

## AIR POLLUTION CONTROL DISTRICT SAN LUIS OBISPO COUNTY

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## **Executive Summary**

While the majority of San Luis Obispo County experienced low levels of ozone pollution in 2015, ozone levels exceeding both state and federal standards were measured on a few days in the rural eastern portion of the county. This area (Figure 1) was designated as a nonattainment zone for the federal ozone standard in May 2012, but air quality there continues to improve, with 2015 recording the fewest number of standard exceedences since monitoring began there (Figures 8 & 10). In October 2015, the federal 8-hour ozone standard was lowered from 75 to 70 parts per billion (ppb); only one day in 2015 exceeded the old standard, while 4 days exceeded the new standard. By comparison, in 2014 there were 3 days which exceeded the old standard and 10 which would have exceeded the new standard.

Smoke from wildfires can often adversely affect air quality. The Cuesta Fire began on August 16<sup>th</sup> and eventually burned almost 2,500 acres in the area east of the Cuesta Grade on U.S. 101 and south of Santa Margarita. The year's highest 1-hour ozone concentrations at Red Hills and Carrizo Plain occurred on August 18<sup>th</sup> and are directly attributable to this fire. Elevated PM<sub>10</sub> and PM<sub>2.5</sub> concentrations were observed in San Luis Obispo, Atascadero, and Paso Robles during this fire.

South County air quality continues to be impacted by dust blown from the Oceano Dunes State Vehicular Recreation Area (ODSVRA) along the coast. While the federal PM<sub>10</sub> standard was not exceeded at any site in 2015, numerous exceedences of the more stringent state PM<sub>10</sub> standard were recorded at all 3 monitoring sites located on the Nipomo Mesa (Mesa2, CDF, and Nipomo Regional Park). In addition, the federal 24-hour PM<sub>2.5</sub> standard was exceeded once at CDF. Generally, there were fewer exceedences of the particulate matter standards at these sites in 2015 compared with 2013 and 2014; as discussed in the Appendix, this is likely due to 2015 being less windy than previous years rather than mitigations that were in place on the ODSRVA this year.

One day exceeded the state 24-hour  $PM_{10}$  standard at Atascadero this year. This was caused by construction and debris removal in the immediate vicinity of the station and is not representative of ambient air conditions in the area that day. There were no exceedences of the standards for nitrogen dioxide or sulfur dioxide at any stations this year.

Finally, there were a few notable network changes in 2015:

- In February, the Atascadero station was relocated from 6005 Lewis Avenue to behind the Colony Park Community Center at 5599 Traffic Way.
- In July, a new PM<sub>10</sub> monitor was established within the Oso Flaco area of the ODSVRA. This monitor fulfills the "Control Site Monitor" requirement of District Rule 1001. While owned by the California Department of Parks of Recreation, the monitor is operated by the District.
- Due to a safety issue, the PM<sub>10</sub> and PM<sub>2.5</sub> monitors at the San Luis Obispo station were temporarily shut down from September 2015 through mid-June 2016; this site is run by the California Air Resources Board.

The air quality database for San Luis Obispo County is a public record and is available from the San Luis **Obispo County Air Pollution** Control District office in various forms, including comprehensive records of all hourly or other sample values acquired anywhere in the County. Data summaries are published in Annual Air Quality Reports, like this one. Summary data appear weekly in the Saturday edition of <u>The Tribune</u>, a local newspaper. All ambient monitoring data is added to separate archives maintained by the federal **Environmental Protection** Agency (EPA) and by the Air Resources Board (ARB). Summary data from San Luis Obispo County can be found in EPA and ARB publications and on the world wide web at the following websites:

www.slocleanair.org APCD website www.arb.ca.gov ARB website www.epa.gov US EPA website www.airnow.gov Air Quality Index site

## Air Quality Monitoring and Data

San Luis Obispo County air quality was measured by a network of eleven ambient air monitoring stations in 2015; their locations are depicted in Figure 1. The San Luis Obispo County Air Pollution Control District (District or APCD) owns and operates seven permanent stations which are named for their locations: Nipomo Regional Park (NRP), Grover Beach, Morro Bay, Atascadero, Red Hills, Carrizo Plain, and the CDF fire station on the Nipomo Mesa. The California Air Resources Board (ARB) owns and operates stations in San Luis Obispo and Paso Robles. Two stations are owned by third parties but operated by the APCD: Mesa2, located on the Nipomo Mesa and owned by the Phillips 66 refinery, and Oso Flaco, located within the ODSVRA and owned by the California Department of Parks and Recreation. See Table 2 for a summary of the pollutants monitored at each station.

Air quality monitoring is subject to rigorous federal and state quality assurance and quality control requirements and subject to periodic equipment and data audits to ensure data validity. Gaseous pollutant levels are measured every few seconds and averaged to yield hourly values. Particulate matter (PM<sub>2.5</sub> and PM<sub>10</sub>) is sampled hourly using Beta Attenuation Monitors (BAMs). All monitoring instruments are Environmental Protection Agency (EPA)-approved Federal Equivalent Methods (FEMs) or Federal Reference Methods (FRMs).

The dataset for 2015 reviewed in this report was downloaded from the EPA's Air Quality System (AQS) database in June 2016. Prior to being uploaded to AQS, all data were thoroughly reviewed and validated by the collecting agency (i.e., ARB for data from Paso Robles and San Luis Obispo and the District for all other sites). The raw data and the R-code used to compile the statistics and generate the graphs in this report are available online at https://github.com/sloapcdkt/2015aqrptR.



#### Figure 1: Map of Monitoring Stations in San Luis Obispo County

#### Table 1: Ambient Air Quality Parameters Monitored in San Luis Obispo County in 2015

-											
	O <sub>3</sub>	NO	NO <sub>2</sub>	NOx	SO <sub>2</sub>	CO	PM <sub>10</sub>	PM <sub>2.5</sub>	WS	WD	ATM
APCD Permanent Stations											
Atascadero	Х	Х	Х	Х			Х	Х	Х	Х	X
Morro Bay	Х	Х	Х	Х					Х	Х	
Nipomo Regional Park	Х	Х	Х	Х			Х		Х	Х	X
Red Hills	Х								Х	Х	Х
Carrizo Plain	Х								Х	Х	Х
CDF							Х	Х	Х	Х	
Grover Beach									Х	Х	
ARB Stations											
San Luis Obispo	Х						Х	Х	Х	Х	Х
Paso Robles	Х						Х		Х	Х	Х
Operated by APCD											
Mesa2					Х		Х	Х	Х	Х	Х
Oso Flaco							Х		Х	Х	X
Acronyms: O <sub>3</sub> Ozone NO Nitric Oxide NO <sub>2</sub> Nitrogen Dioxide	SO <sub>2</sub> CO	Sulfur l Carbor	Dioxide 1 Monoxide	PI PI	M <sub>10</sub> Pari M <sub>2.5</sub> Pari	ticulates < 1 ticulates < 2	10 microns 2.5 microns	WS WD ATM	Wind Sp Wind Di Ambien	beed irection t Temp	
Grover Beach  ARB Stations  San Luis Obispo Paso Robles  Operated by APCD  Mesa2 Oso Flaco  Acronyms: O3 Ozone NO Nitric Oxide NO2 Nitrogen Dioxide NOx Oxides of Nitrogen	X X X SO <sub>2</sub> CO	Sulfur I Carbor	Dioxide	PI	<b>X</b> M <sub>10</sub> Pari M <sub>2.5</sub> Pari	ticulates < 1 ciculates < 2	X X X 10 microns 2.5 microns	X X WS WD ATM	W W Ar	X X X X ind Sp ind Di mbien	X     X       X     X       X     X       X     X       X     X       ind Speed       ind Direction       mbient Temp

## **Ambient Air Pollutants Of Local Concern**

#### Ozone

Ozone (O<sub>3</sub>) is a gas that is naturally found near the earth's surface at low concentrations, typically 10 to 40 parts per billion (ppb). It is also a principle component of photochemical smog, produced when precursor pollutants such as volatile organic compounds and nitrogen oxides react under the influence of sunlight. Ozone precursors are emitted by many human activities, but industrial processes and the wide use of motor vehicles are primary sources. The chemistry of atmospheric ozone is complex, and in the absence of sunlight ozone is destroyed by reaction with the same precursor molecules that fuel its formation during the day. As a result, ozone concentrations typically increase as sunlight intensity increases, peaking midday or in the afternoon and gradually declining from there, typically reaching their lowest levels in the early morning hours and just before sunrise, as shown in Figure 2, below.



Figure 2: Example of Diurnal Ozone Pattern from Carrizo Plain, June 7, 2013

As a pollutant, ozone is a strong oxidant gas that attacks plant and animal tissues. It can cause impaired breathing and reduced lung capacity, especially among children, athletes and persons with compromised respiratory systems; it can also cause significant crop and forest damage. Ozone is a pollutant of particular concern in California where geography, climate and emissions from industrial and commercial sources and millions of vehicles contribute to frequent violations of health-based air quality standards.

While ground level ozone is harmful to plants and animals and is considered a pollutant, upper level (stratospheric) ozone occurs naturally and protects the earth from harmful ultra-violet energy from the sun.

#### **Particulate Matter**

Ambient air quality standards have been established for two classes of particulate matter: PM<sub>10</sub> (respirable particulate matter less than 10 microns in aerodynamic diameter), and PM<sub>2.5</sub> (fine particulate matter 2.5 microns or less in aerodynamic diameter). Both consist of many different types of particles that vary in their chemical activity and toxicity. PM<sub>2.5</sub> tends to be a greater health risk since these particles can get lodged deep in the lungs or enter the blood stream, causing both short and long-term damage. Sources of

particulate pollution include diesel exhaust; mineral extraction and production; combustion products from industry and motor vehicles; smoke from open burning; paved and unpaved roads; condensation of gaseous pollutants into liquid or solid particles; and wind-blown dust from soils disturbed by demolition and construction, agricultural operations, off-road vehicle recreation, and other activities.

In addition to its harmful health effects, particulate matter can also greatly reduce visibility.

#### Nitrogen Dioxide, Sulfur Dioxide, and Carbon Monoxide

Nitrogen dioxide (NO<sub>2</sub>) is the brownish-colored component of smog. NO<sub>2</sub> irritates the eyes, nose and throat and can damage lung tissues. Sulfur dioxide (SO<sub>2</sub>) is a colorless gas with health effects similar to NO<sub>2</sub>. Both pollutants are generated by fossil fuel combustion from mobile sources such as vehicles, ships, and aircraft and at stationary sources such as industry, homes and businesses. SO<sub>2</sub> is also emitted by petroleum production and refining operations. These pollutants can create aerosols, which may fall as acid rain causing damage to crops, forests, and lakes. They can also exacerbate asthma and harm the human respiratory system.

Carbon monoxide (CO) is a colorless and odorless gas that can interfere with the ability of red blood cells to transport oxygen. Exposure to CO can cause headaches, fatigue, and even death. CO results from fuel combustion of all types, but motor vehicles are by far the chief contributor of CO in outdoor air.

## State and National Ambient Air Quality Standards

California ARB and the federal EPA have adopted ambient air quality standards for six common air pollutants of primary public health concern: ozone, particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>), nitrogen dioxide, sulfur dioxide, carbon monoxide, and lead. These are called "criteria pollutants" because the standards establish permissible airborne pollutant levels based on criteria developed after careful review of all medical and scientific studies of the effects of each pollutant on public health and welfare.

The National Ambient Air Quality Standards (NAAQS; see Table 2) are used by EPA to designate a region as either "attainment" or "nonattainment" for each criteria pollutant. A nonattainment designation can trigger additional regulations for that region aimed at reducing pollution levels and bringing the region into attainment. For most pollutants, the NAAQS allow a standard to be exceeded a certain number of times each calendar year without resulting in a nonattainment designation. Additionally, exceedences caused by exceptional events (see below) may be excluded from attainment/nonattainment determinations at the discretion of the EPA.

In May 2012, the EPA designated the eastern portion of San Luis Obispo County as marginally nonattainment for the 8-hour ozone standard. This was based on data from enhanced monitoring over the previous decade that revealed previously unrecognized elevated ozone levels in that region; the western portion of the county retained its federal ozone attainment status. (See Figure 1 for a map showing the boundary between the attainment and nonattainment areas.) In October 2015, the standard was lowered from 75 to 70 ppb; the EPA has yet to designate the County with regard to the new standard. The county is currently designated as attainment for all of the other NAAQS; the Nipomo Mesa does, however, exceed federal standards for 24-hour PM<sub>10</sub> and annual average PM<sub>2.5</sub>, and risks being designated as nonattainment for these pollutants if exceedences continue.

The California Ambient Air Quality Standards are generally more restrictive (i.e. lower) than the NAAQS, and typically are specified as not to be exceeded. Thus, a single exceedence is a violation of the applicable standard and triggers a nonattainment designation. As a result, San Luis Obispo County is designated as a nonattainment area for the state one-hour and 8-hour ozone standards, as well as the state 24-hour and annual PM<sub>10</sub> standards. The county is currently designated as attaining the state annual PM<sub>2.5</sub> standard, but is expected to be designated as nonattainment the next time that ARB finalizes area designations.

The state and national standards for NO<sub>2</sub> have never been exceeded in this county. The state standard for SO<sub>2</sub> was exceeded periodically on the Nipomo Mesa until 1993. Equipment and processes at the facilities responsible for the emissions were upgraded as a result, and the state SO<sub>2</sub> standard has not been exceeded since that time. Exceedences of the federal SO<sub>2</sub> standard had never been recorded here until 2014, when maintenance activities at these facilities resulted in emissions exceeding the 1-hour standard of 75 ppb that was established in 2011. State CO standards have not been exceeded in San Luis Obispo County since 1975.

#### **Exceptional Events**

Exceptional Events are unusual or naturally occurring events that can affect air quality but are not reasonably controllable or preventable and are unlikely to reoccur at a particular location. Thus, air quality monitoring data influenced by exceptional events can sometimes be excluded from regulatory determinations related to violations of the NAAQS, if recommended by the APCD and approved by the EPA. The APCD has not submitted any exceptional event documentation for 2015 and does not expect any data compiled in this report to be excluded from future attainment determinations.

#### Table 2: Ambient Air Quality Standards for 2015 and Attainment Status\*

A standard exceedence occurs		Averaging Time	California Standard <sup>†</sup>	National Standard <sup>†</sup>
when a measured pollutant	Ozone	8 Hours	70 ppb	<b>70 ppb</b> <sup>§</sup>
concentration exceeds (or in some	(O₃)	1 Hour	90 ppb	
applicable standard	Respirable Particulate	24 Hours	50 µg/m³	150 μg/m³
federal agencies. It does not necessarily	Matter (PM <sub>10</sub> )	1 Year <sup>‡</sup>	20 μg/m³	
constitute a violation.	Fine Particulate	24 Hours		35 μg/m³
A standard violation may occur following a single or cumulative series of standard exceedences. Criteria constituting a violation are unique for each pollutant. A nonattainment designation occurs when a state or federal agency formally declares an area in violation of a standard. Typically, ARB performs designations annually. Several years often pass between EPA designations.	(PM <sub>2.5</sub> )	1 Year <sup>‡</sup>	12 μg/m³	12 μg/m³
	Carbon Monoxide (CO)	8 Hours	9.0 ppm	9 ppm
		1 Hours	20 ppm	35 ppm
	Nitrogen Dioxide (NO <sub>2</sub> )	1 Year <sup>‡</sup>	30 ppb	53 ppb
		1 Hour	180 ppb	100 ppb
	Sulfur Dioxide	3 Hours		500 ppb (secondary)
	(SO <sub>2</sub> )	1 Hour	250 ppb	75 ppb (primary)
	Hydrogen Sulfide (H <sub>2</sub> S)	1 Hour	0.03 ppm	
	Visibility	8 Hours	Sufficient amou prevailing visibilit miles when the re less tha	nt to reduce the ty to less than ten elative humidity is in 70 %.

<sup>\*</sup> San Luis Obispo County (in whole or in part) is designated as nonattainment for the standards in **boldface print** as of June 2016.

<sup>†</sup> For clarity, the ozone, SO<sub>2</sub>, and NO<sub>2</sub> standards are expressed in parts per billion (ppb), however most of these standards were promulgated in parts per million (ppm).

<sup>‡</sup>This standard is calculated as a weighted annual arithmetic mean.

<sup>§</sup> The national 8-hour ozone standard was lowered from 75 to 70 ppb on October 1, 2015. Eastern San Luis Obispo County is still designated as nonattainment for the old standard. The EPA has yet to designate the County with regard to the new standard.

### **Ozone and Gaseous Pollutant Summary**

In October 2015, the federal 8-hour ozone standard was lowered from 75 to 70 parts per billion (ppb), which is the same level as the state 8-hour standard. The old standard of 75 ppb was exceeded only once; this is the fewest number of exceedences of this standard ever recorded in the county. Exceedences of the new more stringent standard (70 ppb) occurred on 4 days countywide, with 4 days at Red Hills and two days at Carrizo Plain. The state 1-hour standard for ozone (90 ppb) was exceeded once this year at Carrizo Plain during the Cuesta Fire. Standards for nitrogen dioxide and sulfur dioxide were not exceeded this year.

#### First, Second and Third Highest Hourly Averages

Table 3 lists the highest hourly (and for ozone, 8-hour) values recorded in 2015 for ozone, sulfur dioxide, and nitrogen dioxide at the stations where they are monitored. Concentrations are in parts per billion (ppb). Sampling date and hour appear under each pollutant value in the format "month/day: hour." All times are Pacific Standard Time; for 8-hour averages, the hour noted is the beginning hour. Values that exceed federal standards are shown in **bold**, and those exceeding state standards are <u>underlined</u>.

Station	c	)₃ 1-hou	our O <sub>3</sub> 8-hour SO <sub>2</sub> 1-hour				Jr	NO₂ 1-hour				
Station	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Paso Robles	<b>73</b> 04/18:11	<b>73</b> 09/25:12	62 06/08:16	68 06/08:11	<b>66</b> 09/19:10	65 04/17:11						
Atascadero	<b>73</b> 06/12:11	72 04/18:14	72 09/20:12	66 04/17:11	65 04/18:09	65 09/20:10				<b>34</b> 10/26:19	<b>33</b> 10/30:21	<b>33</b> 12/02:18
Morro Bay	<b>64</b> 04/16:17	<b>63</b> 04/30:16	60 10/08:10	<b>57</b> 04/16:11	<b>53</b> 04/17:09	52 04/30:11				<b>43</b> 04/16:06	<b>33</b> 11/05:07	<b>32</b> 11/22:17
San Luis Obispo	<b>66</b> 09/19:10	<b>63</b> 04/17:10	62 09/20:16	62 04/17:10	<b>59</b> 04/16:10	<b>59</b> 09/20:09						
Red Hills	82 <sub>08/18:11</sub>	82 09/09:03	<b>79</b> 06/26:02	<u>78</u> 09/09:03	<u>74</u> 09/08:23	<u>74</u> 09/20:09						
Carrizo Plain	<u>92</u> 08/18:13	<b>79</b> 09/09:15	<b>73</b> 06/17:14	<u>71</u> 09/09:10	<u>71</u> 09/20:09	<b>69</b> 04/18:10						
Nipomo Regional Park	<b>79</b> 01/21:04	<b>67</b> 09/19:10	66 10/08:12	<b>63</b> 09/19:09	62 04/16:10	62 04/17:09				<b>30</b> 01/05:18	<b>29</b> 01/06:18	<b>26</b> 01/07:19
Mesa2, Nipomo							<b>4</b> 01/29:11	<b>4</b> 02/25:15	<b>3</b> 01/05:17			

 Table 3: Highest Measurements for Gaseous Pollutants in 2015

#### Monthly Ozone Summary

Figures 3 and 4 depict monthly ozone variation during 2015 at the seven monitoring stations in the county where this pollutant is monitored. In these "box and whisker" plots, the top and bottom of each box show the 75<sup>th</sup> and 25<sup>th</sup> percentile daily maximum 8-hour averages for each month, the heavy horizontal bar marks the median, and the dotted lines (the whiskers) extend to the maximum and minimum values. In other words, for each month the middle 50% of all measured values are captured in the pink box; the top 25% of values fall between the top of the box and the upper whisker line, and the bottom 25% of the values fall between the bottom of the box and the lower whisker line. The solid red line marks the current federal and state 8-hour ozone standards of 70 ppb, and the dashed red line below it marks the previous federal 8-hour standard of 75 ppb.



Figure 3: Monthly Ozone Variation in 2015





## **Particulate Matter Summary**

In 2015, there were no exceedences of the federal 24-hour  $PM_{10}$  standard (150 µg/m<sup>3</sup>) anywhere in the county. Exceedences of the more stringent state 24-hour  $PM_{10}$  standard (50 µg/m<sup>3</sup>) were observed on 64 different days: 62 at CDF, 30 at Mesa2, 8 at NRP, 1 at Atascadero, and 1 at Oso Flaco.<sup>1</sup> This year, NRP, CDF, and Mesa2 also exceeded the state annual average  $PM_{10}$  standard of 20 µg/m<sup>3</sup>. Note that the San Luis Obispo  $PM_{10}$  monitor operated for only about 8 months this year, and the Oso Flaco monitor only began reporting in July.

The federal 24-hour  $PM_{2.5}$  standard (35 µg/m<sup>3</sup>) was exceeded once in 2015 at CDF. This year, the federal and state standards for annual average  $PM_{2.5}$  (both 12 µg/m<sup>3</sup>) were not exceeded at any site; however, attainment of the federal standard is based on the 3-year average of annual averages, and for CDF the most recent 3-year period (2013–2015) exceeds the standard. Note that the San Luis Obispo  $PM_{2.5}$  monitor operated for only about 8 months this year.

#### Highest 24-hr Concentrations and Annual Averages

Table 4 lists the highest 24-hour concentrations recorded in 2015 and the dates on which they occurred, as well as the annual means for  $PM_{10}$  and  $PM_{2.5}$  for all stations where these pollutants were monitored. Concentrations are in  $\mu g/m^3$ . Values exceeding federal standards are shown in **bold**; those exceeding state standards are <u>underlined</u>.

Chatien	24	-hour PM	10	Annual	24	-hour PN	Annual	
Station	1st	2nd	3rd	Average PM <sub>10</sub> ‡	1st	2nd	3rd	Average PM <sub>2.5</sub> <sup>‡</sup>
Paso Robles	<b>36</b> 08/17	<b>35</b> 08/16	<b>35</b> 09/25	16.5				
Atascadero <sup>†</sup>	<u>92</u> 06/30	<b>48</b> 07/01	<b>38</b> 01/13	18.9	<b>29.1</b> 01/13	26.9 12/31	<b>23.7</b> 01/12	6.0
San Luis Obispo *	<b>42</b> 04/30	<b>38</b> 08/16	<b>37</b> 03/29	15.1	16.4 <sub>08/20</sub>	15.4 <sub>08/25</sub>	15.2 <sub>08/19</sub>	5.6
CDF, Arroyo Grande	<u>149</u> 04/04	<u>141</u> <sub>03/31</sub>	<u>136</u> <sub>08/30</sub>	<u>34.9</u>	<b>36.0</b> 04/04	<b>30.3</b> <sub>03/31</sub>	29.9 04/01	11.1
Nipomo Regional Park	<u>76</u> 04/04	<u>76</u> 06/19	<u>58</u> 09/18	<u>22.8</u>				
Oso Flaco *	<u>59</u> 12/07	<b>41</b> 09/19	<b>41</b> 12/08	19.7				
Mesa2, Nipomo	<u>122</u> 04/04	<u>121</u> <sub>03/31</sub>	<u>118</u> 04/01	27.2	31.6 04/04	28.2 <sub>03/31</sub>	27.2 04/01	8.7

#### Table 4: PM<sub>10</sub> and PM<sub>2.5</sub> Summary for 2015

\* Incomplete year, see text for details.

<sup>†</sup> The Atascadero site moved this year; this table combines values from both locations.

<sup>‡</sup>Weighted arithmetic mean as calculated by an AMP450 AQS report.

<sup>&</sup>lt;sup>1</sup> ARB and EPA apply different conventions to the handling of significant digits. The ARB website (<u>http://www.arb.ca.gov/adam/topfour/topfour1.php</u>) thus counts 68 exceedences of the state PM<sub>10</sub> standard at CDF and 34 at Mesa2.

#### Monthly PM<sub>10</sub> Summary

Figures 5 and 6, below, summarize the 24-hour  $PM_{10}$  values from the seven stations where this pollutant was measured in 2015. As with the ozone plots, above, 50% of all measured values are captured in the pink box for each month; 25% of values fall between the top of the box and the upper whisker line, and 25% of the values fall between the bottom of the box and the lower whisker line. The dashed and solid red lines mark the state and federal 24-hour standards of 50 and 150 µg/m<sup>3</sup>, respectively.



Figure 5: Monthly PM<sub>10</sub> Variation in 2015



Figure 6: Monthly PM<sub>10</sub> Variation in 2015

#### Monthly PM<sub>2.5</sub> Summary

Monitoring for fine particulate matter ( $PM_{2.5}$ ) was performed at four locations in 2015: San Luis Obispo, Atascadero, Mesa2, and CDF. The following graphs summarize 24-hr  $PM_{2.5}$  values by site. The dashed red line marks the federal 24-hour standard of 35  $\mu$ g/m<sup>3</sup>; there is no state 24-hour standard for  $PM_{2.5}$ .



Figure 7: Monthly PM<sub>2.5</sub> Variation in 2015

## **10-year Trends**

#### Ozone

Figures 8 and 9 below depict the total number of hours in a given year at each site during which the ozone concentration was at or above 65 ppb. This is a useful indicator for trends, even though there are no health standards for single-hour exposure to this level of ozone. Figure 10 shows ozone design values over the same period. Design values are used by EPA to determine whether an area attains a federal standard. For ozone, the design value is calculated by averaging the 4<sup>th</sup> highest annual 8-hour average over three consecutive years. For example, a 2015 design value is the average of the 4<sup>th</sup> highest 8-hour averages from each year for 2013, 2014, and 2015. Only design values meeting data completeness requirements are included in Figure 10; the solid red line is the current federal and state 8-hour standard (70 ppb) and the dashed red line is the previous federal 8-hour standard, 75 ppb.



Figure 8: Hours At or Above 65 ppb Ozone, 2006-2015



Figure 9: Hours At or Above 65 ppb Ozone, 2006-2015



Figure 10: Ozone Design Value Trends, 2006-2015

#### **Particulate Matter**

Figure 11 below depicts the annual average  $PM_{10}$  concentrations at six locations in San Luis Obispo County over the past 10 years.<sup>2</sup> The red dashed line marks the state  $PM_{10}$  standard for the annual arithmetic mean, 20 µg/m<sup>3</sup>. While occasional exceedences of the standard occur at most sites, the monitors on the Nipomo Mesa at Nipomo Regional Park, Mesa2, and CDF are consistently higher than elsewhere in the county.

Trends in the annual average  $PM_{2.5}$  levels are depicted in Figure 12 for the four sites in the county where it is measured. Data for the past 10 years are shown, and years with partial data are omitted. The red dashed line marks the 12 µg/m<sup>3</sup> state and federal  $PM_{2.5}$  standard for the annual mean. As with  $PM_{10}$ , the stations on the Nipomo Mesa record higher levels than those elsewhere in the county.



<sup>&</sup>lt;sup>2</sup> In general, these are seasonally weighted averages as calculated by AQS. For years when sampling methodology changed, the average depicted is the time-weighted average of the methodologies.



Figure 12: PM<sub>2.5</sub> Annual Averages, 2006-2015

## **Ambient Air Monitoring Network Plans**

Each year, the APCD prepares an Ambient Air Monitoring Network Plan. This document is an annual examination and evaluation of the county network of air pollution monitoring stations. The annual review is required by 40 CFR 58.10 and helps ensure continued consistency with the monitoring objectives defined in federal regulations.

Each report is a directory of existing and proposed monitors in the county network and serves as a progress report on the recommendations and issues raised in earlier network reviews. Reports also address ongoing network design issues. The most recent Ambient Air Monitoring Network Plan is available online at <u>slocleanair.org/airquality/monitoringstations.php</u>.

As highlighted in the 2015 and 2016 reports, the following major changes were made to the APCD network in 2015:

- In February, the Atascadero air monitoring station was moved from the Atascadero Fire Station at 6005 Lewis Avenue to behind the Colony Park Community Center at 5599 Traffic Way.
- In July, the Oso Flaco air monitoring station began operation. This station hosts a PM<sub>10</sub> monitor and meteorological sensors and was established to fulfill a requirement of APCD Rule 1001. This station is operated by the APCD but is owned by the California Department of Parks and Recreation and located within the ODSVRA.

## **Appendix: Recent Trends in South County Particulate Matter**

#### Introduction

Enacted by the District Board in 2011, Local Rule 1001 requires the operator of the ODSVRA to implement dust mitigation measures with the goal of eventually reducing PM<sub>10</sub> emissions from the park to natural background levels. In 2014, the operator (California Department of Parks and Recreation) implemented a dust control project consisting of 15 acres of temporary wind fencing in the riding area and 30 acres of straw bales in a non-riding area. In 2015, 40 acres of wind fencing were temporarily installed in the riding area, the previous year's straw bale array was "refreshed," and 6 acres of vegetation was established in a non-riding area. In both years, the wind fencing was in place during the windy season (April through July) when exceedences of particulate matter standards are most frequent. All project elements were sited upwind of the CDF monitoring station.<sup>3</sup>

Over the same time period,  $PM_{10}$  levels at CDF and Mesa2 have been decreasing. Figure 11 above shows that the annual average  $PM_{10}$  values on the Nipomo Mesa decreased from 2013 to 2014 and again from 2014 to 2015. Trends in the annual number of exceedences of the State  $PM_{10}$  standard (50 µg/m<sup>3</sup>) are similar, as shown in Figure A1, below. In fact, there were fewer exceedences at CDF in 2015 than in any prior year. Is this decrease a result of the mitigations that were in place on ODSVRA in 2014 and 2015, or do these trends simply reflect annual variations in meteorology?



Figure A1: Annual Exceedences of the State 24-hr PM<sub>10</sub> Standard

<sup>&</sup>lt;sup>3</sup> See District webpage, "Oceano Dunes Dust," at <u>http://www.slocleanair.org/air-quality/oceano-dunes.php</u> for the text of Rule 1001, summaries of mitigation measure enacted thus far, and related documents.

Examining wind roses for CDF shows that 2014 and 2015 were indeed less windy than previous years. More specifically, high winds out of the northwest occurred less frequently in 2014 and 2015. Figure A2 below shows wind roses for the month of April for each year from 2010 to 2015. Note that in 2015, the frequency of winds from 285 to 315-degree sector is only about 20%, while in previous years it is typically 25 to 30%. Note also that the proportion of winds in this sector, which are greater than 12 mph, decreased from 2013 to 2014 and again from 2014 to 2015. Wind roses for May and June (Figures A3 and A4, below) show similar year-to-year changes.



Figure A2: Wind Roses for CDF in April, 2010 to 2015



Figure A3: Wind Roses for CDF in May, 2010 to 2015



Figure A4: Wind Roses for CDF in June, 2010 to 2015

While 2014 and 2015 were less windy than previous years, does this observation fully account for the decrease in standard exceedences observed over the same period? The following sections explore this question using two different approaches.

# Approach 1: Filter Days—a Methodology to Determine Effectiveness of PM<sub>10</sub> Emissions Mitigation Techniques in the ODSVRA

This section is by Mel Zeldin, Consultant to the District, and Karl Tupper, Air Quality Specialist with the District

In its most general form, the observed concentration of a non-reactive pollutant, such as crustaloriginating PM<sub>10</sub>, is a function of both emissions and meteorological conditions. On the Nipomo Mesa, wind conditions can transport PM<sub>10</sub> from the ODSVRA such that exceedances of the federal ambient air quality standards are occasionally measured at the CDF monitoring site, and the more stringent California PM<sub>10</sub> standard is exceeded on a regular basis. Emissions can occur from sufficiently strong wind conditions or from activities occurring within the ODSVRA. Since both emissions and meteorology vary from day to day, it can be very difficult to determine the effectiveness of mitigation efforts intended to reduce the severity of PM<sub>10</sub> transported inland from the dunes.

The fundamental equation relating emissions to measured concentrations is as follows:

(1) 
$$\mathbf{C} = f(\mathbf{Em}, \mathbf{Met})$$

where **C** is the measured concentration, and *f*(**Em**, **Met**) is a function related to emissions and meteorological conditions. Without accounting for changes in **Met**, the assumption that a change in **C** at CDF is due to some mitigation of **Em** could lead to erroneous conclusions about the effectiveness of the mitigation efforts.

One way to better relate changes in **Em** to changes in **C** is to examine a subset of the available data chosen such that, to the degree possible, **Me**t is held constant, and thus any change in **C** is actually

reflective of changes in **Em**. The challenge is to devise a set of appropriate "filters" stringent enough to create quasi-fixed meteorological conditions, yet not so restrictive as to limit the number of occurrences to too few to be statistically meaningful.

The meteorological filter was developed using data from years 2011 through 2014. In essence, this fouryear period represents a baseline of pre-mitigation conditions, since the first major mitigations occurred in 2015. (While mitigations were in place in 2014, they were less extensive and further away from CDF, and thus less likely have a discernable effect on measured PM<sub>10</sub> levels.) The filter uses data from CDF and the S1 meteorological tower within the ODSVRA<sup>4</sup> to select days with *approximately* constant meteorological conditions that are likely to have high 24-hr average PM<sub>10</sub> concentrations.

The specific criteria for defining a "filter day" are as follows:

#### During the six-hour period from 10 am to 3:59 pm:

- 1. All PM<sub>10</sub>, S1, and CDF wind speed and direction measurements must be valid;
- 2. The S1 vector average wind direction must be between 285 and 300 degrees for the six-hour period;
- 3. The S1 site must have <u>all</u> hourly wind speeds greater than or equal to 5 m/s;
- 4. The S1 site must have at least 3 of the six hourly wind speed greater than 10 m/s;
- 5. The S1 site must <u>not</u> have any hourly wind direction > 310 degrees;
- 6. The CDF site must not have any hourly wind direction < 285 degrees.

As noted above, these criteria were developed using data from 2011-2014, and then applied to 2015. (Data from 2010 was not used because the S1 tower was not yet operational.)

#### **Statistical Estimates for the Baseline Period**

For the 2011-2014 baseline period, there were 61 days meeting the filter day criteria. The following analysis uses the data from the six-hour period from 10 am to 3:59 PM for these filter days. Data were aggregated for each year, and because average wind speeds varied slightly year to year, the PM<sub>10</sub> concentrations were normalized to wind speed to get an average concentration per m/s for each year. From these annual values, a pooled average and standard deviation were determined, as follows:

YEAR	# FILTER DAYS	CDF PM <sub>10</sub> (μg/m <sup>3</sup> )	S1 WIND (m/s)	PM <sub>10</sub> per m/s
2011	10	270	10.3	26.2
2012	16	357	11.7	30.2
2013	21	325	11.5	28.3
2014	14	317	10.7	29.6
Average		317	11.1	28.6
SD				1.8

Note that the normalized values for all four years are remarkably similar. Year 2011 has the fewest number of data filter days with an annual total of 10.

<sup>&</sup>lt;sup>4</sup> The S1 tower is located with the ODSVRA and owned and maintained by the California Department of Parks Recreation. The District plays no role in the collection or validation of these data, which are available at <u>http://ohv.parks.ca.gov/?page\_id=26819</u>.

As a double check of the average normalized value as shown in the above table, all 366 hourly data points for the 61 days over the four years were averaged and then normalized. The resulting value was 28.7, identical (as rounded) to the average of the four annual values.

#### **Evaluation of 2015**

The filter day results for 2015 are shown below:

YEAR	# FILTER DAYS	CDF PM <sub>10</sub> (μg/m³)	S1 WIND (m/s)	PM <sub>10</sub> per m/s
2015	5	336	10.2	32.9

There are some very notable results for 2015. In order to better understand the annual distribution of filter days, these are the occurrences by month for the 4-year baseline period:

March	3	
April	17	
Мау	23	
June	12	
July	2	
August	0	
September	3	
October	1	
(Other month	is have	e no exceedences)

As can be seen, for 2011-2014 the month with the most filter days is May. However, in May 2015 there were zero filter days. This was a meteorologically anomalous month with a number of late winter/early spring storms parading through California. In fact, there were also no filter days in June, and only five in all of 2015: March 31, April 1, April 4, April 26, and July 7, all when wind fencing was either fully or mostly installed. In this approach, it would be preferable to have at least 10 filter day events, as in the baseline years; because of the lower number of filter days in 2015, some caution is advised in interpreting the results. However, the results show a normalized value of  $32.9 \,\mu\text{g/m}^3$  per m/s, which is 2.4 standard deviations greater than the value for the baseline years. The increased normalized value runs contrary to the expected mitigation results, since these days occurred when most or all of the wind fencing was in place. One would expect to see results on the lower side of the baseline if the mitigations were effective at reducing downwind PM<sub>10</sub> levels.

Figure A5, below, plots S1 wind speed versus CDF  $PM_{10}$  for filter days, aggregated by year. The data are from the tables, above, and include only values from 10 am to 3:59 PM. While this approach attempts to hold meteorology constant, in practice this can be done approximately, and the annual average S1 wind speeds on filter days ranges from 10.2 to 11.7 m/s. For the baseline years (2011-2014), the figure shows that CDF  $PM_{10}$  follows the expected trend: as S1 wind speed increases, so does CDF  $PM_{10}$ , even over this narrow range. Note that 2015 is anomalous to this trend.



#### **An Alternative Statistical Analysis**

Because there were so few filter days in 2015, an alternative statistical analysis was used to determine if any significance can be attached to the results for 2015.

This approach involves the analysis of variance (ANOVA) to explore between-year variance versus withinyear variance. First, the PM<sub>10</sub>/wind speed ratios for the filter days from the baseline years (2011-2014) were analyzed by one-way ANOVA to determine whether these years differed significantly from one another. The resulting p-value of 0.095 is not statistically significant, indicating that within-year variance is much greater than any between-year variance. In other words, the PM<sub>10</sub>/wind speed ratios for the different baseline years are not significantly different from each other, so it is appropriate to pool them.

These years were therefore pooled together, and then the data for 2015 was compared to this baseline, again using one-way ANOVA. The resulting p-value was 0.049, which is marginally significant at the 95% confidence level, indicating that 2015 is different from the other years, albeit just barely.

Since the  $PM_{10}$ /wind speed ratio for 2015 is higher than for the baseline years, the inference is that 2015 is worse than the previous years. Note that this approach is equivalent to performing a T-test comparing 2015 to the pooled baseline years. This assumes equal variances, and an F-test suggests that the assumption of equal variances is valid (p-value = 0.39). ANOVA and T-tests both assume that the data is normally distributed, and a histogram of the ratios looks normal (not shown). Nonetheless, the analysis was repeated using the non-parametric Kruskal-Wallis rank sum test. This test also showed that the ratio for 2015 was slightly statistically significant higher than the baseline years (p-value = 0.031).

#### Approach 2: A Decision Tree for Predicting Exceedences

In this approach, first the meteorological conditions associated with exceedences of the state PM<sub>10</sub> standard at CDF were identified. Next, the number of days each year with these conditions was

determined and compared to the number of exceedences actually observed. As with the first approach, data from 2011 to 2014 was treated as a baseline, and 2015 as a test year.

#### Meteorological Conditions Associated with Exceeding the State PM<sub>10</sub> Standard

In order to identify the conditions associated with exceedences of the state standard, a decision tree for predicting exceedences was developed using hourly wind speed and wind direction data from CDF and the S1 tower from 2011-2014. The decision tree was "grown" and "pruned" using the "tree" package in R (version 3.3.0).<sup>5</sup> The optimized decision tree is very simple and predicts an exceedence of the standard at CDF when:

• S1 wind speed at 3 pm exceeds 9.445 m/s **and** CDF wind direction at 1 pm is greater than 289.5 degrees.

This simple rule accurately classifies 90.6% (95% confidence interval: 89.0 to 92.2%) of days in 2011-2014 as exceedences or not. By comparison, a naïve method which ignores meteorology and always classifies days as not exceeding the standard would have an accuracy of 78.2%.

## Trends in the Annual Number of Days with Meteorological Conditions Associated with Exceeding the State PM<sub>10</sub> Standard

Figure A6, below, plots the number of days each year with the wind characteristics identified above. Also depicted are the number of exceedences observed at CDF each year. Qualitatively, the trends track each other closely, even though there are many more observed exceedences than the rule predicts. (The downward bias in the number of predicted exceedences is an artifact the skewed distribution of the 24-hour average PM<sub>10</sub> values.) The plot shows a steady decrease, from 2013 to 2015, in the number of days each year with these meteorological conditions: a trend that is very similar to that seen in the number of standard exceedences observed over this period.



Figure A6: Predicted and Observed Exceedence Day at CDF by Year

<sup>&</sup>lt;sup>5</sup> Brian Ripley (2015). tree: Classification and Regression Trees. R package version 1.0-36. <u>CRAN.R-project.org/package=tree</u>.

#### Conclusions

Neither of the two approaches discussed above suggest that the 2014 or 2015 dust control projects were able to measurably mitigate  $PM_{10}$  levels at CDF. The first approach attempts to detect year-to-year changes in the emissivity of the ODSVRA by looking at  $PM_{10}$  levels under approximately constant wind conditions. Under the wind conditions examined, for 2011-2014 the ratio of CDF  $PM_{10}$  to S1 wind speed was 28.6  $\mu g/m^3$  per m/s, while for 2015 the ratio was *higher* at 32.9  $\mu g/m^3$  per m/s. The first approach thus suggests that, if anything, the ODSVRA was actually more emissive in 2015 than in earlier years.

The second approach attempts to identify the wind conditions associated with exceedences of the state PM<sub>10</sub> standard at CDF and then compares the number of days each year, exhibiting these conditions, to the number of days each year that exceed the standard. If the frequency of these wind conditions had remained constant or increased from year-to-year, while exceedences became less frequent, then this would suggest that the dust control projects were mitigating PM<sub>10</sub> levels at CDF to some extent. Instead, the approach suggests that wind conditions conducive to exceeding the standard became less frequent from 2013 to 2015, a trend that parallels the year-to-year change in exceedences. Thus, like the first approach, this approach finds no evidence of measurable impacts of the ODSVRA dust control projects, and suggests instead that annual variations in meteorology are responsible for the decreased frequency of exceedences observed at CDF in recent years.

An advantage of using a decision tree for identifying the wind conditions associated with exceedences is that it yields a very simple rule that is straight forward to understand and communicate. A disadvantage is that it is rather inflexible: the relationship between PM<sub>10</sub> levels and meteorology on the Nipomo Mesa is very complicated and the rule derived above is surely an oversimplification. A more flexible, and thus complicated, methodology for identifying the conditions associated with exceedences might yield more accurate predictions and possibly different conclusions about year-to-year changes in the frequency of such conditions.

Finally, it is worth noting that the 2014 and 2015 dust control projects were sited upwind of CDF and appear to have been designed specifically to reduce the  $PM_{10}$  levels at that monitor. The projects would not be expected to have much of an impact, if any, on  $PM_{10}$  levels at Mesa2. Yet, as shown in Figure A1, the trend in annual exceedences at Mesa2 tracks the trend in exceedences seen at CDF. This also suggests that factors other than the dust control projects are responsible for the decreased frequency of exceedences observed on the Nipomo Mesa in recent years.