PRELIMINARY DRAFT

SOUTH COAST
AIR QUALITY
MANAGEMENT DISTRICT

April 2015

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
GOVERNING BOARD

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LIST OF ACRONYMS AND ABBREVIATIONS

AQMP	Air Quality Management Plan
Basin	South Coast Air Basin
BC	Black Carbon
CAA	Clean Air Act
CARB	California Air Resources Board
CMAQ	Community Multi-scale Air Quality model
DPM	Diesel Particulate Matter
EC	Elemental Carbon
GHG	Greenhouse Gas
MATES	Multiple Air Toxics Exposure Study
NAAQS	National Ambient Air Quality Standards
NH_3	Ammonia
NOx	Nitrogen Oxides
OC	Organic Carbon
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter with a dynamic diameter less than or equal to 2.5 microns
PM_{10}	Particulate Matter with a dynamic diameter less than or equal to 10 microns
ppm	Parts per million
RACM	Reasonably Available Control Measure
RACT	Reasonably Available Control Technology
RECLAIM	REgional CLean Air Incentives Market
SCAQMD	South Coast Air Quality Management District
SIP	Standard Implementation Plan
SOA	Secondary Organic Aerosol
SOx	Sulfur Oxides
SVOC	Semi-Volatile Organic Compound
U.S. EPA	United States Environmental Protection Agency
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound
$\mu g/m^3$	Micrograms per cubic meter
μm	Micrometers

Preface

The purpose of this 2016 Air Quality Management Plan (AQMP) White Paper on Particulate Matter (PM White Paper) is to provide background technical information and present the policy challenges associated with attaining the National Ambient Air Quality Standards (NAAQS) for fine particulate matter ($PM_{2.5}$), with a focus on the newly adopted federal annual $PM_{2.5}$ standard of 12 micrograms per cubic meter ($\mu g/m^3$). Annual $PM_{2.5}$ concentrations continue to decrease and the South Coast Air Basin (Basin) is projected to be near attainment of the new annual $PM_{2.5}$ standard once the ozone attainment strategy is fully implemented, but further actions may be needed to ensure attainment. Several scientific and policy issues will be described, including the roles of directly emitted $PM_{2.5}$ emissions and $PM_{2.5}$ precursor gases, and the $PM_{2.5}$ co-benefits from the ozone control program. Key to the policy discussion is the potential need for additional measures for $PM_{2.5}$ given that the attainment strategy cannot rely on the “black box” advanced technology emissions reductions that are used to demonstrate attainment of the ozone standard under federal Clean Air Act (CAA) Section 182(e)(5). Even though the NOx reductions for the ozone strategy will have significant $PM_{2.5}$ benefits, only specific measures adopted at the time of the 2016 AQMP submittal can be credited towards the $PM_{2.5}$ attainment demonstration. This PM White Paper will address these issues as well as the science behind $PM_{2.5}$ formation, followed by potential $PM_{2.5}$ control approaches including seasonal, episodic or geographically-focused controls.

1. Introduction

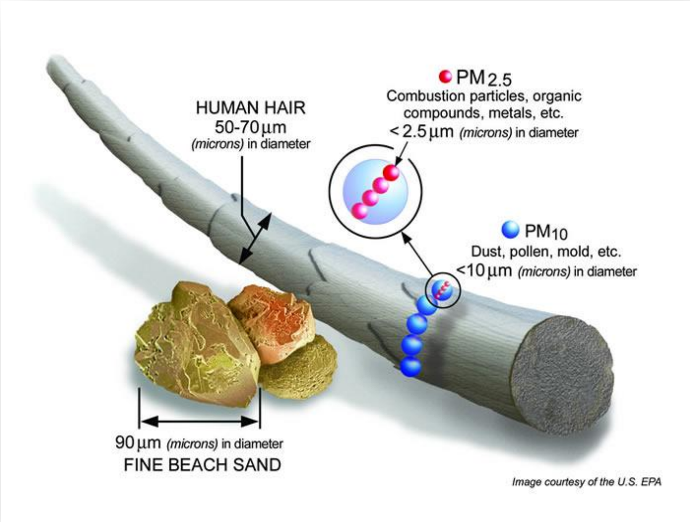
The Basin has experienced remarkable improvement in air quality since the 1970's as a direct result of a comprehensive, multi-year strategy of reducing air pollution from all sources. Yet the Basin is still not in attainment of current federal and state air quality standards and, in fact, is still the worst in the nation for ozone. Currently, the Basin is not attaining federal ozone standards or the federal annual and 24-hour fine particulate matter ($PM_{2.5}$) standards.

While the 2012 AQMP was designed to bring the Basin into attainment with the 24-hour $PM_{2.5}$ standard by 2015, with additional measures to address the 1997 8-hour ozone standard by 2023, the primary focus of the 2016 AQMP will be to demonstrate attainment of the 2008 ozone standard by 2032 and the annual $PM_{2.5}$ standard by the 2021-2025 timeframe. Attaining the federal ozone standard will have the added benefit of emission reductions that will further improve $PM_{2.5}$ levels.

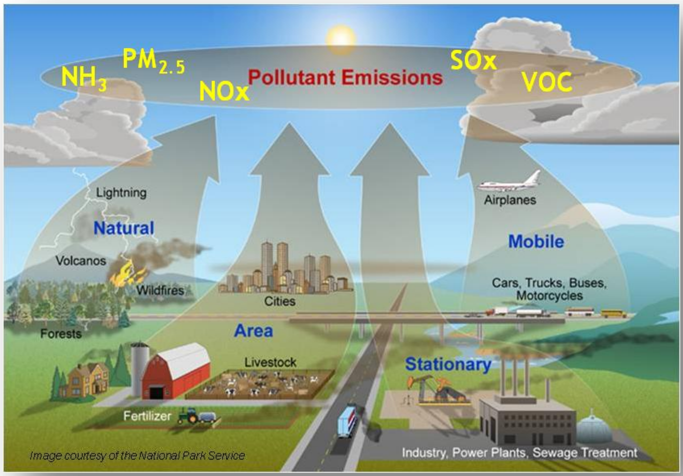
The purpose of this 2016 AQMP PM White Paper is to provide background technical information and present the policy challenges associated with attaining PM air quality standards. The focus will be primarily on the newly adopted federal annual $PM_{2.5}$ standard of 12 $\mu g/m^3$, but some emission control measures that can be implemented sooner will help to ensure attainment of the 24-hour $PM_{2.5}$ standard of 35 $\mu g/m^3$. This PM White Paper will describe the scientific basis of $PM_{2.5}$ formation including the major sources of direct $PM_{2.5}$ and $PM_{2.5}$ precursor gases. The PM reduction co-benefits from ozone control programs and climate change strategies will also be described. Finally, potential strategies for further $PM_{2.5}$ control will be considered.

2. Background

$PM_{2.5}$ and Precursors



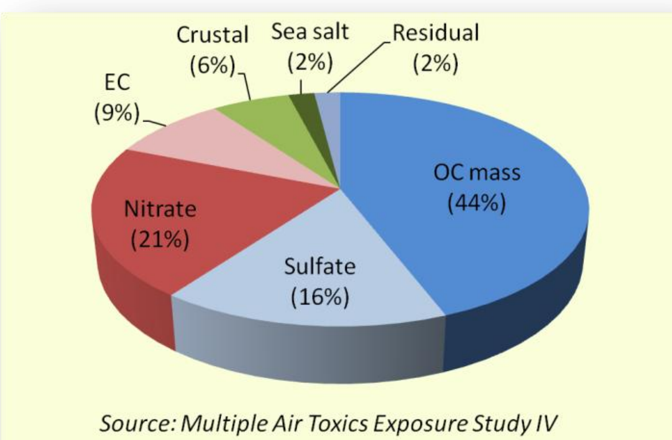
Particulate matter (PM), also known as particle pollution, is a complex mixture of microscopic solid and liquid particles suspended in air. Particles of concern are classified into two categories: Inhalable coarse particles ($PM_{10-2.5}$) and fine particles ($PM_{2.5}$). Inhalable coarse particles are generally created by mechanical or natural processes, such as grinding, sanding, sea spray, windblown dust, and soil. Coarse particles have sizes larger than 2.5 micrometers (µm) and smaller than 10 µm in diameter. Fine particles, such as those found in smoke and haze, are 2.5 µm in diameter or smaller, and are generally formed by combustion processes or by chemical reactions that occur in the atmosphere. $PM_{2.5}$ is of primary concern because it, once inhaled, can travel deeply into the respiratory tract, reaching the lungs. Scientific studies have linked increases in daily $PM_{2.5}$ exposure with increased respiratory and cardiovascular hospital admissions, emergency department visits, and even deaths. Studies also suggest that long-term exposure to $PM_{2.5}$ may be associated with increased rates of chronic bronchitis, reduced lung function and increased mortality from lung cancer and heart disease. People with breathing and heart problems, children, and the elderly may be particularly sensitive to $PM_{2.5}$. Recently, an additional particle category known as ultrafine particles (often defined as particles less than 0.1 µm) has been studied and found to have distinct chemical and toxicological properties. However, given that there are no ambient standards for ultrafine particles, and that the purpose of this white paper is to address fine particle standards, issues related to ultrafine and coarse particles are beyond the scope of this discussion.



PM in the atmosphere can be categorized as either primary or secondary particles. Primary particles are directly emitted PM from sources, such as construction sites, unpaved roads, sea salt, abrasion, fuel combustion, cooking, or fires. Secondary particles are formed in complex chemical reactions that occur in the atmosphere, often aided by sunlight (known as photochemical reactions). In these reactions, precursor gases, such as volatile organic compounds (VOCs), sulfur oxides (SOx), ammonia (NH_3), and nitrogen oxides (NOx), are transformed into solid or liquid products that contribute to ambient PM levels. NOx and SOx will combine with ammonia to form ammonium sulfate or ammonium nitrate salts, which are generally solids at ambient temperatures and can dissolve into water-containing particles. VOCs react with atmospheric oxidants, producing products with lower volatility that condense and form secondary organic aerosol (SOA), another component of PM. Many combustion processes emit both primary PM and precursor gases that ultimately form PM in the atmosphere. For example, in processes such as motor-vehicle gasoline combustion[1] and wood burning[2], SOA produced by oxidation of the emitted VOCs can exceed the amount of emitted primary organic $PM_{2.5}$.

"A large portion of $PM_{2.5}$ in the Basin is formed from precursor gases of anthropogenic origin."

Secondary particles make up the majority of ambient $PM_{2.5}$ in the Basin. Basin-wide average ambient $PM_{2.5}$ speciation profiles[3] measured during the recent Multiple Air Toxics Exposure Study (MATES) IV show that the Basin's $PM_{2.5}$ mass was comprised of four major chemical components: organic carbon (OC), ammonium nitrate, ammonium sulfates, and elemental carbon (EC) with smaller fractions of crustal particles, sea salt, and other trace elements. Elemental carbon (EC), which is similar to the short-lived climate forcing species

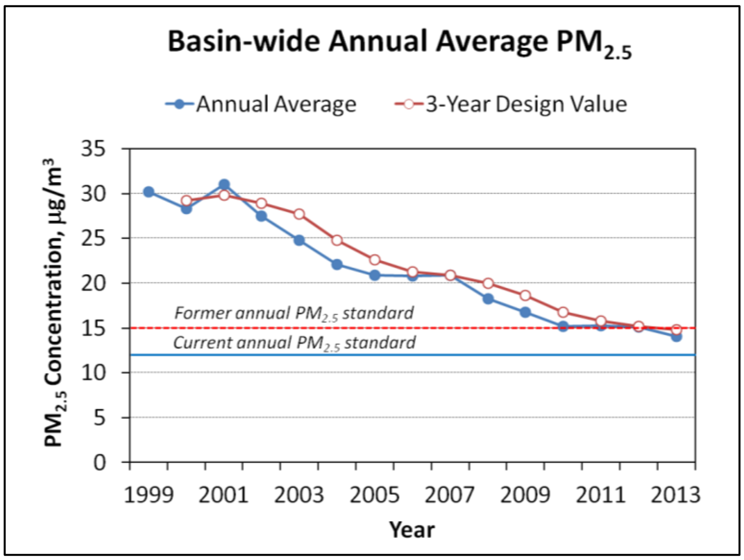


[1] Gordon, T.D., et al. Secondary Organic Aerosol Formation Exceeds Primary Particulate Matter Emissions for Light-Duty Gasoline Vehicles, *Atmos. Chem. Phys.* 2014, 14, 4661-4678.
[2] Hennigan, C.J., et al. Chemical and physical transformations of organic aerosol from the photo-oxidation of open biomass burning emissions in an environmental chamber, *Atmos. Chem. Phys.* 2011, 11, 7669-7686.
[3] SCAQMD, Draft Multiple Air Toxics Exposure Study IV, October 3, 2014.

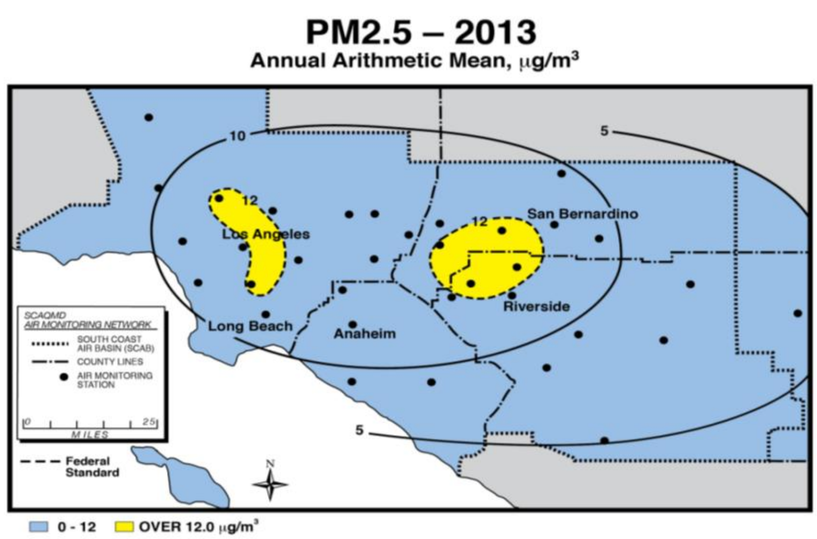
Black Carbon (BC), is an important component of directly emitted $PM_{2.5}$ from internal combustion engines, especially diesel engines. The OC mass portion includes both primary and secondary particle material.

Trends in $PM_{2.5}$ Levels

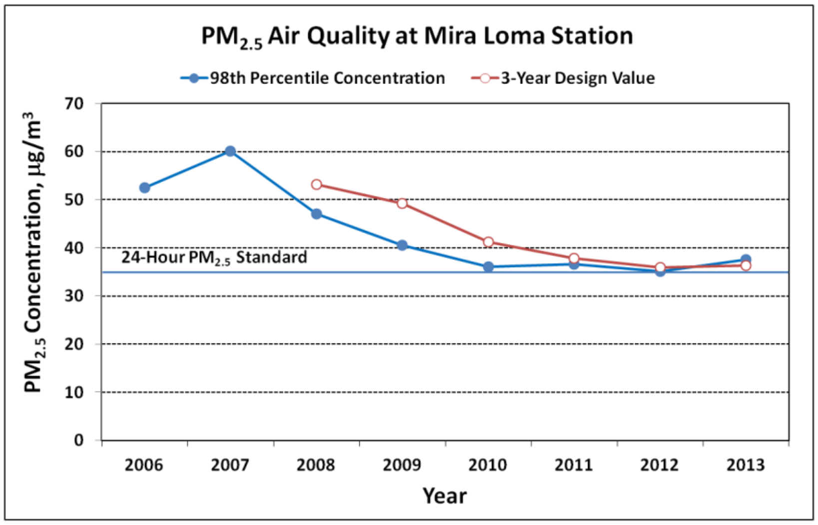
The levels of $PM_{2.5}$ in the Basin have been continually improving since measurements and standards were initiated in the late 1990s. These improvements occurred over a period of significant growth in the Basin's population, vehicle miles traveled (VMT) and economic activity, and are directly attributable to the region's air quality control program.



Based on measurement data through 2013, no air monitoring station in the Basin violated the previous 1997 federal annual $PM_{2.5}$ standard (15 $\mu g/m^3$ for three years), and in December of 2014, U.S. Environmental Protection Agency (U.S. EPA) proposed a clean data determination finding that the Basin has met the 1997 $PM_{2.5}$ standards. This is based on the form of the federal standard, known as the *design value*, which is the 3-year average of the annual $PM_{2.5}$ average, calculated by station.

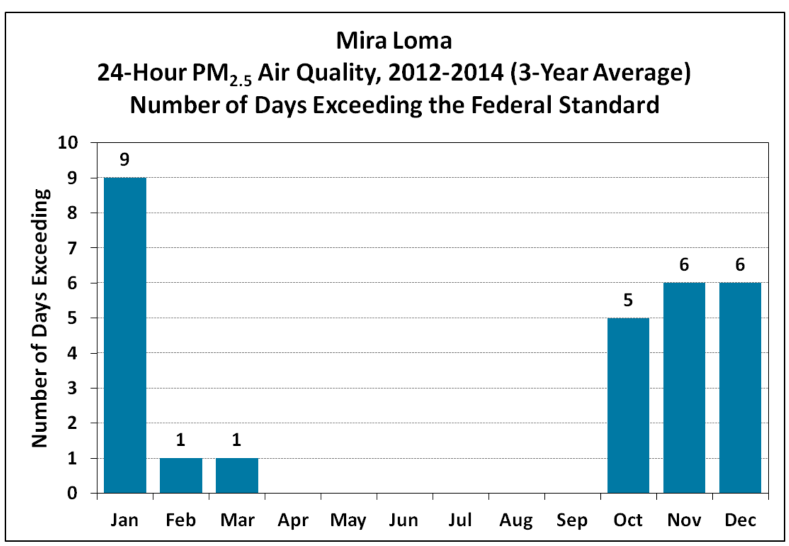


However, exceedances still occur above the new 2012 annual $PM_{2.5}$ standard of 12 $\mu g/m^3$ in the San Bernardino and Riverside County metropolitan areas, with the highest levels in Mira Loma. Los Angeles County also exceeded the new $PM_{2.5}$ standard in the Central Los Angeles and East San Fernando Valley areas in 2013. This new standard requires additional reductions of direct $PM_{2.5}$ and $PM_{2.5}$ precursor gases in order to meet the annual $PM_{2.5}$ standard by the 2021-2025 statutory timeframe.



Despite significant progress, the Basin remains in nonattainment for the current 24-hour $PM_{2.5}$ federal standard of 35 µg/m³. As of 2013, the 24-hour $PM_{2.5}$ *design value* (in this case, the 3-year average of annual 98th percentile of the monitored 24-hour concentrations by station), exceeds the federal 24-hour $PM_{2.5}$ standard at only one air monitoring station in Mira Loma in northwestern Riverside County. The 2012 AQMP projected attainment of the 24-hour $PM_{2.5}$ standard by the end of 2014. However, preliminary monitoring data through June of 2014 indicates that attainment of this standard is not likely to be achieved, largely because of the unanticipated air quality impacts of the severe drought conditions in California. The lack of winter storms and associated rainfall leads to dryer and thus more emissive ground surfaces as well as reduced cleansing and dilution of atmospheric particles. The drought has not only affected $PM_{2.5}$ levels in Southern California; many areas across the state have experienced this reversal in long-term downward trends of $PM_{2.5}$ levels.

In addition, a recent court decision has compelled U.S. EPA to implement $PM_{2.5}$ standards according to the federal CAA, Title 1, Part D, Subpart 4 (hereafter "Subpart 4") planning requirements specific to PM_{10}, rather than the general pollutant planning requirements (Subpart 1). Subpart 4 provides for attainment by 2015, with potential extensions. In February 2015, the South Coast Air Quality Management District (SCAQMD) Governing Board approved a Supplement to the 2012 AQMP 24-hour $PM_{2.5}$ SIP for the Basin to comply with Subpart 4 and target attainment in 2015. The Governing Board also directed SCAQMD staff to bring forward early action measures for $PM_{2.5}$ to ensure progress towards attainment under continuing drought conditions. The Supplement was subsequently approved by California Air Resources Board (CARB) and has been submitted to U.S. EPA for consideration.



While ozone concentrations peak in the summer months, PM levels can be high at anytime of the year, but are typically higher in winter months. These higher winter values are specifically influenced by wintertime temperature inversions and stagnant conditions that reduce atmospheric dilution and trap emissions near ground level.

Furthermore, sources such as wood burning have increased emissions during colder weather. Consistent with U.S. EPA guidance, seasonal, episodic, or geographical controls that focus on bringing the Mira Loma station into compliance can continue to be considered as a method to bring the Basin into attainment.

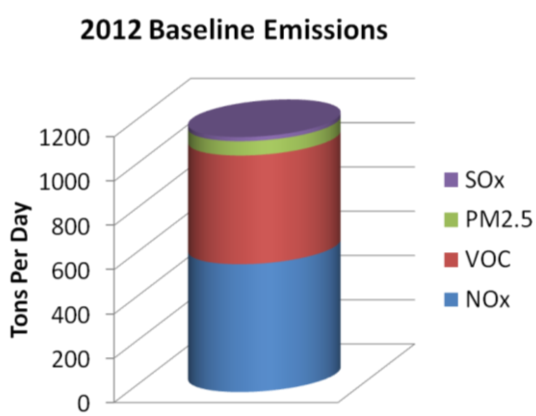
3. Assessing Future Control Strategies

Emission Sources of $PM_{2.5}$

As mentioned above, most $PM_{2.5}$ in the Basin is formed in the atmosphere, and thus a full picture of the sources of $PM_{2.5}$ must also consider precursor gases. Based on the emissions inventory for 2012, there were 578 tons of NOx emissions per day, 491 tons of VOC emissions, 65 tons of directly emitted $PM_{2.5}$ emissions, and 19 tons of SOx emissions. The Top 10 emission sources of direct $PM_{2.5}$ and its precursor gases are contained in Appendix A.

"Trucks are the No. 1 source of NOx emissions that form both ground-level ozone and $PM_{2.5}$ in the atmosphere."

On-road and off-road vehicles emit more than 80% of the total NOx emissions combined. Consumer products solvent evaporation was the single largest contributor to VOC emissions. Mobile (on- and off-road) sources collectively emit more than half of the total VOC emissions. Transportation sources, such as ships, commercial boats, and aircraft, account for more than one-third of the total SOx emissions. RECLAIM SOx sources emit another one-third of the SOx emissions, and service and commercial processes and passenger cars are next largest contributing source categories.



Commercial cooking is the largest emission source of directly emitted $PM_{2.5}$, followed by residential fuel combustion and paved road dust. These top sources are largely uncontrolled sources of directly emitted $PM_{2.5}$. The content of particles emitted from commercial cooking, the majority of which comes from under-fired charbroiling of meat, are almost all organic carbon[4], and studies have shown that commercial meat-cooking contributes more than 20% of the $PM_{2.5}$ organic carbon fraction in Los Angeles air.[5] Residential fuel combustion is the second largest emission source of directly emitted $PM_{2.5}$, mostly in the form of wood stove and fireplace wood burning.

[4] McDonald, J.D. et al. Emissions from charbroiling and grilling of chicken and beef. JAWMA, 2003, 53, 185-194.
[5] Norbeck, J. *Standardized Test Kitchen and Screening Tools Evaluation for South Coast Air Quality Management District Proposed Rule 1138;* Prepared under Contract No. S-C95073 for the South Coast Air Quality Management District, El Monte, CA, by CE-CERT: University of California, Riverside, CA, 1997.

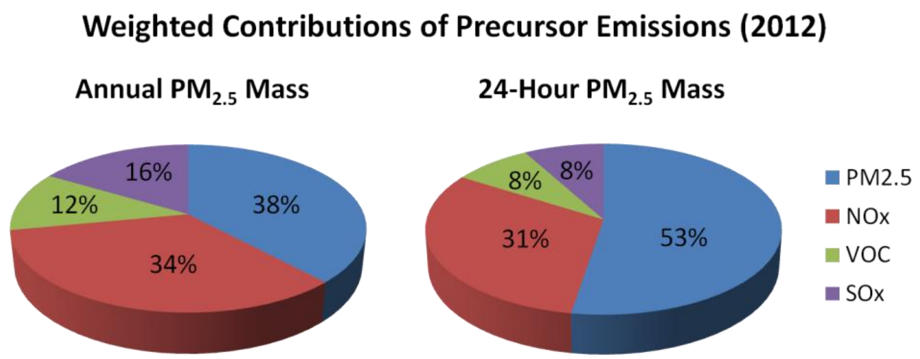
Control Effectiveness

In the SCAQMD's 2012 AQMP, a detailed computer air quality model (CMAQ v4.7.1) was used to estimate the regional reductions of ambient $PM_{2.5}$ concentrations that result from reductions in PM precursor emissions. On a ton-per-ton basis, primary $PM_{2.5}$ and SOx emissions controls were found to be the most effective in reducing $PM_{2.5}$ mass concentrations, compared to NOx emissions controls. VOC emissions reductions had the lowest effect on reducing annual $PM_{2.5}$ mass concentration. As shown, this comparative effectiveness of emissions reductions is different for the 24-hour $PM_{2.5}$ standard, and may also change with season and location in the Basin.

Comparative Effectiveness of Reductions To Achieve Federal $PM_{2.5}$ Air Quality Standards				
	NOx	**SOx**	**VOCs**	**$PM_{2.5}$**
Annual $PM_{2.5}$ Standard	1	15	0.4	10
24-hour $PM_{2.5}$ Standard	1	8	0.3	15

However, the CMAQ model, while state-of-the-art, has been shown to significantly underestimate SOA formation from VOCs[6]. Future versions of CMAQ will strive to eliminate this under prediction as additional SOA formation processes are better understood and incorporated in the model.

Using 2012 emissions inventories weighted by the relative effectiveness factors, contributions of precursor emissions to achieving both annual and 24-hour $PM_{2.5}$ standards were estimated. For example, while SOx has a higher relative effectiveness factor than NOx, total emissions of NOx are much greater than those of SOx. Therefore, as shown in the charts below, NOx and $PM_{2.5}$ contribute more to $PM_{2.5}$ levels than SOx or VOC. As shown, controls of NOx emissions will make a significant contribution to reducing annual $PM_{2.5}$ mass concentrations, and thus meeting the federal annual $PM_{2.5}$ standard.

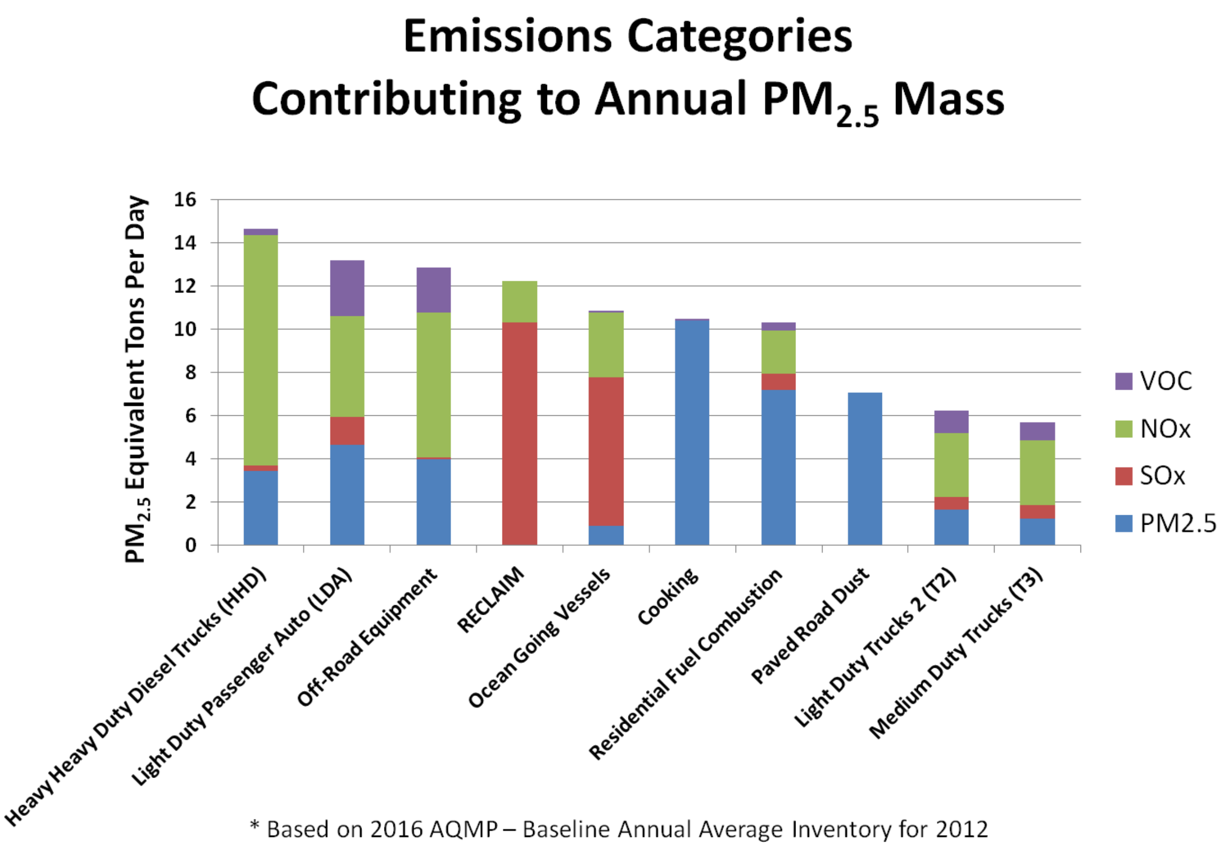


Attaining the ozone standards requires significant reductions in emissions of NOx well above and beyond those resulting from current rules, programs, and commercially available

[6] Carlton, A.G., et al. Model Representation of Secondary Organic Aerosol in CMAQ v4.7, *Environ. Sci. Technol.* 2010, 44, 8553-8560

technologies. Most of these additional reductions now rely on the development of new control techniques or improvement of existing control technologies, also known as "black box" measures, as authorized under Section 182(e)(5) of the federal CAA. These "black box" measures, if implemented successfully, will not only allow attainment of the ozone standards, but will also provide significant help in reaching $PM_{2.5}$ standards. In fact, if NOx emissions reductions designed to meet the former ozone standard in 2023 are achieved, $PM_{2.5}$ levels in the Basin are projected to be very near, if not meeting, the current 2012 federal annual $PM_{2.5}$ standard of 12 $\mu g/m^3$ by that time. However, attainment of the PM2.5 standard may not rely on Section 182(e)(5) measures.

More detailed analysis of the emissions categories contributing to ambient $PM_{2.5}$ mass, using the weighting factors for precursors described above, shows what emission sources could be prioritized for a focused and cost-effective PM control program. Area sources, such as commercial cooking, residential fuel combustion, and paved road dust are major contributors to ambient $PM_{2.5}$, primarily through direct $PM_{2.5}$ emissions. Mobile sources, both on-road and off-road, are also significant sources of $PM_{2.5}$, both through direct $PM_{2.5}$ emissions but also precursors such as NOx.



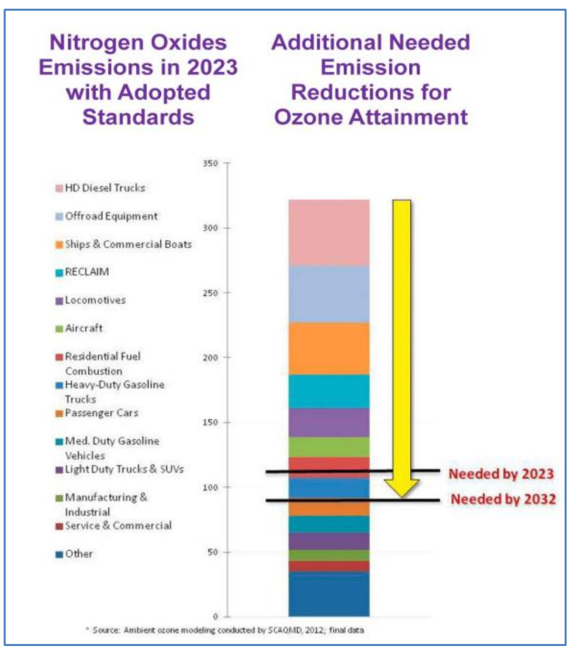
4. Recommendations - Path to $PM_{2.5}$ Attainment in the 2016 AQMP

Control Strategy

Through the 2007 and 2012 AQMPs, it was demonstrated that the previous control strategies employed for the PM_{10} and 1-hour ozone SIPs also benefited $PM_{2.5}$ and 8-hour ozone reductions. Taking the same multi-pollutant approach to assess strategies for the 2016 AQMP suggests that a heavy NOx strategy is the most efficient approach for the reduction of fine particulate matter because NOx reductions are needed anyway for the 1-hour and 1997 8-hour ozone standards with approximately the same timeframe for the federal annual $PM_{2.5}$ attainment demonstration. The $PM_{2.5}$ strategy can be further augmented with targeted and cost-effective directly emitted $PM_{2.5}$ and SOx controls when needed if NOx controls from other control programs are insufficient, not timely, or do not materialize.

Based on the above discussion, several attainment paths can be developed with varying degree of controls among directly emitted $PM_{2.5}$ and PM precursors. Selecting the most efficient path for $PM_{2.5}$ attainment takes into consideration many factors, such as the amount of total reductions needed, technology readiness, attainment deadlines, and the inter-relationship with other NAAQS pollutants such that the control strategy does not need to make drastic mid-term adjustments, thus minimizing potential control costs. The following sections describe the staff recommendations for a prioritized approach in the development of a $PM_{2.5}$ attainment strategy.

1) Co-Benefits from the Ozone NOx Strategy



Many of the most significant direct $PM_{2.5}$ and $PM_{2.5}$ precursor emission sources are already well controlled, but additional reductions from implementation of adopted control measures from the 2007 and 2012 AQMPs may still not be adequate for attainment of the new federal annual $PM_{2.5}$ standard. $PM_{2.5}$ levels will be further reduced from the additional NOx emissions reductions needed for the ozone control strategy. The 2012 AQMP specifies approximately another 200 tons per day of NOx reductions needed to meet the 1-hour and 1997 8-hour ozone standards by 2023 and 2024, respectively. This is within the timeframe of 2012 annual $PM_{2.5}$ standard attainment deadline of 2021-2025. Preliminary projections suggest that without any additional PM controls, but with the ozone NOx strategy alone, the Basin's annual $PM_{2.5}$ design value would be the very near the standard of 12 $\mu g/m^3$ in 2023.

Given the goal of developing the most efficient and cost-effective path to meeting all clean air standards, and given that these NOx reductions are needed for ozone attainment anyway, the most desirable path is to control NOx emissions, not only from stationary and area sources, but more so from mobile sources that fall under state and federal jurisdiction. Significant reductions are needed from on-road vehicles, off-road engines, ships, and locomotives to achieve the necessary NOx reductions to meet the federal ozone standards. The 2016 AQMP will capture the anticipated NOx reductions from the ozone plan, as well as anticipated concurrent reductions of VOCs, SOx, and directly emitted $PM_{2.5}$ from zero tailpipe emission technologies or efficiency measures that reduce vehicle trips/vehicle miles traveled.

2) Co-Benefits from Climate Change or Air Toxic Control Programs

SCAQMD staff recognizes, to the extent available under the U.S. EPA's $PM_{2.5}$ implementation rule, that there are several near-term measures that are being pursued by CARB under the AB 32 Scoping Plan, such as reductions in short-lived climate forcers such as BC. Comprised of microscopic particles emitted from incomplete combustion of biomass, wood, and fossil fuels, BC is a major contributor to global climate change and also a primary component of diesel particulate matter (DPM). Cutting BC emissions would immediately result in reduction of the rate of warming, as well as $PM_{2.5}$ benefits. Identifying the most promising control measures or mitigation options to address BC emissions reductions in the areas of stationary and mobile sources, residential wood combustion, and open biomass burning will provide climate change as well as $PM_{2.5}$ benefits in the near term.

Air toxic control programs reducing DPM or toxic metals would also contribute to $PM_{2.5}$ reductions. Despite significant decreases in air toxics exposure over the past couple of decades, the recent SCAQMD MATES IV results continue to show unacceptably high risk of exposure to DPM, representing two-thirds of the overall air toxic cancer risk. This result emphasizes that continuous efforts towards reducing DPM emissions are needed at local, state, and federal levels and via cooperation with the ports, airports, and other stakeholders. Alternative fueled vehicles with significant zero emission miles traveled, along with coordinated land use and transportation planning with the goal of reducing VMT, will contribute to reduction of DPM, GHG, as well as NOx emissions. Toxic metals emitted from industrial processes can cause risks to public health and the environment. SCAQMD will continue to develop new rules or amend existing rules by strengthening requirements to reduce toxic metal emissions and exposure from various metal industry sources. These measures, although not developed for SIP purposes, will achieve concurrent reductions in directly emitted $PM_{2.5}$ and should be quantified and credited toward needed SIP reductions.

3) Outreach and Incentive Programs

Other programs supporting PM control measure implementation are also important to ensure expected emission reductions are being realized. These programs include outreach and incentive programs. SCAQMD staff utilizes a variety of tools to raise public awareness and understanding of the significance and health effects of particle pollution and thus, the importance of PM controls to protect public health. Enhanced public outreach should continue to be pursued by various means, including targeted and focused communications campaigns, community workshops, educational brochures and videos, and other digital media formats.

Incentive funding for stationary sources can be pursued and best applied where controls are cost-effective, but not necessarily affordable by the affected sources, especially when controls are considered for smaller businesses. Such incentive funds can be used to subsidize low-emitting equipment purchases either by businesses or the public. Funding for such incentive programs can originate from state and federal grants, penalties collected from industry, and other sources.

4) Additional Measures for $PM_{2.5}$ Attainment

Since the federal CAA does not allow for reliance on future technologies (i.e., "black box," Section 182(e)(5) measures) in the $PM_{2.5}$ attainment plan, portions of NOx controls that are part of the ozone attainment strategy may be not eligible for inclusion as SIP measures for $PM_{2.5}$ purposes. For this reason, additional measures to ensure attainment will need to be evaluated and implemented where needed. Suggested control concepts based on the Reasonably Available Control Technology (RACT) or Reasonably Available Control Measure (RACM) analysis for $PM_{2.5}$ and its precursors as part of the 2016 AQMP will be evaluated for their feasibility and applicability for this air basin. Any additional measures needed to meet the RACT/RACM requirements will be further developed for inclusion in the 2016 AQMP.

Based on the $PM_{2.5}$ formation potentials described above, if additional reductions are still needed for timely $PM_{2.5}$ attainment demonstration, additional SOx and/or direct $PM_{2.5}$ measures should be first priority. Examples of such measures can be found in Appendix B.

In developing the $PM_{2.5}$ strategy, geographic, seasonal, and episodic controls should also be considered as they minimize compliance costs while targeting emissions reductions when and where they are needed. Examples of these measures are contained in Appendix C. Such targeted measures will have even greater benefits for avoiding exceedances of the 24-hour $PM_{2.5}$ standard given that the exceedances are episodic and occur almost exclusively in the colder months. As attainment deadlines for the 24-hour standard are imminent, $PM_{2.5}$ measures arising from the 2016 AQMP development process that can help to ensure timely attainment of the 24-hour $PM_{2.5}$ standard should be developed and adopted as early action measures, parallel to the 2016 AQMP development.

Continuing Research and Scientific Studies

Continuing research and scientific studies are needed to better quantify organic compounds and their contribution to $PM_{2.5}$ formation. In the Basin, approximately 30-50% of the $PM_{2.5}$ mass is composed of organic compounds. However, the organic component of $PM_{2.5}$ in the Basin needs further study as certain semi-volatile organic compounds (SVOC) have not been historically inventoried, controlled or incorporated in regional air quality modeling. Continuing research and scientific studies are required to better quantify SVOC emissions and their contribution to $PM_{2.5}$ formation.

The role of ammonia emissions will also be examined further in the 2016 AQMP modeling analysis. Some areas within the Basin may be saturated with ammonia now or in the future relative to SOx and NOx, and thus modest ammonia controls may have little effect. Other areas may show that ammonia controls are effective in reducing ambient $PM_{2.5}$. Even if large ammonia reductions may have benefits, it may not be feasible given the nature of the sources.

Summary

The 2016 AQMP modeling analysis and attainment demonstration analysis will provide refinement to the analysis described above, but it is clear that an integrated approach to multiple air quality challenges will minimize control costs while achieving multiple goals. It is clear that a NOx-heavy control strategy will not only provide for attainment of the ozone standards, but also provide significant co-benefits for the reduction of fine particulate matter. Concurrent targeted, strategic, and timely reductions in directly emitted $PM_{2.5}$ and precursors can ensure meeting the federal annual and 24-hour $PM_{2.5}$ standards by the attainment deadlines.