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Air Resources Board

Short Term Study of Outdoor Air Quality at Two Sacramento Schools on Watt Avenue

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I. Introduction

The Sacramento metropolitan area faces air quality challenges and does not attain state or federal ozone and PM10 ambient air quality standards. The primary source of air pollution in this area is motor vehicles. One unanswered question is whether schools and residents near high traffic areas in Sacramento are exposed to significantly higher levels of air pollution than the region as a whole. The purpose of the study was to examine the effects of traffic and other local sources of pollution on two schools located on Watt Avenue in Sacramento, California to determine if elevated air pollution levels could be observed due to the location of the schools along a high traffic roadway.

Motor vehicles emit a variety of air pollutants that can cause adverse health effects and are the largest source of air pollution in most urban areas of California. Several projects are actively investigating the health effects of traffic-related air pollution. A recently completed pilot study "Evaluation of Health Effects of Toxic Air Pollutants in a Southern California Community: A Pilot Study" provided valuable insights into the health effects of volatile organic compounds on asthmatics. The findings, coupled with experimental and other epidemiological evidence in the literature, suggest that the traffic-related pollutants can lead to adverse effects in asthmatic children (1).

Other studies involve the work done by Dr. Beate Ritz of UCLA and the effect of traffic-related pollutants on birth outcomes. In Dr. Ritz's studies, pollution exposures were estimated to determine if high average concentrations during specific periods of pregnancy were associated with an increased risk of low birth weight, premature birth, or birth defects. The first study found an increased risk of low birth weight for women who experienced high ambient carbon monoxide (CO) concentrations during their last trimester. The second study found an increased risk of premature birth for women who experienced high ambient PM10 or CO during the first six weeks or the last four weeks of their pregnancy. The third study found an increased risk of heart birth defects for women who experienced high ambient CO or ozone during their second month of pregnancy (2,3,4).

Hoek and colleagues (5) recently published a study investigating the health effects of long-term exposure to traffic-related air pollution in the Netherlands. They found that cardiopulmonary mortality in individuals between the ages of 55 and 69 was associated with living near a major road, and less consistently with the estimated ambient background concentration. In another study from the Netherlands, Brunekreef (6) examined the effect of truck traffic pollution on lung function changes in children. They found that lung function deficits were associated with truck traffic in children and was strongest in children living closest to the roadways. The results of this study indicate that diesel exhaust particulates may be associated with reduced lung function in children living near major roads.

These studies emphasize the potential for traffic pollution to cause substantial health impacts. The pollutants of concern include particulate matter, diesel particulate matter, carbon monoxide, and benzene. Research is underway to examine the effects of different size fractions and chemical constituents of particulate matter. Exposure to ultrafine particles is a new area of growing concern.

Because of concerns regarding traffic and health effects, the American Lung Association approached the Air Resources Board in 2001 for assistance in looking at the air quality at two schools located along a heavily traveled roadway. Working with the Sacramento Metropolitan Air Quality Management District, the American Lung Association chose two schools to evaluate. These schools were the Arden Middle School (Arden School) and the Frederick C. Joyce Elementary School (Joyce School). The two schools were chosen because they are both located on Watt Avenue and are located in different kinds of land use areas. The Arden School is located in a residential and light commercial area, whereas the Joyce School is located in a mixed residential, commercial, and industrial area.

The two objectives for this project were: (1) to determine if selected air pollutant concentrations were different between the two schools; and (2) to assess air pollutants arising from motor vehicles traveling on Watt Avenue and the potential health risk at each school. The limited air quality evaluation consisted of the analysis of historical monitoring data to determine air pollutant concentrations in the Sacramento area, one month of special purpose ambient air monitoring to determine air pollutant concentrations at each school, and the use of air quality models to estimate where ambient air pollutant concentrations may be elevated in the area of our study. This study was not meant to be a comprehensive analysis of the air quality along Watt Avenue due to traffic, but rather to indicate if there were issues of concern that would merit a follow-up investigation.

II. Study Methods and Analysis

A. <u>Analysis of Historical Monitoring Data</u>

Historical air pollution data collected between 1998-2000 at the existing routine monitoring network in Sacramento was analyzed to see if the concentration of air pollutants obtained from the two schools was similar to the concentration of air pollutants collected at the routine network sites. In this context, routine monitoring refers to long-term monitoring sites used to measure attainment of air quality standards and long-term air quality trends. The analysis of historical monitoring data of the Sacramento area includes a discussion of the routine air monitoring locations in the area, a discussion of the air pollution issues this air basin is facing, and the methods used to analyze the data.

1. California Routine Air Monitoring Network

The ARB and the State's local air districts operate and maintain an air monitoring network throughout California. These network sites operate year-round and collect data on the ambient concentrations of one or more air pollutants and often include meteorological data collection capabilities. This air monitoring network monitors for both criteria pollutants and toxic air contaminants.

Criteria pollutants are air pollutants for which the ARB and Federal government has set health-based standards called Ambient Air Quality Standards. These include traditional pollutants such as ozone, particulate matter (PM10 and PM2.5), carbon monoxide (CO), and nitrogen dioxide (NO_2). Research has connected these pollutants with various health effects including breathing difficulties. The data collected from routine criteria pollutant monitoring sites are used to assess a region's status with respect to State and Federal Ambient Air

Quality Standards, to establish long-term air quality trends, and to provide air quality data used in health research.

In addition to criteria pollutant monitoring, the State also monitors for toxic air pollutants at about 20 of the routine network monitoring sites. Approximately 60 toxic air contaminants are monitored at each of these sites. Toxic air contaminants are air pollutants which may cause or contribute to an increase in mortality or in serious illness, or which may pose a present or potential hazard to human health (California Health and Safety Code 39655). ARB identifies pollutants as toxic air contaminants and adopts control measures to reduce public exposures. The toxic air contaminants monitored at these sites include those compounds typically associated with specific stationary sources (e.g., the dry cleaning solvent perchloroethylene) as well as motor vehicle emissions (i.e., benzene, 1,3-butadiene). Data from the toxic air monitoring sites are used to assist in the identification of toxic "hot spots" and to assess the effectiveness of air toxics control measures.

2. Sacramento Valley Air Basin

The Sacramento Valley Air Basin occupies 15,043 square miles and includes the counties of Butte, Colusa, Glenn, Sacramento, Shasta, Tehama, Yolo, Yuba and portions of Placer and Solano counties. There are over two million people that live in the region. There are eleven routine air monitoring sites in the Sacramento area (Figure 1). In addition, the Roseville site also is one of the twenty air toxics monitoring sites. For the current study, criteria pollutant and toxic air contaminant monitoring data were used to characterize the ambient pollutant concentrations in the Sacramento region. The same data were also used to establish a basis for comparison with the concentrations of the pollutants measured at the Arden and Joyce schools.

Air quality is evaluated by studying air pollutant concentrations and emissions in a particular region. To keep track of emission information for all sources of air pollution, emission information is compiled into what is called an emission inventory. In the Sacramento Valley Air Basin, motor vehicles in the Sacramento Metropolitan Urban Area are the single largest source of air pollution. Emissions of nitrogen oxides (NOx), reactive organic gases (ROG - a component of particulate matter and ozone), and carbon monoxide (CO) decreased over the past two decades (7).

Ozone peak values have decreased slightly over the past twenty years but still exceed State and Federal Ambient Air Quality Standards. However, the numbers of days that exceedances occurred have declined substantially over the past twenty years. Population growth, increased vehicle travel, and area wide sources (road dust and construction) have increased PM10 emissions in the Sacramento Valley Air Basin. Because many sources that contribute to ozone also contribute to PM10, future ozone controls should improve PM10. While pollutant concentrations have generally declined over the years, additional regulations will be needed to attain the State and Federal Ambient Air Quality Standards for the Sacramento Valley air basin for PM10 and ozone (7).

3. Analysis of Historical Data from Routine Monitoring Sites

Historical air pollution data from the routine monitoring sites in Sacramento were analyzed to see if the concentrations of air pollutants obtained from the two schools were similar to the concentrations of air pollutants collected at the routine network sites. The analysis was also used to determine whether there were significant differences in the concentration of air pollutants among communities in the greater Sacramento region. The following pollutants were monitored at each site as indicated in Table 1, but the analysis will focus on CO, PM, and selected toxics (Table 2). The results of this analysis will be presented in Part III Section A-1 of this report.

Figure 1- Map of Sacramento Monitoring Locations

Table 1 - Monitoring Locations

Site	NO_2	O_3	PM10	PM2.5	CO	*Total Non-Methane Hydrocarbons	Toxics
Elk Grove – Bruceville Rd	X	X				X	
Folsom – Natoma St.	X	X				X	
North Highlands – Blackfoot Wy	X	X	X		X		
Sacramento – 1309 T St.	X	X	X	X	X	X	
Sacramento – Airport Rd.	X	X	X		X	X	
Sacramento – Branch Center Rd.			X				
Sacramento – Del Paso Manor	X	X	X	X	X	X	
Sacramento – El Camino					X		
Sacramento – Health Dept.			X	X			
Sloughhouse		X					
Roseville-Sunrise Blvd.	X	X	X	X	X		X

*Total Non-Methane Hydrocarbon-The sum of all hydrocarbon air pollutants except methane. Significant precursors to ozone formation.

B. Special Purpose Monitoring

Special purpose air monitoring projects have limited objectives and are used for focused monitoring of one or more pollutants to determine air pollution impacts at a specific location. For this study, the ARB measured ambient concentrations of carbon monoxide, particulate matter (PM10, PM2.5, and elemental carbon), and selected toxic gases to evaluate the impacts of motor vehicle emissions on the two schools.

1. Special Purpose Monitoring Locations

The American Lung Association and the Sacramento Metropolitan Air Quality Management District worked together to choose the two schools for this study. The first school, Arden Middle School (Arden School), is located at 1640 Watt Ave, and has a student population of 750. This Sacramento County school is located in a middle income neighborhood that consists of single family residences and small emission sources such as dry cleaners and service stations. The second school, located five and a half miles north of Arden Middle School, is the Frederick C. Joyce Elementary School (Joyce School) at 6050 Watt Ave, and has a student population of 500. This North Highlands School is located in a low-income neighborhood that consists of mixed residential and commercial areas including McClellan Business Park.

These two schools were chosen because they are both located along Watt Avenue and would allow us to compare ambient air pollutant concentrations at the two schools. We expected that the Joyce School would show higher air pollutant concentrations because it is located in a mixed-use zone and high-traffic area. Data from the routine monitoring site located at Del Paso Manor School was used for comparison purposes. This school is located in a residential area two miles from Arden School and five miles from Joyce School. (See Figure 1.) The data from this short-term monitoring study was used to calculate cancer risk values for each school for comparison with routine monitoring site data. Because of the limited scope of this data, the risks calculated are for comparison purposes and not intended to represent a true risk estimate for the area. Normally cancer risk estimates require at least one year of monitoring data.

2. Monitored Pollutants

We measured carbon monoxide, particulate matter (PM10, PM2.5, and elemental carbon), and toxic air contaminants to evaluate air pollutant concentrations at the two schools and to evaluate the impact of motor vehicle emissions on the two schools.

Carbon monoxide (CO) is a colorless, odorless gas resulting from the incomplete combustion of fuels that interferes with the blood's ability to carry oxygen to the body's tissues (8). Carbon monoxide ambient levels are primarily due to motor vehicle exhaust and are usually a function of traffic volume in surrounding areas.

Particulate matter (PM) is any material, except pure water, that exists in the solid or liquid state in the atmosphere. The size can vary from coarse, wind blown dust particles to fine particles or liquid aerosols found in combustion by-products. PM10 refers to a particle with a diameter of 10 microns or less and PM2.5 particles with a diameter of 2.5 microns or less. When inhaled, these particles invade the respiratory systems natural defenses and lodge deep in the lungs decreasing the respiratory function (8). Ambient levels of particulate matter come from motor vehicle exhaust, wood burning fireplaces, industrial sources, construction dust, and from particles that are formed when other air pollutants undergo chemical reactions in the atmosphere.

Elemental carbon (EC) is a component of particulate matter, is the black soot that results from carbon-based fuel combustion, and is indicative of particulate from diesel and other combustion sources.

Toxic air contaminants are air pollutants which may cause or contribute to an increase in mortality or in serious illness, or which may pose a present or potential hazard to human health (California Health and Safety Code 39655). We measured nineteen toxic pollutants for this study. We focused on benzene and 1,3-butadiene because these have the highest health risk as measured by our air toxics monitoring sites. They account for approximately 54% of the total health risk for this air basin (excluding diesel particulate) (7). These two compounds are primarily found in gasoline powered motor vehicle exhaust, and can result in neurological and reproductive disorders, and are carcinogenic (9,10). A complete list of monitored toxic compounds can be found in Table 2. For comparison purposes, we estimated cancer risks based on the concentrations of eight toxic compounds that were measured during this study. These results can be found in Part III Section A-4 of this report.

Table 2 - Monitoring List of Toxic Compounds

List of Toxic Compounds Monitored for Sacramento Study		
Benzene	Dichloromethane	1,1,1-Trichloroethane
Bromomethane	cis-1,3-Dichloropropene	Trichloroethylene
1,3-Butadiene	trans-1,3-Dichloropropene	Toluene
Carbon Tetrachloride	Ethylbenzene	m/p-Xylene
Chloroform	Methyl tert-butyl ether	o-Xylene
o-Dichlorobenzene	Perchloroethylene	
p-Dichlorobenzene	Styrene	

Diesel Particulate Matter

Particulate matter from diesel exhaust (diesel PM) has been identified as a toxic air contaminant and is thought to be the single largest contributor to air pollution health risk. Although diesel PM risks have been calculated from emissions and modeling, it has proven difficult to measure in the atmosphere. The difficulty in measuring diesel PM is that it is composed of literally hundreds of compounds, and many are not unique to diesel engines. Elemental carbon was the first compound to be used as diesel marker but as diesel technologies improved and the diesel fleet became cleaner, it was clear that elemental carbon alone was not a good marker for diesel PM. This is also supported in the Health Effects Institute's Diesel Epidemiology Working Group report entitled, "Research Directions to Improve Estimates of Human Exposure and Risk from Diesel Exhaust." The executive summary of this report states the following:

> "Working Group agrees with the investigators that elemental carbon may be a useful indicator of occupational exposure to diesel exhaust in settings where diesel exhaust is the dominant source of particulate emissions. However, additional surrogates should be explored because elemental carbon as the only marker lacks the sensitivity and specificity necessary as a signature for ambient exposure, which includes elemental carbon from other combustion sources. Improved surrogates for diesel exhaust exposure might be used to enhance exposure assessment for past studies, to strengthen future epidemiological studies, and to assess population exposure. " (11)

Because elemental carbon is not a good surrogate for diesel particulate and the lack of a generally accepted direct measurement method for ambient diesel PM, diesel PM concentrations were not measured in this study, but a discussion of overall diesel risk can be found in Part III Sections A-2 and B-4.

3. Monitoring Schedule

Air monitoring was conducted at both schools during January 2002. We monitored during the winter season because the pollutant concentrations are generally their highest, due to poor atmospheric mixing.

Carbon monoxide was monitored continuously (each hour for the 30-day study) at each school using federally approved devices (Dasibi 3008). Elemental carbon and PM10 were monitored at both schools using a federal reference sampler for PM10 (Sierra Andersen Model 1200). The ARB's laboratory in Sacramento analyzed the samples. Both PM10 samplers collected a single 24-hour sample every six days. The laboratory also used a portion of the PM10 filter to measure elemental carbon using the method developed by the National Institute for Occupational Safety and Health.

PM2.5 was monitored at both schools using BGI PQ100 Air Samplers. ARB's laboratory analyzed the samples. Both PM2.5 samplers collected a single 24-hour sample every six days. In addition, a continuous PM2.5 sampler (Met One 1020 Beta Attenuation Monitor (BAM)) was deployed by the Sacramento Metropolitan Air Quality Management District at Joyce School.

The air toxics samples were collected at both schools over a 24-hour period using a stainless steel canister and pump. This is the same technique used in the statewide air toxic monitoring sites. The sampling schedule was the same as the PM sampling schedule, i.e. one sample every six days. The ARB laboratory analyzed canisters for a variety of toxic compounds using ARB Method 58. See Table 3 for a summary of the monitoring schedule.

Table 3 - Sampling Schedule

LOCATION	POLLUTANT				
	CO	**PM10**	**PM2.5**	**Elemental Carbon**	**Toxics**
Arden Middle School	continuous	1 in 6	1 in 6	1 in 6	1 in 6
Frederick C. Joyce Elementary	continuous	1 in 6	1 in 6 and continuous	1 in 6	1 in 6

C. <u>Emission Inventory and Modeling</u>

To supplement the information obtained from the analysis of historical monitoring data and special purpose monitoring, a screening level modeling analysis of the Arden and Joyce Schools was conducted to identify areas where air pollutant concentrations may be elevated. Air quality simulation models use emissions data, meteorological data, and other factors to estimate the resulting air pollution concentrations in the ambient air. The modeling approach used in this study relied on several models that are being evaluated for use at the local level. The modeling area is centered on Watt Avenue, includes both schools, and is approximately four and a half miles wide and seven and a half miles long.

Emissions information was obtained from the California Emission Inventory Development and Reporting System (CEIDARS). The inventory provides an estimate of the amount of pollutants emitted into the atmosphere from major mobile, stationary (non-mobile), area-wide (fireplaces or road dust), and natural source (biological and geological sources) categories. Off-road mobile sources (trains) and on-road mobile sources were included in this inventory. The mobile source on-road inventory was compiled from EMFAC2001 (V 2.08-CY2000), an ARB on-road emission model, and the travel demand model from the Sacramento Area County of Governments (SACOG). The off-road emission estimates were obtained from the Sacramento Metropolitan Air Quality Management District and railroad companies. Selected local facility types (gas stations, automobile repair shops, print shops, dry cleaners and welding facilities) that were not contained in CEIDARS were identified using electronic yellow pages and district permit files and mapped using Geographic Information System (GIS) software to determine their locations.

The emissions information was used in several air dispersion models to estimate the concentrations of carbon monoxide and other pollutants in an effort to estimate the health risks posed by air pollution in the area of study. The Industrial Source Complex Model (ISC) is a United States Environmental Protection Agency (U. S. EPA) approved model. This model is used to estimate close distance impacts from industrial sources. The Caline Model, another U. S. EPA approved model, uses traffic emissions, site geometry, and meteorology to predict air pollutant concentrations near roadways. The other model used was the

Hot Spots Analysis and Reporting Program (HARP). This tool is designed for site-specific health risk analysis using the Office of Environmental Health Hazard Assessment (OEHHA) risk assessment guidelines, an EPA approved dispersion model, and this program is under development at the Air Resources Board. (Table 4).

Table 4 – Air Dispersion Models

Name	Purpose
Industrial Source Complex	Estimate close distance impacts from industrial sources
Caline	Predict air pollutant concentrations near roadways
Hot Spots Analysis and Reporting Program (HARP)	Modeling and risk assessment program designed for site specific health risk analysis

III. Results

A. Analysis of Historical Monitoring Data

We analyzed air quality data from routine monitoring sites in the Sacramento region to evaluate air pollutant concentrations in various Sacramento neighborhoods. The data collected at eleven routine sites were analyzed during the period of 1998-2000. See Figure 1 for monitor locations. The pollutants analyzed were CO, PM10, PM2.5, ozone, NOx, NMHC, and toxic air pollutants.

1. Criteria Pollutants

Average concentrations of CO, PM10, PM2.5, and several other pollutants are presented in Table 5. Table 6 shows the percentages of measured days exceeding health-based standards.

Carbon Monoxide – The State and Federal Ambient Air Quality Standard for carbon monoxide is 9 ppm over an 8-hour averaging period. The CO levels at all locations are well below this standard.

PM10 – This criteria pollutant has four health-based ambient air quality standards. Based on an annual arithmetic mean, the State and Federal Ambient Air Quality Standards for PM10 are 20 ug/m^3 and 50 ug/m^3, respectively. Table 5 shows the results of the analysis of data with respect to this standard. The PM10 annual average concentration levels were similar and slightly lower than the State average. All values are above the State annual PM10 standard but below the Federal annual PM10 standard.

The other standard for PM10 is based on a 24-hour average, and the State and Federal Ambient Air Quality Standards are 50 ug/m^3 and 150 ug/m^3, respectively. As can be seen in Table 6, the percentages of days exceeding these health-based standards varies from site to site. All values are above the State 24-hour standard but below the Federal 24-hour standard. In addition, it should be noted that the Sacramento site that most frequently exceeded the State Ambient Air Quality

Standard for PM10 is the Branch Center site. This site is located southeast of the Watt Avenue sites.

PM2.5 – This criteria pollutant has three health-based ambient air quality standards. The annual average State and Federal Ambient Air Quality Standards for PM2.5 are 12 ug/m^3 and 15 ug/m^3, respectively. As can be seen in Table 5, the annual concentration levels are similar and are slightly lower than the Federal annual standard but higher than the State annual standard.

The other standard is a Federal 24-hour daily average for PM2.5. This Federal Ambient Air Quality Standard is 65 ug/m^3 and the percentage of days exceeding this standard can be seen in Table 6. The State does not have a separate standard for PM2.5 with a 24-hour averaging time.

Ozone – Ozone's air quality standards are based on one-hour averaging times. The State and Federal Ambient Air Quality Ambient Air Quality Standards for ozone are 0.09 ppm and 0.12 ppm, respectively. Table 5 shows that the values at all locations except for Folsom and Sloughouse are lower than the State average for ozone. Table 6 shows the percentage of days exceeding the health-based standards for ozone. Although the percentages of days exceeding air quality standards vary, all sites in the Sacramento region report days above both the State and Federal Ambient Air Quality Standards for ozone.

NOx – This general term refers to compounds of nitric oxide, nitrogen dioxide, and other oxides of nitrogen. Nitrogen dioxide is the only pollutant of this group which has an ambient air quality standard. The Federal Ambient Air Quality Standard, which is based on an annual arithmetic mean, is 0.053 ppm and the State Ambient Air Quality Standard, which is based on a one hour averaging time, is 0.25 ppm (Table 5).

NMHC –Total Non-Methane Hydrocarbons (NMHC) are the sum of all hydrocarbon air pollutants except methane. Although there is no ambient air quality standard for this pollutant, it is included in the table because it is a significant precursor to ozone formation.

The Sacramento Valley Air Basin remains in non-attainment for ozone and PM10. More work needs to be done to bring this area into attainment of the State and Federal Ambient Air Quality Standards.

Table 5 - Annual average pollution levels at the routine sites in the Sacramento region (1998-00)

Site\Pollutant	CO[1] (ppm) (8hr)	PM10[2] (ug/m3) (24hr)	PM2.5[2] (ug/m3) (24hr)	Ozone[1] (ppm) (1hr)	NOx[1] (ppm) (1hr)	NMHC[3] (ppm) (1hr)
Elk Grove	-	-	-	0.059	0.04	0.16
Folsom	-	-	-	0.068	0.03	0.30
North Highlands	1.2	23	-	0.064	0.07	-
1309 T St.	1.5	25	15	0.056	0.11	0.49
Airport Rd.	1.3	22	-	0.060	0.10	0.54
Branch Center Rd.	-	29	-	-	-	-
Del Paso Manor	1.5	23	14	0.064	0.08	0.29
El Camino & Watt	2.0	-	-	-	-	-
Health Dept.	-	24	15	-	-	-
Sloughhouse	-	-	-	0.068	-	-
Roseville	0.9	23	14	0.064	0.08	-
Statewide	1.5	29	17	0.060	0.08	Not provided

1. No annual average ambient air quality standard
2. PM10 annual average ambient air quality standard: State=20 ug/m3 Federal=50 ug/m3
   PM2.5 annual average ambient air quality standard: State=12 ug/m3(newly adopted)
   Federal 15 ug/m3
3. Total Non-Methane Hydrocarbon-The sum of all hydrocarbon air pollutants except methane.
   Significant precursors to ozone formation but not a criteria pollutant.

Table 6 - Percentage of Days Exceeding Air Quality Standards in the Sacramento Region (1998-00)

Site\Pollutant	Percent of Days Exceeding Air Quality Standards*		
	PM10 (ug/m3) (24hr) State Std Level (50 ug/m3) Federal Std. Level (150 ug/m3)	PM2.5 (ug/m3) (24hr) Fed Std Level (65 ug/m3) No separate State Std	Ozone (ppm) (1hr) State Std Level (0.09 ppm) Federal Std Level (0.12 ppm)
Elk Grove	-	-	2% State / .1% Federal
Folsom	-	-	7% State / 1.5% Federal
North Highlands	4% State / 0% Federal	-	3% State / 1% Federal
1309 T St.	8% State / 0% Federal	2%	2% State / .2% Federal
Airport Rd.	8% State / 0% Federal	-	2% State / .2% Federal
Branch Center Rd.	12% State / 0% Federal	-	-
Del Paso Manor	6% State / 0% Federal	3%	4% State / 2% Federal
El Camino & Watt	-	-	-
Health Dept.	5% State / 0% Federal	3%	-
Sloughhouse	-	-	12% State / 4% Federal
Roseville	4% State / 0% Federal	1%	4% State / 2% Federal

* Number of exceedances/ number of measurement days during 1998-2000

2. Toxic Air Contaminants

The data obtained from the only toxics monitoring site in the Sacramento Valley Air Basin (Roseville) was used to estimate the cancer risks due to air pollution in the Sacramento area. The total excess air pollution related cancer risk at the Roseville site, excluding diesel particulate, is about 160 cancer cases per million people based on constant exposure over a 70-year lifetime for the year 2000 (7).

In an effort to evaluate the regional cancer risk of diesel PM, we used the 2002 California Almanac of Emissions and Air Quality, which contains estimates of diesel concentration levels and risk values for the air basins of California using a particulate matter-based exposure method (7). This method uses the ARB PM10 emissions database, ambient PM10 monitoring data and the results from several studies on the chemical composition of particulate matter, along with receptor modeling techniques, to estimate statewide outdoor concentrations of diesel particulate matter. The details of the methodology are described in Appendix VI to the ARB report titled: “Risk Reduction Plan to Reduce Particulate Matter Emissions and from Diesel-Fueled Engines and Vehicles,” dated October 2000 (12). Table 7 indicates the diesel PM health risks values for several California air basins.

Table 7 - 2002 ARB Almanac Diesel Health Risk Estimates for 2000

2002 ARB Almanac Diesel Heath Risk Estimates For 2000			
Air Basin	**Diesel PM Health Risk**	**Ave. Basin Risk w/out Diesel**	**Ave. Basin Risk w/Diesel**
South Coast	720	285	1005
San Francisco	480	179	659
San Joaquin	390	196	586
San Diego	420	187	607
Sacramento	360	160	520
Statewide	540		

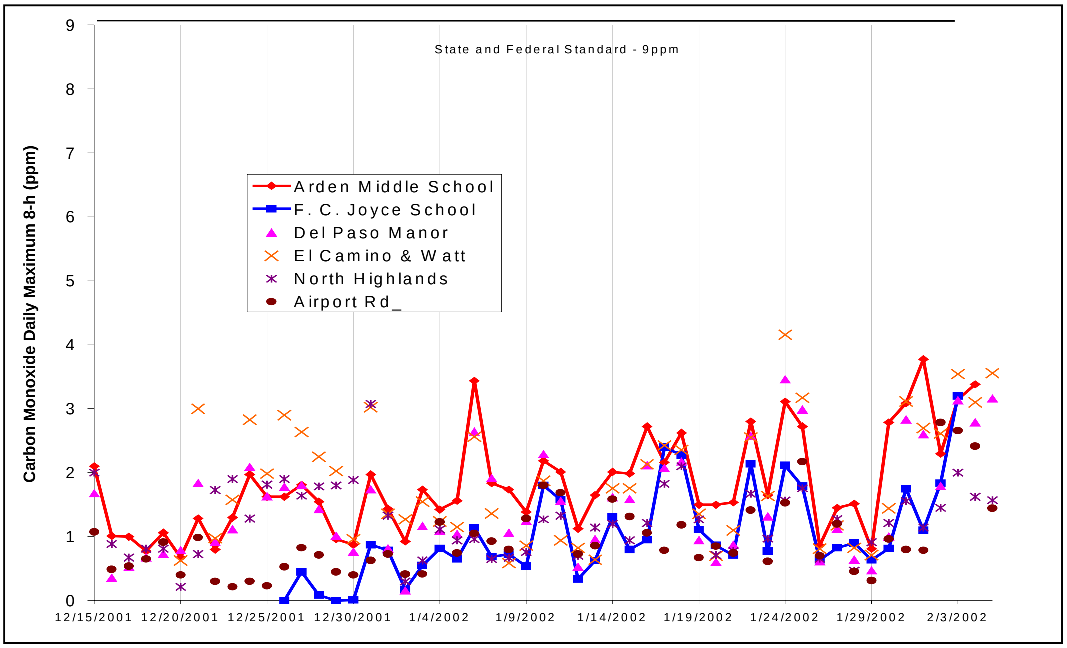
B. <u>Special Purpose Monitoring Results</u>

1. Carbon Monoxide

As a result of the requirements for cleaner vehicles and fuels, the CO levels have dropped below the health-based State and Federal Ambient Air Quality Standard of 9 ppm (8 hr) at most sites in California. Although the data in Figure 2 shows that the CO levels at Arden Middle School were twice is high as the CO levels at the Joyce School, both schools had CO levels that were less than half the State and Federal Ambient Air Quality Standard.

To determine if CO was proportional to traffic counts by each school, we obtained traffic count data from the Sacramento County Department of Engineering. Arden School has a vehicle count of about 82,000 vehicles per day whereas Joyce School has a vehicle count of about 41,000 vehicles per day. The data confirms that the differences in CO concentrations were proportional to the traffic counts at each school.

Figure 2 - CO Daily Maximum 8 hour Average Concentrations



2. Particulate Matter

Figure 3 shows PM10 samples from both schools and routine network sites in the Sacramento region during late January through early February of 2002. The State 24-hour Ambient Air Quality Standard for PM10, which is 50 ug/m3, was exceeded at Arden Middle School on February 1, 2002. The Federal 24-hour Ambient Air Quality PM10 Standard, which is 150 ug/m3, was not exceeded during the sampling period at either school. With the exception of the result from February 1, the PM10 levels at both schools and the routine site located at 13th and T were similar. The PM10 levels at both schools were generally higher than the other routine monitoring sites. In should also be noted that the PM10 differences were not proportional to the traffic differences between the schools, as was the case with CO.

Figure 3 - PM10 24-hour samples

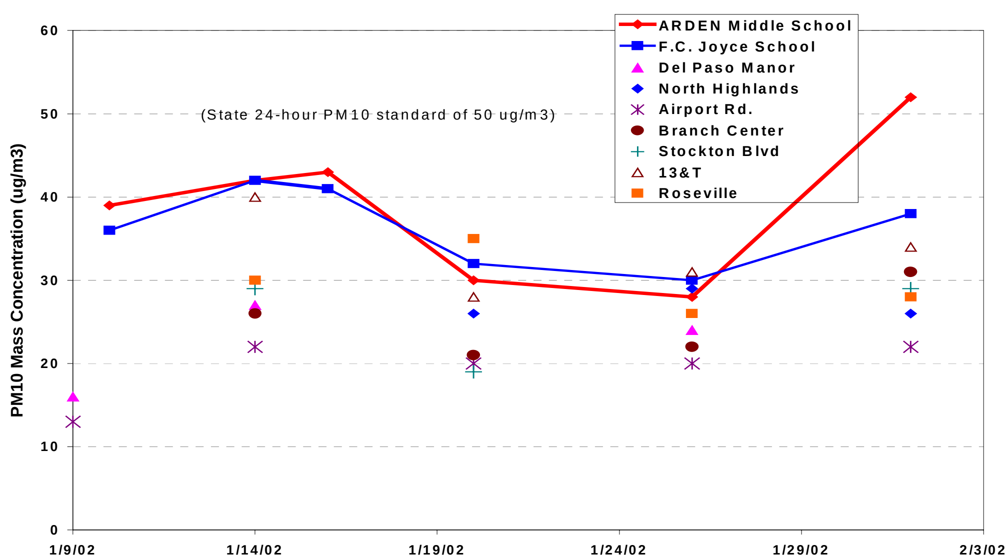


Figure 4 shows the 24-hour PM2.5 samples collected at the two schools along with other routine sites during the special study period. There were no exceedances of the State or Federal 24-hour Ambient Air Quality Standard of 65 ug/m3 at any site during the special study period. There is no PM2.5 data due to sampler malfunction on February 1, a day when there was a PM10 exceedance at Arden School. The average of the PM2.5 samples collected during the entire study period at Arden School is slightly higher than that at Joyce School. However, when comparing only samples collected on matched days at both sites, levels at the two schools are nearly the same. Again, the difference between the two schools does not appear to be proportional to traffic count. In addition, both schools have slightly higher average PM2.5 levels than the sites at 13th and T and Roseville.

Figure 4 - PM2.5 24-hour samples

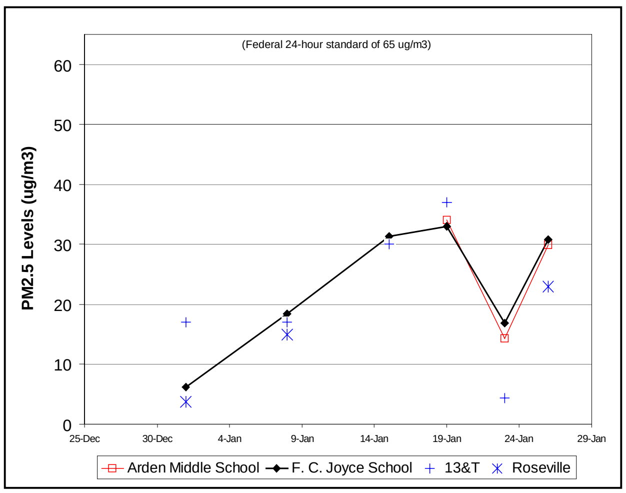
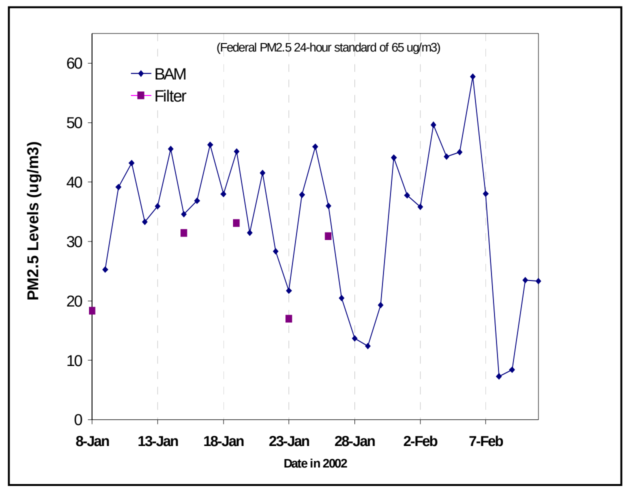


Figure 5 - PM2.5 Comparison Filter vs BAM



PM2.5 was also measured continuously using a beta attenuation monitor (BAM) at the Joyce School. The PM2.5 data are averaged daily and compared with PM2.5 24-hour filter data. The PM2.5 BAM 24 hour average concentrations are 23% higher than the PM2.5 filter data collected at the same location but still indicate values below the State and Federal Ambient Air Quality Standard for PM2.5 (Figure 5). Community air monitoring studies conducted in other areas of California are also discovering that the BAM monitor tends to report higher PM2.5 concentrations than the filter sampler. ARB Staff is currently investigating this to better understand the reasons for the differences between these two instruments.

3. Elemental Carbon

Only two of the twelve elemental carbon samples collected had values above the detection limit of 1 microgram carbon per cubic meter (1 ugC/m^3). The values were from the Joyce School on January 16, 2002,with a measurement of 1.3 ugC/m^3 and from Arden School on February 1, with a measurement of 1.8 ugC/m^3. Since we have no matched samples for comparison, we cannot determine if the schools show a difference in EC levels. For reference, the EC measurement collected at the Hawaiian Street Elementary School in the Wilmington community of Los Angeles, ranged from below the limit of detection to 4.9 ugC/m3.

4. Toxic Air Contaminants

As previously discussed, toxic air contaminants may cause or contribute to an increase in mortality or serious illness, or may pose a potential hazard to human health. As discussed in Part II Section B-2, we focused on the toxic gases benzene and 1,3-butadiene. Figures 6 and 7 indicate the results obtained during the study period. When comparing samples collected on the same day, both schools and the Roseville site show similar concentrations of both pollutants.

Figure 6 - Benzene Levels

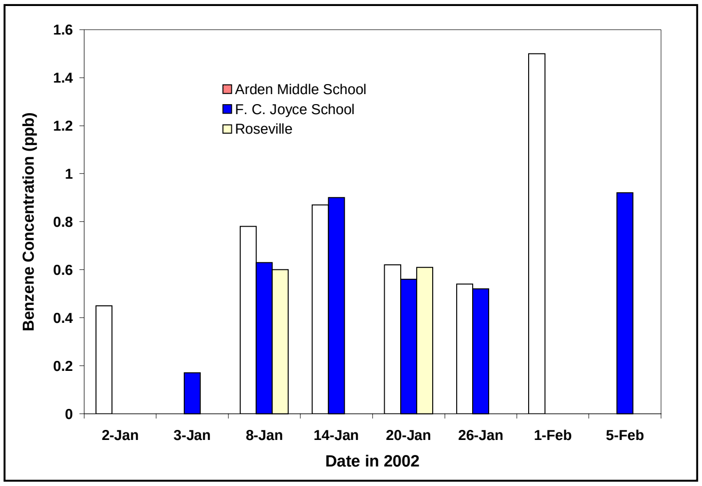
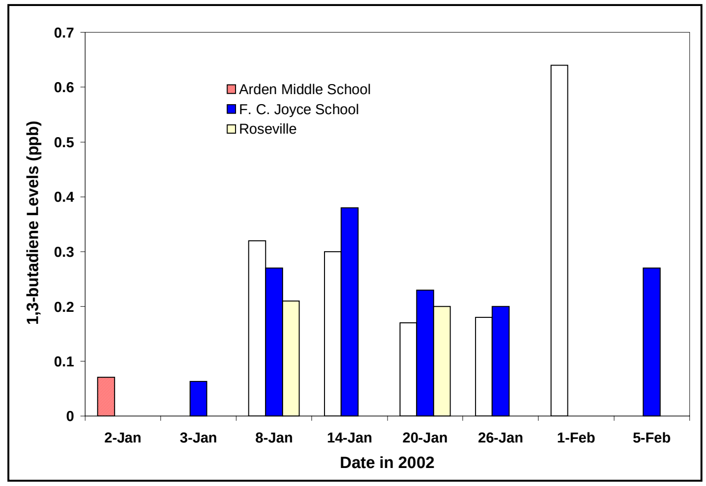


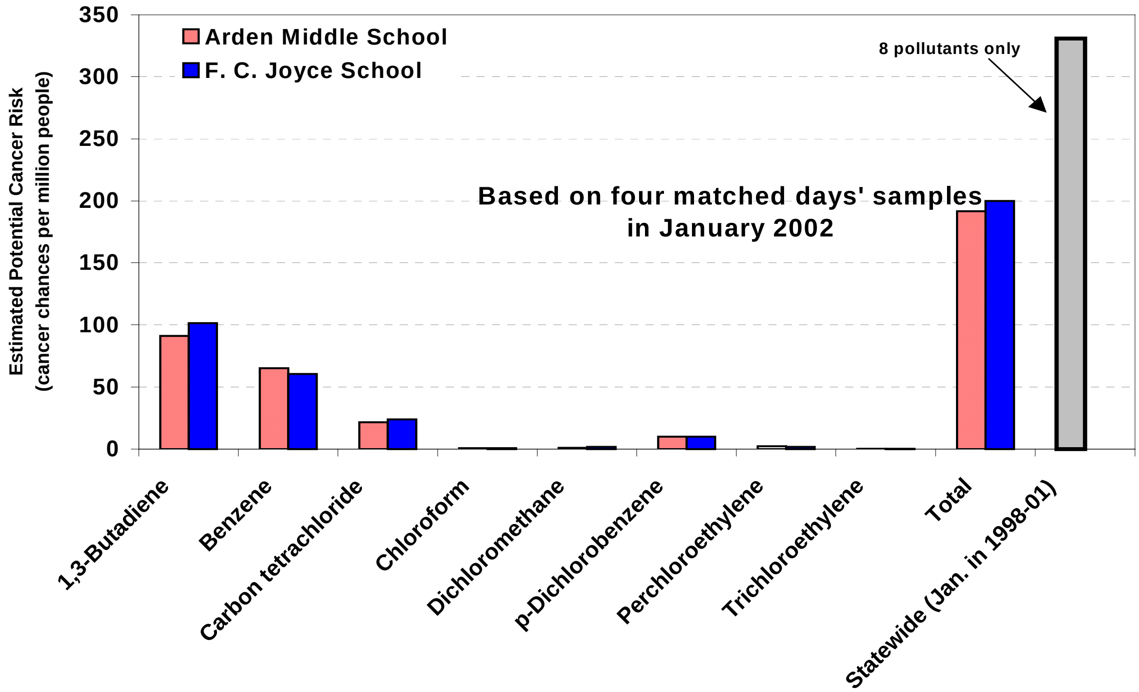
Figure 7 - 1,3-Butadiene Levels



In addition to focusing on the concentration levels of these two toxic compounds, cancer risks for the eight toxic air contaminants were calculated for comparison purposes. Normally at least one year of monitoring data is required to obtain a statistically robust risk estimate. Cancer risks are expressed as the potential number of excess cancer cases per million people, assuming constant exposure over a 70-year lifetime. Since there is no approved measurement technique for diesel PM, it is not included in this calculation of cancer risk. Cancer risk calculations typically use data collected over one year but we have included it here for comparison purposes. For this study, cancer risks were calculated for the eight compounds that can cause cancer from four measurements obtained in January 2002 and should only be considered a very rough approximation of actual risk levels.

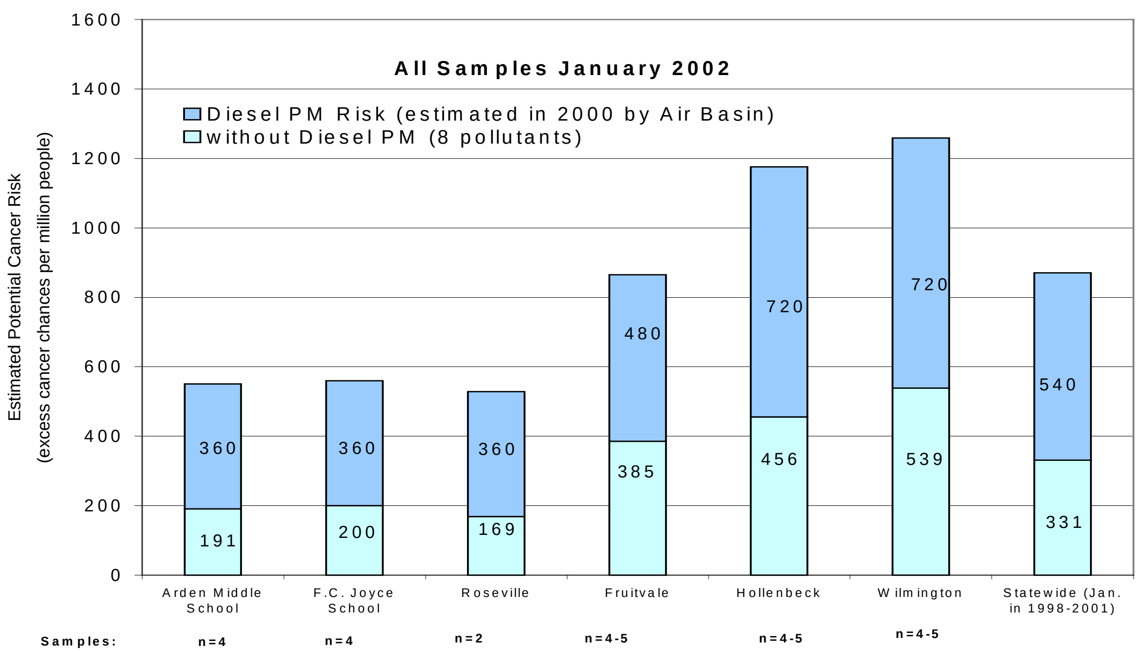
Figure 8 shows that the estimated cancer risk values based on eight compounds at both schools were very similar, and the total risk values are lower than the January statewide urban average for 1998-2001 (using eight compounds). Estimated cancer risks from measured toxic air contaminants are usually higher in the winter so an annual cancer risk value calculation based on an entire year of measurements would likely be lower than those presented in Figure 8. It should be noted that the presence of carbon tetrachloride is due to the regional air background level and not local sources.

Figure 8 - Estimated Cancer Risk of Measured Toxic Air Pollutants



For comparison purposes, Figure 9 presents estimates of what the overall cancer risk values might be with diesel PM included at various locations around the State. As has been previously mentioned, this example is very limited due to the limited sample sizes and the fact that the diesel risk values were calculated for an entire basin not the individual site listed.

Figure 9 - Risk Estimates for Two Schools and other Sites Including Diesel PM



C. Emission Inventory and Modeling Results

As discussed in Part II Section C, a screening level modeling analysis was developed to identify areas where air pollutant concentrations may be elevated. This analysis included evaluating the concentrations of CO along a defined area of Watt Avenue and estimating the health risk values at Arden and Joyce Schools. The modeling area was centered on Watt Ave, includes both schools, and is approximately four and a half miles wide and seven and a half miles long. This screening level analysis gave us an estimate of the emissions originating in the modeling area and does not include regional emissions.

Emission Inventory Results

In addition to using CEIDARS for local source emissions, EMFAC and the travel demand model for mobile sources, actual traffic counts were obtained for the study. These traffic counts, obtained from the Sacramento County Department of Engineering, were compared with the traffic counts obtained from the travel demand model. Arden School has a vehicle count of approximately 82,000 vehicles per day whereas Joyce School has a vehicle count of approximately 41,000 vehicles per day. The modeled counts were approximately 20% lower than the actual traffic counts. The difference between actual traffic counts and modeled traffic counts were well within the established range allowed by the travel demand model.

A stationary source (non-mobile) inventory was compiled from CEIDARS. An emission summary by facility was obtained and totals were calculated. There were only few small sources of criteria pollutants reported by CEIDARS for this area and they were added to the modeling calculations for aircraft ground support equipment at McClellan and the rest of the localized emissions inventory can be seen in Table 8. The facilities in the area include a hospital, a veterinary hospital, 17 dry cleaners, and three autobody shops. Selected local facility types not reporting to CEIDARS were identified and mapped using GIS software. These facilities included autobody shops, gas stations, and dry cleaners. A list of these facilities was compiled from an Internet search in approximately a one-mile radius around each school. We crosschecked this list with the Sacramento Metropolitan Air Quality Management District permit list and local yellow pages and a GIS map showing the locations of these facilities was generated (See Figure 10).

Modeling Results

The modeled CO concentrations at Arden and Joyce School were 0.40 ppm and 0.25 ppm, respectively. As was seen with the monitoring results, both of the modeled concentrations are well below the State and Federal Ambient Air Quality Standard level of 9 ppm. The modeled results are substantially lower than the monitored results and these differences can be attributed to several things. The air dispersion modeling performed in this study estimates the ambient air pollution concentrations due to emissions from sources within the study area. The ambient air monitoring data provides the actual ambient concentration at a specific location, and this concentration is due to a combination of emissions from local sources and background air pollution from other parts of the region. The other reasons why the modeling results are lower than the monitoring results include the selection of model chosen and the emission inventory that is used. Each model has its own strengths and weakness and compiling a complete emissions inventory is a difficult task. Even with these inherent uncertainties the modeling results it still reflects the traffic differences between the two schools.

To evaluate the health risk levels at Arden and Joyce schools, three models were used (ISC, Caline, and HARP) and combined to establish an estimated modeled risk assessment level for both schools. The modeled cancer risk values at Arden and Joyce Schools are 7 and 5 (excess cancer cases per million people), respectively (Figure 11). As can be seen in Figure 11, the darker shading indicates areas of higher risk values, primarily along the freeways, but drops off quickly as you move away from a roadway. When comparing these values to the calculated risk values from the special purpose monitoring we see a substantial difference. These differences may be attributed to the fact that the modeling does not include the regional air pollution that is transported into the area. It only reflects the emissions that were located in our study area.

Table 8 - CEIDARS Toxics Inventory

Toxic Substance	Emissions (lbs./yr.)	Toxic Substance	Emissions (lbs./yr.)
Carbon Black Extracts	455	Mercury	0.512
Glycol Ethers	3619	Nickel	0.056
Xylenes	1877	Arsenic	0.006
Benzene	42.0	Cadmium	0.009
Toluene	4729	Chromium, hexavalent (&compds)	0.002
Isocyanates	33.6	Vinyl Chloride	0.002
Formaldehyde	13.5	Acetaldehyde	7.17
Methlyene chloride	304	Hydrochloric Acid	8.27
PAH's	7.19E-03	Hydrogen fluoride	0.073
Diesel engine exhaust, particulate matter	77	Dioxin Total	1.83E-06
Diesel engine exhaust, total organic matter	102	Styrene	37.4
Lead	0.013	Perchloroethylene	22412

Figure 10 - GIS Map of Facilities

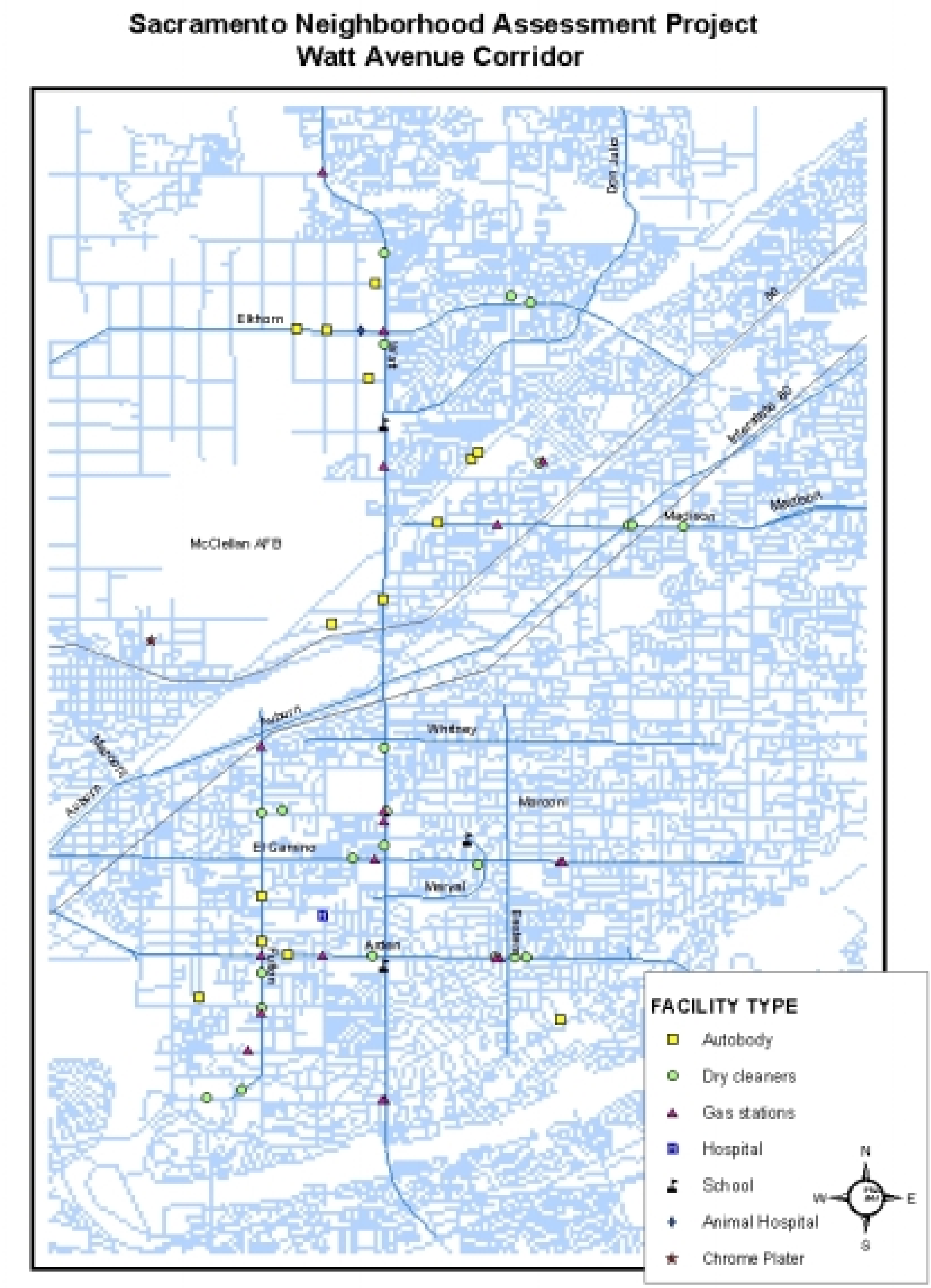
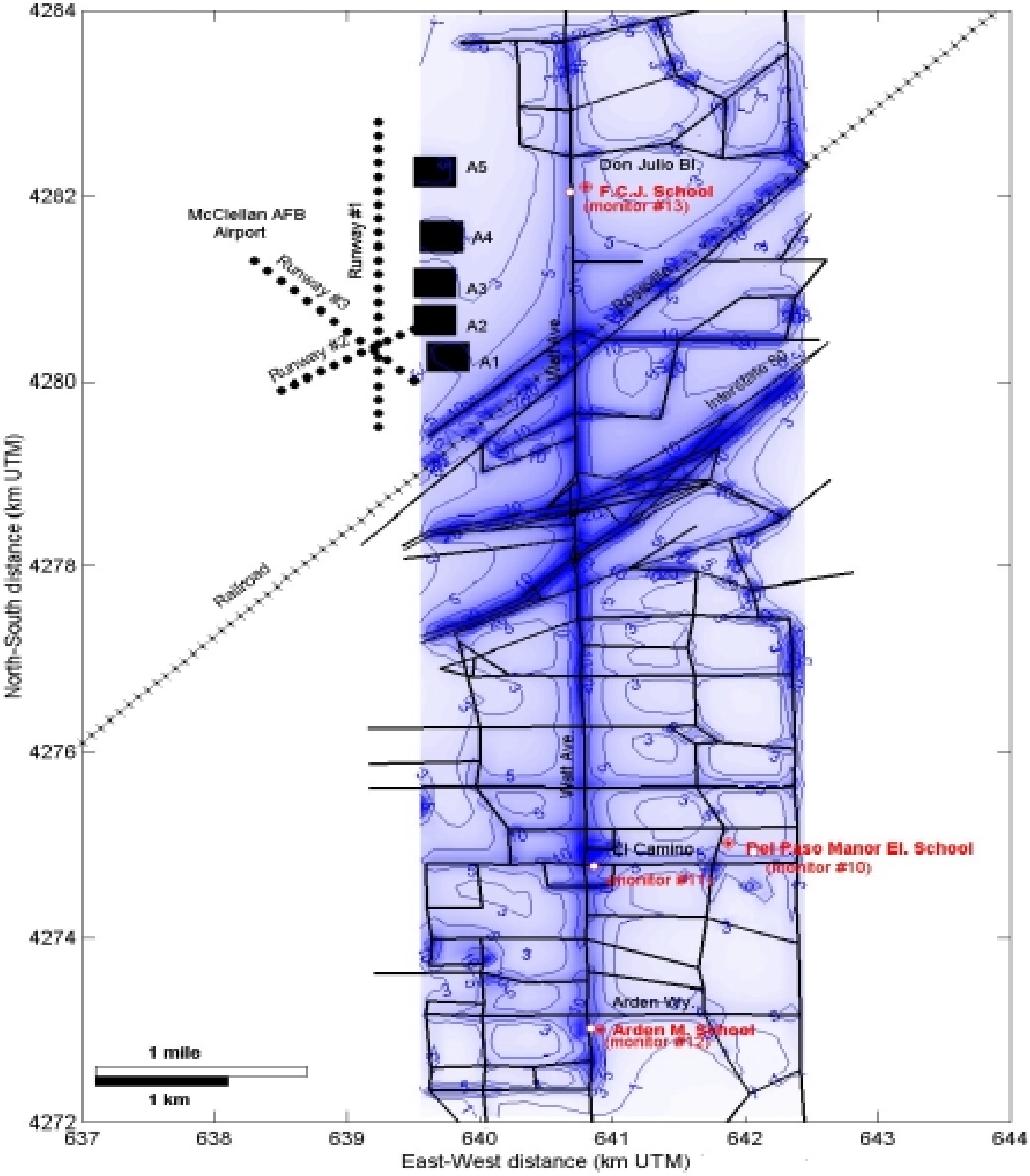


Figure 11 – Health Risk Values –All Sources



IV. Conclusions

At the request of the American Lung Association and the Sacramento Metropolitan Air Quality Management District, the Air Resources Board designed and conducted a short-term air quality study at two schools along Watt Avenue, a high traffic roadway, in Sacramento, California. To address this request, the Air Resources Board designed a study with two objectives: (1) to determine if selected air pollutant concentrations were different between the two schools; and (2) to assess air pollutant concentrations arising from motor vehicles traveling on Watt Avenue and the potential health risk at each school.

The air quality study consisted of an analysis of three years of historical air monitoring data to characterize pollutant concentrations in the Sacramento region; one month of special purpose ambient air monitoring in January 2002 to determine air pollutant concentrations at each school; and the use of air quality models to estimate where ambient air pollutant concentrations may be elevated in the area of our study.

The analysis of the historical Sacramento monitoring data for the years 1998-2000 showed that the average annual criteria pollutant concentrations were generally in the same range at all eleven Sacramento routine monitoring sites. Exceedances of the State or Federal Ambient Air Quality Standards were seen at most Sacramento sites for at least one pollutant. Although the concentration levels of pollutants are similar within the Sacramento area, these levels are still too high and future emission controls will be needed for this area to reach attainment of the air quality standards for all pollutants.

In general, the special purpose air monitoring results indicate that the air pollutant concentrations at the two schools were similar to each other and to other air monitoring sites in the Sacramento area. CO was the only pollutant where there was a large difference between the schools. The CO concentrations although well below all air quality standards, were twice as high at the Arden School than the Joyce School. The traffic count data obtained also showed that the traffic counts were approximately two times higher at the Arden School than at the Joyce School. These results may suggest that the differences between schools could be a function of traffic count and not mixed zoning of Joyce School as originally anticipated. In addition, the PM10 results were similar at both schools but were generally higher than most values measured at the routine sites of the Sacramento region. The slightly higher averages may indicate that the traffic on Watt Avenue has an influence on these two schools. With such a limited data set, a broader conclusion cannot be made.

The calculated cancer risk values, although limited due to sample size, were also similar at the two schools. The lack of a laboratory method for measuring diesel particulate prevents us from making a direct estimate of the full air pollution health risk. Air dispersion modeling was used to simulate dispersion of compounds emitted into the air within the study area. The model results did not identify any potential hotspot areas. The methodologies for conducting air dispersion modeling in communities is still under development and is being explored and tested by many agencies. The preliminary air modeling results for this study indicated that the risk values at both of the schools were similar. This short-term air quality study of two schools on Watt Avenue included the analysis of historical monitoring data, special purpose monitoring and the use of a screening level air dispersion model. This limited study provided some insight into the air quality of the two schools, but showed that the overall Sacramento region had a stronger influence over the air quality of the schools than the local sources of air pollution.

Because the monitoring results did not show large differences between the two schools, and the air modeling did not indicate the presence of any potential air pollution hotspots, we do not believe that additional localized monitoring will provide new information on the pollutants measured in the study. Diesel particulate was not measured as part of this study, because no methods to measure diesel particulate were available to ARB at the time the study was conducted. When methods become available to measure diesel particulate, the ARB intends to conduct monitoring at schools located near high-traffic areas to better understand children's exposure to diesel particulate while at school.

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