Community Air Quality Monitoring: Special Studies

Crockett

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California Environmental Protection Agency
Air Resources Board

Executive Summary

This report presents the final results from a special air quality monitoring study in the community of Crockett in Contra Costa County. The California Air Resources Board (ARB) conducted the study as part of a larger statewide evaluation of the adequacy of the State's air quality monitoring network as required by the Children's Environmental Health Protection Act (Escutia, Senate Bill 25, 1999 (SB 25)). The purpose of this study was to determine if current routine monitoring sites capture children's exposure to air pollution.

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The ARB selected the Crockett community in Contra Costa County due to its proximity to industrial facilities and mobile source emissions. Oil refineries and major oil storage facilities are located in nearby cities. Crockett is also the location of a major food processing operation and a heavy-rail transfer facility.

For the study, monitoring of ambient air quality at John Swett High School in the Crockett community began in October 2001 and continued until May 2003. The monitoring site shut down from December 20, 2002 through February 14, 2003 due to a lack of electrical power. The site collected information on approximately 50 air pollutants. These pollutants are known or suspected to cause cancer or other serious illnesses. Ambient levels of toxic air pollutants are routinely monitored at approximately 20 sites in the California air toxics monitoring network. The closest monitoring site to Crockett in the region is Fremont - Chapel Way, where data for the last 3 years are available for comparison of air toxics. Criteria gaseous pollutants from Crockett were compared to measurements from 2 of the closest permanent air quality monitoring sites, Vallejo and San Pablo.

Average levels of criteria air pollutants at Crockett are comparable to measurements from the nearest long-term monitoring sites in Vallejo and San Pablo. Crockett, like many other areas in the Bay Area, didn't exceed the State standards for either ozone or carbon monoxide (CO). The Crockett site exceeded the State 24-hour particulate matter that is 10 microns in diameter and smaller (PM_{10}) standard on one occasion. The Vallejo site exceeded the State 24-hour PM_{10} standard on two occasions, whereas the San Pablo site exceeded the standard on three occasions. Comparisons of the PM_{10} from all three sites indicated that the average concentrations of PM_{10} were similar between Crockett and Vallejo, while San Pablo was only slightly higher.

While standards for particulate matter and ozone have not been achieved, programs are in place for reducing levels of these pollutants. CO and nitrogen dioxide (NO_2) concentrations in Crockett are close to regional air pollution levels and are well below the State's air quality standards.

When assessing the impact of toxic air pollution, the study found that the cancer risk associated with air pollution at John Swett High School was lower than at the Fremont - Chapel Way site. The John Swett High School monitoring site has lower levels of toxic pollutants from motor vehicles, primarily benzene and 1, 3-butadiene, than generally measured at the sites measured as part of SB 25. You can locate all of Crockett's air monitoring data at http://www.arb.ca.gov/ch/aq_result/crockett/crockett.htm

The air monitoring conducted in Crockett was part of a larger study to evaluate the statewide air quality monitoring network. The complete evaluation is contained in a report titled *The Assessment of California's Statewide Air Monitoring Network* (Adequacy Report). The Adequacy Report was written before all of the data used in this report were available. As a result, the analyses and findings relating to Crockett in the Adequacy Report may differ somewhat from those contained in this report.

Introduction

Investigating the relationship of air pollution to children's health is an ongoing priority at the California Air Resources Board (ARB). The ARB has sponsored many studies on the health effects of children and their exposure to air contaminants. These and other studies indicate that children:

- are more vulnerable to environmental contaminants than adults;
- have higher exposure compared to adults relative to their body size;
- breathe more air on a comparable scale; and
- tend to be more active and breathe more rapidly than adults — therefore taking in larger doses of air contaminants.

In the long term, exposure to air pollutants can adversely affect the development of children's lungs, heart, and immune systems.

The Children's Environmental Health Protection Act

In recognition of children's vulnerability to air pollution, the California Legislature enacted the Children's Environmental Health Protection Act (SB 25). This legislation directed the ARB to take additional steps to ensure that the State's air pollution programs are protective of children's health. These steps include:

- a review of air quality standards to ensure children are protected;
- an evaluation of the adequacy of the current outdoor ambient air monitoring network to gather data necessary to determine children's exposure, including special monitoring studies in six communities in air pollution non-attainment areas around the State; and
- the review and development, where needed, of air toxic control measures to protect children's health.

SB 25 also requires the Office of Environmental Health Hazard Assessment (OEHHA) to identify those pollutants that are most harmful to children.

Crockett Air Quality Monitoring Study

This report presents the final results from a special air quality monitoring study in the community of Crockett in Contra Costa County. The ARB conducted the air monitoring in Crockett from October 2001 through May 2003. The study is one of six special community air quality monitoring studies required by the Act.

The Crockett study was part of a larger study to evaluate the adequacy of the statewide air monitoring network. This evaluation is contained in a report titled *The Assessment of California's Statewide Air Monitoring Network* (Adequacy Report) (http://www.arb.ca.gov/ch/programs/sb25/adequacy.htm). The Adequacy Report was written before all the data from the Crockett site were available. As a result, the analyses and findings relating to Crockett in the Adequacy Report may differ somewhat from those contained in this report.

Description of the Air Monitoring Study

Site Selection

The ARB selected Crockett as a study site to investigate the impact of industrial facilities and mobile source emissions on children's exposure to air pollution and to evaluate the ability of the State's permanent monitoring network to gauge that exposure. SB 25 required limited-term monitoring in six communities around the State. The air pollution monitors were placed at locations where children live, learn, and play. The other SB 25 sites include: Fruitvale, Fresno, Wilmington, Boyle Heights, and Barrio Logan.

Figure 1: Crockett Study Site

The City of Crockett is located in northern Contra Costa County where the Carquinez Bridge (Interstate 80) crosses the Carquinez Strait. The high school is located at 1098 Pomona Street.

The ARB conducted air quality monitoring at John Swett High School. The student population of John Swett High School is approximately 650. Crockett is home to two schools, John Swett High School and Carquinez Middle School. Carquinez Middle School, located directly across Pomona Street from the high school, has a student population of 500. Both schools are located

approximately one-half mile from Interstate 80, a major source of vehicle emissions.

Pollutants Sampled

Outdoor air samples for approximately 50 air pollutants were collected at John Swett High School during a 19-month period from October 2001 through May 2003. This site did not operate from December 20, 2002 through February 14, 2003 due to a lack of electrical power. The sampled pollutants included both toxic air pollutants and others known as "criteria pollutants" that are subject to ambient air quality standards.

Table 1: Some Key Pollutants Monitored in Crockett

John Swett High School	
Toxic Air Pollutants	**Criteria Pollutants**
1,3-butadiene	PM_{10}
Benzene	$PM_{2.5}$
Acetaldehyde	Ozone
Formaldehyde	Carbon monoxide
Perchloroethylene	Oxides of nitrogen
Carbon tetrachloride	
Methylene chloride	
Para-dichlorobenzene	
Hexavalent chromium	
Polycyclic aromatic hydrocarbons	
Arsenic	
Lead	
Nickel	
Elemental Carbon	

Table 1 lists the key pollutants measured and reviewed for this report. The levels of the other pollutants measured were very low or below the limit of detection. Particulate matter from diesel-powered engines, an important contributor to cancer risk, was not directly measured as part of this study. Currently, there is no accepted method for measuring diesel particulates in the air. As a result, estimates from the study do not include risk from diesel particulates. Monitoring methods for diesel particulates are still under development.

Toxic air pollutants are known or suspected to cause cancer or other serious illnesses. Ozone and particulate matter are examples of "criteria pollutants" for which health-based criteria or air quality standards have been established. The standards establish the levels above which a criteria pollutant may cause adverse health effects in humans.

California's Air Monitoring Network

The State's ambient air quality monitoring network is a key tool in measuring air quality in California and for determining children's exposure to air pollution. The data collected by this network of over 250 air quality monitoring sites are used to:

- track progress towards clean air;
- help determine exposures to sensitive populations, such as children and the elderly;
- help evaluate which pollutants in the outdoor air present the greatest hazards and thus help the ARB establish priorities for control;
- guide the announcement of "Spare the Air" days and other potentially hazardous conditions; and
- investigate the relationships between air pollution and children's health.

Crockett Data Compared to Long-term Monitoring Sites

Staff compared measurements from John Swett High School to measurements from two of the closest permanent air quality monitoring sites: San Pablo and Vallejo (see Figure 2). Vallejo is 3.3 miles from John Swett High School, about one-half mile away from Interstate 80. San Pablo is approximately 10 miles southwest of John Swett High School and about one-half mile from Interstate 80.

Figure 2: Crockett and Long-term Monitoring Sites

Air Monitoring Results for Criteria Pollutants

Criteria pollutant
An air pollutant with established safety thresholds and standards.

Criteria pollutants are air pollutants for which acceptable levels of exposure can be determined, and where ambient air quality standards have been set. Criteria pollutants can cause lung damage, heart problems, and in some cases, premature deaths. Based on the health and environmental impacts of these pollutants, State and federal air quality agencies have identified safety thresholds and established air quality standards for these pollutants to protect public health.

Five criteria pollutants — particulate matter that is 10 microns in diameter and smaller (PM_{10}), particulate matter that is 2.5 microns in diameter and smaller ($PM_{2.5}$), ozone, carbon monoxide (CO), and oxides of nitrogen (NOx), — were measured at John Swett High School. These pollutants are also routinely measured at the San Pablo and Vallejo long-term monitoring sites.

Particulate Matter (PM_{10})

The San Francisco Bay Area (Bay Area) region currently meets the State or federal air quality standards for PM_{10}. The very small size of PM_{10} allows the pollutant to reach deep in the lungs where it may be deposited and cause adverse health effects. Major sources of PM_{10} in California include motor vehicles, area-wide sources such as dust from construction and landfills, wood-burning stoves and fireplaces, wildfires and brush/waste burning, and industrial facilities. PM_{10} can also be formed in the atmosphere through chemical reactions between other air pollutants.

From year 1990 to 2000, overall PM_{10} emissions increased as the population of California rose. This was primarily the result of increased fugitive dust from paved and unpaved roads, reflecting the growth of vehicle travel in California. However, emissions of diesel particulate matter, which poses the most significant health risk, dropped 40 percent from 1990 to 2000 due to stricter emission standards and the introduction of cleaner diesel fuel.

Table 2 summarizes PM_{10} levels at John Swett High School and nearby long-term monitoring sites over a 19-month period (October 2001 through May 2003, the site shutdown from December 20, 2002 through February 14, 2003). It is customary to study air quality for a year or more to account for seasonal variations. Unlike the other criteria pollutants, which are measured continuously, PM_{10} is usually measured over a 24-hour period once every six days.

Table 2. Particulate Matter (PM_{10}) from October 2001 through May 2003

Location	Average*	Maximum*	Number of Days Above State Standard** (19 months)
Crockett (John Swett)***	19	70	1 of 77 days
San Pablo	21	67	3 of 80 days
Vallejo	19	84	2 of 94 days

* Values are 24-hour average concentrations reported in units of micrograms per cubic meter (ug/m3).
Average is the average of all valid 24-hour samples collected at that location.
Maximum is the highest 24-hour sample measured at that location.

** Particulate matter standards—federal 24-hour average: 150 micrograms/m^3 (µg/m^3); State: 24-hour average: 50 µg/m^3.

*** The Crockett site was shut down due to an electrical outage from 12/20/2002 until 2/14/2003.

The federal 24-hour PM_{10} standard (150 µg/m^3) was not exceeded at any of the sites during the study. As shown in Table 2, all three sites examined had exceedances of the State 24-hour PM_{10} standard (50 µg/m^3). The San Pablo site exceeded the State 24-hour standard three times. The Vallejo site exceeded the State 24-hour standard two times, whereas the Crockett site only exceeded the State 24-hour standard one time. Comparisons of the PM_{10} from all three sites indicated that the average concentrations of PM_{10} were comparable between Crockett and Vallejo, while San Pablo was only slightly higher. All three sites exceeded the State 24-hour PM_{10} standard on November 28, 2002, which was Thanksgiving Day. This suggests that something out of the ordinary happened that day such as a large amount of people using their fireplaces on Thanksgiving Day, or some other unusual condition. The measurements presented in this table were not always collected on the same days at all three sites, but were collected during the same 19-month period.

Background level

The pollutant concentration present at a constant level throughout a region.

PM2.5

During the study we initially recorded unexpectedly high PM2.5 measurements at John Swett High School. We later found this was due to an improperly adjusted PM2.5 monitor. In general, the instrument problem caused the monitor to read about 25% higher than actual values. Because of this instrument problem, most of the PM2.5 monitoring data collected in the Crockett study was invalidated. Those Crockett PM2.5 values that were valid were slightly lower than comparable PM2.5 values measured in Concord.

Ozone

Ozone is a product of the chemical reactions of nitrogen oxides and volatile organic compounds in the presence of sunlight and is a major indicator of smog. Near the earth's surface, ozone can cause breathing difficulties and even lung damage. Ground-level ozone can also damage vegetation, buildings, rubber, and plastics. Currently, many areas of California do not meet the federal or State air quality standards for ozone.

Table 3. Ozone from October 2001 through May 2003

Location	Average*	Maximum*	Number of Days Above State Standard**
Crockett (John Swett)***	40	89	0
San Pablo	37	71	0
Vallejo	37	109	1

* Values are one-hour average concentrations reported in units of parts per billion (ppb).
Average is the average of all daily one-hour maximum concentrations measured at that location.
Maximum is the highest one-hour concentration measured at that location.

** Ozone standards—federal 1 hour: 120 ppb, State 1 hour: 90 ppb.

*** The Crockett site was shut down due to an electrical outage from 12/20/2002 until 2/14/2003.

As summarized in Table 3, levels of ozone at John Swett are comparable to those routinely measured in this part of the Bay Area region. The federal one-hour ozone standard (120 ppb) was not violated at any site during the duration of the study. Over the 19-month period, the study found all ozone levels below the State standard (90 ppb) at John Swett and at San Pablo. The Vallejo site violated the State one-hour ozone standard (90 ppb), on one day. The Vallejo site is 3.3 miles away from the Crockett site. While the averages for all three sites were comparable, the slightly higher average one-hour ozone concentration at the Crockett site resulted in no violations of the State one-hour ozone standard (90 ppb).

California has adopted aggressive emission controls on motor vehicles and other sources. As a consequence, the ozone levels have decreased over the last two decades in the Bay Area region. The ARB expects continued progress toward reducing ozone.

Carbon Monoxide (CO)

CO is a colorless, 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.

CO 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 CO emissions in California. The contribution of industrial sources to overall CO emissions is small. Currently, CO levels in most areas of California are below the State standard, so CO is a diminishing problem in California.

As shown in Table 4, CO levels at Crockett appear to be slightly lower than at the two long-term sites, but all sites were still well below the State standard. The higher CO average at the Vallejo site may possibly be attributed to higher traffic impacts from motor vehicles. Much of the progress in reducing levels of CO is attributable to motor vehicle emission controls and the introduction of cleaner fuels. The ARB expects further reductions of CO levels statewide.

Table 4. Carbon Monoxide from October 2001 through May 2003

Location	Average*	Maximum*	Number of Days Above State Standard**
Crockett (John Swett)***	0. 5	1. 6	0
San Pablo	0. 7	1. 8	0
Vallejo	1. 0	3. 9	0

* Values are 8-hour average concentrations reported in units of parts per million (ppm).
Average is the average of all daily maximum 8-hour average concentrations measured at that location.
Maximum is the highest 8-hour average concentration measured at that location.

** Carbon monoxide standards: federal and State 8 hour: 9 ppm.

*** The Crockett site was shut down due to an electrical outage from 12/20/2002 until 2/14/2003.

Oxides of Nitrogen (NO_x)

NO_x contribute to the formation of ozone and particulate matter, both of which are major air pollutants that reach unhealthy levels in many areas of California. NO_x is emitted during the high-temperature combustion of fuels. On-road motor vehicles and other mobile sources currently contribute most of the NO_x emissions in California.

The two major types of NO_x are nitric oxide (NO) and nitrogen dioxide. (NO_2). Air quality standards have been established for NO_2, but not for NO_x. The Bay Area region and other areas of the State are currently attaining the State standard for NO_2. The NO_2 standard was not exceeded at Crockett during the study.

Because the Bay Area and other areas of the State are currently attaining the State Standard for NO_2, this report will discuss NO_x. As shown in Table 5, Crockett's annual levels of NO_x are very similar to the levels measured at the San Pablo site, while the Vallejo site was approximately twice as high as the Crockett site. The higher average of NO_x at the Vallejo site could possibly be attributed to higher traffic impacts.

Table 5. Oxides of Nitrogen* from October 2001 through May 2003

Location	Average**	Maximum**
Crockett (John Swett)***	43	218
San Pablo	59	224
Vallejo	86	420

* No federal or State standard has been established for NO_x; the State standard for NO_2 (250 ppb for a one-hour average) was not exceeded during the study.

** Values are one-hour average concentrations reported in units of parts per billion (ppb).
Average is the average of all daily maximum one-hour average concentrations measured at that location.
Maximum is the highest one-hour average concentration measured at that location.

*** The Crockett site was shut down due to an electrical outage from 12/20/2002 until 2/14/2003.

Emissions of NO_x from on-road motor vehicles declined by more than 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 cleaner burning gasoline. Emissions from industrial sources have also decreased, largely because of a switch from fuel oil to natural gas and the implementation of combustion controls. However, the ARB continues to work toward reducing levels of NO_x due to its role in the formation of ozone and particulate matter.

Criteria Pollutant Monitoring Summary

Average levels of criteria air pollutants at Crockett are comparable to measurements from the nearest long-term monitoring sites in Vallejo and San Pablo. Crockett, like many other areas in the Bay Area, didn't exceed the State standards for either ozone or CO. The Crockett site exceeded the State 24-hour PM_{10} standard on one occasion. The Vallejo site exceeded the State 24-hour PM_{10} standard on two occasions, whereas the San Pablo site exceeds the standard on three occasions. Comparisons of the PM_{10} from all three sites indicated that the average concentrations of PM_{10} were similar between Crockett and Vallejo, while San Pablo was only slightly higher.

While standards for particulate matter and ozone have not been achieved, programs are in place for reducing levels of these pollutants. CO and NO_2 concentrations in Crockett are close to regional air pollution levels and are well below the State's air quality standards. You can locate all of Crockett's air monitoring data at http://www.arb.ca.gov/ch/aq_result/crockett/crockett.htm

Air Monitoring Results for Key Toxic Air Pollutants

Health Effects of Toxic Air Pollutants

Toxic air pollutants can cause adverse health effects, including cancer, asthma, respiratory problems, and other serious illnesses. Cancer risk estimates related to toxic air pollution represent the chance of excess cancer cases in one million people, assuming exposure over a 70-year lifetime.

Key Toxic Air Pollutants Monitored in Crockett

Benzene

1,3-Butadiene

Formaldehyde

Acetaldehyde

Perchlorethylene

Carbon Tetrachloride

Monitoring results indicate that the potential cancer risk at Crockett is mostly attributable to six of the toxic air pollutants measured during the study: benzene, 1,3-butadiene, formaldehyde, acetaldehyde, perchlorethylene, and carbon tetrachloride. This report only assesses the cancer risk posed by levels of these six toxic air pollutants measured during this study. Including the other toxic air pollutants measured at these sites does not significantly change the overall risk at each site nor does it change the overall relationship of cancer risk between sites. These cancer risk estimates did not include diesel particulate matter (diesel PM).

Diesel PM is believed to be the primary contributor to health risks from urban toxic air pollutants. However, diesel PM was not measured as part of this study because a proven method for measuring it is not currently available. The ARB is in the process of developing methods to measure diesel PM. California already has an aggressive program to reduce diesel PM emissions throughout the State. You can locate the final diesel risk reduction plan by visiting the ARB's webpage: (http://www.arb.ca.gov/diesel/documents/rrpapp.htm)

Cancer risk estimates for pollutants at Crockett

To put the results from Crockett into perspective, ARB staff calculated estimates of potential cancer risk for the six key toxic air pollutants at Crockett, Fremont and California Statewide. The potential cancer risk due to these key toxic air pollutants at Crockett appeared to be lower than that estimated for the same toxic air pollutants at Fremont and Statewide. A similar analysis found there was enough of a difference between Crockett and Fremont to conclude that the cancer risk is higher at Fremont.

Why does the potential total cancer risk differ between Crockett and Fremont? To answer this question, staff looked at the key toxic air pollutants individually. Table 6 shows how much each key toxic air pollutant contributes to the overall cancer risk shown in Figure 3. In general, the major differences between Crockett and Fremont was in the concentrations of benzene and 1,3-butadiene, which is likely due to a greater impact from motor vehicles.

The health risks estimates 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 pollutants and limitations in scientific understanding of pollutants' health effects. Furthermore, our analysis of health risks from toxic air pollutants focused on one possible adverse health effect, cancer, whereas these pollutants may also cause a variety of respiratory, reproductive, and other adverse health effects.

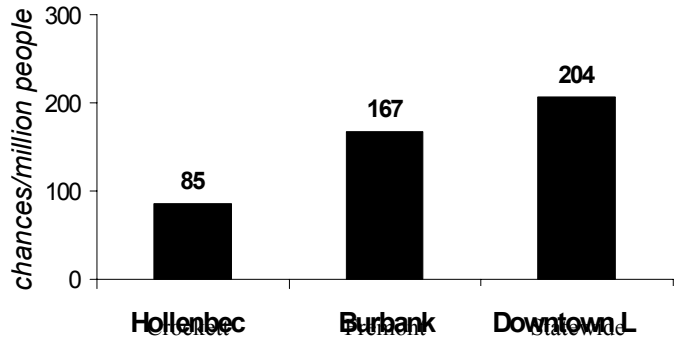
Table 6. Annual Average Levels of Key Toxic Air Pollutants (10/01-9/02)

		Crockett (John Swett)		Fremont (Chapel Way)	
Pollutant	Risk (1) Factor	Average (2) concentration	cancer risk (3)	Average (2) concentration	cancer risk (3)
Benzene	93	0.24	22	0.58	54
1,3-Butadiene	376	0.05	21	0.16	63
Formaldehyde	7	1.8	13	2.28	17
Acetaldehyde	5	0.4	2	0.79	4
Perchlorethylene	40	0.02	0.8	0.07	3
Carbon Tetrachloride	264	0.09	24	0.09	24

1. Toxicity values for cancer causing air pollutants expressed in terms of risk per unit concentration of the air pollutant given in chances of cancer per million people.
2. Values are 24-hour average concentrations reported in units of parts per billion (ppb).
3. Cancer risk estimates are calculated as (risk factor · average concentration) = cancer risk. 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.

- Formaldehyde and Acetaldehyde were missing monitoring data at Fremont (Chapel Way) from 11/01 through 2/02, so the average concentration was based on data from 3/02 through10/02.
- Hexavalent Chromium was not provided since there were missing monitoring data at Fremont (Chapel Way) for comparison for the whole time period except for one data point.
- These toxic air pollutants had no matching monitoring dates in January 2002.

Figure 3. Annual Levels of Key Toxic Air Pollutants



* Figure 3 does not include estimated risk from diesel PM. The potential risk estimates assume a lifetime exposure through breathing pathway only. Estimates for Crockett are based on 10/2001-9/2002 data. Fremont and California Statewide data are based on the time period of (1998 – 2001).

Benzene and 1,3-Butadiene

Benzene and 1,3-butadiene produced the majority of the cancer risk at both sites. Because levels of benzene and 1,3-butadiene were higher at Fremont than at Crockett, the resulting cancer risk was higher at Fremont. Because these two pollutants are directly emitted by motor vehicles, this suggests that heavier traffic near Fremont was the cause of the higher pollutant levels. Emissions from these two pollutants have been reduced in California through aggressive regulations requiring motor vehicle emission controls, gasoline vapor recovery systems, and cleaner fuels. From 1990 to 2000, outdoor statewide levels declined 72 percent for benzene and 53 percent for 1,3-butadiene. The ARB has regulations in place to further reduce emissions from benzene and 1,3-butadiene.

Formaldehyde and Acetaldehyde

As seen in Table 6, Fremont had higher overall cancer risk levels than Crockett. When comparing the Crockett and Fremont sites, the associated cancer risk was higher for both acetaldehyde and formaldehyde at the Fremont site. Acetaldehyde and formaldehyde can be directly emitted into the air; the two pollutants are also formed when hydrocarbons emitted by motor vehicles and other sources chemically react with oxygen in the atmosphere. This makes it difficult to identify the sources of these two pollutants impacting each monitoring site. The

threshold for exposure to formaldehyde above which there is some acute health concerns is 2 parts per billion (ppb). Average concentrations of formaldehyde at the Crockett site were 1.8 pbb, which is slightly below the threshold of 2 ppb. The maximum concentration measured at Crockett was 5.1 ppb, which indicates that some individuals might experience mild eye irritations during peak exposures. The average concentration for formaldehyde at the Fremont site measured during the study was above the 2 ppb threshold. The statewide annual average for formaldehyde in 2001 was 3.2 ppb. Emissions of acetaldehyde and formaldehyde have been reduced in California through aggressive regulations requiring motor vehicle emission controls and cleaner fuels. Data for acetaldehyde and formaldehyde are more variable, but levels have decreased significantly since 1990. The ARB has regulations in place to further reduce emissions of acetaldehyde and formaldehyde. ARB is developing an airborne toxics control measure (ATCM) to reduce formaldehyde emissions from composite wood product production.

Perchloroethylene

Levels of perchloroethylene, a persistent organic pollutant, were higher at Fremont than what was measured at Crockett. In addition to potential cancer risks, perchloroethylene can irritate the eyes and respiratory tract. Perchloroethylene can also depress the central nervous system. Levels of perchloroethylene measured at Crockett were way below non-cancer thresholds. Industrial processes and dry cleaners are the major sources of emissions of perchloroethylene. ARB's control measures on dry cleaning facilities have helped to reduce levels of perchloroethylene statewide, and the ARB is investigating further control on dry cleaners. Statewide outdoor perchloroethylene levels in 2000 were approximately 58 percent lower than 1990 levels. Controls on degreasers used for automotive maintenance and repairing that are already in place should further reduce levels of this pollutant.

Carbon Tetrachloride

Average levels of carbon tetrachloride at the Crockett site were comparable to the levels at the Fremont site. The average concentrations of carbon tetrachloride were exactly the same at both Crockett and Fremont; therefore the cancer risk associated with carbon tetrachloride was the same. Because carbon tetrachloride emissions are very low in California, levels throughout the State are relatively constant. In fact, carbon tetrachloride levels are fairly constant around the globe,

the lingering effect of past use. Carbon tetrachloride takes about 50 years to break down in the atmosphere.

Air Monitoring Results for Other Toxic Air Pollutants

In addition to the criteria and toxic air pollutants discussed above, other air pollutants related to industrial sources near Crockett were measured as part of this study. These pollutants were either measured at very low levels or were below the levels of detection.

Para-dichlorobenzene and methylene chloride

For most samples, levels of the solvents para-dichlorobenzene and methylene chloride at Crockett were below the level of detection. The average levels of the detectable samples of methylene chloride at Crockett were comparable to levels at Fremont. All samples of para-dichlorobenzene were below the level of detection. Para-dichlorobenzene is used as a room deodorant, in mothballs, and as a dye intermediate. It is also a registered insecticide.

Many manufacturers of consumer products are voluntarily phasing out their use of methylene chloride. In the case of aerosol paints, use will be restricted by an ARB regulation. In 2000, the ARB adopted a control measure to eliminate the use of methylene chloride in degreasers for automotive maintenance and repair.

Level of detection

Lowest concentration of a pollutant that a monitor can measure.

Nanogram

One billionth of a gram.

Hexavalent Chromium

The amount of hexavalent chromium in most samples collected at the Crockett site was too low to be measured by laboratory instruments. Most hexavalent chromium samples were below the level of detection (LOD). Only one out of the eighty-three total samples was above the LOD. The sample taken above the LOD was sampled in July of 2002. California adopted a control measure in 1988 to reduce emissions of hexavalent chromium from chrome plating; as a result, statewide levels have been reduced. Because hexavalent chromium is highly toxic, even minute amounts still pose a health risk.

Other Metals

Several metals, including manganese, nickel, and lead, were measured at Crockett. However, the measured levels of these metals are not high enough to pose a significant health risk. For instance, while average levels of manganese at Crockett were 18 nanograms per meter^3 (ng/m^3), the threshold above which there is some health concerns, is 200 ng/m^3. Sources of these metals include industrial and commercial operations as well as motor vehicles.

Levels of arsenic at Crockett were comparable to other sites and to average statewide levels. Observed levels did not pose a significant health risk. While average levels of arsenic at Crockett were 1.3 ng/m^3, the threshold above which there is some health concerns is 30 ng/m^3. The primary industrial sources of arsenic in California are electrical services and metal mining. Arsenic is also used in insecticides, weed killers, fungicide, and as a wood preservative.

Monitoring Results for Elemental Carbon

Elemental carbon is a material found in PM_{10} and $PM_{2.5}$. In the past, it has been used as an indicator of, or surrogate for, diesel particulate matter (diesel PM) levels because of the relatively high content of elemental carbon in diesel. Elemental carbon consists of tiny, black, solid particles of soot, most of which are smaller than 2.5 microns. This small size allows the particles to reach deep into the lungs where they may be deposited and result in adverse health effects.

Recently, however, diesel technologies have improved and the diesel fleet has become cleaner. Other combustion processes such as fireplaces, cooking, forest fires, gasoline engines, agricultural burning, and power plants also emit elemental carbon. As emissions from the diesel fleet have decreased, these sources now account for a larger percentage of total elemental carbon in the air. With these changes, elemental carbon alone is no longer a good marker for diesel PM.

Elemental carbon is not routinely monitored, and there are no standards or thresholds established for which levels of elemental carbon are deemed unsafe. ARB used the U.S. EPA-approved method to measure elemental carbon in this study. However, earlier studies have used different analysis methods, so there are no historical regional or statewide values available for comparison.

Elemental carbon was monitored at Crockett for the entire nineteen months of the study. Inspection of those data revealed that all of the samples where below the LOD. The LOD for elemental carbon is 1 ugC/m^3. You can locate all of Crockett's air monitoring data at
http://www.arb.ca.gov/ch/aq_result/crockett/crockett.htm

Meteorological Impact on Air Quality

Weather can have a significant effect on air pollution levels. Because of their location near the coast, John Swett High School and the nearby air monitoring sites at San Pablo and Vallejo both enjoy weather that tends to prevent the build up of air pollution in their respective communities.

The difference in land and water temperature produces an onshore breeze almost daily for any place located near the coast. In this area, an onshore breeze will begin in midmorning and it will force any air over the coast into the interior valleys or vertically lift the air away from the surface. This natural ventilation carries cleaner surface air into the area for as long as the onshore breeze blows. This type of a breeze continues through the day until it dies down late in the afternoon. This favorable meteorology seems to explain why the air pollution levels measured in this study were lower than one might anticipate from the air pollution sources in the Crockett area.

Conclusions

The school monitoring site in Crockett was chosen to comply with the SB 25 requirement to look at the impact of industrial facilities and motor vehicle emissions from nearby freeways on locations where children live, learn, and play. Based on outdoor air measurements collected at Crockett, along with data from the long-term monitoring sites in San Pablo and Vallejo, ARB staff found the following patterns in the air quality data.

The most significant finding was that air quality in Crockett and San Pablo is reasonably similar for all criteria pollutants, except PM_{10}. Comparisons of the PM_{10} from all three sites indicated that the average concentrations of PM_{10} were comparable between Crockett and Vallejo, while San Pablo was only slightly higher. This suggests that similar regional rather than local conditions are the primary factors influencing the levels of most air pollutants at these three sites. The higher levels of PM_{10} observed at San Pablo suggests that local sources contribute to the local PM_{10} burden, especially with respect to the maximum PM_{10} levels observed. The overall air quality measured at John Swett High School was comparable and in some cases better than what was measured at monitoring sites in other nearby cities in the Bay Area.

Cancer Risk

In general, the risk from toxic pollutants measured at John Swett High School was approximately one-half of what was measured at Fremont. Based on the information collected in this study, the estimated cancer risk associated with toxic air pollutants (not including diesel particulate) in Crockett is 85 excess cases of cancer per million people exposed. This is approximately one-half of the estimated toxic air pollutant cancer risk of 167 in a million in Fremont and about 40% of the statewide urban average toxic air pollutant risk of 204 in a million. The estimated potential cancer risk represents the chances in a million of developing cancer due to breathing toxic air pollutants. These numbers do not include diesel particulate. Currently, there is no accepted method for measuring diesel particles in the air. As a result, estimates from the study do not include risk from diesel particles.

For toxics that represent the greatest risk, the levels were lower at John Swett than the levels routinely found at the Fremont site. However, because Fremont is 50 miles away, it is questionable about how much this site is representative of the Crockett area. John Swett High School monitoring site has lower levels of toxic pollutants from motor vehicles, primarily benzene and 1,3-butadiene, than generally seen at other SB 25 sites in California.

Reducing Air Pollution in Crockett

There are numerous programs that specifically target mobile source emissions such as those found in Crockett. The ARB is responsible for developing statewide programs and strategies to reduce the emission of smog-forming pollutants and toxics by mobile sources. The ARB has programs such as the Diesel Risk Reduction Program and the California Motor Vehicle Program that help reduce air pollution from motor vehicles.

The Diesel Risk Reduction Program reduces diesel emissions from both new and existing diesel engines and vehicles. One of the key elements of the plan is to retrofit existing diesel engines in California to reduce diesel particulate emissions to near zero, in the shortest time possible. The program focuses on several control options such as the catalyst-based diesel particulate filters or traps and other viable alternative technologies and fuels. You can find out more information about the diesel risk reduction plan at:
http://www.arb.ca.gov/diesel/documents/rrpapp.htm

The ARB also has a website that lists information on all mobile source related programs. You can find more information about these programs at: http://www.arb.ca.gov/msprog/msprog.htm

The ARB will continue to evaluate the health effects of pollutants in the air while implementing programs with local authorities that aim at reducing levels of air pollution in communities such as Crockett.

For more information, contact:

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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

"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.