Woodsmoke Impacts: Assessment and Mitigation

Stationary Source and Climate Impacts Committee Meeting
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Presentation Outcomes

- Informational Item

- Provide preliminary information on the air quality and health impacts of residential woodsmoke in the Bay Area

- Receive feedback on upcoming steps to improve our understanding of this source category

Presentation Outline

Assessing Woodsmoke Impacts

- Background on residential woodsmoke

- Emissions Inventory Updates

- Woodsmoke impacts from monitoring and modeling analyses

Mitigating Woodsmoke Impacts

- Incentive Programs

- Regulatory Approaches

Upcoming Work

Assessing Woodsmoke Impacts

Background on Residential Woodsmoke

- Woodsmoke is a unique source that presents challenges for understanding air quality impacts and for designing regulations
  - *Significant spatial and temporal variations in woodburning activity*
  - *Multiple types of devices and uses (e.g., aesthetics vs. home heating)*

- Woodsmoke is a significant source of fine particulate matter ($PM_{2.5}$) and contains gaseous air toxics such as benzene and formaldehyde

- District staff are working to better characterize residential woodsmoke impacts on air quality and human health
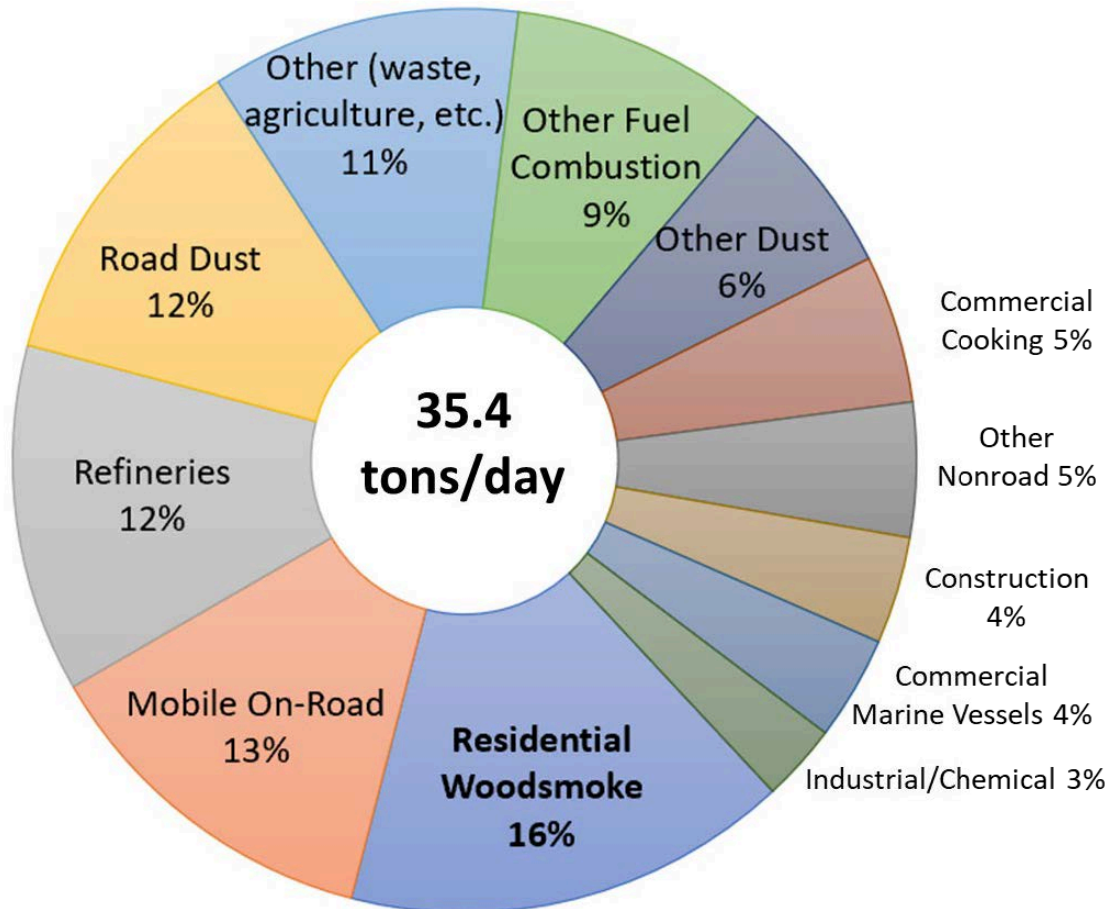
Emissions Inventory Updates

- The District recently contracted with Baseline Environmental to update residential woodsmoke emissions estimates

- The methodology relies on results from the District's Spare the Air surveys conducted from 2004-2020

- Key parameters include device populations, wood consumption rates, emission factors, and the impact of control programs

Emissions Inventory Summary

Bay Area PM$_{2.5}$ Emissions for 2019

- In the updated inventory, PM$_{2.5}$ emissions from residential woodsmoke total 5.7 tons per day (tpd) on an annual average

- Residential woodsmoke accounts for 16% of annual PM$_{2.5}$ emissions in the Bay Area (2019)

- During peak winter months (Dec-Jan), PM$_{2.5}$ emissions from residential woodsmoke exceed 16 tpd, accounting for over one-third of total Bay Area emissions

Emissions Trends

**PM$_{2.5}$ Emissions from Residential Woodsmoke in the Bay Area**
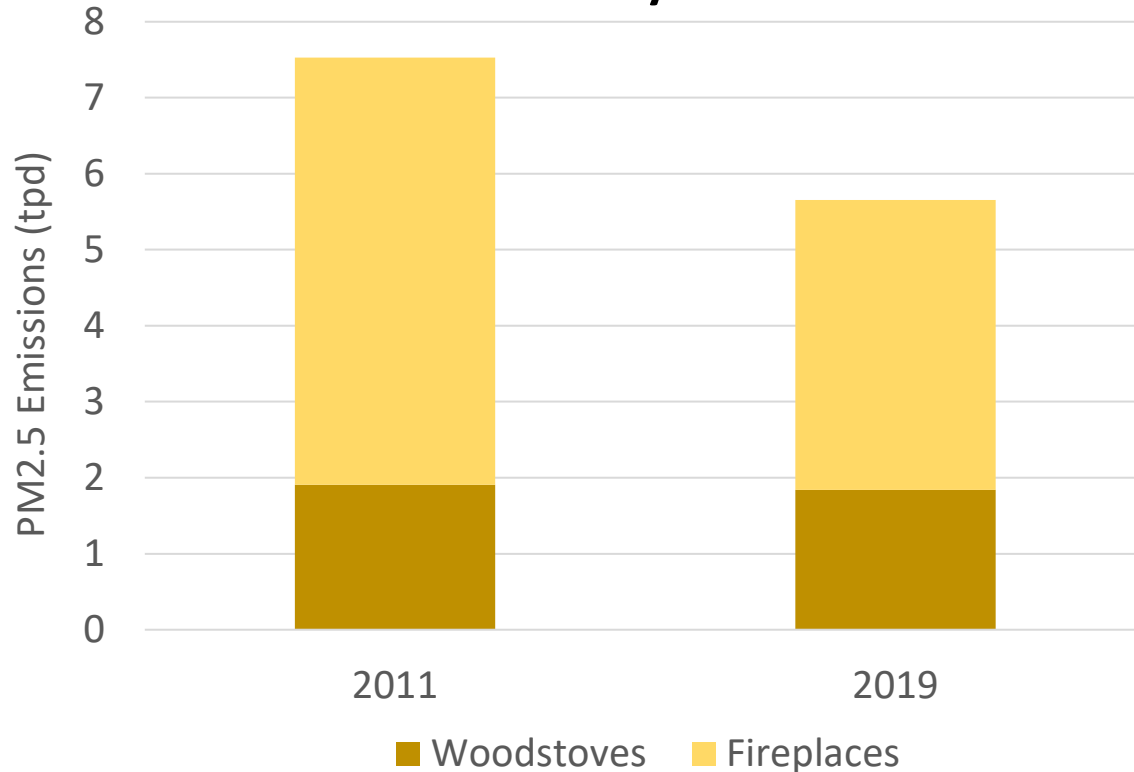
- Nine years ago, District staff used STA survey results to estimate 2011 residential woodsmoke emissions

- 2019 PM$_{2.5}$ emissions are 25% lower than the 2011 estimate

- Emission changes are largely associated with fireplaces (woodstove emissions are virtually unchanged)

Device Population and Activity Trends

**Bay Area Wood-burning Device Populations**
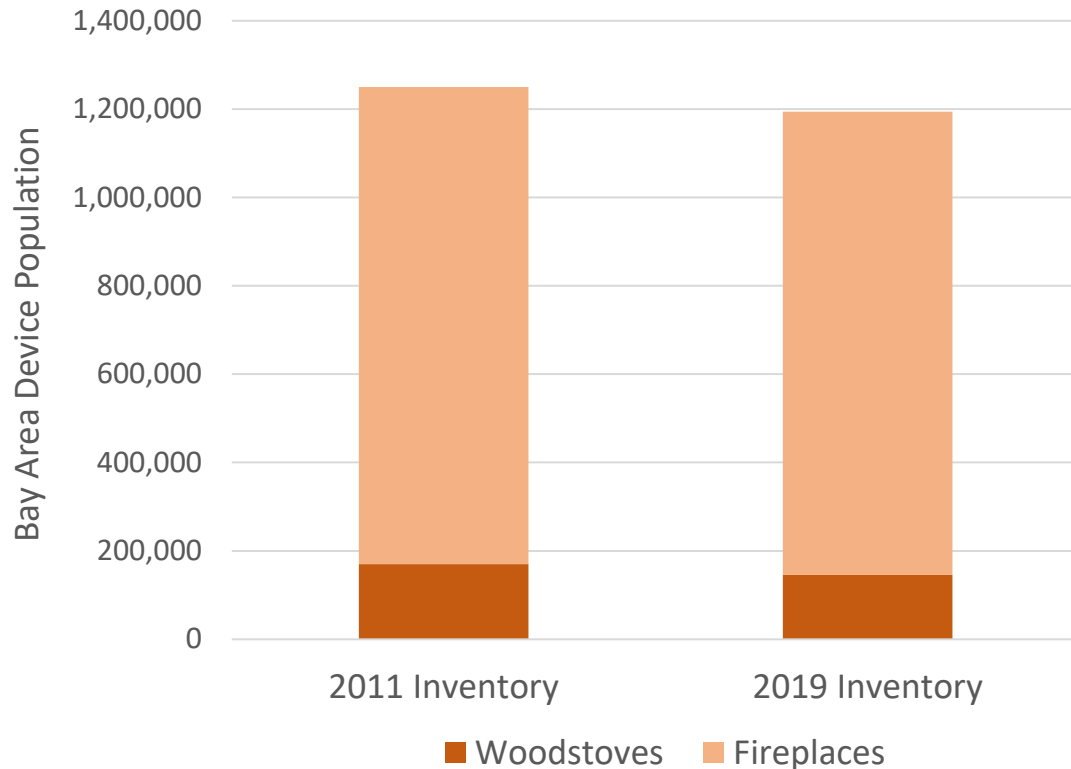
- Wood-burning device populations fell by about 5% between the 2 inventory years

- The Bay Area fireplace population decreased by 3%, while the woodstove population decreased by 14%

- Pre- and post-2012 survey results indicate that the fraction of homes planning to use their woodburning devices has declined by about 11% between the inventory periods

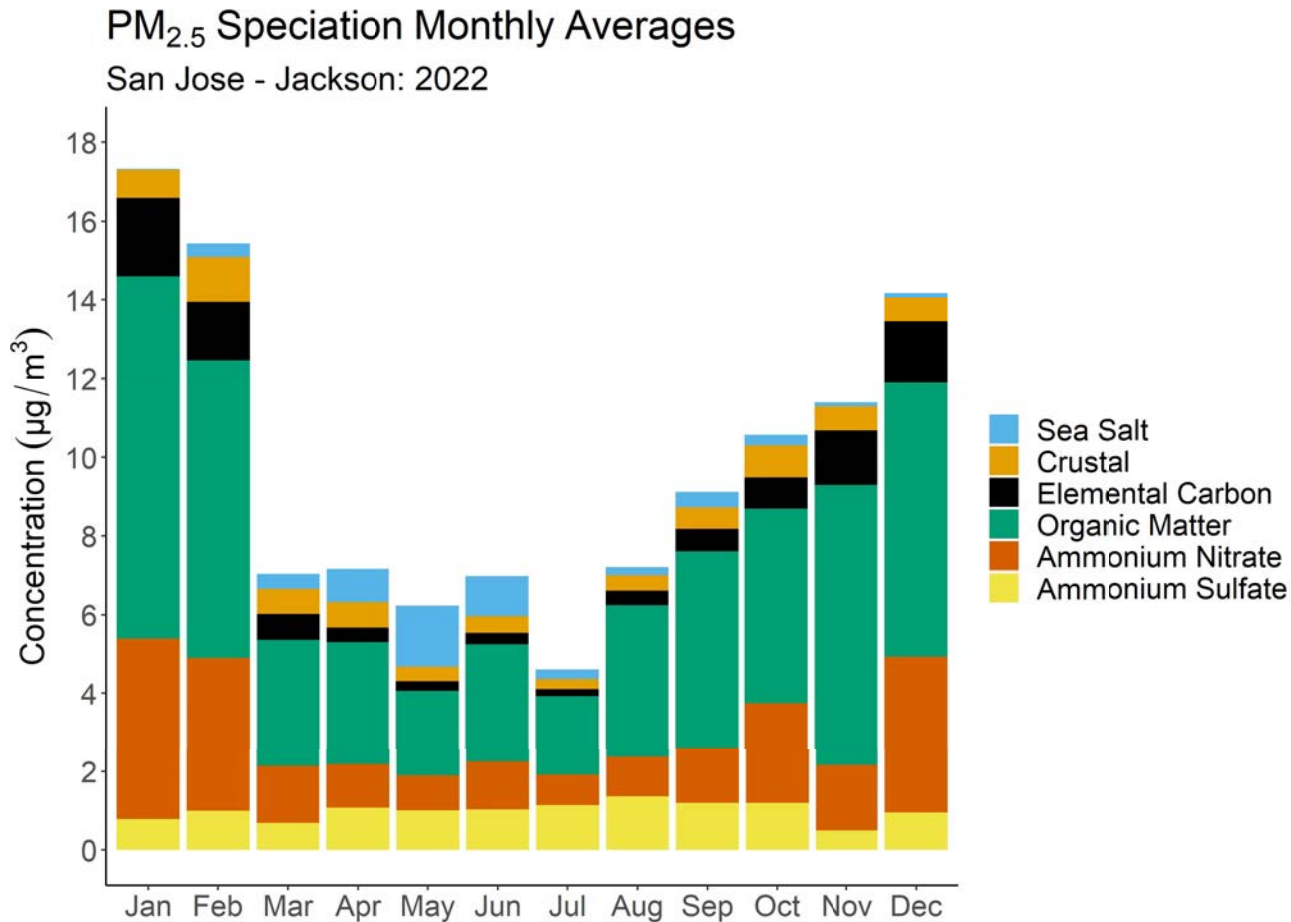# Residential Woodsmoke Causes Elevated Black Carbon Levels

Black Carbon Levels by Time of Day (2016-2020 Average)
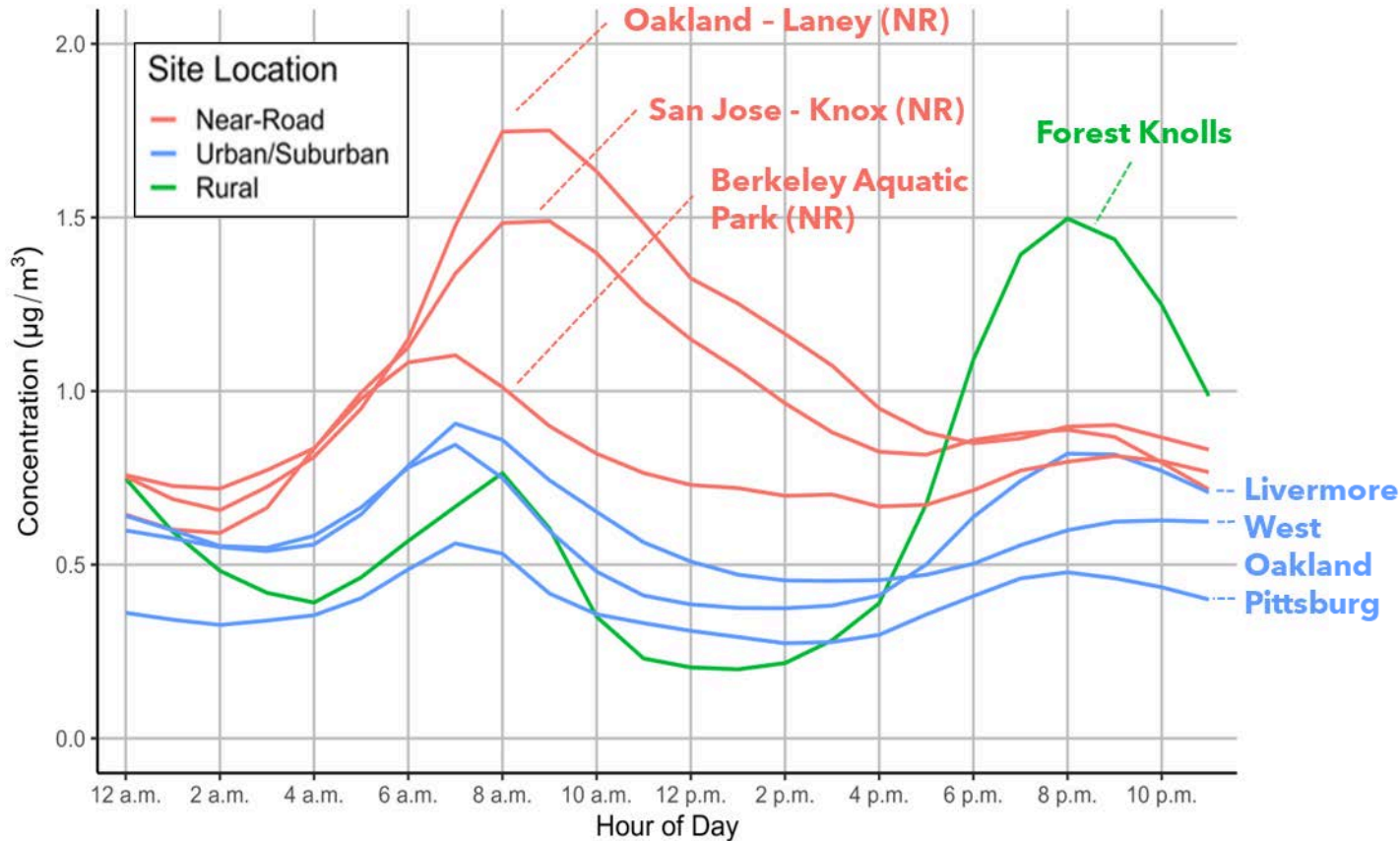
NR: Near-Road Monitoring Site

- Black carbon (BC) is a component of $PM_{2.5}$ mainly produced by combustion of fossil fuels, wood, or other materials.

- BC is associated with asthma, and other respiratory problems, low birth rates, heart attacks and lung cancer.

- At monitoring sites next to freeways, BC is higher during morning commute hours due to car and truck emissions

- High levels of BC at Forest Knolls, similar to the levels near freeways, occur in the evening when people use their woodstoves and fireplaces.

Analysis of PM$_{2.5}$ Composition by Month

PM$_{2.5}$ Speciation Monthly Averages
San Jose - Jackson: 2022

Legend:
- Sea Salt
- Crustal
- Elemental Carbon
- Organic Matter
- Ammonium Nitrate
- Ammonium Sulfate

- Residential woodsmoke emissions contribute to higher PM$_{2.5}$ in the fall and winter (higher particulate organic matter and elemental carbon components)

- Other factors also contribute to higher PM$_{2.5}$ in the fall and winter

- Upcoming analyses will better quantify the contributions from local residential woodsmoke and the other factors such as fossil fuel combustion and transport from outside the Bay Area

Air Quality Modeling Approach

- Residential woodsmoke impacts on Bay Area $PM_{2.5}$ concentrations were modeled using the District's 2018 regional modeling platform.

- The Community Multiscale Air Quality (CMAQ) model was run with multiple Bay Area residential woodsmoke emissions scenarios to estimate the contribution of this source to annual average $PM_{2.5}$ levels.

- Simulated $PM_{2.5}$ contributions include primary (directly emitted) and secondary (chemically formed) components.

- Modeled $PM_{2.5}$ concentrations attributable to residential woodsmoke were then combined with population data in EPA's Benefits Mapping and Analysis Program (BenMAP) to estimate health impacts.

Preliminary Modeling Results

Contours =
+0.3 µg/m³
ΔPM$_{2.5}$
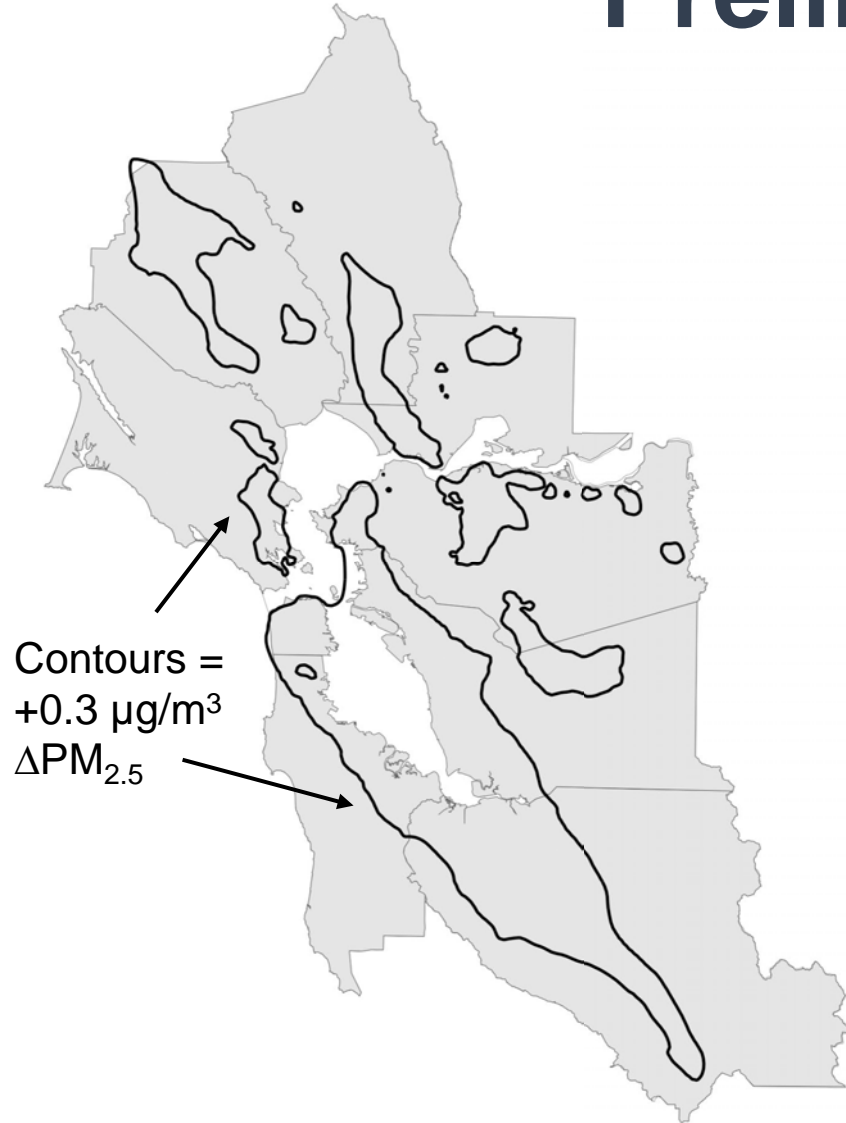
- On an annual-average basis, modeled PM$_{2.5}$ contributions on the order of 0.3 µg/m³ or more are seen across most of the Bay Area

- About 6.6 million Bay Area residents are impacted at this level (≥0.3 µg/m³)

- Areas with the greatest woodsmoke impacts are still under investigation

*Total modeled population = **7.7 million***

Preliminary Estimates of Impacts

- **Modeled health impacts** are about 4 times as high for residential woodsmoke, compared to space and water heating

  - In terms of undifferentiated annual average $\Delta PM_{2.5}$

  - Estimates for selected endpoints:

	Mortality	Asthma
Residential woodsmoke *Preliminary assessment*	**160–350**	**480**
Space & water heating appliances *Rule 9-4/9-6 assessment*	37–85	110

*Mortality = premature adult mortality. **Asthma** = pediatric asthma onset (new cases). Values are annual incidence (events per year) attributed to modeled sources.*

Mitigating Woodsmoke Impacts

Air District Sponsored Woodsmoke Reduction Incentive Programs

2008-2009

- $336,000
- ~ 665 projects
- Replacement options: gas and EPA certified wood & pellet stoves
- No area limitations

2016-2019

- $3 million
- ~ 1000 projects
- Replacement options: gas, electric heat pumps & device removal
- Funding prioritized and plus-up funding for impacted communities and low-income residents

2023-2024 Clean HEET

- $2 million
- ~ 270 projects
- Replacement option: **Only electric heat pumps**
- **> 60% funding to benefit priority communities. Plus-up funding for low-income participants**

Woodsmoke Reduction Incentive Program

- Clean HEET, or Clean Heating Efficiently with Electric Technology, Program will offer $2 million to homeowners to replace **operating and heating wood stoves and wood-burning fireplace inserts with electric heat pumps**

- **Incentivize ~270 households' transition to heat pumps technology while reducing wood smoke pollution**

- Competitive solicitation and evaluation criteria to prioritize awards to households in priority communities & low-income residents

- Funded by Environmental Protection Agency Targeted Airshed Grant and Air District General Fund

https://www.baaqmd.gov/woodsmokegrant
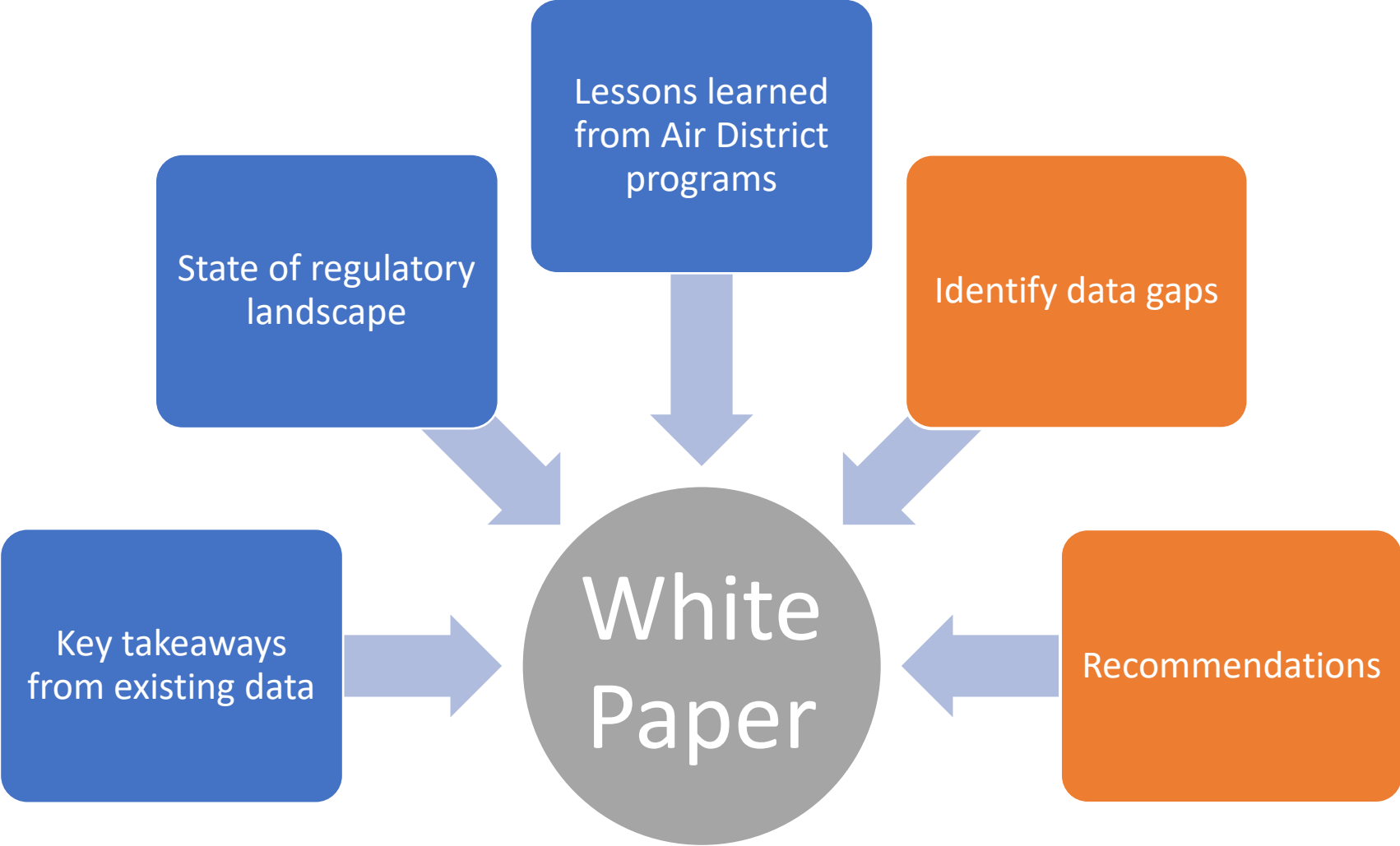
Regulation 6, Rule 3

- Bans wood burning when 24-hour $PM_{2.5}$ levels are forecast to be above the federal standard (Spare the Air Alert), with some exemptions.

- Prohibits the installation of a wood-burning device in new building construction (effective Nov. 1, 2016).

- Fireplace and chimney remodels costing more than $15,000 and requiring a local building permit must install an EPA-certified wood-burning device.

- Excessive smoke is prohibited year-round.

Scoping Phase of the Rule Development Process

Knowledge Assessment and Gaps Analysis

⭐ We are here

Release of White Paper

Spring 2024

Public engagement on White Paper Findings

White Paper Development

Potential Policy Options to Explore

Regulatory Measures

- Restriction on activity
  - Example: Call more burn ban days
- Restriction on equipment
  - Example: New requirement to replace or decommission devices at point of sale

Incentives and Outreach

- Replace dirty devices with cleaner devices via incentives program
- Education and outreach on health impacts and alternatives to burning

Fill data gaps

- Perform further studies and data collection to support decision-making

Upcoming Work

- Analyze air quality data from different types of measurements to identify days that are affected by woodsmoke

- Evaluate how woodsmoke affects $PM_{2.5}$ concentrations and other toxic gases
  - Spatial and temporal differences in total $PM_{2.5}$ concentrations on days with high woodsmoke impacts from air sensors and other data sources
  - Trends in the woodsmoke contribution to $PM_{2.5}$ and other pollutants
  - Quantify woodsmoke contribution to peak and long-term exposures to $PM_{2.5}$ and other pollutants

- Further evaluate the spatial distribution of woodsmoke emissions with a view toward more refined analyses of health impacts

- Conduct additional air quality modeling for a more current year (e.g., 2022)