WILDFIRE SMOKE

Considerations for California's Public Health Officials

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This document provides information to California's public health officials and others interested in the health effects of wildfire smoke, actions that can be taken to reduce exposure, and other public health considerations.

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EXECUTIVE SUMMARY

California has faced an increasing number of wildfires in the last decade and this trend may continue into the foreseeable future. In addition to the personal and economic toll resulting from destructive fire activity, wildfire smoke can impact the health of communities and people near and far.

WILDFIRE SMOKE

- Wildfires contribute to air pollution through the emission of primary pollutants and the production of secondary pollutants, e.g., ozone, during photochemical processing.
- Particulate matter (PM) is currently the principal known pollutant of concern from wildfire smoke for relatively short-term exposures (hours to days).
- Wildfire smoke can impact large geographic areas that span multiple California health jurisdictions and air districts. Involved governmental agencies may include local health departments, local/regional air agencies, local environmental health departments, local emergency management agencies, school districts, and multiple state and federal agencies.

REGULATORY AIR MONITORING

- Federal and state legislation establish air quality standards for major pollutants, including particulate matter (PM).
- Primary standards are established to protect public health, including sensitive populations, with an adequate margin of safety.
- In California, 35 local/regional air agencies are responsible for air quality monitoring and controlling pollution from stationary sources. The California Air Resources Board is the lead state agency on air quality.
- California has approximately 250 regulatory air monitoring stations that comprise the State and Local Air Monitoring Network.

AIR QUALITY INDEX

- The US EPA developed the Air Quality Index (AQI) to communicate information about air quality to the public.
- The AQI uses a 6-level color system (Green, Yellow, Orange, Red, Purple and Maroon); each level is associated with a descriptive term for air quality progressing from “Good” to “Hazardous.”

- For each pollutant, the AQI scale value of 100 corresponds to the 24-hour primary health standard.
- The health standard for the main known health risk associated with wildfire smoke, PM2.5, is 35 µg/m (corresponding to an AQI of 100).
- The AQI is most often displayed for two pollutants, PM2.5 and ozone.
- EPA developed a NowCast method to compute AQI to provide closer to "real-time" reporting. The NowCast AQI method is based on a 12-hour period, with emphasis on the final 3 hours during rapidly changing conditions.
- Some California air agencies report hourly AQI to more rapidly reflect changing wildfire smoke conditions.
- It is important to understand the different averaging windows that may be used in AQI reporting. See table:

Parameter Name	Reporting Period	Source(s)	Notes
AQI	24 hours (midnight-to-midnight)	US EPA AirNow; Local Air Agencies	
NowCast AQI "Current Conditions" on AirNow	12 hours (emphasizes last 3 hours if conditions are rapidly changing)	US EPA AirNow; Local Air Agencies	More closely approximates observed conditions vs. 24 hour data
Hourly AQI	Hourly	Some Local Air Agencies	Provides close to real-time air quality information, including forecasts of cleaner air periods

Reporting periods for standard AQI, NowCast AQI, and hourly AQI. When conditions are rapidly changing, e.g., during wildfire smoke events, NowCast AQI and hourly AQI reporting provide closer to real-time information.

LOW-COST AIR SENSORS

- An increased demand for real-time monitoring of pollutant concentrations, coupled with advances in technology, has led to the introduction of a variety of low-cost air quality sensors.
- Low-cost air quality sensors can be precise but do not have the same accuracy as regulatory air monitors that are based on federal reference (or equivalent) methods (FRM or FEM).
- Although no governmental agency certifies low-cost air quality sensors, a California regional air agency conducts laboratory and field testing of low-cost PM sensors (AQ-SPEC).

- Public health officials should be aware of the general limitations and potential advantages of low-cost air quality sensors.
- Low-cost air sensor networks may provide useful qualitative information to augment existing air monitoring networks, particularly in communities that may not have an air monitoring station.

WILDFIRE SMOKE AND HEALTH

- Most healthy people will recover quickly from wildfire smoke exposure and will not suffer long-term health consequences.
- Exposure to particulate matter (PM) is currently the principal known public health threat from wildfire smoke. Fine particles from smoke and coarse particles from ash are respiratory irritants that can cause coughing, wheezing, and difficulty breathing.
- Certain groups may be sensitive to wildfire smoke due to life stage (children and older adults), pre-existing medical condition (e.g., lung and heart conditions), and socioeconomic factors (access to safe housing and health care, linguistic isolation, lack of transportation, and other socioeconomic factors).
- The risk of health effects due to PM appears to vary throughout a lifetime, generally being higher in childhood, lower in young adults, and increasing in middle age through old age as the prevalence of heart, lung, and metabolic disease increases.
- Recent reviews conclude that a strong association exists between exposure to wildfire smoke and all-cause mortality and respiratory morbidity.
- The epidemiological data linking wildfire smoke exposure to cardiovascular morbidity and mortality have been mixed, although several recent studies identified elevated risks of specific health outcomes, including emergency department visits for ischemic heart disease, dysrhythmia, heart failure, pulmonary embolism, and stroke.
- Groups that are sensitive to wildfire smoke likely include:
    - Infants and Children
    - Older Adults
    - Pregnant Women
    - People with Lung Conditions
    - People with Heart Conditions
    - People with Social Vulnerabilities

STRATEGIES TO REDUCE EXPOSURE

- Stay Indoors (if air quality is better indoors and heat is not a factor)
- Manage Indoor Air Quality
    - Reduce Indoor Sources of Air Pollutants
    - Use California-Approved Air Cleaners
    - Create a Clean Space at Home
- Consider Temporary Re-Location
- Use Approved Respirator if Necessary and Safe

PUBLIC HEALTH CONSIDERATIONS

- Build Strong Partnerships in Advance

  Successful response to wildfire smoke requires coordination among multiple entities, including local health departments, local/regional air agencies, local environmental offices/departments, local emergency management agencies, school districts, and others.

- Public Messaging

  To the extent possible, public messaging should be coordinated among response agencies. Jointly-issued advisories support consistent messaging.

- Schools

  The decision to modify school activities in response to wildfire smoke is typically made by school district officials with input from local health officials and air districts.

- Community Cleaner Air Shelters and Spaces

  Jurisdictions should pre-identify Cleaner Air Shelters and Spaces that would be suitable for use during a wildfire smoke event. It may be advantageous to consider previously identified Cooling Centers, as wildfire smoke and extreme heat may co-occur.

- Respirators (Masks)

  The most effective action the public can take to reduce the risk of adverse health effects due to wildfire smoke is to stay indoors in cleaner air (while avoiding excessive heat). N95 respirators may serve a protective role in reducing smoke exposure if more effective protective actions cannot be implemented and it is safe for the individual to wear an N95 respirator.

INTRODUCTION

Since 2000, nine of the 10 largest fires in California's recorded history occurred, burning nearly 2.5 million acres, costing dozens of lives, and destroying neighborhoods and towns. California's typical fire season is expanding – the Thomas Fire began in December of 2017 and was not contained until mid-January. California could face a 50% increase in the number of wildfires that burn more than 25,000 acres by the end of the century if current trends, including climate change, are not reversed.[1]

This new reality has created significant challenges for California's public health officials. The California Department of Public Health and California Conference of Local Health Officers engaged in a series of after-action discussions in 2018 that identified challenges experienced by health officers during recent wildfires.

This document, prepared by the California Department of Public Health, contains information about wildfire smoke, health effects, sensitive populations, strategies to reduce exposure, and potential public health actions. Additional resources, including links, are provided throughout the document and in the appendices.

The primary audience for this document is California's physician health officers with an understanding that a successful public health response to wildfire smoke requires collaboration among multiple entities, including local health departments, local/regional air agencies, local environmental health departments, local emergency management agencies, school districts, healthcare providers, and multiple state and federal agencies.

The main sources of information include published research, government agency recommendations, and information provided by local, state and federal subject matter experts involved in public health and air quality. Links are provided to assist public health officials and their staff locate additional information. This document should be updated regularly to incorporate new information and maintain the currency of embedded links.

Important Note:

The viewpoints expressed herein do not represent the official policy of any organization, including the California Department of Public Health. Any mention of commercial products or trade names is for informational purposes only and is neither an endorsement nor recommendation for use.

[1] California's Fourth Climate Change Assessment: http://www.climateassessment.ca.gov/

WILDFIRE SMOKE

Wildfires produce large amounts of particles and gases, including fine and coarse particles, greenhouse gases (carbon dioxide, methane, nitrous oxide), photochemically reactive compounds (e.g., carbon monoxide), non-methane volatile organic carbon, and nitrogen oxides. Wildfires contribute to air pollution through the emission of primary pollutants and the production of secondary pollutants, e.g., ozone, during photochemical processing.

The impact of wildfires on air quality depends on meteorology, fire plume dynamics, amount and chemical composition of the emissions, and atmosphere into which the emissions are dispersed.

Wildfire smoke can impact large geographic areas that span multiple health jurisdictions and air districts. Involved governmental agencies may include local health departments[2], local/regional air agencies[3], local environmental health departments, local emergency management agencies, school districts, and multiple state and federal agencies. In California, the California Air Resources Board (CARB), California Department of Public Health (CDPH), California Governor's Office of Emergency Services (Cal OES) and other state agencies support local jurisdictions impacted by wildfire smoke.

Particulate Matter

Particulate matter (PM) is currently the principal known pollutant of concern from wildfire smoke for relatively short-term exposures (hours to days).[4] PM is a general term to describe small particles suspended in air that are typically a mixture of solid particles and liquid droplets.

The health impact of PM varies according to the size of the particles. Larger particles greater than 10 micrometers in diameter can irritate the eyes, nose, and throat but generally do not penetrate deeper into the lungs. Particles with diameters less than or equal to 10 micrometers (PM10) cause irritation and can travel further into the throat and lungs; PM10 is referred to as *inhalable particles*. Particles between 10 and 2.5 micrometers (PM10-2.5) penetrate to the upper airways and are referred to as *coarse particles.*

[2] California has 58 county health departments and 3 city health departments. Each health department has a legally appointed physician Health Officer.

[3] California has 35 air districts that are county or regional governing authorities that have primary responsibility for monitoring air quality and controlling air pollution from stationary sources. See https://www.arb.ca.gov/capcoa/roster.htm.

[4] US EPA Wildfire Smoke FAQs

A smaller category of particles with diameters less than or equal to 2.5 micrometers (PM2.5) can penetrate more deeply into the lungs and has been shown to increase systemic inflammation, oxidative stress, and coagulation through PM2.5-mediated changes in the autonomic nervous system. PM2.5 are referred to as *fine particles* and are currently the principal known pollutant of concern from wildfire smoke for short-term exposures (hours to days); it is the most commonly monitored PM type due to its impact on the deeper lungs. Both PM10 and PM2.5 are regulated air pollutants.

The smallest category, *ultrafine particles* smaller than 0.1 micrometers (UFP or PM0.1), are not currently regulated but are known to present health risks due to their small size and ability to penetrate into the blood stream.

Particulate Matter (PM)			
Name	**Symbol**	**Diameter**	**Description**
Inhalable	PM_{10}	≤ 10 µm	All inhalable particles
Coarse	$PM_{10\text{-}2.5}$	2.5 - 10 µm	Coarse particles that deposit in the throat and upper airways
Fine	$PM_{2.5}$	≤ 2.5 µm	Fine inhalable particles, deposit deeper in lungs
Ultrafine	$PM_{0.1}$	≤ 0.1 µm	Ultrafine inhalable particles; pass into circulatory system

Table 1. Categories of Particulate Matter

Other Pollutants in Wildfire Smoke

Ground-level ozone can also cause inflammation of the airways, reductions in lung function, coughing, wheezing, and shortness of breath. These effects can be more serious in people with asthma and other lung diseases. Respiratory effects attributed to ozone exposure can lead to increased use of medication, emergency room visits for asthma and chronic obstructive pulmonary disease (COPD), and respiratory-related hospital admissions. The evidence for ozone's effects on the cardiovascular system is more limited but it appears that short-term exposure to ozone may cause effects such as systemic inflammation and changes in heart rate variability.

Wildfire smoke also contains significant quantities of other respiratory irritants that can produce eye and respiratory irritation. Hazardous Air Pollutants, also referred to as Toxic Air Contaminants by the California Environmental Protection Agency (CalEPA), are present in wildfire smoke and may contribute to adverse health effects in infants; children; pregnant women and their fetuses; elderly persons; those with existing lung, heart, or liver diseases; and persons engaging in physical activity. Acetaldehyde, acrolein, formaldehyde and benzene are of particular concern because of their differential impact on infants and children compared to adults.

REGULATORY AIR MONITORING

The Clean Air Act requires the U.S. Environmental Protection Agency (US EPA) to establish air quality standards for major pollutants: **primary standards** to protect public health and **secondary standards** to protect the public against environmental effects, including adverse impacts to soil, water and crops. Primary standards must protect public health, including sensitive populations, with an adequate margin of safety.

The US EPA establishes National Ambient Air Quality Standards[5] (NAAQS) for six major air pollutants (also called "criteria air pollutants"), including particulate matter (PM), ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead. California law establishes California Ambient Air Quality Standards (CAAQS) that may be more stringent than national standards and include additional pollutants as determined by the California Air Resources Board (CARB).[6]

There are two primary standards for PM2.5: a **24-hour standard** and an **annual standard**. The 24-hour standard is designed to protect the public from short-term exposure and the annual standard is designed to protect the public from long-term exposure.

PM2.5 Primary Standards	Purpose	Limit	Computational Method
24-hour	Protect short-term health	35 µg/m^3	An area meets the 24-hour average standard ("attainment") if the 98th percentile of the 24-hour average PM2.5 concentrations in one year, averaged over three years, is less than or equal to 35 µg/m^3.
Annual	Protect long-term health	12 µg/m^3	An area meets the annual average standard if the three-year average of its annual average PM2.5 concentration is less than or equal to 12 µg/m^3.

Table 2. Regulatory standards for PM2.5

[5] National Ambient Air Quality Standards (NAAQS)

[6] California Ambient Air Quality Standards (CAAQS)

Air Quality Regulation in California

Implementing air quality standards is the joint responsibility of states and the US EPA. States are responsible for developing enforceable state implementation plans to achieve and maintain air quality that meets national standards. State and local agencies are responsible for air monitoring.

The state agency responsible for air quality standards in California is the California Air Resources Board (CARB). The local regulatory component is provided by the state's 35 local/regional agencies called Air Quality Management Districts (AQMDs) or Air Pollution Control Districts (APCDs). [7] Each air agency has an appointed Air Pollution Control Officer[8] and a governing board.

The primary purpose of California's *State and Local Monitoring Network*[9] is to monitor key air pollutants and determine if areas are in attainment of established standards. Regulatory air monitoring stations must comply with federal and state requirements and involve significant resources to acquire, site, operate, and maintain (see Figure 1).

Figure 1. Regulatory Air Quality Monitoring Station (fixed location)

Figure 2. Environmental Beta Attenuation Monitor (E-BAM) (portable air quality monitor)

When areas of the state further away from permanent monitoring stations are impacted by wildfire smoke, local, state, and federal agencies may deploy portable air monitoring equipment, Environmental Beta Attenuation Monitor (E-BAMs) (see Figure 2), from existing

[7] California Local Air Districts

[8] See California Association of Air Pollution Control Officers

[9] Regulatory air monitoring stations are operated through the combined efforts of CARB, local air districts, private contractors, and the US Forest Service/National Park Service (USFS/NPS).

caches. The California Air Resources Board (CARB) maintains a cache of field-deployable E-BAMs that can augment existing monitoring capacity during smoke events. The U.S. Forest Service's Wildland Fire Air Quality Response Program (https://www.wildlandfiresmoke.net/) has also stockpiled smoke monitoring equipment that can be deployed during wildfire smoke events.

AIR QUALITY INDEX (AQI)

The US EPA created the Air Quality Index (AQI) to communicate information about air quality to the public.[10] The AQI communicates the health impacts of air pollutant concentration using a 6-level color system (Green, Yellow, Orange, Red, Purple and Maroon). Each color-coded level has an associated descriptive term, progressing from "Good" to "Hazardous." For each pollutant, the AQI scale value of 100 corresponds to the 24-hour primary health standard. The AQI is most often displayed for two pollutants, PM2.5 and ozone.

For PM2.5, the 24-hour health standard of 35 µg/m^3 corresponds to the AQI value of 100; AQI values greater than 100 indicate increasing levels of health risk, beginning with "Sensitive Groups" in the Orange category and progressing to "Everyone" in the Red, Purple, and Maroon categories. See Table 3 below.

Category	AQI	PM2.5 (µg/m^3) 24-hour
Good	0-50	0.0-12.0
Moderate	51-100	12.1-35.4
Unhealthy for Sensitive Groups	101-150	35.5-55.4
Unhealthy	151- 200	55.5-150.4
Very Unhealthy	201-300	150.5-250.4
Hazardous	301-500	250.5-500.4

An **AQI of 100** corresponds to a PM2.5 health standard of **35 µg/m**. AQI values > 100 are associated with increasing concentrations of PM2.5.

Table 3. Air Quality Index (AQI) for PM2.5

The AQI standard for PM2.5 is based on a 24-hour average measured from midnight to midnight, therefore it may not be sufficiently responsive to the rapidly changing conditions associated with a wildfire smoke event. Shorter averaging periods are desirable for taking actions to mitigate smoke exposure. The next sections will focus on the NowCast AQI and new hourly AQI reporting used by some local California air agencies.

[10] AQI Basics

NowCast AQI

The determination of compliance with air quality standards is based on collecting data that are averaged over extended periods of time. For PM2.5, compliance is based on averaging 24-hour measurement periods. However, wildfire smoke conditions may change rapidly based on a number of factors including weather conditions, terrain, and time of day.

The US EPA recognized a need to provide air quality information that is more responsive to rapidly changing conditions so that people can take action to reduce their exposure to air pollutants. In 2013, the US EPA updated its method of reporting AQI "Current Conditions" using a method called NowCast.

In brief, the NowCast method looks at data collected over the most recent 12 hours. If conditions are stable, the NowCast AQI is averaged across the 12 hours. If the PM2.5 values are changing rapidly (either increasing or decreasing), the data from the last three hours are more heavily weighted in the computation of the NowCast AQI. See Figure 3. This provides information to the public that is closer to real-time information during an event where conditions are rapidly changing.

Figure 3. NowCast AQI for PM2.5 ("Current Conditions" on AirNow).

Even the NowCast AQI may lag during rapidly changing wildfire smoke conditions and some California air agencies have begun implementing local hourly AQI reporting and forecasting to enable the public to make effective decisions during periods of poor air quality.

Hourly AQI

Some California air agencies are implementing hourly AQI reporting and forecasting for the areas served by their air agency. For example, the South Coast AQMD recently launched a new hourly forecast for PM2.5 and ozone for up to two consecutive days. This forecasting includes anticipated periods of "better air quality" so people can tailor their activities accordingly. This information can be helpful to those who wish to plan their day to minimize

exposure, e.g., exercise during better air quality periods. See Appendix F. South Coast AQMD has also developed an app for iPhone and Android that allows consumers to directly access this information.[11]

When making decisions about air quality during wildfire smoke events, it is important to understand the averaging windows used by various reporting agencies. This affects how air quality data are presented and should be considered relative to public health recommendations. See table below.

Parameter Name	Reporting Period	Source(s)	Notes
AQI	24 hours (midnight-to-midnight)	US EPA AirNow; Local Air Agencies	
NowCast AQI "Current Conditions" on AirNow	12 hours (emphasizes last 3 hours if conditions are rapidly changing)	US EPA AirNow; Local Air Agencies	More closely approximates observed conditions vs. 24 hour data
Hourly AQI	Hourly	Some Local Air Agencies	Provides close to real-time air quality information, including forecasts of cleaner air periods

Table 4. Reporting periods for standard AQI, NowCast AQI, and hourly AQI. When conditions are rapidly changing, e.g., during wildfire smoke events, NowCast AQI and hourly AQI reporting provide closer to real-time information.

[11] Air Quality Forecast for South Coast Air Quality Management District

LOW-COST AIR SENSORS

The purpose of regulatory air monitors is to ensure that federal and state air quality standards are met for the protection of public health. There are approximately 250+ regulatory air monitors in California for approximately 40 million people. Wildfire smoke patterns can be highly variable due to a number of factors and it's possible that some impacted areas may not have a regulatory air monitor nearby.

In recent years, an increased demand for real-time monitoring of pollutant concentrations, coupled with advances in technology, has led to the introduction of low-cost air quality sensors by private companies, academic institutions, private-public partnerships, and others. Low-cost sensors can be precise but do not have the same accuracy as regulatory air monitors that are based on federal reference (or equivalent) methods (FRM or FEM) and the readings may be different than FRM or FEM.[12] There is no governmental agency that requires these sensors meet the performance standards of an FRM or FEM. Therefore, information provided by low-cost sensors should be viewed cautiously by public health officials relative to recommended public health actions.

With that understanding, low-cost sensors have the potential to provide useful information to individuals and communities that may not be served by nearby local and state regulatory air monitoring stations. If located indoors, low-cost air sensors can also provide feedback on indoor air quality and the effectiveness of different exposure reduction strategies (e.g., improved filtration or portable air cleaners).

One of California's regional air agencies, the South Coast Air Quality Management District (SCAQMD), created the Air Quality Sensor Performance Evaluation Center (AQ-SPEC) to independently evaluate the performance of low-cost air quality sensors. See AQ-SPEC.

AQ-SPEC conducts testing under both controlled (laboratory) and ambient (field) conditions to characterize the performance of air quality sensors. AQ-SPEC provides performance reports for each low-cost sensor evaluated and a summary table of results. Over 40 sensor technologies have been evaluated as of August 2019.

An example of the sensors evaluated by AQ-SPEC is the PurpleAir (PA-II) that costs approximately $250 (see Figure 4).[13] The PA-II sensor uses a laser particle counter to count

[12] Low-cost sensors may provide information that differs from the AQI reported by governmental agencies due to accuracy differences and differences in reporting periods.

[13] Any mention of trade names or commercial products is for informational purposes only and is neither an endorsement nor recommendation for use.

the number of particles of various sizes and uses the count data to calculate mass concentrations of PM1, PM2.5, and PM10. The measured values are transmitted to the manufacturer, converted to AQI, and posted to the PurpleAir website. Values are updated every 80 seconds. The sensor must be connected to a power source and a Wi-Fi network that allows the data to be shared on the PurpleAir website (see PurpleAir Map). These sensors may be used in either outdoor or indoor settings. Anyone can view the data regardless of whether they own a PurpleAir sensor or not.

Figure 4. PurpleAir PA-II sensor.

AQ-SPEC's evaluation found that the PA-II sensors correlated well with the reference test method for PM2.5 in both field ($R^2 > 0.93$) and laboratory studies ($R^2 > 0.99$); exhibited relatively high precision; tracked diurnal changes well; and showed moderate to good accuracy.[14]

Users should be aware of the general limitations and potential advantages of low-cost air quality sensors. As previously stated, low-cost sensors do not match the accuracy of regulatory air monitors that are based on federal reference or equivalent methods. Another factor is that PurpleAir sensors update information every 80 seconds, whereas the AQI reporting by governmental agencies will reflect longer averaging periods. It is important to note that differences in reported air quality information may reflect a number of factors, including differences based on location, measurement periods, technology, and other computational factors.

It is also possible that low-cost sensors may drift over time. The accuracy and precision of any low-cost sensor should be investigated and considered relative to the intended application.

[14] AQ-SPEC evaluates low-cost air quality sensors in comparison to US EPA approved federal reference method (FRM) or federal equivalent method (FEM) instruments.

However, given these considerations, low-cost sensors have the potential to provide significant value to communities and individuals. The availability of low-cost sensors, if sufficiently accurate and precise, may lead to better understanding of spatial and temporal impacts to specific communities, including environmental justice communities.[15,16]

As of 2019, CARB has provided more than 400 PA-II sensors to 31 air agencies throughout California. The sensors are used in areas that have a high probability of recurring wildfire activity. These sensors:

- Can complement the existing regulatory monitoring network
- Are used to identify locations requiring additional monitoring focus
- Do not replace traditional smoke monitors
- Can collect indoor and outdoor measurements, depending on placement
- Can provide backup information when network monitors are unavailable
- Can be used for monitoring at schools. These sensors:
    - Use existing infrastructure if available (power/Wi-Fi/security)
    - Serve as an informational tool for administrators to help reduce student exposure
    - Serve as an educational resource for students – encouraging interest in air quality, technology, measurement, and health

CARB maintains a list of known community air monitoring networks at Community Air Monitoring Systems in California.

At some point in the future, a governmental agency or consortium may develop a sensor certification program. Until then, a good option is to refer to the AQ-SPEC website for testing information on air quality sensors.

[15] Environmental Justice is defined in California's Government Code 65040.12 as "*The fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations and policies*."

[16] Environmental justice communities are commonly identified as those where residents are predominantly low-income or people of color; where residents have been excluded from the environmental policy setting or decision-making process; where they are subject to a disproportionate impact from one or more environmental hazards; and where residents experience disparate implementation of environmental regulations, requirements, practices and activities in their communities. (see https://ww2.energy.ca.gov/public_advisor/environmental_justice_faq.html)

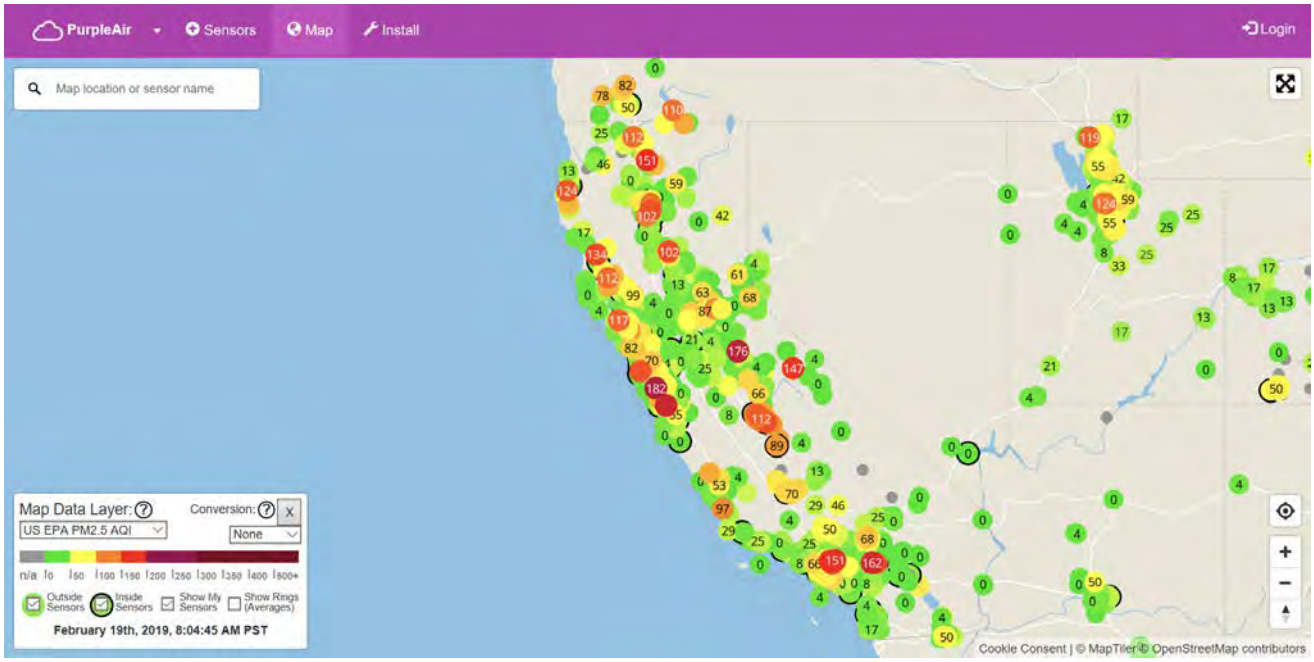

Figure 5. PurpleAir map for California.

Monitoring Can Inform Exposure Reduction Strategies

Sensitive individuals and other interested parties can use low-cost sensors to assess the effectiveness of exposure reduction strategies, provided they are installed correctly and not influenced by nearby or unintended sources or air pollution such as a wood burning, barbeque, idling vehicles, generators, cigarette smoke, or other sources of particle pollution.

For example, a low-cost sensor may be placed outside or inside the home or building, providing information on outdoor and indoor smoke impacts. This information can be used to determine how much specific actions reduce exposure within the home, such as closing windows; upgrading to a high-efficiency air filter if the home has a forced air system; and avoiding indoor activities that worsen air quality, such as frying or broiling at high heat, burning candles or incense, or vacuuming without a high efficiency particulate air (HEPA) filter. It can also provide information on the effectiveness of air filtration in a designated clean room in the home.

The PurpleAir map allows the viewer to display a combination of outdoor and indoor sensors, outdoor sensors only, or indoor sensors only. See image below:

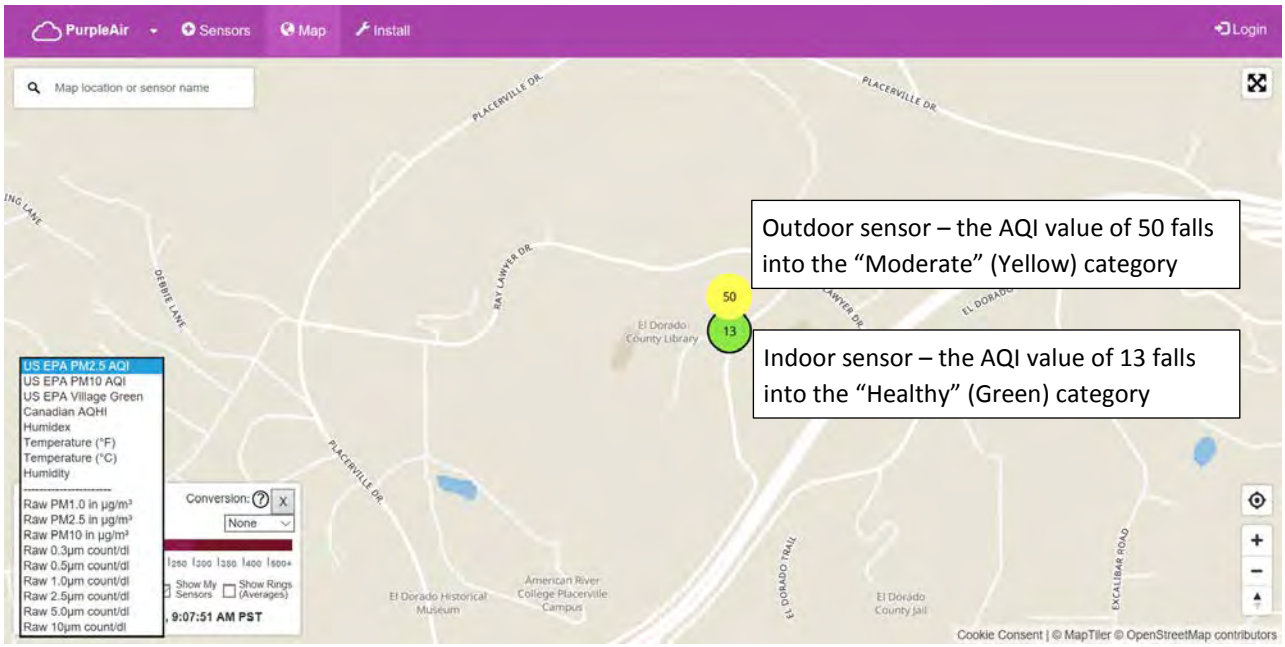

Figure 6. PurpleAir map displaying an outdoor sensor and indoor sensor, allowing comparison of indoor air quality to outdoor air quality.

WILDFIRE SMOKE AND HEALTH

Poor air quality due to wildfire smoke may persist for days or weeks and lead to significant public health impacts. Until recently, most of the research on the detrimental health impacts of air pollution were not wildfire-specific. Wildfire smoke measurement and epidemiology are active areas of research with new approaches uncovering associations that were previously undetectable, particularly for acute smoke events. New methods are being developed to measure the constituents of wildfire smoke and deploy these methods in affected communities. The recent increase in fire activity in California and other states has led to an uptick in published research on a broad range of health outcomes, including visits to hospital emergency departments, hospitalizations, and medication prescribing.

Most healthy people will recover quickly from wildfire smoke exposure and will not suffer long-term health consequences. However, certain people may experience more severe acute and chronic symptoms. Certain people may have increased sensitivity due to biologic factors (e.g., life stage or pre-existing medical condition) and extrinsic, non-biologic factors (e.g., socioeconomic status, lack of access to adequate housing, lack of access to health care services). Members of sensitive groups should pay particular attention to reducing their exposure to wildfire smoke.

The risk of health effects due to particulate matter appears to vary throughout a lifetime, generally being higher in childhood, lower in young adults, and increasing in middle age through old age as the prevalence of heart, lung, and metabolic disease increases.

Exposure to particulate matter (PM) is currently the principal known public health threat from wildfire smoke. Fine particles from smoke and coarse particles from ash are respiratory irritants that can cause coughing, wheezing, and difficulty breathing. Particulate matter may also affect the body's physiological mechanisms that remove inhaled foreign materials from the lungs, such as pollen and bacteria. Studies of ambient air pollution have found that exposure to fine and coarse particles (PM2.5 and PM10) is linked with increased risk of premature mortality and aggravation of pre-existing respiratory and cardiovascular disease.

Recent reviews conclude that a strong association exists between exposure to wildfire smoke or wildfire-PM2.5 and all-cause mortality and respiratory morbidity.[17,18,19] Strong positive

[17] Youssouf H, Liousse C, Roblou L, et al. Non-accidental health impacts of wildfire smoke. Int J Environ Res Public Health. 2014;11(11):11772-804.

[18] Liu JC, Pereira G, Uhl SA, Bravo MA, Bell ML. A systematic review of the physical health impacts from non-occupational exposure to wildfire smoke. Environ Res. 2015;136:120-32.

[19] Reid CE, Brauer M, Johnston FH, Jerrett M, Balmes JR, Elliott CT. Critical Review of Health Impacts of Wildfire Smoke Exposure. Environ Health Perspect. 2016;124(9):1334-43.

associations have been found between wildfire smoke exposure and exacerbations of asthma, COPD, bronchitis and pneumonia.[17,18,19]

Studies have linked fine particulate matter to increased risks of heart attacks and sudden death from cardiac arrhythmia, heart failure, or stroke.[20] The epidemiological data specifically linking wildfire smoke exposure to cardiovascular morbidity and mortality have been mixed, although several recent studies identified elevated risks of specific health outcomes, including emergency department visits for ischemic heart disease, dysrhythmia, heart failure, pulmonary embolism, and stroke.[21,22]

The following sections provide more specific information on population groups that may be particularly sensitive to wildfire smoke.

Infants and Children

All children are considered sensitive to the adverse health effects of air pollution, including wildfire smoke, because their lungs and immune systems are still developing. Several factors lead to increased exposure in children compared with adults – children inhale more air (and therefore more pollutant) per pound of body weight; tend to spend more time outside; and engage in more vigorous activity – all of which can contribute to adverse effects on developing lungs.[23]

Wildfire smoke may exacerbate asthma symptoms and trigger attacks. In a study of Medi-Cal beneficiaries associated with a large wildfire in San Diego, young children (age 0-4) appeared most affected by wildfire smoke, with increased emergency department visits for asthma, upper respiratory infections, and acute bronchitis.[24] The researchers found that:

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

[21] Wettstein ZS, Hoshiko S, Fahimi J, Harrison RJ, Cascio WE, Rappold AG. Cardiovascular and Cerebrovascular Emergency Department Visits Associated With Wildfire Smoke Exposure in California in 2015. J Am Heart Assoc. 2018;7(8).

[22] DeFlorio-Barker S, Crooks J, Reyes J, Rappold AG. Cardiopulmonary Effects of Fine Particulate Matter Exposure among Older Adults, during Wildfire and Non-Wildfire Periods, in the United States 2008-2010. Environ Health Perspect. 2019;127(3):37006.

[23] Sacks JD, Stanek LW, Luben TJ, et al. Particulate matter-induced health effects: who is susceptible? Environ Health Perspect. 2011;119(4):446-54.

[24] Hutchinson JA, Vargo J, Milet M, et al. The San Diego 2007 wildfires and Medi-Cal emergency department presentations, inpatient hospitalizations, and outpatient visits: An observational study of smoke exposure periods and a bidirectional case-crossover analysis. PLoS Med. 2018;15(7):e1002601.

- Respiratory diagnoses, especially asthma, were elevated during the wildfires in the vulnerable population of Medi-Cal beneficiaries
- Wildfire-related healthcare utilization appeared to persist beyond the initial high-exposure period
- Increased adverse health events were apparent even at mildly degraded AQI levels

It is possible that children without asthma may also experience respiratory symptoms, resulting in school absences and other limitations of normal activities. Children may also experience significant emotional distress from wildfires and smoke.

A recent study examined rhesus macaque monkeys who were exposed to wildfire smoke from California's 2008 wildfires during infancy and tested at three years of age (adolescence).[25] Wildfire smoke-exposed monkeys displayed significantly reduced inspiratory capacity, residual volume, vital capacity, functional residual capacity, and total lung capacity per unit of body weight relative to control animals. The researchers concluded that wildfire smoke exposure during the postnatal period was associated with immune dysregulation and reduced lung function in adolescence.

Stanford researchers examined the impact of wildfire versus prescribed fire (controlled burns) on the immune and cardiovascular systems of children.[26] The researchers found that children were exposed to higher air pollutant levels during the wildfire than during a similar-sized controlled burn, and the difference was reflected by changes in immune markers. More research is needed on the public health value of using prescribed fire to reduce the high fuel levels that can lead to large wildfires.

Older Adults

Older adults are considered more sensitive to the adverse health effects of wildfire smoke due to a gradual decline in physiological processes and the higher prevalence of lung and heart diseases found in this age range compared to younger groups.

Liu et al. studied associations between wildfire-specific fine particles and the amount of hospital admissions for respiratory causes among those older than 65 years in the western

[25] Black C, Gerriets JE, Fontaine JH, et al. Early Life Wildfire Smoke Exposure Is Associated with Immune Dysregulation and Lung Function Decrements in Adolescence. Am J Respir Cell Mol Biol. 2017;56(5):657-666.

[26] Prunicki M, Kelsey R, Lee J, et al. The Impact of Prescribed Fire versus Wildfire on the Immune and Cardiovascular Systems of Children. Allergy 2019.

U.S.[27] They found that the increased risk of respiratory admission was higher for women than for men (10.4% vs. 3.7%), blacks than whites (21.7% vs. 6.9%), and, although associations were not statistically different, people in counties with lower educational attainment compared to counties with higher educational attainment (12.7% vs. 6.1%).

Wettstein et al. examined cardiovascular and cerebrovascular emergency department visits and wildfire smoke exposure among adults in eight California air basins in 2015.[21] They found:

- Wildfire smoke exposure was associated with increased rates of emergency department visits for numerous cardiovascular disease outcomes, including ischemic heart disease, dysrhythmia, heart failure, pulmonary embolism, and stroke
- The observed risk was greatest among adults aged > 65 years

Pregnant Women

Physiologic changes occur during pregnancy (e.g., higher respiratory rates and increased blood and plasma volumes) that influence a woman's vulnerability to environmental exposures. Holstius et al. examined the impact of wildfire smoke on pregnancy outcomes in Southern California.[28] The researchers found that pregnancy during these wildfires was associated with slightly reduced average birth weights among infants exposed *in utero* (9.7 g lower when exposure occurred during the second trimester and 7 g lower when exposure occurred during the third trimester). A small decline in birth weight is unlikely to have clinical relevance for individual infants and there is debate about whether a small shift in the population distribution of birth weight has broader health implications. Furthermore, it is not known how the psychological stress that may result from wildfires affects the health of pregnant women and their fetuses.

People with Lung Conditions

Persons with asthma, chronic obstructive pulmonary disease (COPD), or other chronic lung diseases may experience breathing difficulties during smoke events. Asthma is characterized by chronic inflammation of the bronchi and smaller airways with intermittent airway constriction that may lead to coughing, wheezing, and shortness of breath.

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[27] Liu JC, Wilson A, Mickley LJ, et al. Who Among the Elderly Is Most Vulnerable to Exposure to and Health Risks of Fine Particulate Matter From Wildfire Smoke? Am J Epidemiol. 2017;186(6):730-735.

[28] Holstius DM, Reid CE, Jesdale BM, Morello-Frosch R. Birth weight following pregnancy during the 2003 Southern California wildfires. Environ Health Perspect. 2012;120(9):1340-5.

Individuals with COPD, encompassing emphysema and chronic bronchitis, may also experience worsening of symptoms due to exposure to wildfire smoke. Patients with COPD often have an asthmatic component to their condition that may result in their experiencing asthma-like symptoms. However, because their lung capacity is usually reduced, additional airway constriction may result in symptoms requiring medical attention.

Extensive evidence from epidemiologic studies focusing on exposure to fine particles demonstrates increased risk of emergency department visits and hospital admissions for asthma and COPD.[20] In a review, Reid et al. found consistent evidence of associations between wildfire smoke exposure and respiratory morbidity in general, and specifically for exacerbations of asthma and COPD.[19]

People with Heart Conditions

Cardiovascular disease is the leading cause of mortality in the U.S. and includes high blood pressure, heart failure, and vascular diseases such as coronary artery or cerebrovascular disease. Air pollution studies have linked particulate matter to increased risks of heart attacks, heart failure, cardiac arrhythmias, and other adverse effects in those with existing cardiovascular disease.[20] Chemical messengers released into the blood due to lung inflammation may increase the risk of blood clot formation, angina episodes, heart attacks, and strokes. Despite this evidence regarding cardiovascular effects, wildfire-related cardiovascular studies have been inconsistent, although several recent investigations have identified elevated risks of specific health outcomes, including increased rates of emergency department visits for ischemic heart disease, dysrhythmia, heart failure, pulmonary embolism, and stroke.[21,22]

Wettstein et al. conducted a population-based epidemiologic analysis of cardiovascular and cerebrovascular emergency department visits and wildfire smoke among adults in eight California air basins during 2015.[21] A positive association was found between wildfire smoke density and emergency department visits attributable to cardiovascular, cerebrovascular, and respiratory disease. Impacts were greatest on medium and dense smoke days and among adults aged ≥65 years, although also observed among younger age groups for some clinical conditions.

People with Social Vulnerabilities

Certain groups have increased sensitivity to wildfire smoke based on life stage (e.g., children and older adults) or the presence of one or more medical conditions (e.g., lung and heart conditions). Other groups may be more vulnerable to the adverse health impacts of wildfire smoke due to other reasons, including but not limited to socioeconomic status, housing, access to health care, race/ethnicity, access and functional needs, and language barriers.

People of color and impoverished children and adults bear a disproportionate burden of asthma and other respiratory diseases.[29] Some groups experience greater exposure due to living conditions (e.g., those who are homeless or live in poorly insulted housing without air filtration) or who work outdoors (e.g., farm workers, day laborers, utility workers).

Resource constraints directly impact the ability of certain groups to avoid high-smoke environments or implement mitigation strategies such as improved filtration or the use of portable air cleaners.

The following table summarizes the main groups that are currently recognized as sensitive to wildfire smoke:

Group	Potential Health Effects from Wildfire Smoke
Children	All children: possible coughing, wheezing, difficulty breathing, chest tightness, decreased lung function. Children with asthma: possible worsening of asthma symptoms, heightened risk of asthma attacks.
Older adults	Possible exacerbation of heart and lung disease leading to the need for medical care, emergency department visits or hospital admissions.
People with lung disease	Possible breathing difficulties (e.g., coughing, wheezing, and chest tightness) and exacerbations of chronic lung diseases (e.g., asthma and COPD) that may lead to increased medication usage, emergency department visits, or hospital admissions.
People with heart disease	Possible triggering of ischemic events, such as angina, heart attack, or stroke; abnormal heart rhythms that could lead to emergency department visits or hospital admissions; worsening of heart failure.
Pregnant women	Limited evidence shows air pollution-related effects on pregnant women and the developing fetus.
People with social vulnerabilities	Greater exposure to wildfire smoke due to reduced access to measures to reduce exposure, along with a higher likelihood of untreated or inadequately treated health conditions such as lung, heart, or metabolic disease. Those who must work outdoors may experience greater exposure due to environmental working conditions.

Table 5. Summary of population groups that may be more sensitive to wildfire smoke

[29] Brim SN, Rudd RA, Funk RH, Callahan DB. Asthma prevalence among US children in underrepresented minority populations: American Indian/Alaska Native, Chinese, Filipino, and Asian Indian. Pediatrics. 2008;122(1):e217-22.

Community Vulnerability

Past wildfires have shown that specific groups and communities face heightened vulnerability to wildfires and wildfire smoke. Identifying communities that are most vulnerable to adverse health outcomes due to wildfire smoke exposure can increase community resilience by focusing on pre-incident planning and mitigation activities.

Environmental justice (EJ) communities[15,16] are commonly identified as those where residents are predominantly low-income or people of color; where they are subject to a disproportionate impact from one or more environmental hazards; where residents have been excluded from the environmental policy setting or decision-making process; and where residents experience disparate implementation of environmental regulations, requirements, practices and activities in their communities. Environmental justice efforts attempt to address the inequities of environmental protection in these communities.

Planning activities should consider the environmental justice status of communities, as people living in such communities may experience higher exposures due to reduced access to mitigation options during wildfire smoke events (e.g., access to air conditioned spaces, ability to leave the area, ability to reduce time spent laboring outdoors, etc.)

A study by Rappold et al.[30] developed an index of community vulnerability based on factors known to define susceptibility to the adverse health effects of air pollutants. These factors included county prevalence rates for asthma in children and adults, COPD, hypertension, diabetes, obesity, percent of population 65 years of age and older, and indicators of socioeconomic status including poverty, income and unemployment.

The California CalBRACE[31] project assesses community vulnerabilities based on type of environmental exposure, population sensitivity, and adaptive capacity. The factors included in CalBRACE are:

• Children	• Households w/o Vehicles
• Elderly	• Linguistic Isolation
• Poverty	• Physical and Mental Disability
• Educational Attainment	• Adults Lacking Health Insurance
• Outdoor Workers	• Violent Crime Rate

[30] Rappold AG, Reyes J, Pouliot G, Cascio WE, Diaz-Sanchez D. Community Vulnerability to Health Impacts of Wildland Fire Smoke Exposure. Environ Sci Technol. 2017;51(12):6674-6682.

[31] California Building Resilience Against Climate Effects (CalBRACE)

Information on Climate Change and Health Vulnerability Indicators for California are provided by CDPH's Climate Change and Health Equity Program at https://cdph.ca.gov/cchviz.

County data are available at:
https://www.cdph.ca.gov/Programs/OHE/Pages/ClimateHealthProfileReports.aspx.

Information on adaptive capacity and resilience factors within communities can be found here: https://www.naacp.org/wp-content/uploads/2016/04/Equity_in_Resilience_Building_Climate_Adaptation_Indicators_FINAL.pdf

In California, a community-based environmental monitoring network was developed to fill the need for more detailed data on particulate matter in an area that often exceeds air quality standards.[32] The network provides real-time particulate matter data from 40 low-cost sensors throughout Imperial County.

CARB maintains a list of known community air monitoring networks at Community Air Monitoring Systems in California.

[32] English PB, Olmedo L, Bejarano E, et al. The Imperial County Community Air Monitoring Network: A Model for Community-based Environmental Monitoring for Public Health Action. Environ Health Perspect. 2017;125(7):074501.

STRATEGIES TO REDUCE EXPOSURE

Basics

Prior to discussing options to reduce exposure, it may be helpful to consider the primary factors that determine exposure to the harmful air pollutants in wildfire smoke. Understanding the relationship between these variables can assist public health officials, healthcare providers, and risk communication professionals in recommending exposure reduction strategies. These factors include:

1) Concentration of the wildfire smoke pollutant (e.g., PM2.5) near the breathing zone
2) Rate at which the pollutant is inhaled into the lungs (pulmonary ventilation)
3) Duration of exposure (time spent in smoky conditions)

The second factor is a function of the person's *respiratory rate* and the volume of air contained in each breath called *tidal volume*; the product of these is *pulmonary ventilation*.[33] The table below illustrates how much ventilation can increase from rest to moderate activity to vigorous activity:

Breathing at Rest, Moderate Activity, and Vigorous Activity[34]			
	Respiratory Rate (breaths/minute)	**Tidal Volume (liters/breath)**	**Pulmonary Ventilation (liters/minute)**
Rest	12	0.5	6
Moderate Activity	30	2.5	75
Vigorous Activity	50	3.0	150

Table 6. Breathing parameters at rest, moderate activity, and vigorous activity (estimate for adult male).

Ventilation at rest averages about 6 liters/minute but can increase to 75 liters/minute with moderate activity (12-fold increase) and up to 150 liters/minute with vigorous activity (25-fold increase).

[33] In reference to human breathing, *ventilation* is the movement of air between the lungs and atmosphere (commonly referred to as pulmonary or minute ventilation). In reference to buildings or homes, *ventilation* refers to the provision of fresh air to the indoor space.

[34] Both breathing frequency (respiratory rate) and the size of an inhaled breath (tidal volume) increase with exertion level. At rest, most people breathe through their nose, which helps to filter incoming air.

Considering these three factors, the optimal strategy is to avoid high concentrations of smoke; reduce or eliminate exertion in smoky environments; and reduce or eliminate time spent in smoky environments.

Stay Indoors

This common advisory issued during wildfire smoke events requires two qualifications:

1) Indoor air quality should be better than outdoor air quality, and
2) In warm/hot conditions, the risk of overheating must be avoided

The value of staying indoors and closing windows to avoid smoke exposure depends on how well the home or building prevents infiltration of outdoor smoke coupled with the ability to maintain acceptable air quality (e.g., enhanced filtration, air cleaners). In general, newer homes have a tighter building envelope and are more effective at keeping smoke out. In leaky homes and buildings, outdoor particulate matter can more easily infiltrate indoors, in which case guidance to stay inside provides less protection.

It is important to prioritize the avoidance of heat stress and remember to refresh the air in homes when smoke levels subside.

When windows are open, the indoor concentration of particulate matter can approach 70% to 100% of outdoor levels; however, when windows are closed, it is more common that the indoor concentrations of particulate matter are 50% or less of outdoor concentrations.[35,36]

Activity surveys indicate that people spend approximately 85% of their time indoors, 5% of their time in a vehicle, and 10% of their time outdoors.[37] Because people spend such a large percentage of their time indoors, a significant portion of total personal exposure to particulate matter occurs in indoor environments.

An important drawback of advising people to stay inside and close windows and doors of homes without air conditioning during smoke events is the increased risk of heat stress.[38]

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[35] Allen RW, Adar SD, Avol E, et al. Modeling the residential infiltration of outdoor PM(2.5) in the Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air). Environ Health Perspect. 2012;120(6):824-30.

[36] Chen C, Zhao B. Review of relationship between indoor and outdoor particles: I/O ratio, infiltration factor and penetration factor. Atmos Environ. 2011;45(2):275–288.

[37] Klepeis NE, Nelson WC, Ott WR, et al. The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. J Expo Anal Environ Epidemiol. 2001;11(3):231-52.

[38] The term *air conditionin*g refers to controlling temperature, moisture, and ventilation.

Extreme heat conditions pose a substantial health risk, especially for vulnerable populations including young children, elderly, those with chronic diseases or disabilities, and pregnant women.

If temperatures are high during a smoke event, people who do not have access to cleaner, cool air at home should be advised to visit family members, neighbors, or public buildings with air conditioning and enhanced air filtration. The same suggestion applies to people who live in older, leaky homes who don't have forced air systems that can accommodate better filters. Examples of potentially suitable locations include libraries, indoor shopping malls, or cooling centers. Some public buildings may have older air conditioning systems that use low efficiency filters, in which case they may be less adequate with respect to providing substantially cleaner air. In coordination with local emergency managers, public health officials should obtain information about the filtration and cooling capabilities of buildings prior to recommending specific shelters.

Long-term smoke events usually have periods when the air quality is better. When air quality improves, even temporarily, homes should be aired out to reduce indoor air pollutants.

Avoid High Smoke Periods

Smoke levels may change substantially over the course of day and night, creating opportunities to tailor activities to avoid the worst periods of smoke. Wildfire smoke impacts often follow a pattern, e.g., nighttime smoke travels downhill and settles into valleys before lifting out the next day. Communities farther downwind from a fire may see smoke arrive in the mid-to-late afternoon and occasionally remain overnight. It is often possible for people to plan their day to avoid exposure during the smokiest periods.

To obtain air quality information during smoke events, check the web site of the local/regional air agency or see "Current Conditions" on the US EPA's AirNow website (AirNow Current Conditions). Another source of rapidly updated information is the PurpleAir website (PurpleAir Map); see section on Low-Cost Sensors for more information on the application of low-cost air quality sensors.

Specific wildfire smoke impacts may be forecast and posted on state smoke blogs, including the California Smoke Blog at https://californiasmokeinfo.blogspot.com/. Information may also be found on the InciWeb site at https://inciweb.nwcg.gov/. Additionally, local air agencies are most familiar with their area and may provide wildfire smoke forecasts.

Manage Indoor Air Quality

The degree to which wildfire smoke exposure is reduced within any building, including homes, depends on two factors:

1) How well the building is sealed (which slows the rate of smoke entry), and
2) How quickly and effectively any available air cleaning equipment removes smoke from the indoor air.

By slowing the rate that smoke enters, there is more time for air cleaning equipment and natural removal processes to reduce the concentration of smoke inside the building.

Reducing smoke entry starts with closing all windows and doors and turning off any fans that operate routinely to provide ventilation, i.e., the entry of outdoor air. Starting in 2008, California statewide building standards have required that all newly constructed or extensively renovated homes must have ventilation fans to ensure that there is always enough outdoor air coming into the home. Normally, this helps to maintain indoor air quality. These ventilation fans should be turned off during outdoor air pollution events – including wildfire smoke events – and turned on again when wildfire smoke (or other pollution) clears. The most common system is an exhaust fan that is designed to operate continuously at low speed or intermittently at higher speed, e.g., for 20–30 minutes every hour. These fans may be in the laundry room or one of the bathroom fans. In some homes, ventilation is provided by a ducted connection between the central forced air heating and cooling system and outdoors. These may be called a “fresh vent” or “outdoor air supply vent” and the airflow through them may be controlled by the thermostat or by a separate controller. California statewide building standards require labeling of switches that control ventilation fans although labels are sometimes unclear or missing. If you live in a newer home or think you may have a ventilation fan, it is helpful to determine in advance how to control the system.

There are two main ways that pollutants can be removed from air in homes:

1) By operating a forced air system with suitable filters, and
2) By operating standalone or portable air filtration units

Some air pollutants – including fine particulate matter, nitrogen dioxide, and odorous compounds – are also removed from the air by interactions with materials inside the home, including walls, flooring, furniture and furnishings.[39] The speed of this removal process – called deposition – varies based on many factors, but is generally fast enough to substantially

[39] Chemical reactions and transformations can also impact air pollutants in the home but those processes are generally less important than the ones noted above.

reduce the levels of these pollutants. Deposition is faster when there is more air movement, so operating fans inside the house can help. (Note that some of the deposited odorous compounds will move back from materials into the air after the smoke event has ended and may present a residual odor challenge.)

Many California homes have a central forced air system that draws air from the living space, heats or cools the air as needed, then pushes air back into the home through registers on the walls or ceilings. Air is pulled from the house through one or more large "return" grilles that are usually located near the center of the house with at least one per floor.

Every forced air system should have slots for filter(s) either behind the return grilles or at the location where the return ductwork is connected to the heating or cooling system. Originally, filters were designed to protect only the heating and cooling equipment, but today there are many filters available for under $20 that can remove a substantial fraction of particulate matter from smoke and other sources of air pollution. If there are no filters behind the return grille(s), they may be with the heating and cooling system located in the attic, garage, crawlspace, or a utility closet.

Modern forced air systems can be set to circulate air – from the return grille, through the filter, and back out to the supply registers – even when no heating or cooling is needed. This type of operation can be controlled using the thermostat and typically involves setting the fan to "on" or "circulate" mode.

If you have a forced air system, it is generally recommended to use the highest performance filter(s) that the system can accommodate as it will improve indoor air quality in general and especially when there are challenges such as wildfire smoke events. However, caution should be taken to ensure that the central air system is able to handle the increased airflow resistance that may result from a higher efficiency filter. It may be necessary to consult with an HVAC technician or the central air system manufacturer to confirm performance requirements for high efficiency filters to work with any specific system.

Filtration efficiency is a function of the *fractional removal efficiency* of a filter and *airflow*. Filters can remove particles only when the system fan is on and passing air through the filter. A filter's performance rating is based on an industry standard called the *Minimum Efficiency Reporting Value* (MERV) that can range from MERV 1 to MERV 16, or proprietary test metrics developed by certain manufacturers including the *Microparticle Performance Rating* (MPR) and *Filter Performance Rating* (FPR). In general, the higher the filter rating, the higher the filter's removal efficiency.

Rating System	Best	Very Good	Good	Special Use
MERV (general industry standard)	MERV 12 or better	MERV 9-11	MERV 7-8	MERV 16 or HEPA
FPR (Honeywell)	FPR 8-10	FPR 7	FPR 5	
MPR (3M Filtrete)	MPR 2200 or better	MPR 1000-1900	MPR 600	

Table 7. Filter rating systems[40]

Because high-efficiency filters may be difficult to find during a wildfire smoke event, it is strongly recommended that a supply of such filters be obtained before fire season, particularly if the household includes people who may be sensitive to wildfire smoke (children, pregnant women, older adults, those with heart or lung conditions, or anyone who is sensitive to wildfire smoke).

Filters should be replaced on a regular basis and always after a wildfire smoke event.

To summarize, the following actions should be considered during wildfire smoke events:[41]

- Keep windows and doors closed
- Close fireplace dampers
- If applicable to your system, turn off continuous ventilation systems that pull in outside air
- Upgrade to higher efficiency filters (MERV 12 or higher)
- Operate central fan on "circulate"

Reduce Indoor Sources of Air Pollutants

There are numerous sources of indoor air pollutants that should be reduced to the extent possible during a wildfire smoke event. Examples include smoking cigarettes; using gas, propane and wood-burning stoves and furnaces that are not vented to the outside; frying or broiling foods; burning candles or incense; and using cleaning methods that promote the re-suspension of particles (e.g., dusting or using a vacuum without HEPA filtration).

[40] See http://built-envi.com/wp-content/uploads/Fazli-and-Stephens-Air-Media-Fall-2016-In-situ-Filter-Testing.pdf for additional information on filter efficiency.

[41] Heat can be more dangerous than wildfire smoke; seek a cooler environment if necessary.

To illustrate the impact of indoor air pollutants, it takes about 10 minutes for the smoke of a single cigarette in a standard room (125 square feet) to generate hazardous indoor levels of PM2.5 (160 µg/m^3). This corresponds to an AQI in the "Very Unhealthy" range.

Combustion processes that are not properly vented to the outdoors can be another source of indoor air pollutants. "Room-vented" or "vent-free" appliances such as unvented gas or propane fireplaces, decorative logs, and portable heaters can contribute substantial quantities of pollutants to indoor air.

Frying or broiling at high heat generally produces high levels of particulate matter. These sources can also increase the levels of polycyclic aromatic hydrocarbons, carbon monoxide, acrolein, and nitrogen oxides, all of which are potentially harmful to health. Burning candles and incense can produce surprisingly large quantities of particulate matter and should be avoided during smoke events.

Lastly, certain cleaning practices can affect indoor air quality. People who wish to clean their residences during or after smoke events should use cleaning practices that reduce re-suspension of particles that have settled. Preferred cleaning activities include using a HEPA filter-equipped vacuum, damp-mopping, and dusting with a damp cloth. Hosing off window screens in addition to cleaning window coverings may also be helpful. Because chemical cleaning products should be used in a well-ventilated environment, it may be better to clean after the smoke has cleared and outdoor air quality is acceptable, allowing ventilation of the home's interior during the use of cleaning products.

Use California-Approved Air Cleaners

Portable air cleaners[42] can be very helpful for improving indoor air quality during a smoke event. Particularly for homes that have smoke-sensitive occupants, the decision to purchase an air cleaner is best made before a smoke event occurs. Smoke events can lead to a high demand for air cleaners and commercial suppliers may not be able to meet the demand.

Air cleaners will provide the most protection when placed where people spend most of their time, such as a bedroom. Air cleaners generally work better in smaller rooms rather than large spaces.

Air cleaners have different air-cleaning capacities. It is important to match the air cleaner's specifications to the size of the space to be cleaned. The Association of Home Appliance Manufacturers (AHAM) maintains a certification program for air cleaners

[42] Machines that remove particulate matter from air may be called portable air cleaners, air scrubbers, air purifiers, or negative air machines. Air cleaners that produce ozone should be avoided.

(http://ahamverifide.org/directory-of-air-cleaners/). The *Clean Air Delivery Rate* (CADR) is a rating that combines efficiency and airflow; the higher the CADR, the faster the unit filters air. CADR numbers are reported based on the highest fan speed.

The AHAM seal on the air cleaner's box lists three CADR numbers – one for tobacco smoke, one for pollen, and one for dust. The CADR for tobacco smoke is most relevant to wildfire smoke.

As a general rule of thumb, choose a unit with a CADR for tobacco smoke that is at least 2/3 of the room's area. For example, a 10' x 12' room (120 square feet) would require an air cleaner with a CADR for tobacco smoke of at least 80 (higher numbers are even better). If the ceiling is higher than 8', an air cleaner rated for a larger room is needed.

If the goal it to clean the air in a larger room, e.g., 500 square feet, a higher-capacity air cleaner is needed. Again, using the 2/3's rule, an air cleaner with a minimum CADR of 333 for tobacco smoke would be needed.

To maximize effectiveness, operate the portable air cleaner continuously or as often as possible on the highest fan speed. Ensure that airflow to the air cleaner is not obstructed. Keep doors and windows closed to prevent additional particulate matter from entering the room.

Generally, air cleaners with higher CADRs cost more than smaller capacity units and also tend to be noisier due to larger fans. If occupants are sensitive to noise and have the resources, an option would be to purchase multiple, smaller units that operate on lower, quieter speeds.

The California Air Resources Board (CARB) certifies air cleaners that produce little or no ozone, which is a respiratory irritant. Only CARB-certified air cleaners may be sold in California. See their list of certified air cleaners at http://www.arb.ca.gov/research/indoor/aircleaners/certified.htm.

Devices that remove gases and odors in addition to PM typically cost more to purchase and maintain. They force air through materials such as activated charcoal or alumina coated with potassium permanganate. However, with smaller-sized air cleaners, the filtering medium can become quickly overloaded and may need to be replaced often. Large gas-removing devices may be useful for sensitive individuals and may require less frequent replacement of the filtering medium. New models that combine particle and gas removal are available in both portable and in-duct models.

Portable air cleaners may be used in combination with central forced air system filter upgrades as described in the preceding section to maximize the reduction of indoor particles. One strategy – if resources allow – is to use the central forced air system for air cleaning

when household members are moving about the house then use a portable air cleaner in each occupied bedroom overnight (with the central system turned off). Portable air cleaners can effectively reduce particle concentrations even in homes that do not have central air conditioning if windows and doors remain closed and excessive heat is not a concern.

Fisk and Chan investigated the impact of six different filtration interventions to reduce indoor exposure to PM2.5 during a 10-day period of wildfires in Southern California.[43] They estimated the reduction in PM2.5 due to each intervention:

Forced Air System Operation	Efficiency of Filter in Forced Air System	Continuously Operating Portable Air Cleaner	Decrease in Predicted PM2.5 Concentration
Continuous	Upgraded to high	Yes	62%
Continuous	Typical low	Yes	51%
Continuous	Upgraded to high	No	47%
No forced air	N/A	Yes	45%
Continuous	Typical low	No	24%
Intermittent	Upgraded to high	No	11%

Table 8. Comparison of filtration interventions

As can be seen, simply running a forced air system continuously, with no filter upgrade, reduces PM2.5 in the home by an estimated 24%, while continuous fan operation plus a filter upgrade doubles the benefit to 47%. The combination of continuous forced air system operation coupled with a filter upgrade and a portable air cleaner leads to the greatest PM2.5 reduction of 62%.

Create a Clean Space at Home

People who live in areas where the wildfire risk is high, particularly those who are more sensitive to wildfire smoke, may wish to prepare a “clean room” in their home before the next smoke event. A good choice is an interior room, with as few windows and doors as possible, where people spend most of their time. It is easier to clean air in a smaller room in comparison to a larger room.

[43] Fisk WJ, Chan WR. Health benefits and costs of filtration interventions that reduce indoor exposure to PM2.5 during wildfires. Indoor Air. 2017;27(1):191-204.

Some suggestions for preparing and maintaining a clean room (in addition to the other actions taken, such as turning off any automatic ventilation systems in newer homes, upgrading the filter in a forced air system, etc.):

- Keep windows and doors closed (unless this leads to a dangerous heat situation).
- Set up a properly-sized portable air cleaner to help remove particulate matter from indoor air while emitting no or minimal levels of ozone.
- Run the air conditioning system if you have one. If the air conditioner provides a fresh air option, keep the fresh-air intake closed to prevent smoke from getting inside. Make sure that the filter is clean enough to allow good airflow.
- Do not smoke or burn anything in the house, including candles or incense.
- Smoke events usually have periods when the air quality is better. When air quality improves, even temporarily, air out your home to reduce indoor air pollutants.
- If it is too warm to stay inside with the windows closed, or if you are especially sensitive to smoke, consider temporary relocation, i.e., seek shelter elsewhere. Some particulate matter will enter a home even if efficient filtration and air cleaners are employed.
- If necessary, use cleaning activities that do not re-suspend particles:
    - Use a HEPA-filter equipped vacuum
    - Clean hard surfaces by damp-mopping or damp-dusting
    - Ideally, wait until the smoke clears to use household cleaners, since chemical cleaning products should be used in a well-ventilated environment

Reduce Physical Activity in Smoke

Reducing or eliminating physical exertion is an effective strategy to lower the dose of inhaled air pollutants during a smoke event. As described in the “Basics” section, people can increase their air intake by as much as 10 to 25 times their resting level through physical exertion. Increased breathing rates and deeper breathing patterns bring more pollution into the gas exchange areas of the lungs.

At rest, most people breathe primarily through their noses. During exercise, people breathe more through the mouth, bypassing the natural filtering ability of the nasal passages. They also tend to breathe more deeply, modifying the usual patterns of particulate matter deposition in the lungs.

Children tend to rely more on oral breathing compared to adults at rest and during exercise, further emphasizing the need for children to avoid exercising in smoky conditions.

The best option for exercise during smoky periods is to identify an indoor environment with acceptable air quality or a forecasted period of improved outdoor air quality.

Consider Temporary Relocation

Temporarily leaving an area impacted by dense smoke may the best protective measure for people who are particularly sensitive to wildfire smoke. Another option is the possibility of re-locating to a more protective house within the area. However, this may be difficult for many, since a number of factors influence the ability to temporarily relocate, including work commitments, children in school, financial considerations, etc.

Use Approved Respirator if Necessary and Safe

This section provides basic information on respirators and considerations relative to their use to reduce exposure to wildfire smoke.

The most effective action the public can take to reduce the risk of health effects from the inhalation of wildfire smoke is to stay indoors in cleaner air and minimize the amount of time spent outdoors in smoky conditions.[44] People with pre-existing medical conditions should check with their healthcare provider before using a respirator, since using a respirator can make it harder to breathe.

The N95 respirator is a common type of particulate filtering facepiece respirator.[45] N95 respirators must be certified by the National Institute of Occupational Safety and Health (NIOSH) to filter at least 95% of airborne particles greater than 0.3 microns in size. It is important to understand that N95 respirators only filter particulates; they do not reduce exposure to other potentially harmful constituents of wildfire smoke such as gases.

There are other types of paper masks that are commercially available but unless they are NIOSH-certified as N95 or higher (e.g., P100), they are unlikely to protect against the particulate matter contained in smoke.

[44] The advice to "stay indoors" assumes the indoor environment does not present heat risk. Heat risk should be avoided.

[45] An N95 respirator may also be called an *air-purifying respirator* or *filtering facepiece respirator*. N95 respirators are sometimes referred to as "masks". The "N" indicates the filtering material is not resistant to oil.

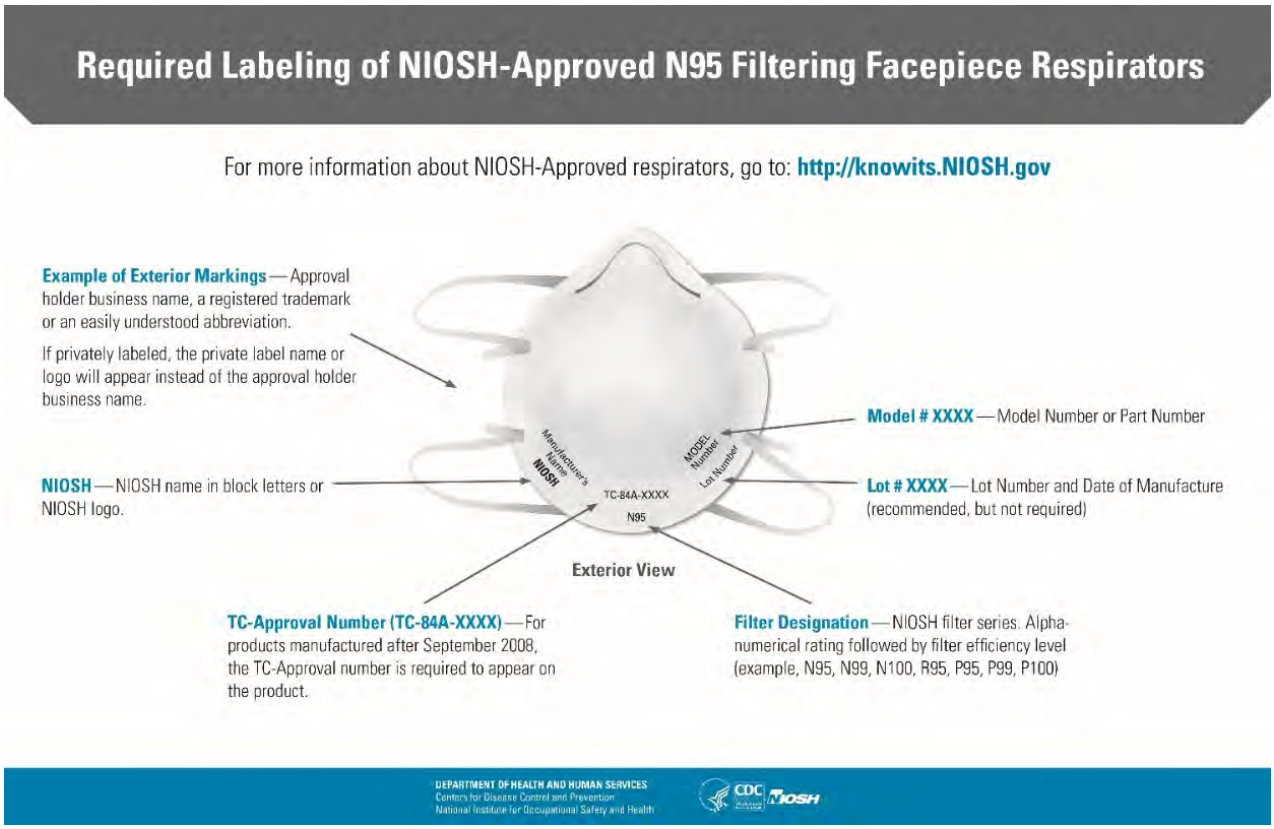

Figure 7. Required Labeling of NIOSH-Approved N95 Respirators.

When a person is required to wear a respirator for protection from occupational hazards, specific regulations apply that include: 1) medical evaluation and clearance (to determine if the user is physically fit to wear a respirator); 2) fit testing (to determine which respirator model/size provides the proper fit for the user), and 3) training (to ensure the user is familiar with respirators, proper use, and protective limitations). All of these conditions are met by a comprehensive respiratory protection program that is the responsibility of the employer.[46] In California, the Division of Occupational Safety and Health (Cal/OSHA) is responsible for enforcing California laws and regulations pertaining to workplace safety and health.[47]

N95 respirators are commercially available to the public. In a non-occupational application, there are no requirements for medical evaluation, fit testing, and training. However, for those who must be outdoors during smoke events, N95 respirators offer some protection for adults if selected and used properly, although the public should be advised to take more effective measures first to limit their exposure.

[46] California Regulation on Respiratory Protection; Guide to Respiratory Protection at Work

[47] Cal/OSHA

It is difficult to assess the relative benefits and risks of N95 respirator usage in members of the public who may have pre-existing medical conditions. While these individuals may be more sensitive to the adverse effects of wildfire smoke compared to healthy individuals, they may also be more sensitive to the physiologic or psychological burden of wearing an N95 respirator. To date, there is no published research examining the relative benefits and risks of wearing an N95 respirator across the full range of people who may be exposed to wildfire smoke.

The majority of published studies on the physiologic burden of wearing an N95 respirator have been conducted in healthy individuals, not a representative sample of the general population that includes people with a variety of pre-existing medical conditions. Research studies have identified certain consequences of wearing an N95 respirator, including:[48,49]

- Discomfort due to thermal stress in the area of the respirator
- Mildly increased breathing resistance
- Carbon dioxide buildup and oxygen reduction in the space between the respirator and face

The FDA website on *Masks and N95 Respirators*[50] states:

> *"People with chronic respiratory, cardiac, or other medical conditions that make breathing difficult should check with their healthcare provider before using an N95 respirator because the N95 respirator can make it more difficult for the wearer to breathe."*

During recent smoke events, questions arose about the use of N95 respirators in infants and children. NIOSH does not currently certify respirators for children. If new research findings on safety and efficacy become available, guidance by U.S. government agencies may be issued on the proper use of respirators by older children.

During recent wildfires, state agencies also received questions regarding the respiratory protection of animals. The same principles are relevant to the protection of pets – avoid exposure to smoky air to the extent possible. See Protect Your Pets from Wildfire Smoke and Wildfire Smoke and Animals.

In order for an N95 respirator to be effective at filtering particulate matter, the user must achieve a seal between the edges of the mask and the face. Leakage around the face seal

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[48] Roberge RJ, Coca A, Williams WJ, Powell JB, Palmiero AJ. Physiological impact of the N95 filtering facepiece respirator on healthcare workers. Respir Care. 2010;55(5):569-77.

[49] Tong PS, Kale AS, Ng K, et al. Respiratory consequences of N95-type Mask usage in pregnant healthcare workers-a controlled clinical study. Antimicrob Resist Infect Control. 2015;4:48.

[50] FDA Masks and Respirators

significantly reduces the effectiveness of the respirator. Wearing an N95 respirator without fit testing will provide an unknown level of protection. The presence of facial hair can impact the ability to achieve a good seal; NIOSH has provided an infographic on facial hair at Facial Hairstyles and Filtering Facepiece Respirators.

A research study evaluated the public's ability to properly don N95 respirators in post-Katrina New Orleans.[51] Respirators were strongly recommended for mold remediation activities and users were given a copy of the manufacturer's instructions for proper use. The most significant donning errors included:

• nose clip not tightened (71%)	• respirator worn upside down (22%)
• straps incorrectly placed (52%)	• only 1 of 2 straps used (21%)
• visible gap between respirator and skin (32%)	• facial hair (11%)

Overall, approximately 80% of the study population (433 out of 538 participants) exhibited at least one of the above donning errors. The authors concluded that although the New Orleans residents were highly motivated, most of the study participants did not properly don an N95 respirator, even when provided with manufacturer instructions.

Another study examined the fitting characteristics of 18 different N95 respirator models with and without fit testing.[52] Assuming that members of the general public will not be fit tested, it is relevant to consider how much protection may be provided by different examples of N95 respirators. In this study, subjects followed the manufacturer's instructions and performed a user seal check.[53] Using the Target Assigned Protection Factor (APF)[54] of 10, subjects achieved this target in 74% of donnings without fit testing when averaged across all 18 models of N95 respirators. It is worth noting that values for different N95 respirators ranged from 31% to 99%, depending on the fitting characteristics of the particular respirator. This illustrates that not all N95 respirators are equal – some N95 respirators have "good fitting characteristics" while others have less optimal fitting characteristics.

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[51] Cummings, K.J., Cox-Ganser, J., Riggs, M.A., Edwards, N. and Kreiss, K., 2007. Respirator donning in post-hurricane New Orleans. Emerging infectious diseases, 13(5), p.700; Respirator Donning in Post-Hurricane New Orleans.

[52] Coffey CC, Lawrence RB, Campbell DL, Zhuang Z, Calvert CA, Jensen PA. Fitting characteristics of eighteen N95 filtering-facepiece respirators. J Occup Environ Hyg. 2004;1(4):262-71.

[53] User Seal Check

[54] A Target Assigned Protection Factor (APF) of 10 means that no more than one-tenth of the contaminants to which the wearer is exposed will leak into the inside of the mask. An APF of 100 means only one percent leakage.

When the models were evaluated for their ability to achieve a Target APF of 3 or higher, subjects achieved this target without fit testing in 95% of donnings. The results of this study indicate that there is variability in the fitting characteristics of different N95 respirators, and that without fit testing, wearing an N95 respirator should offer some level of particulate protection for most wearers.[55]

A sample calculation illustrates the protective value of wearing an N95 respirator under ideal conditions (i.e., achieving full protection at an APF = 10) in comparison to a non-fit tested public where the PF may be closer to 3. An AQI of 301 for PM2.5 falls into the "Hazardous" (Maroon) range with a corresponding PM2.5 concentration of 250.5 µg/m^3. For a person wearing a well-fitting N95 respirator that achieves a PF of 10, the concentration of PM2.5 in the interior of the mask would drop to 1/10th of the ambient value, or 25 µg/m^3, corresponding to an AQI in the "Moderate" (Yellow) range. If the wearer achieves a PF of 3, the concentration of PM2.5 in the mask would drop to 1/3rd the ambient value, or 83.5 µg/m^3, corresponding to an AQI in the "Unhealthy" (Red) range.

Another concern regarding the use of N95 respirators by the public in response to wildfire smoke is the extent to which wearing an N95 respirator gives the wearer a "false sense of security". If a person voluntarily elects to wear an N95 respirator who has not been trained and fit-tested, they could theoretically risk unnecessary exposures under the assumption that the N95 respirator provides full protection. N95 respirators should be considered only when other more effective options are not available (such as remaining indoors in cleaner air).

In addition to NIOSH-certified N95 respirators, there are two other types of non-powered air purifying respirators (which should also be NIOSH-certified) shown below:

N95 Respirator **Half mask (Elastomeric)** **Full facepiece (Elastomeric)**

Figure 8. Air Purifying Respirators (Non-Powered).

[55] Assuming the person wearing the N95 respirator reads the manufacturer's instructions and performs a user seal check.

If the decision is made to provide N95 respirators to specific populations, the following considerations may be helpful:

- Provide a copy of the manufacturer's instructions for use with each N95 respirator
- Provide a list of possible contraindications to the safe use of N95 respirators
- Recommend that recipients consult with their healthcare provider prior to use if they have any concerns about their ability to safely wear an N95 respirator
- Provide detailed instructions on donning and doffing and tips for achieving proper fit
- Provide guidance on the prioritization of more effective protective actions
- Select N95 respirators with good fitting characteristics

Future Direction

It is clear that more research is needed to understand the safety and efficacy of personal interventions to reduce exposure to wildfire smoke. The impacts of specific exposure reduction methods on the general population, including people with a variety of medical conditions and social vulnerabilities, are largely unknown. Interventions such as enhanced air filtration and respiratory protection can be studied in controlled trials to evaluate health outcomes in different populations. In the meantime, healthcare providers and public health officials may wish to apply a hierarchal approach that guides advice regarding personal actions to reduce exposure.

PUBLIC HEALTH CONSIDERATIONS

Build Strong Partnerships in Advance

Local health officers, air agency officials, environmental health directors, school district officials, and emergency managers should establish strong working relationships prior to a wildfire smoke event. These relationships and pre-planning are critical to creating consistent messaging and coordinated response during smoke events.

California has total of 61 local health departments that include 58 county and 3 city health departments (Berkeley, Long Beach, and Pasadena). Environmental health may be part of the local health department or its own department, depending on the organization of the jurisdiction. California has 35 air agencies that have primary responsibility for monitoring air quality, many of which are single-county, although regional air agencies may span multiple counties. Local emergency management agencies include those at the county or city level. Tribal leaders or their representatives should be included in pre-incident planning activities.

Wildfire smoke events do not respect city or county boundaries. Prolonged, dense smoke events are likely to affect multiple jurisdictions in an area. It may be wise for officials to engage in pre-planning according to air basin geography rather than jurisdictional boundaries.

Ideally, jurisdictions will identify agreed-upon roles and responsibilities of response partners during a wildfire smoke event, including planned coordination activities. Planning for wildfire smoke should include the following:

- Local health department
- Local/regional air agency
- Local environmental health office/department
- Local school district(s)
- Local emergency management agency

Public Messaging

Consistent public messaging about current air quality, forecasted air quality, and recommended protective actions is helpful to the public who may be concerned and anxious during smoke events. Messaging should strive to be multilingual and accessible to people of different abilities (e.g., low literacy levels, vision impaired).

Communication is more effective if the involved local/regional agencies collaborate on issuing joint advisories, or at a minimum, communicate the same information to their respective audiences. Under stress, the public seeks trustworthy information and can become frustrated when information is not consistent among sources.

Typically, the lead agency for providing information on air quality, including air quality alerts, is the local/regional air agency. It is routine business for California's 35 air agencies to issue air quality alerts, including "Spare the Air" announcements or advisories.

During a smoke event, local public health officials may also issue advisories on recommended actions to protect the public from the harmful effects of wildfire smoke. An example of an air quality warning jointly issued by a local health department and local air agency can be found in Appendix H. An example of a wildfire smoke public announcement can be found in Appendix I. Local health departments may also disseminate these messages to their local community-based organizations, physicians, schools, and other partners.

Schools

Schools and childcare facilities can take steps to enhance preparedness for wildfire smoke events.

Many factors impact the quality of indoor air in schools during wildfire smoke events. The age of the building is one factor – newer buildings generally have a tighter building envelope that restricts smoke intrusion. In addition, school HVAC systems vary in their ability to filter contaminants from air. A significant challenge for schools is the need to provide adequate ventilation to classrooms because studies show that elevated carbon dioxide from under-ventilation can negatively impact learning.

Within the school environment, students should be supervised, encouraged to have lower activity levels in smoky environments, and spend more time indoors during smoke events. Certain students may be more sensitive to smoke than others, e.g., those with asthma. It is essential that such students have an Asthma Action Plan.[56,57] School administrators may wish to give parents flexibility about keeping kids home if the parents have concerns about their child's health.

[56] CDC Asthma Action Plan

[57] Asthma rates for California children differ by region, averaging 15% for all school-age children. County estimates vary. See Estimated percentage of California children ages 1-17 who have ever been diagnosed with asthma.

Some communities impacted by wildfire smoke focus on doing what they can to safely keep students in school. Closing schools can leave some students without a safe place to go. In addition, some California schools and residential childcare institutions provide meals to students who qualify.[58] When school is cancelled due to wildfire smoke, these students may not have access to this important source of nutrition. Closing schools may also cause a hardship for working parents who may not be able to arrange supervision for children not in school.

The California Department of Education partnered with the California Air Resources Board, California Air Pollution Control Officers Association, California County Superintendents Educational Services Association, Association of California School Administrators, and California School Boards Association to develop guidance that local education leaders can use in conversation with local air districts and public health officials to determine how school activities will be affected when air quality is poor. See Air Quality Guidance Tool for California Schools and https://www.cde.ca.gov/ls/ep/airquality.asp.

This guidance identifies factors that should be considered when making a school closure decision:

Health and Safety:

- Indoor air quality. Ventilation and filtration systems at schools may offer a higher level of protection than residential systems.
- Supervision. The school environment provides appropriate student supervision by trained and caring adults who can ensure students remain indoors.
- Student support services. School may be the primary place where students receive needed health and counseling services.
- Nutrition services. Schools serve healthy meals to a significant proportion of students. If school is closed, it is a substantial challenge at best for local educational agencies to feed students.

Using an Equity Lens:

- Socioeconomically disadvantaged families may not have options for alternate child care.
- Working parents and guardians are disproportionately affected by school closure and could suffer significant professional or economic consequences as a result.

[58] School Nutrition

- Students receiving free or reduced-price meals may not have a reliable alternate source of healthy food.
- Students with Individualized Education Programs (IEPs) may not have access to needed services during school closure.
- Schools provide safe and supportive environments for their students; our most vulnerable students rely on them most.

In a western state community frequently impacted by wildfire smoke, school officials work with public health officials and others during the non-fire season to evaluate school buildings, implement mitigation measures (MERV 12+ filtration[59], acquisition of air scrubbers), and develop response plans that allow students to remain safely in school. This includes a combination of pre-fire season mitigation measures and agreed-upon response plans for wildfire smoke events.

Low-cost technology advances are likely to benefit schools. For example, low-cost sensor technology is utilized in a project involving Southern California schools[60] whose goals are to:

- Educate youth about air quality issues
- Inspire students' interest in science
- Increase awareness of air quality health impacts among parents
- Convert awareness into action
- Inspire and train the next generation of air quality advocates

Another project that includes schools is underway in Denver where a network of 100+ air sensors are being installed to augment existing regulatory monitors; a significant percentage of the new monitors will be made available to teachers to use in air quality related curricula.[61]

For more information on schools and indoor air quality, see the US EPA web sites on Creating Healthy Indoor Air Quality in Schools and Indoor Air Quality Tools for Schools Action Kit.

[59] Brown KW, Minegishi T, Allen JG, Mccarthy JF, Spengler JD, Macintosh DL. Reducing patients' exposures to asthma and allergy triggers in their homes: an evaluation of effectiveness of grades of forced air ventilation filters. J Asthma. 2014;51(6):585-94.

[60] https://www.ccair.org/clear/stem-program/

[61] Denver Department of Public Health and Environment: Air Quality

Athletic Events

In general, the decision to cancel an athletic event is made by the event sponsor, preferably in consultation with local public health and air agency officials. Wildfire smoke can adversely impact both participating athletes and spectators. For participating athletes, higher ventilation rates during athletic competition substantially increase personal exposure to smoke pollutants. For spectators, travel to and from the athletic event and fan activities can contribute to increased exposure.

In September 2018, the National Collegiate Athletic Association (NCAA) Committee on Competitive Safeguards and Medical Aspects of Sports updated its previous 2016 guidance on practice and competition activities during poor air quality.[62] The following guidance was provided to member institutions:

- *At AQIs of over 150, outdoor activities should be shortened, and exertion should be minimized by decreasing the intensity of activity. Sensitive athletes should be moved indoors.*
- *At AQIs of 200 or above, serious consideration should be given to rescheduling the activity or moving it indoors. Prolonged exposure and heavy exertion should be avoided. Avoid all outdoor physical activity for sensitive individuals.*
- *At AQIs of 300 or above, outdoor activities should be moved indoors or cancelled if indoor activity is not an option.*

The 2016 NCAA guidance reflected lower AQI thresholds, e.g., recommending that all athletes should be removed from outdoor practice or competition at AQIs of 200 or above.

Community Cleaner Air Shelters and Spaces

Local jurisdictions may want to consider evaluating sites that could be used as community cleaner air shelters and spaces prior to fire season. Information on the basic requirements of a community cleaner air shelter is provided in Appendix K.

In some communities, the indoor air quality may not be significantly better than outdoor air quality due to the age of the homes, lack of air conditioning systems, or lack of appropriate indoor air filtration. Certain populations, such as the homeless, may not have access to acceptable indoor air spaces.

[62] https://www.ncaa.org/sport-science-institute/air-quality

Newer commercial buildings are likely to have better indoor air quality in comparison to the outdoor environment or older, leaky buildings. However, even modern commercial buildings may have worsened air quality if many people are entering and exiting, allowing more outside air into the building.

Air Resource Advisors

Air Resource Advisors (ARAs) are technical specialists who may be assigned to the Incident Management Team (IMT) during large fires. They work with meteorological data and smoke models to produce a smoke forecast for areas being impacted by wildfire smoke. Currently, most large federal IMTs will request an ARA when needed and this is a new capability for CalFire IMTs. If an ARA is not assigned to a fire, the Incident Meteorologist (IMET) may be able to produce a limited forecast.

Respirators (Masks)

In work settings, a well-established "hierarchy of controls" is applied to protect the health and safety of workers from occupational hazards.[63] This hierarchy can also inform the protection of individuals during a smoke event.

This hierarchy of controls progresses from "most effective" to "least effective" options (see Figure 9). If the hazard cannot be eliminated or replaced, the most effective option is to isolate people from the hazard (called "Engineering Controls"). If that is not an option, then making changes to the way people deal with the hazard is the next most effective approach (called "Administrative Controls"). The least effective approach is to protect the worker with Personal Protective Equipment, which could include N95 respirators.

[63] NIOSH Hierarchy of Controls

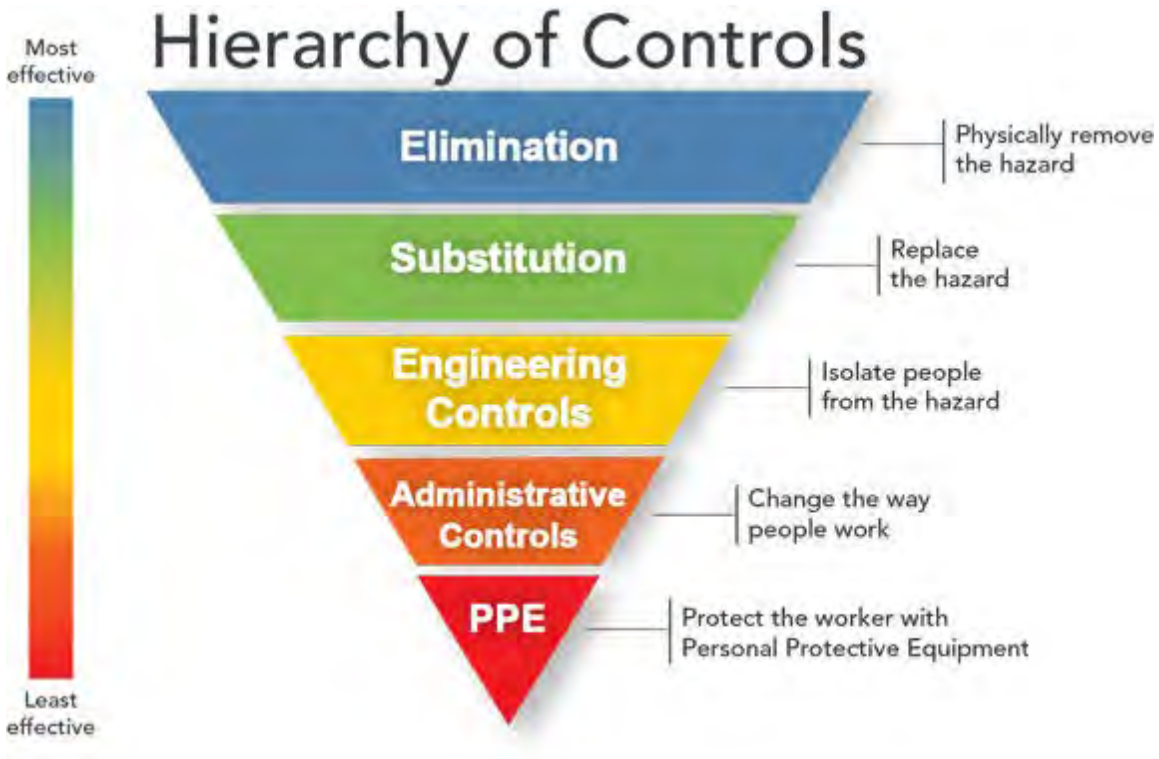


Figure 9. Hierarchy of Controls

N95 respirators may serve a protective role in reducing smoke exposure if more effective protective actions cannot be implemented and it is safe for the individual to wear an N95 respirator (i.e., those with a medical condition have discussed the issue with their healthcare provider). Concerns regarding the use of N95 respirators on a population basis should be carefully considered (including the factors discussed in the section on Strategies to Reduce Exposure).

The following table summarizes a recent publication on personal interventions to reduce exposure to wildfire smoke:

Tier in Hierarchy of Controls	Exposure Control Action	Estimated Exposure Reduction	Considerations
1. Elimination	Relocation	100%	Stress of relocation may be harmful, especially for vulnerable populations Exposure to air pollution and other unsafe conditions while in transit May not have feasible places to go
2. Engineering	Reduce indoor infiltration by closing doors and windows Filter air with portable air filters, central air filters, or air conditioners in recirculation mode	20–80%	Effectiveness varies greatly with ventilation and filtration rates. Portable HEPA filters generally more effective, if properly sized and used Central forced-air filtration is generally less effective due to lower-efficiency filters and shorter run times. Upfront costs, but may provide year-round benefit by reducing indoor PM from other sources
3. Administrative	Stay indoors Avoid heavy or prolonged physical activity	~50% on average, but varies widely Lowers inhaled dose of pollutants	Without added filtration, the building envelope limits infiltration to a widely variable extent depending on tightness Especially important for outdoor activity Pulmonary ventilation rates may increase 10- to 20-fold during heavy exertion If temporary, little risk of harmful reduction in beneficial physical activity
4. Personal protective equipment	Wear a NIOSH-approved N95 or P100 filtering facepiece respirator	90% or greater, depending on quality of fit. Near 0% if poorly fitted	Should be used only when outdoor activity cannot be avoided Performance depends on fit Fit testing and medical clearance are not generally available Physiological stress due to increased work of breathing, heat, discomfort Populations vulnerable to wildfire PM may also be more vulnerable to adverse effects of wearing a respirator

Definition of abbreviations: HEPA = high-efficiency particulate air; NIOSH = National Institute for Occupational Safety and Health; PM = particulate matter.

Table 9. Summary of personal actions for reducing exposure to particulate matter from wildfire smoke, in order of priority according to hierarchy of controls.

Protection of Workers

Cal/OSHA is responsible for enforcing California laws and regulations pertaining to workplace safety and health and for providing assistance to employers and workers. Comprehensive information on the protection of workers can be found on Cal/OSHA's website.

One of the challenges associated with wildfire smoke events is the protection of workers who are not normally exposed to workplace respiratory hazards (e.g., farm workers or day laborers). In 2019, an emergency regulation was adopted to protect such workers from wildfire smoke. The proposed rule was approved by California's Occupational Safety and Health Standards Board and implemented by Cal/OSHA effective July 29, 2019. See Occupational Safety and Health Standards Board - Protection from Wildfire Smoke.

APPENDIX A. ACRONYMS

AHAM	Association of Home Appliance Manufacturers
AQ-SPEC	Air Quality Sensor Performance Evaluation Center
AQI	Air Quality Index
AQMD	Air Quality Management District
APCD	Air Pollution Control District
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CAAQS	California Ambient Air Quality Standards
CADR	Clean Air Delivery Rate
CARB	California Air Resources Control Board
CCLHO	California Conference of Local Health Officers
CDC	U.S. Centers for Disease Control and Prevention
CDPH	California Department of Public Health
Cal EPA	California Environmental Protection Agency
Cal/OSHA	California Division of Occupational Safety and Health
COPD	Chronic Obstructive Pulmonary Disease
EPA	U.S. Environmental Protection Agency
FPR	Filter Performance Rating
FPR	Filter Performance Rating
HEPA	High Efficiency Particulate Air
ISA	Integrated Science Assessment
LHO	Local Health Officer
MERV	Minimum Efficiency Reporting Value
MPR	Microparticle Performance Rating
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NIOSH	National Institute of Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
PM	Particulate Matter
SCAQMD	South Coast Air Quality Management District
USFS	U.S. Forest Service

APPENDIX B. RESOURCES AND LINKS[64]

The resources and links provided in the following tables are current as of August 2019.

WILDFIRE SMOKE		
California Smoke Information	Multi-Agency	Website maintained by local, tribal, state, and/or federal agencies to coordinate and aggregate information for California communities affected by wildfire smoke.
Wildfire Smoke	CDC	
Protect Yourself from Wildfire Smoke	CDC	
Protect Pets in Emergencies	CDC	
Wildfire Smoke: A Guide for Public Health Officials	US EPA (lead); multi-agency	The 2019 version describes health effects due to wildfire smoke, mitigation strategies, communication, and recommended public health actions.
Smoke Sense Study and App Resources	US EPA	These resources can be used to share information about the Smoke Sense study and the Smoke Sense app. Encourages individuals to participate as citizen scientists.

AIR QUALITY INFORMATION		
AirNow	US EPA	Government website provides the Air Quality Index (AQI) that may range from Green ("Good") to Purple ("Hazardous").
Smoke Monitoring Data	USFS	Government website that displays permanent and temporary smoke monitoring stations and information.
Smoke Forecast Outlooks	USFS	Smoke forecast outlooks are issued in areas where smoke from wildland fires may be of concern and Air Resource Advisors (ARAs) have been deployed.
Air Quality Index (AQI) Basics	US EPA	Explains how the AQI is calculated.
Air Quality Guide for Particle Pollution	US EPA	Provides information on particle pollution.
AQI Calculator	US EPA	Allows calculation of AQI from pollutant concentration, e.g., PM2.5, and vice versa.

[64] These resources and links are current as of August 2019 and are subject to change.

SMOKE MAPPING TOOLS		
NOAA Hazard Mapping System Fire and Smoke Product	NOAA	Hazard mapping system for fire and smoke.
USFS Smoke Monitoring Map	USFS	Displays PM2.5 information during smoke events from both the permanent and portable monitors (E-BAMs) on a map; permanent monitors are identified with round icons and temporary monitors are identified with triangles.
Smoke Forecast Outlooks	USFS	Smoke forecast outlooks are issued in areas where smoke from wildland fires may be of concern and an Air Resource Advisor (ARA) has been deployed. Outlooks are issued under the authority and auspices of the organization or incident requesting the ARA.
Wildland Fire Air Quality Tools	USFS	US Forest Service-led program.
InciWeb: Incident Information System	USFS	Provides interagency information on specific wildfires including photographs, maps, announcements, and closures.

WILDFIRE SMOKE AND HEALTH		
AirNow: Fires and Your Health	US EPA	Website provides information on how wildfire smoke affects health and protective actions.
Million Hearts: Particle Pollution and Your Health	CDC	Raises awareness of heart disease and its link to air pollution and other environmental factors.
Wildland Fire Publications, Fact Sheets, and Other Resources	US EPA	
Particle Pollution and Your Health	US EPA	
Reducing the Health Effects of Wildfire Smoke	Oregon Health Authority	
Heart Disease, Stroke, and Outdoor Air Pollution	US EPA	The flyer was jointly developed by the US EPA, American College of Cardiology, American Heart Association, and American Stroke Association
Video: Be Smart, Protect Your Heart from Air Pollution	US EPA	

FACT SHEETS		
Reduce Your Smoke Exposure	US EPA	
Wildfire Smoke FAQs	CDPH	
Protecting Children from Wildfire Smoke and Ash	US EPA	The factsheet was jointly developed by the US EPA, American Academy of Pediatrics, and Pediatric Environmental Health Specialty Units.
Protect Your Lungs From Wildfire Smoke or Ash	US EPA	
Indoor Air Filtration	US EPA	
Asthma and Outdoor Air Pollution	US EPA, CDC	
Montana Wildfire Smoke FAQs	Montana Department of Public Health and Health Services	
Clean Air at Home	Oregon Health Authority	

INFOGRAPHICS		
Reduce Health Risks in Areas With Wildfire Smoke	US EPA	
How to Use a Respirator	US EPA	
Wildfire Smoke and Health	Santa Barbara County APCD	
4 Questions to Ask When Buying an Air Quality Sensor	Santa Barbara County APCD	
Air Monitoring Facts	Bay Area AQMD	
Protecting Your Health during Wildfire Season	Alameda County Public Health Department	

AIR QUALITY SENSOR EVALUATION		
Air Quality Sensor Performance Evaluation Center (AQ-SPEC)	South Coast AQMD	
Sensor Performance (Summary Table)	South Coast AQMD	

SCHOOLS		
Air Quality Guidance Tool	California Department of Education	
Air Quality	California Department of Education	
Air Quality and Outdoor Activity Guidance for Schools	US EPA	
Oregon Public Health Guidance: School Outdoor Activities During Wildfire Events (English)	Oregon Health Authority	
Oregon Health Guidance: School Outdoor Activities During Wildfire Events (Spanish)	Oregon Health Authority	
Oregon: Frequently Asked Questions about Wildfire Smoke and Public Health (English)	Oregon Health Authority	
Oregon: Frequently Asked Questions about Wildfire Smoke and Public Health (Spanish)	Oregon Health Authority	
Air Pollution and School Activities	Washington State Department of Health	Note that Washington State uses a modification of the US EPA's AQI called the Washington Air Quality Advisory (WAQA) to advise residents about air quality levels. The WAQA bases its advice on lower levels of fine particles relative to the EPA's national AQI.
Activity Guidelines for Wildfire Smoke Events	Idaho Department of Health and Welfare	
Improving Ventilation and Indoor Air Quality during Wildfire Smoke Events	Washington State Department of Health	Recommendations for schools and buildings with mechanical ventilation.
Indoor Air Quality in Schools	Lawrence Berkeley National Lab	Information on the indoor air quality of schools.

IDENTIFYING VULNERABLE POPULATIONS		
Climate Change and Health Vulnerability Indicators for California	CDPH	
CalBRACE	CDPH	
County Climate and Health Profile Reports	CDPH	
Tracking California	Public Health Institute	
National Environmental Health Tracking Network	CDC	
California Healthy Places Index	Public Health Alliance of Southern California	
CalEnviroScreen	California Office of Environmental Health Hazard Assessment	

FILTERS AND PORTABLE AIR CLEANERS		
Air Filters and Air Cleaners in the Home	US EPA	General information
Residential Air Cleaners	US EPA	General information
California Certified Air Cleaning Devices	California Air Resources Board	Database of air cleaning devices certified by CARB to meet ozone and electrical safety standards for California.
AHAM Certified Room Air Cleaners	AHAM	Searchable database of air cleaners that meet standards established by the Association of Home Appliance Manufacturers.
How do I select a portable air cleaner for my home?	Lawrence Berkeley National Lab	General information

AIR CLEANERS (INDUSTRIAL) - RENTAL		
Air Scrubbers from HERC Rentals	HERC	
Air Scrubbers from Home Depot	Home Depot	
Air Scrubbers from United Rentals	United Rentals	
Air Scrubbers from Dryco	DRYCO	

INFORMATION FOR HEALTHCARE PROVIDERS		
Climate Change and Health Training Modules for Clinicians	San Francisco Department of Public Health	
Air Quality Resources for Clinicians	San Francisco Department of Public Health	
Particle Pollution and Your Patients' Health	US EPA	This course is designed for family medicine physicians, internists, pediatricians, occupational and rehabilitation physicians, nurse practitioners, nurses, asthma educators, pulmonary specialists, cardiologists, and other medical professionals.
Children and Disasters: Wildfires	American Academy of Pediatrics	Information on about the impact of wildfires and smoke on children
Healthy Heart ToolKit and Research	US EPA	This toolkit from the US EPA has resources for both clinicians and patients that explain how air pollution can trigger heart attacks and strokes and worsen heart conditions in people with known heart disease.
Particle Pollution and Heart Disease	US EPA	The US EPA is raising awareness of heart disease and its link to air pollution and other environmental factors as a partner in Million Hearts, a national initiative to prevent heart attacks and strokes.
What Healthcare Providers Should Know About Particle Pollution and Cardiovascular Risk	US EPA	This course is designed for family medicine physicians, internists, pediatricians, occupational and rehabilitation physicians, nurse practitioners, nurses, asthma educators, pulmonary specialists, cardiologists, and other medical professionals.
What Healthcare Providers Should Know about Particle Pollution and Cardiovascular Risk	US EPA	1-page infographic

CLEAN AIR SHELTERS		
Identification of Cleaner Air Shelters/Spaces for Protection from Wildfire Smoke	Oregon Health Authority	
Air Shelters during Wildfires	Canada	
Home and Community Clean Air Shelters to Protect Public Health during Wildfire Smoke Events	Canada	

N95 RESPIRATORS		
Use of Particulate Respirators (Masks) to Protect from Wildfire Smoke or Ash	CDPH	
Non-Occupational Uses of Respiratory Protection	NIOSH/CDC	
How to Properly Put On and Take Off a Disposable Respirator	NIOSH/CDC	
Respirator Reuse and Extended Use	NIOSH/CDC	
Facial Hairstyles and Filtering Facepiece Respirators	NIOSH/CDC	
Masks and N95 Respirators	FDA	

MISCELLANEOUS		
Indoor Environment Group, Lawrence Berkeley National Laboratory (LBNL)	Indoor Environment Group, LBNL	Excellent source of information on indoor air quality, including air quality tips and resources during a wildfire.
Air Resources Advisor (ARA)	USFS	ARAs are specialists that are deployed during large smoke events. ARAs analyze, summarize, and communicate these impacts to incident teams, air quality regulators, and the public.

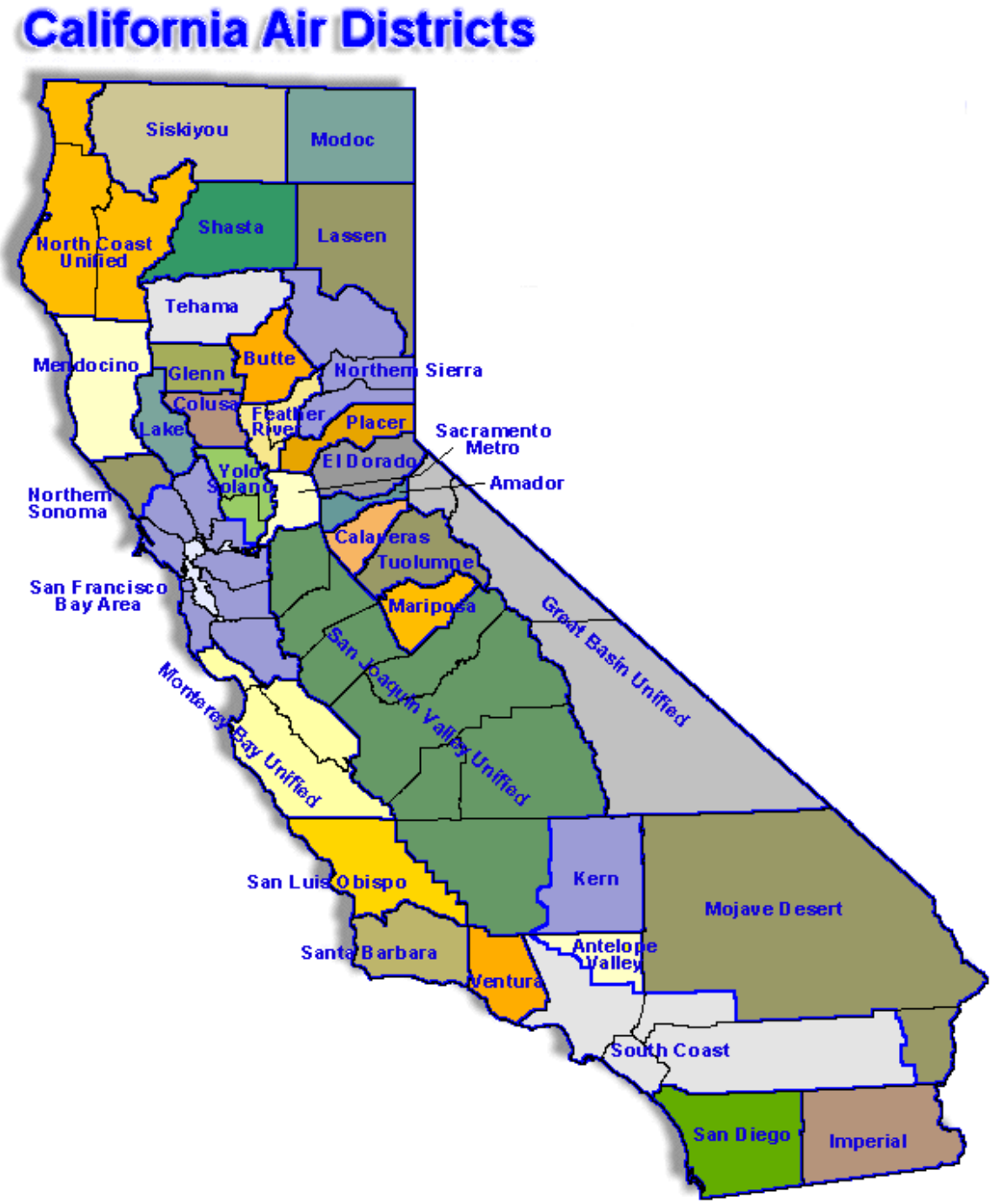
APPENDIX C. ROLES AND RESPONSIBILITIES

The following table outlines major roles and responsibilities during a wildfire smoke event.

Agency/Organization	Activities/Expertise
Local	
Local Health Department (58 counties and 3 cities) – Local Health Officer	Coordinate with the local/regional air agency and other local/state/federal response agencies. The jurisdiction's health officer has the authority to issue advisories notifying the public and media of health risks from smoke in addition to recommended protective actions. During wildfire smoke events, consider coordinating public messaging with the local/regional air agency if not already doing so. If additional smoke monitoring support is needed, coordinate with local air agency officials to request support from the California Air Resources Board (CARB) Incident Air Monitoring Support (IAMS) section.
Air Quality Management District / Air Pollution Control District – Air Pollution Control Officer	Coordinate with impacted local health jurisdictions and local/state/federal response agencies including the California Air Resources Board Incident Air Monitoring Section. Tracks local air quality monitoring data for health implications. May need to respond to inquiries from the public and elected officials. The Air Pollution Control Officer issues air quality advisories to the public. During wildfire smoke events, consider coordinating public messaging with the local health department if not already doing so.
School Districts	With assistance from supporting agencies, determine student health risk and make decisions on event cancellations and school closures. Collaborate with the local air agency and public health officer for information to support decision-making.
City and County Governments	Coordinate with local health departments and emergency management agencies.
Tribal	
Tribal Governments	Request assistance as needed; coordinate with response agencies.

State	
California Air Resources Board Incident Air Monitoring Section	Deploy air monitoring personnel to set up and operate portable particulate monitoring and meteorological instruments that can provide data for forecasting, identify areas at risk, support public/media outreach, and coordinate with air agencies, local health departments, federal land managers, and others.
California Department of Public Health	Actively monitor the situation from a public health perspective and collaborate with health jurisdictions as needed. Assess potential health effects and recommend protective measures. Provide subject matter expertise in environmental science, occupational health, and disaster epidemiology. Work closely with healthcare facilities in the affected areas. Prepare guidance materials and disseminate information to the public and media.
California Office of Health Hazard Assessment	Assist responders in assessing health effects and characterizing risk to public health and the environment; assess burn debris; provide guidance for handling ash during cleanup; provide health information to incident command and Public Information Officers.
Federal or National	
FEMA	Federal response agency for natural disasters.
Federal Land Managers (U.S. Forest Service, National Park Service, Bureau of Land Management, Fish and Wildlife Service)	Wildfire suppression and containment, smoke management and air quality expertise, request and staff incident management teams, provide wildfire status updates, deploy air monitoring personnel and equipment, and support public outreach and communication.
US EPA Region 9	Coordinate with state and local air agencies, tribes, and other response partners. May respond to inquiries from the public. Conduct Clean Air Act regulatory process after the fact.
Air Resources Advisor, Wildland Fire Air Quality Response Program	Technical specialist (THSP-ARA) with expertise in air quality monitoring and modeling for public health, transportation safety, and firefighter safety. Provide detailed smoke forecasts. Advise IC/UC and analyzes, summarizes, and communicates smoke impacts to the incident teams, air quality regulators, and the public.

APPENDIX D. MAP OF CALIFORNIA AIR DISTRICTS



APPENDIX E. LOCAL AIR DISTRICTS

California has 23 Air Pollution Control Districts (APCDs) and 12 Air Quality Management Districts (AQMDs). These agencies are county or regional governing authorities that have primary responsibility for controlling air pollution from stationary sources. The air districts range from small, single-county districts to multi-county, regional agencies such as the Bay Area and South Coast AQMDs. Air districts provide local expertise and experience particular to their air basins and weather patterns.

Each air district is governed by a Board of Directors consisting primarily of elected officials, and are staffed by engineers, planners, attorneys, inspectors, meteorologists, chemists, and technicians. In general, local air districts are responsible for control of stationary sources of emissions. While mobile source emissions are mostly controlled by state and federal regulations, local districts have authority to implement control measures which affect transportation sources, including automobiles. Local district activities are overseen by both the state and federal agencies. The primary activities of air districts include:

EMISSIONS CONTROL – Districts adopt cost-effective rules to limit harmful emissions from commercial and industrial facilities.

MONITORING – Many air districts operate a sophisticated and extensive network of monitors to measure daily ambient concentrations of pollutants in a local area and track compliance with state and federal air quality standards.

COMPLIANCE – Tens of thousands of sources of air pollution are inspected on a regular basis statewide to assure compliance with local, state and federal regulations. Assistance programs are set up to help business comply.

PERMITTING – Facilities that emit air pollutants must obtain an operating permit to ensure the sources operate according to the rules and regulations of their respective districts. Operating conditions and emissions data are reviewed to ensure that regulations are implemented in a timely and environmentally sound manner.

COMPLAINTS – Citizen complaints are promptly and thoroughly investigated by air district personnel to make sure the public health is being adequately protected.

PLANNING & RESEARCH – Districts must look ahead to identify future needs to meet state and federal mandates. Research projects are conducted to find new technologies, such as alternative fuels, which support our efforts.

OUTREACH – Districts have established outreach programs, including business assistance programs designed to help the business community understand and more easily comply with applicable regulations, and to provide businesses with technical, financial, and administrative assistance. Many air districts have school and community outreach programs to educate students and adults about air quality and what we can do to keep our air clean.

APPENDIX F. AIR QUALITY FORECAST (EXAMPLE)

Some local/regional California air agencies are providing additional information, including smoke forecasting, to enable people to make informed choices during a smoke event. This includes hourly AQI reporting and smoke forecasts that identify the best time of day to be outdoors. The following air quality forecast is from the South Coast Air Quality Management District.

Air Quality Forecast for the South Coast Air Quality Management District (South Coast AQMD)

www.aqmd.gov/forecast

The air quality forecast is a prediction of air pollution for the next one or two days. South Coast AQMD staff use weather forecasts, air pollution measurements, satellite data, and mathematical models to predict particle ($PM_{2.5}$ and PM_{10}), ozone, nitrogen dioxide, and carbon monoxide concentrations. Forecast models are tools for making predictions, which are trained and evaluated with air pollution measurements. Traditionally, South Coast AQMD staff issued a daily air quality forecast summarizing conditions expected over the entire day for 45 geographical areas throughout the region. However, with new models developed and maintained by NOAA[1] scientists, South Coast AQMD staff can now issue hourly forecasts of $PM_{2.5}$ and ozone for the next day. These models are customized using local measurements and state-of-the-science models of air pollution levels, resulting in more accurate predictions. The predicted pollutant levels are reported as an Air Quality Index (AQI). Higher AQI means that air pollution levels are higher, potentially resulting in greater health concerns for the exposed population. The AQI is divided into six categories and each category is symbolized by a color.

Example Forecast

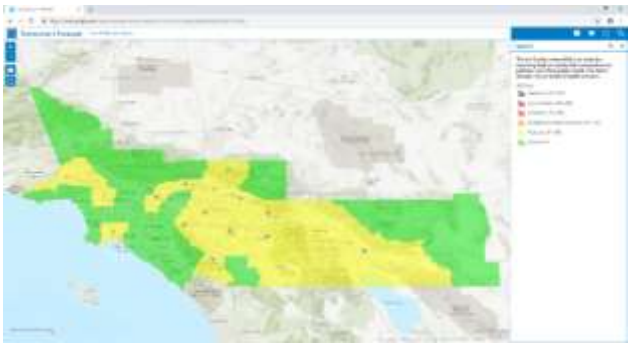
Area	Forecast Area	AQI	AQI Description	Pollutant	Cleanest Time of Day *
1	Central Los Angeles County	85	MODERATE	PM2.5	Cleanest from 6 AM to 1 PM
2	Northwest Coastal Los Angeles Co.	40	GOOD	PM2.5	Similar all day

How can I use the Forecast?

Check the forecast to see general information about air quality. **You can check the forecast AQI, AQI Graph, and Cleanest Time of the Day to plan outdoor activities,** like exercise. When the AQI is unhealthful, you can choose to reschedule strenuous outdoor activities to times of the day when the predicted AQI is lower, like the Cleanest Time of the Day.

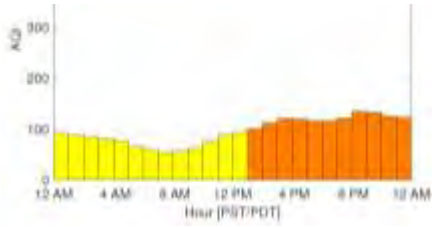
Forecast Summary PDFs list the predicted AQI for the entire day within each of the 45 forecast areas. The AQI Description is colored by the predicted AQI category for the day.

Forecast Maps show the predicted AQI for the entire day within 38 forecast areas. Each forecast area is colored by the predicted AQI category for the day. Click on a forecast area to see more info about the forecast and access an AQI time-series Graph.



The **Cleanest Time of the Day** is when the predicted AQI (based on $PM_{2.5}$ and ozone) is lowest and more than 10 AQI points below than the predicted daily average AQI.

AQI Graphs depict how the AQI is predicted to change throughout the day in that area. The height of each bar is the AQI value and each bar is colored by the AQI category.



Tips

Visit www.aqmd.gov/AQI to learn about AQI

The actual AQI may be different from the predicted AQI. Users should also check the current AQI at www.aqmd.gov/aqimap to plan outdoor activities.

The AQI Graph and Cleanest Time of the Day are based only on $PM_{2.5}$ and Ozone, which are the pollutants that typically drive the AQI. During high wind events, PM_{10} levels can lead to unhealthful air quality.

Visit www.aqmd.gov/advisory to view current air quality advisories for the region

[1] National Oceanic and Atmospheric Administration

Air Quality Forecast for the South Coast Air Quality Management District (South Coast AQMD)

www.aqmd.gov/forecast

Air Quality Product	Description	When Might I Use This?	What Air Pollutants are Included?
Forecast Summary PDF	Lists the predicted AQI for the entire day within each of the 45 forecast areas.	Plan outdoor activities or precautionary measures for today and tomorrow. View the predicted AQI in a source receptor area.	$PM_{2.5}$, PM_{10}, ozone, nitrogen dioxide, carbon monoxide
Forecast Map	Shows the predicted AQI within 38 forecast areas on a map.	Plan outdoor activities or precautionary measures for today and tomorrow. View the predicted AQI in a source receptor area.	$PM_{2.5}$, PM_{10}, ozone, nitrogen dioxide, carbon monoxide
Current Air Quality Map	Shows the current AQI calculated using the NowCast method within 38 forecast areas on a map.	Plan outdoor activities or precautionary measures in the next hour. View the predicted AQI in a source receptor area.	$PM_{2.5}$, PM_{10}, ozone, nitrogen dioxide, carbon monoxide
Cleanest Time of Day	Shown on the Forecast Summary PDF. The time when the predicted AQI in that area is lowest and more than 10 AQI points below than the predicted daily average AQI.	Plan the time of day to conduct outdoor activities during today and tomorrow.	$PM_{2.5}$, ozone
AQI Graph	Shown by clicking on the link in the Forecast Summary PDF. Depicts how the AQI is predicted to change throughout the day in that area.	Plan the time of day to conduct outdoor activities or precautionary measures for today and tomorrow. View the predicted change of the AQI over a day in your area.	$PM_{2.5}$, ozone
Wildland & Agricultural Burn Forecast	Details the wildland and agricultural burn forecast. “Final Burn Decision” files indicate the final burn forecast and will not change. “Burn Forecast Outlook” files indicate the most likely burn designation, and may change when the final forecast is issued.	Plan periods to conduct wildland or agricultural burning today, tomorrow, and the day after tomorrow. Identify areas that wildland and/or agricultural burning is permitted.	--
Current Advisories	Provides information during extreme air quality events such as wildfires, windblown dust events, odors, pollution episodes, and residential burning prohibition periods (Check Before You Burn)	Determine if extreme air quality events will affect your location. Plan precautionary measures to protect yourself from poor air quality. Determine if residential wood burning is permitted in your area.	--

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
AIR QUALITY FORECAST

Forecast Valid Wednesday, September 04, 2019

Issue Date: Tuesday, September 03, 2019

Area	Forecast Area	AQI	AQI Description	Pollutant	Cleanest Time of Day *
1	Central Los Angeles County	55	MODERATE	PM2.5	Similar all day
2	Northwest Coastal Los Angeles Co.	46	GOOD	PM2.5	Similar all day
3	Southwest Los Angeles County Co.	46	GOOD	PM2.5	Similar all day
4	South Coastal Los Angeles Co.	37	GOOD	Ozone	Similar all day
5	Southeast Los Angeles Co.	38	GOOD	Ozone	Similar all day
6	West San Fernando Valley	84	MODERATE	Ozone	Cleanest from 6 AM to 10 AM
7	East San Fernando Valley	57	MODERATE	PM2.5	Similar all day
8	West San Gabriel Valley	61	MODERATE	Ozone	Similar all day
9	East San Gabriel Valley	87	MODERATE	Ozone	Cleanest from 5 PM to 10 PM
10	Pomona/Walnut Valley	101	UNHEALTHY FOR SENSITIVE GROUPS	Ozone	Cleanest from 6 AM to 12 PM
11	South San Gabriel Valley	47	GOOD	Ozone	Similar all day
12	South Central Los Angeles Co.	46	GOOD	PM2.5	Similar all day
13	Santa Clarita Valley	93	MODERATE	Ozone	Cleanest from 5 PM to 10 PM
14	Antelope Valley	47	GOOD	Ozone	Similar all day
15	San Gabriel Mountains	59	MODERATE	PM2.5	Similar all day
16	North Orange County	50	GOOD	PM2.5	Similar all day
17	Central Orange County	46	GOOD	PM2.5	Similar all day
18	North Coastal Orange County	39	GOOD	Ozone	Similar all day
19	Saddleback Valley	74	MODERATE	Ozone	Cleanest from 5 PM to 10 PM
20	Central Coastal Orange County	44	GOOD	Ozone	Similar all day
21	Capistrano Valley	51	MODERATE	Ozone	Similar all day
22	Corona/Norco Area	140	UNHEALTHY FOR SENSITIVE GROUPS	Ozone	Cleanest from 6 AM to 11 AM
23	Metropolitan Riverside County	151	UNHEALTHY	Ozone	Cleanest from 6 AM to 12 PM
24	Perris Valley	136	UNHEALTHY FOR SENSITIVE GROUPS	Ozone	Cleanest from 6 AM to 11 AM
25	Lake Elsinore Area	101	UNHEALTHY FOR SENSITIVE GROUPS	Ozone	Cleanest from 6 AM to 10 AM
26	Temecula Valley	80	MODERATE	Ozone	Similar all day
27	Anza Area	58	MODERATE	Ozone	Similar all day
28	Hemet/San Jacinto Valley	87	MODERATE	Ozone	Similar all day
29	Banning/San Gorgonio Pass	115	UNHEALTHY FOR SENSITIVE GROUPS	Ozone	Cleanest from 6 AM to 11 AM
30	Coachella Valley	71	MODERATE	Ozone	Similar all day
31	East Riverside County	71	MODERATE	Ozone	Similar all day
32	Northwest San Bernardino Valley	90	MODERATE	Ozone	Cleanest from 6 PM to 10 PM
33	Southwest San Bernardino Valley	93	MODERATE	Ozone	Cleanest from 6 PM to 10 PM
34	Central San Bernardino Valley	143	UNHEALTHY FOR SENSITIVE GROUPS	Ozone	Cleanest from 6 AM to 12 PM
35	East San Bernardino Valley	166	UNHEALTHY	Ozone	Cleanest from 6 AM to 12 PM
36	West San Bernardino Mountains	53	MODERATE	PM2.5	Similar all day
37	Central San Bernardino Mountains	140	UNHEALTHY FOR SENSITIVE GROUPS	Ozone	Cleanest from 6 AM to 1 PM
38	East San Bernardino Mountains	133	UNHEALTHY FOR SENSITIVE GROUPS	Ozone	Cleanest from 6 AM to 1 PM
39	Phelan	87	MODERATE	Ozone	Similar all day
40	Hesperia	87	MODERATE	Ozone	Similar all day
41	Trona	67	MODERATE	Ozone	Similar all day
42	Victorville	74	MODERATE	Ozone	Similar all day
43	Yucca Valley	58	MODERATE	Ozone	Similar all day
44	Barstow	77	MODERATE	Ozone	Similar all day
45	Twentynine Palms	74	MODERATE	Ozone	Similar all day

* The **Cleanest Time of the Day** is based on forecasts of below-average AQI for $PM_{2.5}$ and Ozone. These forecasts do not include PM_{10}. They may differ from the actual AQI and users should also check the current AQI measurements at http://www.aqmd.gov/aqimap to plan outdoor activities.

What To Do When Air Pollution Reaches Unhealthy Levels

In areas with **UNHEALTHY FOR SENSITIVE GROUPS** air quality (AQI of 101 to 150), sensitive or susceptible persons, including children, older adults and those with heart or lung disease, should minimize outdoor activity.

In areas with **UNHEALTHY** air quality (AQI of 151 to 200) or an **Ozone HEALTH ADVISORY Alert** (AQI of 132 to 200 for 1-hour ozone), everyone should discontinue prolonged, vigorous outdoor exercise lasting longer than one hour. Examples of the kinds of outdoor activities that should be avoided are calisthenics, basketball, running, soccer, football, tennis, swimming laps, and water polo. Susceptible persons, such as those with heart or lung disease, should avoid outdoor activity entirely.

In areas with **VERY UNHEALTHY** air quality (AQI of 201 or above) or an **Ozone STAGE-1 Alert** (AQI of 201 or above for 1-hour ozone), everyone should discontinue all vigorous outdoor activities regardless of duration.

Detailed Air Quality Forecasts Including Wildland & Agricultural Burn Forecasts: http://www.aqmd.gov/forecast

Daily Air Quality Forecasts and Advisories by Email -- Subscribe or Modify Settings at: http://www.airalerts.org

AQMD Web Site for Current AQMD Air Quality Measurements, Forecasts and Advisories: http://www.aqmd.gov/

or by **Telephone** with our Interactive Voice Response System: **1-800-CUT-SMOG** (1-800-288-7664)

Contact AQMD: 1-**800-CUT-SMOG** or **(909) 396-2000** **Forecast Area Map:** http://www.aqmd.gov/ForecastAreas

APPENDIX G. REQUESTING STATE AIR MONITORING SUPPORT

Requesting CARB Emergency Air Monitoring Support Services

Note: If additional air monitoring support is needed, it is preferred that local agencies coordinate with local air district officials to request support from the California Air Resources Board (CARB) Incident Air Monitoring Support (IAMS) section.

This procedure applies to any emergency involving release of a hazardous airborne contaminant for which a local agency has exhausted its resources to protect public health or the environment. Requesting agencies typically include local air districts, public or environmental health departments, and county or city fire departments. The process for requesting State support is established by the Emergency Services Act (Government Code § 8550-8692 et seq.) and the State Emergency Management System, or SEMS.

The California Air Resources Board's (CARB) Incident Air Monitoring Section (IAMS) can provide State-level support for air contaminant monitoring, sampling, analysis, and dispersion modeling. IAMS also coordinates with numerous partner agencies to provide emergency toxicological assessments, health advisory recommendations, indoor air quality assessments, air monitoring for recovery operations, and assessment of air quality for re-entry.

Steps to Obtain IAMS Support:

1) Contact IAMS

a) Contact an IAMS team member from the Contact Table below at the earliest indication of the need for air monitoring and/or assessment support. If IAMS cannot be reached, call the State Warning Center directly at (916) 845-8911 to initiate a support request.

b) Describe in as much detail as possible the release situation and the specific services needed. This enables us to assess your needs and determine how we can provide timely assistance.

c) Follow up the request with an e-mail, including your name, position, agency, contact information and name of the incident if known.

d) IAMS will review your request, assess the situation and resources available and respond as quickly as possible with initial recommendations. This will be documented in e-mail.

2) Obtain a State Support "Mission Task"

a) Contact your Operational Area or County Emergency Operations Center (EOC), the organization designated to coordinate assistance from the State.

b) Ask the Operational Area to assist you in submitting a "Mission Request" for air monitoring support. This is the official process for counties or special districts to request state assistance. You will need to provide the same information as noted in Step 1b and 1c above.

3) If your agency (e.g., air district) covers more than one county jurisdiction, it will be most expedient to submit a Mission Request via the most impacted county.

4) Mission Request Approval

a) The Operational Area will forward a Mission Request to the Regional Emergency Operations Center (REOC). The REOC will approve the mission or forward it to the State Office of Emergency Services Operations Center (SOC) for approval.

b) Once approved, a "Mission Task" is issued authorizing IAMS to support the incident and expend available resources as necessary.

c) The REOC or SOC will notify IAMS and the Operational Area duty officer of the approval and the Mission Task number.

5) Deployment

a) IAMS will contact the requesting agency directly to coordinate monitoring logistics and data disposition. IAMS will work with you to complete a Monitoring and Sampling Plan for the incident.

b) IAMS will contact Incident Command or Unified Command and monitoring partners of our activities.

c) IAMS will follow-up with the requesting agency on data access, equipment performance, potential equipment repositioning, short-term monitoring needs, and demobilization plans as dictated by the incident.

SERVICE NOTE: CARB does not have an on-call system. IAMS makes every effort to maximize their availability for during emergency events, but is not a 24/7 operation.

Contact Table: CARB Emergency Air Monitoring Support

Name	Position	Work Phone	Cell Phone	Email (@arb.ca.gov)
Charles Pearson	Team Coordinator	916-322-7054	916-541-9026	charles.pearson
Catherine Dunwoody	Back-up Coordinator	916-324-5070	916-870-1428	catherine.dunwoody
Joseph McCormack	Monitoring Co-Lead	916-455-e	--	joseph.mccormack
Russ Bennett	Monitoring Co-Lead	916-324-1149	916-206-1771	russ.bennett
State Warning Center		916-845-8911		

APPENDIX H. AIR QUALITY WARNING TEMPLATE (EXAMPLE)

[Agency(ies) logo]

FOR IMMEDIATE RELEASE [DATE]

Public Health Contact: [NAME], Public Information Officer, [DIRECT LINE AND/OR CELL]

Air Pollution Control District Contact: [NAME, TITLE, PHONE NUMBER]

Air Quality Warning Issued for [LOCATION]

Smoke from [NAME] Fire near [LOCATION]

[CITY/COUNTY], Calif. — The [NAME] Public Health Department and the [NAME] Air Pollution Control District today issued an Air Quality Warning for [LOCATION] areas [DIRECTION; EAST/WEST/NORTH/ SOUTH]. Air quality is impacted due to smoke from due to smoke from the [NAME] fire [SPECIFIC AREAS DESIGNATED BY ROAD BOUNDARIES OR GEOGRAPHIC DESIGNATIONS].

If you see or smell smoke in the air, be cautious and use common sense to protect yourself and your family's health. Everyone, especially people with heart or lung disease (including asthma), children, and older adults should limit the amount of time spent outdoors to reduce exposure to smoke pollutants. Everyone should avoid outdoor exercise when smoke is in the area. If you develop mild symptoms such as eye irritation or coughing, contact your healthcare provider. Call 9-1-1 or go to an emergency department if more serious symptoms develop, e.g., chest tightness or pain.

The level of smoke may vary during the day/night and will depend on fire and weather conditions. This Air Quality Warning will be updated [FREQUENCY TBD].

For more information [WEBSITE OR OTHER LINKS]. For recorded advisory updates, call [PHONE NUMBER].

APPENDIX I. WILDFIRE SMOKE NEWS RELEASE (EXAMPLE)

News Release

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

FOR IMMEDIATE RELEASE
Date
Ph
CONTACT: Corey Egel | 916.440.7259 | CDPHpress@cdph.ca.gov

CDPH Recommends Stay Indoors and Reduce Outdoor Activity To Avoid Wildfire Smoke Inhalation

SACRAMENTO – The California Department of Public Health (CDPH) today advised residents where wildfires have been burning, along with people in the smoke's path, to stay indoors and reduce outdoor activity.

"Smoke from wildfires can cause eye and lung irritation. Breathing smoke can also make asthma symptoms worse. People with underlying lung or heart problems should limit their exposure by staying indoors," said State Public Health Officer and CDPH Director Dr. Karen Smith. "Heavy smoke exposure can also cause more serious disorders, including reduced lung function and bronchitis."

People who must be outdoors for long periods, in areas with heavy smoke, or where ash is disturbed, should wear an N95 respirator mask. Since wearing a respirator can make it harder to breathe, those with lung or heart problems should ask their doctor before using one.

"Residents should seek medical care if they experience health issues such as chest pain, chest tightness or shortness of breath. It is especially important to monitor the elderly, children and young adults as they may be more susceptible to the health effects of fire recovery," said Dr. Smith.

Visit CDPH's website for more information on how you can protect yourself from smoke inhalation during a wildfire and the California Governor's Office of Emergency Services for more information on the hazardous debris, wildfire recovery and worker safety in wildfire regions.

www.cdph.ca.gov

###

APPENDIX J. INTEGRATED SCIENCE ASSESSMENT FOR PM

The Clean Air Act requires review of the National Ambient Air Quality Standards (NAAQS) periodically to incorporate the latest evidence of both short-term and long-term health impacts. The last published Integrated Science Assessment (ISA) on Particulate Matter (PM) was issued in 2009; an updated draft ISA on PM was released for public comment in October 2018.[65]

An array of outcomes is evaluated as part of a broad health effect category: physiological measures (e.g., airway responsiveness), clinical outcomes (e.g., hospital admissions), and cause-specific mortality. The draft 2018 ISA remains in draft form and *"does not represent and should not be construed to represent any Agency determination or policy"*. The research referenced in the draft 2018 ISA is publically available.

The table below is adapted from the 2009 ISA and draft 2018 ISA on PM (Table ES-1) regarding health effects from PM2.5.

PM2.5		
Health Effects and Exposure Duration	**2009 PM ISA**	**Current Draft PM ISA (2018)**
Respiratory Effects—Short-term exposure	Likely to be a causal relationship	Likely to be a causal relationship
Respiratory Effects— Long-term exposure	Likely to be a causal relationship	Likely to be a causal relationship
Cardiovascular Effects— Short-term exposure	Causal relationship	Causal relationship
Cardiovascular Effects— Long-term exposure	Causal relationship	Causal relationship
Nervous System Effects—Long-term exposure	Not evaluated	Likely to be a causal relationship
Cancer—Long-term exposure	Suggestive of, but not sufficient to infer, a causal relationship	Likely to be a causal relationship
Total mortality—Short-term exposure	Causal relationship	Causal relationship
Total mortality—Long-term exposure	Causal relationship	Causal relationship

[65] Integrated Science Assessment (ISA) for Particulate Matter

APPENDIX K. CLEANER AIR SHELTERS

This document provides information to consider in selecting a site to be used as a community cleaner air shelter. Desirable facility characteristics include:

- Public accessibility (e.g., community centers or libraries)
- Newer construction (newer buildings have tighter building envelopes, reducing smoke infiltration)
- Central air conditioning with enhanced system filtration capability (e.g., high efficiency in-duct MERV 13 or higher filters)
- If necessary, access to portable air cleaners/scrubbers (may be purchased or leased)

An important source of information for assessing the suitability of a particular building as a Community cleaner air shelter are the building managers or facilities maintenance staff who are familiar with the building's design and HVAC system. Steps that can be taken to reduce wildfire smoke intrusion into a building:

- Reduce the amount of outdoor air introduced into the building while still maintaining the minimum amount required per the State Building Standards Code (refer to California Code of Regulations, title 8, section 5142).
- If the building has dual door vestibules, have the outer entry doors close before proceeding through the inner doors so that both sets of doors are not open at the same time.
- Temporarily route access into and out of the building through a single entry. For example, close all other doors and seal with painter's tape or have staff present to redirect traffic and open the doors in the event of an emergency.
- Provide sticky mats at entries to reduce the amount of smoke particulate from entering the space via foot traffic.
- Inspect the Air Handling Unit (AHU) filters for the building to determine if the filters are seated correctly and if the filters are becoming overloaded with particulate matter. Change the filters when they have become overloaded.
- Place carbon filters over the AHU's intakes for odor reduction and additional particulate filtration.
- Temporarily install portable air filtration devices to assist in filtering the air continuously. Devices should be equipped with high efficiency particulate air (HEPA) filters.

Reference: Medina, Enrique (Editor), *Technical Guide for Wildfire Impact Assessments for the OEHS Professional*, AIHA, 2018. https://online-ams.aiha.org/amsssa/ecssashop.show_product_detail?p_mode=detail&p_product_serno=1558

APPENDIX L. RECOMMENDATIONS FOR OUTDOOR PHYSICAL ACTIVITY DURING SMOKY CONDITIONS (EXAMPLE)

Recommendations for Outdoor Physical Activity during Smoky Conditions

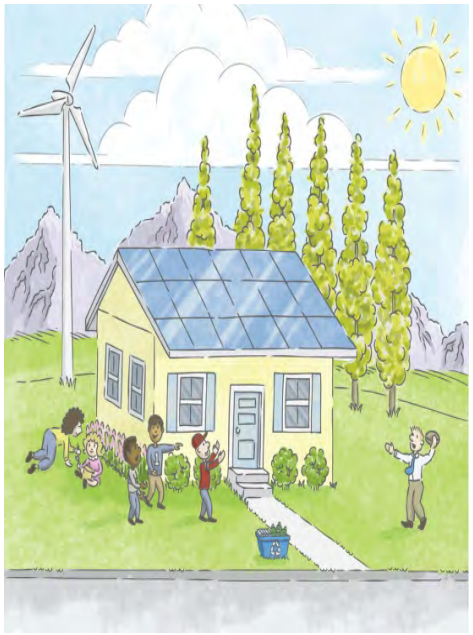
This guide is intended to help you make decisions on outdoor activities when it's smoky outside.
Group information is listed below.

Length of Outdoor Physical Activity	**Good for Groups (1 – 3)**	**Moderate for Group 1 Individuals**	**Unhealthy for Group 1 & 2 Individuals**	**Unhealthy for Group 1 - 3 Individuals**	**Very Unhealthy for Group 1 - 3 Individuals**	**Hazardous for Group 1 – 3 Individuals**
	Visibility ≥ 11 miles	**Visibility 6 - 10 miles**	**Visibility 3 – 5 miles**	**Visibility 1.5 – 2.75 miles**	**Visibility 1 – 1.25 miles**	**Visibility < 1 mile**
30 Minutes	**No Restrictions**	**Group 1 Individuals should monitor or reduce physical activity.**	**Groups 1 & 2 should limit time spent outdoors or reduce physical activity.**	**Groups 1 & 2 should avoid the outdoors and Group 3 should reduce physical activity.**	**All Groups should avoid the outdoors and physical activity.**	**All Groups should avoid the outdoors and physical activity.**
1 Hour	**No Restrictions**	**Group 1 Individuals should monitor or reduce physical activity.**	**Groups 1 & 2 should considerably limit time spent outdoors and reduce physical activity.**	**All Groups should avoid the outdoors and physical activity.**		
2 Hours or More	**No Restrictions**	**Group 1 Individuals should limit prolonged physical activity.**	**Groups 1 & 2 should avoid the outdoors and Group 3 should reduce physical activity.**			

WHICH GROUP ARE YOU IN?		
Group 1 Individuals	**Group 2 Individuals**	**Group 3 Individuals**
This group includes those with respiratory or heart disease, angina, pulmonary disease, asthma, emphysema or any other disease that may be impacted by any level of smoke.	This group includes those with asthma, or recent respiratory infections, those who experience seasonal allergies, work outside, or in general are more sensitive to the acute effects of smoke.	This group includes those who are more resistant to the short term effects of smoke. Healthy people may also experience adverse effects of smoke depending on duration and exposure.

Points to Consider

- If you smell smoke, or see smoke around you, consider restricting your outdoor activities.
- The chance of being affected by smoke increases substantially with strenuous or prolonged activity outdoors.
- Keep in mind that air quality can change rapidly at different times during the day due to wind shifts. It is important to monitor the smoke throughout the day in your area and make plans for outdoor activities accordingly.



Local visibility can be used to determine air quality in your area! It's a great way for you to decide whether it's safe to go outside when it's smoky.

Not every community has a monitor that measures particle levels in the air. It's up to you to decide whether to change your outdoor plans until smoke conditions improve. The chart on the front of this card has the visibility information for each level. Facing away from the sun, if you can, focus on a local ridge top, building, or landmark which is approximately 3 to 6 miles away and determine how far you can see. This can help you to visually assess the quality of the air. If you are concerned about poor outdoor air quality, consider waiting for better conditions. Your health and the health of your family should always be first priority.

Dust masks do not protect you from smoke impacts!

Paper "comfort" or "dust" masks – the kinds you can commonly buy at the hardware store – are designed to trap large particles, such as sawdust. These masks generally will not protect your lungs from the fine particles in smoke; in addition they may restrict airflow. Also, wet bandanas tied over the face will not protect you from fine particles and may restrict air flow.

If there is an advisory to stay indoors, take steps to keep indoor air as clean as possible. Keep your windows and doors closed – unless it's extremely hot outside. Run your air conditioner, if you have one, keeping the filter clean, and keeping the fresh air intake closed (recirculation mode) to prevent bringing additional smoke inside.

Note: If you don't have an air conditioner, staying inside with the windows closed may be dangerous in extremely hot weather. In these cases, seek alternative shelter such as going to a mall, the movies, or libraries. Often, when smoky conditions continue over an extended time, your local government may provide cooling centers to go to in order to avoid smoke exposure and heat. Contact your local government for further information.

Placer County Air Pollution Control District
110 Maple Street
Auburn, CA 95603
(530) 745-2330 ● www.placer.ca.gov/apcd

APPENDIX M. SCHOOL ACTIVITIES GUIDANCE (EXAMPLES)

This appendix contain various recommendations for modification of school activities due to air quality, including:

Guidance	Source
Air Quality Guidance Template	California Department of Education
Air Quality and Outdoor Activity Guidance for Schools	US EPA
Public Health Guidance: School Outdoor Activities During Wildfire Events	Oregon Health Authority
Activity Guidelines for Wildfire Smoke Events	Idaho Department of Health and Welfare
Air Pollution and School Activities (Note: this guidance from Washington State is based on the Washington Air Quality Advisory (WAQA) levels rather than the US EPA's AQI)	Washington State Department of Health

Memo: Get Smart about Wildfire Smoke - Clear Guidelines for Schools and Wildfire Smoke

Over the last decade, devastating wildfires have ravaged communities and school districts in every corner of this state.

These massive disasters impacted tens of thousands of Californians in the communities they call home and blanketed entire regions of California with thick, unhealthy smoke.

When a wildfire occurs nearby, the decision to close or evacuate a school is straightforward. However, as we have seen over the past several years, wildfire smoke can settle in communities hundreds of miles from the location of the fire and impact the health of students and school district operations.

Without clear state guidelines, districts have been forced to make difficult, last minute decisions on whether to cancel classes, remain open, or modify school events.

This is why leaders from the education, air quality, and public health communities established a working group to develop state guidance regarding air quality for California's 1,026 school districts during wildfire smoke days.

The guidelines attached to this message are intended to advance local conversations between school districts, public health officers, air districts, and the community, and provide educational leaders with the data they need to make informed decisions when their communities are inundated with wildfire smoke.

The guidelines are not meant to supersede any protocols or guidelines school districts may have already adopted.

We encourage districts that haven't already addressed this issue to begin the conversation now, prior to the start of the 2019-20 school year. California's next big wildfire is not a matter of if, but when.

For questions on how to track air quality in your community, please contact your local air district. To find which air district serves your community, visit https://www.arb.ca.gov/app/dislookup/dislookup.php.

Thank you for your partnership on this critical issue.

School Air Quality Activity Recommendations

PROTECT STUDENT HEALTH DURING POOR AIR QUALITY

Air quality is an important consideration for schools in terms of student activities. Local air districts are available to assist schools with understanding local air quality concerns and actions they can take to protect student health. To find out more, contact your local air district. Visit this page to learn which District serves your area: www.arb.ca.gov/app/dislookup/dislookup.php

The following school activity recommendations are based on consultation with health researchers and several important principles drawn from recent studies.

Modify these levels to correspond with the AQI, emissions concentration, or other air district recommended method for your region.

Air Quality Level

Activity	Level 1	Level 2	Level 3	Level 4	Level 5 *School districts may consider school closures based on site-by-site concerns.* ***
Recess (15min)	No restrictions	Ensure that sensitive individuals are medically managing their condition.*	Sensitive individuals should exercise indoors or avoid vigorous outdoor activities.*	Exercise indoors or avoid vigorous outdoor activities. Sensitive individuals should remain indoors.*	No outdoor activity. All activities should be moved indoors.
P.E. (1hr)	No restrictions	Ensure that sensitive individuals are medically managing their condition.*	Sensitive individuals should exercise indoors or avoid vigorous outdoor activities.*	Exercise indoors or limit vigorous outdoor activities to a maximum of 15 minutes Sensitive individuals should remain doors.*	No outdoor activity. All activities should be moved indoors.
Athletic Practice & Training (2-4hurs)	No restrictions	Ensure that sensitive individuals are medically managing their condition.*	Reduce vigorous exercise to 30 minutes per hour of practice time with increased rest breaks and substitutions. Ensure that sensitive individuals are medically managing their condition.*	Exercise indoors or reduce vigorous exercise to 30 minutes of practice time with increased rest breaks and substitutions. Sensitive individuals should remain indoors.*	No outdoor activity. All activities should be moved indoors.
Scheduled Sporting Events	No restrictions	Ensure that sensitive individuals are medically managing their condition.*	Increase rest breaks and substitutions per CIF guidelines for extreme heat.** Ensure that sensitive individuals are medically managing their condition.*	Increase rest breaks and substitutions per CIF guidelines for extreme heat.** Ensure that sensitive individuals are medically managing their condition.*	Event must be rescheduled or relocated.

* Sensitive Individuals include all those with asthma or other heart/lung conditions

** California Interscholastic Federation

*** To meet the conditions for approval of a waiver due to emergency conditions (Form J-13A) from the State Superintendent of Public Instruction poor air quality must be shown to be caused by an emergency event such as a wildfire.

Air Quality Guidance Template for Schools

About the Guidelines:

- These guidelines are based on the United States Environmental Protection Agency (U.S. EPA) and Centers for Disease Control's Air Quality and Outdoor Activity Guidance for Schools and Wildfire Smoke: A Guide for Public Health Officials. The guidelines are designed to assist in your decision-making process.

- Modify the template and chart as needed after consultation with your local county office of education, local school districts, local air district, and local public health experts to determine which air quality monitoring methodology, such as Air Quality Index, total emissions concentration, or other air district-recommended method best applies in your school district.

- This template and chart are not intended to supersede existing guidelines and policies developed by local authorities, including the school districts or air districts.

- These guidelines are intended to assist school districts in making decisions when air quality is poor. *School closure and event cancellation is ultimately a school district-by-school district decision based on local conditions.*

- The impact of smoke depends on the sensitivity of the person and the length of exposure, as outlined in the sample chart below. Children with respiratory or heart conditions are vulnerable to poor air quality and may require extra precautions. School districts should advise parents to consult with their family health care provider.

Using the Guidelines:

- School districts will need to monitor local air quality conditions using air quality tracking tools recommended by their local air district. One example of such a tool is U.S. EPA's air quality index (AQI) available at AirNow.gov. However, because other air quality tracking methodologies may be used in your jurisdiction, it is highly recommended to contact your local air district for advice on the most appropriate tools to use for your region.

- School districts should make decisions about school activities and closures based on air quality measurements and local conditions, such as the availability and quality of school building air filtration and direct observation of onsite indoor/outdoor air quality.

- School districts may wish to consult with their local air district regarding outdoor air and their local public health official regarding indoor air before making a final determination.

- School districts should report any school closures to their County Office of Education for media notification as well as announce closures to families using normal school closure procedures.

Additional Air Quality Information & Resources

About AirNow.gov:

- A network of monitors maintained and operated by trained government agencies.
- It is recommended by many air districts, the California Air Resources Board, and U.S. EPA.
- AirNow monitors form a network to track regional air quality. Pollutants like smoke tend to be well-mixed in the atmosphere and may be adequately represented by these monitors, even if a monitor is not in the same neighborhood as a school.
- Uses highly accurate tools that are regularly monitored for quality control by U.S. EPA. Tools remain accurate at all levels as opposed to personal sensors like Purple Air, which overestimate (especially at AQI of 150 or higher)
- Although AirNow is relied on by many jurisdictions, please consult with your local air district about resources school districts can use that will best represent local air quality.

About Masks:

- When air is unhealthy, the best option is to reduce physical activity and stay indoors with windows/doors closed. If indoor temperature is high, get to a location with clean filtered air such as a public library, shopping mall or other building with heating, ventilation, and air conditioning (HVAC) system filtration.
- Masks have limitations. Surgical gauze masks provide no protection from smoke. N95 respirator masks are designed for professional use by trained adults and are not intended for children. Therefore, masks are not recommended for children by air quality districts/public health agencies.
- N95 masks require a perfect seal to be effective. If these masks are not fitted correctly, they will provide little if any protection.
- Masks can exacerbate breathing difficulty for sensitive breathers or potentially cause deeper breathing, which draws particulates deeper into the lungs if they are not fitted correctly.
- Masks must be kept clean and replaced frequently to be effective. If a mask is used, please refer to the mask manufacturer's recommendations on cleaning and replacement intervals.

Recommendations for Ensuring Cleaner Air at School:

- Install and maintain HVAC air conditioning system with medium or high-efficiency filtration. Install high efficiency particulate air (HEPA) filters if possible. See below for U.S. EPA recommendations for air filtration. https://www3.epa.gov/airnow/smoke_fires/indoor-air-filtration-factsheet-508.pdf
- Install portable HEPA filters in classrooms where possible.

- Approved filters: https://www.arb.ca.gov/research/indoor/aircleaners/certified.htm
- Be sure that portable filters are sized correctly for the room.
- Ensure doors and windows are sealed tightly. Minimize air movement in and out of room.

Considerations for School Districts from CDE: Before You Make a Decision to Close a School

Outdoor air quality is one factor local educational agencies (LEAs) need to consider when making a school closure decision. LEAs should consider the factors below, in addition to any other relevant local conditions or concerns, when deciding to close school.

Health and Safety:

- **Indoor air quality.** Ventilation and filtration systems at schools may offer a higher level of protection than residential systems.
- **Supervision.** The school environment provides appropriate student supervision by trained and caring adults who can ensure students remain indoors.
- **Student support services.** School may be the primary place where students receive needed health and counseling services.
- **Nutrition services.** Schools serve healthy meals to a significant proportion of students. If school is closed, it is a substantial challenge at best for LEAs to feed students.

Using an Equity Lens:

- Socioeconomically disadvantaged families may not have options for alternate child care.
- Working parents and guardians are disproportionately affected by school closure and could suffer significant professional or economic consequences as a result.
- Students receiving free or reduced-price meals may not have a reliable alternate source of healthy food.
- Students with Individualized Education Programs (IEPs) may not have access to needed services during school closure.
- Schools provide safe and supportive environments for their students; our most vulnerable students rely on them most.

Instructional Time:

- Instructional time is foundational to students' academic achievement. LEAs should consider adding instructional days or minutes to the school calendar when time is lost due to school closure.

- LEAs that have a foreseeable loss of instructional time due to a history of school closures should consider adding “built-in emergency” days to the annual school calendar.

- Information on requesting credit for lost attendance and instructional time during an emergency is available on the California Department of Education’s website at https://www.cde.ca.gov/fg/aa/pa/j13a.asp.

National School Lunch Program Meal Reimbursement:

- *Education Code* Section 49505 allows for LEAs to submit an application for meal reimbursement during a disaster.

- The disaster would require a state or federal declaration for the county affected by the disaster.

- The application is available on the California Department of Education’s website at https://www.cde.ca.gov/ls/nu/sn/documents/disastermealapp.doc.

Guidance for Families When Schools are Closed:

- Stay indoors.

- Keep doors and windows closed.

- Consult a Physician if you have concerns about your child’s health.

Air Quality and Outdoor Activity Guidance for Schools

Regular physical activity — at least 60 minutes each day — promotes health and fitness. The table below shows when and how to modify outdoor physical activity based on the Air Quality Index. This guidance can help protect the health of all children, including teenagers, who are more sensitive than adults to air pollution. Check the air quality daily at www.airnow.gov.

Air Quality Index	Outdoor Activity Guidance
 GOOD	Great day to be active outside!
 MODERATE	Good day to be active outside! Students who are unusually sensitive to air pollution could have symptoms.*
 UNHEALTHY FOR SENSITIVE GROUPS	It's OK to be active outside, especially for **short activities** such as recess and physical education (PE). For **longer activities** such as athletic practice, take more breaks and do less intense activities. Watch for symptoms and take action as needed.* Students with asthma should follow their asthma action plans and keep their quick-relief medicine handy.
 UNHEALTHY	For **all outdoor activities**, take more breaks and do less intense activities. Consider moving **longer or more intense activities** indoors or rescheduling them to another day or time. Watch for symptoms and take action as needed.* Students with asthma should follow their asthma action plans and keep their quick-relief medicine handy.
 VERY UNHEALTHY	Move **all activities** indoors or reschedule them to another day.

* Watch for Symptoms

Air pollution can make asthma symptoms worse and trigger attacks. Symptoms of asthma include coughing, wheezing, difficulty breathing, and chest tightness. Even students who do not have asthma could experience these symptoms.

If symptoms occur:
The student might need to take a break, do a less intense activity, stop all activity, go indoors, or use quick-relief medicine as prescribed. If symptoms don't improve, get medical help.

Go for 60!

CDC recommends that children get 60 or more minutes of physical activity each day. www.cdc.gov/healthyyouth/physicalactivity/guidelines.htm

Plan Ahead for Ozone

There is less ozone in the morning. On days when ozone is expected to be at unhealthy levels, plan outdoor activities in the morning.

Questions and Answers

How long can students stay outside when the air quality is unhealthy?

There is no exact amount of time. The worse the air quality, the more important it is to take breaks, do less intense activities, and watch for symptoms. Remember that students with asthma will be more sensitive to unhealthy air.

Why should students take breaks and do less intense activities when air quality is unhealthy?

Students breathe harder when they are active for a longer period of time or when they do more intense activities. More pollution enters the lungs when a person is breathing harder. It helps to:

- ✔ reduce the amount of time students are breathing hard (e.g., take breaks; rotate players frequently)
- ✔ reduce the intensity of activities so students are not breathing so hard (e.g., walk instead of run)

Are there times when air pollution is expected to be worse?

Ozone pollution is often worse on hot sunny days, especially during the afternoon and early evening. Plan outdoor activities in the morning, when air quality is better and it is not as hot.

Particle pollution can be high any time of day. Since vehicle exhaust contains particle pollution, limit activity near idling cars and buses and near busy roads, especially during rush hours. Also, limit outdoor activity when there is smoke in the air.

How can I find out the daily air quality?

Go to www.airnow.gov. Many cities have an Air Quality Index (AQI) *forecast* that tells you what the local air quality will be later today or tomorrow, and a *current* AQI that tells you what the local air quality is now. The AirNow website also tells you whether the pollutant of concern is ozone or particle pollution. Sign up for emails, download the free AirNow app, or install the free AirNow widget on your website. You can also find out how to participate (and register your school) in the School Flag Program (www.airnow.gov/schoolflag).

If students stay inside because of unhealthy outdoor air quality, can they still be active?

It depends on which pollutant is causing the problem:

Ozone pollution: If windows are closed, the amount of ozone should be much lower indoors, so it is OK to keep students moving.

Particle pollution: If the building has a forced air heating or cooling system that filters out particles then the amount of particle pollution should be lower indoors, and it is OK to keep students moving. It is important that the particle filtration system is installed properly and well maintained.

What physical activities can students do inside?

Encourage indoor activities that keep all students moving. Plan activities that include aerobic exercise as well as muscle and bone strengthening components (e.g., jumping, skipping, sit-ups, pushups). If a gymnasium or open space is accessible, promote activities that use equipment, such as cones, hula hoops, and sports balls. If restricted to the classroom, encourage students to come up with fun ways to get everyone moving (e.g., act out action words from a story). Teachers and recess supervisors can work with PE teachers to identify additional indoor activities.

What is an asthma action plan?

An asthma action plan is a written plan developed with a student's doctor for daily management of asthma. It includes medication plans, control of triggers, and how to recognize and manage worsening asthma symptoms. See www.cdc.gov/asthma/actionplan.html for a link to sample asthma action plans. When asthma is well managed and well controlled, students should be able to participate fully in all activities. For a booklet on "Asthma and Physical Activity in the School," see http://www.nhlbi.nih.gov/health/resources/lung/asthma-physical-activity.htm.

EPA United States Environmental Protection Agency

CDC Centers for Disease Control and Prevention

School Flag Program

EPA-456/F-14-003
August 2014

Activity Guidelines for Wildfire Smoke Events

Recommendations for Schools and Others Responsible for Children during a Wildfire Smoke Event

Activity	GOOD (10+ miles visibility)	MODERATE (6 – 10 miles visibility)	UNHEALTHY FOR Sensitive Groups * (3 – 6 miles visibility)	UNHEALTHY (1.5 – 3 miles visibility)	VERY UNHEALTHY/ HAZARDOUS (<1.5 miles visibility)
Recess (15 minutes)	No restrictions	No restrictions	Keep children with asthma or other respiratory problems indoors. Make indoor space available for all children.	Keep all children indoors.	Keep all children indoors.
P.E. (1 hour)	No restrictions	Monitor kids with asthma or other respiratory problems and limit their vigorous activities.	Keep children with asthma or other respiratory problems indoors. Make indoor space available for all children. If outdoors, limit vigorous activities. Individuals with asthma or other respiratory illness should be medically managing their condition.	Conduct P.E. indoors. If outdoors, only allow light activities for all participants. Individuals with asthma or other respiratory illness should be medically managing their condition.	Keep all children indoors.
Scheduled Sporting Events	No restrictions	Monitor kids with asthma or other respiratory problems and limit their vigorous activities.	Individuals with asthma or other respiratory illness should be medically managing their condition. Increase rest periods and substitutions for all participants to lower breathing rates.	Consider rescheduling or relocating event.	Reschedule or relocate event.
Athletic Practice, Training & Games (2-4 hours)	No restrictions	Monitor kids with asthma or other respiratory problems and limit their vigorous activities.	Individuals with asthma or other respiratory illness should be medically managing their condition. Increase rest periods and substitutions for all participants to lower breathing rates.	Conduct practice and games indoors. If outdoors, allow only light activities for all participants. Add rest breaks or substitutions to lower breathing rates. Individuals with asthma or other respiratory illness should be medically managing their condition.	Conduct practice and games indoors only.
Examples of light activities: • **Walking slowly on level ground** • **Carrying school books** • **Hanging out with friends**		**Examples of moderate activities:** • **Skateboarding** • **Slow pitch softball** • **Shooting basketballs**		**Examples of vigorous activities:** • **Running, jogging** • **Playing football, soccer, and basketball**	

*If your child has lung or heart problems he or she may be more sensitive to air pollution and it is recommended that you talk with a doctor about his or her condition.

How to estimate air quality based on visibility for areas without an air quality monitor or airport visibility estimate:

1. Face away from the sun.
2. Determine the limit of your visible range by looking for targets at known distances (miles).
3. Visible range is when an object you can easily see in the distance disappears.
4. Use the visibility values above to determine the local wildfire smoke category.

IDAHO DEPARTMENT OF HEALTH & WELFARE

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY

Oregon Health Authority



Public Health Guidance: School Outdoor Activities During Wildfire Events

Check the local Air Quality Index (AQI) online (http://www.deq.state.or.us/aqi/) and do a visual inspection outside.* Compare the AQI and visibility test to determine the air conditions in your community. Then, use the guide below to determine activity level for your students.**

Air Quality Index	Visibility Scale	Recess (15 min)	P.E. (1 hr)	Athletic events and practices (2–3 hrs)
Good	> 5 miles with no noticeable haze in the air	Great day to be active outdoors!	Great day to be active outdoors!	Great day to be active outdoors!
Moderate	5–15 miles with noticeable haze in the air	It is a good day for students to be active outside. • Watch students who are unusually sensitive to air pollution for symptoms of shortness of breath or coughing.	• Watch students who are unusually sensitive to air pollution. • Look for symptoms of shortness of breath or coughing. • Monitor symptoms and reduce or cease activity if symptoms arise.	• Watch students who are unusually sensitive to air pollution. • Look for symptoms of shortness of breath or coughing. • Increase rest periods and make substitutions for these students as needed. • Monitor symptoms and reduce or cease activity if symptoms arise.
Unhealthy for sensitive groups	3–5 miles	It is an OK day for students to be active outside. • Allow students who are unusually sensitive to air pollution to stay indoors if they'd like.	• Move activities indoors for students sensitive to air pollution. • Limit other students to light outdoor activities or move the activities indoors. • Increase rest periods and make substitutions. • Monitor symptoms and reduce or cease activities if symptoms arise.	• Move activities indoors for students sensitive to air pollution. • Limit other students to light outdoor activities or move the activities indoors. • Increase rest periods and make substitutions. • Monitor symptoms and reduce or cease activities if symptoms arise.
Unhealthy	1–3 miles	• Consider keeping all students indoors or allowing only light outdoor activity. • Move activities indoors for students sensitive to air pollution.	• Move activities indoors for students sensitive to air pollution. • Consider moving all activities indoors. • Limit all students to light activities. • Increase rest periods and make substitutions.	Consider any of the following: • Cancel the event. • Move the event indoors. • Postpone the event. • Move the event to an area with "good" air quality.
Very unhealthy/ hazardous	1 mile or less	Keep all students indoors.	• Move all activities indoors. • Limit all students to light activities. • Increase rest periods and make substitutions.	Do any of the following: • Cancel the event. • Move the event indoors. • Postpone the event. • Move the event to an area with "good" air quality.

* If you get conflicting results when you compare the AQI to your visual inspection, err on the side of caution. Follow the recommendations for the worse of the two assessments.

**Students with asthma action plans should follow them closely. They should monitor their breathing and exposure to wildfire smoke. Anyone experiencing symptoms should contact a health care provider for further advice. They should call 911 in an emergency.

Watch for symptoms

Wildfire smoke can make asthma symptoms worse. It can trigger asthma attacks. Symptoms of asthma include coughing, shortness of breath, wheezing and chest tightness. Even students without known asthma can have symptoms when exposed to unhealthy levels of wildfire smoke pollution.

Students with asthma should follow their Asthma Action Plan. This will help them decide if they need to take special precautions while engaging in outdoor activities. Athletes with asthma should have rescue inhalers readily available. Use should be as directed by their health care provider. Anyone experiencing symptoms should contact a health care provider. Call 911 in an emergency.

Air Quality Index

How clean or polluted the air is and the level of health concern is in the Air Quality Index (AQI). The AQI categorizes air quality based on air measures collected from Department of Environmental Quality (DEQ) air monitors. For more about AQI in Oregon and how the AQI is calculated, go to http://www.deq.state.or.us/aqi/.

Visibility Scale

In addition to the AQI, you can use your own observations to determine the air conditions in your area. To do a visual inspection:

- Go outside.
- Face away from the sun.
- Determine the limit of your visible range by looking at objects at known distances (miles). Visible range is the point at which even high contrast objects totally disappear.

School closures

School closures are the decision of the individual school district, usually in consultation with the local health department. Consult your local health department if you have questions about air pollution and health.

More information

For more information on how wildfire can affect your health, see http://public.health.oregon.gov/Preparedness/Prepare/Pages/PrepareForWildfire.aspx.

Consult with your local or tribal health authority if you have questions about air pollution and health.

Children and air pollution

Children are particularly sensitive to smoke because their respiratory systems are still developing. In addition, their airways are smaller, and they breathe in more air per pound body weight. Children who may be more sensitive to air pollution include those with:

- Asthma
- Respiratory infection
- Lung or heart disease

Parents of these children should follow their health care providers' advice about prevention and treatment of symptoms. Parents should also watch the smoke forecast to decide when to limit their child's activities.

Oregon Health Authority
PUBLIC HEALTH DIVISION
Health Security, Preparedness and Response
Phone: 971-673-1315
Fax: 971-673-1309

OHA website: http://public.health.oregon.gov/Preparedness/Prepare/Pages/PrepareForWildfire.aspx
OHA Facebook: www.facebook.com/OregonHealthAuthority
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***** NOTE: Activity recommendations are based on the Washington Air Quality Advisory (WAQA) index. *****

Air Pollution and School Activities

Public Health Recommendations for Schools on Fine Particle Air Pollution

Washington State Department of Health

	Air Quality Conditions* First, check local air conditions at https://fortress.wa.gov/ecy/enviwa/ and then use this chart.				
	Good	**Moderate**	**Unhealthy for Sensitive Groups**	**Unhealthy**	**Very Unhealthy/ Hazardous**
Recess (15 minutes)	No restrictions.	Allow students with asthma, respiratory infection, lung or heart disease to stay indoors.	Keep students with asthma, respiratory infection, and lung or heart disease indoors.	Keep all students indoors and keep activity levels light.	Keep all students indoors and keep activity levels light.
P.E. (1 hour)	No restrictions.	Monitor students with asthma, respiratory infection, lung or heart disease. Increase rest periods or substitutions for these students as needed.	Keep students with asthma, respiratory infection, lung or heart disease, and diabetes indoors. Limit these students to moderate activities. For others, limit to light outdoor activities. Allow any student to stay indoors if they don't want to go outside.	Conduct P.E. indoors. Limit students to light indoor activities.	Keep all students indoors and keep activity levels light.
Athletic Events and Practices (Vigorous activity 2-3 hours)	No restrictions.	Monitor students with asthma, respiratory infection, lung or heart disease. Increase rest periods and substitutions for these students as needed.	Students with asthma, respiratory infection, lung and heart disease, or conditions like diabetes shouldn't play outdoors. Consider moving events indoors. If events are not cancelled, increase rest periods and substitutions to allow for lower breathing rates.	Cancel events. Or move events to an area with "Good" air quality — if this can be done without too much time spent in transit through areas with poor air quality.	Cancel events. Or move events to an area with "Good" air quality — if this can be done without too much time spent in transit through areas with poor air quality.

Students with asthma should be following their Asthma Action Plan in all Air Quality Conditions.

Light Activities: Playing board games, throwing and catching while standing, and cup stacking.

Moderate Activities: Yoga, shooting basketballs, dance instruction, and ping pong.

Vigorous Activities: Running, jogging, basketball, football, soccer, swimming, cheerleading, and jumping rope.

School Closures

School closures are the decision of the individual school district, usually in consultation with the local health department. Consult your local health department (www.doh.wa.gov/localhealth) if you have questions about air pollution and health.

WAQA Index

Activity recommendations are based on the Washington Air Quality Advisory (WAQA) index. The WAQA uses the same color-coded categories as the EPA's Air Quality Index (AQI), but the WAQA fine particulate matter ($PM_{2.5}$) categories are set at lower levels of air pollution to be more protective of health. The WAQA shows air quality as poor earlier, with less pollution in the air.

Fine Particulate Matter, Indoor Air Quality, and Health

Wildfires, wood burning, and air stagnation increase the fine particulate matter in the air we breathe. Fine particulate matter travels easily indoors, especially if ventilation systems are drawing outside air into their system. It also comes in through doors, windows, and small openings. Over time, concentrations of fine particulate matter indoors can approach concentrations outdoors.

Exercising students breathe deeper and more often and take in more air, and more air pollution, into their lungs. Breathing polluted air can cause health problems, including aggravating asthma and other respiratory diseases. Anyone experiencing symptoms such as wheezing, shortness of breath, chest pain, headache, and dizziness should be seen by a medical provider.

Schools should reduce inside physical activities once air quality has reached or exceeds the "Unhealthy" category. Increased physical activity requires students to breathe faster, use more oxygen, and produce more CO_2.

School buildings with enhanced filtration will have improved indoor air quality. Supplemental use of properly sized HEPA-charcoal air filters, have been shown to improve indoor air quality by reducing particulate matter and chemicals in smoke.

Asthma Action Plan

http://www.doh.wa.gov/YouandYourFamily/IllnessandDisease/Asthma/WhatShouldIExpectfrommyHealthCareProvider.aspx

More Information

For more information on indoor or outdoor air quality issues, including wildfire smoke, see http://www.doh.wa.gov/CommunityandEnvironment/AirQuality.aspx or contact us toll free at 1-877-485-7316.