Community Air Quality Monitoring: Special Studies

Boyle Heights

Los Angeles County

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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 Boyle Heights in Los Angeles. The California Air Resources Board (ARB) conducted the study during 2001 and 2002 as part of a larger statewide evaluation of the adequacy of the State's air quality monitoring network as required by the Children's Environment Health Protection Act (Escutia, Senate Bill 25, 1999).

The ARB selected Boyle Heights to investigate the impact of heavy traffic on children's exposure to air pollution. Busy surface streets and four freeways (Interstates 5 and 10, and U.S. Highway 101 and State Route 60) run through the community, which contains 16 schools and childcare centers.

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For the study, Hollenbeck Middle School (Hollenbeck) was chosen as the primary air monitoring site. Data from the Hollenbeck site were compared to data from long-term monitoring sites in downtown Los Angeles and Burbank that are part of the State's existing ambient air quality monitoring network. In addition, the ARB set up special monitoring sites at the East Los Angeles Mathematics, Science, and Technology Center (Science Center) and the Soto Street Elementary School (Soto School) to provide additional information about particulate matter (PM_{10}) concentrations near freeways. Although all the Boyle Heights monitoring sites in this study are near one or more major freeways, Soto School is closest—immediately adjacent to an off ramp and the intersection of several freeways. Science Center is near State Route 60. Hollenbeck is approximately one-half mile from the area's freeways.

The study found that particulate matter (PM_{10}) levels were highest at Soto School, the site that was closest to the heavy traffic of the area's freeways. That site exceeded the State air quality standard for PM_{10} about three times as often as Science Center, Hollenbeck, and the two long-term sites. PM_{10} levels dropped rapidly as you moved away from Soto School and the adjacent freeways and traffic.

When assessing the impact of toxic air pollution, the study found that the cancer risk associated with air pollution at Hollenbeck was comparable to that at Burbank, but about 20 percent higher than the cancer risk at the Downtown Los Angeles site. Higher levels of benzene and 1,3-butadiene, the main toxic pollutants associated with cancer risk in these areas, were responsible for the increased risk at Hollenbeck and Burbank. Since motor vehicles are the primary

source of both these pollutants, heavy traffic near the two sites is probably the cause of the higher pollutant levels.

Average criteria pollutant levels were similar at Hollenbeck and the two long-term monitoring sites at Downtown Los Angeles and Burbank; however, Burbank had higher peak levels of ozone and about twice as many days above the State standard for ozone. Burbank's hotter summer temperatures are possibly responsible for the higher ozone concentrations, which depend heavily on weather conditions and terrain.

The air monitoring conducted in Boyle Heights was part of a larger study to evaluate the statewide air quality monitoring network. This 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 2001 and 2002 data from the downtown Los Angeles and Burbank sites used in this report were available. As a result, the analyses and findings relating to Boyle Heights 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 agency 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 (Escutia, Senate Bill 25, 1999). 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.

The Children's Environmental Health Protection Act (Act) also requires the Office of Environmental Health Hazard Assessment (OEHHA) to identify those pollutants that are most harmful to children.

Boyle Heights Air Quality Monitoring Study

This report presents the final results from a special air quality monitoring study in the community of Boyle Heights in Los Angeles. The ARB conducted the air

monitoring during 2001 and 2002 as one of six special community air quality monitoring studies required by the Act.

The Boyle Heights study was also 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 of the 2001 and 2002 data from the downtown Los Angeles and Burbank sites used in this report were available. As a result, the analyses and findings relating to Boyle Heights in the Adequacy Report may differ somewhat from those contained in this report.

Description of the Air Monitoring Study

Site Selection

The ARB selected Boyle Heights as a study site to investigate the impact of high traffic levels on children's exposure to air pollution and to evaluate the ability of the State's permanent monitoring network to gauge that exposure. The Act required limited-term monitoring in six communities around the State. The air pollution monitors were placed at locations where children live, learn, and play.

Boyle Heights lies near major roads and freeways and has a large number of children living in the community. Four freeways (Interstates 5 and 10, US Highway 101, and State Route 60) run through the area, which contains approximately 16 schools and childcare centers.

Figure 1: Boyle Heights Study Sites

The ARB conducted air quality monitoring at three schools in the community. Hollenbeck Middle School (Hollenbeck), the primary location for monitoring, is approximately one-half mile downwind of the convergence of four major Los

Angeles area freeways. The school has a large student population of about 2500 students and is located across from one of the largest senior high schools in Los Angeles County.

Short-term monitoring for particulate matter (PM_{10}) was also conducted at two satellite sites near Hollenbeck: the East Los Angeles Mathematics, Science, and Technology Center (Science Center) which is near State Route 60, and Soto Street Elementary School (Soto School) which is adjacent to a freeway off ramp and several freeways (see Figure 1). These satellite sites provided additional information about PM_{10} concentrations near freeways.

Pollutants Sampled

Outdoor air samples for approximately 70 air pollutants were collected at Hollenbeck during a 16-month period from February 2001 through May 2002. The sampled pollutants included both toxic air pollutants and others known as "criteria pollutants" that contribute to smog and particulate matter.

In addition, outdoor monitoring for PM_{10} and polycyclic aromatic hydrocarbons (PAHs) was conducted at Science Center and Soto School from March 2001 through October 2001.

Table 1 lists the key pollutants measured and reviewed for this report. The levels of the other pollutants measured were very low. Particulate matter from diesel-powered engines, an important contributor to cancer risk, was not directly measured as part of this study. Monitoring methods for diesel particulates and some other air pollutants that may cause adverse health effects are still under development.

Toxic air pollutants are known or suspected to cause cancer or other serious illnesses. Ozone and particulate matter are "criteria pollutants" for which health-based criteria or

Table 1: Some Key Pollutants Monitored in Boyle Heights

Hollenbeck Middle School	
Toxic Air Pollutants	**Criteria Pollutants**
1,3-butadiene	Particulate matter
Benzene	Ozone
Acetaldehyde	Carbon monoxide
Formaldehyde	Oxides of nitrogen
Perchloroethylene	
Carbon tetrachloride	
Methylene chloride	
Para-dichlorobenzene	
Hexavalent chromium	
Polycyclic aromatic hydrocarbons	
Arsenic	
Lead	
Manganese	
Nickel	
Science Center and Soto Street School	
Polycyclic aromatic hydrocarbons	Particulate Matter

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

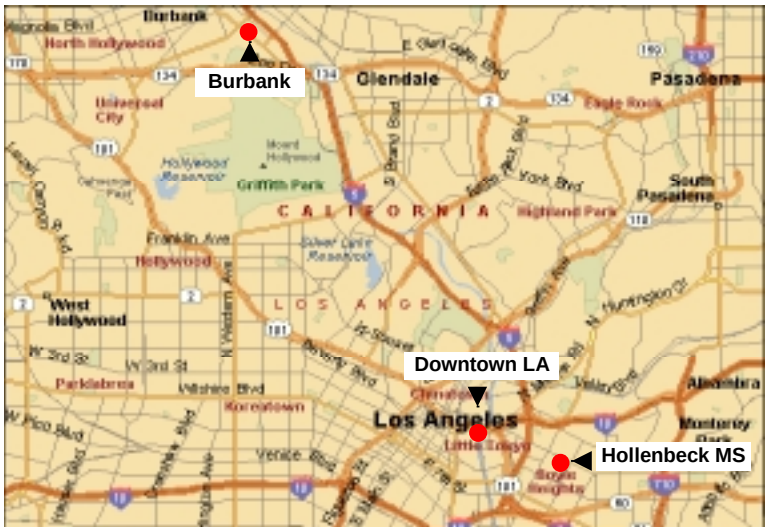
The State's ambient air quality monitoring network is a key tool in measuring air quality in California and for determining children's exposure to air pollution. The data collected by this network of over 250 air quality monitoring sites are used to:

- 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.

Boyle Heights Data Compared to Long-term Monitoring Sites

Air quality measurements from Hollenbeck were compared to measurements from two of the closest permanent air quality monitoring sites: Los Angeles-North Main and Burbank (see Figure 2). Los Angeles-North Main (Downtown Los Angeles) is four miles northwest of Hollenbeck, about one-half of a mile from State Route 110, and about three-quarters of a mile from Interstate 5. Burbank is thirteen miles northwest of Hollenbeck and about one-third of a mile from Interstate 5.

Figure 2: Boyle Heights and Long-term Monitoring Sites



Air Monitoring Results for Criteria Pollutants

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

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.

Four criteria pollutants—particulate matter that is 10 microns in diameter and smaller (PM_{10}), ozone, carbon monoxide (CO), and oxides of nitrogen (NOx), — were measured at Hollenbeck. These pollutants are also routinely measured at the Burbank and Downtown Los Angeles long-term monitoring sites.

Particulate Matter (PM_{10})

The Los Angeles region currently does not meet the State or federal air quality standards for particulate matter (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. As population increased in Los Angeles , so did activities that increased PM_{10} emissions. However, there has been a downward trend in measured levels of PM_{10} since 1990. Also, 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 Hollenbeck and nearby long-term monitoring sites over a 16-month period (February 2001 to May 2002). 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 February 2001 through May 2002

Location	Average*	Maximum*	Number of Days Above State Standard** (16 months)
Boyle Heights (Hollenbeck)	44	81	22 of 75 days
Downtown Los Angeles	43	97	21 of 74 days
Burbank	40	85	18 of 79 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

As shown in Table 2, levels of PM_{10} monitored at the Hollenbeck and Downtown Los Angeles sites were above the State standard about one in every three days. Levels were higher than the State standard on about one out of four days monitored at Burbank. The average daily levels and maximum daily levels were in the same general range at all three sites during the 16-month period. The measurements presented in this table were not always collected on the same days at all three sites, but were collected during the same 16-month period.

PM_{10} air samples were also collected at Soto School and Science Center from March 2001 to October 2001 on the same sampling schedule as Hollenbeck. Table 3 summarizes results for PM_{10} over this eight-month period. (Because Table 2 is based on 16 months of data, the values in Tables 2 and 3 will differ.)

Table 3. Particulate Matter (PM_{10}) from March 2001 through October 2001

Location	Average*	Maximum*	Number of Days Above State Standard** (8 months)
Boyle Heights (Hollenbeck)	46	78	10 of 34 days
Science Center	47	79	10 of 32 days
Soto School	62	96	28 of 37 days
Downtown Los Angeles	45	82	12 of 41 days
Burbank	41	85	7 of 41 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

While the federal PM_{10} standard was not exceeded at any of these sites, the 24-hr State PM_{10} standard (50 $\mu g/m^3$) was exceeded at all the sites. PM_{10} levels and the frequency of State standard exceedances were comparable at the Hollenbeck, Science Center, Downtown Los Angeles, and Burbank monitoring sites for the period. However, PM_{10} levels at Soto School were over 30 percent higher than at the other sites and the State standard was exceeded about three times more frequently. It is worth noting that PM_{10} levels in distant sites in the Los Angeles region can be about twice as high as those seen during this study.

The monitoring suggests that the multiple adjacent freeways and the traffic on the nearby off ramp are causing significantly higher PM_{10} levels at Soto School than at the other Boyle Heights sites. The lower levels at Hollenbeck and Science Center indicate that the traffic impacts observed at Soto School decrease rapidly as you move away from Soto School and the heavy freeway traffic near that site. Both Hollenbeck and Science Center are about one-half mile away from Soto School. While Science Center is near Route 60, the traffic-related air pollution at that site appears to be much less than what was observed at Soto School.

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, large portions of the Los Angeles region, as well as many other areas of California, do not meet the federal or State air quality standards for ozone.

Table 4. Ozone from March 2001 through May 2002

Location	Average*	Maximum*	Number of Days Above State Standard**
Boyle Heights (Hollenbeck)	46	111	6
Downtown Los Angeles	48	116	8
Burbank	49	129	16

* 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

As summarized in Table 4, levels of ozone at Hollenbeck are comparable to those routinely measured in this part of the Los Angeles region. Over a period of fifteen months, the study found ozone levels above the State standard (90 ppm) on six days at Hollenbeck and eight days at the closest long-term site (Downtown Los Angeles). These sites had approximately half the number of days above the State standard as the Burbank site. While the averages for all three sites were similar, the higher one-hour concentrations at Burbank resulted in more days above the State standard. Burbank also exceeded the less stringent federal one-hour ozone standard (120 ppm) on two days during the study. Warmer summer temperatures in Burbank are a possible explanation for the higher maximum levels of ozone.

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

Carbon Monoxide

Carbon monoxide (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.

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

As shown in Table 5, CO levels at Hollenbeck appear to be slightly higher than at the two long-term sites, but were still well below the State standard. Much of the progress in reducing levels of carbon monoxide is attributable to motor vehicle emission controls and the introduction of cleaner fuels. The ARB expects further reductions of carbon monoxide levels statewide.

Table 5. Carbon Monoxide from March 2001 through May 2002

Location	Average*	Maximum*	Number of Days Above State Standard**
Boyle Heights (Hollenbeck)	2. 0	5. 6	0
Downtown Los Angeles	1. 6	4. 5	0
Burbank	1. 6	5. 0	0

* Values are 8-hour average concentrations reported in units of parts per million (ppm).
Average is the average 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

Oxides of Nitrogen

The two major types of oxides of nitrogen are nitric oxide (NO) and nitrogen dioxide (NO_2). Air quality standards have been established for NO_2, but not for NO. Since, the Los Angeles region and other areas of the State are currently attaining the State standard for NO_2, this report will discuss NO_x. The NO_2 standard was not exceeded at Hollenbeck during the study.

Oxides of nitrogen (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. As shown in Table 6, Hollenbeck's annual levels of NO_x are very similar to the levels measured at the Downtown Los Angeles and Burbank sites.

Table 6. Oxides of Nitrogen* from March 2001 through May 2002

Location	Average**	Maximum**
Boyle Heights (Hollenbeck)	188	580
Downtown Los Angeles	181	570
Burbank	165	569

* 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.

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.

Background level

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

Criteria Pollutant Monitoring Summary

Average levels of criteria air pollutants at Hollenbeck are comparable to measurements from the nearest long-term monitoring sites in the Los Angeles region. Hollenbeck, like many other areas in Los Angeles, exceeds State standards for both ozone and PM_{10}. Measurements at Soto School indicate that PM_{10} levels are higher closer to high traffic areas and rapidly fall off with distance.

While standards for particulate matter and ozone have not been achieved, programs are in place for reducing levels of these pollutants. Carbon monoxide and NO_x concentrations are close to regional background levels and are well below the State's air quality standards.

Air Monitoring Results for Six Key Toxic Air Pollutants

Health Effects of Toxic Air Pollutants

Toxic air pollutants can cause adverse health effects individually and collectively. Some of the health effects include 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.

Top 6 Air Toxics Monitored in Boyle Heights

1,3-Butadiene
Benzene
Acetaldehyde
Formaldehyde
Perchlorethylene
Carbon Tetrachloride

Monitoring results indicate that the potential cancer risk at Hollenbeck 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).

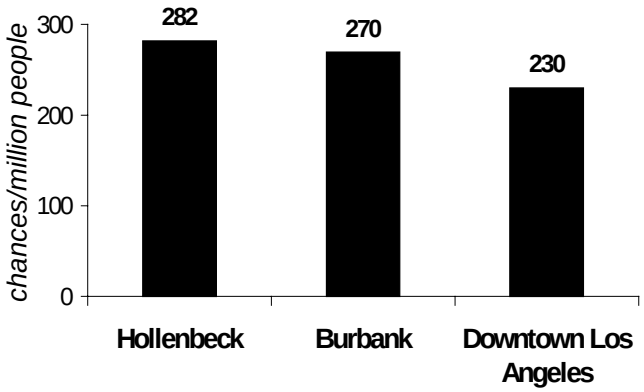
Diesel PM is believed to be the primary contributor to health risks from urban toxic air pollutants. The estimated average potential cancer risk from diesel PM in the Los Angeles area is 720 chances per million. However, diesel PM was not measured as part of this study because a proven method for measuring 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 clicking on the link provided below.
(http://www.arb.ca.gov/diesel/documents/rrpapp.htm)

Cancer risk estimates for pollutants measured at Hollenbeck

To put the results from Hollenbeck into perspective, ARB staff calculated estimates of potential cancer risk for the six pollutants at Hollenbeck and the two nearby Los Angeles sites using matched days (Figure 2). The potential cancer risk due to these six pollutants at Hollenbeck appeared to be higher than that estimated for the same six pollutants at the Downtown Los Angeles and Burbank sites. However, a statistical analysis found that there was no real difference in cancer risk between Hollenbeck and Burbank. A similar analysis found there was enough of a difference between Hollenbeck and Downtown Los Angeles to conclude that the cancer risk is higher at Hollenbeck.

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.

Figure 2. Potential Cancer Risk* for Six Key Toxic Air Pollutants



* Figure 2 does not include estimated risk from diesel PM. The potential risk estimates assume a lifetime exposure through breathing pathway only. Estimates for Hollenbeck, Downtown LA, and Burbank are based on February 2001 – January 2002 data, for matched days only (see Table 7).

Matched Days

A comparison of monitoring measurements taken on the same days. The toxic air pollutants in this study were usually measured for 24 hours every six days.

Table 7. Annual Levels of Key Toxic Air Pollutants for 2001

		Boyle Heights (Hollenbeck)		Burbank		Downtown LA	
Pollutant	Risk* Factor	Average** concentration	cancer risk***	Average** concentration	cancer risk***	Average** concentration	cancer risk***
Benzene	93	1. 00	93	0. 86	80	0. 76	70
1,3-Butadiene	376	0. 34	129	0. 30	113	0. 25	95
Formaldehyde	7	3. 27	23	5. 02	35	4. 30	30
Acetaldehyde	5	1.38	7	1.87	9	1.18	6
Perchlorethylene	40	0. 16	7	0. 25	10	0. 15	6
Carbon Tetrachloride	264	0. 09	23	0. 08	22	0. 08	22

* 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.

** Values are 24-hour average concentrations reported in units of parts per billion (ppb).

*** 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.

Why does the potential cancer risk differ among the Hollenbeck, Downtown Los Angeles, and Burbank sites? To answer this question, staff looked at the six pollutants individually. Table 7 shows how much each toxic pollutant contributes to the overall cancer risk shown in Figure 2. The following discussion of toxic pollutants is based on all of the data collected on matched days between February 2001 and January 2002.

Benzene, 1,3-Butadiene, Formaldehyde, and Acetaldehyde

While motor vehicles are the primary source of benzene, 1,3-butadiene, formaldehyde, and acetaldehyde, levels of these pollutants did not follow the same pattern at all sites.

Benzene and 1,3-butadiene produced the majority of the cancer risk at all three sites. Because levels of benzene and 1,3-butadiene were higher at Hollenbeck and Burbank than at Downtown Los Angeles, the resulting cancer risk was higher at those two sites. Because these two pollutants are directly emitted by motor vehicles, this suggests that heavier traffic near Hollenbeck and Burbank was the cause of the higher pollutant levels.

Levels of acetaldehyde and formaldehyde did not follow the clear pattern set by benzene and 1,3-butadiene. While Hollenbeck had the highest levels of benzene and 1,3-butadiene, it had the middle value for acetaldehyde concentrations and the lowest value for formaldehyde. A possible reason for this is that while acetaldehyde and formaldehyde can be directly emitted into air, the two pollutants are also formed when other air pollutants chemically react in the atmosphere. This makes it difficult to identify the sources of these two pollutants impacting each monitoring site.

In addition to increased potential cancer risk, breathing these four pollutants can cause the following non-cancer health effects.

- 1,3-butadiene can cause neurological effects such as blurred vision, fatigue, headache, and vertigo at very high levels.
- Benzene can cause central nervous system depression.
- Acetaldehyde and formaldehyde can irritate the eyes, skin, and respiratory tract.

These non-cancer health effects result from much higher concentrations of these air pollutants than were observed in this study, except for formaldehyde. Formaldehyde can be an irritant for individuals at levels over 2 parts per billion (ppb). The average formaldehyde level measured in this study was 3.7 ppb, which indicates that some individuals might experience mild eye irritation during peak exposures.

Emissions of all four 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. 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 for all four pollutants.

Level of detection
Lowest concentration of a pollutant that a monitor can measure.

Nanogram
One billionth of a gram

Perchloroethylene

Levels of perchloroethylene, a persistent organic pollutant, were higher at Hollenbeck than at the Downtown Los Angeles and Burbank sites. In addition to potential cancer risks, perchloroethylene can irritate the eyes and respiratory tract. It can also depress the central nervous system. 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, but more needs to be done. 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 Hollenbeck were comparable to those in the Los Angeles region and statewide. 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.

Seasonal Variations

Many pollutants showed seasonal variations. For example, benzene and 1,3-butadiene were higher in the winter than in the summer. This seasonal pattern is

common because the air tends to be more stagnant with less mixing in the winter months, allowing pollutants to accumulate.

Air Monitoring Results for Other Toxic Pollutants

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

Metals

Several metals, including manganese, nickel, and lead, were higher at Hollenbeck than at the Downtown Los Angeles and Burbank sites. 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 Hollenbeck were 27 nanograms per meter^3 (ng/m^3), the threshold above which there are 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 Hollenbeck 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 Hollenbeck were 1.7 ng/m^3, the threshold above which there are 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.

Most hexavalent chromium samples were below the level of detection. California adopted a control measure in 1988 to reduce emissions of hexavalent chromium from chrome plating; as a result, statewide levels have been reduced.

Para-dichlorobenzene and methylene chloride

For most samples, levels of the solvents para-dichlorobenzene and methylene chloride at Hollenbeck were below the level of detection. The average levels of the detectable samples of methylene chloride at Hollenbeck were comparable to levels at Downtown Los Angeles and Burbank. Para-dichlorobenzene is used as a room deodorant, in moth balls, 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.

Monitoring Results for Elemental Carbon (A Possible Surrogate for Diesel Particulate Matter)

Elemental carbon is a material found in particulate matter (PM_{10}). 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. Because diesel PM emissions are of major concern in Boyle Heights, elemental carbon was monitored in this study. 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 generally 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.

As shown in Table 8, Soto School had the most measurements above the level of detection for the seven-month monitoring period at that site. While not useful as a surrogate for diesel PM, the results were consistent with the higher traffic-related PM_{10} levels measured at Soto School.

Table 8. Elemental Carbon from March 2001 to October 2001.

Location	Average*	Maximum*	Number of Days Above Limit of Detection
Boyle Heights (Hollenbeck)	1. 6	1. 7	2 of 34 days
Science Center	3. 7	3. 7	1 of 32 days
Soto School	2. 0	4. 0	6 of 37 days

* Values are 24-hour average concentrations reported in units of ug carbon(c)/m3.

Average: The percentages of values below the limit of detection for Hollenbeck (94%), Science Center (97%), and Soto Street (84%) were very high, therefore the average values only include the data above the limit of detection (1 ug C/m3). In the case of Science Center, there was only one value above the limit of detection, so both the maximum and average are the same value.

Maximum is the highest single 24-hour concentration measured at that location.

Elemental carbon was monitored at Hollenbeck for the entire sixteen months of the study. Inspection of those data reveals 7 out of approximately 70 samples above the detection limit. The maximum elemental carbon measured during this time period was 3 ugC/m^3.

Conclusions

The school monitoring sites in Boyle Heights were chosen to fulfill the Children's Environmental Health Protection Act's requirement to look at the impact of motor vehicle emissions from nearby busy roads and freeways on locations where children live, learn, and play. Based on outdoor air measurements collected at Hollenbeck, Science Center, and Soto School, along with data from the long-term monitoring sites in downtown Los Angeles and Burbank, ARB staff found the following patterns in the air quality data.

Higher PM_{10} Levels Near Heavy Traffic Areas

The most significant finding was the difference in levels of PM_{10} at Hollenbeck, Science Center, and Soto School. PM_{10} levels at the Soto School satellite site were higher and exceeded the State 24-hour standard much more frequently than levels at the Hollenbeck and Science Center sites. Soto School is the site closest to I-5 and SR-60 freeway merge and is near an off ramp. The lower PM_{10} levels at Hollenbeck and Science Center indicate that the average and maximum levels of PM_{10} fell quickly as distance from Soto School increased. These results show that heavy traffic can have a large impact on the air quality of nearby schools and residences. This was consistent with other monitoring and modeling studies that found elevated PM_{10} levels near high traffic areas that decrease rapidly as you move away from the high traffic area.

While the State PM_{10} standard was exceeded at all the Boyle Heights sites, maximum PM_{10} levels at more distant monitoring sites in the Los Angeles region can be about twice as high.

Elemental carbon samples were collected at the three Boyle Heights study sites. Most samples were below the level of detection.

Cancer Risk

The potential cancer risk value at Hollenbeck, based on the six top risk pollutants measured, is comparable to the cancer risk calculated for the nearby long-term monitoring site in Burbank. However, cancer risk at Hollenbeck is higher than the risk calculated for the long-term monitoring site in Downtown Los Angeles.

Higher levels of benzene and 1,3-butadiene, the main toxic pollutants associated with cancer risk measured in these areas, were responsible for the increased risk at Hollenbeck and Burbank. Since motor vehicles are the primary source of both pollutants, heavy traffic near the two sites is probably the cause of the higher pollutant levels. While we did not measure diesel particulate in this study, the risk due to diesel particulate is probably larger than the risk posed by benzene and 1,3 butadiene.

Comparison of Long-term and Special Monitoring Sites

Average criteria pollutant levels at Hollenbeck were comparable to the two nearby long-term sites in Downtown Los Angeles and Burbank. However, Burbank had higher peak levels of ozone and about twice as many days above the State standard for ozone. Burbank's hotter summer temperatures are possibly responsible for the higher ozone concentrations, which depend heavily on weather conditions and terrain.

Reducing Air Pollution in Boyle Heights

There are numerous programs that specifically target mobile source emissions such as those found in Boyle Heights. 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 Boyle Heights.

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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.