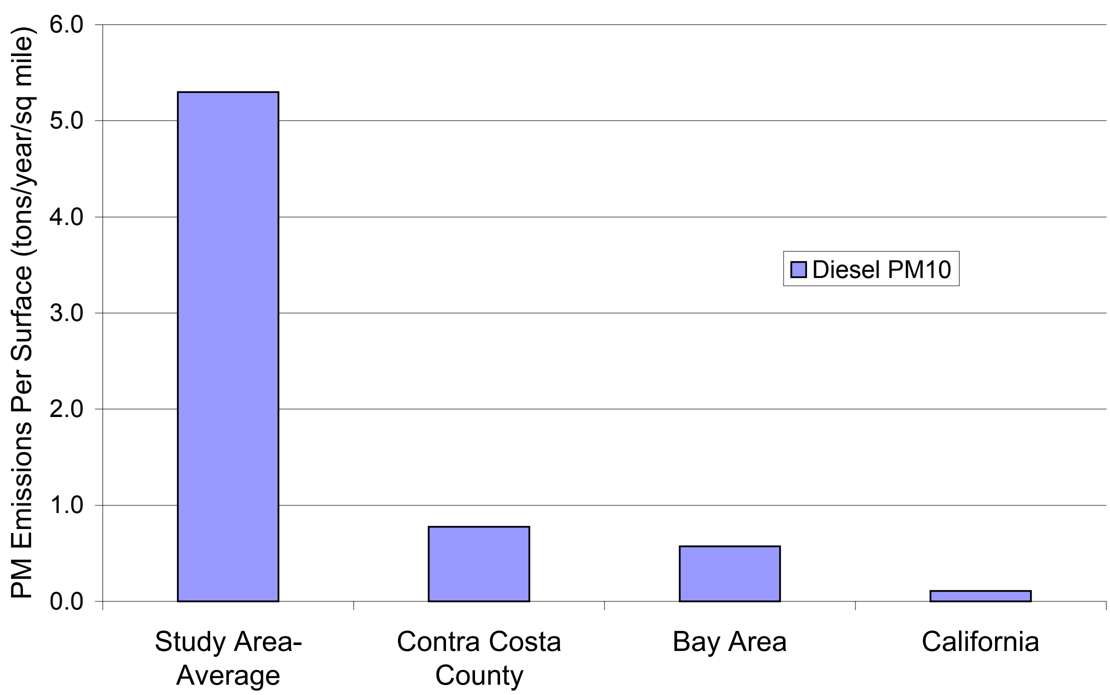


Figure IV-5 Emission Per Surface Area in the Study Area, Contra Costa County, the Bay Area, and California



SECTION V: STUDY AREA INDOOR AIR MONITORING

The estimates of the diesel PM emitted in study area in Section IV indicate that there is a disproportionately greater amount of diesel PM released in the study area compared to the county average. However these estimates do not provide us information on how much diesel PM in the air that study area residents breathe. During the November 2003 town hall meeting that launched the activities of the Asthma and Diesel Committee, residents articulated two main questions about diesel PM pollution:

- How much diesel PM is in the air we breathe?
- How does it compare to other locations in Contra Costa County?

These questions were used as the research objectives for the development of a community driven pilot air monitoring project focusing on indoor air quality. This pilot project was funded by the US EPA Environmental Justice Hazardous Substance Research Small Grant. The next sections describes in detail the monitoring project protocol and results.

A. MONITORING PURPOSE

The project's central goal is to conduct a community-driven research program to answer community questions about health and the environment, and build the foundation for further research and action. This limited indoor air monitoring study aims to document the extent of diesel particulate matter pollution in West Contra Costa County. The results of the monitoring project will provide a foundation for a community-led process to identify solutions to reduce diesel emissions and exposure to diesel particulate matter. The experience gained from the development and implementation of the monitoring project will lay the groundwork for further community–based research efforts.

B. MONITORING PROJECT ADVISORY GROUP

The project is a collaborative effort joining the Community Health Initiative, the Neighborhood House of North Richmond, the Pacific Institute, West County Toxics Coalition, and Contra Costa Health Services. The following Table V.1 provides more information on the project partners and identifies each partner's project role. The project partners together form the Project Advisory Group (PAG). The PAG is the project's main decision-making body and meets on a regular basis to review project progress and decide on next steps.

Table V-1 Project Partners and Roles

Organization	Organization Type	Project Role
Community Health Initiative	Coalition of West Contra Costa County community based organizations	Lead Agency
Neighborhood House of North Richmond	Community based non profit organization	Fiscal Sponsor and outreach Coordinator
West County Toxics Coalition	Community based non profit organization	Project Advisor
The Pacific Institute	Non-profit research organization	Lead Technical Organization
Contra Costa Health Services	County government agency	Project Advisor

In addition to the Project Advisory Group, a number of technical advisors were contacted at various stages of the monitoring protocol preparation. Theses advisors' involvement in the development and implementation of the monitoring protocol is varied. Some advisors were contacted to discuss their experience with community-driven diesel particulate monitoring projects. Others reviewed and commented on draft versions of this methodology document. Finally, others participated in project meetings and outreach events. Table V-2 provides a list of the project technical advisors.

Table V-2 Project Technical Advisors

Name	Organization	Title
Diane Bailey	Natural Resources Defense Council	Scientist
Kathy Edgren, MPH	Community Action Against Asthma	Project Manager
Robert Gunier, MPH	California Department of Health Services, Environmental Health Investigation Branch (EHIB)	Research scientist
Michael Kent	Contra Costa County Health Services	Ombudsman
Dr. Patrick Kinney	Columbia University, School of Public Health	Professor
Dr. Geoff Lomax	California Department of Health Services, Environmental Health Investigation Branch (EHIB)	Research Director
Dr. William Nazaroff	UC Berkeley, Department of Civil and Environmental Engineering	Professor
Dr. Dara O'Rourke	UC Berkeley, Department of Environmental Science, Policy, and Management	Professor
Swati Prakash	West Harlem Environmental ACT	Environmental Health Director
Eric Stevenson	Bay Area Air Quality Management District	Air Monitoring Manager

C. MONITORING PROTOCOL

a. Target Pollutant and Analysis Method

There are currently no direct measurement techniques for diesel particulate matter. The target pollutant for monitoring is therefore a surrogate. Both elemental carbon and black carbon have been used as surrogates for diesel PM in a number of studies and in a diversity of environments.[107] These compounds are defined by how they are measured. Elemental carbon (EC) is the portion of carbon in particulate matter that is "neither carbonate carbon nor organic carbon" resulting from a thermal or optical analysis.[108] Black carbon is the portion of carbon that absorbs light.[2] Both EC and BC have been shown to be highly correlated with each other across measurement techniques and particulate matter sources.[109]

The main challenge in monitoring EC/BC as surrogates for diesel PM is that there are other sources of EC/BC in both indoor environments and outdoors. EC/BC is a primary pollutant that can be generated by all combustion of carbonaceous material including gasoline and wood burning. However, the rate of BC generated per mile driven by heavy-duty vehicles is much larger (how many times) than the generation rate for gasoline vehicles.[110] Fireplace wood burning is expected to be seasonal and to mainly occur in the late fall and winter.

A previous two-year study of indoor BC concentrations found that indoor sources contributed 16% the first year and 31% the second year to the total indoor concentrations.[111] The predominant indoor source found in this study was candle burning which generated high levels of BC at each occurrence. Food cooking using natural gas was also shown in this study to be an important source of BC. Its importance is more due to its frequent occurrence than the level of BC generated by each event.

To increase the relevance of indoor BC measurements in this study, a selection criterion was developed to ensure that the locations chosen would not only be representative of the proximity of diesel sources to residential areas but also limit indoor BC emissions. The selected monitoring locations and the selection criteria are discussed in Section V.3.3, including no smoking, candle, incense and wood burning during the study.

b. Sampling Equipment and Analysis Techniques

Two monitoring techniques were deployed to measure indoor BC/EC concentrations. The first monitoring technology was installed at all of the monitoring locations. It consists of a pump and filter setup to collect samples to be analyzed according to the National Institute for Occupational Safety and Health (NIOSH) Method 5040 for elemental carbon from diesel particulate matter. The filter-based sampling hardware is composed of a quartz filter medium and a pump set to a flow rate of 2 liters per minute. Samples were collected on a daily basis representing approximately 24 hours of sampling time or a volume of about 2,900 liters of indoor air. The equipment, shown in Figure V.1, was provided by the laboratory that subsequently performed the NIOSH 5040 analysis, Galson Laboratory. [112] Table V.3 provides additional details on the monitoring equipment used. Filters were pre-cleaned at the laboratory to eliminate contamination from carbonaceous material. The pumps were calibrated using a primary standard at Galson Laboratory before monitoring began and calibration was checked in the field daily using a field rotameter.

Figure V-1 Pump and Filter Monitor Setup

The NIOSH 5040 method is an evolved gas analysis technique using a thermal-optical analyzer to distinguish the mass of organic carbon (OC) from the mass of elemental carbon deposited on a filter. [113] Organic carbon is composed of oxygenates and hydrocarbons from primary or secondary aerosols.[114] Concentrations of OC, EC, and the sum as total carbon (TC) are calculated by dividing the measured mass by the volume of air that was pumped through the filter. The filter detection limit for the method is reported as 0.3 μg in the NIOSH documentation, which corresponds to a time-average concentration of 0.1 μg/m^3 for a 24-hour sample at 2 L/min. The laboratory selected for this study used a lower detection limit of 1 μg/m^3. One field blank was prepared for each group of 20 samples and the mass on the blank samples was subtracted from the other sample results.

The second monitoring hardware type is an aethalometer shown in Figure V.2, which was installed in a subset of the monitored locations. This instrument provides minute-by-minute average concentrations of black carbon. Particulate matter from the ambient air is pumped through a quartz filter tape. The instrument measures the attenuation of infrared light through the filter tape. This attenuation is proportional to the mass of black carbon deposited on the filter. The calculated concentration based on the black carbon mass is displayed on the instrument display screen and is saved in a comma delimited file on a floppy disk. The instrument also records operation parameters such as flow rate for each concentration measurement. The limit of detection is 0.005 μg of BC per measurement, which corresponds to 0.02 $\mu g/m^3$ at 4 L/min.

Figure V-2 Aethalometer Setup

Table V-3 Monitoring Equipment Detail

Equipment	Description
Time-integrated Equipment	
Pump	SKC AirChek 52 Pump, Constant flow 5-3,000 ml/min SKC Product Code: 224-52
Rotameter	SKC Product Code: 320-4A5 SKC Field Rotameter, 4" scale. Range: 0.4-5.0 L/min.
Filter Paper (50/pkg)	SKC Preloaded Cassette, Quartz, For NIOSH 5040, 37mm, 3 Piece, SKC Product Code: 225-401
Continuous Equipment	
Aethalometer	Magee Scientific AE-42 Portable

c. Monitoring Sites

At the recommendation of the community members in the PAG, the outreach activities were targeted at obtaining 2 monitoring locations in each of the 4 communities in the study area, Parchester Village, Iron Triangle, North Richmond, and San Pablo. This goal was achieved in all neighborhoods except the Iron Triangle. All the monitoring locations are within 200 meters of an expected diesel pollution source such as the Richmond Parkway, the Burlington Northern Santa Fe (BNSF) and Union Pacific (UP) rail tracks, and the BNSF rail yard. Further details on the monitoring location and the proximate diesel emissions sources are presented in Table V.4. None of the locations are in near proximity to the Port of Richmond because the port is removed from more residential areas. However it is expected that the ships and diesel equipment operating at the port contribute to pollution at the neighborhood scale for air and pollutant mixing (about 1 to 3 miles).[115]

Two control locations were selected instead of one owing to scheduling constraints. The first control residence is located at the southernmost end of the study area. Most of the major sources of diesel pollution in study area are upwind of this residence as the prevailing winds in the region are from the southwest. The second control residence is in Lafayette, California, about 2 miles north of Highway 24. This control location was chosen to represent concentrations influence mainly by the urban scale (3 to 30 miles) of pollutants and air mixing in Contra Costa County.[9]

Table V-4 Monitoring Locations and Proximate Diesel PM Sources

Location	Proximate Diesel Particulate Matter Source	Estimated Proximity (feet)
North Richmond A	Construction site	<700
	Richmond Parkway traffic	1,500
North Richmond B	Illegal heavy-duty truck traffic on neighborhood street	<700
San Pablo A	Train traffic and idling	<700
	Richmond Parkway traffic	1,500
San Pablo B	Heavy-duty truck idling at retail delivery docks	<700
Iron Triangle A	Train traffic and idling (Burlington Northern Santa Fe Rail Yard)	<700
	Richmond Parkway traffic	<300
Parchester Village A	Train traffic and idling	<300
Parchester Village B	Train traffic and idling	<300
Control A	No proximate diesel PM sources	N/A
Control B	No proximate diesel PM sources	N/A

The study area locations and the proximate sources are displayed in Figure V.3. Other host location and monitor placement characteristics are presented in Table V.5. It is important to note that the Iron Triangle location was unoccupied during the duration of monitoring and therefore no cooking activities occurred during that time. Monitors were typically installed near a window or door in the living room or family room. At the Parchester Village B location the monitor was moved from the dinning room/kitchen to a bedroom following the host's request. The sampling inlets were located at breathing height for a seated person (about 3 feet and above) whenever possible.

Figure V-3 Map of Study Area Monitoring Locations[116]

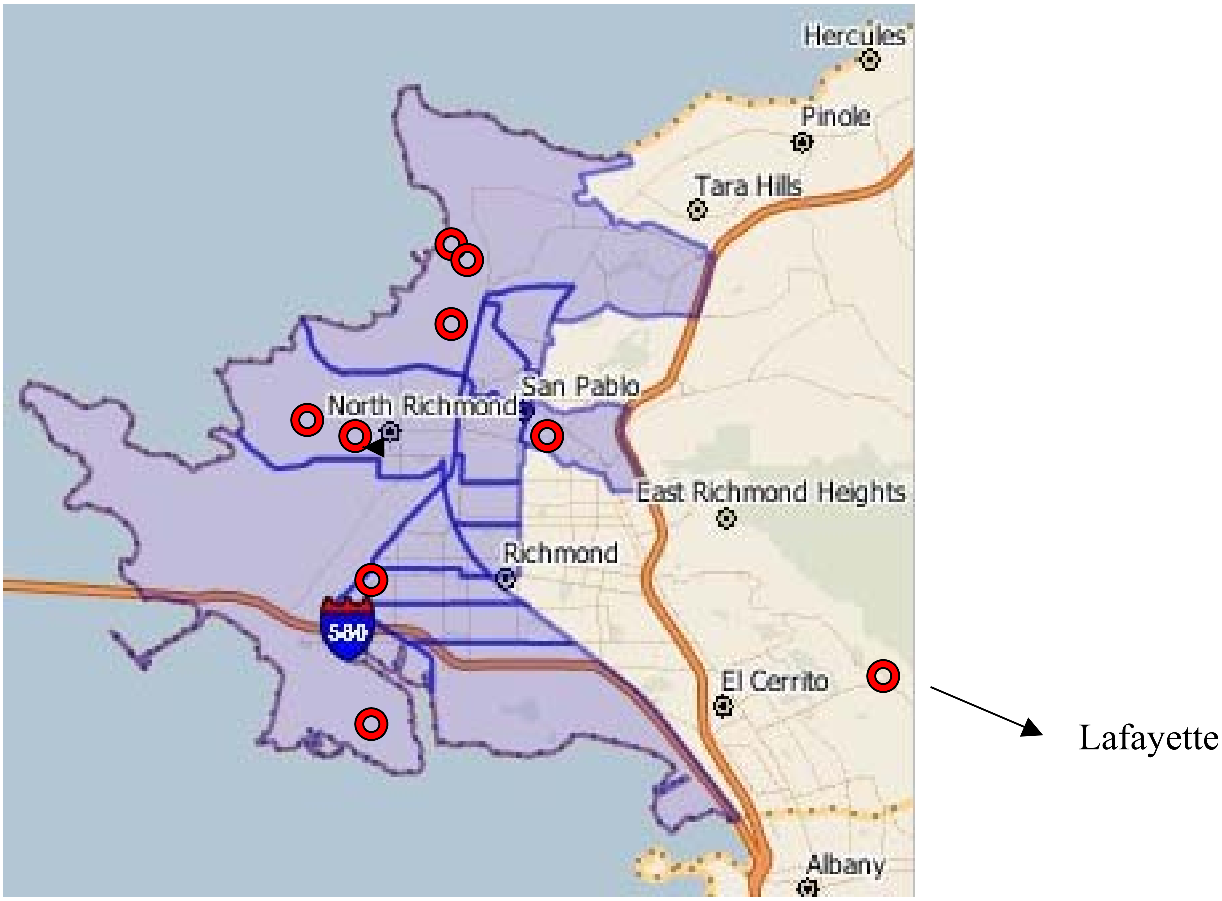


Table V-5 Monitoring Location Characteristics

Location	Heating Fuel	Cooking Fuel	Number of occupants	Monitor Location	Sampling Height (feet)
North Richmond A	Gas	Gas	3	Living Room	4
North Richmond B	Gas	Gas	4	Living Room	< 3
San Pablo A	Gas	Gas	3	Living Room	3
San Pablo B	Gas	Electric	3	Living Room	< 3
Iron Triangle A	Gas	Gas	0	Kitchen	4
Parchester Village A	Gas	Electric	2	Living Room	< 3
Parchester Village B	Gas	Gas	2	Dinning Room (2 days), Bedroom	4
Control A	Electric	Electric	2	Indoor Patio	4
Control B	Gas	Gas	1	Dinning Room	4

Strict criteria were used to select the homes that participated in the study. The set of criteria was developed to limit indoor sources of BC/EC. All the houses selected were non-smoking households where candle and incense burning as well as fireplace use were prohibited during the monitoring period. Although cooking was not restricted during monitoring, log sheets were provided to the hosts to record any heavy cooking or burnt food event. An example log sheet is provided in Appendix C with the remainder of the host packet. The logs were also used to record outdoor events that may impact DPM and thus EC/BC levels, including rail or truck idling and construction activity. The complete host selection criteria are presented in Figure V.4.

Figure V-.4 Host Selection Criteria

Home Location

This criterion is aimed at ensuring that selected homes are representative of the sources that residents are most concerned about. The residences will preferably be located within 300 meters and downwind from a known source of diesel PM in the study area: I-580, Richmond Parkway, Burlington Northern Santa Fe rail yard, major truck trip generator (United Parcel Service depot, West Contra Costa Sanitary Landfill, Post Office Bulk Center).

Inside the Home

This criterion is aimed at limiting indoor sources of elemental carbon that could potentially interfere with air monitoring. The residences will be required to be non-smoking home and to abide by the following rules:

No smoking, using the fireplace, or burning candles and incense, or BBQ allowed during the project

Provide a safe location in the living room or dining room for monitoring equipment where it will not be disturbed and be out of reach of small children and pets

Provide an electric outlet for monitoring equipment

Access during Monitoring

This criterion ensures field staff can access equipment during experiment. Residents must allow a daily pre-scheduled visit by field technician to verify equipment setup and collect filter. The monitoring will be completed over a 5 consecutive weekend/weekday period (typically Saturday through Thursday).

Other Homeowner Requirements

Residents will be required to keep a daily log of activities in the home or right outside the home or answer a monitoring debrief questionnaire to identify elemental carbon producing activities such as diesel idling outside home, cooking, burning food that occurred during the five days.

d. Time scale

The monitoring spanned the period from mid-March 2005 to mid-April 2005. The monitoring schedule was developed to maximize simultaneous monitoring during the first two weeks as shown in Table V.6. Supplemental aethalometer monitoring was performed the subsequent three monitoring periods. In most cases monitoring equipment was installed on a Saturday and operated through Thursday. This allowed collecting data both during the weekend and weekday. It is expected that outdoor diesel PM emitting activities are lower on weekends as compared to weekdays.

Table V.6 Monitoring Schedule

Monitoring Dates	Sites Monitored
3/13 to 3/17	North Richmond A (aethalometer), San Pablo A, San Pablo B, Control A
3/20 to 3/24	North Richmond B, Atchison A, Parchester A, Parchester B (aethalometer), Control B
3/26 to 3/27	Parchester B (aethalometer only)
4/2 to 4/7	San Pablo A (aethalometer only)
4/11 to 4/18	Control B (aethalometer only)

Weather conditions were variable during the monitoring period. Table V.7 includes the average temperature and wind direction for all the days on which concentration data were collected. In the first monitoring week, the study area experienced wind from the North for four days, which is atypical for the area. The mean wind speed was calculated using the harmonic mean of hourly wind speed measurements. During Week 2 and Week 3, the total precipitation for the monitored days was greater than the typical normal precipitation in the weather records. [117]

Table V-7 Monitoring Period Weather

	Monitoring Date	Avg. Temperature (°C)	Wind Speed[a] (m/s)	Avg. Wind Direction	Total Daily Precipitation (Inches)
Week 1	3/12/2005	58	3.2	NW	0.01
	3/13/2005	58	4.4	NW	0
	3/14/2005	61	3.6	NE	0
	3/15/2005	55	2.3	NE	0
	3/16/2005	55	2.5	SW	0
	3/17/2005	57	4.9	SE	0
Week 2	3/21/2005	56	5.1	SE	0.5
	3/22/2005	55	6.6	SW	0.8
	3/23/2005	53	6.7	NW	0.2
	3/24/2005	54	3.0	SW	0
	3/26/2005	54	2.6	SW	0
	3/27/2005	55	5.6	SE	0.5
Week 3	4/2/2005	56	4.7	SW	0
	4/3/2005	54	4.3	SW	0.4
	4/4/2005	53	3.5	SW	0
	4/5/2005	56	2.7	SE	0
	4/6/2005	57	3.4	SW	0
	4/7/2005	55	6.4	NW	0.1
Week 4	4/11/2005	57	4.5	SW	0
	4/12/2005	53	4.5	SW	0
	4/13/2005	51	3.9	SW	0
	4/14/2005	53	2.7	SE	0
	4/15/2005	59	4.8	SW	0
	4/16/2005	62	7.1	SW	0
	4/17/2005	60	7.7	SW	0

[a] Harmonic mean of reported hourly average values

e. Quality Control

- Sampling Handling and Custody

Filter samples were handled by trained project staff. Collected samples were labeled and stored to ensure stability. The samples did not require special storage accommodation but were be maintained in a secured compartment awaiting shipping. Samples were shipped by express mail to Galson Laboratory (6601 Kirkville Road East Syracuse, New York 13057-0369) for analysis at the end of the second monitoring period. Residents were trained prior to the advent of monitoring and agreed to follow certain precautions to ensure accuracy of the results. This included not allowing smoking in the household, not burning candles, incense, or firewood as described in Figure V.4. Project staff discussed any unusual activities during each 24-hour period of monitoring at time of filter collection. Unusual activities could include a diesel truck idling outside their residence, food burning during cooking, or a guest smoking in the residence

- Instrument/Equipment Testing Inspection and Maintenance

Equipment and consumables were provided by Galson Laboratories and by SKC Inc., which are suppliers of NIOSH approved materials for air monitoring. Instruments (pumps and rotameter) were calibrated by the provider, Galson Laboratory, before sampling. Pump flow rate was verified each day with a field rotameter.

- Special Training and Certification

Staff received training in pump calibration and appropriate filter handing. Monitoring equipment hosts were also provided training on the purpose of the project and their role. Residents of host residences received information on the restricted activities during monitoring. They were also trained on how the monitoring equipment functions. Appendix C contains the fact sheets provided to host residents.

- Data Management

The project staff ensured that any information remained confidential and that data is only released in aggregated formats. The measures undertaken included but are not limited to:

- Maintaining any personally-identifiable written materials in locked storage
- Removing any personal identifiers from summary tables containing air monitoring results (results are coded)
- Maintaining all electronic records are maintained in a secure network environment

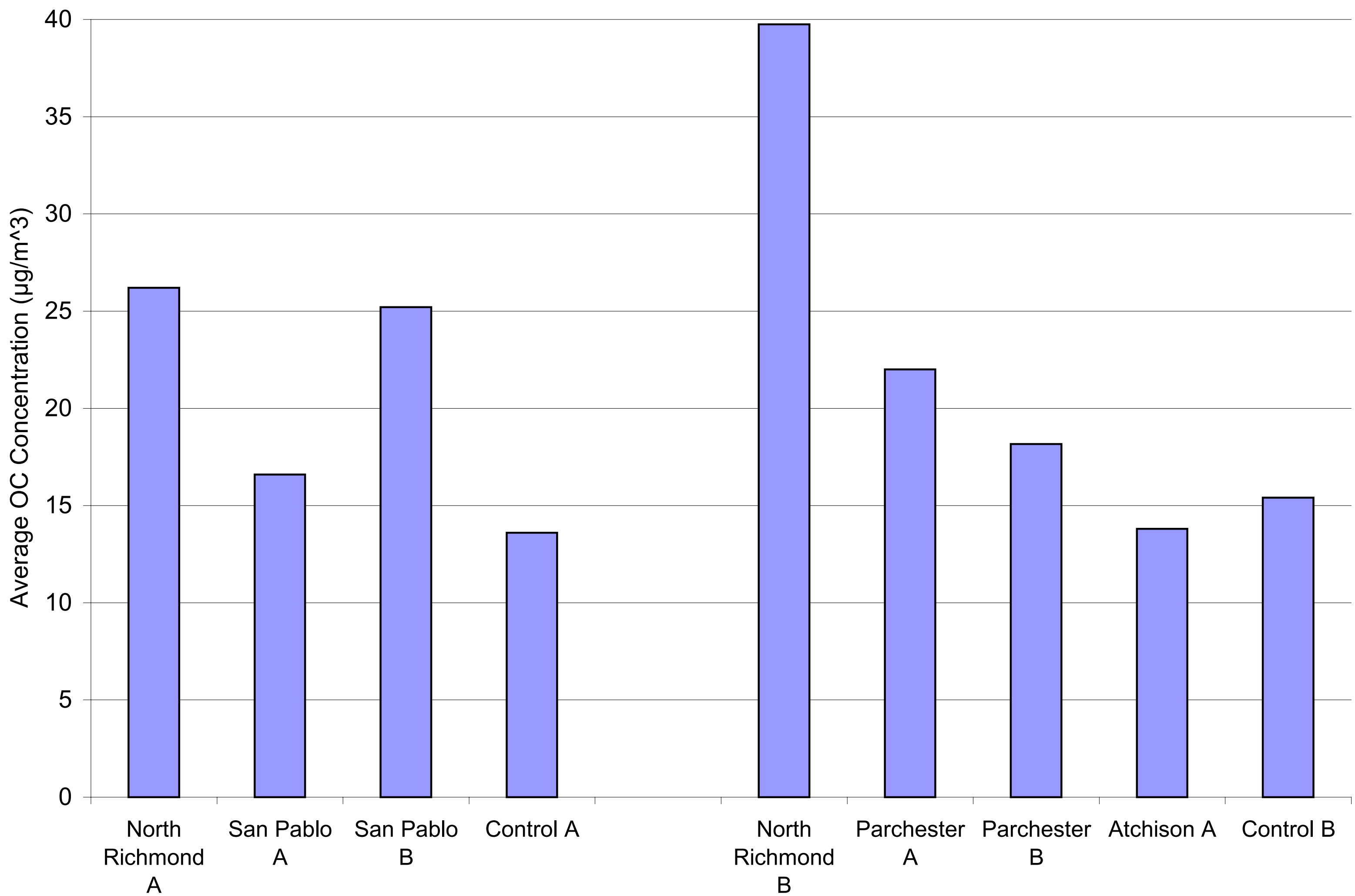
D. MONITORING RESULTS

a. NIOSH 5040 Results

The laboratory performed the NIOSH 5040 method with a level of quantification of 3µg for OC, EC and 6 µg for TC. With a 2 L/min pump flow rate, this translates to a minimum quantifiable EC concentration of 1 $\mu g/m^3$. All the samples collected during the monitoring period represented EC levels below this limit concentration. These findings are in agreement with the BC concentrations results found through aethalometer monitoring that presented in the following section. Sampling for a longer time period or at a higher flow rate would have increased filter loading, thus allowing a lower resolution for concentration.

The daily OC concentration measured ranged from 10 to 70 $\mu g/m^3$. The average OC concentrations observed at each location are provided in Figure V.5. As OC was not a target pollutant, these results are not further discussed in this study.

Figure V.5 Average Indoor Organic Carbon Concentrations in μg/m^3



b. Aethalometer Results

The aethalometer's raw outputs are minute by minute concentrations that are converted into hourly averages. Figures V.6 through V.9 present the hourly averages for the four sites where the aethalometer was installed: North Richmond A, Parchester Village B, San Pablo A, and Control B. The graphs include information on emission events that were reported on the host logs. Several significant concentration peaks such as the one that occurred on Tuesday in North Richmond A happened when no occupants were present.

Power outage interrupted monitoring at the Parchester Village B location on two occasions. Additional monitoring was therefore performed on the weekend following the first monitoring period to obtain weekend concentrations.

Table V.8 provides the daily average concentration for each location. The italicized values are averages that were calculated with less than 75% of the data for the 24 hour period considered. This occurred on the day the instrument was installed in each location.

Table V-8 Daily Average Black Carbon Concentration in μg/m^3

Location	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
North Richmond A	*0.30*	0.31	0.44	0.78	0.56	0.76	N/A
Parchester Village B	*0.71*	0.17	0.51	N/A	0.25	0.38	N/A
San Pablo A	*0.17*	0.14	0.15	0.37	0.48	0.20	N/A
Control B	0.20	0.11	*0.14*	0.12	0.07	0.12	0.16

In addition to hourly and daily average, the aethalometer results were used to calculate a weekday and daytime weekday average. The daytime was defined as the period extending from the beginning to the end of the carpool hours on local highways. These averages are presented along with the Sunday average in Figure V.10.

Figure V-6 North Richmond Hourly Indoor BC Concentration (µg/m^3)

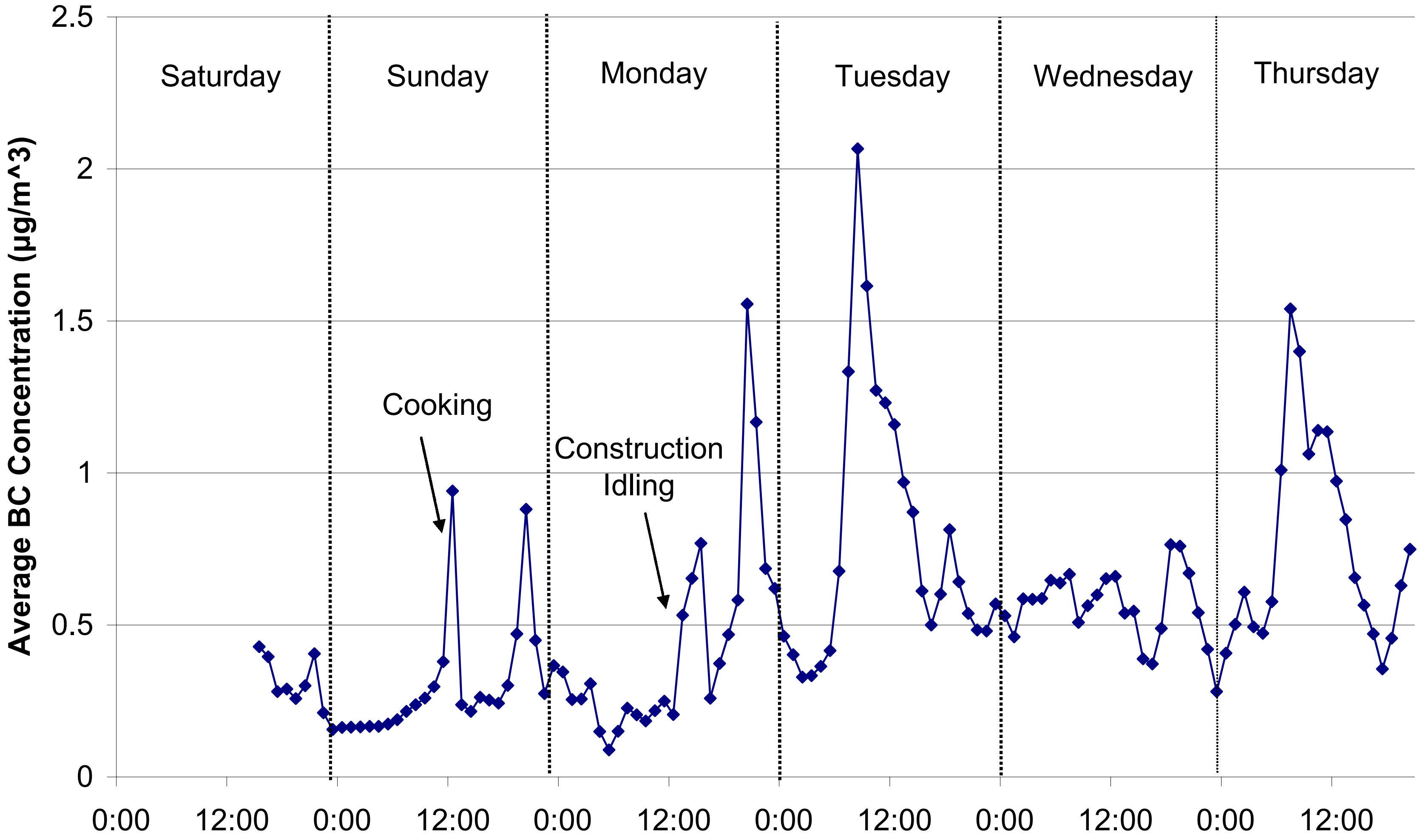


Figure V-7 Parchester Village Hourly Indoor BC Concentration (µg/m^3)

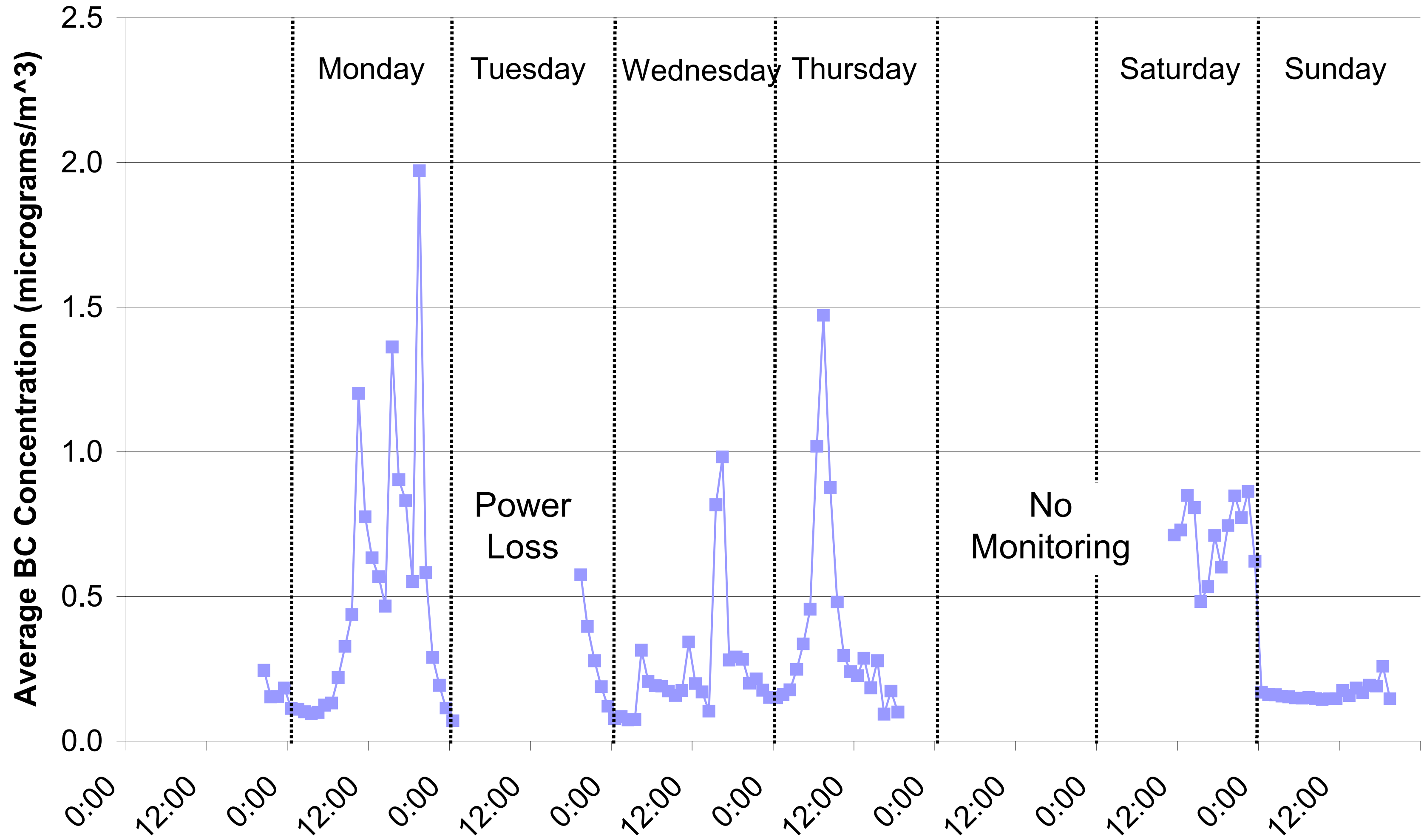


Figure V-8 San Pablo A Hourly BC Concentration (µg/m^3)

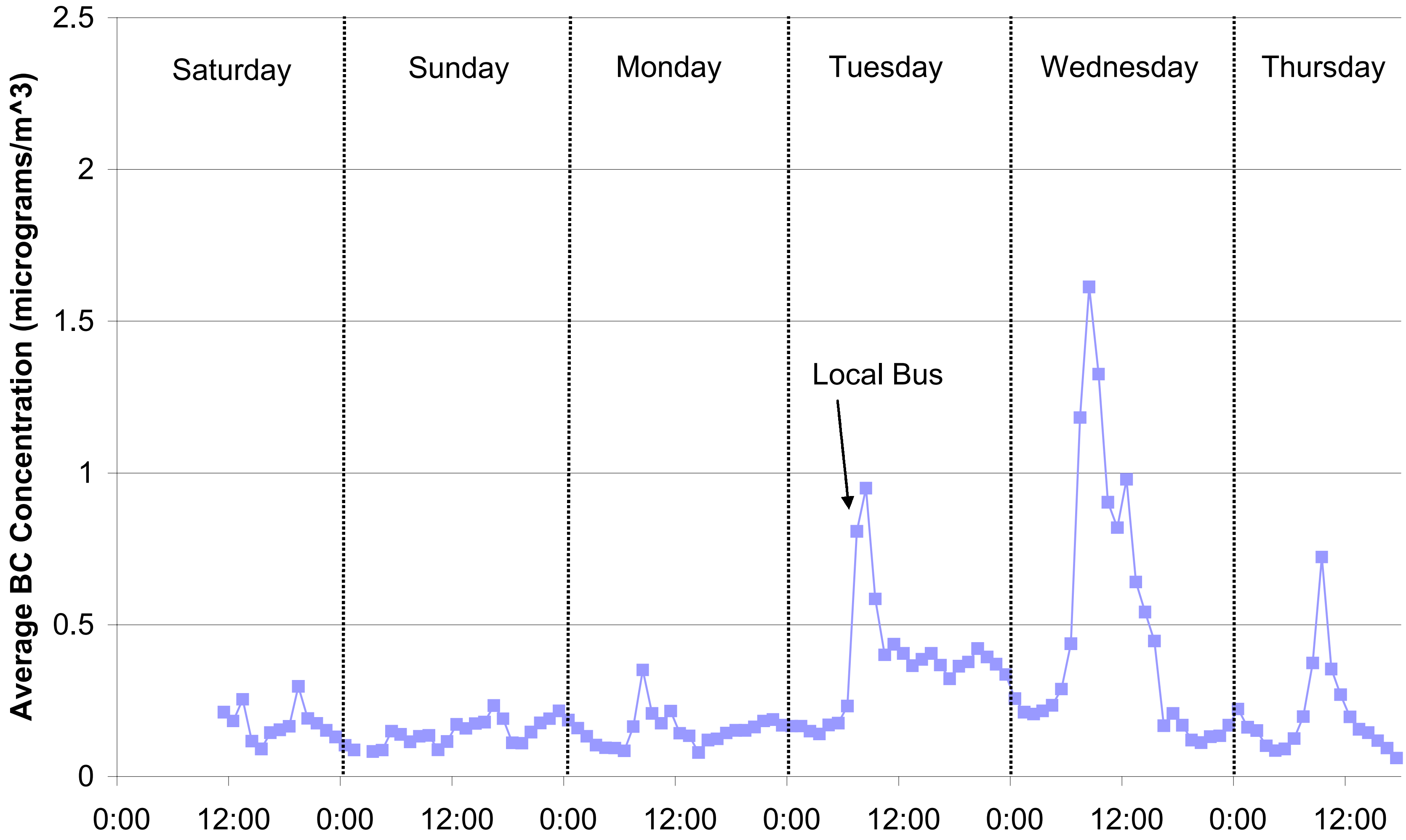


Figure V-9 Control B Hourly BC Concentration (µg/m^3)

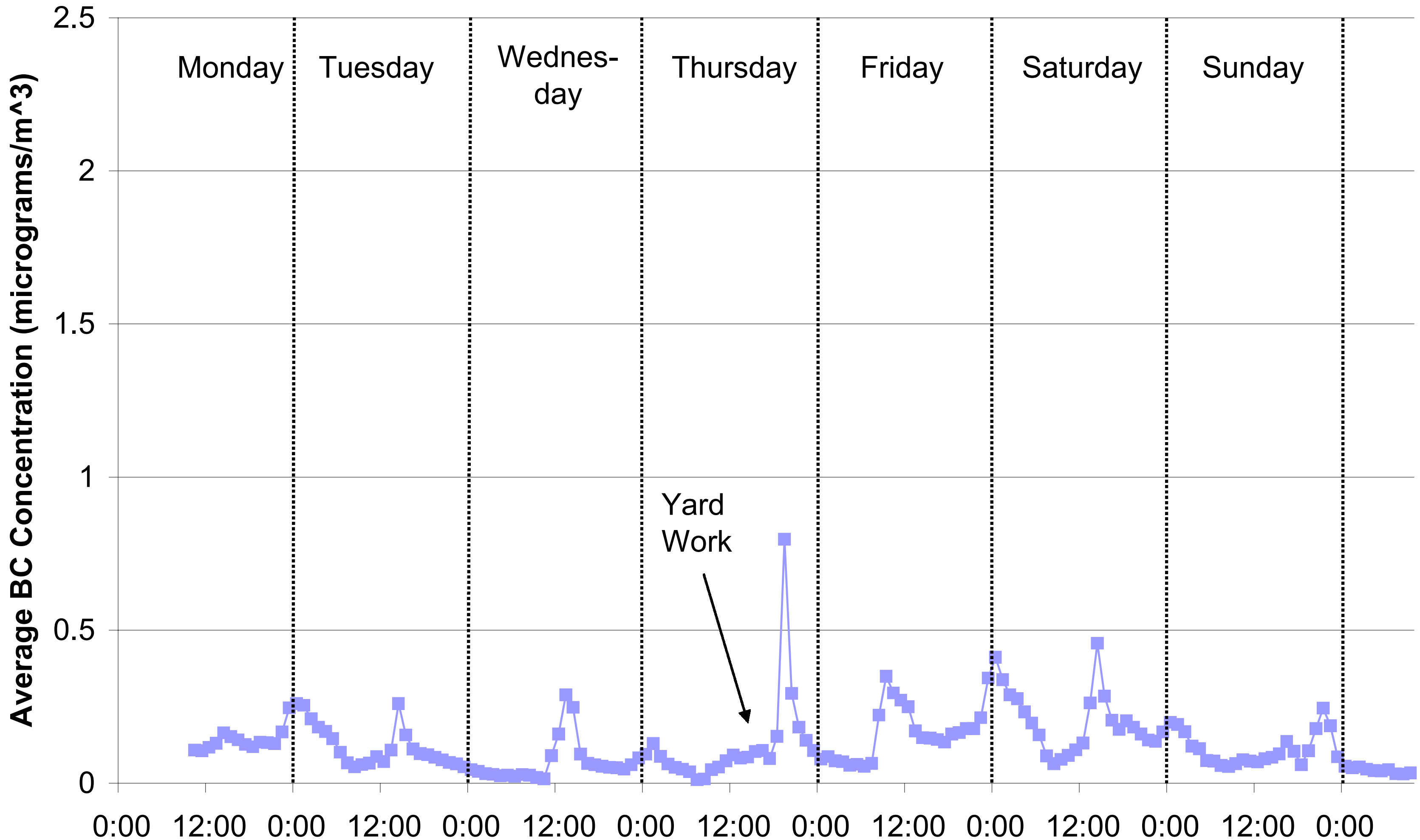
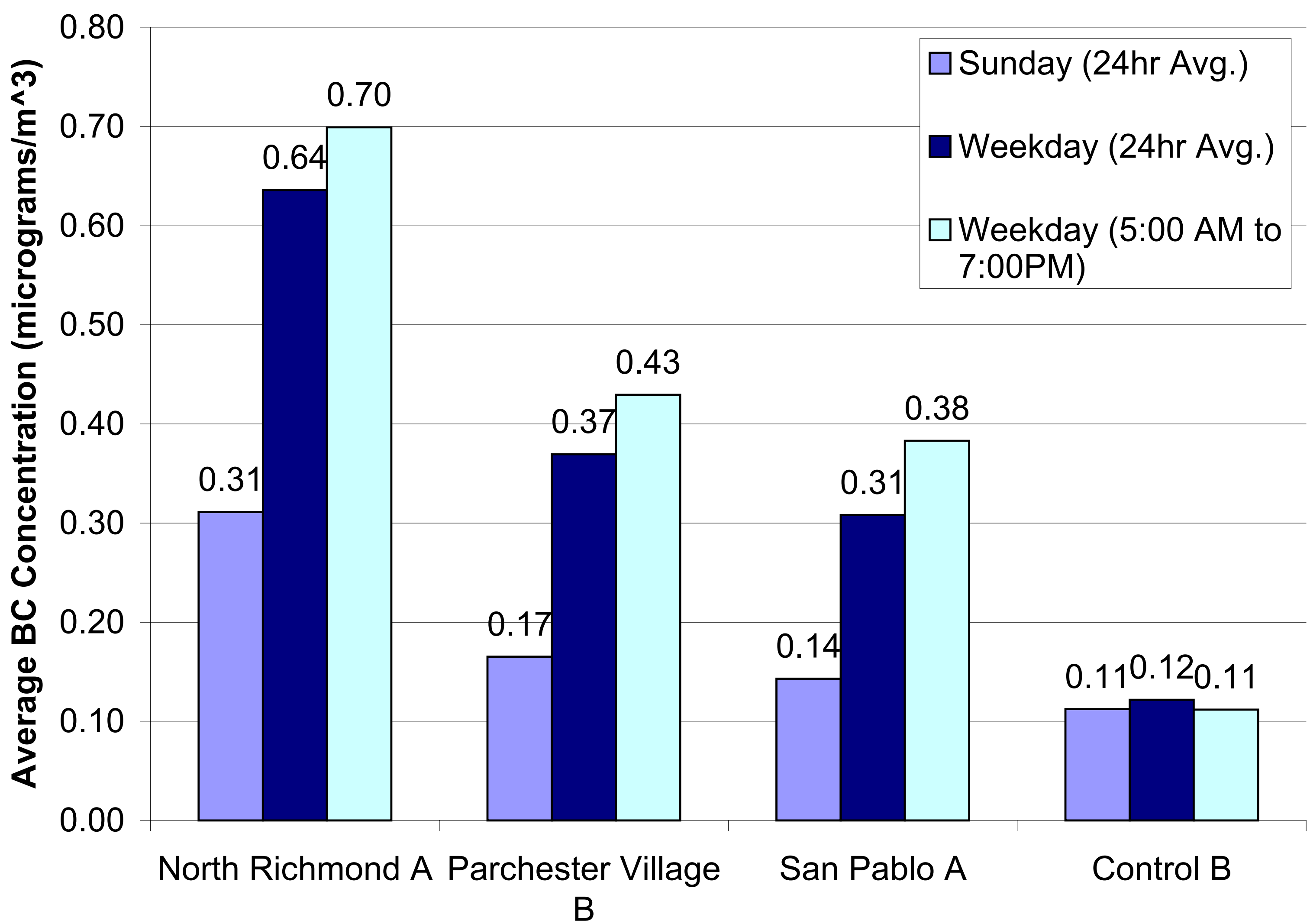


Figure V-10 Weekend, 24-Hour, and Daytime Weekday Average BC Concentrations (µg/m^3)



E. RESULT DISCUSSION AND ANALYSIS

The levels of EC/BC in the monitored homes are on the lower end of the range found in previous indoor concentration studies as summarized in Table V.9. These studies represent a range from urban to suburban locations with a variety of monitoring techniques, including those implemented in this study.

Figures V.6 through V.9 provide evidence of the impact of outdoor sources on indoor BC concentrations. The hourly concentration graphs have peaks associated with reported BC generating activities outdoors. For example, on Monday in North Richmond, a several-hour peak occurred subsequent to construction equipment idling within 50 m of the home. Similarly, the San Pablo A residents noted local bus activities in front of their house between 6:00 and 7:00 AM, which related to a peak in concentrations inside the home. Finally, gardening activities including the use of a leaf blower at the Control B location on Thursday resulted in the highest peak in concentration observed during the monitoring period.

Another indication of the influence of outdoor sources in the study area is the clear difference between indoor concentrations measured on Sunday and the average of weekday concentrations. In each of the residences monitored in the study area, the weekday average indoor BC concentration is about two times the average Sunday concentration as illustrated by Figure V.10. Sundays are characterized by reduced commercial trucking activities and are typically off days for construction activities. However, study area residents reported that train activity does not decrease significantly over the weekend. Ship and cargo handling activity at the Port of Richmond is sporadic owing to its nature as a bulk petroleum product port.

To further corroborate the influence of proximate outdoor sources on indoor BC concentrations, we also found no observable difference between Sunday and weekday average in the Control B location. This observation might be explained by the fact that the indoor concentrations measured in the Control B location are more influenced by the average pollution at the air basin level rather than by nearby sources. Indeed the location was selected as a control location because it was considered to not have any significant nearby diesel particulate matter sources.

The hourly average concentrations also provide evidence that indoor sources contribute to indoor BC concentration. Natural gas fired cooking activities on Sunday in North Richmond A coincides with a peak. The duration of that peak is shorter than the one observed during the construction equipment idling event in North Richmond or the bus activity in San Pablo. The lack of other cooking event logs does not allow any generalizations to be drawn from this one observation.

Overall, the shapes of the hourly average concentration curves from the study area and the control location (Figures V.6 through V.9) do not exhibit any distinctive temporal patterns. Peaks occur from the early morning to late in the evening. Averages calculated for the period between 5 AM and 10 PM (morning rush hours) and 3 PM and 7 PM (afternoon rush hours) do not show any clear trend. These averages are presented in Table V.10. The hourly average concentration curve shapes do seem to indicate that there is a fairly steady baseline concentration represented by the bottom part of the graph upon which the effects of the proximate and neighborhood scale sources are layered.

Table V-9 Previous Elemental Carbon and Black Carbon Study Concentration Results[118]

					Results (mean µg/m^3)		
Study	City	Location	Pollutant	Method	Indoor	Outdoor	Back-ground
Na et al. (In press)	Mira Loma, CA	Residential Homes	EC (PM2.5)	Thermal Optical (NIOSH 5040)	2	2.5	
Geller et al. (2002)	Coachella Valley, CA	Residential Homes	EC (PM2.5)	Thermal Oxidation	0.05 to 1.25	0.3 to 1.2	
LaRosa et al. (2002)	Suburban Washington DC	Residential Homes	BC	Aethalometer	0.46	0.74	
LaRosa et al. (2002)	Suburban Washington DC	Residential Homes	BC	Aethalometer	0.35	0.68	
Landis et al. (2001)	Towson, MD	Retirement Facility	EC (PM2.5)	Thermal Optical	0.4	0.5	0.5
Funasaka et al. (2000)	Osaka City, Japan	Residential Homes	EC (PM2)	Thermal Oxidation	5.5	10	6.4
Long et al. (2000)	Boston Area, MA	Residential Homes	EC	N/A	0.9	1	

Table V-10 Commute, Daytime and 24-Hour Averages (µg/m3)

	North Richmond A	Parchester Village B	San Pablo A	Control B
AM Commute (5:00-10:00 AM)	0.78	0.44	0.49	0.07
PM Commute (3:00-7:00 PM)	0.52	0.56	0.22	0.11
Daytime (5:00 AM-7:00 PM)	0.70	0.43	0.38	0.11
24-Hour	0.64	0.37	0.31	0.12

F. CONCLUSION

Although the BC concentration measured in the study area locations were similar to the low end of previously monitored locations, several features of the obtained results validate the residents general concerns about diesel particulate matter pollution in the study area. These features include the effect of proximate diesel sources on indoor concentrations as well as the differences between average black carbon concentrations in the study area and the control location. The weekday average black carbon concentration measured in the study area locations was about four times larger than the concentration measured in the control location. Additionally, an increased frequency and magnitude of peak events in the study area as compared to the control location was also found. Nevertheless, the small number of sampling locations in this pilot study and the inability to separate the effects of indoor and outdoor sources on the measured concentrations limit the ability to definitively conclude on whether the study area is disproportionately impacted by diesel particulate matter pollution and to what extent. Overall, the obtained results tend to confirm the resident's concern about diesel particulate matter impact in their community. Additional data on outdoor concentrations and more extensive monitoring would be necessary to develop statistically significant results. This pilot study has set the foundations for project participants to conduct further assessments using a community-driven research model.

APPENDIX A

Reducing Diesel Pollution in West Contra Costa County

Draft Workplan from
The West County Asthma and Diesel Committee

A. Background

At the November Air Pollution Town Hall meeting organized by the Community Health Initiative Air Monitors and the West County Asthma Advocates, community residents identified the air pollution and health issues they were concerned about. A major issue of concern was diesel pollution from trucks, trains and other sources. In February, the Asthma Advocates organized a session looking at the links between diesel pollution and asthma. The panel of speakers identified that diesel pollution could not only make asthma worse, but may actually cause asthma.

To address this issue, a number of organizations, residents, and agencies came together to find ways to reduce diesel pollution in West Contra Costa County. In the next year, we would like to conduct research to understand how much diesel pollution is in the community, find out how it is affecting our health, and what we can do to reduce diesel pollution and improve our health.

Following is a suggested workplan to begin addressing diesel pollution issues in West Contra Costa County. <u>We need your feedback!</u> We want to make sure this workplan addresses your questions, and lays out a clear strategy to get us the information and tools we need to reduce diesel pollution in our neighborhoods.

B. Diesel Pollution in West Contra Costa County

- Diesel pollution from the train terminals in our area and from oil tankers at Chevron and other ships docking at the Port of Richmond causes great concern among the community.
- Approximately 3,820 trucks use the Richmond Parkway daily to access I-580. Richmond Parkway and I-580 border the affected areas.
- On average, there are 11,000 diesel trucks driving daily through each of the highways, freeways, and parkways in Richmond and San Pablo.
- In addition, the amount of daily diesel truck traffic is expected to increase with the planned construction of a landfill transfer station in North Richmond.
- Exposure to diesel air pollution can increase the risk of cancer, heart disease and asthma in a community. There are currently more than 12,000 children and 23,000 adults estimated to be diagnosed with asthma in Contra Costa County.

Workplan to Identify and Reduce Diesel Pollution in the Community

In the next year, we propose to work with community residents to identify the information they want on diesel pollution, conduct a series of studies on diesel pollution, identify solutions to the problem, and work with elected officials and agencies to implement solutions.

Specifically, we propose to:

1. Identify Community Questions

- Identify the environmental and health questions residents have about diesel pollution.
- Work with neighborhood councils and other neighborhood organizations to ensure that the diesel research and solutions meet their needs.

2. Conduct Research

- Develop an inventory of all diesel emissions to which North Richmond residents are exposed (freeway traffic, truck traffic, etc.).
- Work with the Contra Costa County Public Works Department to document the pattern of truck transit through the neighborhoods.
- Conduct a limited indoor air monitoring study in West County homes. Determine the exposure of West County residents to diesel pollution in indoor air.
- Determine the health impacts to West County residents, and residents along Interstate 80, 580 and the Richmond Parkway due to existing pollution levels and exposure.
- Develop materials to promote community education on diesel pollution and health, and educate residents on West County toxics issues at community forums, churches, and other community venues.

3. Identify and Implement Solutions

- Identify alternatives to reduce diesel pollution in North Richmond. Mitigation measures might include alternate fuels, alternate truck routes, purchasing newer vehicles that pollute less and retrofitting older vehicles, and altering the locations of refueling stations. Determine and identify opportunities to reduce truck traffic at the proposed transfer station.
- Work with elected officials and agencies to present findings on diesel pollution and solutions to reduce diesel pollution and improve health in the community.
- Implement solutions in partnership with policymakers and agencies.

We Need Your Feedback!

- What questions do you have about diesel pollution and health in your community?
- We think that the geographic area should include areas of North Richmond, Parchester Village, Iron Triangle and San Pablo. What other areas should be included in this study?

- What neighborhood street corners do you think have a lot of truck traffic that should to be monitored?
- Other feedback?

APPENDIX B

Table I Data Not Used in Preparing the Heavy Heavy-Duty Truck Inventory

Author/Source	Title	Data Not Used and Why
Fehr & Peers	MacDonald Avenue Existing Transportation Documentation	Not Used: Traffic volume on Macdonald Avenue Why: Does not distinguish truck traffic from other vehicle traffic
West Contra Costa Sanitary Landfill	WCCSL Bulk Materials Processing Center and Related Actions Draft Environmental Impact Report	Not Used: Truck counts at facility entrance and freeway entrances Why: Does not distinguish truck traffic from other vehicle traffic
Impact Sciences, Inc.	Edgewater Technology Park/Breuner Marsh Mitigation Bank Draft Environmental Impact Report	Not Used: Peak hours traffic counts at 14 intersections Why: - Does not distinguish truck traffic from other vehicle traffic - Does not provide study area-wide truck counts
City of Richmond Planning Agency	Parkway Commerce Center Draft EIR	Not Used: Existing and projected peak traffic flow at 11 intersections Why: - Does not distinguish truck traffic from other vehicle traffic - Does not provide study area-wide truck counts

Table II Data Not Used in Preparing the Construction Equipment Inventory

Author/Source	Title	Data Not Used and Why
California Air Resources Board	OFFROAD Emission Model	Used: Construction equipment population inventory for Contra Costa County Why: Population inventory could not be used without further assumptions about equipment emission factors

Appendix C

Selected Host Packet Materials

NEIGHBORHOOD HOUSE OF NORTH RICHMOND

Community Health Initiative

PACIFIC INSTITUTE
Research for People and the Planet

CONTRA COSTA HEALTH SERVICES

March 18, 2005

Dear Host,

The West Contra Costa County Indoor Air Quality Monitoring Project Team would like to sincerely thank you for volunteering to host the indoor air quality monitoring equipment. Your participation is essential to the success of this very important project.

This project to monitor diesel soot in homes is the result of a collaborative effort joining the Neighborhood House of North Richmond, Community Health Initiative, the Pacific Institute, and Contra Costa Health Services. The project is aimed at answering important community questions about diesel pollution raised at a town hall meeting on air quality held in November 2003. This indoor air monitoring will tell us how much diesel soot is in the air inside residents' homes, and give us important information to develop solutions to reduce this pollution. This packet contains information on the monitors we have installed in your house, contact information for the project team, as well as information on how to get involved in efforts to reduce diesel pollution in your community. Thanks again for your participation.

Lee Jones Jannat Muhammad Fanta Kamakaté
The West Contra Costa County Indoor Air Quality Monitoring Project Team

Important Reminders for Monitor Hosts

Put this in a place where all family members can see it

PLEASE REMEMBER:

- ✓ Any smokers should smoke outside for those 5 days.
- ✓ Wait until the 5 days of monitoring are completed to burn candles, incense, or wood in the fireplace.
- ✓ Keep the monitor in the same location, always plugged in.

If the following occurs while you are at home, please mark the date, time and event on the provided Log sheet:

- ✓ Food is burnt
- ✓ Truck or train is idling near your home
- ✓ Smoking occurs indoors
- ✓ Power goes out

If you notice that the monitor is not operating as it is supposed to (or accidentally unplugged?), please contact the technical support team:

Fanta Kamakaté at (650) 575-8823 cell phone, or (510) 540-8060 home

Lee Jones at (510) 798-3322

Your Home Monitoring Log

Please record any activities that happen in the next 5 days that could affect the air in your home. For example, if you are toasting bread and it burns, you need to record the day & time it happens because it changes the air in your home. This does not mean you can't toast bread, we just need to know when these activities happen so we can take them into account when we look at the indoor air quality in your home.

EVENT ↓	DAY 1: Sunday	DAY 2: Monday	DAY 3: Tuesday	DAY 4: Wednesday	DAY 5: Thursday
	If any of the following events occurred during the 5 monitoring days, please check the appropriate box and write down what time it happened under the day it happened (example below)				
***Example**: Idling Truck near your Home*	☑ 11:30 am – 11:45 am	☑ 5 – 6:45 am	☑ 9 – 9:30 am	☐	☑ 12 – 1 pm
	☑ 5:30 – 6 pm	☐	☑ 7 – 8 pm	☐	☐
	☐	☐	☐	☐	☐
Burning Food	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
Idling Truck near your Home	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
Idling train near your Home	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
Smoking indoors	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
Power failure	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
______________	☐	☐	☐	☐	☐
Other:	☐	☐	☐	☐	☐
______________	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
Other:	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
______________	☐	☐	☐	☐	☐

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