



BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT

PM Health Protection Symposium (Advisory Council Meeting of October 28, 2019)

Chair Stan Hayes
Advisory Council
December 9, 2019



PM Focus: Context

- Following three years of **intense wildfire smoke**, focus on **reducing diesel PM** emissions, and conclusion that PM is overwhelming **health risk driver** in Bay Area air
- Air District asked Advisory Council to **focus on PM**
- Provide Advisory Council's take on **latest and best science**, in science-affirming way
- **Assist Air District** to identify those further PM measures that would most move public health needle, especially in most impacted communities



PM Symposia: Overview

- Convened by Advisory Council as **series of meetings**
- Engage **nationally-recognized experts**, including leading experts previously engaged at the Federal level
- **Support Air District** in identifying health-focused “target” guidelines based on latest science, beyond standards already in effect
- Facilitate **Advisory Council feedback** on Air District planning
- Include **local stakeholders**
- Provide **national leadership**

Key Points

- The National Ambient Air Quality Standard (NAAQS) Science Review Process Worked Well Until 2017
- EPA Administrators Pruitt and Wheeler Have **Broken the Process**
- Particulate Matter Science Review By the EPA Clean Air Scientific Advisory Committee (CASAC) is Highly Deficient: **Appropriate to Look Elsewhere**
- Disbanded CASAC PM Review Panel Reconvened Itself
- Key Findings of the Independent Particulate Matter Review Panel



Particulate Matter: Spotlight on Health Protection



BAY AREA AIR QUALITY
MANAGEMENT DISTRICT



Particulate Matter: Spotlight on Health Protection



Date: Oct. 28, 2019 Time: 9:00 am - 4:45pm Advisory Council Chair: Mr. Stan Hayes Facilitator: Jeff McKay

Agenda Items

8:30 AM	Registration/Coffee and light breakfast	Atrium
9:00 AM	Welcome	Board Room
9:25 AM	PM Health Effects Panel	Board Room
11:05 AM	Break	Atrium
11:15 AM	Joint Discussion: Health Effects Panel	Board Room
12:00 PM	Lunch with Keynote Speaker – Former EPA Administrator Gina McCarthy	Yerba Buena
1:15 PM	PM Exposure & Risk Panel	Board Room
2:55 PM	Break	Atrium
3:10 PM	Joint Discussion: Exposure & Risk Panel	Board Room
4:00 PM	Advisory Council Deliberation	Board Room

Additional information

This is a meeting of the BAAQMD Advisory Council.

Public comment will take place during welcome remarks.

For ADA related assistance, please contact Areana Flores at aflores@baaqmd.gov.

375 Beale Street, Suite 600, San Francisco, California 94105 • 415.749.5000 • baaqmd.gov



Particulate Matter: Spotlight on Health Protection

- ~160 registrants
- 2 panels
 - PM Health Effects
 - PM Exposure & Risk
- 9 leading experts

Gina McCarthy

- **Former EPA Administrator**
- Finalized the Clean Power Plan and the Clean Water Rule
- Professor of the Practice of Public Health in the Department of Environmental Health at Harvard T.H. Chan School of Public Health
- Director of the Center for Climate, Health, and the Global Environmental
- Member of the Board of Directors of the Energy Foundation and Ceres
- M.Sc. in Environmental Health Engineering, Planning and Policy from Tuft's University





Jason Sacks, M.P.H.

- Senior Epidemiologist in the Center for Public Health & Environmental Assessment within U.S. EPA's Office of Research and Development
- **Assessment lead for the Particulate Matter Integrated Science Assessment (Draft PM ISA)**
- Key leadership roles in synthesizing the health effects evidence of air pollution for various National Ambient Air Quality Standards reviews
- International training on U.S. EPA's Environmental Benefits Mapping and Analysis Program – Community Edition
- M.P.H. from Johns Hopkins University in 2003



Michael Kleinman, Ph.D.

- UC Irvine Professor of Environmental Toxicology
- Co-Director of the Air Pollution Health Effects Laboratory in the Department of Community and Environmental Medicine
- Adjunct Professor in College of Medicine
- **Serves on the Air District Advisory Council**
- Ph.D. in Environmental Health Sciences from New York University
- **CA Scientific Review Panel on Toxic Air Contaminants; CA Air Quality Advisory Committee**



John R. Balmes, M.D.

- Professor of Medicine at UC San Francisco
- Professor of Environmental Health Sciences in the School of Public Health at UC Berkeley
- Director of the Northern California Center for Occupational and Environmental Health
- Authored over 300 papers on occupational and environmental health-related topics
- **Physician Member of the California Air Resources Board**



H. Christopher Frey, Ph.D., F. A&WMA, F. SRA

- Glenn E. Futrell Distinguished University Professor of Environmental Engineering in the Department of Civil, Construction, and Environmental Engineering at North Carolina State University
- Adjunct professor in the Division of the Environment and Sustainability at the Hong Kong University of Science and Technology
- Fellow of the Air & Waste Management Association and of the Society for Risk Analysis
- Ph.D. in Engineering and Public Policy from Carnegie Mellon
- **Former Chair/Member, EPA Clean Air Scientific Advisory Committee (CASAC)**
- **Former Chair/Member, 10 different CASAC NAAQS Review Panels**
- **Chair, Independent PM Review Panel**



Lauren Zeise, Ph.D.

- **Appointed by Gov. Brown as Director of the California Office of Environmental Health Hazard Assessment in December 2016**
- Former Chief of the cancer unit at the California Department of Health Services
- Leading role in OEHHA's development of CalEnviroScreen
- Co-led the team that developed the hazard trait regulation for California's Safer Consumer Products program
- Member, fellow, former editor, and former councilor of the Society for Risk Analysis
- 2008 recipient of the Society's Outstanding Risk Practitioner Award
- Ph.D. from Harvard University



Julian Marshall, Ph.D.

- **Kiely Endowed Professor of Environmental Engineering at University of Washington with a focus on air quality management**
- Founded and runs the Grand Challenges Impact Lab, a UW study abroad program in Bangalore, India
- Associate Editor for Environmental Health Perspectives and Development Engineering
- Published over 100 peer-reviewed journal articles
- Ph.D. in Energy and Resources from UC Berkeley



Scott Jenkins, Ph.D.

- Senior Environmental Health Scientist in EPA's Office of Air Quality Planning and Standards (OAQPS)
- **Currently leading EPA's review of the National Ambient Air Quality Standards (NAAQS) for Particulate Matter (PM)**
- Howard Hughes Postdoctoral Research Fellow in the Department of Cell Biology at Duke University
- Ph.D. in Behavioral Neuroscience from the University of Alabama at Birmingham



Phil Martien, Ph.D.

- **Director of the Assessment, Inventory, & Modeling Division at the Bay Area Air Quality Management District**
- Leading role in the Technical Assessment of AB617's West Oakland Community Action Plan
- Leading role in the Technical Assessment of the Air District's 2017 Clean Air Plan: Spare the Air, Cool the Climate
- Leading role in the Air District's Community Air Risk Evaluation Program
- Ph.D. from UC Berkeley



**PM Health Effects
Panel**



**PM Exposure & Risk
Panel**

Advisory Council Discussion with Experts

BAAQMD's Questions

Example Response

- Are current PM standards sufficiently protective? **Emphatic NO – definitely not for PM_{2.5}.**
- How has the PM health evidence been strengthened? **Better “exposure” models, much larger study populations at much lower levels than before.**
- What new health effects are now recognized? **Strengthening of some causality determinations, but largely the focus is still premature mortality, respiratory morbidity, and cardiovascular morbidity.**
- New endpoints like cancer and central nervous system effects? **Opinions differ.**
- New sensitive groups, like children and lower socioeconomic status, SES, populations? **Growing recognition of “at risk” groups.**
- Are all types of PM equal? **Probably not.** Or, are some more dangerous than others? **Probably. But, more work needed. No components are as yet ‘exonerated.’**
- How severe are PM health risks? **Premature mortality is severe.**
- What additional health benefits can be achieved by further reducing PM to below current standards? **Difficult to quantify with certainty but on the order of tens of thousands of deaths nationally.**

Discussion Questions (EXAMPLE, DO NOT CITE)

Are current PM standards sufficiently health protective?

NOT PROTECTIVE, STANDARDS SHOULD BE LOWERED

Are some species of PM more dangerous than others?

QUITE POSSIBLY BUT NOT ENOUGH INFORMATION, NO PM COMPONENTS “EXONERATED”

What is role of ultrafine particles (UFPs)?

NOT YET CLEAR, TOX STUDIES OF CONCERN, NEED UFP FEDERAL REFERENCE METHOD, MORE MONITORING, EPI STUDIES

Should PM “target” expand to account for more than just mass?

IN RESEARCH ABSOLUTELY, IN REGULATION TOO SOON, UNLESS HIGHLY RISK-AVERSE

How should we include draft PM ISA’s new “likely-causal” health endpoints (nervous system effects, cancer) and new more sensitive populations (children, lower socio-economic status)?

NEW HEALTH EFFECTS AND GROWING RECOGNITION OF “AT RISK” GROUPS IMPORTANT (SUCH AS CHILDREN AND LOW SES), NEED TO CONSIDER

What are health impacts of high-concentration acute events (e.g., wildfires)? How should we compare them to day-to-day PM impacts?

NOT WELL-KNOWN SCIENTIFICALLY BUT OF CONCERN, DATA ON SUB-DAILY EXPOSURES TOO LIMITED AS YET, POTENTIALLY SERIOUS EFFECTS IN EARLY STUDIES, OTHER STUDIES ONGOING, MORE RESEARCH NEEDED



Advisory Council: Initial Deliberation

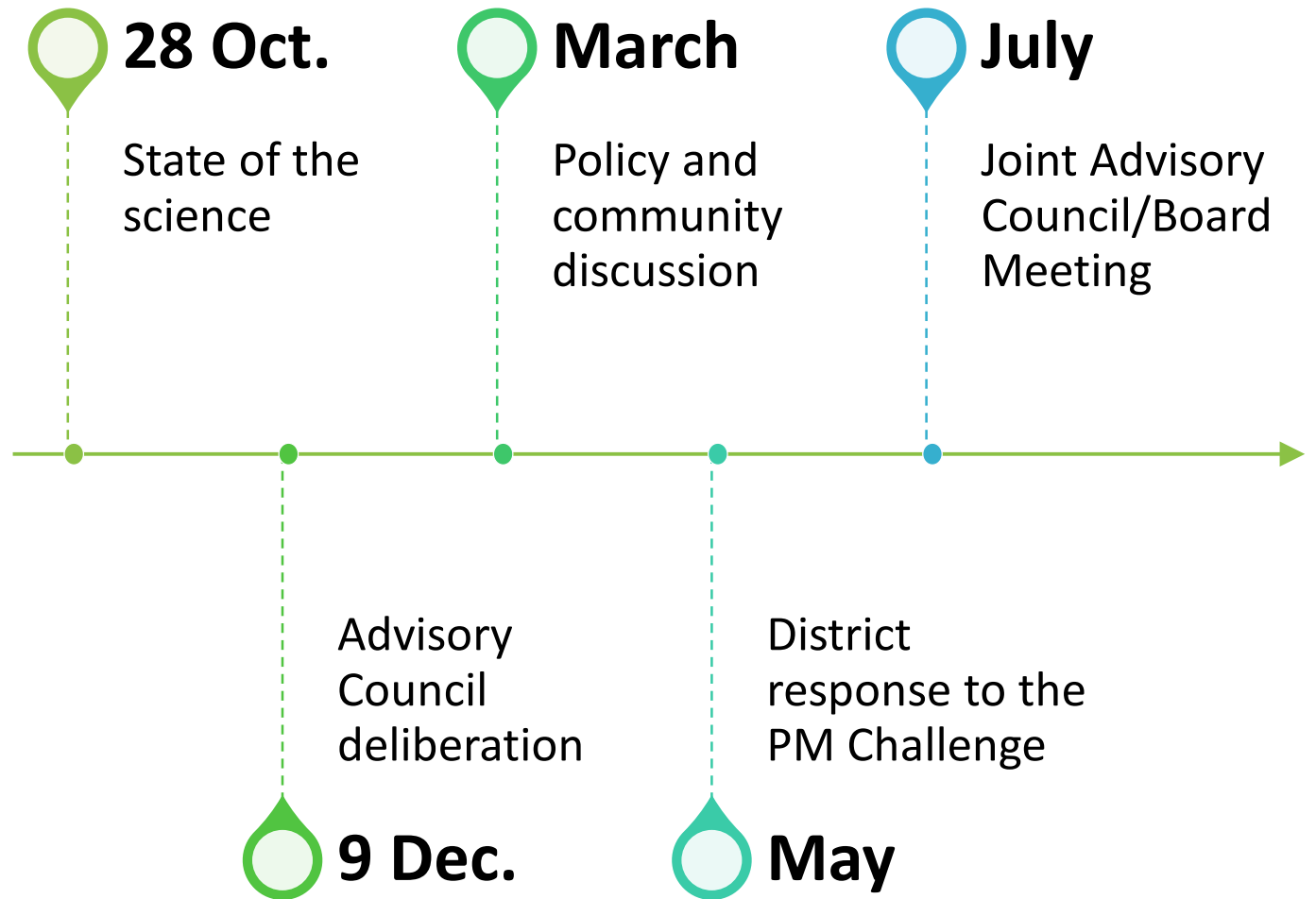
Sense of the Council

- The current standards are **not adequately health protective**.
- Further reductions in PM will realize significant **additional health benefits**.
- We need **more science, and we should act now**.

Further Exploration

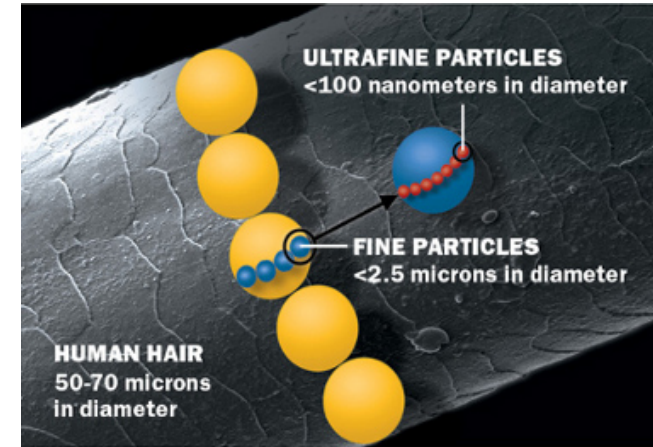
- Treating PM as an **air toxic**
- Expanded monitoring of **UFP**
- Health effects of **acute PM exposures**, e.g., wildfire smoke
- Identifying **PM species** that are particularly dangerous
- Assisting District in identifying strategies having **“highest bang for buck”** for health protection
- Pursuing strategies that have **climate and other co-benefits**

PM Symposium Series



Ambient Particulate Matter (PM)

- PM is a mixture, including particles of differing origin (combustion, crustal, biological) and varying size.
- Multiple sources



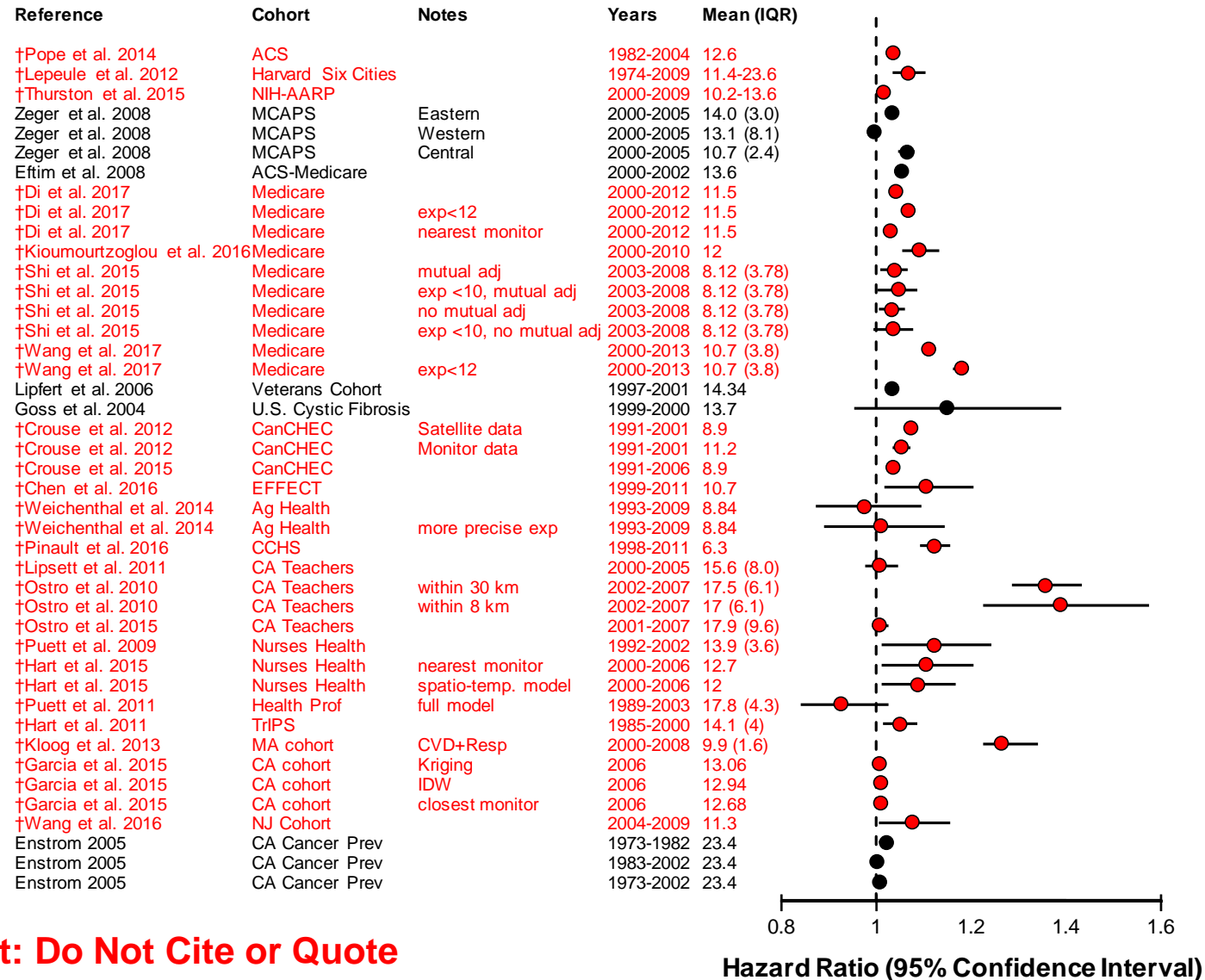
Mortality – Long-term PM_{2.5} Exposure

Recent evidence supports and extends the conclusions of the 2009 PM ISA that there is a **causal relationship** between long-term PM_{2.5} exposure and mortality

Figure 11-18.
Associations
between long-term
PM_{2.5} and total
(nonaccidental)
mortality in recent
North American
cohorts.

Note: Associations are presented per 5 µg/m³ increase in pollutant concentration.

Red = recent studies;
Black = studies evaluated in the 2009 PM ISA



Draft PM ISA Health Effects: Causality Determinations

Table 1-5. Summary of causality determinations for health effect categories for the draft PM ISA.

Draft PM ISA:

- 1,879 pages
- 2,647 references

HUMAN HEALTH EFFECTS						
		ISA	Current PM Draft ISA			
		Indicator	PM _{2.5}	PM _{10-2.5}	UFP	
Health Outcome	Respiratory	Short-term exposure				Respiratory (LIKELY CAUSAL)
		Long-term exposure				
	Cardiovascular	Short-term exposure				Cardiovascular (CAUSAL)
		Long-term exposure	*			
	Metabolic	Short-term exposure	*	*	*	
		Long-term exposure	*	*	*	
	Nervous System	Short-term exposure	*		*	Nervous System (LIKELY CAUSAL)
		Long-term exposure	*	*	*	
	Reproductive	Male/Female Reproduction and Fertility				
		Pregnancy and Birth Outcomes				
	Cancer	Long-term exposure	*	*		Cancer (LIKELY CAUSAL)
	Mortality	Short-term exposure				Mortality (CAUSAL)
		Long-term exposure	*			

Causal
 Likely causal
 Suggestive
 Inadequate

* = new determination or change in causality determination from 2009 PM ISA

Populations Potentially at Increased Risk of a PM-related Health Effect

- The NAAQS are intended to protect both the population as a whole and those potentially at increased risk for health effects in response to exposure to criteria air pollutants
 - *Are there specific populations and lifestages at increased risk of a PM-related health effect, compared to a reference population?*
- The ISA identified and evaluated evidence for factors that may increase the risk of PM_{2.5}-related health effects in a population or lifestage, classifying the evidence into four categories:
 - Adequate evidence; suggestive evidence; inadequate evidence; evidence of no effect
- Conclusions:
 - **Adequate: children and nonwhite populations**
 - Suggestive: pre-existing cardiovascular and respiratory disease, overweight/obese, genetic variants glutathione transferase pathways, low SES
 - Inadequate: pre-existing diabetes, older adults, residential location, sex, diet, and physical activity

Summary of Risk Estimates

Estimates of PM_{2.5}-associated deaths in the full set of 47 study areas

Endpoint	Study	Air quality simulation approach*	Current Standard Absolute Risk (12/35 µg/m ³)	CS (12/35) % of baseline**	Alternative Standard Absolute Risk	
					Alternative Annual (10 µg/m ³)	Alternative 24-hr (30 µg/m ³)
Long-term exposure related mortality						
Ischemic Heart Disease	Jerrett 2016	Pri-PM	16,500 (12,600-20,300)	14.1	14,400 (11,000-17,700)	16,400 (12,500-20,000)
		Sec-PM	16,800 (12,800-20,500)	14.3	14,200 (10,900-17,500)	16,500 (12,600-20,200)
	Pope 2015	Pri-PM	15,600 (11,600-19,400)	13.3	13,600 (10,100-17,000)	15,400 (11,500-19,200)
		Sec-PM	15,800 (11,800-19,600)	13.4	13,400 (9,970-16,700)	15,600 (11,600-19,400)
All-cause	Di 2017	Pri-PM	46,200 (45,000-47,500)	8.4	40,300 (39,200-41,400)	45,700 (44,500-47,000)
		Sec-PM	46,900 (45,600-48,200)	8.5	39,700 (38,600-40,800)	46,200 (44,900-47,500)
	Pope 2015	Pri-PM	51,300 (41,000-61,400)	7.1	44,700 (35,700-53,500)	50,700 (40,500-60,700)
		Sec-PM	52,100 (41,600-62,300)	7.2	44,000 (35,100-52,700)	51,300 (41,000-61,400)
	Thurston 2015	Pri-PM	13,500 (2,360-24,200)	3.2	11,700 (2,050-21,100)	13,300 (2,330-24,000)
		Sec-PM	13,700 (2,400-24,600)	3.2	11,500 (2,010-20,700)	13,500 (2,360-24,200)
Lung cancer	Turner 2016	Pri-PM	3,890 (1,240-6,360)	8.9	3,390 (1,080-5,560)	3,850 (1,230-6,300)
		Sec-PM	3,950 (1,260-6,460)	9.1	3,330 (1,060-5,470)	3,890 (1,240-6,370)
Short-term exposure related mortality						
All cause	Baxter 2017	Pri-PM	2,490 (983-4,000)	0.4	2,160 (850-3,460)	2,460 (970-3,950)
		Sec-PM	2,530 (998-4,060)	0.4	2,120 (837-3,400)	2,490 (982-3,990)
	Ito 2013	Pri-PM	1,180 (-16-2,370)	0.2	1,020 (-14-2,050)	1,160 (-16-2,340)
		Sec-PM	1,200 (-16-2,400)	0.2	1,000 (-14-2,020)	1,180 (-16-2,370)
	Zanobetti 2014	Pri-PM	3,810 (2,530-5,080)	0.7	3,300 (2,190-4,400)	3,760 (2,500-5,020)
		Sec-PM	3,870 (2,570-5,160)	0.7	3,250 (2,160-4,330)	3,810 (2,530-5,070)

Current annual standard of 12 ug/m³ = ~ 47 thousand deaths per year

Lower annual standard from 12 to 10 ug/m³ = ~ 6-7 thousand fewer deaths per year (13-15%)

* Pri-PM (primary PM-based modeling approach), Sec-PM (secondary PM-based modeling approach)

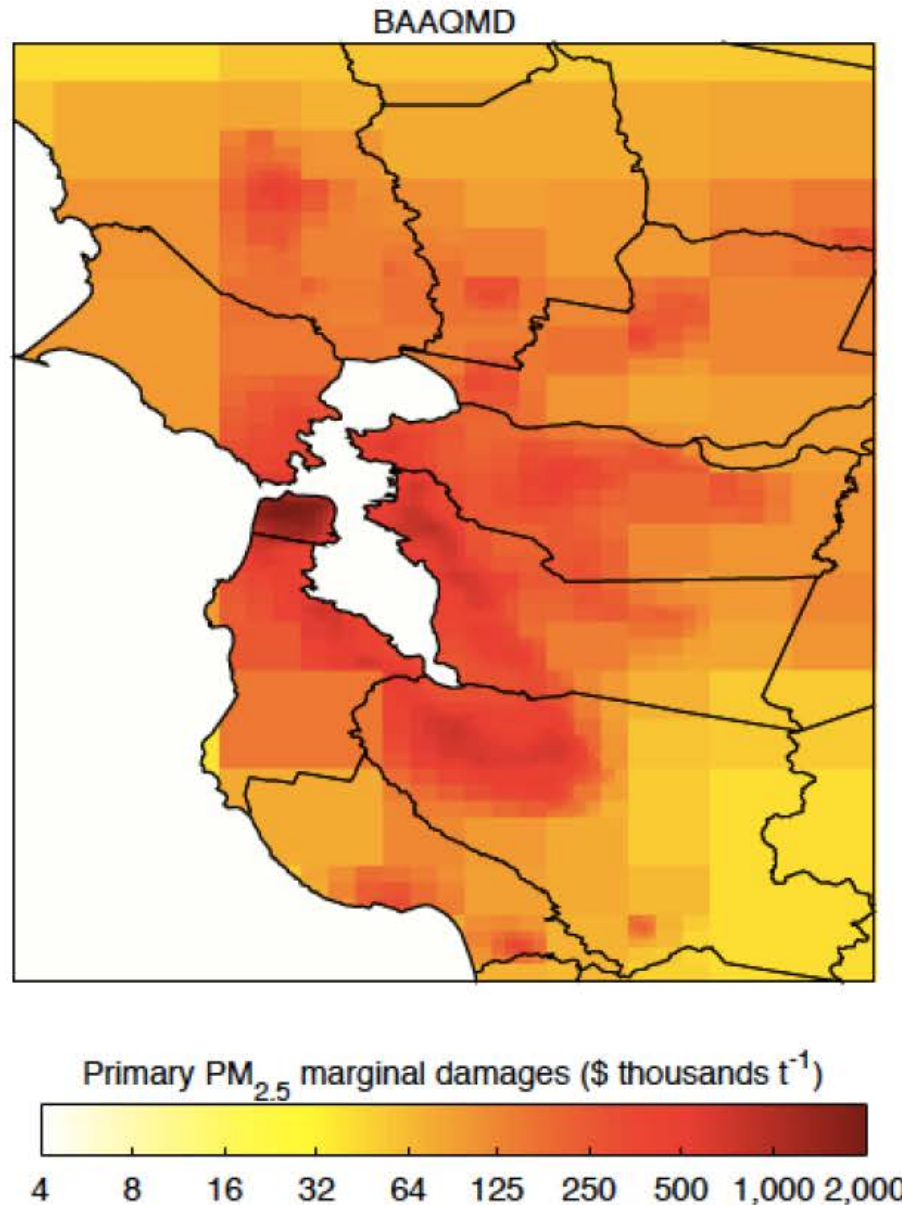
** CS denotes the current standard.

Preliminary Conclusions on the Current Primary PM_{2.5} Standards

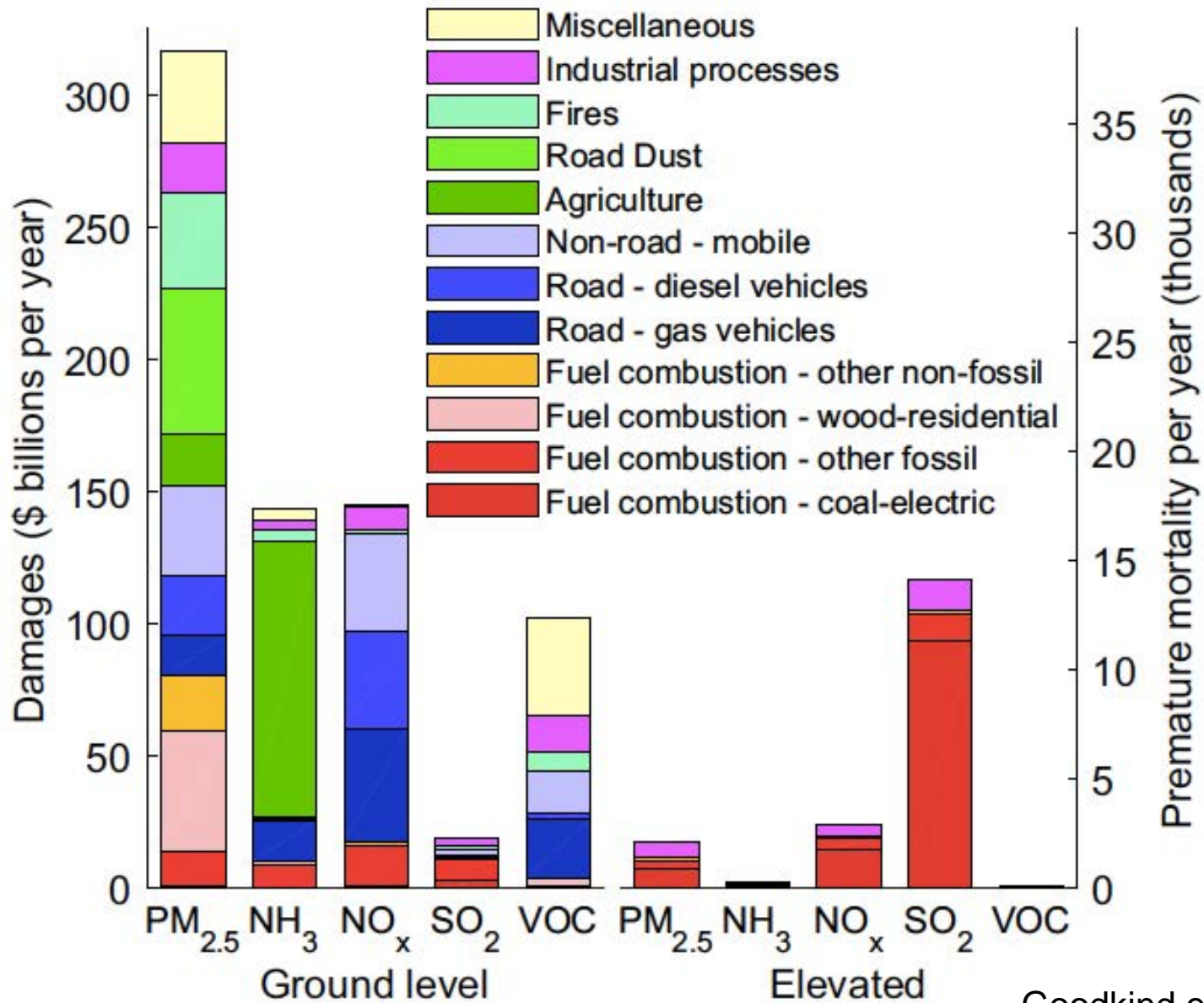
- The available scientific information can reasonably be viewed as calling into question the adequacy of the public health protection afforded by the current annual and 24-hour primary PM_{2.5} standards
- Basis for this preliminary conclusion:
 - Long-standing body of health evidence, strengthened in this review, supporting relationships between PM_{2.5} exposures and various outcomes, including mortality and serious morbidity effects
 - Recent U.S. and Canadian epidemiologic studies reporting positive and statistically significant health effect associations for PM_{2.5} air quality likely to be allowed by the current standards
 - Analyses of pseudo-design values indicating substantial portions of study area health events/populations in locations with air quality likely to have met the current PM_{2.5} standards
 - Risk assessment estimates that the current primary standards could allow thousands of PM_{2.5}-associated deaths per year – most at annual average PM_{2.5} concentrations from 10 to 12 µg/m³ (well within the range of overall mean concentrations in key epidemiologic studies)

**Draft EPA
PM Policy
Assessment
(PA)**

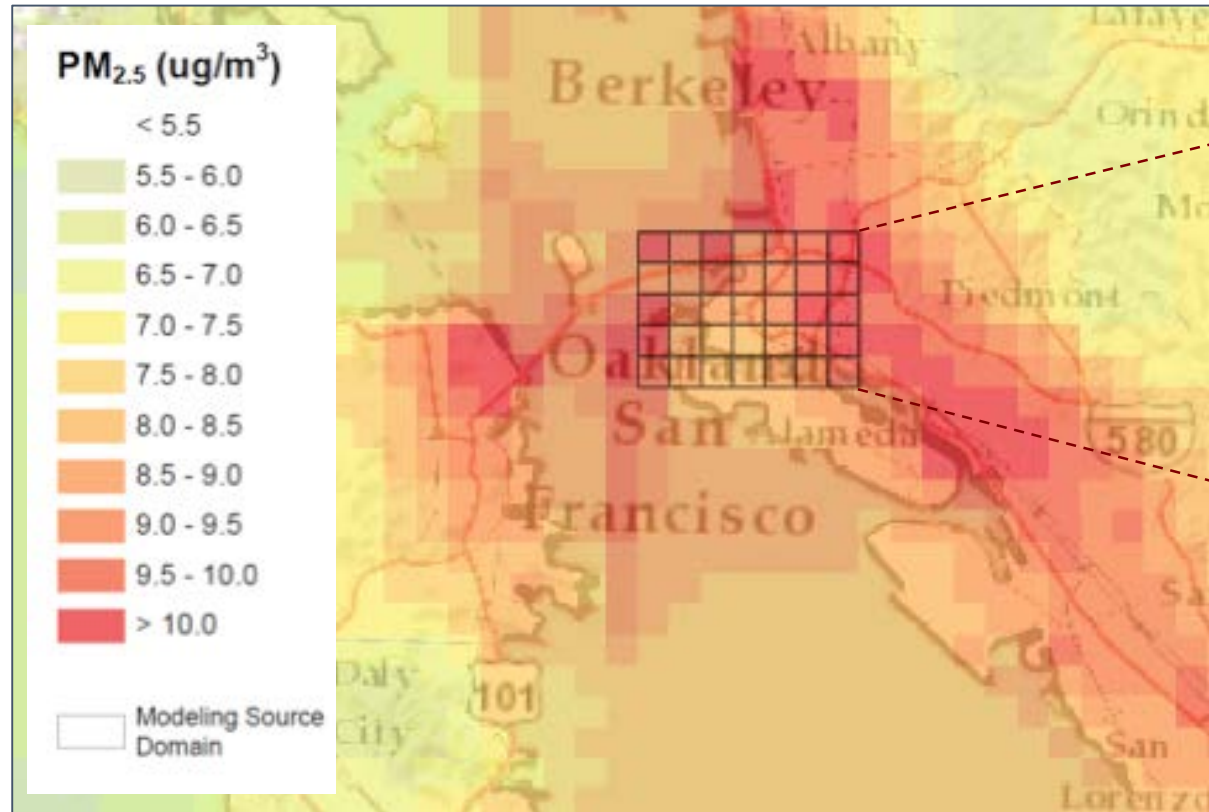
Primary PM_{2.5} Marginal Damages



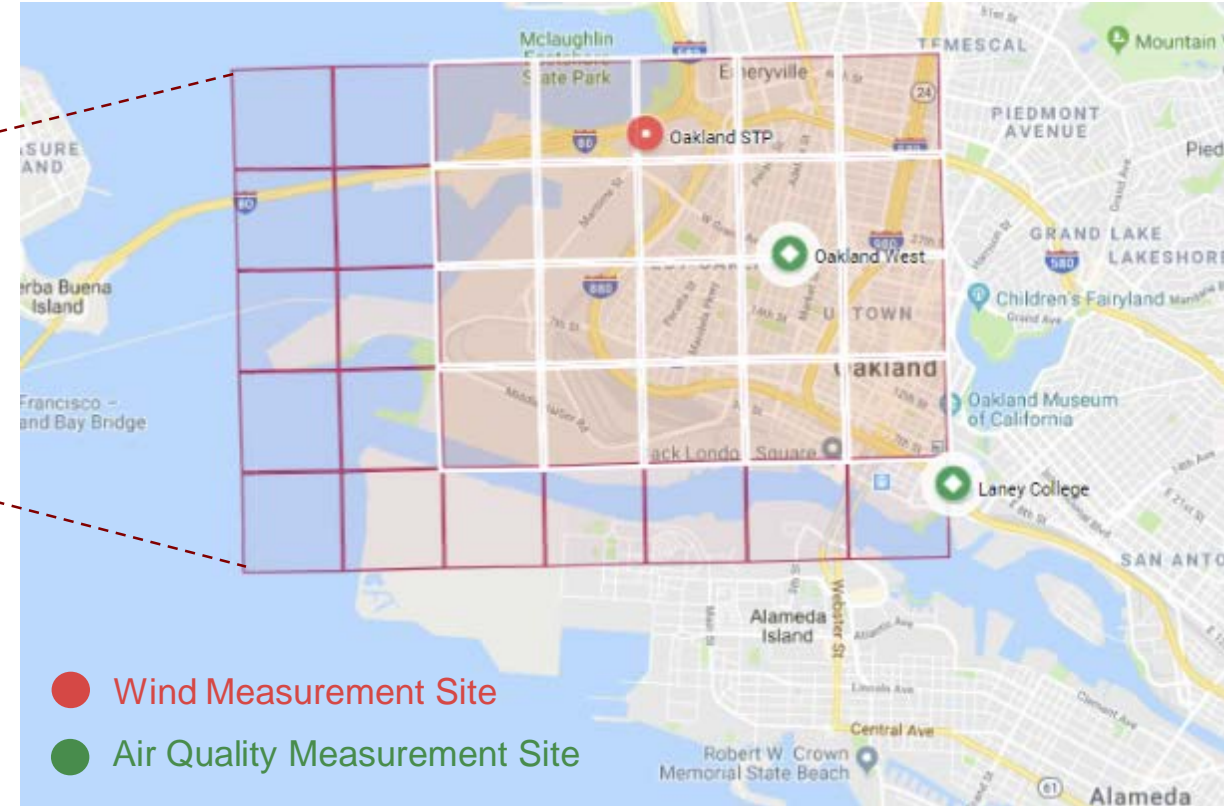
Damages and Premature Mortality



Regional-Scale and Community-Scale Modeling (2017)



Regional-scale modeling: covers the Bay Area



Local-scale modeling: covers West Oakland, including impacts in receptor area (white) from sources in source area (red)

Clear evidence of an association between wildfire smoke and respiratory health

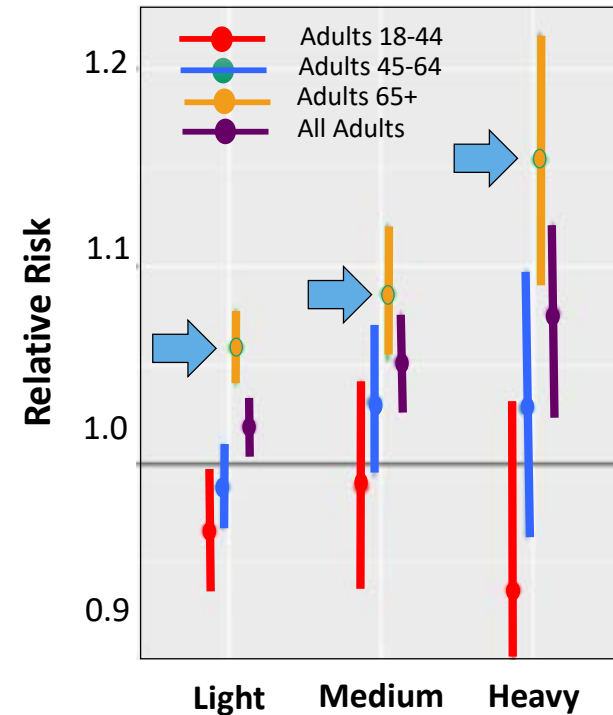
- Asthma exacerbations significantly associated with higher wildfire smoke ***in nearly every study***
- Exacerbations of chronic obstructive pulmonary disease (COPD) significantly associated with higher wildfire smoke in most studies
- Growing evidence of a link between wildfire smoke and respiratory infections (pneumonia, bronchitis)



Wildfire-PM_{2.5} Increases Heart Attack & Stroke

- **Wildfire-PM_{2.5} associated with heart attacks and strokes for all adults, particularly for those over 65 years old**
- **Increase in risk the day after exposure:**
 - All cardiovascular, 12%
 - Heart attack, 42%
 - Heart failure, 16%
 - Stroke, 22%
 - All respiratory causes, 18%
 - Abnormal heart rhythm, 24%
(on the same day as exposure)

All Cardiovascular Causes



31



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Update on Particulate Matter (PM)

Air District Work:

Regional-and Local-Scale PM_{2.5} Source Apportionment

Phil Martien, PhD

Director of Assessment, Inventory, and Modeling

**Advisory Council Meeting
December 9, 2019**

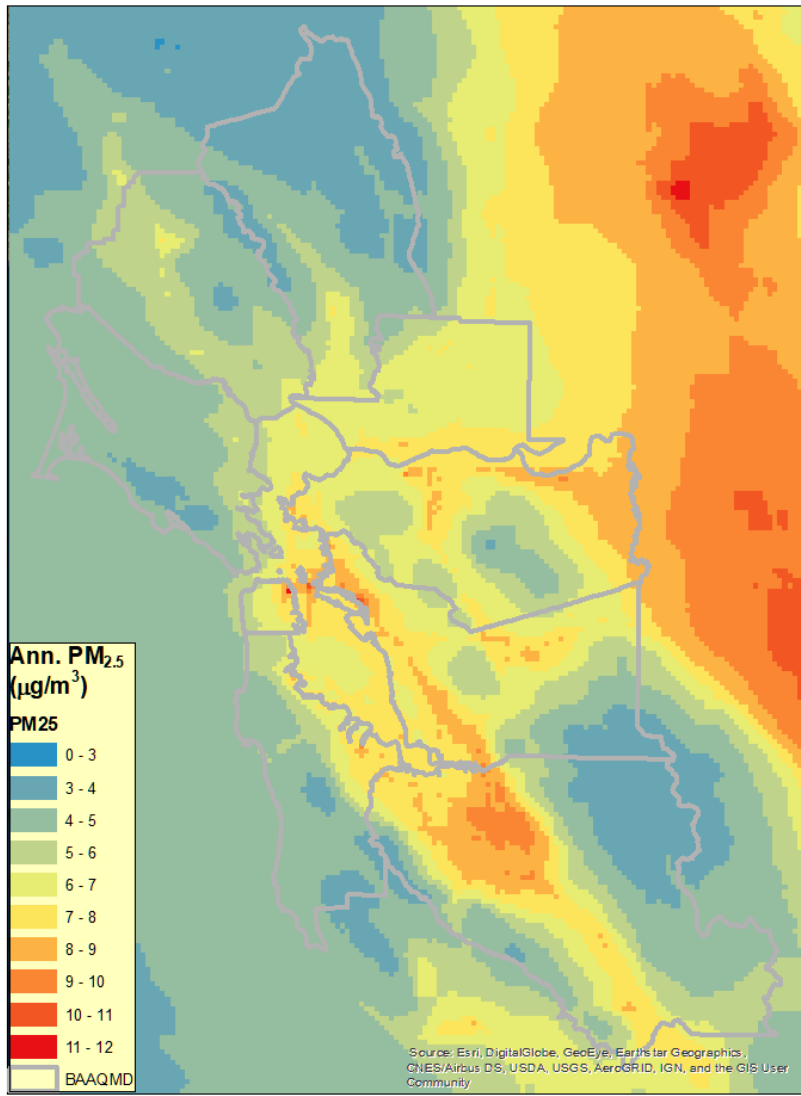


Overview

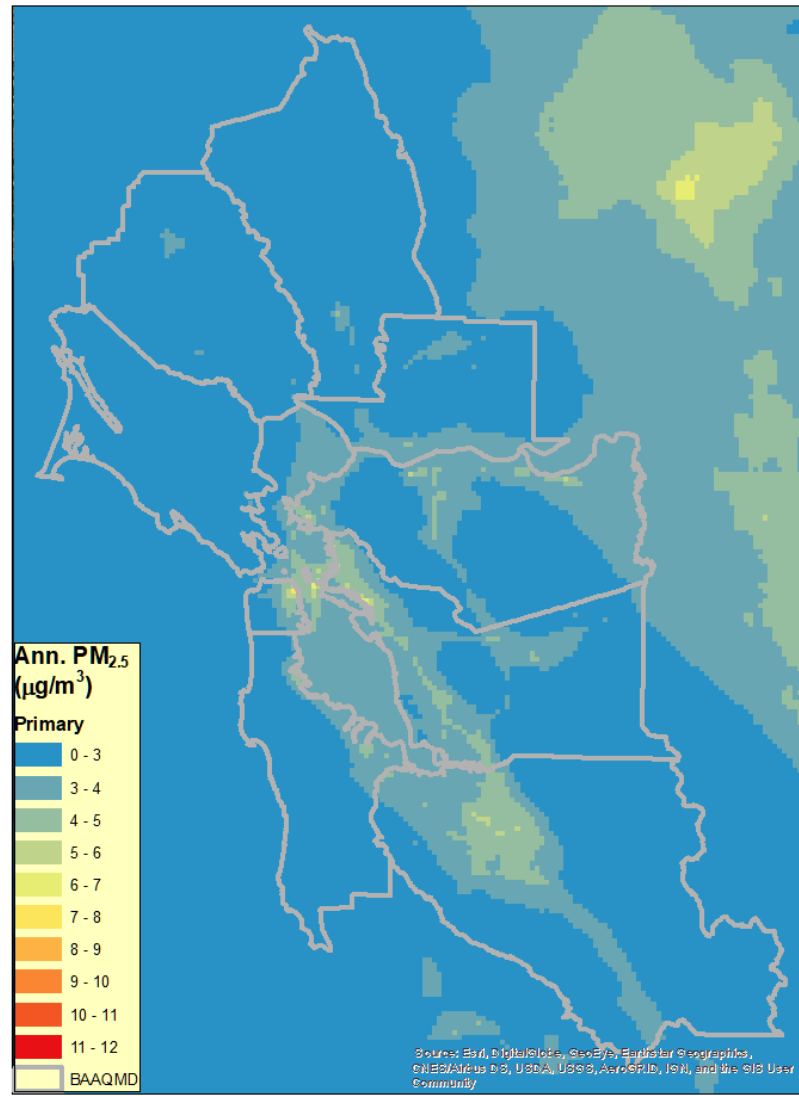
- **Regional-scale PM_{2.5} source apportionment:**
 - Informs actions to maintain attainment of PM standards
 - Reveals information gaps, as top sources are controlled
- **Local-scale PM_{2.5} source apportionment:**
 - Indicates near-source exposures add to total pollution burden
 - Reveals additional information gaps
 - Suggests a regulatory gap: actions to reduce near-source exposures?

Regional Modeling: Primary and Secondary Contributions

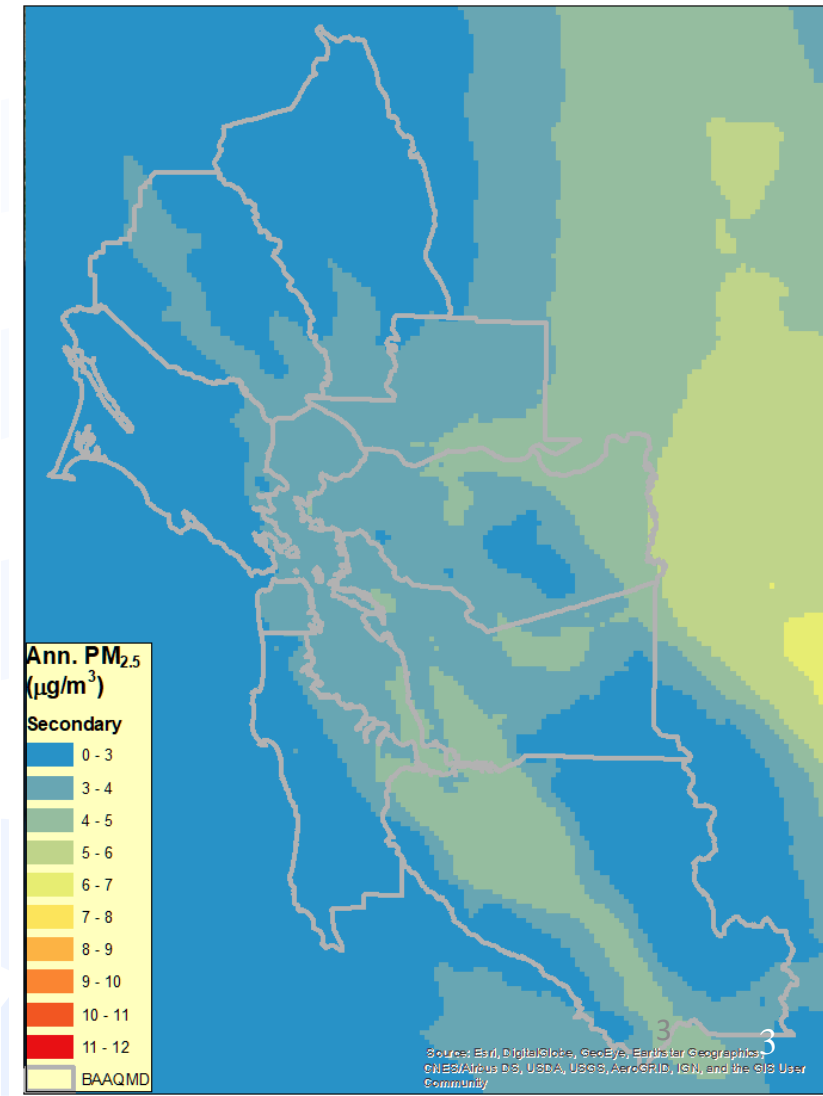
Total PM_{2.5}



Primary PM_{2.5} (about 53%)



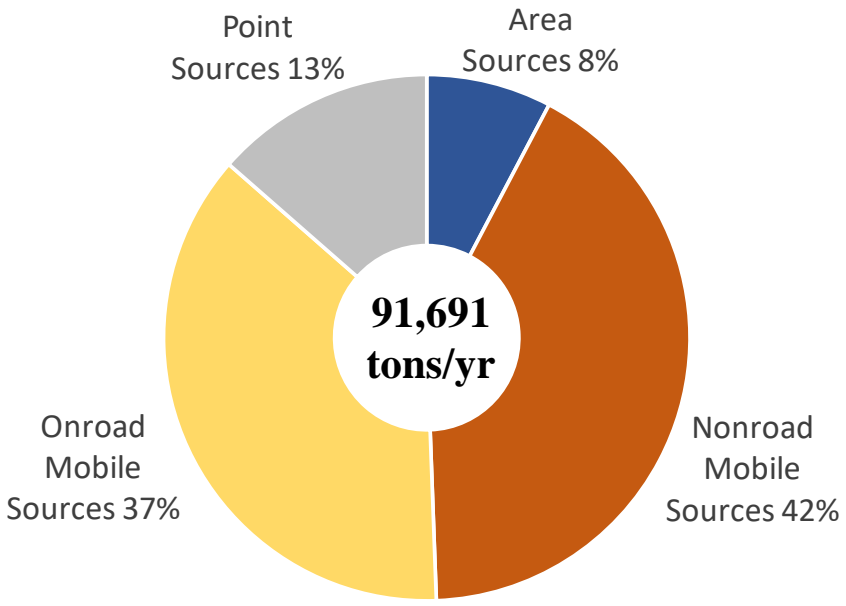
Secondary PM_{2.5} (about 47%)





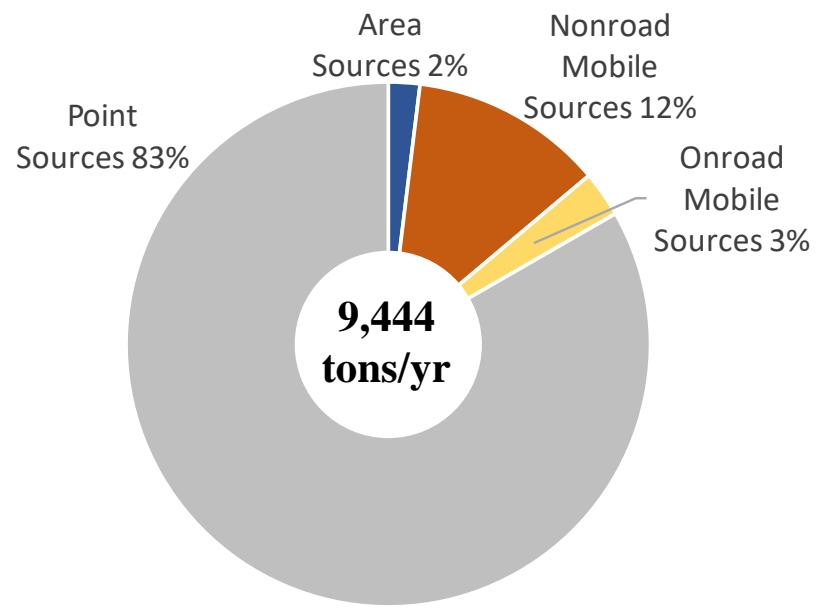
2016 Bay Area Emissions Summary for Key Secondary PM_{2.5} Precursors

NO_x



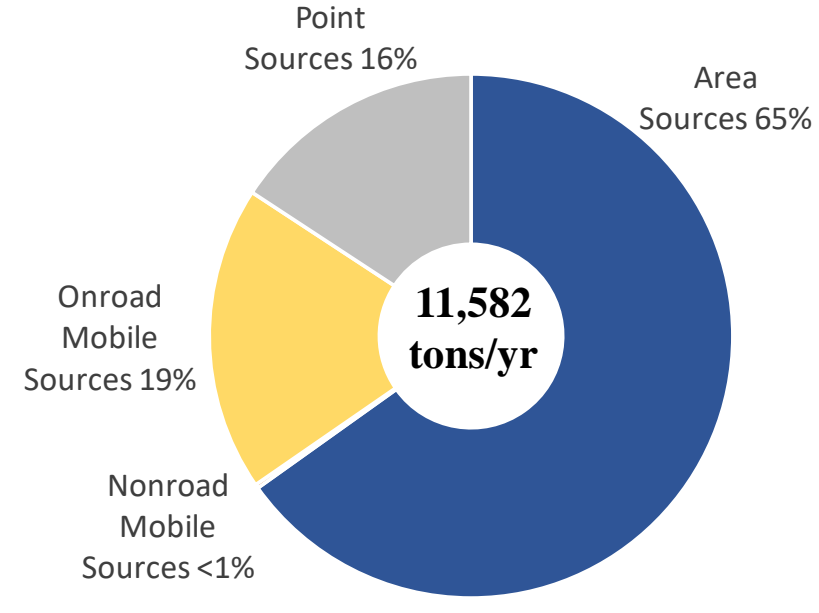
Key NO_x Sources: Diesel trucks and diesel-powered off-road equipment

SO₂



Key SO₂ Sources: Petroleum refineries, manufacturing plants (cement, chemicals)

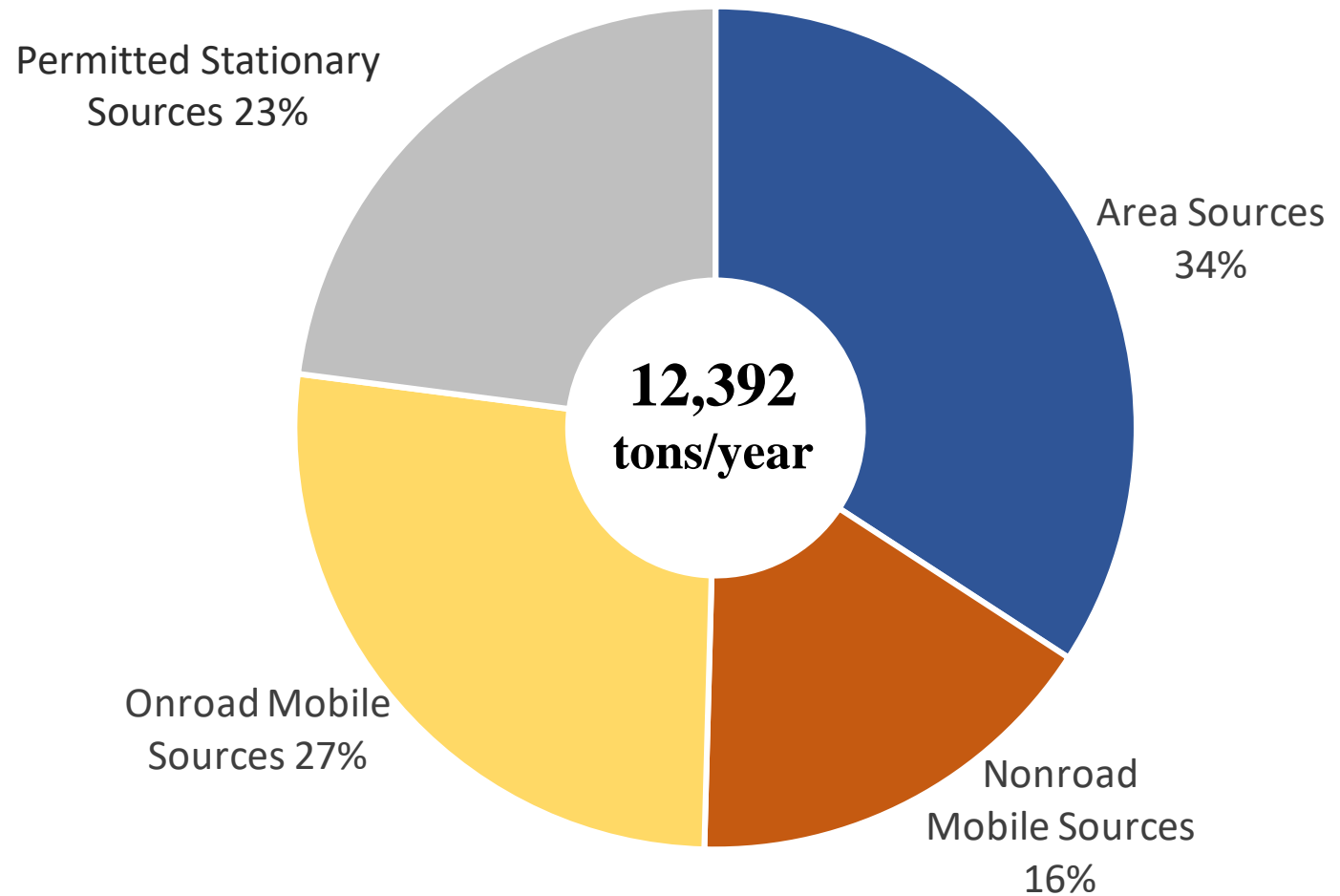
NH₃



Key NH₃ Sources: Agricultural activity (livestock husbandry, fertilizer application)

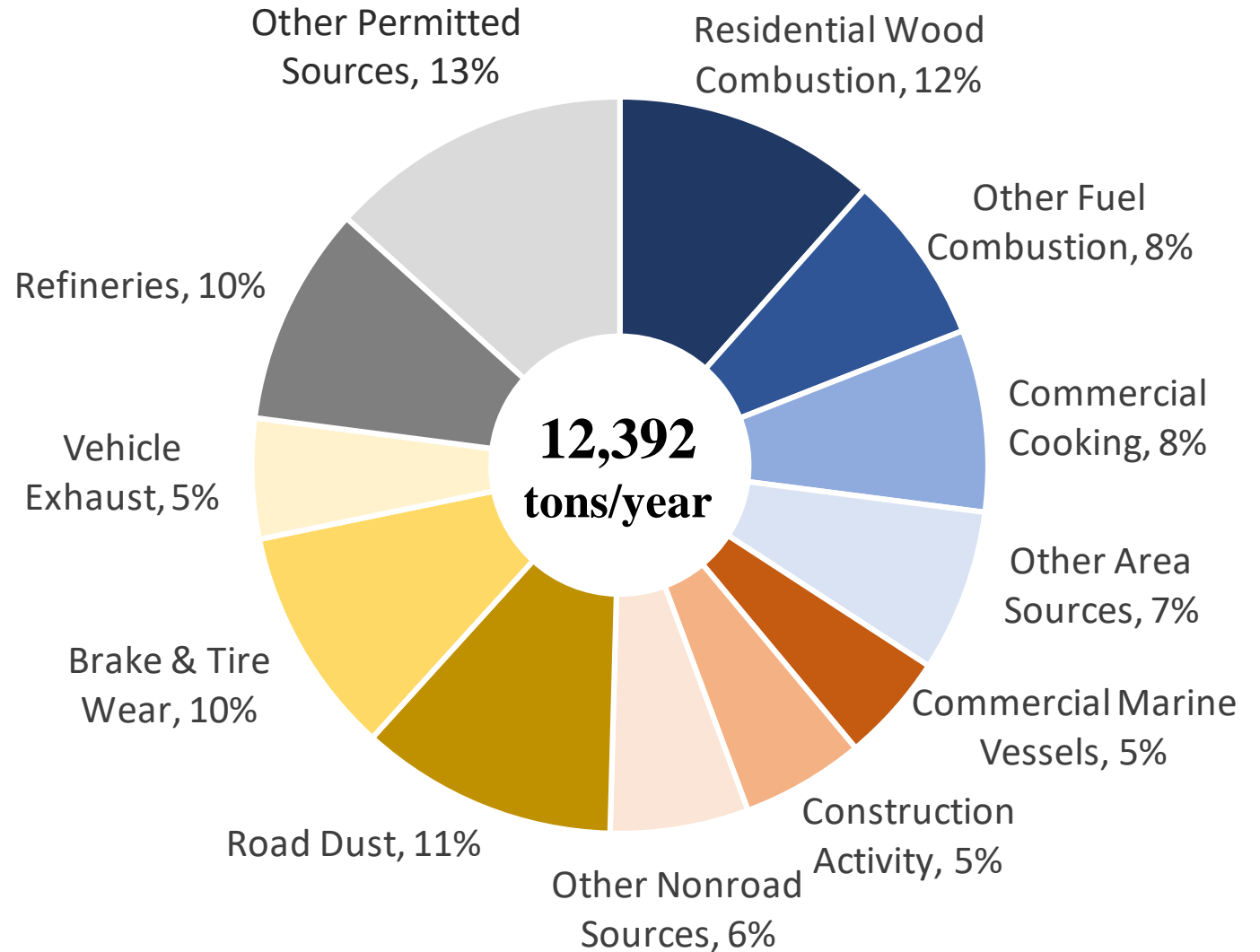
PM_{2.5} Bay Area Emissions Summary for Primary PM_{2.5}

2016 annual
average PM_{2.5}
emissions



PM_{2.5} Bay Area Emissions Summary for Primary PM_{2.5}

2016 annual
average PM_{2.5}
emissions





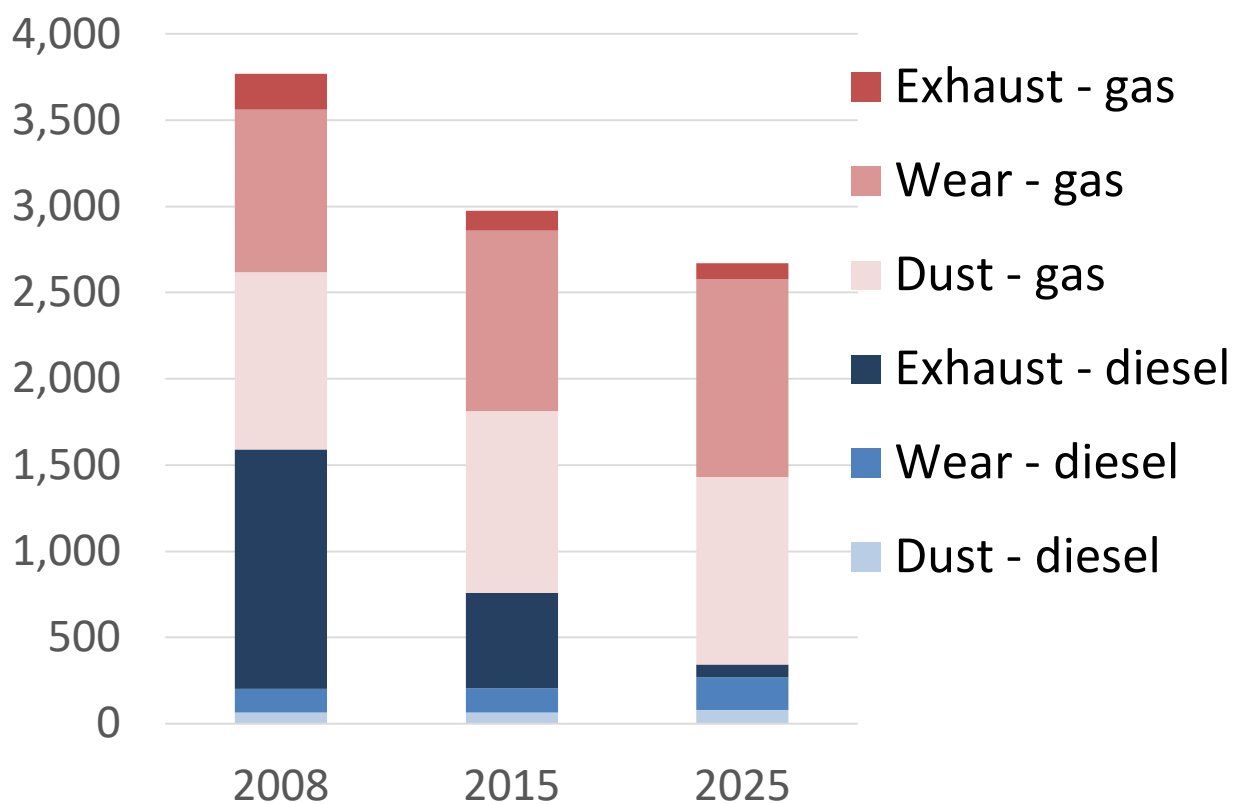
Emissions Inventory Information Gaps

- **On-road wear emissions and road dust**
- **Some area source categories**
 - Residential wood combustion
 - Commercial cooking

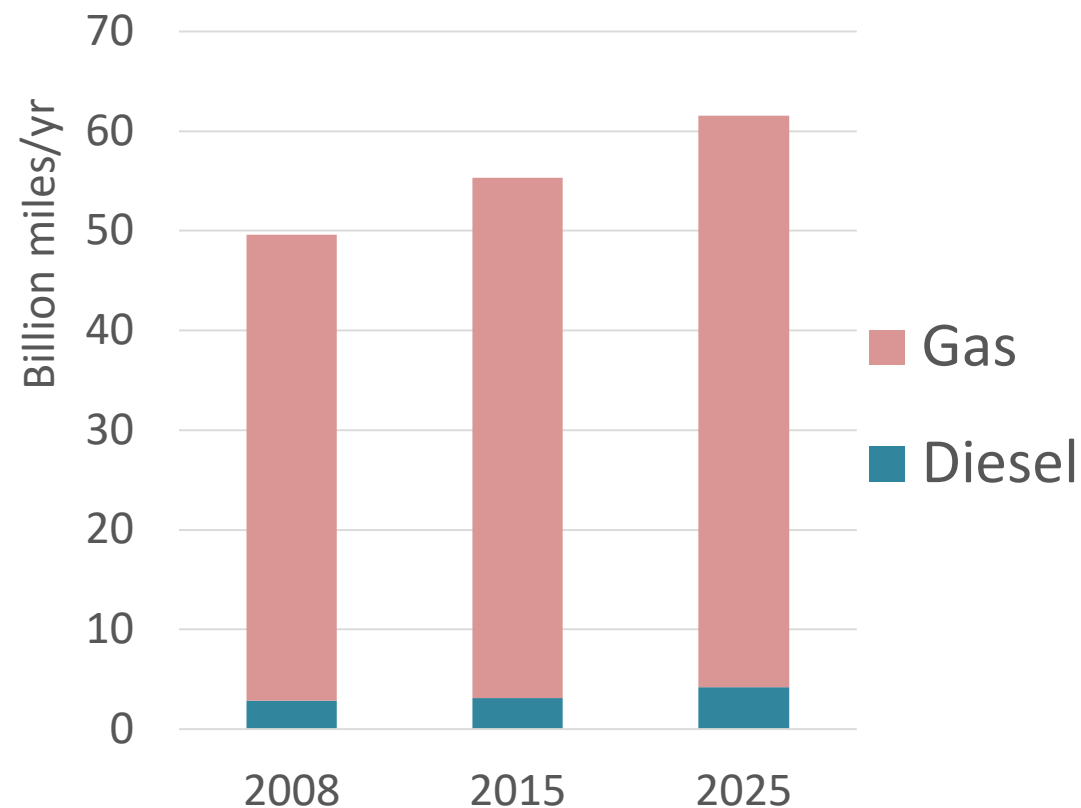


PM_{2.5} Bay Area Emissions Apportionment: On-road Vehicles

PM_{2.5} (tons/yr)

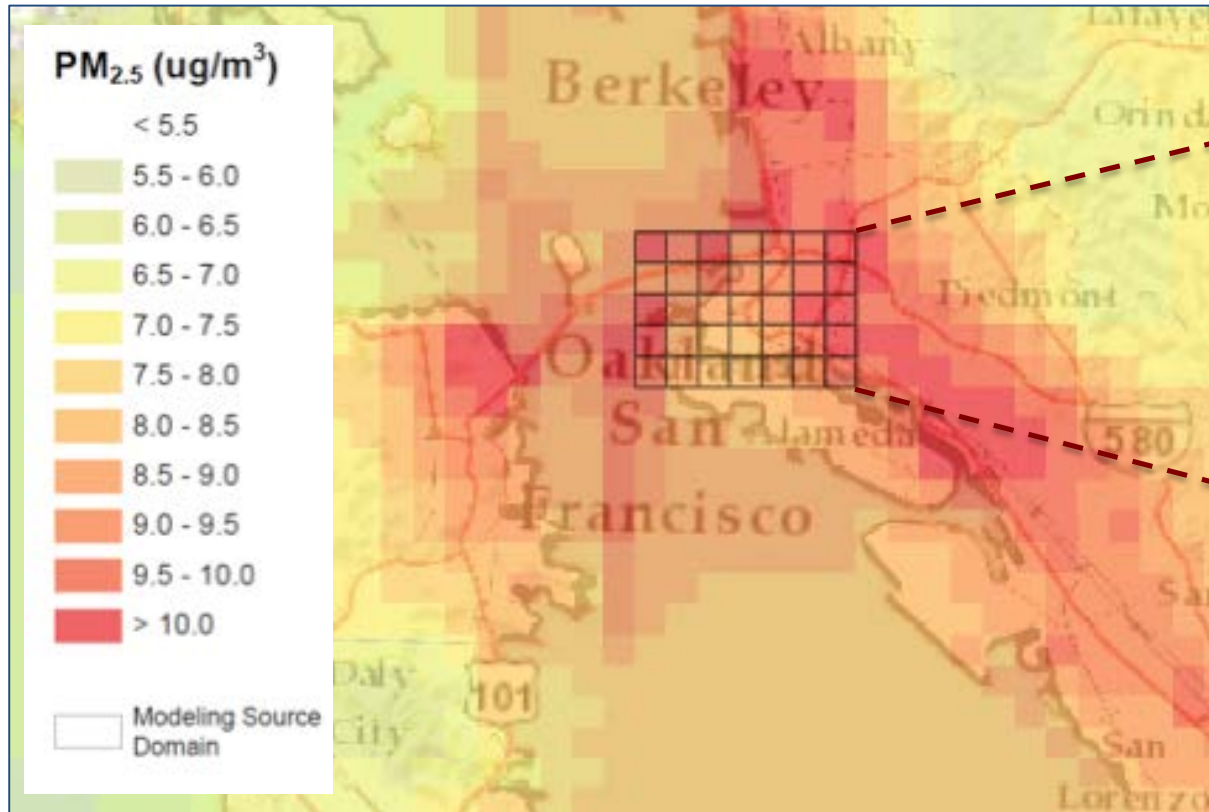


Vehicle Miles Travelled (VMT)

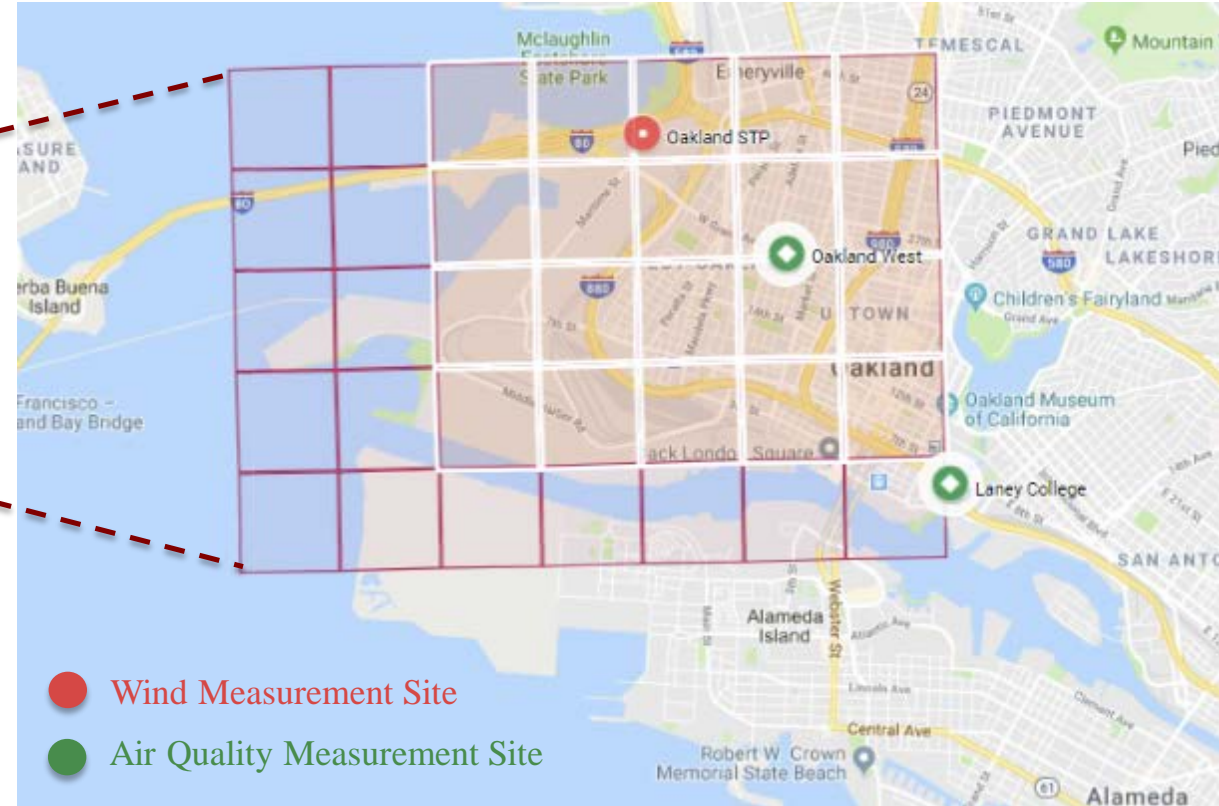


Data sources: EMFAC2017, California Air Resources Board 2016 State Implementation Plan Inventory

Regional-Scale and Community-Scale Modeling (2017)



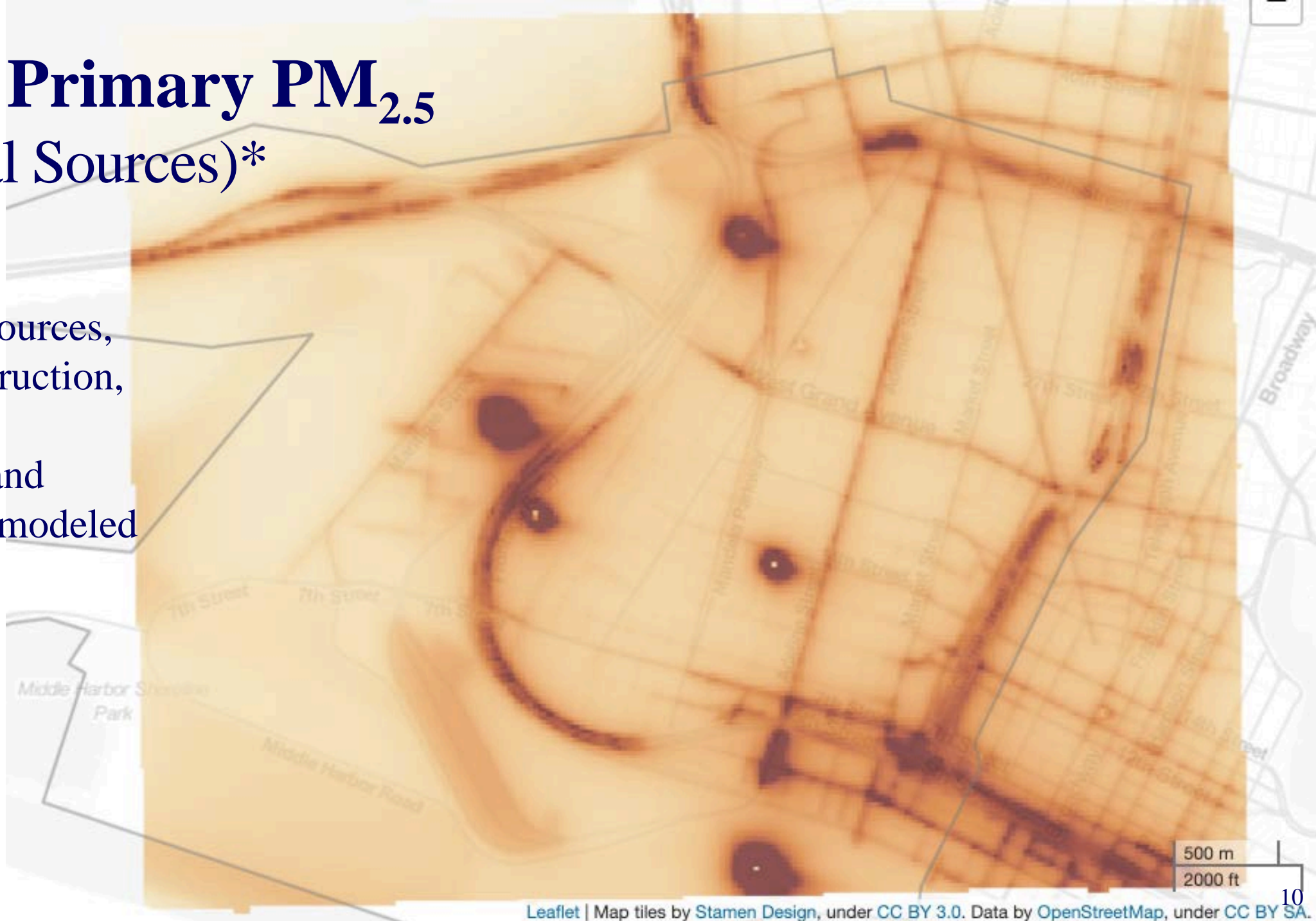
Regional-scale modeling: covers the Bay Area



Local-scale modeling: covers West Oakland, including impacts in receptor area (white) from sources in source area (red)

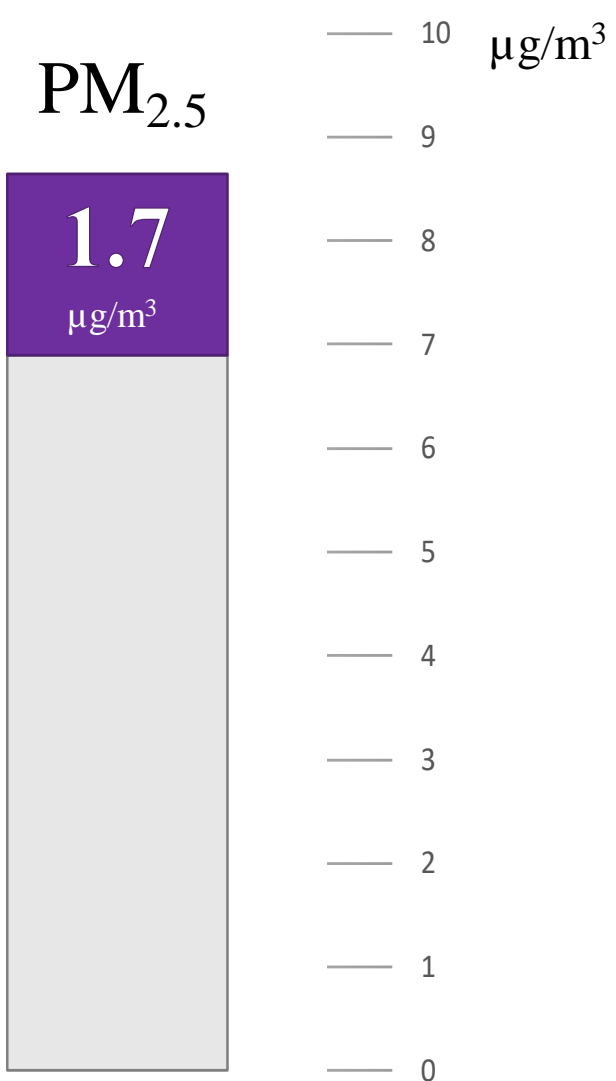
Modeled Primary PM_{2.5} (from Local Sources)*

* 30% of PM_{2.5} sources, including construction, residential woodburning, and restaurants not modeled





Local vs. Regional: West Oakland Example



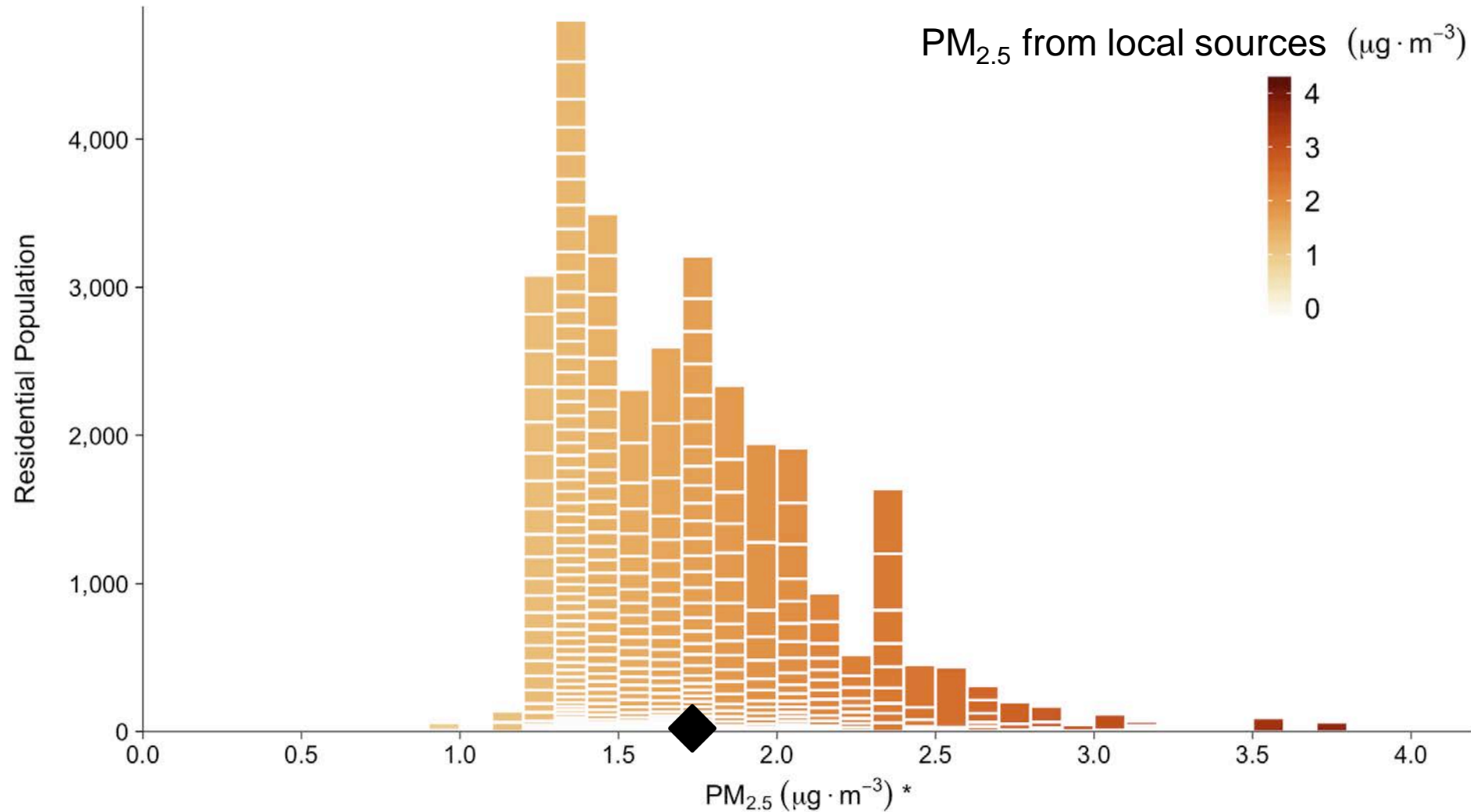
Community-scale model – mapped impacts*



Regional-scale model (minus West Oakland)

*30% of PM_{2.5} sources, including construction, residential woodburning, and restaurants not modeled

Unequal Impacts: PM_{2.5} in West Oakland



* Contributed by modeled "present-day" emissions from existing local sources. Impacts from sources outside West Oakland not included.

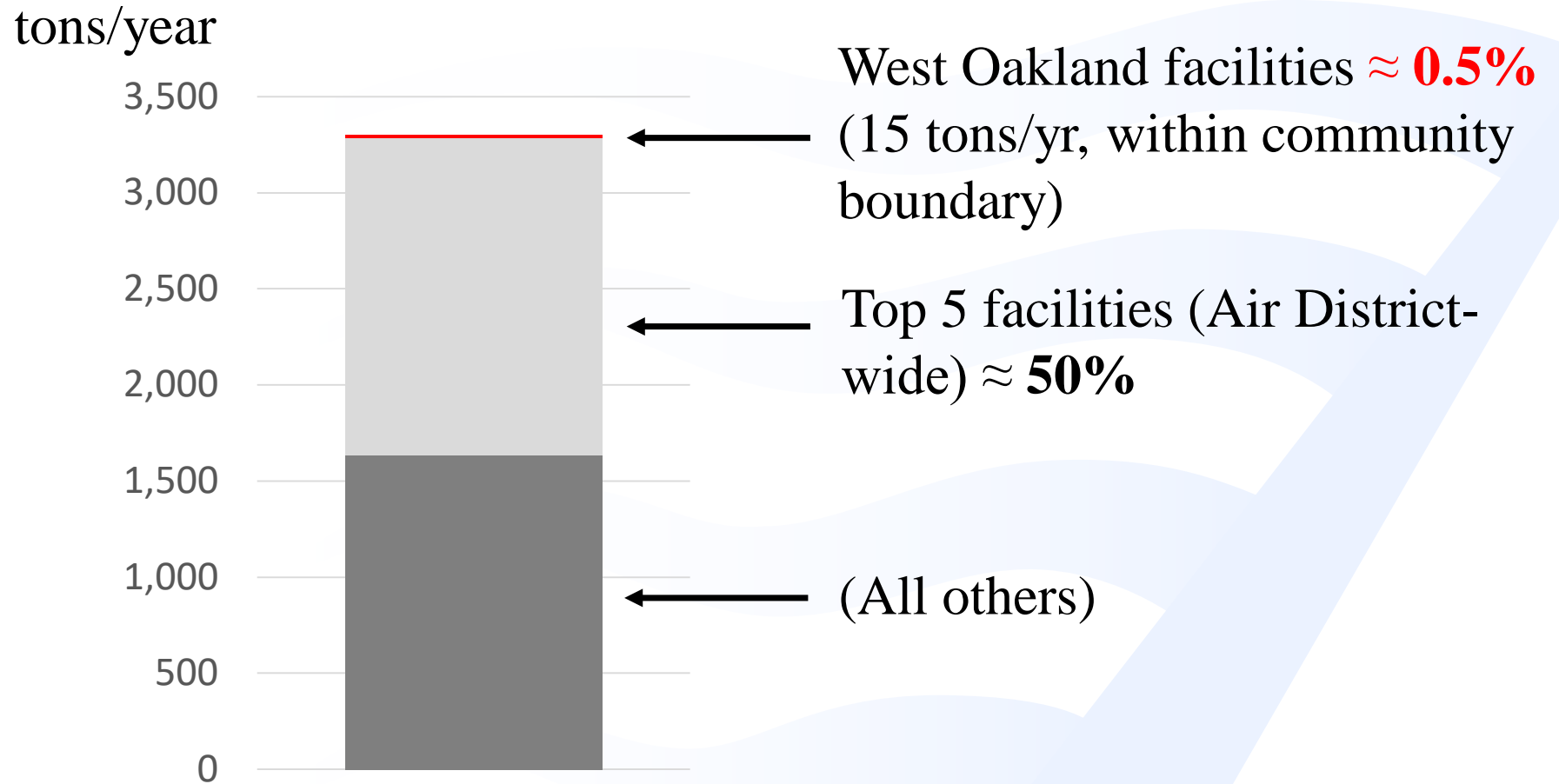


Additional Emissions Inventory Information Gaps Identified

- Local-scale exposures: a different lens for evaluating priorities
- Same concerns about on-road wear and road dust emissions estimates
- We require more information about permitted sources that are not top priorities from a regional perspective



PM_{2.5} Emissions (tons/yr) from Permitted Facilities





Summary

- Continuing regulatory programs to reduce PM_{2.5} with the current regional focus will improve health throughout the Bay Area
- As top sources are controlled, new sources become priorities and we identify new information gaps
- Local-scale assessments bring to focus the importance of some permitted sources that are a low priority from a regional perspective
- A regulatory gap: a framework that promotes PM_{2.5} reductions from near-source exposures will improve health in Assembly Bill 617 communities



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Update on Particulate Matter (PM) Air District Work:

Monitoring

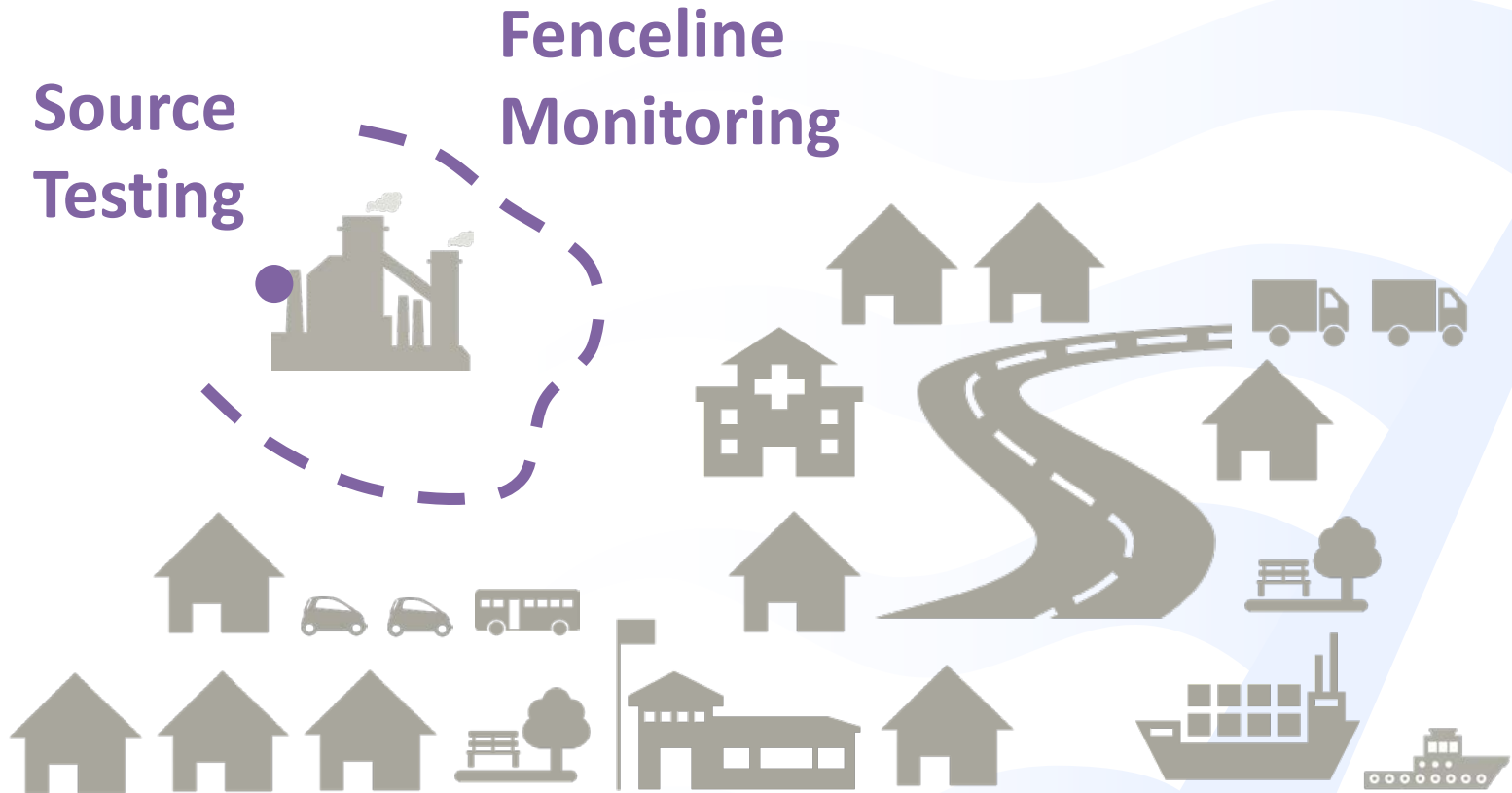
Ranyee Chiang
Director of Meteorology & Measurements

Advisory Council Meeting
December 9, 2019

Measurements in the Bay Area



Measurements in the Bay Area (cont.)



Measurements in the Bay Area (cont.)



Measurements in the Bay Area (cont.)



Sensor Networks

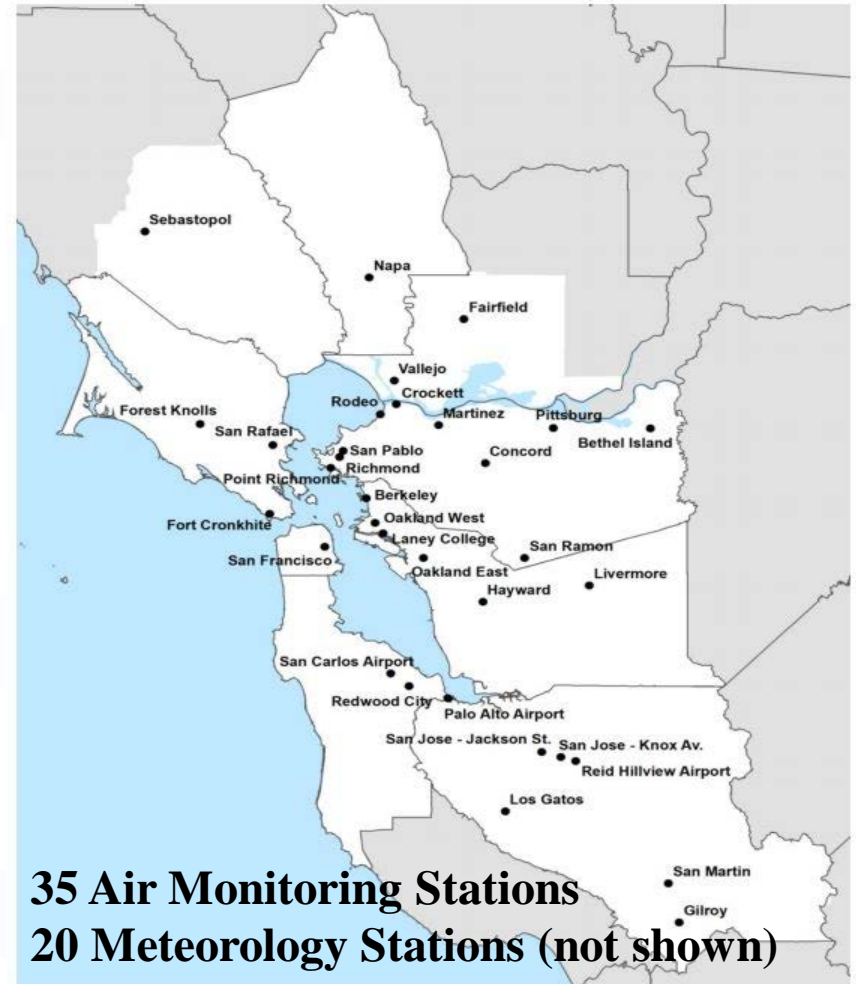


Outline: PM Monitoring

- Regional Network and Community Monitoring
 - Current capabilities
 - New developments
- What does the data show?
 - Ultrafine particles
 - Wildfire incidents
- Looking ahead
 - How could data be used
 - Options to strengthen air quality monitoring

Regional/Regulatory Network: Objectives

- Provide timely ambient air quality data to the general public
- Air quality forecasting for Spare the Air Program
- Support compliance with California and national ambient air quality standards
- Support air pollution research studies



Monitoring Network Design Criteria

- Site Types
 - Population-oriented
 - Highest concentration of pollutants
 - Source-oriented (downwind of major pollution sources)
 - General background sites
 - Regional transport (near borders of the Air District)
- Based on population (2010 Census or estimates)
 - Number of monitoring sites in the Bay Area exceeds the required number

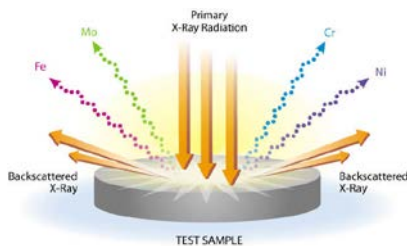


40 Code of Federal Regulations 58 Appendix D

Particulate Matter (PM) Measurements

Mass Measurements

- Compliance with California and National PM_{10} and $PM_{2.5}$ standards
- Designate areas as attainment or nonattainment

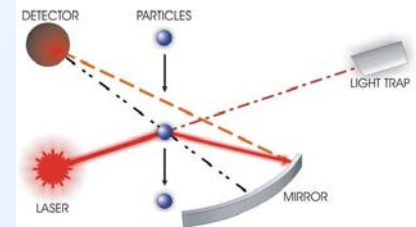


Chemically Resolved or Speciated Data

- Support emission reduction strategies






Particle Counts

- Explore science on emissions, air quality impacts, and health effects associated with exposures





Air District PM Instrumentation

	PM ₁₀ Mass	PM _{2.5} Mass	PM _{2.5} Speciation	Ultrafine Particles (PM _{0.1})	Black Carbon Mass
Analytical methods	Gravimetric	Gravimetric or Filter-based beta attenuation	Chemical extraction	Laser-based particle counter	Filter-based light attenuation
Active monitors	7	20	4	6	7
Example photo					

Ultrafine PM Monitoring

Strengths:

- 7+ years of experience with deployment in diverse siting applications
- Current data can be used to understand diurnal and seasonal patterns, trends, or differences between background, near-road, and typical urban settings



Limitations:

- Cost (\$60k - \$100K / unit)
- Instruments in PM-burdened areas require frequent maintenance
- Difficult to assess sources and sinks
- Data may not be robust enough to link to specific health impacts

New Developments: Hyperlocal, Street-by-Street Monitoring

- Partnership with Aclima to determine differences in air quality on a highly localized scale
- Sensor-based instrumentation (NO_x, CO, O₃, BC, PM_{2.5})
- Data reported through a public portal
- Began in Richmond-San Pablo in summer 2019; entire Bay Area within two years

Use cases:

- Empower communities with information about air quality typical of where they live and work
- Identify areas having elevated background concentrations for further investigation



New Developments: Mobile Laboratory



- High accuracy, real-time instrumentation to screen for PM and air toxics at a local scale
 - PM concentration
 - Inferred particle age
 - Size-binned measurements (ultrafine through PM₁₀)
 - Black carbon
 - Potential to test for chemical components of PM in the future

Use cases:

- Identify and prioritize local sources of air toxics or PM
- Air quality between fixed-site monitors
- Identify locations for portable or fixed-site monitoring stations

New Developments: Portable Platforms

- High quality, battery powered, filter-based PM samplers that are relocatable
- Self-contained “suitcase” for continuous, real-time measurements using high quality, low power instruments

Use cases:

- Concentration variations throughout the day or week near an identified PM hotspot
- Measure air quality when the power is out due to high winds and fire hazard
- Verify low-cost sensor nodes





Outline: PM Monitoring

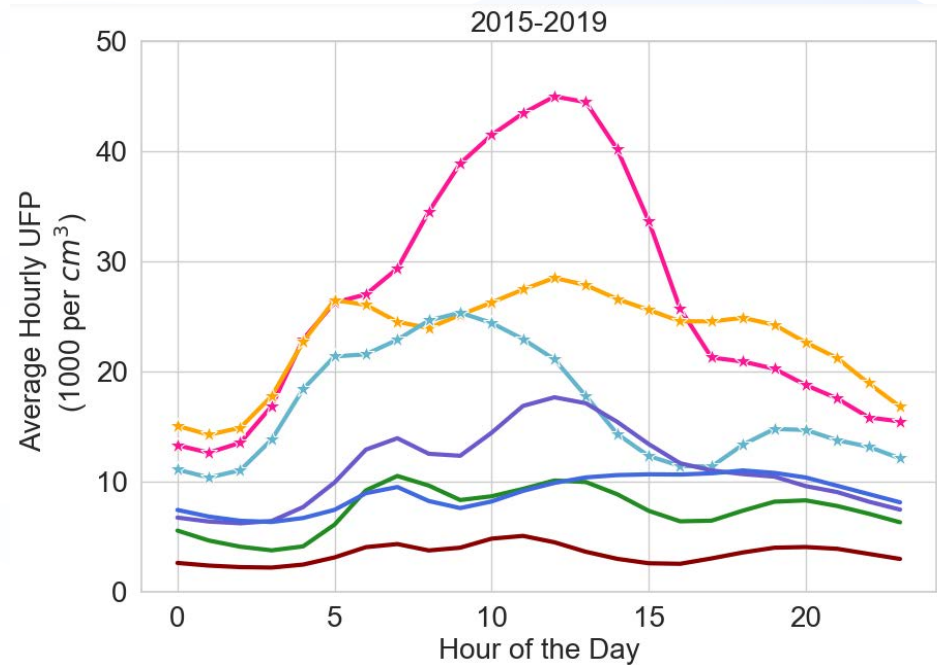
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What Do the Ultrafine Particulate (UFP) Data Show?

Levels influenced by traffic and/or photochemical reactions

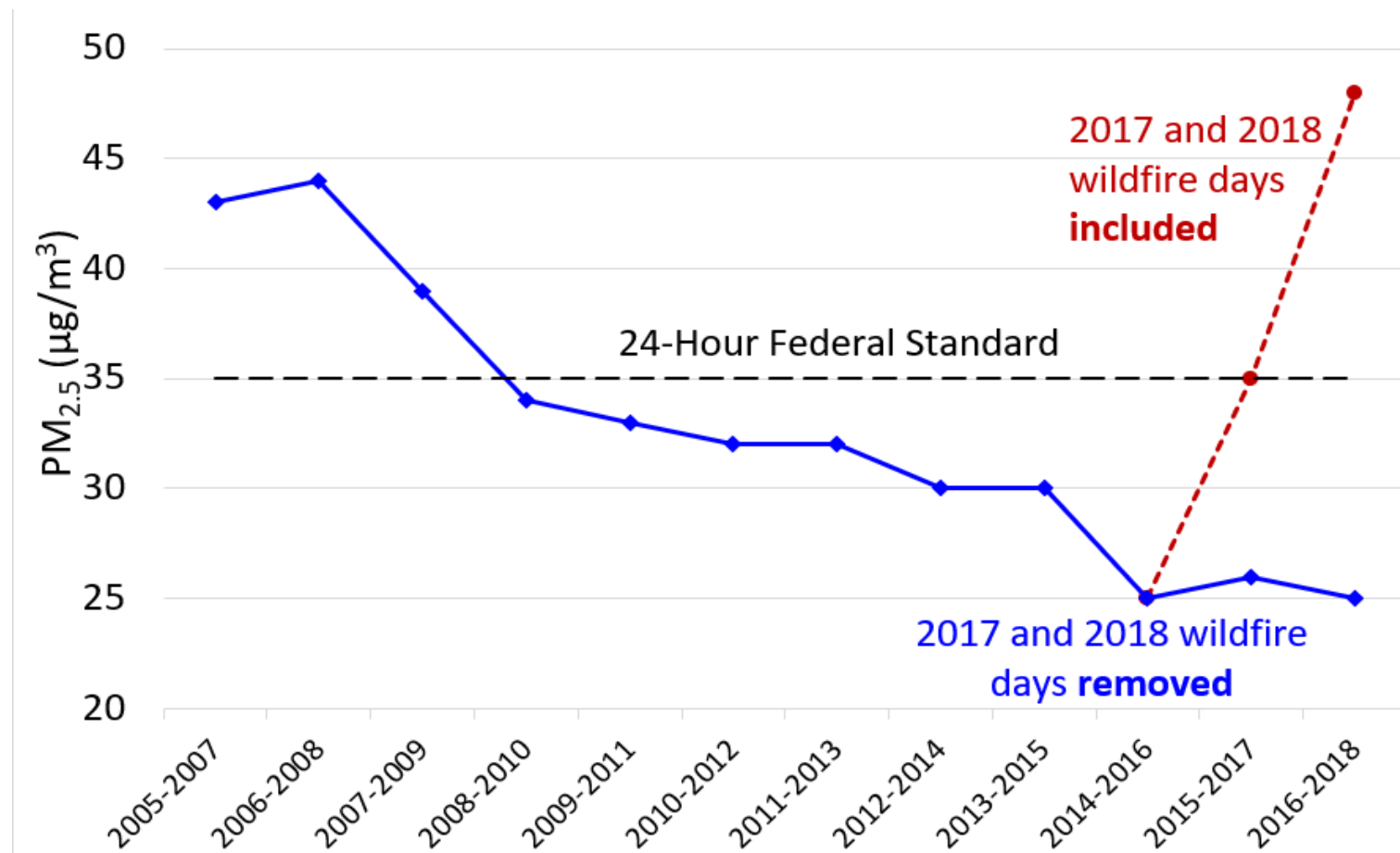
- UFP highest at near-road sites
- Some sites consistently low, while others vary

Patterns of UFP throughout region differ from $PM_{2.5}$



- *— Laney College (near road)
- *— San Jose - Knox Ave (near road)
- *— Berkeley Aquatic Park (near road)
- San Pablo - Rumrill
- Redwood City
- Livermore - Rincon Ave
- Sebastopol

Wildfire Smoke Dramatically Affects Bay Area PM_{2.5} Levels



Air District's Strategy to Reduce Impacts from Wildfire Smoke



Communication with the public

- Issue smoke advisories and Spare the Air alerts based on air quality forecasts
- Understanding air quality measurements and data
- How to reduce exposure during smoke impacts



Grants and incentives for recovery assistance



Work with other Air Districts and Public Health Officers

- Consistent wildfire health information
- Provide guidance for schools



Outline: PM Monitoring

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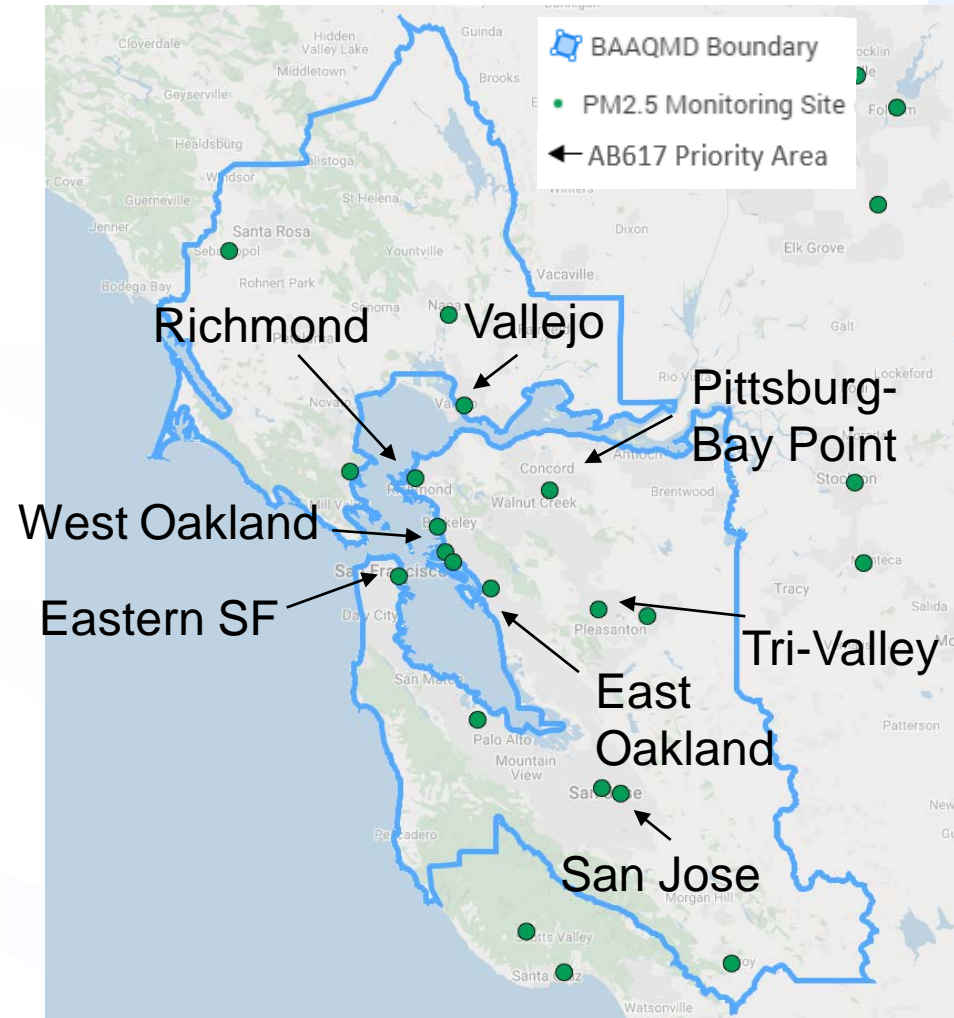


Combining Monitoring Strategies for Multiple Objectives

Network	Measurements	Network Objectives
Regional Network	<ul style="list-style-type: none"> - PM_{2.5} and PM₁₀ Mass 	<ul style="list-style-type: none"> - Comparison with health-based standards - Public information - Track long-term trends - Assess out of area transport
Special Projects (fixed site, portable, or mobile)	<ul style="list-style-type: none"> - PM size distribution - PM speciation - UFP - Black Carbon 	<ul style="list-style-type: none"> - Source identification - Assessment of specific emission sources - Characterization of near-road environments
Sensor Networks (mobile or fixed)	<ul style="list-style-type: none"> - PM Mass - Particle Count 	<ul style="list-style-type: none"> - More challenging to interpret due to higher levels of uncertainty - Public education - Personal exposure - Identification of hot-spots - Comparative assessment of local air quality - Tracking high PM episodes

Integrated PM Network Assessment (to be completed by July 2020)

- Evaluate PM measurement network to recommend improvements with available resources
- Address existing requirements and goals
 - Federal and state requirements
 - Understand criteria pollutant levels
- Strengthen network to address gaps
 - Incorporate multiple monitoring approaches
 - Support community air monitoring activities
 - Provide data to support other Air District activities





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Update on Particulate Matter (PM) Air District Work: Air District Grant Programs Overview

**Karen Schkolnick
Strategic Incentives Division Director**

**Advisory Council Meeting
December 9, 2019**



Overview

- Background
- Grants Overview and Priorities
 - Project Evaluation
 - Eligible Projects
- Supporting Air District Initiatives
- Results and Highlights
- Next Steps

Background



**Monitoring
Planning
Regulations &
Enforcement**

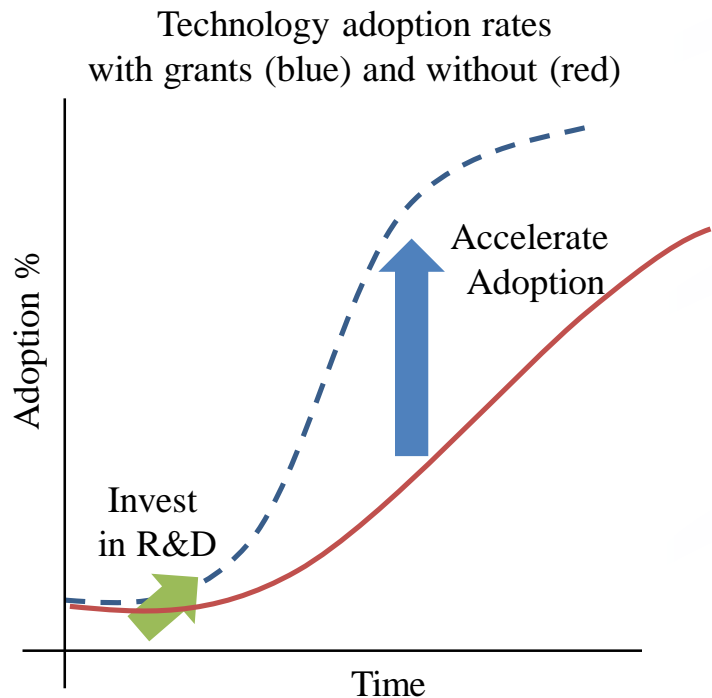


**Education
&
Outreach**



**Grants
&
Loans**

Grants Overview and Priorities



- Cost-effective air quality and climate protection benefits
- Accelerated adoption of cleanest commercially available technologies and investments in R&D
- Expedited emissions reductions in disproportionately impacted communities



Project Evaluation

Cost-Effectiveness (CE)

$$CE = \frac{\text{Funds Awarded}}{\text{Tons of } NO_x + ROG + (PM_{10} \times 20) \text{ reduced}}$$

CE* estimates *quantifiable*,

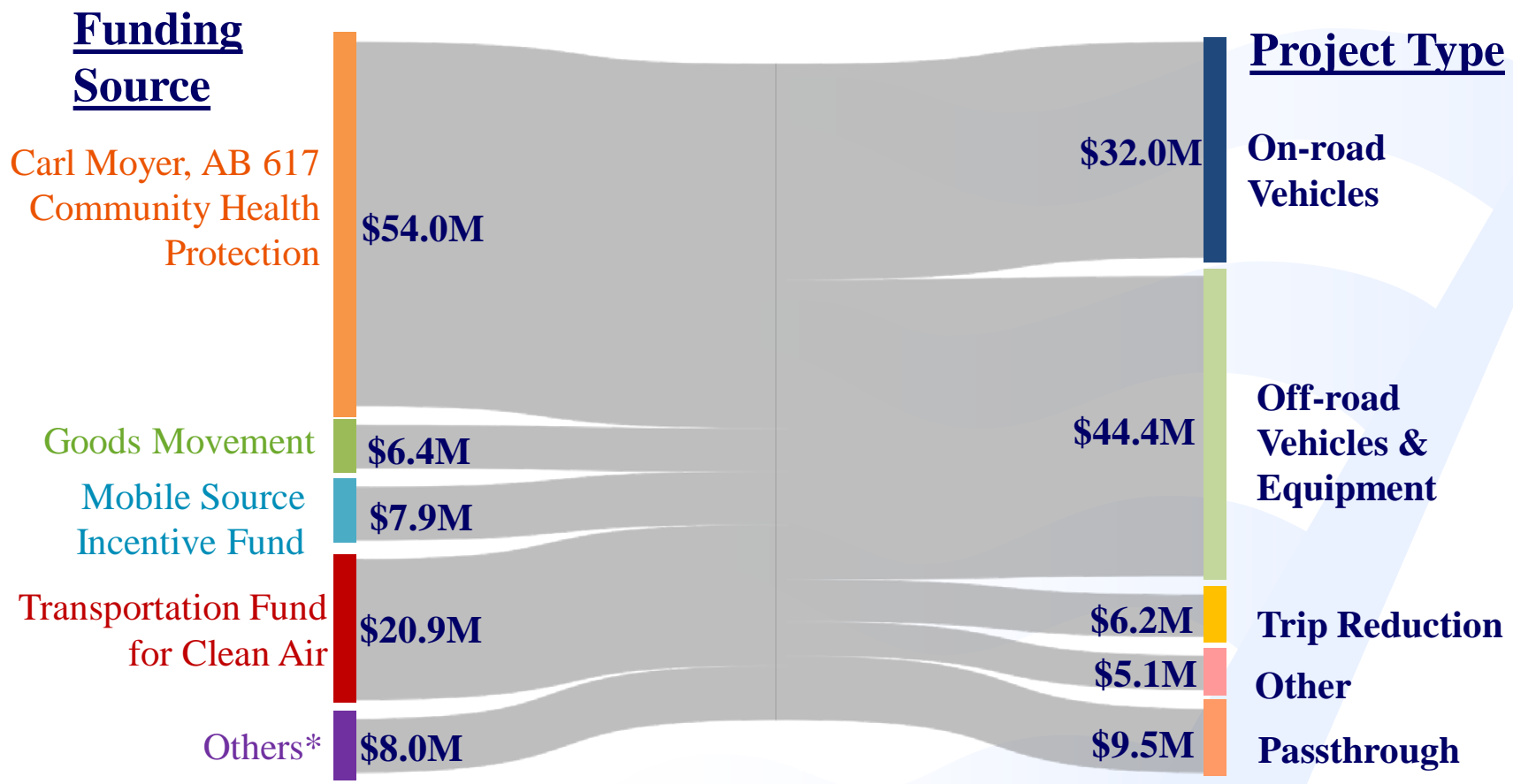
verifiable,

and surplus lifetime emission reductions

*CE formula is provided by CARB Carl Moyer Program Guidelines



>\$97M Awarded in 2018 to Eligible Projects



* Other funding sources include U.S. EPA's DERA, California Climate Investments, & Air District's general fund

Eligible Projects

On-road Vehicles

\$32.0M

On-road
Vehicles

Cars &
Charging
Stations



Trucks



Buses





Eligible Projects

Off-road Vehicles & Equipment

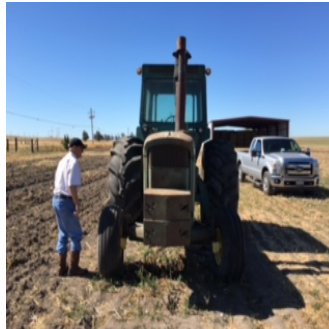
\$44.4M

Off-road
Vehicles
And
Equipment

**Cargo
Equipment**



**Ag
Equipment**



**Marine &
Locomotive**



**Other
Off-road**



Eligible Projects

Trip Reduction

Shuttles & Ridesharing



Pilot Services

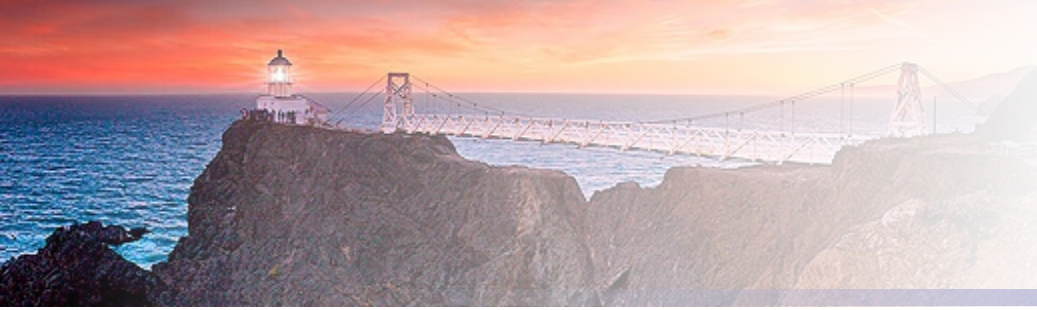


Bicycle Projects



\$6.2M

Trip Reduction



Eligible Projects

Other & Passthrough

Lawn & Garden



Wood Smoke



Climate Protection



County Programs



\$5.1M

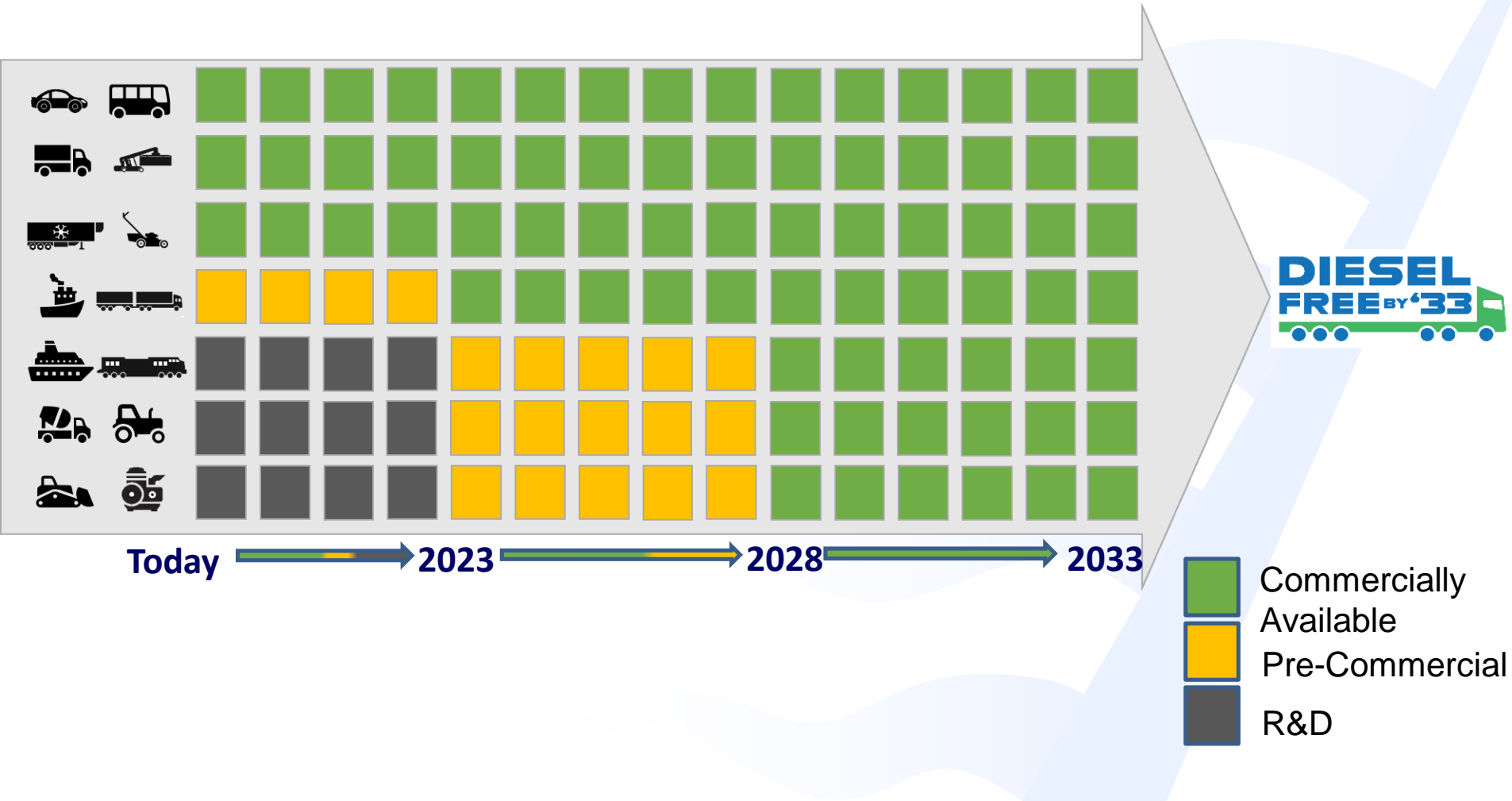
Other

\$9.5M

Passthrough

Supporting Air District Initiatives

Path to Diesel Free by '33



Supporting Air District Initiatives

Bay Area Electric Vehicle Trends & Goals

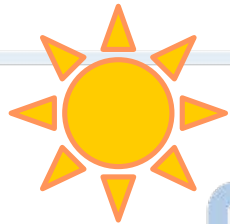
 7,750 public charging ports

Over \$15M invested to date

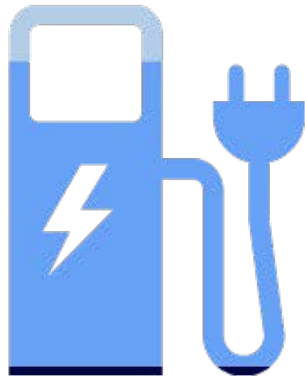
3% of the cars are EVs



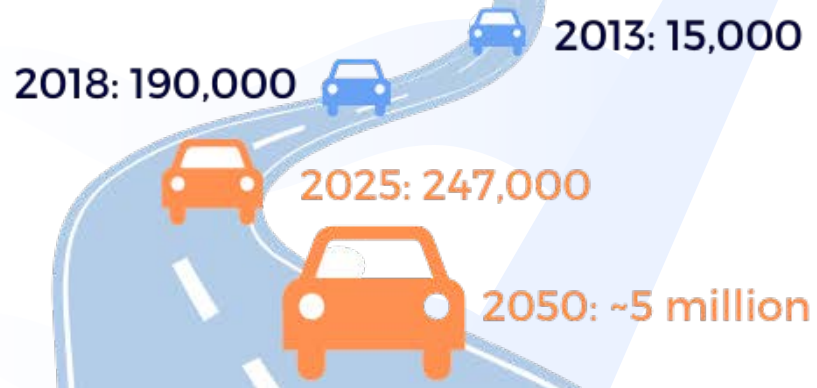
10+ EV Incentive Programs



~25% of funded stations included renewables



Progress towards our EV Adoption Goals



Supporting Air District Initiatives

Advanced Technology Demonstrations

\$2.9M to deploy 11 electric trucks & haulers for commercial delivery service



\$3M to deploy hydrogen-powered ferry for passenger service



Supporting Air District Initiatives

Early Emissions Reductions at Port of Oakland

Equipment Type	*DPM Inventory (tons)	
	2005	2017
Oceangoing Vessels	208.5	42.2
Harbor Craft	13.4	6.1
Cargo Handling Equipment	21.2	1.6
Trucks	15.9	0.3
Locomotives	2.0	0.3
Other	--	0.3
Total	261	51

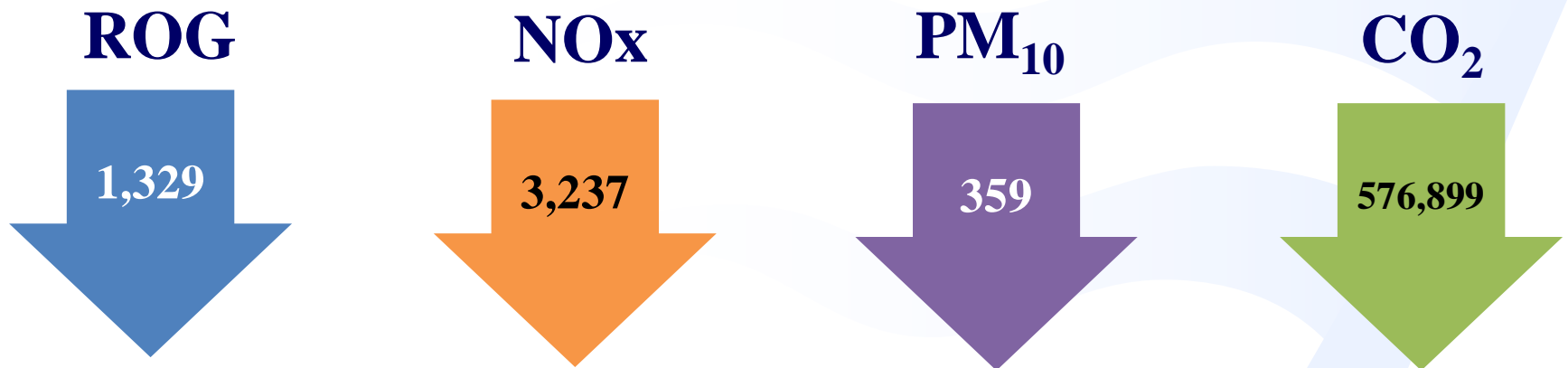
>\$100M in grants invested at Port of Oakland including:

- Retrofitted/replaced <1,900 drayage trucks
- Installed shorepower at 14 berths
- Replaced >1,090 on-road trucks

*Diesel Particulate Matter

Results and Highlights

Regionwide Cumulative Emissions Reduced (tons) Since 2015



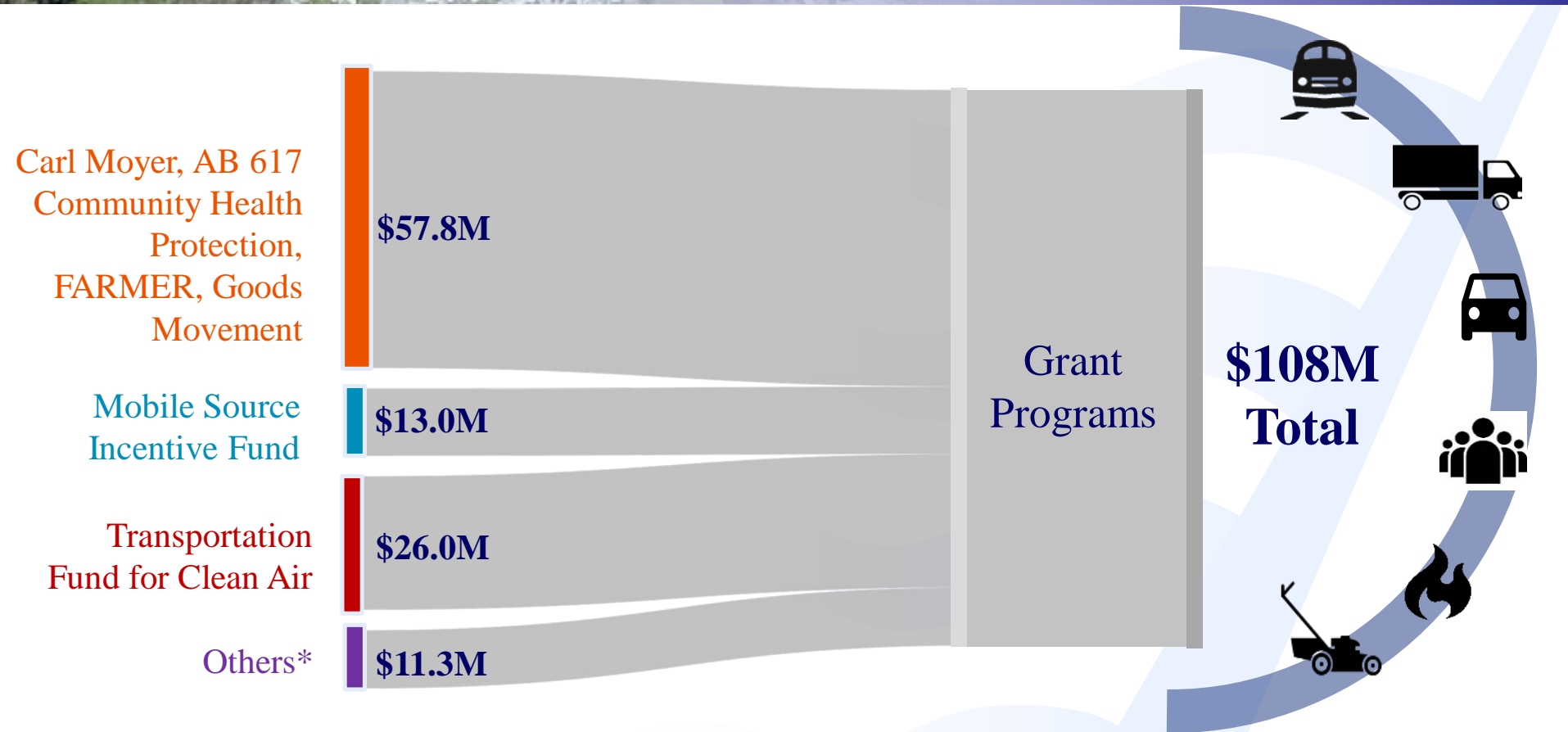
Highlights 2015 - 2019

- 1,000+ EV charging stations
- ~40 miles of bikeways
- 1,200+ woodstoves and fireplaces
- >100 ZE transit and school buses

**53% of funds
in CARE areas**

Next Steps

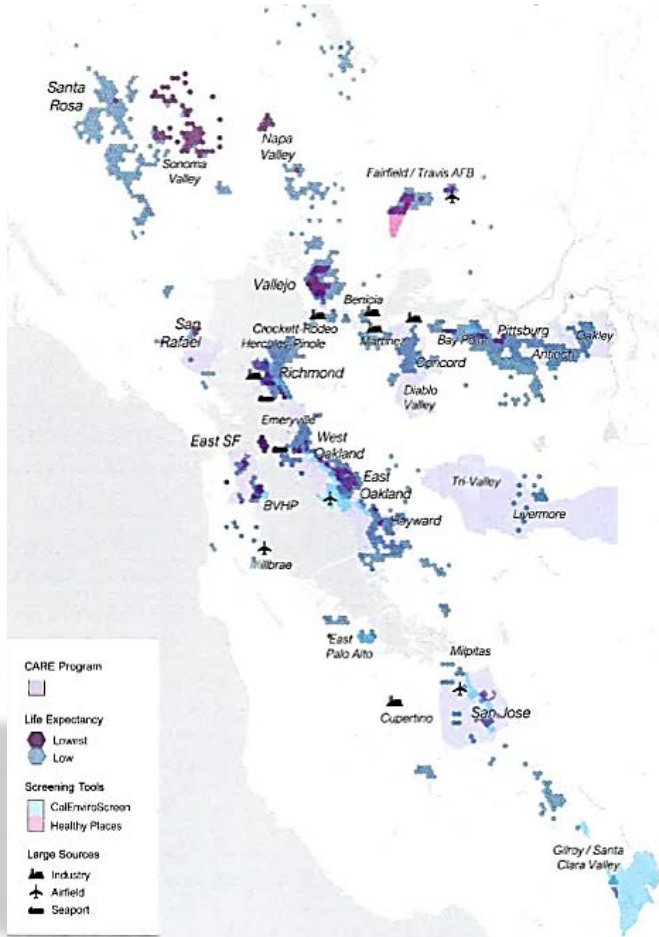
Incentive Revenues for 2020 (in millions)



* Others include Clean Cars for All and Climate Tech Finance (loan guarantee)

Next Steps

New & Expanded Grant Programs



- Secure new sources of funding
- Expand eligibility and initiate new programs
 - Expediting public health benefits in disproportionately impacted areas
 - Prioritizing programs that provide co-benefits



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Update on Particulate Matter (PM) Air District Work:

PM Rules and Regulatory Development

**Victor Douglas
Rule Development Manager**

**Advisory Council Meeting
December 9, 2019**



Overview

- Approaches to Regulate PM
- PM Rules and Regulations
- Current and Future Efforts
 - Regional attainment
 - Localized impacts
 - Gap analysis



Regulation of PM

- **Three Ways to Regulate PM:**
 1. **Originally regulated as a Nuisance**
 - Open burning (original Reg 1)
 - Dust and aerosol (original Reg 2)
 2. **Criteria (i.e., regional)**
 3. **Toxic (i.e., local/community level)**
 - Diesel PM



Regional Approach

- Attainment of ambient air quality standards
- Control of Primary PM
 - Filterable
 - Condensable
- Control of Secondary PM
 - Oxides of Nitrogen (NO_x)
 - Sulfur Dioxide (SO₂)



PM Rules & Regulations

- Regulation 2: Permits
- Regulation 5: Open Burning
- Regulation 6: Particulate Matter
- Regulation 9: Inorganic Gaseous Pollutants
- Regulation 11: Hazardous Pollutants
- Regulation 12: Miscellaneous Standards of Performance



PM Rulemaking Efforts

- 2012 – **Rule 2-2 amendments** to add New Source Review permitting requirements for PM_{2.5}
- 2012 – **New Rule 9-13** to reduce PM emissions from Portland cement kilns
- 2013 – **New Rule 6-4** and **new Rule 12-13** to reduce PM emissions from metal foundries and shredding facilities



PM Rulemaking Efforts

- 2015 – **Rule 6-3 amendments** to further reduce wood smoke from wood-burning devices
- 2016 – **New Rule 9-14** to reduce precursors of secondary PM from petroleum coke calcining operations
- 2018 – **New Regulation 6, new Rule 6-6, and Rule 6-1 amendments** to reduce PM emissions from fugitive dust sources
- 2019 – **Rule 6-3** to extend No Burn Days for the Wildfire Response Program



2018 PM Rules

- New Regulation 6 for common definitions and test methods
- New Rule 6-6 for prohibition of trackout
- Rule 6-1 amendments for general requirements and bulk material handling
- Reduce PM emissions from fugitive dust sources
- Expected emission reductions of 1.6 tpd PM_{10} , 0.2 tpd $PM_{2.5}$



Current and Future Efforts

- Continued **regional** efforts on further PM reductions (e.g., Rule 6-5: PM from FCCUs)
- Source categories and rule efforts identified in planning efforts
- Additional areas from gap analysis
 - Restaurants
 - Wood smoke
 - Indirect and magnet sources
 - PM as a toxic pollutant



Current and Future Efforts (cont.)

- To address **localized** PM issues
- Regulatory framework for site-specific localized PM impacts
- Existing localized approaches for toxics
 - Air District Rule 11-18 for Air Toxic Emissions from Existing Facilities
 - AB 2588 Air Toxic Hot Spots Program



Discussion

Questions?