Air Quality and the Wildland Fires of Southern California October, 2003

A preliminary review of particulate matter, air toxics, and carbon monoxide

California Air Resources Board
Emergency Response Team
December, 2003

A powerful group of wildland fires struck the southern California area as the 2003 fire season began to wind down. Strong, dry winds from the desert fanned flames from as many as nine distinct fires from Ventura County in the north, to the U.S. Mexican border in the south. The fires burned nearly three-quarters of a million acres of land and destroyed approximately 5000 residences and outbuildings. Almost half of the acreage that burned was in San Diego County alone. The smoke from the fires formed an enormous blanket that covered much of the Southland for days.

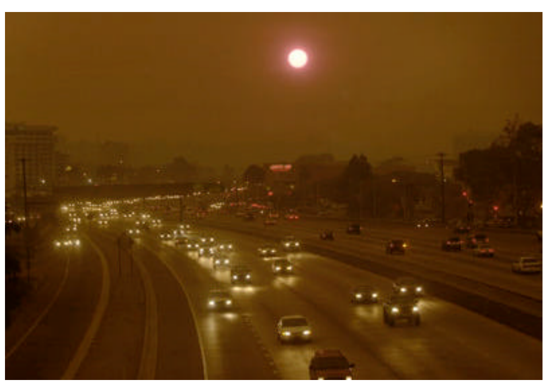


Figure 1- Midnight at noon in San Diego County

The fires began on October 21 in the northern counties and were generally contained by early November. The large smoke plumes made it relatively easy to assess the size and location of the fires, and provided information about the direction the pollutants would initially drift. Individual visual observations were aided by daily statements, forecasts, and alerts produced by local air quality districts and weather services. The plume gradually reached the ground and brought smoke at high concentrations into heavily populated areas. Throughout the region activities were halted and businesses closed as people responded to avoid or reduce their exposure to the smoke.

Figure 2- Smoke plumes over southern California skies

A network of air monitors, operated by the local air pollution districts tracked particulate matter movement and were key in developing reports of the day's pollutant levels. The Ventura County Air Pollution Control District (APCD), the South Coast Air Quality Management District (AQMD), the San Diego County APCD (SDCAPCD), and the Mojave Desert AQMD posted particulate matter (PM) air quality information on their web pages for the current day and forecast for the following day. The California Air Pollution Control Officers Association (CAPCOA) consolidated the districts' web offerings onto a one-stop web page, '*Smoke Impact*.' The CAPCOA web page included publications about fires posted by the California Air Resources Board (ARB) and the U.S. Environmental Protection Agency (USEPA) that dealt with personal exposure, risk reduction, and effective personal protective equipment.

Air toxics were a concern as well because of the magnitude of the fires and that past studies confirmed the potential for toxics to be emitted during wildland fires. Air agencies were able to collect several samples from their urban air toxics sampling networks during the fire that were analyzed for compounds known to be carcinogenic. Several additional samples were analyzed for air toxics at non-network sites in San Diego County, and the USEPA-Region 9 took several 'near fire' samples in the mountain community of Julian toward the end of the fire. The ARB provided laboratory analyses for PM and air toxics (volatile organic compounds (VOC), carbonyls, polycyclic aromatic hydrocarbons (PAH), and metals).

The health effects from air pollutants can be divided into three categories: acute and chronic noncancer, and cancer. Acute noncancer health effects can occur after short duration exposure to relatively high concentrations. Chronic noncancer health effects can occur after exposure to pollutants for longer periods of time. The severity of exposure for some components in smoke are contained in Acute and Chronic Reference Exposure Level Health Standards from the Office of Environmental Health Hazard Assessment. These health standards are “safe levels” for short term (acute) or long term (chronic) exposure. However, many of the chemicals emitted by forest fires may not have health values because they are uncommon except when generated by combustion. Regardless, the respiratory irritation from exposure to chemicals in smoke can be particularly serious for those with pre-existing lung disease (e.g. asthma).

Fires and other types of combustion can generate cancer-causing chemicals as well. The total amount of these chemicals that a person is exposed to over time determines the amount of excess risk of cancer. Somewhat higher exposures during relatively short duration events, such as a forest fire, are not likely to be significant in comparison to lower concentrations from exposure over ones lifetime.

This preliminary review addresses an initial concern about PM, toxics, and carbon monoxide, and compares the sample results to various benchmarks to put the data in context that can be easily understood. The indicators used here are the state and federal ambient air quality standards, the Air Quality Index (AQI), and ambient air toxic levels from the past three years.

The ambient air quality data from the period of the fires were assembled from an assortment of single purpose air monitoring networks operated by local and state agencies. These are the particulate matter networks (PM2.5 and PM10 micron), the ambient air toxics network, the real time ‘criteria pollutant’ network, the real time monitors that support the daily Air Quality Index (AQI), and the Photochemical Assessment Monitoring Stations (PAMS). State and local agencies operate the networks, and local air districts implement the AQI program. The USEPA developed the AQI program and was instrumental in funding a variety of monitoring networks.

1. *Particulate Matter (PM)*

Individuals with heart and lung disease and disorders are at the greatest risk to high PM levels. A range of health effects can occur in a relatively short time, and hospitalization rates for people with pre-existing conditions increase with ambient PM. The rate PM is generated varies depending on a fire's size, the fuel involved, and the fire's behavior. Tons of PM can be generated each minute from large fires. In addition,ground and airborne sampling indicates that approximately 90 percent of the particulate mass is <2 um in diameter. In this size range, particles can penetrate deeply into the lung.

1.1 PM Air Quality Standards

Particulate matter from fires is made up primarily of soot, char, and entrained dust. Gases and metals are also produced and at times reach levels of concern. The ARB and the USEPA have adopted health based air quality standards for ambient PM mass, shown in Table 1, which identifies the level above which particulate matter can impair respiratory functions. The standards for particles are divided into two size ranges, those less than or equal to 10 microns, and less than or equal to 2.5 microns in diameter.

Table 1
PM Ambient Air Quality Standards (24 hour)

	National	**State**
PM10	150 ug/m3	50 ug/m3
PM2.5	65ug/m3	--

The state PM standards were reviewed in 2003. Federal standards are undergoing scientific review at this time.

1.2 Air Quality Index (AQI)

The Air Quality Index is a uniform monitoring and data reporting program of air quality levels in urban areas. It is based on the same health evidence as are the ambient standards and is gathered and disseminated to keep the public apprised of the current ambient levels of criteria pollutants in their community. It includes several elements, but principally transforms air quality data into discrete levels with narrative for each level. It addresses individual segments of the population that may be at risk, and steps they can take to reduce their exposure.

Air districts in major urban areas develop and distribute AQI information on a daily basis to the public, local schools, and public health officials. They use a variety of print and television outlets, and a range of Internet, pager and cell resources to notify the public. The advisories identify air quality as 'Good', 'Unhealthy for Sensitive People', 'Unhealthy', 'Very Unhealthy', or 'Hazardous'. The descriptor for 'Hazardous', for example, advises that people with heart or lung disease, older adults, or children should remain indoors and keep activity levels low, and that all others should avoid all physical activity outdoors.

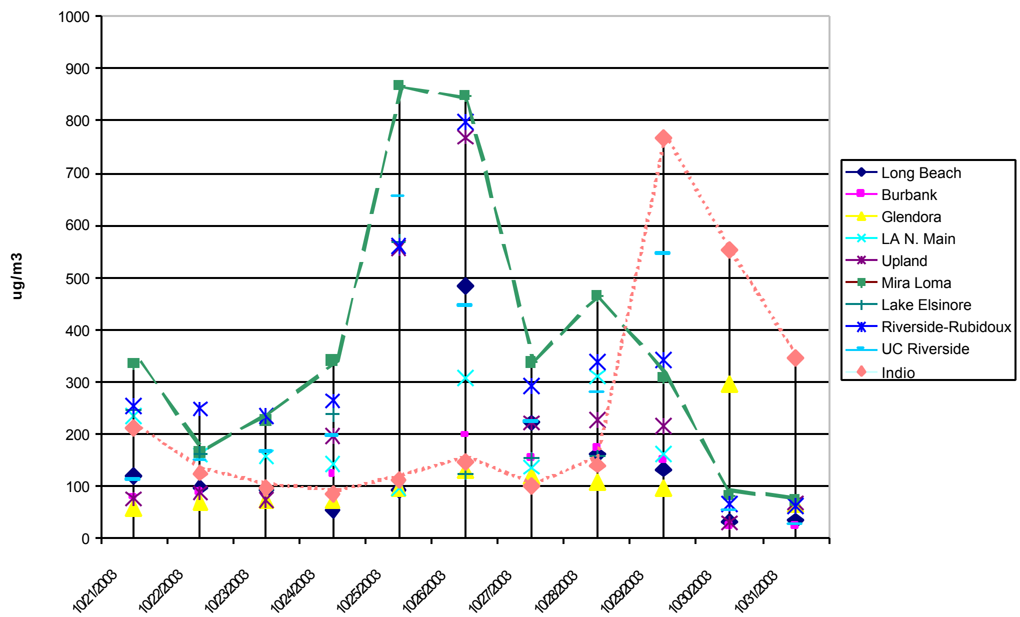
Real time PM monitors are the foundation of the AQI for fires, and are the most relevant single measurement of the air quality impairment from fires. Because of this, the alerts and warnings can be used as a general indicator of potential harm not just from PM, and should provide a measure of protection for other fire-related pollutants as well.

1.3 Summary of Particulate Matter Data

The PM data are compiled as two averaging times, one-hour, and 24-hour. This is because the time of exposure and the concentration of the pollutant affect people's responses. Of the times reported, only the 24-hour data can be compared directly to the ambient air quality standards. The one-hour data are very valuable, and are being reviewed for short-term effects, but for now they are used primarily to provide insight into the occurrence and behavior of the smoke.

Once a smoke plume reached the ground, PM levels began to soar. The peak one-hour PM 2.5 levels exceeded 500 ug/m3, and one-hour PM10 levels reached 900ug/m3 at various locations. Mid-way through the fires, the dry easterly Santa Ana winds gave way to clean moisture-laden westerly winds from the Pacific Ocean. This is evident in Figure 3 as the peak one-hour PM10 levels dropped at Mira Loma with the wind shift. However, while the ocean breezes brought relief to the coastal and inland areas, it carried the smoke-laden air to desert communities inland. The result was an abrupt increase in PM concentrations in the Coachella Valley (Indio) on October 29, and Victorville in the high desert. The plume carried as far as Las Vegas, NV where the airport reported greatly reduced visibility for several days. The South Coast area continued to record transient high one hour PM levels, although air quality was much improved throughout most of the day after October 29.

Figure 3
South Coast Air Basin
Wildland Fires
1 hr PM10 Maximum Concentrations



The federal and state PM 24-hour standards were exceeded throughout much of southern California during this time. Table 2 shows the high one-hour, and the 24-hour high values.

Table 2

Basin Maximum Particulate Matter (PM2.5) Concentrations*

Southern California Wildland Fires,

October, 2003

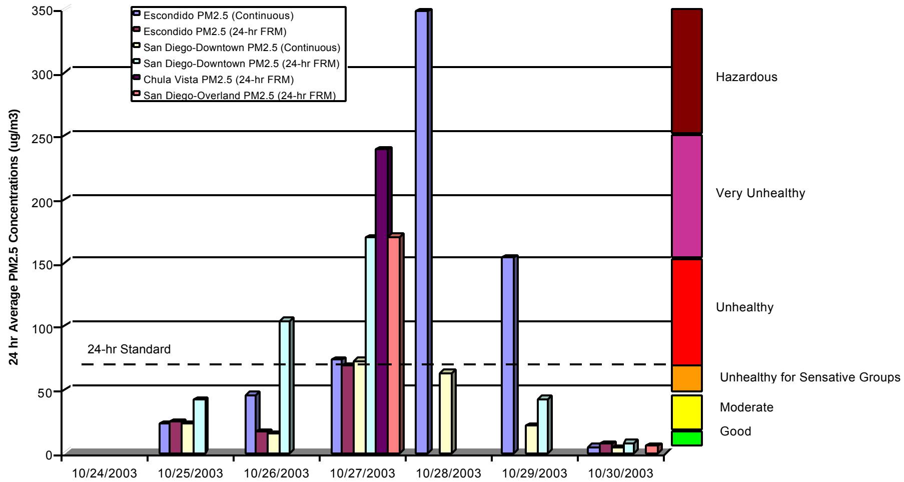
		Ventura		San Diego		South Coast		Mojave		Imperial	
		1hr	24hr	1hr	24hr	1hr	24hr	1hr	24hr	1hr	24hr
24	Fri	27	**22**								
25	Sat	33	**8**		**42**		74			549	**61**
26	Sun	220	**46**	146	**104**	347	150			124	**34**
27	Mon	199	**125**	--	**239**	118	71			111	**42**
28	Tue	303	**164**	738	**350**	569	119			96	**35**
29	Wed	154	**85**	375	**154**	218	117	~700**		175	**35**
30	Thurs	21	**14**	30	**8**	524	40			271	**59**
31	Fri	11	**7**			498	71			183	**31**
Nov 1	Sat	25	**9**			484	28			24	**11**

* Preliminary data, pending final qc review
** PM10 level was 906 ug/m3. Approximate PM2.5=700 ug/m3

The PM2.5 air quality levels in San Diego County during the fires were four to five times the federal standard. On October 27, the 24-hour PM2.5 levels in Chula Vista reached 239 ug/m3. On the following day, levels in Escondido reached 350 ug/m3. Short-term (one-hour) concentrations in San Diego exceeded 700 ug/m3 during the smokiest days.

The PM2.5 concentrations are shown with the AQI descriptors for San Diego and Ventura in Figures 4 and 5. San Diego's air quality was declared to be 'Unhealthy' on three days, and reached 'Very Unhealthy' levels twice. The Escondido levels reached the highest or 'Hazardous' levels on October 28. An AQI value of 100 generally corresponds to the 24 hour national air quality standard for PM2.5 (65 ug/m3).

Figure 4
San Diego County Wildland Fires
PM2.5 Levels- October, 2003



Particulate levels in Ventura County exceeded the air quality standard on several days. The AQI alerts for the district warned people the air was 'Very Unhealthy' on one occasion. The onshore winds that helped clear out the South Coast, beginning on October 30, cleared the smoke from Simi, Thousand Oaks (T.O.), Piru and El Rio as well.

Figure 5
Ventura County Wildland Fires
PM2.5 Levels- October, 2003

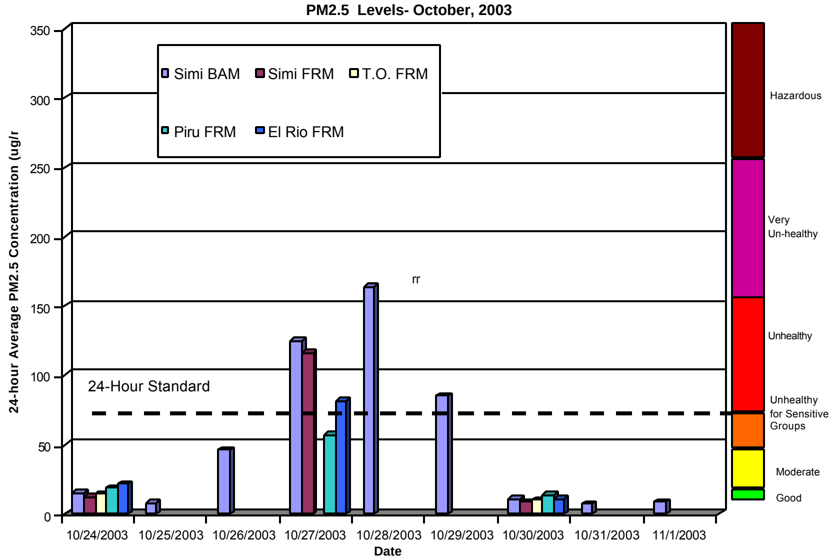


Table 3 contains a comparison of the PM2.5 concentration (24-hr average values) during the fires with those recorded in previous years. Not surprisingly, the measured PM2.5 levels during the fires had not been observed in any of the four air basins in recent years. The maximum 24-hr average values and those obtained during the fires are reported in Table 3.

Table 3

High Particulate Matter (PM2.5) Concentrations

Historical v. Fire

(24 hour Average Concentration)

Air Basin	**1999-2001** Highest 24 hour average value (ug/m3)	**2003 Wildland Fire** Highest 24 hour average value (ug/m3)
South Central Coast (Ventura Co)	64	164
South Coast	121	150
San Diego	66	350
Mojave Desert	48	na

- The federal 24-hour ambient air quality standard for PM2.5 is 65 ug/m3.

Strong Santa Ana winds returned to the San Diego area several weeks after the fires were contained and brought with them ash that had been intrained from the burned areas (Figure 6). In contrast to the very small (PM2.5) combustion aerosols that dominated the area during the fire, the particle size of the ash was considerably larger, i.e. predominantly PM10.

Figure 6- Offshore winds carry ash plume from

inland burn areas. November 23, 2003

The 24-hr PM10 concentrations measured on November 23rd were:
Kearny Mesa: 280; El Cajon: 230; Downtown (12th Street): 140; Escondido: 124; and Chula Vista: 75 ug/m3. The pollution levels at Kearny Mesa and El Cajon exceeded the federal and state PM10 standards, and were well above the maximum 24-hour level recorded in the District for the 1999-2001 timeframe.

2. *Air Toxics*

Wildland fire smoke can also contain a range of potentially toxic constituents. These can be generated either directly during biomass combustion, or indirectly through chemical interactions with other combustion by-products in the smoke plume. When structures are involved, incineration of household and commercial chemicals, building materials, and a variety of other non-biomass fuels are a potential concern. During a firestorm, it is also possible for trace metals to be entrained in the smoke that had been deposited over time onto vegetation, and possibly from soils that are rich in metals.

The toxic compounds reported here are grouped into volatile organic compounds and aldehydes (VOC), semi-volatile polycyclic aromatic hydrocarbons (PAH), and trace metals. Air toxics are distinguished from 'criteria pollutants' because of their acute toxic or carcinogenic nature, and are generally not referenced to a bright line that denotes a safe level.

Unlike real time instruments, the air toxic sampler network uses manual samplers preset on timers to collect 24-hour average samples. The process requires samples collected in the field to be sent to the laboratory for analyses. Samples are scheduled onan regular, yet intermittent basis, in part due to nature of the equipment used and to the principle need for the data, i.e. long-term population exposure. Real time air toxic analyzers are not cost effective for network or rapid relocation at this time. Hand held instruments can be is especially useful as screening devices recognizing their limitations. Fortunately, during the fires, field personnel were able to obtain several extra samples.

Several sources of air toxic data were compiled for this comparison. They include samples from local air districts in Ventura, San Diego, Imperial counties, and the South Coast Air Basin. The California ARB and the San Diego County APCD conducted most of the sample analyses. The data collected in San Diego County, lead by efforts of the San Diego County APCD, provided an air toxic data record for VOC, PAH and metals analyses. Data for VOC and metals came from the California air toxic and PM2.5 networks, from several grab samples (instantaneous) samples from the San Diego County APCD, and from the District's year-around PAMS sites. The PM10 network provided filters for PAH analyses.

The USEPA took samples from three locations in the eastern portion of the San Diego Air Basin for VOC, semi-volatile compounds and metals. The Ventura County APCD and South Coast AQMD collected an additional sample at one of its air toxic network sites. With data coming from different sources, the overall data set contains, at times, dissimilar attributes.

The primary means of assessing the fire-related data was to compare it to the previous three-year average and peak values. We also compared the results of several pollutants to their respective ambient air quality standards. There are no risk calculations presented given the short timeframe involved, however, information on airborne risk from the long-term exposure to specific chemicals detected in the fires can be found on the ARB Air Quality Data web page.

Toxic compounds that become a health threat are generally those people are exposed to at high concentrations for a relatively short time. For example, workplace standards exist generally for eight hour (time weighted averages) and 15 minute (short term exposure limits) intervals. They are one of several benchmarks against which short term exposure can be evaluated. The other exposure scenario comes fromlong term (over a lifetime) exposure to lower concentrations.

Several of the more potent compounds drew the greatest interest at the outset of the fire including benzene, toluene, acrolein, formaldehyde, PAH (benzo (a) pyrene), arsenic, lead, nickel, and mercury. There was concern both for the emergency response workers, residents living near fires, and the general population.

2.1 Volatile Organic Compounds and Aldehydes (VOC)

Benzene and several VOCs were of particular interest during the fires because of their prominent contribution to toxicity in urban air. Benzene is emitted principally with toluene and the xylenes (commonly referred to as BTX) in the exhaust gases of gasoline powered engines. It is emitted to some degree during forest fires. Although benzene is not present in household products, except possibly in small amounts in some automotive and cleaning products, it is a widely used industrial chemical. The combustion of structures and their contents during the fire raised additional concern for benzene and other toxic compounds in the smoke.

Acrolein is another irritating chemical generated by forest fires and of interest for its cancer properties as well. It was added to the air toxic network target list in 2003 and as yet has no historical point of reference for comparison during the fires. Like so many other toxic compounds, it is produced during incomplete combustion in forest fires.

Aldehydes are compounds that can irritate mucous membranes of the human body. Formaldehyde is one of the most abundantly produced compounds of this class. It is also a relatively potent carcinogenic compound and is routinely found at low levels in urban air. Formaldehyde is both directly emitted into the atmosphere and formed through photochemical reactions. During fires, it is formed during wood combustion as large carbon chain molecules break down into smaller units.

2.2 Polycyclic aromatic hydrocarbons (PAH)

Polycyclic aromatic hydrocarbons (PAH) are a group of high molecular weight organic compounds that are synthesized during incomplete combustion from carbon fragments. PAH originates in low oxygen environments yet can transform to other forms depending on the fire's behavior and its combustion characteristics.

Benzo [a] pyrene (BaP) is perhaps the most thoroughly researched of the family of PAH compounds. It is a known carcinogen and has other toxic properties when inhaled. A number of the other PAH species measured do not have specific cancer potency factors, however they have been given a relative ranking compared to benzo [a] pyrene potency. The suggested potencies of other measured PAH constituents are between 10% and 40% of BaP at the same concentration.

BaP was measured at four sites in San Diego and at Simi Valley in the north. Measurements were made by the local air districts and analyzed by the ARB. The USEPA-Region 9 took samples in the Julian area.

2.3 Toxic metals

Forest fires are known to emit a variety of metals that are of concern for their cancer and/or noncancer health effects. Previous studies have indicated that metals released by forest fires are not a major risk to human health. Arsenic and mercury were of particular concern because of the potential for arsenic to be released from wood that had been treated with preservatives. Mercury is generally below detection in air samples in California, yet it had been shown, in some parts of the country, to be reintrained during fires after being deposited onto vegetation, or from soils with high mercury levels. Lead, arsenic and nickel are detected periodically in ambient air in California.

The data for metals were obtained from filter samples collected from several sources: the air toxics network, the PM2.5 network, and additional samples sited specifically to monitor the effects of the fire. The San Diego County APCD, the California ARB, and the USEPA-Region 9 contributed staff and resources to the effort. The air toxic network samples reported here were collected by the San Diego County APCD and analyzed by the ARB. The air agencies were also able to obtain metals information from daily PM2.5 samples, which added greatly to the data base on fire impacted days. The USEPA Region 9 collected samples for metal analyses on November 1, 2003, in the mountain communities near Julian.

2.4 Air Toxic Data Summary

Several air toxic gases and metals were elevated during the fire, although the bulk of the compounds were either less than the recent basin high values for the past three years, or were below the analytical limit of detection. The levels of the various gases, metals, and PAH compounds seen during the fire have been observed within the past 10 years in the state in the absence of wildland fires.

2.4.1 Volatile Organic Compounds

Benzene, toluene, and formaldehyde were detected during the height of the fire. Formaldehyde samples collected in the mountains near Julian were the highest of the hydrocarbons compared to historical values. Benzene concentrations are presented in Figure 7 for several populated areas in southern California. The results from the 12 sites in the San Diego area were generally low, i.e. equal to or below 1 ppb, or about half the basin high level of the past three years (2.2 ppb.) The samples taken during the most intensive period of the fire (October 29) were not appreciably higher than samples taken before the smoke inundated the region. Samples taken in the South Coast were slightly higher than those in San Diego, but only on the order of half to three fourths the three-year basin high value. The instantaneous (grab) samples taken by the SDCAPCD tended to be higher although still relatively low. Toluene and the xylene concentrations in San Diego County were about one half of the three-year peak levels in the basin.

The ratio of benzene to toluene in the air samples during the fires was consistently about 30-40% in the urban areas. This ratio is very similar to what is reported on a routine basis in the air toxic network. It also closely matches the benzene to toluene ratio that is found in gasoline powered motor vehicles exhaust gases. This suggests that during the fires, motor vehicle exhaust was the dominant source of benzene, toluene, and xylene emissions. Several samples from the mountain communities of Alpine and Julian taken toward the end of the fire reported a significantly higher benzene to toluene ratio, however. In those instances, the benzene levels themselves were comparable to those seen in urban areas. This suggests that toluene concentrations were likely lower than usual and that there were no new sources of benzene in these rural communities toward the end of the fire.

Acrolein analyses were conducted on regularly scheduled toxic network sampling days. One researcher reported that acrolein concentrations near fires could be as high as .1 to 10 ppm, and that acrolein is suspected to effect respiratory functions at levels as low as 100 ppb. Acrolein sample results on the several days that were sampled during the southern California fires were below 1 ppb inthe San Diego and Ventura counties and in the South Coast.

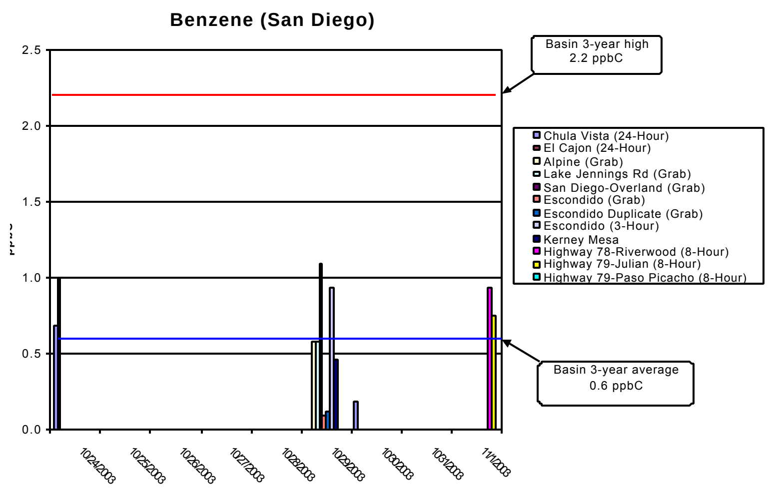
<u>Carbonyls</u>

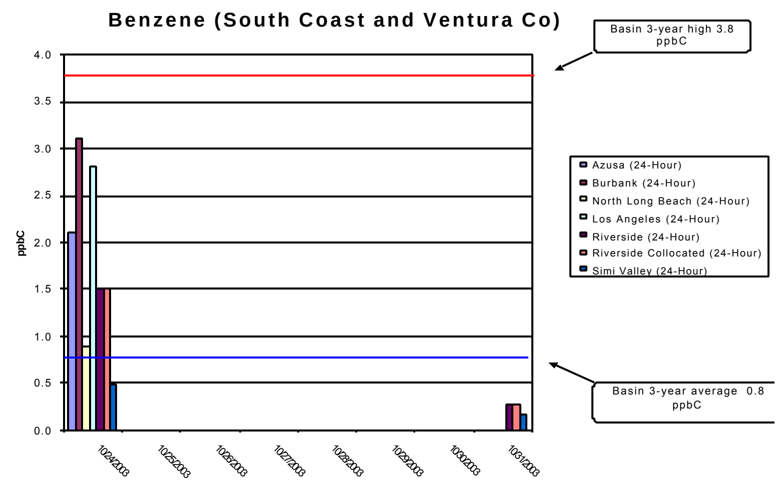
Four aldehyde samples were obtained in San Diego County during the fire. The results from them were at or above the basin average. One exceeded the peak concentration for the past three years. Formaldehyde concentrations in the Julian area exceeded the prior three-year high level by a factor of two. A value of 22 ppb was recorded in a 19-hour sample collected by the USEPA near the Cedar fire at the 'Hiway 79-Julian' site.

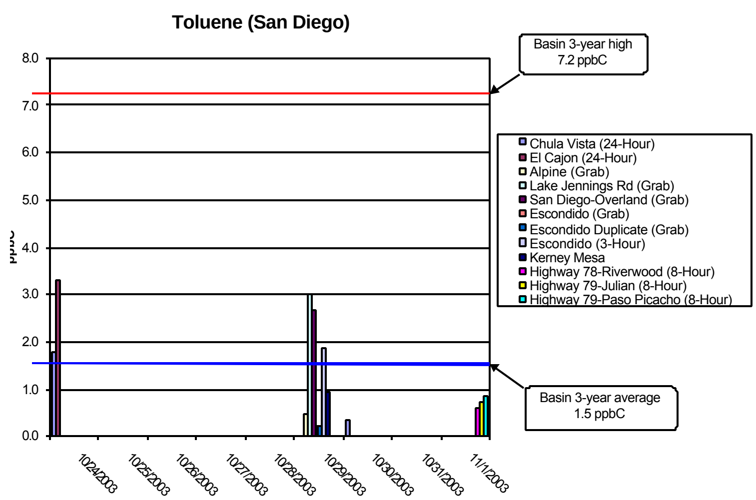
The fire was largely under control by that time, however, it did confirm the presence of formaldehyde in the area during biomass combustion.

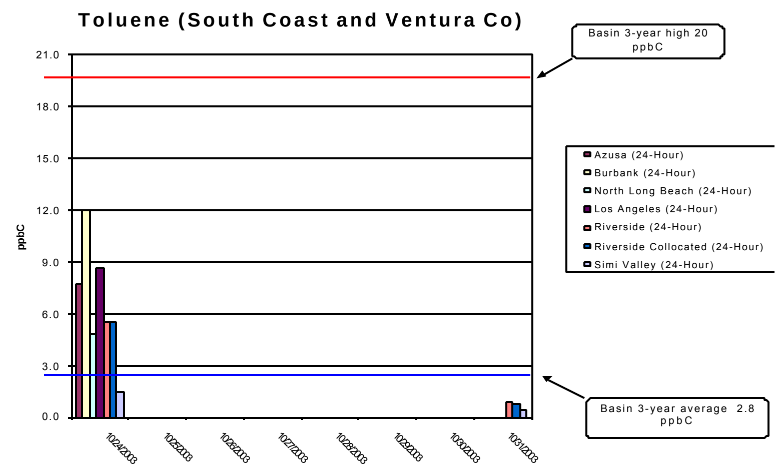
As we saw before, Riverside was heavily affected by smoke for several days on end. It is not surprising, therefore, that formaldehyde was higher at that location than at other sites in the South Coast. Despite that, the level on the highest sample day was one-half of the highest value reported over the past three years.

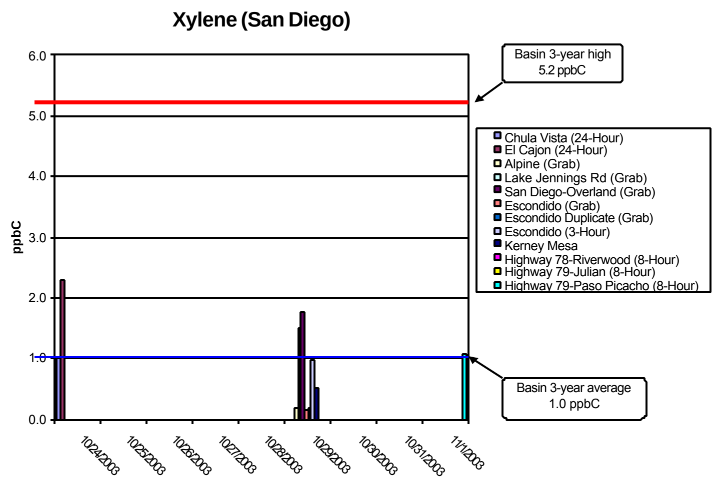
Figure 7
Toxic Gases











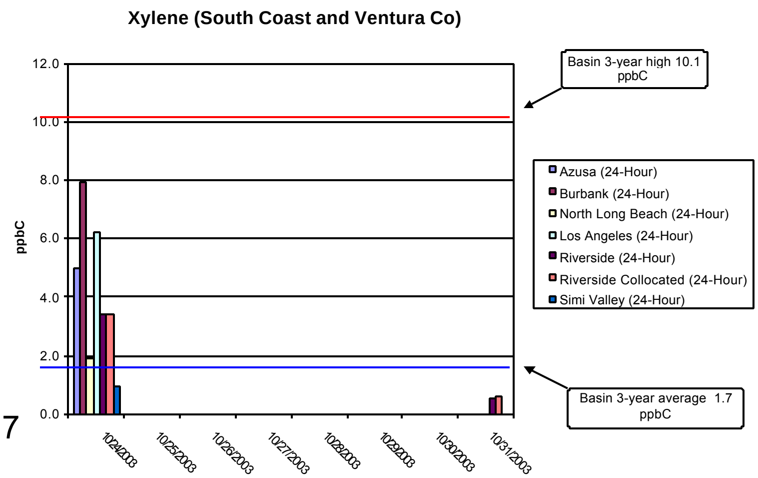
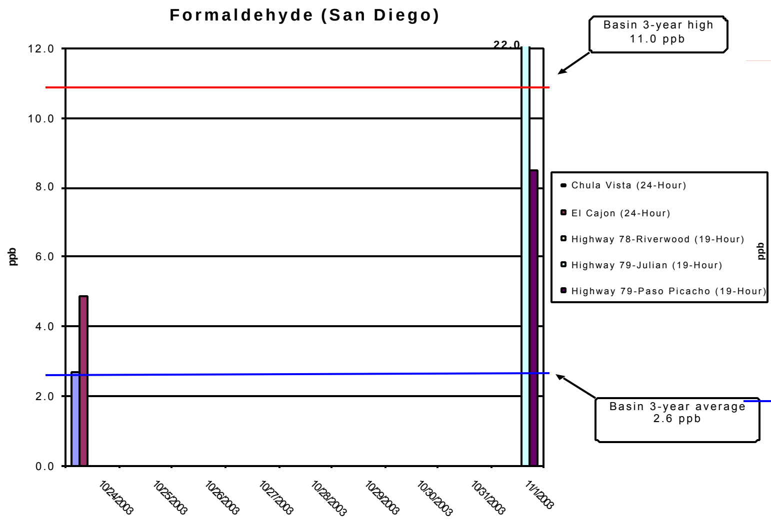
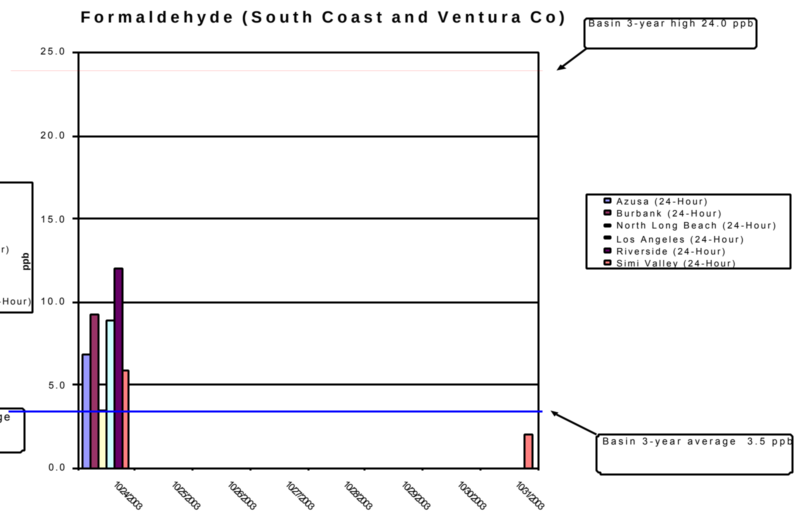
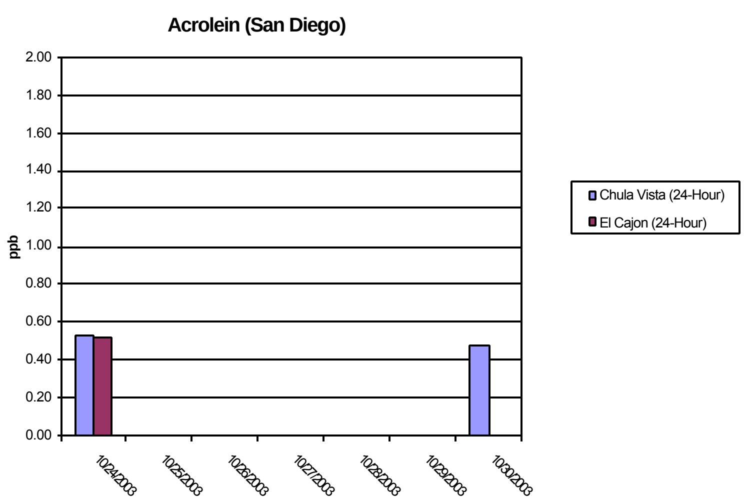


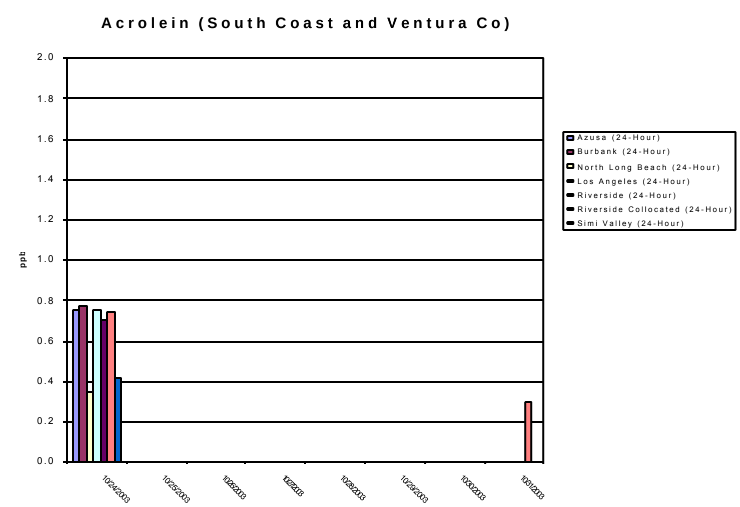
Figure 8

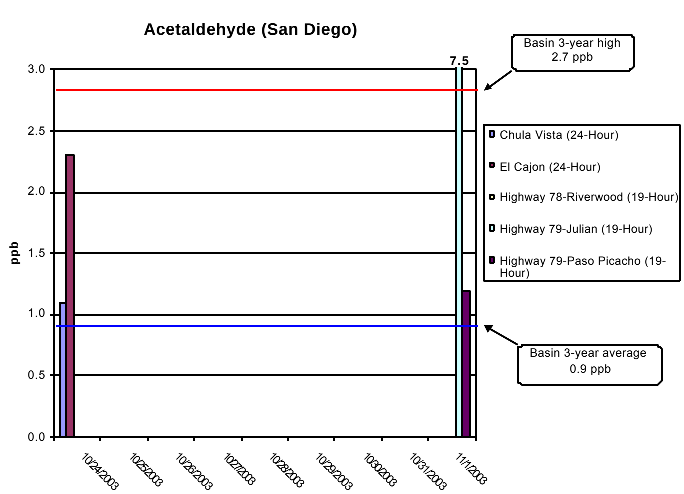
Toxic Gases

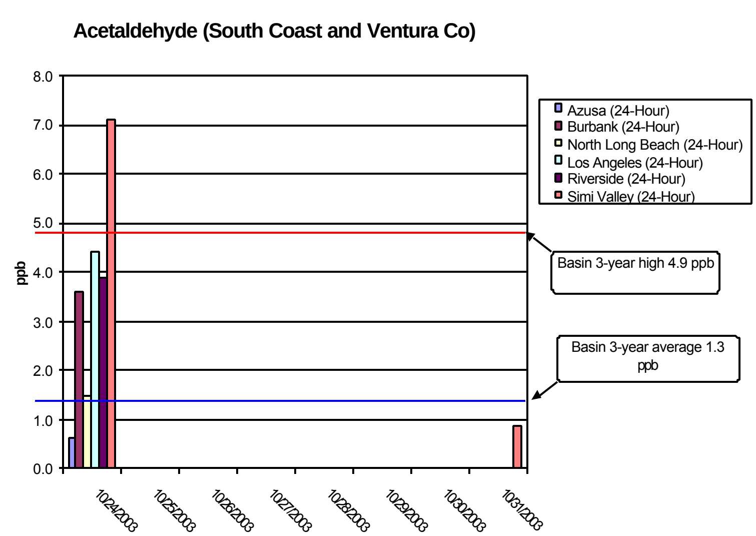












Acetaldehyde in Simi Valley, Figure 8, exceeded the three-year high values (4.9 ppm) for the Southland, and several South Coast sites approached 4 ppb.

2.4.2 Polycyclic Aromatic Hydrocarbons (PAH)

Benzo [a] pyrene has the highest potency of the six reported PAH species; however, it had the lowest reported concentration with respect to its three-year high values. Of the nine BaP samples taken in the San Diego area, only the sample on October 29 at Escondido (1.2 nanograms/cubic meter) was above the detection limit. The three-year high for the basin is 1.4 ng/m3. The five remaining PAH species exceeding their three year high levels, in some cases, by as much as three times.

Table 4

PAH Species

San Diego County

Fire and 3-Year Maximum Concentration

(ng/m3)

	Fire Max	3-year Max
Benzo (a) pyrene	1.2	1.4
Benzo (b) fluoranthene	3.6	1.3
Benzo (ghi) perylene	3.4	2.9
Benzo (k) fluoranthene	0.84	0.23
Dibenz (a,h) anthracene	0.16	0.8
Indeno (1,2,3-cd) pyrene	1.0	0.66

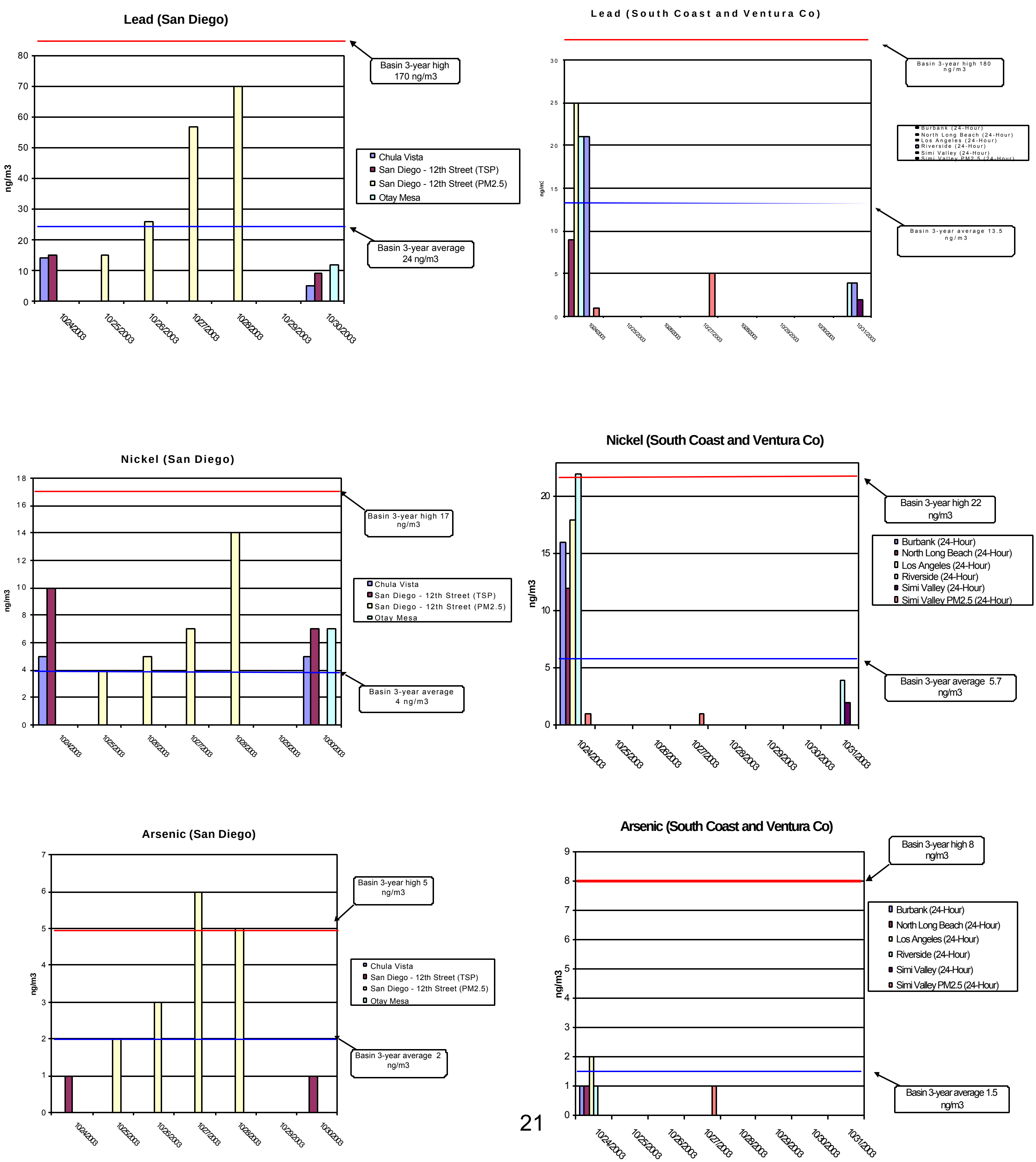
All high values occurred on October 29 in Escondido .

BaP samples collected in Simi Valley in Ventura County on October 24 and the 31 reported concentrations below the limit detection (<lod).

2.4.3 Toxic Metals

None of the four key toxic metals posed a health concern from samples that were collected in the South Coast and San Diego air basins. None of the reported concentrations exceeded their respective three-year maximum values (see Figure 9). No elemental mercury was detected (lod=0.3ng/m3) in either of two very heavily loaded PM2.5 filters in San Diego County. At the levels reported, the short or long-term risk from exposure to any of these metals appeared to be very low. All metal values in the samples taken by the USEPA-Region 9 were below their detection limit for all metals. A high detection limit in those samples, however, affected the results.

Figure 9
Toxic Metals



3. *Other Elements*

The air concentrations of other metals were also measured during the fire. In general, they do not cause cancer, with the exception of a type of chromium (hexavalent chromium). Hexavalent chromium is a fraction of the total chromium shown in Table 5. Neither total chromium or hexavalent chromium was released in large quantities by forest fires.

Potassium is emitted in significant quantities in forest fires and is a good marker for biomass burning. It had the greatest increase of all the metals in San Diego County, with fire related levels 10 to 20 times higher than the recent three-year peak values. Zinc levels were elevated slightly, but concentrations were no higher than in the past. All of these metals are normally present particularly in urban air, as shown by the data.

Table 5

San Diego County

Metals	**Before Fire**	**3 yr Average**	**During Fire**		**3 yr Maximum**
	24-Oct		27-Oct	28-Oct	
	ng/m3	ng/m3	ng/m3	ng/m3	ng/m3
Potassium	261	549	4992	3106	1100
Iron	610	1380	328	227	3100
Chromium	4	2.4	5	5	24
Zinc	65	44.2	136	121	130
Copper	46	34.5	29	28	170
Manganese	26	25.9	33	22	58

4 . *Carbon Monoxide*

Carbon monoxide (CO) gas is also formed by incomplete combustion of carbon bearing fuels. It can show up in high concentrations near fires, however its primary source is from motor vehicles. Carbon monoxide is a ‘criteria pollutant’ and, as such, can adversely affect respiratory and cardiac functions above the level of its air quality standard. It can be harmful both in high concentrations for a short period (1 hour), and at moderate concentrations over a longer period (8 hr).

The highest carbon monoxide concentrations were reported in the city of Escondido during the fire. During an eight-hour interval, between 4 am and noon on October 28, the average carbon monoxide level at Escondido (10.6 ppm) exceeded the state and federal air quality standard (9.0 ppm). No individual hour exceeded the one-hour carbon monoxide standards; 20 ppm (CA), 35 ppm (Federal). Levels at the four other urban locations shown in Table 6 were all low with respect to the standards. This is typical for the area. The region has been formally designated as attaining both carbon monoxide standards.

Table 6

Carbon Monoxide

Maximum 1 hour Values

San Diego County during the Wildland Fires

(parts per million)

	Union St	**Otay Mesa**	**Chula Vista**	**Downtown**	**Escondido**
Oct 26	**4.7**	**-**	**1.5**	**-**	**2.9**
Oct 27	**5.3**	**6.1**	**6.9**	**-**	**5.1**
Oct 28	**6.3**	**5.1**	**6.2**	**-**	**12.7***
Oct 29	**1.8**	**5.4**	**1.5**	**-**	**6.7**
Oct 30	**0.6**	**1.0**	**0.5**	**0.5**	**0.8**
Oct 31	**1.6**	**1.7**	**1.5**	**1.4**	**1.4**

* Also experienced an 8 hr average value of 10.6 ppm. The air quality standard is 9.0 ppm.

5. *Summary/Conclusion*

5.1 Particulate Matter

Particulate concentrations reached very high levels during the wildland fires and at times presented an immediate health threat to the public. The 24-hour health-based air quality standards for PM2.5 and PM10 were exceeded by large margins in many areas. AQI alerts were frequently 'Very Unhealthy' and on at least one occasion listed as "Hazardous.' The one-hour and 24-hour PM values were substantially higher than had been seen in years past for both size fractions of PM.

Data from real time PM samplers in each district proved to be invaluable. They provided air quality staff with an up-to-date understanding of PM levels, and the ability to inform the public about how to minimize their exposure, not just to PM, but other pollutants that were associated with PM in the plumes. AQI alerts were provided through a variety of media outlets, the Internet, and to schools, public health agencies and individuals with respiratory problems.

5.2 Toxics

The levels of some air toxics were high on days impacted by smoke, on the days measured, were generally less than the three year basin high values. Despite a few high concentrations all reported levels had been observed within the past 10 years in the absence of wildland fires. It is clear that additional samples, especially on the most severe smoke days, would have made the data set more complete. The conclusions in this preliminary review are presented with that limitation in mind. Exposure to some toxics for individuals near the fires or near burning structures would likely have been greater. However, it does not appear, from the available data, that the population centers were not unduly exposed to toxic air compounds.

5.3 Carbon Monoxide

Carbon monoxide levels from the fires generally dissipated by the time the plumes reached populated areas. During one intensely smoky period in Escondido, however, carbon monoxide levels exceeded the ambient air quality standard for an eight –hour period. This suggests that levels near the fire lines would most certainly have been higher, and that people working in those areas would be advised to monitor their exposure.

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