

Air Quality at Memorial Academy Charter School in Barrio Logan, a Neighborhood Community in San Diego

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Introduction

Air pollution can cause adverse health effects. Some of these effects are lung damage, heart problems, and in some cases, premature deaths. Traditionally, air quality monitors measure pollutant levels from a regional perspective. These monitors do not necessarily address the impact of nearby sources of emissions on air quality in a particular neighborhood. Hence, certain pockets or neighborhoods within a larger area may have better or worse air than the overall region. Individual communities may want to know about the impacts of air pollution at a smaller, neighborhood level – to see whether their pollution levels differ from the regional averages. In 1999, a special study was begun to address such interests at Barrio Logan, a community located in San Diego. This report discusses the results of the initial 17-month air quality study (from October 1999 to February 2001).

Barrio Logan is a community with both residential and industrial facilities. The population is largely Latino, and 40 percent of households are below the federal poverty level. The residents' interest in learning about the health impact of pollution from industrial operations and the community's proximity to freeways and industrial sources such as shipyards led to a special monitoring study. As a result, the Air Resources Board (ARB), the San Diego County Air Pollution Control District, the Environmental Health Coalition, and others designed a study to evaluate air pollution levels around Barrio Logan. During the study, air quality measurements were collected at Memorial Academy Charter School, located at 28th Street and Logan Avenue in San Diego. The site was selected partly due to its proximity to potential emission sources including a major freeway and industrial sources such as shipyards.

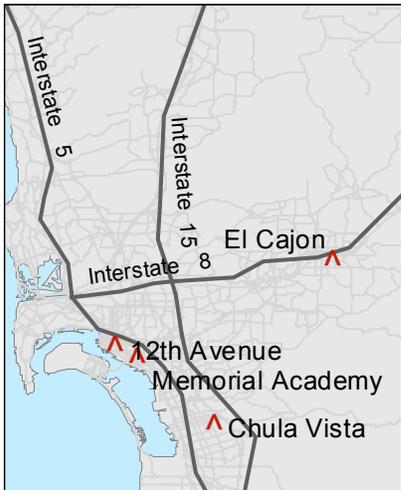
This report documents the ARB's review of outdoor air measurements at Memorial Academy and our initial evaluation of the potential impacts of air pollutants on public health in the Barrio Logan community. Specifically, it addresses the health impact of outdoor air pollutants at Memorial Academy compared with other areas of San Diego and California in general. Greater details of our analyses can be found in a separate Technical Support Document; information about this document appears at the end of this report.



Barrio Logan community was selected due to its unique location, socioeconomic status and community interests in learning about the potential impacts of toxic air pollutants on health. Data were collected at Memorial Academy Charter School.



This report focuses on an initial study of the health impact of outdoor air pollutants at Memorial Academy compared with other areas of San Diego and California in general.



We used data from three long-term sites in the San Diego region to compare against air quality measurements taken at Memorial Academy.

This report focuses on our initial evaluation. Due to the proximity of residences to major truck traffic and industrial sources, and community interest in the effects of toxic air pollutants on the community, additional studies of air quality in Barrio Logan have been conducted to investigate whether or not there are pockets of toxic air pollutants at higher levels than those found at Memorial Academy. Details are available at: <http://www.arb.ca.gov/ch/communities/studies/barriologan>.

We collected outdoor air samples at Memorial Academy from October 1999 through February 2001 for about 50 air pollutants, some of which are toxic while others contribute to smog and particulate matter. Toxic air pollutants are known or suspected to cause cancer or other serious illnesses. Smog and particulate matter are “criteria pollutants” for which health-based criteria or standards have been established. The standards establish the levels above which a criteria pollutant may cause adverse health effects in humans.

In addition to this special-purpose monitoring at Memorial Academy, there are three nearby areas in San Diego where air pollutants are monitored routinely. These long-term air monitoring sites are Chula Vista (six miles southeast of Memorial Academy), El Cajon (thirteen miles northeast of Memorial Academy), and San Diego-12th Avenue (two miles northwest of Memorial Academy). Toxic air pollutants are measured routinely at Chula Vista and El Cajon. Criteria pollutants are measured at all three sites. We used the data from these long-term monitoring sites to compare against air quality measurements taken at Memorial Academy.

Table 1 lists some of the key pollutants measured and reviewed for this report. Particulate matter from diesel-powered engines, an important contributor to cancer risk, was not directly measured as part of this study. Monitoring capabilities for diesel particulates and some other air pollutants that may cause adverse health effects have not been developed.



About 50 air pollutants were measured during 17 months of monitoring.

Table 1. Some Key Pollutants Monitored at Memorial Academy

<i>Toxic Air Pollutants</i>	<i>Criteria Pollutants</i>	<i>Other Pollutants</i>
1,3-Butadiene	Carbon Monoxide	Manganese
Benzene	Oxides of Nitrogen	Nickel
Acetaldehyde	Ozone	Zinc
Formaldehyde	Particulate Matter	Benzo(a)pyrene
Perchloroethylene		
Carbon Tetrachloride		
Methylene Chloride		
Para-Dichlorobenzene		
Hexavalent Chromium		

Pollutants With Health-Based Standards

Criteria pollutants are known to cause lung damage, heart problems, and in some cases, premature deaths. Hence, standards were established to protect public health. Four criteria pollutants - particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NOx), and ozone - were measured at Memorial Academy. These pollutants were also measured at three long-term monitoring sites in the San Diego region – Chula Vista, El Cajon, and San Diego-12th Avenue -- with the following exceptions: CO was not measured at El Cajon and PM was not measured at San Diego-12th Avenue. Levels of particulate matter, ozone, carbon monoxide and oxides of nitrogen at Memorial Academy were comparable to the statewide averages. For comparison purposes, the statewide averages were determined based on all the sites in California.

Particulate Matter

The San Diego area currently does not meet the State standards for particulate matter (PM10). This size of particulate matter allows the pollutant to reach deep in the lungs, where they may be deposited and result in adverse health effects. Major sources of particulate matter in California include motor vehicles, area wide sources such as windblown dust from open lands, dust from construction, landfills and agriculture, wood-burning stoves and fireplaces, wildfires and brush/waste burning, and industrial activities.

Table 2 summarizes results for particulate matter over a 12-month period (October 1999 to September 2000). The same period was analyzed for all criteria pollutants. It is typical to study air quality over such a period to account for seasonal variations. Unlike the other criteria pollutants, which are measured every day, particulate matter is measured once every six days.

Based on the results, in about one out of 8 days measured at Memorial Academy, levels of particulate matter were higher than the established standard (about the same as downtown San Diego). Levels were higher than the state standard in about one out of 30 days measured at Chula Vista, and in about one out of 20 days measured at El Cajon, the levels were above the standard. Although the number of days with levels above the standard may differ between Memorial Academy and the other three sites, the average and maximum levels are comparable. Programs are in place to reduce particulate matter throughout California.

Table 2. Particulate Matter in a 12-Month Period.

<i>Location</i>	<i>Average*</i>	<i>Maximum*</i>	<i>Number of Days Above State Standard</i>
Memorial Academy	35	61	6 of 46 days
Chula Vista	31	59	2 of 55 days
El Cajon	32	60	3 of 58 days
San Diego - 12th Ave.	35	64	7 of 57 days

* Units of measure are micro-grams per cubic meter (ug/m3) for 24 hours.

Ozone

Ozone is a product of chemical reactions of nitrogen oxides, volatile organic compounds and oxygen with the energy of sunlight. Near the earth’s surface, ozone can cause breathing difficulties and even lung damage. Ground-level ozone can also cause damage to vegetation, buildings, rubber, and plastics. Currently, some areas in the San Diego region and many other areas of the State do not meet the State standard for ozone. As summarized in Table 3, levels of ozone at Memorial Academy are comparable to the San Diego region. Over a period of a year, about one day measured at Memorial Academy and

the long-term site (San Diego-12th Avenue) showed levels of ozone above the established standard. California has adopted aggressive emission controls on motor vehicles and other sources, and as a consequence, the ozone levels have greatly decreased over the last several decades in the San Diego region. We expect continued progress toward reducing ozone.

Table 3. Ozone in a 12-Month Period.

<i>Location</i>	<i>Average*</i>	<i>Maximum*</i>	<i>Number of Days Above State Standard</i>
Memorial Academy	42	96	1
Chula Vista	50	91	0
El Cajon	49	106	5
San Diego - 12th Ave.	43	118	1

* Units of measure are parts-per-billion (ppb) for one-hour averages. Average and maximum are based on daily one-hour maximum values.

Nitrogen Oxides

Nitrogen oxides (NOx) contribute to the formation of ozone and particulate matter pollutants, both of which are major air pollutants. Nitrogen oxides are emitted during the high-temperature combustion of fuels. Nitric oxide and nitrogen dioxide make up nitrogen oxides. There are standards established for nitrogen dioxide, but not for nitrogen oxides. On-road motor vehicles and other mobile sources currently contribute most of the NOx emissions in California, while industrial sources contribute some.

Table 4 shows that Memorial Academy’s annual levels of nitrogen oxides are slightly higher than those at Chula Vista and El Cajon, but they are similar to San Diego-12th Avenue. All locations in the San Diego region and other areas of the State currently show levels below the standard for nitrogen dioxide. However, we continue to work toward reducing levels of nitrogen oxides due to its role in the formation of ozone.

Emissions of nitrogen oxides from on-road motor vehicles have declined by over 30 percent from 1990 to 2000 and are projected to decrease by an additional 40 percent between 2000 to 2010, due to stringent

emission standards on motor vehicles and the introduction of a cleaner burning gasoline. Emissions from industrial sources have also decreased, largely due to a switch from fuel oil to natural gas and the implementation of combustion controls.

Table 4. Nitrogen Oxides in a 12-Month Period.

<i>Location</i>	<i>Average*</i>	<i>Maximum*</i>
Memorial Academy	61	234
Chula Vista	31	137
El Cajon	43	184
San Diego - 12th Ave.	54	276

* Units of measure are parts-per-billion (ppb) for one-hour averages. Average and maximum are based on daily one-hour maximum values.

No federal one-hour health-based standard has been established for oxides of nitrogen; the State standard for nitrogen dioxide is 25 ppb for a one-hour average.

Carbon Monoxide

Carbon monoxide (CO) is a colorless and odorless gas at room temperature. It is readily absorbed through the lungs into the blood, causing insufficient oxygen to reach the heart, brain, and other tissues. The resultant harm can be critical for people with heart disease, chronic lung diseases, and anemia, as well as for unborn children, especially at high elevations where the air is less dense.

Carbon monoxide is formed as a result of incomplete combustion of fuels and waste materials such as gasoline, diesel fuel, wood and agricultural debris. Mobile sources generate most of the emissions in California. Industrial sources of carbon monoxide emissions are small.

Currently, carbon monoxide levels in most areas of California are below the State standard. Table 5 shows Memorial Academy, like other sites in San Diego, is no exception. Much of the progress in reducing levels of carbon monoxide is attributable to motor vehicle controls and the introduction of cleaner fuels. We expect continued progress towards reductions in carbon monoxide levels throughout the State, so carbon monoxide is a diminishing problem in California.

Typical levels of the air pollutants with established standards measured at Memorial Academy are comparable to those measured at long-term monitoring sites in the San Diego region.

Table 5. Carbon Monoxide in a 12-Month Period.

<i>Location</i>	<i>Average*</i>	<i>Maximum*</i>	<i>Number of Days Above State Standard</i>
Memorial Academy	1.0	2.7	0
Chula Vista	0.9	2.1	0
El Cajon	Not Monitored	Not Monitored	Not Monitored
San Diego - 12th Ave.	1.2	4.1	0

* Units of measure are parts-per-million (ppm).
The State standard and the daily maximum values are determined for an 8-hour average.

In summary, typical levels of the air pollutants with established standards measured at Memorial Academy are comparable to those measured at long-term monitoring sites in the San Diego region. While standards for particulate matter and ozone have not been achieved, programs are in place for reducing levels of these pollutants.

Next, we discuss the health impacts of toxic air pollutants.

Health Impacts of Toxic Air Pollutants

Toxic air pollutants can produce adverse health effects individually and collectively. Some of the health effects include cancer or other serious illnesses. No standards or safe thresholds have been established for these pollutants. In the following discussion, the individual and combined health effects of pollutants monitored at Memorial Academy and in the surrounding region are described.

Toxic air pollutants can cause long-term health problems such as cancer. Cancer risk estimates represent the chance of excess cancer cases in one million people, assuming these people breathe the average levels of the pollutant over a 70-year lifetime. Cancer risk is commonly expressed as the number of potential chances in a million of developing cancer. Particulate matter from diesel-fueled engines (diesel PM), the primary contributor to health risks from urban toxic air pollutants, was not measured as part of this study. We are still in the process of developing methods to measure diesel PM and some other pollutants that may cause adverse health effects. However, we do have an aggressive program to reduce diesel health risks throughout the State.

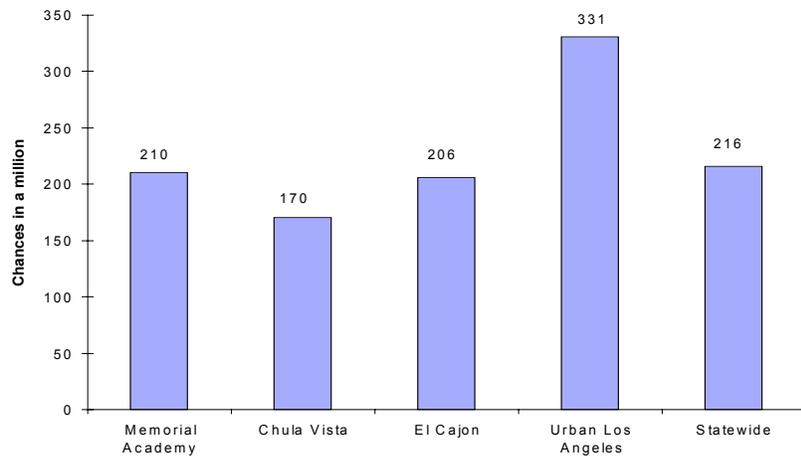
Data from this study indicate that the potential cancer risk due to the 50 pollutants measured at Memorial Academy is mostly attributable to nine pollutants. Our evaluation of the potential cancer risk focused on these top nine pollutants.

To put the results at Memorial Academy into perspective, we provide estimates of potential cancer risk for the top nine pollutants at Memorial Academy, the nearby San Diego sites, urban Los Angeles, and the statewide average across all 22 monitoring sites (which operated in 1998-2000). The potential cancer risk due to the top nine pollutants at Memorial Academy is slightly higher than at Chula Vista, similar to El Cajon and the statewide averages, but much lower than urban Los Angeles. However, the potential cancer risks at Memorial Academy and Chula Vista are not statistically different. Figure 1 compares the potential cancer risk at Memorial Academy, Chula Vista, El Cajon, urban Los Angeles, and statewide based on annual averages.

Figure 1*. Potential Cancer Risk (Without Diesel PM) at Memorial Academy Compared to Statewide and Local Areas (Based on Annual Averages).



Potential cancer risk at Memorial Academy lines up with El Cajon and the statewide average.



*Figure does not include estimated risk from diesel PM. The potential risk estimates assume a lifetime exposure through breathing pathway only. Estimates for Memorial Academy, Chula Vista, and El Cajon are based on October 1999 – September 2000 data; urban Los Angeles and statewide averages are based on October – September from 1998-2000.

The estimates of health risks provided in this report are based on the best available scientific information. Sources of potential uncertainty in these estimates include the unavailability of risk estimates for certain compounds and constraints in scientific understanding of pollutants' health effects. Furthermore, our analysis of health risks from toxic air contaminants focused on one health end-point, cancer, whereas these pollutants may create a variety of respiratory, reproductive, and other adverse health effects.

Why does the potential cancer risk differ somewhat between Memorial Academy and Chula Vista? To answer this question, we looked at all nine pollutants individually. Table 6 presents a summary of annual average levels for the key toxic pollutants that make up the majority of the potential cancer risk. Hexavalent chromium, methylene chloride, and para-dichlorobenzene did not have enough measurements that reached detectable levels for analysis. The statewide average levels are based on the 22 sites in the toxics monitoring network with 1998-2000 data.



Some pollutants showed different levels between Memorial Academy and other sites. However, their levels were comparable to the statewide averages.

Table 6. Annual Levels of Key Toxic Air Pollutants (10/99-9/00).

<i>Pollutant</i>	<i>Units</i>	<i>Memorial Academy</i>	<i>Chula Vista</i>	<i>EI Cajon</i>	<i>Statewide Average</i>
1,3-Butadiene	ppb	0.23	0.16	0.20	0.22
Benzene	ppb	0.80	0.66	0.84	0.81
Acetaldehyde	ppb	0.80	0.86	0.94	1.19
Formaldehyde	ppb	2.22	2.39	2.37	2.80
Perchloroethylene	ppb	0.08	0.09	0.11	0.11
Carbon Tetrachloride	ppb	0.09	0.09	0.09	0.10
Methylene Chloride	ppb	insufficient*	insufficient	insufficient	0.65
Para-Dichlorobenzene	ppb	insufficient	insufficient	insufficient	0.12
Hexavalent Chromium	ng/m3	insufficient	insufficient	insufficient	0.12

*"insufficient" indicates most values were below detectable levels, hence insufficient for our analysis.

For a number of toxic pollutants, emissions are produced directly or indirectly by cars and trucks. Two of these pollutants – 1,3-butadiene and benzene – were noticeably higher at Memorial Academy than at

Chula Vista. These two pollutants led to the differences in potential cancer risk between the two sites. Levels of two other pollutants – formaldehyde and acetaldehyde – were similar at Memorial Academy, Chula Vista, and El Cajon. The average levels for the four pollutants were comparable to the statewide average levels, and the observed differences were not large compared to the range of levels across the State. Gasoline-powered engines are the major source of these four pollutants. Industry-related stationary sources account for approximately 15 percent of these pollutants.

In the short term, 1,3-butadiene can cause neurological effects such as blurred vision, fatigue, headache, and vertigo at very high levels. Pollution from benzene can cause central nervous system depression and increased incidences of leukemia. Acetaldehyde and formaldehyde can irritate the eye, skin and respiratory tract. In short, breathing these four pollutants may cause non-cancer health effects and can contribute to increased potential cancer risk.

Emissions of all four pollutants have been reduced in California through aggressive regulations on motor vehicle emission controls, gasoline vapor recovery systems, and cleaner fuels. From 1990 to 2000, outdoor statewide levels declined 53 percent for 1,3-butadiene and 72 percent for benzene. Data for acetaldehyde and formaldehyde are more variable, but levels have decreased significantly since 1990. Further decline in emissions for all four pollutants is expected to continue.

Levels of perchloroethylene, an organic compound containing chlorine, were lower at Memorial Academy than at El Cajon. Perchloroethylene can irritate the eyes and respiratory tract; it can also depress the central nervous system. Industrial processes are the major sources of emissions of perchloroethylene and other chlorinated pollutants. ARB's control measures on dry cleaning facilities helped reduce levels of perchloroethylene statewide. The 2000 statewide outdoor perchloroethylene level was approximately 58 percent lower than that in 1990. Controls on degreasers used for automotive maintenance and repairing that are already in place should further reduce levels of this pollutant.

Average levels of carbon tetrachloride at Memorial Academy are comparable to the San Diego region and statewide levels. Carbon tetrachloride can cause hepatitis and kidney damage as well as affect the central nervous system. The primary sources of carbon tetrachloride in California are chemical product manufacturers, and petroleum refineries. The statewide emissions are small, and background levels account for most of the potential cancer risk. Carbon tetrachloride is no longer used for dry cleaning purposes. The use of carbon tetrachloride in products to be used indoors has been discontinued in the United States. Due to a very small number of sources, carbon tetrachloride levels throughout the State are constant and attributable to background.

Hexavalent chromium has been identified to cause lung cancer. At much higher levels than measured in California, kidney damage and bleeding of the intestines may also occur. Measurements of this pollutant at all three sites were mostly below detectable levels. We are working to lower the detection levels for hexavalent chromium. Chrome plating is a primary source of hexavalent chromium. Other activities that also result in emissions of this pollutant include welding, spray painting, and firebrick lining of glass furnaces. In California, stationary sources contribute about 61 percent of statewide emissions while other mobile sources such as jet aircraft and ships contribute about 38 percent. California adopted a control measure in 1988 to reduce emissions of hexavalent chromium from chrome plating. Statewide levels have been reduced. Additional special studies to specifically measure hexavalent chromium levels in the Barrio Logan community have been conducted. For details, please see the Web site: <http://www.arb.ca.gov/ch/communities/studies/barriologan>.

Not surprising, many pollutants showed higher values in the winter than the summer.

Many pollutants showed seasonal variations. For example, benzene and 1,3-butadiene were higher in the winter than in the summer. This seasonal pattern is common because the air tends to be more stagnant with less mixing in the winter months. Over the 17 months of monitoring, data in the early winter period (1999/2000) were comparable to the later winter period (2000/2001).

In addition to the criteria and the nine toxic air pollutants, we measured several other pollutants. They are discussed in the next section.

Other Metals and Pollutants

Due to industrial sources such as chrome-plating facilities near the Barrio Logan community, several metals were of particular interest in this study. Manganese, nickel, and zinc are some of the metals measured at Memorial Academy; however, their levels were not determined to pose a health risk. Sources of these metals are industrial and commercial operations and motor vehicles.

Pollution from manganese may cause irritation to the eyes, nose, throat, and respiratory tract. Over time, manganese may affect the central nervous system. The primary stationary sources of manganese in California are shipbuilding and repair facilities, petroleum refining, and electrical services. ARB has also identified manganese in motor vehicle exhaust.

Pollution from nickel dust and some nickel compounds has caused nasal and lung cancer in refinery workers. In the long term, nickel may cause respiratory tract irritation, immune alterations, and asthma. Nickel and nickel compound fumes may cause irritation of the respiratory tract, skin, and eyes. Fuel combustion is responsible for the majority of the nickel emissions in California. The primary industrial sources that have reported nickel emissions are crude oil and gas extraction, electrical services, refineries, and national security installations. Nickel has also been detected in motor vehicle exhaust.

Zinc has a role in normal human growth, taste, and sperm development, but high levels of zinc can cause adverse health effects. High levels of zinc can cause headache, chills, fever, and muscle aches. Some zinc compounds can also damage the mucous membranes of the respiratory tract and the skin. The primary stationary sources of zinc in California are industrial activities.

Polycyclic aromatic hydrocarbons such as benzo(a)pyrene have been found to cause significant health impacts on children when present in high levels. Benzo(a)pyrene can cause dermatitis, photosensitization in sunlight, eye irritation and cataracts. In California, the primary industrial sources that have reported emissions of these hydrocarbons are petroleum refineries, industrial machinery manufacturers, and the wholesale trade in petroleum products. At Memorial Academy, the

levels of these hydrocarbons were not high enough to pose a significant health risk. Programs aimed at reducing emissions of combustion products, from both mobile and industrial sources, will reduce emissions of polycyclic aromatic hydrocarbons.

Table 7 presents a summary of annual average levels for some metals and pollutants at Memorial Academy, the two nearby sites, and the statewide average across all monitoring stations.

Table 7. Average Levels of Some Metals and Other Pollutants in a 12-Month Period (10/99-9/00).

Metal	Units	Memorial Academy	Chula Vista	El Cajon	Statewide Average
Manganese	ng/m3	31	11	24	24
Nickel	ng/m3	4.8	3.1	3.9	3.8
Zinc	ng/m3	78	43	46	56
Benzo(a)pyrene	ng/m3	0.13	0.09	0.19	0.18

Some metals showed different levels between Memorial Academy and other sites. However, their levels were not high enough to pose a health risk.

Manganese, nickel, and zinc were higher at Memorial Academy than at Chula Vista and El Cajon. However, the measured levels of these metals are not high enough to pose a significant health risk. Levels of benzo(a)pyrene at Memorial Academy were comparable to other sites and statewide.

Conclusions

Based on seventeen months of outdoor air measurements collected at Memorial Academy, we found overall air quality levels at Barrio Logan to be similar to the San Diego region and to statewide averages. Some pollutants showed noticeable differences between Memorial Academy and other sites; however, the differences were not important in the overall health risk, and the measured levels of toxic pollutants are typical of urban areas in California. Diesel particulate matter, the primary contributor to health risks from urban toxic air pollutants, was not measured as part of this study. The potential cancer risk value due

In the initial study of Barrio Logan, outdoor air measurements collected at Memorial Academy between October 1999 and February 2001 showed levels in the Barrio Logan community to line up with the statewide averages.



Other issues such as the potential for adverse effects of local sources have been studied.

Findings can be found at: <http://www.arb.ca.gov/ch/communities/studies/barriologan>.

to the top risk pollutants measured at Memorial Academy is slightly higher than Chula Vista but similar to El Cajon and to the statewide average. However, the potential cancer risks at Memorial Academy and Chula Vista are not statistically different. In contrast, the potential cancer risk at Memorial Academy is much lower than that in urban Los Angeles.

Our review of air quality measurements during the first 17 months of the study at Memorial Academy provides an initial characterization of air quality in the Barrio Logan community. Air quality in Barrio Logan has been studied in greater detail after February 2001. Issues that were unresolved by February 2001 included the potential for adverse effects of local sources, such as major truck traffic or industrial and commercial sources, on neighboring residences. Health effects of toxic air pollutants also require further investigation. Our studies focus on computer modeling of all sources of pollution in the Barrio Logan area, monitoring for specific emission sources, roadside inspections of diesel trucks, and truck traffic counting. We expect to report on these activities in the near future.

At the Air Resources Board, we constantly learn about the cumulative health effects of pollutants in the air while continuing to implement programs with local authorities that aim at reducing levels of air pollution throughout the State.

A detailed Technical Support Document prepared by ARB staff can be obtained via mshah@arb.ca.gov, or htran@arb.ca.gov. You can write us at the address below:

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The California Air Resources Board is a part of the California Environmental Protection Agency.

The Mission of the California Air Resources Board is:

"To promote and protect public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the State."