Chapter 2

Air Quality and Health Effects

South Coast Air Quality Management District
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AQMD

CHAPTER 2
AIR QUALITY AND HEALTH EFFECTS

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INTRODUCTION

In this chapter, air quality is summarized for the year 2011, along with prior year trends, in both the South Coast Air Basin (Basin) and the Riverside County portion of the Salton Sea Air Basin (SSAB), primarily the Coachella Valley, as monitored by the South Coast Air Quality Management District (District). The District's 2011 air quality is compared to national ambient air quality standards (NAAQS). Nationwide air quality data for 2011 is also briefly summarized in this chapter, comparing air quality in the Basin to that of other U.S. and California urban areas. Health effects of the criteria air pollutants, that is, those that have NAAQS, are also discussed. More detailed information on the health effects of air pollution can be found in Appendix I: Health Effects.

Statistics presented in this chapter indicate the current attainment or non-attainment status of the various NAAQS for the criteria pollutants to assist the District in planning for future attainment. For ozone (O_3) and fine particulate matter (PM2.5, particles less that 2.5 microns in diameter), the main pollutants for which the U.S. EPA has declared the Basin to be a nonattainment area, maps are included to spatially compare the air quality throughout the Basin in 2011. The Los Angeles County portion of the Basin is also currently a nonattainment area for the federal lead (Pb) standard due to source-specific monitoring, but Pb air quality data and attainment has been addressed separately in greater detail in the 2012 Lead SIP for Los Angeles County. The Basin is a nonattainment area for the federal PM10 (particules less than 10 microns in diameter) standard, although a request to U.S. EPA to redesignate to attainment is pending. The Coachella Valley is currently declared a nonattainment area for both ozone and PM10 by U.S. EPA, although a request to redesignate to attainment for PM10 is pending. Appendix II: Current Air Quality provides additional information on current air quality and air quality trends, changes in the NAAQS, the impact on the District's attainment status for different pollutants, and air quality compared to state standards, as well as more information on specific monitoring station data.

There were some minor changes to the AQMD monitoring network since the 2007 AQMP, which included air quality data through 2005. New stations were added at South Long Beach, close to the Ports of Los Angeles and Long Beach, and at Temecula in southern Riverside County. In addition, the extent and frequency of PM2.5 monitoring has been increased throughout the District.

AMBIENT AIR QUALITY STANDARDS

Federal and State Standards

Ambient air quality standards for ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM10 and PM2.5), and lead (Pb) have been set by both the State of California and the federal government. The state has also set standards for sulfates (SO_4^{2-}) and visibility. The state and federal ambient air quality standards for each of the criteria pollutants and their effects on health are summarized in Table 2-1.

Several changes to the NAAQS have occurred since the last AQMP update in 2007. The federal 1-hour ozone standard was revoked by the U.S. EPA and replaced by the 8-hour average ozone standard, effective June 15, 2005. However, the Basin and the former Southeast Desert Modified Air Quality Management Area (which included the Coachella Valley) had not attained the 1-hour federal ozone NAAQS by the attainment date and have some continuing obligations under the former standard. The 8-hour ozone NAAQS was subsequently lowered from 0.08 to 0.075 ppm, effective May 27, 2008. However, the SIP submittal for this standard is not due until 2015. In 2010, U.S. EPA proposed to lower the 8-hour ozone NAAQS again and solicited comments on a proposed standard between 0.060 and 0.070 ppm. To date, U.S. EPA has not taken final action on a lower ozone standard and the NAAQS currently remains at 0.075 ppm, as established in 2008. Statistics presented in this chapter refer to the most current 2008 8-hour ozone standard (0.075 ppm) and the former 1979 1-hour ozone standard for purposes of historical comparison.

U.S. EPA revoked the annual PM10 NAAQS (50 $\mu g/m^3$) and lowered the 24-hour PM2.5 NAAQS from 65 $\mu g/m^3$ to 35 $\mu g/m^3$, effective December 17, 2006. On June 14, 2012, U.S. EPA proposed to strengthen the annual PM2.5 federal standard from 15 $\mu g/m^3$ to a proposed range between 12 and 13 $\mu g/m^3$. U.S. EPA also proposed to require near-roadway PM2.5 monitoring. Final action on the proposed PM2.5 standards is expected by December 14, 2012.

The national standard for Pb was revised on October 15, 2008 to a rolling 3-month average of 0.15 $\mu g/m^3$, from a quarterly average of 1.5 $\mu g/m^3$. Most recently, U.S. EPA established a new 1-hour NO_2 federal standard of 0.100 ppm, effective April 7, 2010, and revised the SO_2 federal standard by establishing a new 1-hour standard of 0.075 ppm and revoking the annual (0.03 ppm) and 24-hour (0.14 ppm) standards, effective August 2, 2010.

TABLE 2-1

Current Ambient Air Quality Standards and Health Effects

AIR POLLUTANT	STATE STANDARD	FEDERAL STANDARD (NAAQS)	RELEVANT HEALTH EFFECTS[#]
	Concentration, Averaging Time	**Concentration, Averaging Time**	
Ozone (O_3)	0.09 ppm, 1-Hour 0.070 ppm, 8-Hour	0.075 ppm, 8-Hour (2008) 0.08 ppm, 8-Hour (1997)	(a) Pulmonary function decrements and localized lung edema in humans and animals; (b) Risk to public health implied by alterations in pulmonary morphology and host defense in animals; (c) Increased mortality risk; (d) Risk to public health implied by altered connective tissue metabolism and altered pulmonary morphology in animals after long-term exposures and pulmonary function decrements in chronically exposed humans; (e) Vegetation damage; (f) Property damage
Carbon Monoxide (CO)	20 ppm, 1-Hour 9.0 ppm, 8-Hour	35 ppm, 1-Hour 9 ppm, 8-Hour	(a) Aggravation of angina pectoris and other aspects of coronary heart disease; (b) Decreased exercise tolerance in persons with peripheral vascular disease and lung disease; (c) Impairment of central nervous system functions; (d) Possible increased risk to fetuses
Nitrogen Dioxide (NO_2)	0.18 ppm, 1-Hour 0.030 ppm, Annual	100 ppb, 1-Hour 0.053 ppm, Annual	(a) Potential to aggravate chronic respiratory disease and respiratory symptoms in sensitive groups; (b) Risk to public health implied by pulmonary and extra-pulmonary biochemical and cellular changes and pulmonary structural changes; (c) Contribution to atmospheric discoloration
Sulfur Dioxide (SO_2)	0.25 ppm, 1-Hour 0.04 ppm, 24-Hour	75 ppb, 1-Hour	Bronchoconstriction accompanied by symptoms which may include wheezing, shortness of breath, and chest tightness during exercise or physical activity in persons with asthma
Suspended Particulate Matter (PM10)	50 µg/m^3, 24-Hour 20 µg/m^3, Annual	150 µg/m^3, 24-Hour	(a) Exacerbation of symptoms in sensitive patients with respiratory or cardiovascular disease; (b) Decline in pulmonary function or growth in children; (c) Increased risk of premature death
Suspended Particulate Matter (PM2.5)	12.0 µg/m^3, Annual	35 µg/m^3, 24-Hour 15.0 µg/m^3, Annual	
Sulfates-PM10 (SO_4^{2-})	25 µg/m^3, 24-Hour	N/A	(a) Decrease in lung function; (b) Aggravation of asthmatic symptoms; (c) Aggravation of cardio-pulmonary disease; (d) Vegetation damage; (e) Degradation of visibility; (f) Property damage
Lead (Pb)	1.5 µg/m^3, 30-day	0.15 µg/m^3, 3-month rolling	(a) Learning disabilities; (b) Impairment of blood formation and nerve conduction
Visibility-Reducing Particles	In sufficient amount such that the extinction coefficient is greater than 0.23 inverse kilometers at relative humidity less than 70 percent, 8-hour average (10am - 6pm)	N/A	Visibility impairment on days when relative humidity is less than 70 percent

ppm – parts per million by volume ppb – parts per billion by volume
State standards are "not-to-exceed" values; Federal standards follow the design value form of the NAAQS
[#] More detailed health effect information can be found in the 2012 AQMP Appendix I or the U.S. EPA NAAQS documentation at http://www.epa.gov/ttn/naaqs/

U.S. EPA allows certain air quality data to be flagged in the U.S. EPA Air Quality System (AQS) database and not considered for NAAQS attainment status when that data is influenced by exceptional events, such as high winds, wildfires, volcanoes, or some cultural events (Independence Day fireworks) that meet strict requirements. For a few PM measurements in the Basin in 2007 and 2008, the District applied the U.S. EPA Exceptional Events Rule to flag PM10 and PM2.5 data due to high wind natural events, wildfires and Independence Day fireworks (the District has submitted the required documentation and U.S EPA concurrence with these flags is pending). In the Coachella Valley, PM10 data has been flagged for high wind natural events, under the current Exceptional Events Rule and the previous U.S. EPA Natural Events Policy[1]. All of the exceptional event flags through 2011 have been submitted by the District to U.S. EPA's AQS along with the data. The most recent of these are pending submittal of the District's final documentation for each event and all are pending U.S. EPA concurrence. The pending PM10 redesignation request for the Coachella Valley may hinge on U.S EPA's concurrence with the exceptional event flags and the appropriate treatment of these uncontrollable natural events.

In this chapter and in Appendix II, air quality statistics are presented for the maximum concentrations measured at stations or in air basins, as well as for the number of days exceeding state or federal standards. These statistics are instructive in regards to trends and control effectiveness. However, it should be noted that an exceedance of the concentration level of a federal standard does not necessarily mean that the NAAQS was violated or that it would cause a nonattainment designation. The form of the standard must also be considered. For example, for 24-hour PM2.5, the form of the standard is the 98th percentile measurement of all of the 24-hour PM2.5 samples at each station. For 8-hour ozone, the form of the standard is the 4th highest measured 8-hour average concentration at each station. For NAAQS attainment/nonattainment decisions, the most recent 3 years of data are considered (1 year for CO and 24-hour SO_2), along with the form of the standard, and are typically averaged to calculate a *design value*[2] for each station. The overall design value for an air basin is the highest

[1] The U.S. EPA Exceptional Events Rule, *Treatment of Data Influence by Exceptional Events*, became effective May 21, 2007. The previous U.S. EPA *Natural Events Policy* for Particulate Matter was issued May 30, 1996. On July 6, 2012, U.S. EPA released the *Draft Guidance To Implement Requirements for the Treatment of Air Quality Monitoring Data Influenced by Exceptional Events* for public comment.

[2] A design value is a statistic that describes the air quality status of a given area relative to the level and form of the National Ambient Air Quality Standards (NAAQS). For most criteria pollutants, the design value is a 3-year average and takes into account the form of the short-term standard (e.g., 98th percentile, fourth high value, etc.) Design values are especially helpful when the standard is exceedance-based (e.g. 1-hour ozone, 24-hour PM10, etc.) because they are expressed as a concentration instead of an exceedance count, thereby allowing a direct comparison to the level of the standard.

design value of all the stations in that basin. Table 2-2 shows the NAAQS, along with the design value and form of each federal standard.

TABLE 2-2

National Ambient Air Quality Standards (NAAQS) and Design Value Requirements

POLLUTANT	AVERAGING TIME	STANDARD LEVEL	DESIGN VALUES AND FORM OF STANDARDS*
Ozone (O_3)	1-Hour** (1979)	0.12 ppm	Not to be exceeded more than once per year averaged over 3 years
	8-Hour** (1997)	0.08 ppm	Annual fourth highest 8-hour average concentration, averaged over 3 years
	8-Hour (2008)	0.075 ppm	Annual fourth highest 8-hour average concentration, averaged over 3 years
Carbon Monoxide (CO)	1-Hour	35 ppm	Not to be exceeded more than once a year
	8-Hour	9 ppm	
Nitrogen Dioxide (NO_2)	1-Hour	100 ppb	3-year avg. of the annual 98th percentile of the daily maximum 1-hour average concentrations (rounded)
	Annual	0.053 ppm	Annual avg. concentration, averaged over 3 years
Sulfur Dioxide (SO_2)	1-Hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	24-Hour#	0.14 ppm	Not to be exceeded more than once per year
	Annual#	0.03 ppm	Annual arithmetic average
Particulate Matter (PM10)	24-Hour	150 µg/m^3	Not to be exceeded more than once per year averaged over 3 years
	Annual**	50 µg/m^3	Annual average concentration, averaged over 3 years
Particulate Matter (PM2.5)	24-Hour	35 µg/m^3	3-year average of the annual 98th percentile of daily 24-hour concentration
	Annual	15.0 µg/m^3	Annual avg. concentration, averaged over 3 years
Lead (Pb)	3-Month Rolling##	0.15 µg/m^3	Highest rolling 3-month average of the 3 years

* Standard is attained when the design value (form of concentration listed) is equal to or less than the NAAQS; for pollutants with the design values based on "exceedances" (1-hour O_3, 24-hour PM10, CO, and 24-hour SO_2), the NAAQS is attained when the concentration associated with the design value is less than or equal to the standard:

- For 1-hour O_3 and 24-hour PM10, the standard is attained when the 4th highest daily concentrations of the 3-year period is less than or equal to the standard
- For CO and 24-hour SO_2, the standard is attained when the 2nd highest daily concentration of the most recent year is equal to or less than the standard

** Standard is revoked or revised. For 1-hour O_3, nonattainment areas have some continuing obligations under the former 1979 standard. For 8-hour O_3, standard is lowered from (0.08 ppm to 0.075 ppm), but the 1997 O_3 standard and most related implementation rules remain in place until the 1997 standard is revoked by U.S. EPA

Annual and 24-hour SO_2 NAAQS will be revoked one year from attainment designations for the new (2010) 1-hour SO_2 standard

3-month rolling averages of the first year (of the three year period) include November and December monthly averages of the prior year. The 3-month average is based on the average of "monthly" averages

NAAQS Attainment Status

Figure 2-1 shows the South Coast and Coachella Valley 3-year design values (2009-2011) for ozone and PM2.5, as a percentage of the corresponding federal standards. The current status of NAAQS attainment for the criteria pollutants is presented in Table 2-3 for the Basin and in Table 2-4 for the Riverside County portion of the SSAB (Coachella Valley).

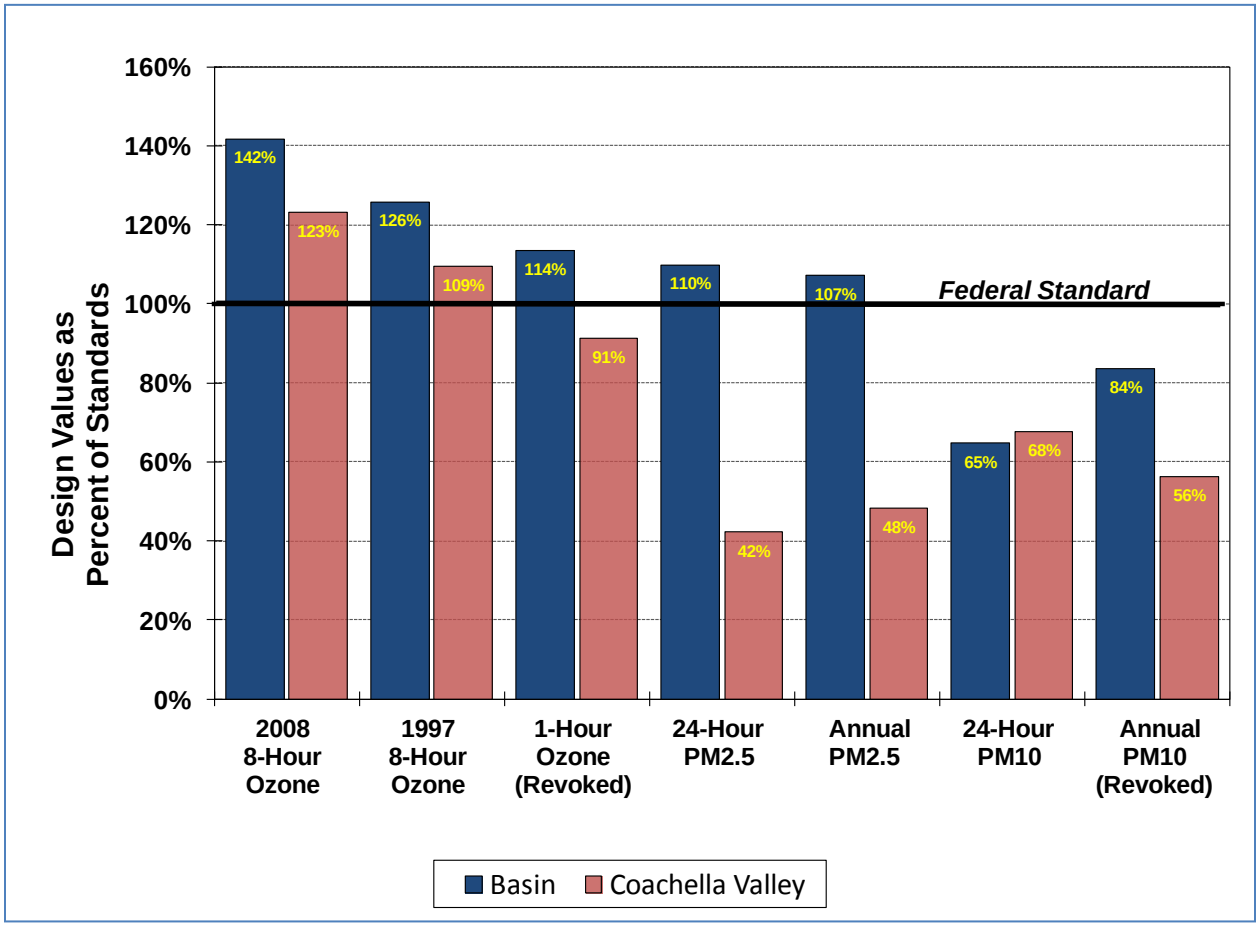

FIGURE 2-1

South Coast Air Basin and Coachella Valley 3-Year (2009-2011) Design Values
(Percentage of Federal Standards, by Criteria Pollutant)

TABLE 2-3

National Ambient Air Quality Standards (NAAQS) Attainment Status
South Coast Air Basin

CRITERIA POLLUTANT	AVERAGING TIME	DESIGNATION [a]	ATTAINMENT DATE [b]
1979 **1-Hour Ozone**[c]	1-Hour (0.12 ppm)	Nonattainment (Extreme)	11/15/2010 (not attained)[c]
1997 **8-Hour Ozone**[d]	8-Hour (0.08 ppm)	Nonattainment (Extreme)	6/15/2024
2008 **8-Hour Ozone**	8-Hour (0.075 ppm)	Nonattainment (Extreme)	12/31/2032
CO	1-Hour (35 ppm) 8-Hour (9 ppm)	Attainment (Maintenance)	6/11/2007 (attained)
NO_2[e]	1-Hour (100 ppb)	Unclassifiable/Attainment	Attained
	Annual (0.053 ppm)	Attainment (Maintenance)	9/22/1998
SO_2[f]	1-Hour (75 ppb)	Designations Pending	Pending
	24-Hour (0.14 ppm) Annual (0.03 ppm)	Unclassifiable/Attainment	3/19/1979 (attained)
PM10	24-hour (150 µg/m^3)	Nonattainment (Serious)[g]	12/31/2006 (redesignation request submitted)[g]
PM2.5	24-Hour (35 µg/m^3)	Nonattainment	12/14/2014[h]
	Annual (15.0 µg/m^3)	Nonattainment	4/5/2015
Lead	3-Months Rolling (0.15 µg/m^3)	Nonattainment (Partial)[i]	12/31/2015

a) U.S. EPA often only declares Nonattainment areas; everywhere else is listed as Unclassifiable/Attainment or Unclassifiable

b) A design value below the NAAQS for data through the full year or smog season prior to the attainment date is typically required for attainment demonstration

c) 1-hour O_3 standard (0.12 ppm) was revoked, effective June 15, 2005; however, the Basin has not attained this standard based on 2008-2010 data and has some continuing obligations under the former standard

d) 1997 8-hour O_3 standard (0.08 ppm) was reduced (0.075 ppm), effective May 27, 2008; the 1997 O_3 standard and most related implementation rules remain in place until the 1997 standard is revoked by U.S. EPA

e) New NO_2 1-hour standard, effective August 2, 2010; attainment designations January 20, 2012; annual NO_2 standard retained

f) The 1971 annual and 24-hour SO_2 standards were revoked, effective August 23, 2010; however, these 1971 standards will remain in effect until one year after U.S. EPA promulgates area designations for the 2010 SO_2 1-hour standard. Area designations are expected in 2012, with Basin designated Unclassifiable /Attainment

g) Annual PM10 standard was revoked, effective December 18, 2006; redesignation request to Attainment of the 24-hour PM10 standard is pending with U.S. EPA

h) Attainment deadline for the 2006 24-Hour PM2.5 NAAQS is December 14, 2014

i) Partial Nonattainment designation – Los Angeles County portion of Basin only

TABLE 2-4

National Ambient Air Quality Standards (NAAQS) Attainment Status
Coachella Valley Portion of the Salton Sea Air Basin

CRITERIA POLLUTANT	AVERAGING TIME	DESIGNATION [a]	ATTAINMENT DATE [b]
1979 **1-Hour Ozone**[c]	1-Hour (0.12 ppm)	Nonattainment (Severe-17)	11/15/2007 (not timely attained[c])
1997 **8-Hour Ozone**[d]	8-Hour (0.08 ppm)	Nonattainment (Severe-15)	6/15/2019
2008 **8-Hour Ozone**	8-Hour (0.075 ppm)	Nonattainment (Severe-15)	12/31/2027
CO	1-Hour (35 ppm) 8-Hour (9 ppm)	Unclassifiable/Attainment	Attained
NO_2[e]	1-Hour (100 ppb)	Unclassifiable/Attainment	Attained
	Annual (0.053 ppm)	Unclassifiable/Attainment	Attained
SO_2[f]	1-Hour (75 ppb)	Designations Pending	Pending
	24-Hour (0.14 ppm) Annual (0.03 ppm)	Unclassifiable/Attainment	Attained
PM10	24-hour (150 µg/m^3)	Nonattainment (Serious)[g]	12/31/2006 (redesignation request submitted)[g]
PM2.5	24-Hour (35 µg/m^3) Annual (15.0 µg/m^3)	Unclassifiable/Attainment	Attained
Lead	3-Months Rolling (0.15 µg/m^3)	Unclassifiable/Attainment	Attained

a) U.S. EPA often only declares Nonattainment areas; everywhere else is listed as Unclassifiable/Attainment or Unclassifiable
b) A design value below the NAAQS for data through the full year or smog season prior to the attainment date is typically required for attainment demonstration
c) 1-hour O_3 standard (0.13 ppm) was revoked, effective June 15, 2005; the Southeast Desert Modified Air Quality Management Area, including the Coachella Valley, has not attained this standard based on 2005-2007 data and has some continuing obligations under the former standard (latest 2009-2011 data shows attainment)
d) 1997 8-hour O_3 standard (0.08 ppm) was reduced (0.075 ppm), effective May 27, 2008; the 1997 O_3 standard and most related implementation rules remain in place until the 1997 standard is revoked by U.S. EPA
e) New NO_2 1-hour standard, effective August 2, 2010; attainment designations January 20, 2012; annual NO_2 standard retained
f) The 1971 Annual and 24-hour SO_2 standards were revoked, effective August 23, 2010; however, these 1971 standards will remain in effect until one year after U.S. EPA promulgates area designations for the 2010 SO_2 1-hour standard. Area designations expected in 2012 with SSAB designated Unclassifiable /Attainment
g) Annual PM10 standard was revoked, effective December 18, 2006; redesignation request to Attainment of the 24-hour PM10 standard is pending with U.S. EPA

In 2011, the Basin exceeded federal standards for either ozone or PM2.5 at one or more locations on a total of 124 days, based on the current federal standards for 8-hour ozone and 24-hour PM2.5. Despite substantial improvement in air quality over the past few decades, some air monitoring stations in the Basin still exceed the NAAQS for ozone more frequently than any other stations in the U.S. In 2011, three of the top five stations in the nation most frequently exceeding the 8-hour federal ozone NAAQS were located within the Basin (i.e., Central San Bernardino Mountains, East San Bernardino Valley and Metropolitan Riverside County). In the year 2011, the former 1-hour[3] and current 8-hour average federal standard levels for ozone were exceeded at one or more Basin locations on 16 and 106 days, respectively.

PM2.5 in the Basin has improved significantly in recent years, with 2010 and 2011 being the cleanest years on record. In 2011, only one station in the Basin (Metropolitan Riverside County at Mira Loma) exceeded the annual PM2.5 NAAQS and the 98th percentile form of the 24-hour PM2.5 NAAQS, as well as the 3-year design values for these standards. (Although other stations had 24-hour averages exceeding the federal 24-hour PM2.5 standard concentration level in 2011, the 98th percentile concentration did not exceed.) Basin-wide, the federal PM2.5 24-hour standard level was exceeded in 2011 on 17 sampling days[4].

The Basin and the Coachella Valley have technically met the PM10 NAAQS and redesignation for attainment for the federal PM10 standard has been requested for both. These requests are still pending with U.S. EPA at this time[5].

The District is currently in attainment for the federal standards for SO_2, CO, and NO_2. While the concentration level of the new 1-hour NO_2 federal standard (100 ppb) was exceeded in the Basin at two stations (Central Los Angeles and Long Beach, on the same day) in 2011, the NAAQS NO_2 design value has not been exceeded (the 3-year average of the annual 98th percentile of the daily 1-hour maximums). Therefore, the Basin remains in attainment of the NO_2 NAAQS. U.S. EPA requirements for future

[3] The federal 1-hour O_3 NAAQS has been revoked by U.S. EPA, although certain nonattainment areas, including the Basin, may be still required to demonstrate attainment of that standard based on recent court decisions.

[4] The number of PM exceedances may have been higher at some locations, since PM2.5 samples are collected every 3 days at most sites. However, seven sites sample every day, including the Basin maximum concentration stations. PM10 filter samples are collected every 6 days, except at the design value maximum sites in the Basin and the Coachella Valley at which samples are collected every 3 days. Daily PM10 data for the Basin maximum stations is provided by supplementing the filter measurements with Federal Equivalent Method (FEM) continuous monitors. The gaseous pollutants, including O_3, NO_2, SO_2, and CO, are sampled continuously.

[5] U.S. EPA has requested additional PM10 monitoring in the southeastern Coachella Valley for a 1-year period to further assess windblown dust in that area. This project is currently ongoing.

near-road NO_2 measurements are not a part of the current ambient NO_2 NAAQS determinations.

U.S. EPA designated the Los Angeles County portion of the Basin (excluding the high desert areas, and San Clemente and Santa Catalina Islands) as nonattainment for the recently revised (2008) federal lead standard (0.15 $\mu g/m^3$, rolling 3-month average), due to the addition of source- specific monitoring under the new federal regulation. This designation was based on two source-specific monitors in Vernon and in the City of Industry exceeding the new standard in the 2007-2009 period of data used. For the most recent 2009-2011 data period, only one of these stations (Vernon) still exceeded the lead standard, with a maximum 3-month rolling average of 0.67 $\mu g/m^3$ occurring in 2009. In 2011, the rolling 3-month average at that site was 0.46 $\mu g/m^3$.

The remainder of the Basin, outside the Los Angeles County nonattainment area, and the Coachella Valley remain in attainment of the new standard and no ambient monitors that are not source-oriented exceed. For areas in attainment of the old 1978 standard (1.5 $\mu g/m^3$, as a quarterly average), the 1978 lead standard remained in effect until one year after an area was designated for the 2008 standard. While the entire Basin and the Coachella Valley have remained in attainment of the 1978 lead standard, U.S. EPA's current lead designations for the new standard became effective on December 31, 2010; thus, the old standard is now superseded by the 2008 revised NAAQS. A separate SIP revision addressing the 2008 lead standard has been submitted to U.S. EPA.

CURRENT AIR QUALITY

In 2011, O_3, PM2.5, NO_2 and Pb exceeded federal standard concentration levels at one or more of the routine monitoring stations in the Basin. An exceedance of the concentration level does not necessarily mean a violation of the NAAQS, given that the form of the standard must be considered. For example, the Basin did not violate the federal NO_2 standard, based on the form of the standard. Ozone and PM10 concentrations exceeded the federal standard concentration levels in the Coachella Valley.

The PM2.5 2011 maximum 24-hour average (94.6 $\mu g/m^3$, measured in the East San Gabriel Valley area) and annual average (15.3 $\mu g/m^3$, measured in the Metropolitan Riverside County area) concentrations were 266 and 101 percent of the federal 24-hour and annual average standard concentration levels, respectively. The highest 24-

hour PM2.5 concentration in the Basin, mentioned above, was recorded on July 5, 2011, associated with Independence Day firework activities and has been flagged in the U.S. EPA Air Quality System (AQS) database for exclusion for NAAQS compliance consideration according to the U.S. EPA Exceptional Event Rule. The next highest 24-hour average PM2.5 concentration was 65 $\mu g/m^3$ recorded in Central San Bernardino Valley. The PM2.5 federal standard was nearly exceeded on one day in the Coachella Valley, during an exceptional event in which dust was entrained by outflow from a large summertime thunderstorm complex over Arizona and Mexico, transporting high concentrations of PM10 and PM2.5 into the Coachella Valley. None of these three stations with the highest 24-hour average PM2.5 concentrations had 98^{th} percentile concentrations exceeding the standard. Only the Metropolitan Riverside County (Mira Loma) station had a 98^{th} percentile concentration over the 24-hour federal standard.

The 2011 maximum PM10 24-hour average concentration measured in the South Coast Air Basin was 152 $\mu g/m^3$ in the Metropolitan Riverside County area, nearly 100% of the federal standard (but not exceeding it, since a concentration of 155 $\mu g/m^3$ is needed to exceed the PM10 standard). This maximum 24-hour average concentration was measured with a Federal Equivalent Method (FEM) continuous monitor. The highest 24-hour PM10 concentration in the Basin measured with the Federal Reference Method (FRM) filter sampler was 84 $\mu g/m^3$ recorded in Central San Bernardino Valley, 56 percent of the standard. The maximum annual average PM10 concentration (42.3 $\mu g/m^3$ in the Metropolitan Riverside County area) is 85 percent of the former (now revoked) federal annual average standard level. The two routine AQMD monitoring stations in the Coachella Valley exceeded the 24-hour PM10 federal standard on two days, both related to windblown dust generated by thunderstorm activity. These two days have been flagged by the District in the U.S. EPA AQS database for consideration under the Exceptional Event Rule.

The 2011 maximum ozone concentrations continued to exceed federal standards by wide margins. Maximum 1-hour and 8-hour average ozone concentrations (0.160 ppm and 0.136 ppm, both recorded in the Central San Bernardino Mountains area) were 128 and 181 percent of the former 1-hour and current 8-hour federal standards, respectively. The Coachella Valley did not exceed the former 1-hour federal standard in 2011, but the maximum 8-hour concentration (0.098 ppm) was 130 percent of the current federal standard.

The maximum 1-hour average NO_2 concentration in 2011 (110 ppb, measured in Central Los Angeles) was 109 percent of the federal standard, exceeding the

concentration level, but not the 98th percentile form of the NAAQS. Lead concentrations in 2011 were well below the recently (2008) revised federal standard at all ambient monitoring sites not located near lead sources. However, the source-specific monitoring site immediately downwind of a stationary lead source in the City of Vernon recorded a maximum 3-month rolling average of 0.46 µg/m^3, or 297 percent of the standard. Concentrations of other criteria pollutants (SO_2 and CO) remained well below the federal standards.

Figure 2-2 shows the trend of maximum pollutant concentrations in the Basin for the past two decades, as percentages of the corresponding federal standards. Most pollutants show significant improvement over the years, with PM2.5 showing the most dramatic decrease. Again, these are maximum concentrations and actual attainment of the standards is based on the design value.

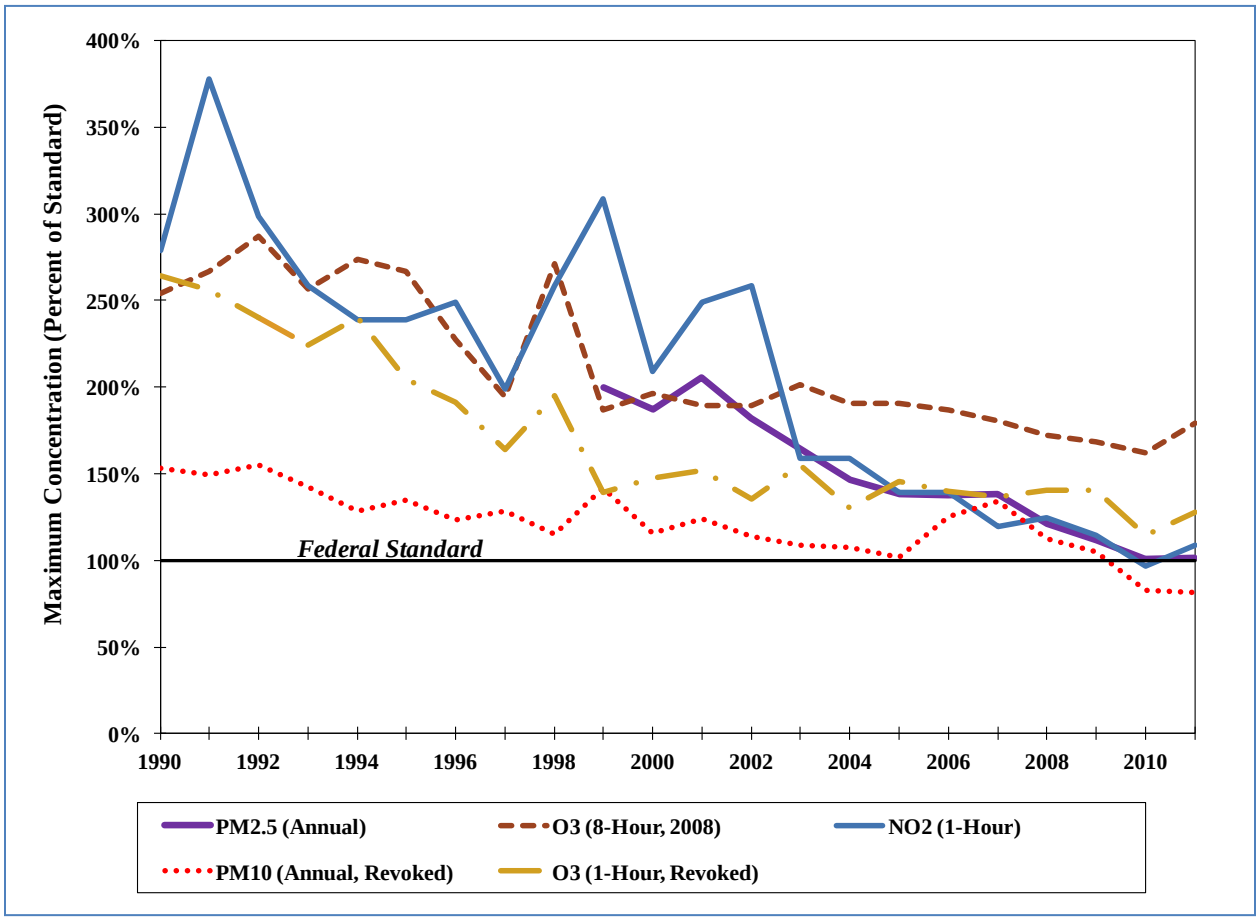

FIGURE 2-2

Trends of South Coast Air Basin Maximum Pollutant Concentrations
(Percentages of Federal Standards)

Particulate Matter (PM2.5 and PM10) Specific Information

Health Effects, Particulate Matter

A significant body of peer-reviewed scientific research, including studies conducted in Southern California, points to adverse impacts of particulate matter air pollution on both increased illness (morbidity) and increased death rates (mortality). The 2009 U.S. EPA *Integrated Science Assessment for Particulate Matter*[6] describes these health effects and discusses the state of the scientific knowledge. A summary of health effects information and additional references can also be found in the 2012 AQMP, Appendix I.

There was considerable controversy and debate surrounding the review of particulate matter health effects and the consideration of ambient air quality standards when U.S. EPA promulgated the initial PM2.5 standards in 1997[7]. Since that time, numerous additional studies have been published[8]. In addition, some of the key studies supporting the 1997 standards were closely scrutinized and the analyses repeated and extended. These reanalyses confirmed the initial findings associating adverse health effects with PM exposures.

Several studies have found correlations between elevated ambient particulate matter levels and an increase in mortality rates, respiratory infections, number and severity of asthma attacks, and the number of hospital admissions in different parts of the United States and in various areas around the world. In recent years, studies have reported an association between long-term exposure to PM2.5 and increased mortality, reduction in life-span, and an increased mortality from lung cancer.

Daily fluctuations in PM2.5 concentration levels have also been related to increased mortality due to cardiovascular or respiratory diseases, hospital admissions for acute respiratory conditions, school and kindergarten absences, a decrease in respiratory function in normal children, and increased medication use in children and adults with asthma. Long-term exposure to PM has been found to be associated with reduced lung function growth in children. The elderly, people with pre-existing respiratory

[6] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F.
[7] Vedal, S. (1997). Critical Review. Ambient Particles and Health: Lines that Divide. JAMA, 47(5):551-581.
[8] Kaiser, J. (2005). Mounting Evidence Indicts Fine-Particle Pollution. Science, 307:1858-1861.
Enstrom, J.E. (2005), "Fine particulate air pollution and total mortality among elderly Californians, 1973–2002," *Inhalation Toxicology* 17:803–16

and/or cardiovascular disease, and children appear to be more susceptible to the effects of PM10 and PM2.5.

The U.S. EPA, in its most recent review, has concluded that long term exposure to PM2.5 is causally related to increases in mortality rates. Despite this, skepticism remains among some quarters whether exposures to PM2.5 in California are responsible for increases in mortality.[9] An expanded discussion of studies relating to PM exposures and mortality is contained in Appendix I of this document.

Air Quality, PM2.5

The District began regular monitoring of PM2.5 in 1999 following the U.S. EPA's adoption of the national PM2.5 standards in 1997. In 2011, PM2.5 concentrations were monitored at 21 locations throughout the District, 20 of which had filter-based FRM monitoring sites while one had only continuous monitoring. Six sites had collocated, continuous monitoring in addition to the FRM samplers. The maximum 24-hour and annual average PM2.5 concentrations in 2011 are shown in Tables 2-5 and 2-6.

Figure 2-3 maps the distribution of annual average PM2.5 concentrations in different areas of the Basin. Similar to PM10 concentrations, PM2.5 concentrations were higher in the inland valley areas of metropolitan Riverside County (highest at the Mira Loma Station). PM2.5 concentrations were also elevated in the metropolitan area of Los Angeles County, but did not exceed the level of the annual federal standard in 2011. Although maximum 24-hour concentrations exceed the standard, the 98th percentile form of the 2009-2011 design value only exceeded the standard at one station in Metropolitan Riverside County (Mira Loma).

The higher PM2.5 concentrations in the Basin are mainly due to the secondary formation of smaller particulates resulting from mobile, stationary and area source emissions of precursor gases (i.e., NOx, SOx, NH_4, and VOC) that are converted to PM in the atmosphere. In contrast to PM10, PM2.5 concentrations were low in the Coachella Valley area of SSAB. PM10 concentrations are normally higher in the desert areas due to windblown and fugitive dust emissions; PM2.5 is relatively low in the desert area due to fewer combustion-related emissions sources.

[9] CARB Symposium: Estimating Premature Deaths from Long-term Exposure to PM2.5, February 26, 2010, [http://www.arb.ca.gov/research/health/pm-mort/pm-mort-ws_02-26-10.htm].

TABLE 2-5

2011 Maximum 24-hour Average PM2.5 Concentrations by Basin and County

BASIN/COUNTY	MAXIMUM 24-HR AVERAGE# ($\mu G/M^3$)	PERCENT OF FEDERAL STANDARD* (35 $\mu G/M^3$)	AREA
South Coast Air Basin			
Los Angeles**	49.5	139	East San Gabriel Valley
Orange	39.2	110	Central Orange County
Riverside	60.8	171	Metropolitan Riverside County
San Bernardino	65.0	183	Central San Bernardino Valley
Salton Sea Air Basin			
Riverside***	35.4	99.7	Coachella Valley

\# Based on FRM data

* Although maximum 24-hour concentrations exceed the standard, the 98th percentile form of the 2009-2011 design value only exceeded the standard at one station in Metropolitan Riverside County (Mira Loma)

** One higher concentration that was recorded due to "Independence Day" firework activities has been flagged for exclusion from NAAQS comparison in accordance with the U.S. EPA Exceptional Events Rule; with this data included, the 2009-2011 design value for East San Gabriel Valley would also exceed the federal standard

*** While this concentration of 35.4 $\mu g/m^3$ is near the level of the standard, it is technically not exceeding the standard (35.5 $\mu g/m^3$ exceeds); this concentration was associated with a high wind exceptional event

TABLE 2-6

2011 Maximum Annual Average PM2.5 Concentrations by Basin and County

BASIN/COUNTY	ANNUAL AVERAGE* ($\mu G/M^3$)	PERCENT OF FEDERAL STANDARD (15 $\mu G/M^3$)	AREA
South Coast Air Basin			
Los Angeles	13.3	89	Central Los Angeles
Orange	11.0	73	Central Orange County
Riverside	15.3	101	Metropolitan Riverside County
San Bernardino	13.3	89	Southwest San Bernardino Valley
Salton Sea Air Basin			
Riverside	7.1	47	Coachella Valley

* Based on FRM data

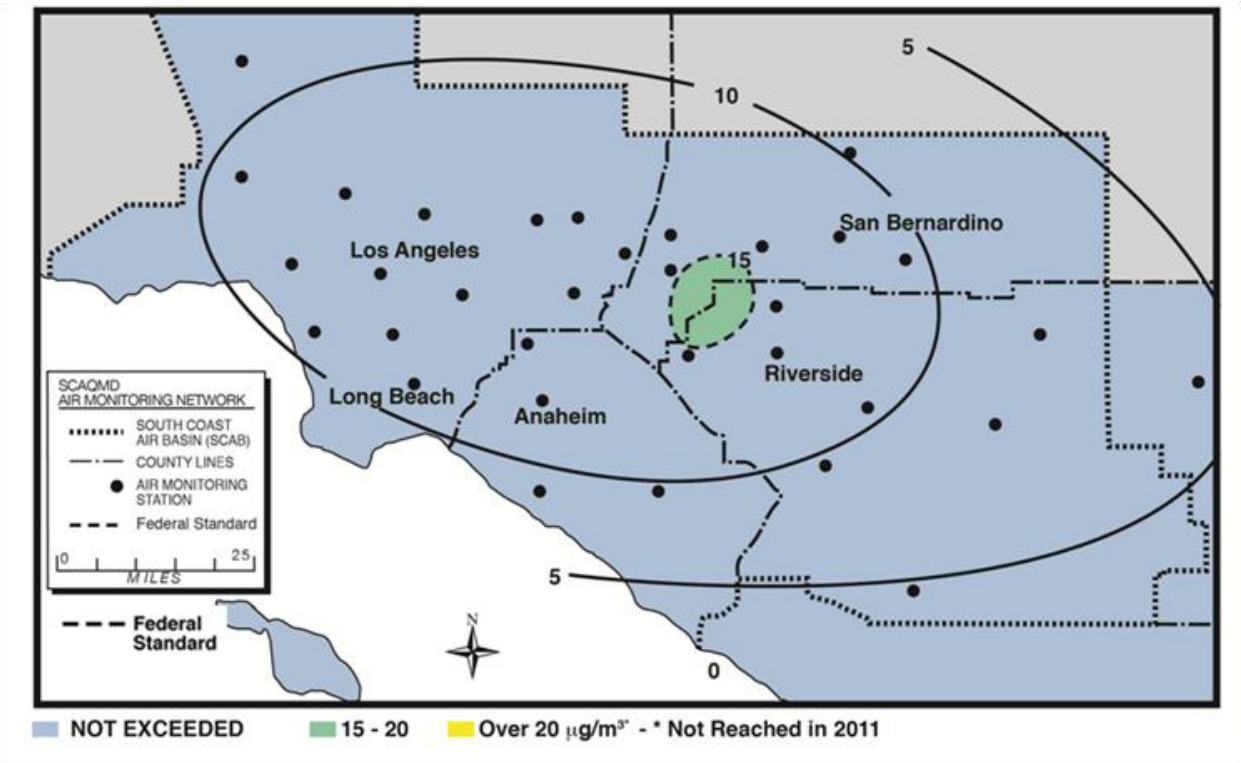

FIGURE 2-3

2011 PM2.5: Annual Average Concentration Compared to the Federal Standard
(Federal standard = 15 µg/m^3, annual arithmetic mean)

Air Quality, PM10

In 2011, the District monitored PM10 concentrations at 25 routine sampling locations, 22 with Federal Reference Method (FRM) filter samplers and 3 with Federal Equivalent Method (FEM) continuous monitors. Five sites had collocated FRM and FEM samplers. Maximum 24-hour and annual average PM10 concentrations in 2011 are shown in Tables 2-7 and 2-8.

The highest annual PM10 concentrations were recorded in Riverside and San Bernardino Counties, in and around the metropolitan Riverside County area and further inland in the San Bernardino valley areas. The federal 24-hour standard was not exceeded at any of the locations monitored in 2011, although Riverside County came close with a 24-hour average concentration of 152 µg/m^3 (155 µg/m^3 is needed to exceed). The revoked annual average PM10 federal standard (50 µg/m^3) was not exceeded in either the Basin or the Coachella Valley in 2011. The much more stringent state standards were exceeded in most areas of the Basin and in the Coachella Valley.

TABLE 2-7

2011 Maximum 24-hour Average PM10 Concentrations by Basin and County

BASIN/COUNTY	MAXIMUM 24-HR AVERAGE* ($\mu G/M^3$)	PERCENT OF FEDERAL STANDARD (150 $\mu G/M^3$)[#]	AREA
South Coast Air Basin			
Los Angeles	119	77	Central Los Angeles
Orange	79	51	Central Orange County
Riverside	152	98	Metropolitan Riverside County
San Bernardino	127	82	Central San Bernardino Valley
Salton Sea Air Basin**			
Riverside	120	77	Coachella Valley

* Based on the FRM and FEM data

** Higher concentrations were recorded for high wind events in the Coachella Valley which have been flagged for exclusion from NAAQS comparison in accordance with the U.S. EPA Exceptional Events Rule

[#] 155 $\mu g/m^3$ is needed to exceed the PM10 standard

TABLE 2-8

2011 Maximum Annual Average PM10 Concentrations by Basin and County

BASIN/COUNTY	ANNUAL AVERAGE* ($\mu G/M^3$)	PERCENT OF FEDERAL STANDARD** (50 $\mu G/M^3$)	AREA
South Coast Air Basin			
Los Angeles	32.7	64	East San Gabriel Valley
Orange	24.9	49	Central Orange County
Riverside	41.4	81	Metropolitan Riverside County
San Bernardino	31.8	62	Central San Bernardino Valley
Salton Sea Air Basin			
Riverside	32.6	64	Coachella Valley

* Based on the FRM and FEM data

** The federal annual PM10 standard was revoked in 2006

Ozone (O_3) Specific Information

Health Effects, O_3

The adverse effects of ozone air pollution exposure on health have been studied for many years, as is documented by a significant body of peer-reviewed scientific research, including studies conducted in southern California. The 2006 U.S. EPA document, *Air Quality Criteria for Ozone and Related Photochemical Oxidants*[10], describes these health effects and discusses the state of the scientific knowledge and research. A summary of health effects information and additional references can also be found in the 2012 AQMP, Appendix I.

Individuals exercising outdoors, children, and people with preexisting lung disease, such as asthma and chronic pulmonary lung disease, are considered to be the most susceptible sub-groups to ozone effects. Short-term exposures (lasting for a few hours) to ozone at levels typically observed in Southern California can result in breathing pattern changes, reduction of breathing capacity, increased susceptibility to infections, inflammation of the lung tissue, and some immunological changes. Elevated ozone levels are associated with increased school absences and daily hospital admission rates. An increased risk for asthma has been found in children who participate in multiple sports and live in high ozone communities.

Ozone exposure under exercising conditions is known to increase the severity of the above-mentioned observed responses. Animal studies suggest that exposures to a combination of pollutants which include ozone may be more toxic than exposure to ozone alone. Although lung volume and resistance changes observed after a single exposure diminish with repeated exposures, biochemical and cellular changes appear to persist, which can lead to subsequent lung structural changes.

Air Quality, O_3

In 2011, the District regularly monitored ozone concentrations at 29 locations in the Basin and the Coachella Valley portion of the SSAB. All areas monitored measured 1-hour average ozone levels well below the Stage 1 episode level (0.20 ppm), but the maximum concentrations measured in the Basin exceeded the health advisory level (0.15 ppm, 1-hour) in San Bernardino County. The maximum ozone concentrations in Los Angeles, Riverside and San Bernardino Counties all exceeded the former 1-

[10] U.S. EPA. (2006). Air Quality Criteria for Ozone and Related Photochemical Oxidants (2006 Final). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-05/004aF-cF.

hour federal standard in 2011; Orange County and the Coachella Valley did not exceed that standard. Maximum ozone concentrations in the SSAB areas monitored by the District were lower than in the Basin and were below the health advisory level. All counties of the Basin and the Coachella Valley exceeded the current 8-hour ozone standard in 2011. Tables 2-9 and 2-10 show maximum 1-hour and 8-hour ozone concentrations by air basin and county.

TABLE 2-9

2011 Maximum 1-Hour Average Ozone Concentrations by Basin and County

BASIN/COUNTY	MAXIMUM 1-HR AVERAGE (PPM)	PERCENT OF FEDERAL STANDARD (0.12 PPM)	AREA
South Coast Air Basin			
Los Angeles	0.144	115	Santa Clarita Valley
Orange	0.095	76	North Orange County
Riverside	0.133	106	Lake Elsinore
San Bernardino	0.160	128	Central San Bernardino Mountains
Salton Sea Air Basin			
Riverside	0.124	99	Coachella Valley

TABLE 2-10

2011 Maximum 8-Hour Average Ozone Concentrations by Basin and County

BASIN/COUNTY	MAXIMUM 8-HR AVERAGE (PPM)	PERCENT OF FEDERAL STANDARD (0.075 PPM)	AREA
South Coast Air Basin			
Los Angeles	0.122	162	Santa Clarita Valley
Orange	0.083	110	Saddleback Valley
Riverside	0.115	152	Metropolitan Riverside County
San Bernardino	0.136	180	Central San Bernardino Mountains
Salton Sea Air Basin			
Riverside	0.098	130	Coachella Valley

The number of days exceeding federal standards for ozone in the Basin varies widely by area. Figures 2-4 and 2-5 map the number of days in 2011 exceeding the current 8-hour and former 1-hour ozone federal standards in different areas of the Basin in 2011. The former 1-hour federal standard was not exceeded in areas along or near the coast in the Counties of Los Angeles and Orange, due in large part to the prevailing sea breeze which transports emissions inland before high ozone concentrations are reached. The standard was exceeded most frequently in the Central San Bernardino Mountains. Ozone exceedances also extended through San Bernardino and Riverside County valleys in the eastern Basin, as well as the northeast and northwest portions of Los Angeles County in the foothill and valley areas. The number of exceedances of the 8-hour federal ozone standard was also lowest at the coastal areas, increasing towards the Riverside and San Bernardino valleys and the adjacent mountain areas. The Central San Bernardino Mountains area recorded the greatest number of exceedances of the 1-hour and 8-hour federal standards (8 days and 84 days, respectively) and 8-hour state standard (103 days). While the Coachella Valley did not exceed the former 1-hour ozone standard in 2011, the 2008 8-hour federal standard was exceeded on 54 days.

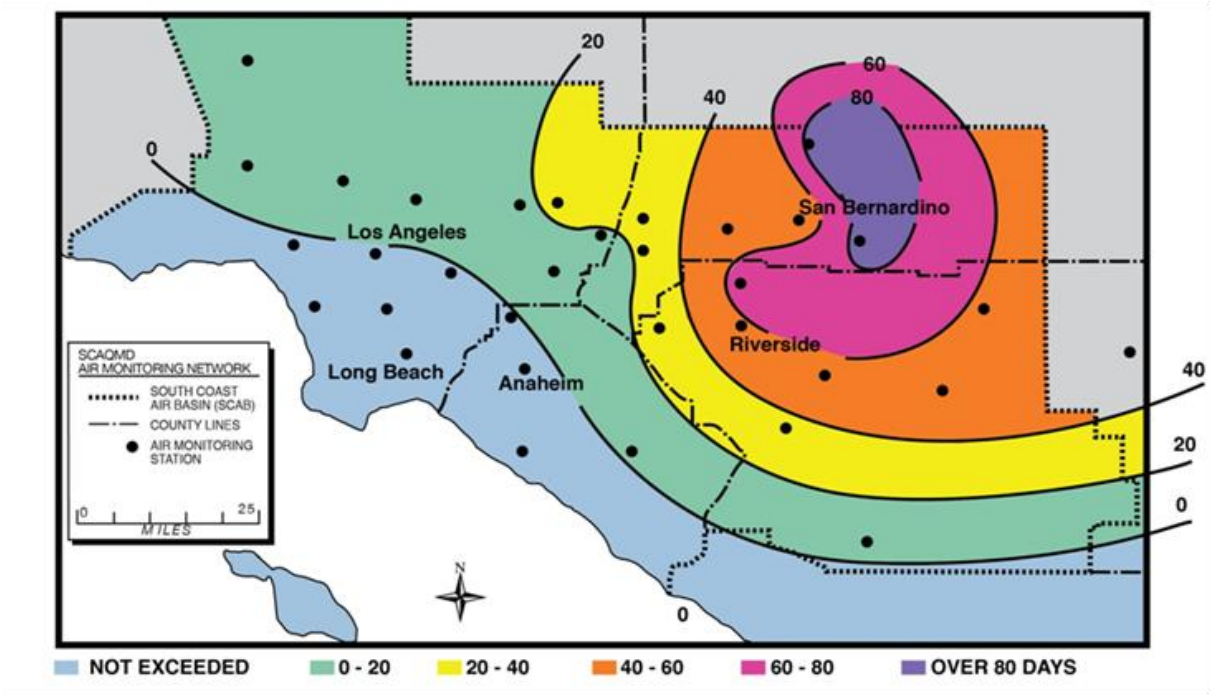

FIGURE 2-4

Number of Days in 2011 Exceeding the 2008 8-Hour Ozone Federal Standard
(8-hour average O_3 > 0.075 ppm)

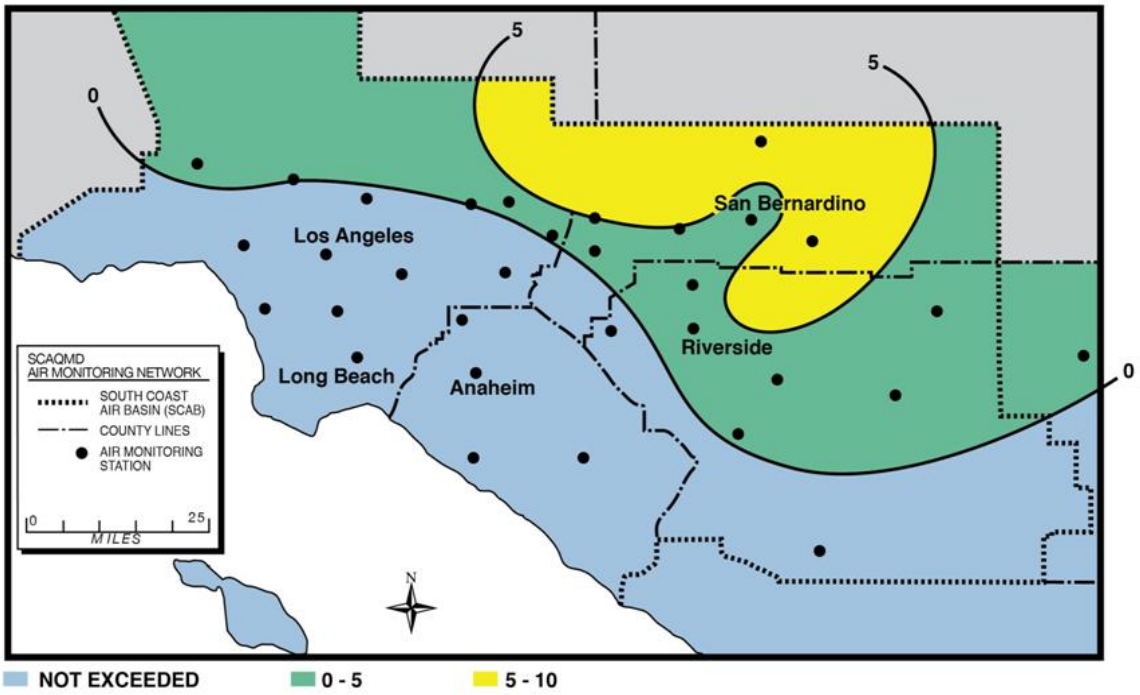

FIGURE 2-5

Number of Days in 2011 Exceeding the 1979 1-Hour Federal Ozone Standard
(1-hour average O_3 > 0.12 ppm)

Other Criteria Air Pollutants

Carbon Monoxide (CO) Specific Information

Health Effects, CO

The adverse effects of ambient carbon monoxide air pollution exposure on health have been recently reviewed in the 2006 U.S. EPA *Integrated Science Assessment for Carbon Monoxide.*[11] This document presents a detailed review of the available scientific studies and conclusions on the causal determination of the health effects of CO. A summary of health effects information and additional references can also be found in the 2012 AQMP, Appendix I.

Individuals with a deficient blood supply to the heart are the most susceptible to the adverse effects of CO exposure. The effects observed include earlier onset of chest

[11] U.S. EPA. (2010). Integrated Science Assessment for Carbon Monoxide (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/019F.

pain with exercise, and electrocardiograph changes indicative of worsening oxygen supply delivery to the heart.

Inhaled CO has no known direct toxic effect on the lungs, but exerts its effect on tissues by interfering with oxygen transport, by competing with oxygen to combine with hemoglobin present in the blood to form carboxyhemoglobin (COHb). Hence, people with conditions requiring an increased oxygen supply can be adversely affected by exposure to CO. Individuals most at risk include patients with diseases involving heart and blood vessels, fetuses, and patients with chronic hypoxemia (oxygen deficiency) as seen at high altitudes.

Reductions in birth weight and impaired neurobehavioral development have been observed in animals chronically exposed to CO resulting in COHb levels similar to those observed in smokers. Recent studies have found increased risks for adverse birth outcomes with exposure to elevated CO levels. These include pre-term births and heart abnormalities.

Air Quality, CO

Carbon monoxide concentrations were measured at 25 locations in the Basin and neighboring SSAB areas in 2011. Table 2-11 shows the 2011 maximum 8-hour and 1-hour average concentrations of CO by air basin and county.

In 2011, no areas exceeded the CO air quality standards. The highest concentrations of CO continued to be recorded in the areas of Los Angeles County where vehicular traffic is most dense, with the maximum 8-hour and 1-hour concentration (4.7 ppm and 6.0 ppm, respectively) recorded in the South Central Los Angeles County area. All areas of the Basin have continued to remain below the federal standard level since 2003.

TABLE 2-11

2011 Maximum 8-Hour and 1-Hour CO Concentrations by Basin and County

BASIN/COUNTY	MAXIMUM 8-HR AVERAGE (PPM)	PERCENT OF FEDERAL STANDARD (9 PPM)	MAXIMUM 1-HR AVERAGE (PPM)	PERCENT OF FEDERAL STANDARD (35 PPM)	AREA
South Coast Air Basin					
Los Angeles	4.7	49	6.0	17	South Central L.A. County
Orange	2.2	23	3.4	10	North Coastal Orange County
Riverside	1.9	20	2.7	8	Metropolitan Riverside County
San Bernardino	1.7	18	1.8	5	Central San Bernardino Valley
Salton Sea Air Basin					
Riverside	0.6	6	3.0	8	Coachella Valley

Nitrogen Dioxide (NO_2) Specific Information

Health Effects, NO_2

The adverse effects of ambient nitrogen dioxide air pollution exposure on health have been recently reviewed in the 2008 U.S. EPA *Integrated Science Assessment for Oxides of Nitrogen – Health Criteria*[12]. This document presents a detailed review of the available scientific studies and conclusions on the causal determination of the health effects of NO_2, including evidence supporting the recently adopted short-term NO_2 standard (1-hour, 100 ppb). A summary of health effects information and additional references can also be found in the 2012 AQMP, Appendix I.

Population-based studies suggest that an increase in acute respiratory illness, including infections and respiratory symptoms in children (not infants), is associated with long-term exposures to NO_2 at levels found in homes with gas stoves, which are higher than ambient concentrations found in Southern California. Increase in resistance to air flow and airway contraction is observed after short-term exposure to NO_2 in healthy subjects. Larger decreases in lung functions are observed in

[12] U.S. EPA. (2008). Integrated Science Assessment for Oxides of Nitrogen – Health Criteria (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/071.

individuals with asthma and/or chronic obstructive pulmonary disease (e.g., chronic bronchitis, emphysema) than in healthy individuals, indicating a greater susceptibility of these sub-groups. More recent studies have found associations between NO_2 exposures and cardiopulmonary mortality, decreased lung function, respiratory symptoms, and emergency room asthma visits.

In animals, exposure to levels of NO_2 that are considerably higher than ambient concentrations results in increased susceptibility to infections, possibly due to the observed changes in cells involved in maintaining immune functions. The severity of lung tissue damage associated with high levels of ozone exposure increases when animals are exposed to a combination of ozone and NO_2.

Based on the review of the NO_2 standards, U.S. EPA has established the 1-hour NO_2 standard to protect the public health against short-term exposure. The standard is set at 100 ppb 1-hour average, effective April 7, 2010.

Air Quality, NO_2

In 2011, NO_2 concentrations were monitored at 25 locations, including one in the Coachella Valley. The Basin has not exceeded the federal annual standard for NO_2 (0.0534 ppm) since 1991, when the Los Angeles County portion of the Basin recorded the last exceedance of the standard in any U.S. county. The recently established 1-hour average NO_2 standard (100 ppb), however, was exceeded on one day in 2011 (but the 98^{th} percentile form of the standard was not exceeded). The higher relative concentrations in the Los Angeles area are indicative of the concentrated emission sources, especially motor vehicles. The maximum 1-hour and annual average concentrations for 2011 are shown in Table 2-12, by basin and county.

TABLE 2-12

2011 Maximum 1-Hour and Annual Average NO_2 Concentrations by Basin and County

BASIN/COUNTY	MAXIMUM 1-HOUR AVERAGE (PPB)	PERCENT OF FEDERAL STANDARD (100 PPB)	MAXIMUM ANNUAL AVERAGE (PPB)	PERCENT OF FEDERAL STANDARD (53 PPB)	AREA
South Coast Air Basin					
Los Angeles	109.6*	109	24.6	46	Central Los Angeles County; Pomona/Walnut Valley
Orange	73.8	73	17.7	33	Central Orange County
Riverside	63.3	63	16.9	32	Metropolitan Riverside County
San Bernardino	76.4	76	21.1	39	Central San Bernardino Valley
Salton Sea Air Basin					
Riverside	44.7	44	8.0	15	Coachella Valley

* Although the maximum 1-hour concentrations exceeded the standard, the 98th percentile form of the design value did not exceed the NAAQS

Sulfur Dioxide (SO_2) Specific Information

Health Effects, SO_2

The adverse effects of SO_2 air pollution exposure on health have been recently reviewed in the 2008 U.S. EPA *Integrated Science Assessment (ISA) for Sulfur Oxides – Health Criteria*.[13] This document presents a detailed review of the available scientific studies and conclusions on the causal determination of the health effects of SO_2, including the justification to rescind the 24-hour standard and replace it with the new (2010) 1-hour standard (75 ppb). A summary of health effects information and additional references can also be found in the 2012 AQMP, Appendix I.

Individuals affected by asthma are especially sensitive to the effects of SO_2. Exposure to low levels (0.2 to 0.6 ppm) of SO_2 for a few (5-10) minutes can result in airway constriction in some exercising asthmatics. In asthmatics, increase in

[13] U.S. EPA. (2008). Integrated Science Assessment (ISA) for Sulfur Oxides – Health Criteria (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/047F.

resistance to air flow, as well as reduction in breathing capacity leading to severe breathing difficulties, are observed after acute high exposure to SO_2. In contrast, healthy individuals do not exhibit similar acute responses even after exposure to higher concentrations of SO_2.

Animal studies suggest that even though SO_2 is a respiratory irritant, it does not cause substantial lung injury at ambient concentrations. However, very high levels of exposure can cause lung edema (fluid accumulation), lung tissue damage, and sloughing off of cells lining the respiratory tract.

Some population-based studies indicate that the mortality and morbidity effects associated with fine particles show a similar association with ambient SO_2 levels. In these studies, efforts to separate the effects of SO_2 from those of fine particles have not been successful. It is not clear whether the two pollutants act synergistically or one pollutant alone is the predominant factor.

Based on the review of the SO_2 standards, U.S. EPA has established the 1-hour SO_2 standard to protect the public health against short term exposure. The 1-hour average standard is set at 75 ppb, revoking the existing annual (0.03 ppm) and 24-hour (0.14 ppm) standards, effective August 2, 2010.

Air Quality, SO_2

No exceedances of federal or state standards for sulfur dioxide occurred in 2011 at any of the seven District locations monitored. Though sulfur dioxide concentrations remain well below the standards, sulfur dioxide is a precursor to sulfate, which is a component of fine particulate matter. Maximum concentrations of sulfur dioxide for 2011 are shown in Table 2-13. Sulfur dioxide was not measured at the Coachella Valley sites in 2011. Historical measurements showed concentrations in the Coachella Valley to be well below state and federal standards and monitoring has been discontinued.

TABLE 2-13

2011 Maximum 1-Hour Average SO_2 Concentrations by Basin and County

BASIN/COUNTY	MAXIMUM 1-HR AVERAGE (PPB)	PERCENT OF FEDERAL STANDARD (75 PPB)	AREA
South Coast Air Basin			
Los Angeles	43.4	57	South Coastal LA County
Orange	7.8	10	North Coastal Orange County
Riverside	51.2	68	Metropolitan Riverside County
San Bernardino	12.4	16	Central San Bernardino Valley
Salton Sea Air Basin			
Riverside	N.D.		Coachella Valley

N.D. = No Data. Historical measurements and lack of emissions sources indicate concentrations are well below standards

Sulfates (SO_4^{2-}) Specific Information

Health Effects, SO_4^{2-}

In 2002, CARB reviewed and retained the state standard for sulfates, retaining the concentration level (25 µg/m^3) but changing the basis of the standard from a Total Suspended Particulate (TSP) measurement to a PM10 measurement. In their 2002 staff report,[14] CARB reviewed the health studies related to exposure to ambient sulfates, along with particulate matter, and found an association with mortality and the same range of morbidity effects as PM10 and PM2.5, although the associations were not as consistent as with PM10 and PM2.5. The 2009 U.S. EPA *Integrated Science Assessment for Particulate Matter*[15] also contains a review of sulfate studies. A summary of health effects information can also be found in the 2012 AQMP, Appendix I.

Most of the health effects associated with fine particles and SO_2 at ambient levels are also associated with sulfates. Thus, both mortality and morbidity effects have been observed with an increase in ambient sulfate concentrations. However, efforts to

[14] CARB. (2002). Staff Report: Public Hearing to Consider Amendments to the Ambient Air Quality Standards for Particulate Matter and Sulfates. California Air Resources Board, Sacramento, CA. http://www.arb.ca.gov/regact/aaqspm/isor.pdf

[15] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F.

separate the effects of sulfates from the effects of other pollutants have generally not been successful.

Clinical studies of asthmatics exposed to sulfuric acid suggest that adolescent asthmatics are possibly a subgroup susceptible to acid aerosol exposure. Animal studies suggest that acidic particles such as sulfuric acid aerosol and ammonium bisulfate are more toxic than non-acidic particles like ammonium sulfate. Whether the effects are attributable to acidity or to particles remains unresolved.

Air Quality, SO_4^{2-}

Sulfate from PM10 was measured at 22 stations in 2011, including one in the Coachella Valley. In 2011, the state PM10-sulfate standard was not exceeded anywhere in the Basin or the Coachella Valley. Maximum concentrations by air basin and county are shown in Table 2-14.

TABLE 2-14

2011 Maximum 24-Hour Average Sulfate (PM10) Concentrations by Basin and County

BASIN/COUNTY	MAXIMUM 24-HR AVERAGE ($\mu G/M^3$)	PERCENT OF STATE STANDARD (25 $\mu G/M^3$)	AREA
South Coast Air Basin			
Los Angeles	8.0	32	Central Los Angeles County
Orange	6.5	26	Central Orange County
Riverside	5.4	22	Metropolitan Riverside County
San Bernardino	6.0	24	Central San Bernardino Valley
Salton Sea Air Basin			
Riverside	5.7	23	Coachella Valley

Lead (Pb) Specific Information

Health Effects, Pb

The adverse effects of ambient lead exposures on health have been reviewed in the 2006 U.S. EPA document, *Air Quality Criteria for Lead (2006) Final Report*.[16] This document presents a detailed assessment of the available scientific studies and presents conclusions on the causal determination of the health effects of lead, including the justification to lower the federal lead standard.

Fetuses, infants, and children are more sensitive than others to the adverse effects of lead exposure. Exposure to low levels of lead can adversely affect the development and function of the central nervous system, leading to learning disorders, distractibility, inability to follow simple commands, and lower intelligence quotient. In adults, increased lead levels are associated with increased blood pressure.

Lead poisoning can cause anemia, lethargy, seizures, and death. It appears that there are no direct effects of lead on the respiratory system. Lead can be stored in the bone from early-age environmental exposure, and elevated blood lead levels can occur due to breakdown of bone tissue during pregnancy, hyperthyroidism (increased secretion of hormones from the thyroid gland), and osteoporosis (breakdown of bony tissue). Fetuses and breast-fed babies can be exposed to higher levels of lead because of previous environmental lead exposure of their mothers.

Air Quality, Pb

Based on the review of the NAAQS for lead, U.S. EPA has established a new standard of 0.15 $\mu g/m^3$ for a rolling 3-month average, effective October 15, 2008 (measured from total suspended particulates, TSP). Except for the source-specific monitoring that is now required under the new standard, there have been no violations of the lead standards at the District's regular air monitoring stations since 1982, as a result of removal of lead from gasoline. However, monitoring at two stations immediately adjacent to stationary sources of lead have recorded exceedances of the standards in localized areas of the Basin in more recent years. Table 2-15 shows the maximum 3-month rolling average concentrations recorded in 2011. In 2011, lead concentrations in the Basin exceeded the new 3-month rolling average standard (0.15 $\mu g/m^3$) at one source-specific monitoring site in Los Angeles County, located immediately downwind of a stationary lead source. The federal rolling 3-month and

[16] U.S. EPA. (2006). Air Quality Criteria for Lead (2006) Final Report. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-05/144aF-bF, 2006.

state 30-day standards for lead were not exceeded in any other area of the District in 2011.

TABLE 2-15

2011 Maximum 3-Month Rolling Average Lead Concentrations by Basin and County

BASIN/COUNTY	MAXIMUM 3-MONTH ROLLING AVERAGE ($\mu G/M^3$)	PERCENT OF FEDERAL STANDARD (0.15 $\mu G/M^3$)	AREA
South Coast Air Basin			
Los Angeles*	0.46	297	Central Los Angeles
Orange	N.D.		
Riverside	0.01	6	Metropolitan Riverside County
San Bernardino	0.01	6	Northwest San Bernardino Valley, Central San Bernardino Valley
Salton Sea Air Basin			
Riverside	N.D.		Coachella Valley

* This high lead concentration was measured at a site immediately downwind of a lead source.
N.D. = No Data. Historical measurements indicate concentrations are well below standards.

COMPARISON TO OTHER U.S. AREAS

The Basin's severe air pollution problem is a consequence of the combination of emissions from the nation's second largest urban area, mountainous terrain surrounding the Basin that traps pollutants as they are pushed inland with the sea breeze, and meteorological conditions which are adverse to the dispersion of those emissions. The average wind speed for Los Angeles is the lowest of the nation's ten largest urban areas. In addition, the summertime daily maximum mixing heights (an index of how well pollutants can be dispersed vertically in the atmosphere) in Southern California are the lowest, on average, in the U.S., due to strong temperature inversions in the lower atmosphere that effectively trap pollutants near the surface. The Southern California area is also an area with abundant sunshine, which drives the photochemical reactions which form pollutants such as ozone and a significant portion of PM2.5.

In the Basin, high concentrations of ozone are normally recorded during the late spring and summer months, when more intense sunlight drives enhanced

photochemical reactions. In contrast, higher concentrations of carbon monoxide are generally recorded in late fall and winter, when nighttime radiation inversions trap the emissions at the surface. High PM10 and PM2.5 concentrations can occur throughout the year, but occur most frequently in fall and winter in the Basin. Although there are changes in emissions by season, the observed variations in pollutant concentrations are largely a result of seasonal differences in weather conditions.

Figures 2-6 and 2-7 show maximum pollutant concentrations in 2011 for the South Coast Air Basin compared to other urban areas in the U.S. and California, respectively. Maximum concentrations in all of these areas exceeded the federal 8-hour ozone standard. The annual PM2.5 standard was exceeded in the Basin and in one other California air basin (San Joaquin Valley). The 24-hour PM2.5 standard, however, was exceeded in a few of the other large U.S. urban areas and in many California air basins. The 24-hour PM10 standard was exceeded in one of the U.S. urban areas shown (Phoenix), although potential flagging of exceptional events may affect the treatment of that data. It is important to note that maximum pollutant concentrations do not necessarily indicate potential nonattainment designations, as the design values that are used for attainment status are based on the form of the standard.

Nitrogen dioxide concentrations exceeded the recently established 1-hour standard in the Basin and Phoenix (on one day each). Denver, Colorado (not shown in Figure 2-7), was the only other U.S. urban area exceeding the NO_2 standard in 2011. Sulfur dioxide concentrations were below the recently established 1-hour federal standard in the Basin and all of the urban areas shown in Figures 2-6 and 2-7. However, the SO_2 standard was exceeded in other U.S. areas, with the highest concentrations recorded in Hawaii, due to volcano emissions. The CO standards were not exceeded in the U.S. in 2011.

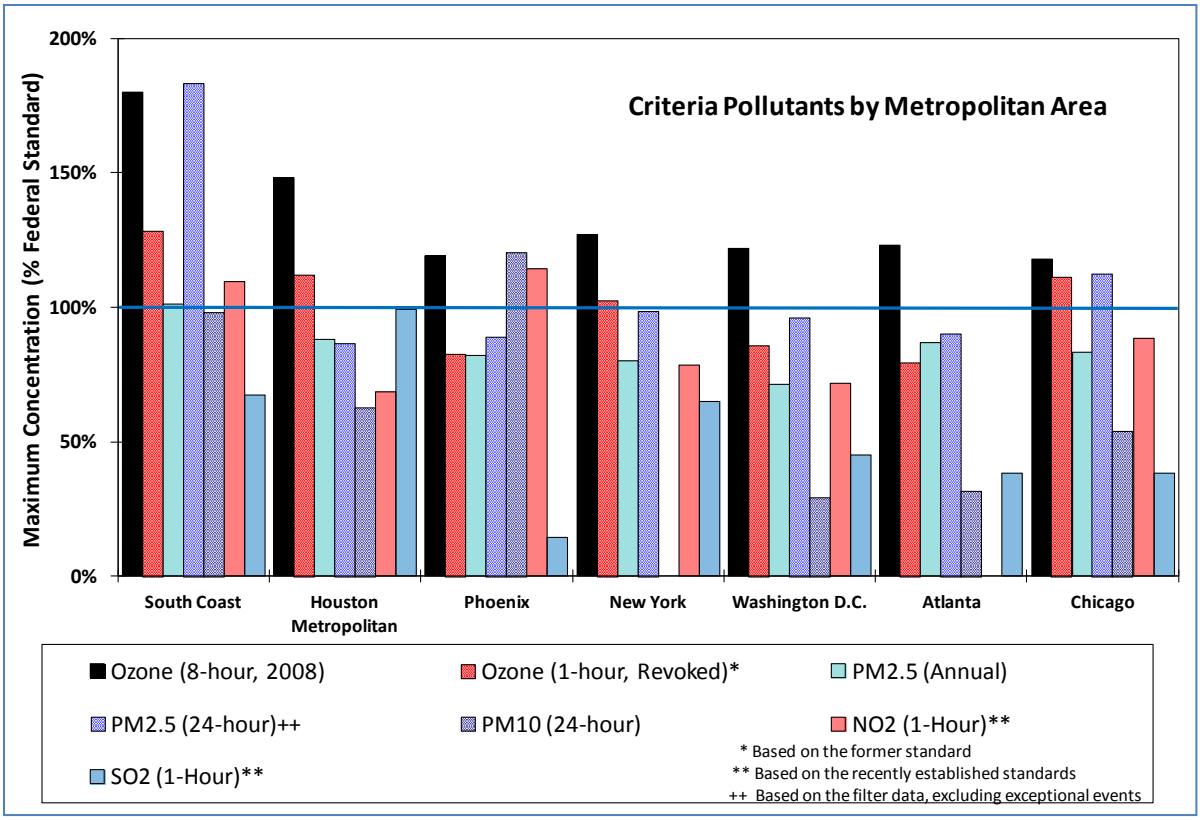

FIGURE 2-6

2011 South Coast Air Basin Air Quality Compared to Other U.S. Metropolitan Areas
(Maximum Pollutant Concentrations as Percentages of Corresponding Federal Standards)

In 2011, the Central San Bernardino Mountains area in the Basin recorded the highest maximum 1-hour and 8-hour average ozone concentrations in the nation (0.160 and 0.136 ppm, respectively). The highest 8-hour average concentration was more than one and a half times the federal standard level. In 2011, seven out of ten stations with the highest maximum 8-hour average ozone concentrations in the nation were located in the Basin[17]. The South Coast Air Basin also exceeded the 8-hour ozone standard on more days (106) than most other urban areas in the country in 2011, with only California's San Joaquin Valley exceeding on more days (109).

[17] The 10 highest measured ozone concentrations in 2011 included 7 Basin stations: Central San Bernardino Mountains (Crestline), East San Bernardino Valley (Redlands), Central San Bernardino Valley (Fontana and San Bernardino), Santa Clarita Valley (Santa Clarita), Northwest San Bernardino Valley (Upland), and Metropolitan Riverside (Rubidoux).

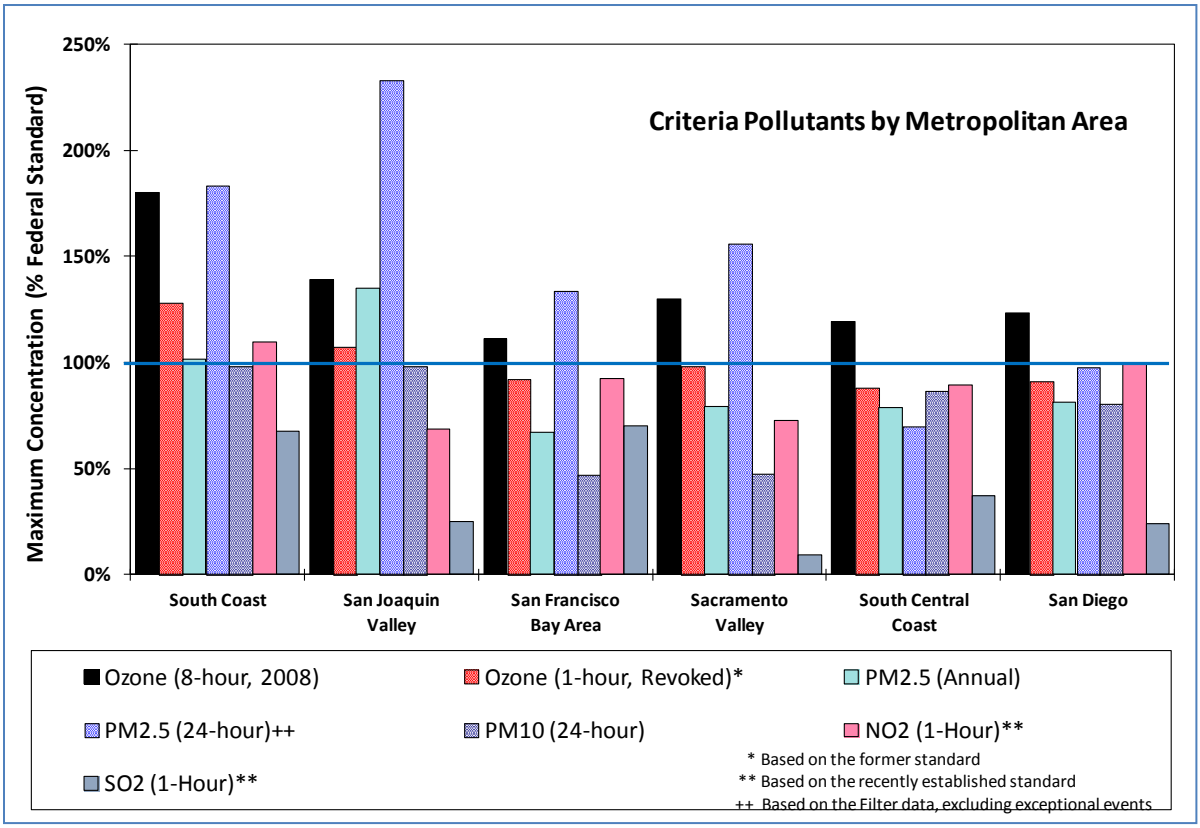

FIGURE 2-7

2011 South Coast Air Basin Air Quality Compared to Other California Air Basins
(Maximum Pollutant Concentrations as Percentages of Corresponding Federal Standards)

SUMMARY

In 2011, the Basin continued to exceed federal and state standards for ozone and PM2.5. The maximum measured concentrations for these pollutants were among the highest in the country, although significant improvement has been seen in recent years for both 24-hour and annual PM2.5 concentrations and only one location in the Basin is currently exceeding the 24-hour and annual design value form of the PM2.5 federal standards. The Basin's federal 3-year design values for ozone and PM2.5 have continued to exhibit downward trends through 2011.

The Coachella Valley area in the Riverside County portion of the Salton Sea Air Basin exceeded federal and state standards for ozone and PM10. However, the high PM10 concentrations exceeding the federal 24-hour PM10 standard occurred on days influenced by high-wind natural events, which the District has flagged in the U.S. EPA AQS database so that U.S. EPA will consider excluding such data when

determining the NAAQS attainment status in accordance with U.S. EPA's Exceptional Events Rule. For the stations in the Coachella Valley, the federal 3-year design values for 8-hour ozone have continued to exhibit downward trends through 2011.

The NO_2 concentrations in Los Angeles County exceeded the recently established short-term federal standard on one day at two locations, but did not exceed the standards anywhere on any other day in the Basin. The 98^{th} percentile form of the federal NO_2 standard was not exceeded and the Basin's attainment status remains intact. The Los Angeles County portion of the Basin also exceeded the 3-month rolling average Pb federal standard at one source-specific monitor adjacent to a Pb source. A separate SIP revision has been submitted to address Pb violations. Maximum concentrations for SO_2, CO, and sulfate (measured from PM10) continued to remain below the state and federal standards.