AIR QUALITY MONITORING

Part 3 – The what, why and how

Community Action to Promote Healthy Environments (CAPHE)

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Air quality monitoring

Air quality monitoring involves the collection and analysis of measurements to assess the status of the air

What we will cover:

- Importance of air quality
- Types, strategies, issues
- Regulatory monitors
- Sensors

Importance of air quality monitoring

If you don’t measure it, you can’t manage it!

1. Determine exposure and inform mitigation actions to stay safe

2. Determine compliance with standards

- Ambient air quality monitoring is required under Titles 1 and 3 and sometimes as a permit condition

3. Identify impact of specific emission sources

- **“Fenceline”** monitoring at industry or highways
- Measure **background** or upwind levels

4. Evaluate whether emission controls are working

5. Trend and impact analyses

- **Impact or burden analyses:** ecological and human health, and environmental justice

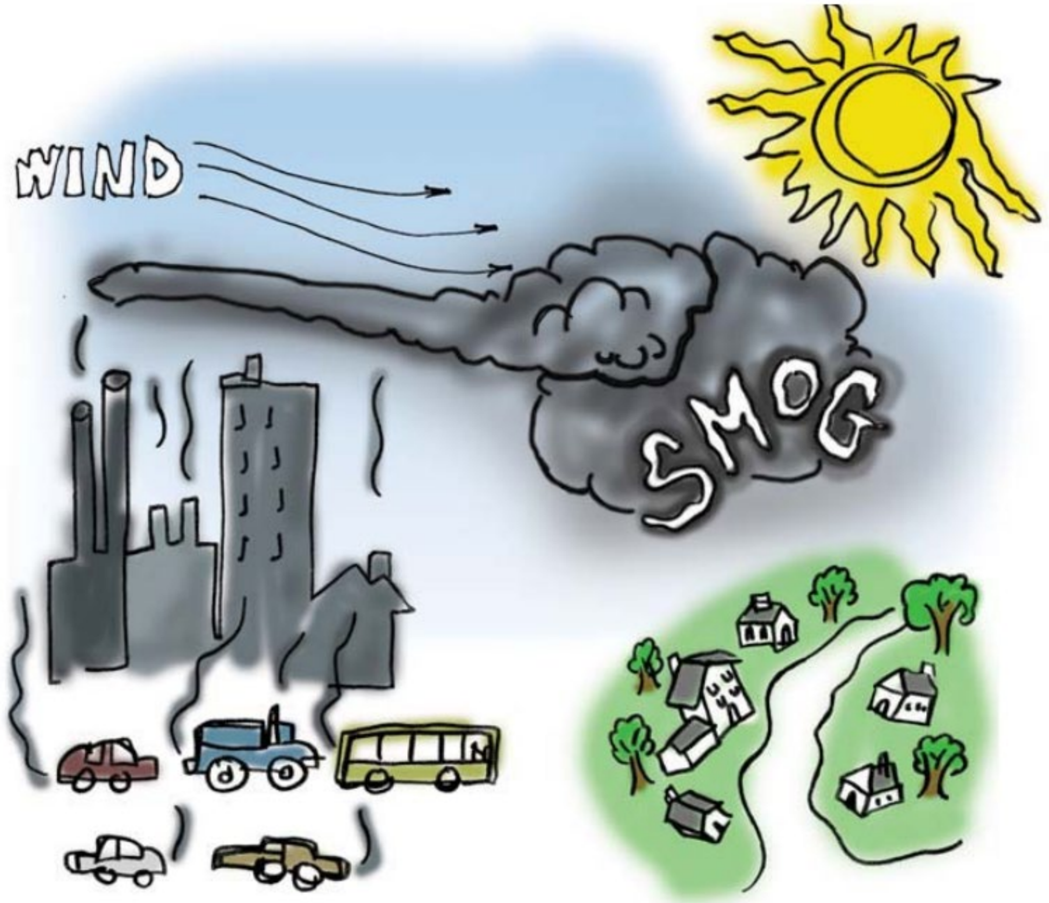
6. Research

- Epidemiological studies, dose-response determinations, standard setting
- Model validation for dispersion and apportionment models

Types of air quality monitoring and challenges

Types of air monitoring

- **Ambient** – neighborhood to regional and global scales
- **Personal** – breathing zone
- **Indoor air** – buildings, HVAC, vehicle cabins, etc.
- **Mobile** – mapping
- **Source** – stack testing
- **Remote sensing** – satellite



Source: US EPA. The Plain English Guide to the Clean Air Act. Office of Air Quality Planning and Standards. P.4. 2007. EPA.gov

Monitoring air quality poses unique challenges

- Concentrations can vary greatly in **space** -- “microenvironments”
- Concentrations can change rapidly in **time**
- People have unique activity patterns
- Must quantity both average and high-end levels in all types of weather
- Some pollutants are technically difficult and expensive to monitor accurately

Monitoring under the Clean Air Act & Amendments

Title I. Attainment and maintenance of National Ambient Air Quality Standards (NAAQS)

- Applies to criteria pollutants: CO, O_3, $PM_{2.5}$, SO_2, NO_2, Pb.
- Requires minimum number of monitoring sites, depending on size

Title III. Toxics (also called Hazardous Air Pollutants) – 189 different pollutants or mixtures

Reference monitoring methods are used for NAAQS pollutants with mandatory methods and QA/QC. Only reference or approved equivalent method can be used.

EPA monitoring networks (1/2)

Photochemical Assessment Monitoring Stations (PAMS)

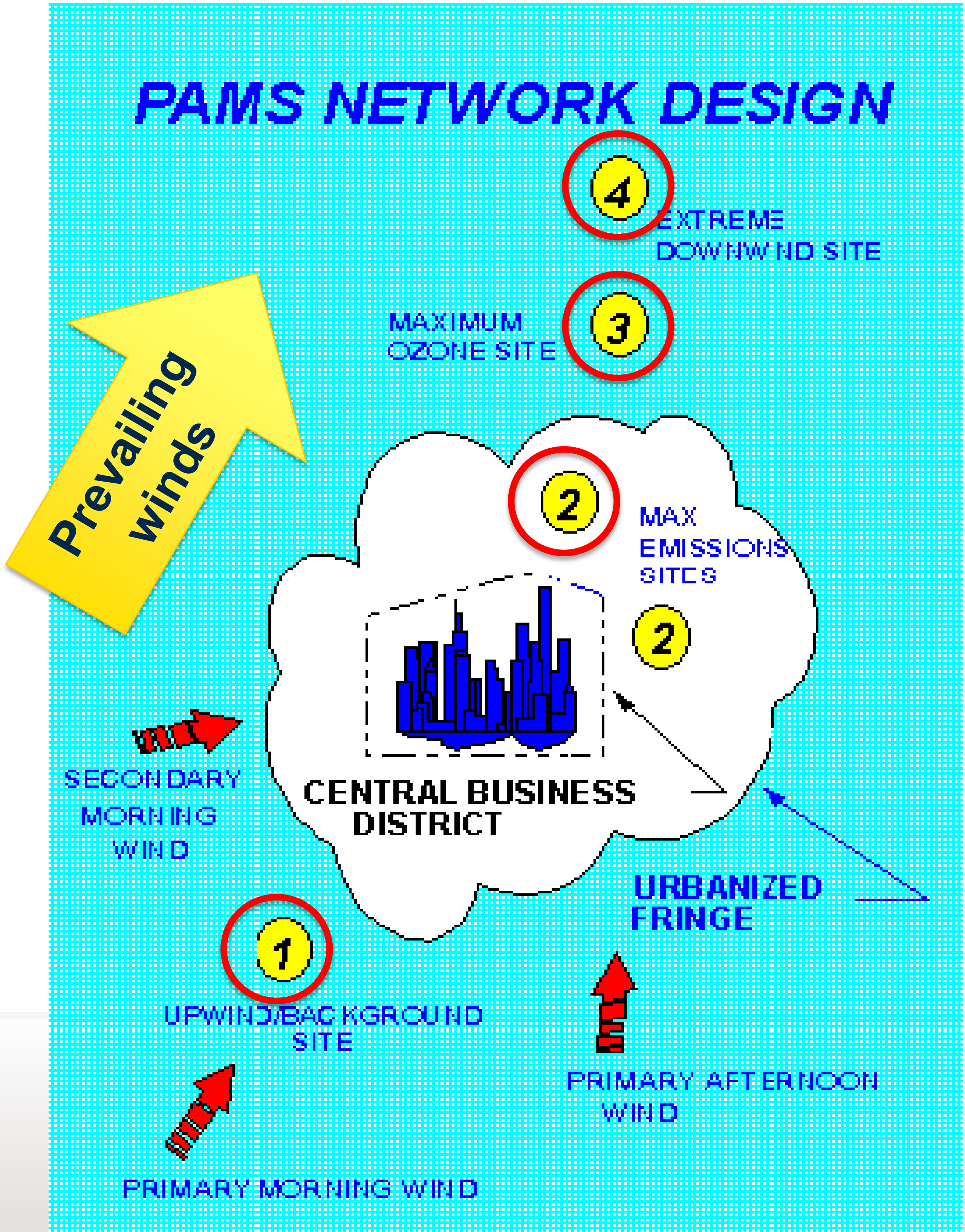
- Enhanced monitoring of O_3, NO_x, and 56 VOCs
- **Transect approach** with sites for:
  1. Upwind/background concentrations
  2. O_3 precursors
  3. Maximum O_3 concentration
  4. Extreme downwind site for transport

Particulate Matter (PM) Networks

- Filter-based (24-hr)$PM_{2.5}$, continuous $PM_{2.5}$
- Chemical Speciation Network (CSN)
- State and Local Air Monitoring Stations (SLAMS)
- Interagency Monitoring of Protected Visual Environments (IMPROVE)

National Core Network (NCore)

- For emission strategies, health assessments, etc,
- Multipollutant including speciated $PM_{2.5}$



EPA monitoring networks (2/2)

Near-road network

- For traffic-related air pollutants (TRAP)
- Within 50 m of major roads
- NO2, CO, sometimes PM, EC/OC, Aethalometers

National Air Toxics Trends Stations

- Long-term monitoring to assess trends & emission controls

Lead (Pb) Monitoring Network

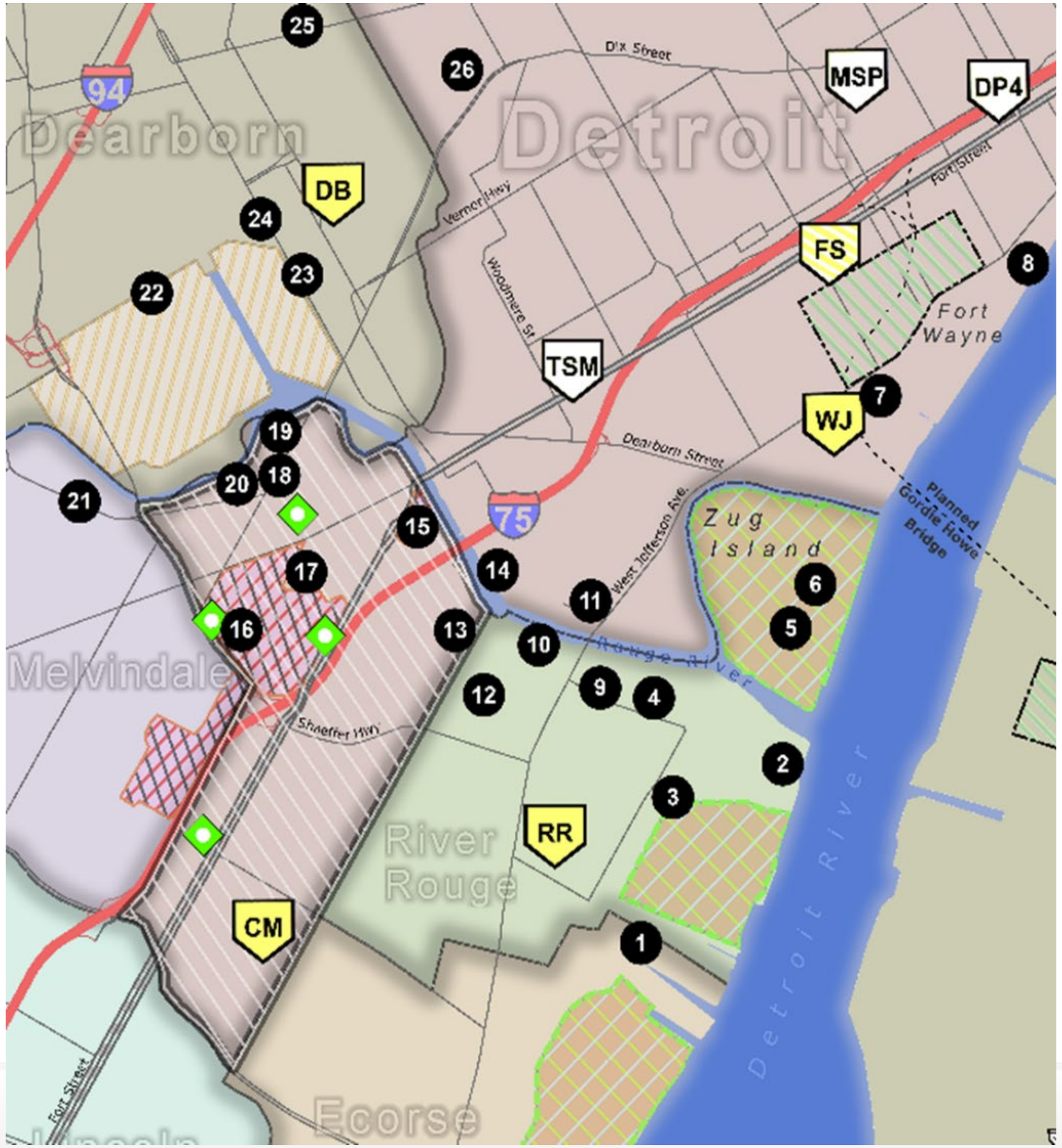
- On $PM_{2.5}$, PM_{10} and Total Suspended Particulate (TSP)

Community Scale Air Toxics and vulnerable populations

Clean Air Status and Trends Network (CASTNET)

- National Park Service and other partners
- For acid deposition and ecological impacts
- Includes SO_2, HNO_3, SO_2^{-4}, NH_4, O_3, deposition

EGLE & Marathon monitoring sites; major sources in SW Detroit



AIR EMISSION SOURCES†

1 Praxair
2 DTE River Rouge
3 Fritz Products
4 Buckeye Terminals River Rouge
5 EES Coke Battery
6 US Steel Great Lakes Works
7 DTE Delray
8 Waterfront Petroleum
9 Carmeuse Lime
10 United States Gypsum
11 Great Lakes Water Authority Treatment
12 Fabricon Products
13 Buckeye Terminals Detroit
14 Saint Mary's Cement
15 Great Lakes Petroleum
16 Marathon Petroleum
17 Detroit Salt
18 Cadillac Asphalt Products
19 Sunoco River Rouge
20 Edw C Levy Co Plant 6
21 Darling Ingredients
22 AK Steel Dearborn
23 Dearborn Industrial Generation
24 Ford Motor Company Rouge Complex
25 Xcel Steel Pickling
26 Edw C Levy Co Plant 1

†These facilities reported 2016 air emissions to the Michigan Air Emission Reporting System (MAERS).

LARGE AREA SYMBOLS

48217 Zip
Marathon
US Steel
AK Steel
Gordie Howe Bridge Plaza

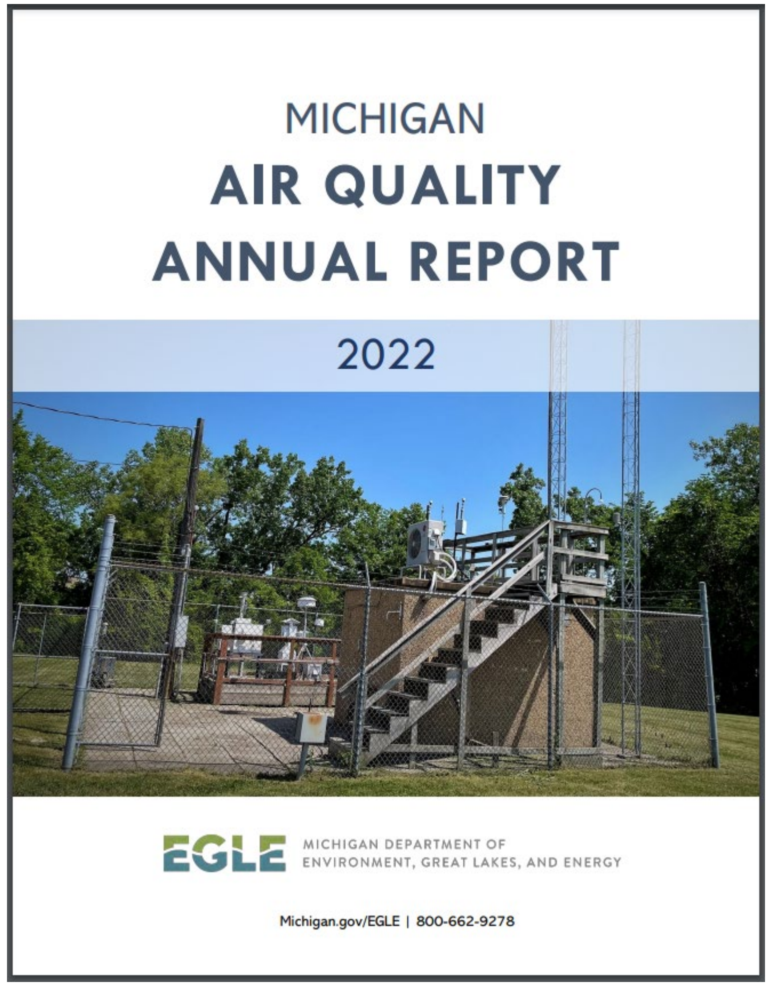
RR River Rouge: Carb, 5 TSP Metals
WJ West Jefferson: 5 TSP Metals
Marathon Monitors: PM10, CO, SO2, Total Reduced Sulfur, VOCs
FS Fort Street (Southwestern High Sch.):** PM2.5, PM2.5 spec., PM10, NOx, SO2, VOCs, Carb, Carbon Black, 5 TSP Metals
DP4 Detroit Police Precinct 4: PM2.5, CO, NOx, SO2, Carbon Black, 5 TSP Metals
DB Dearborn – Salina Elem. Sch.: PM2.5, PM2.5 spec., PM10, PAHs, VOCs, Carb, Carbon Black, 14 TSP and PM10 Metals
CM Community Monitor (48217): PM2.5, SO2, 5 TSP Metals
MSP Military Street Park: PM2.5, NOx, SO2, Carbon Black, 5 TSP Metals
TSM Trinity Saint Marks: PM2.5, CO, NOx, CO2, Carbon Black, 5 TSP Metals

- **Map region:** 7.5 x 8.5 km
- **Major point sources** >10 tons/year of a single pollutant

Source: Michigan EGLE

Monitoring sites in SE Michigan

Choose your monitor & pollutant



https://www.michigan.gov/egle/about/organization/air-quality/air-monitoring (scroll down)

https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Reports/AQD/monitoring/annual-reports/2022-air-quality-annual-report.pdf?rev=bb4ef053f7b74fbebd79c4aac67c6975&hash=DABA1681F93DF43C68BD0BF5ABCF7685

Airs ID	Site Name	CO	NO_2	Trace NO_y	O_3	PM_{10}	$PM_{2.5}$ FRM	$PM_{2.5}$ Continuous	$PM_{2.5}$ Speciation	SO_2	VOC	PAHs	Carbonyls	Trace Metals (As, Cd, Mn, Ni, Pb)	Wind Speed & Direction, Temp.	Relative Humidity	Solar Radiation	Barometric Pressure
260910007	Tecumseh				√			√F							√			√
260990009	New Haven				√			√F					√		√	√	√	
260991003	Warren				√													
261250001	Oak Park				√		√								√			
261470005	Port Huron				√			√F		√					√			
261470031	Port Huron-Rural St.													√				
261610008	Ypsilanti				√		√	√F							√			√
261630001	Allen Park	√*		√	√	√^	√	√F	√+A	√*					√	√		√
261630005	River Rouge												√	√	√			
261630015	Detroit-SW[5]		√			√	√	√F	√+A	√	√		√	√	√	√		√
261630019	Detroit-E 7 Mile		√	√	√		√				√		√		√	√		√
261630033	Dearborn					√^	√	√T	√+A		√	√	√	√#	√	√		√
261630093	Eliza Howell-NR	√	√					√F							√			
261630097	New Mount Hermon (NMH) 48217							√F		√				√				
261630098	Detroit Police 4th Precinct (DP4th)	√	√					√F	A	√				√				
261630099	Trinity	√	√					√F	A	√				√	√			
261630100	Military Park		√					√F	A	√				√				

√ = Data Collected
# = 9 additional metals sampled: Ba, Be, Cr, Co, Cu, Fe, Mo, V, Zn
F = FEM continuous $PM_{2.5}$ monitor
T = TEOM (non-FEM) continuous $PM_{2.5}$ monitor
* = Trace monitor
^ = Continuous PM_{10} monitor
A = Aethalometer monitor

https://www.michigan.gov/egle/public/learn/air-quality Try it!

Scroll way down to get to menu
Or http://www.deqmiair.org/

How's my Air Quality?

Here are some tools to help you better understand the air quality around you including when wildfires are burning. These include a map with color-coded dots showing real-time air quality information. Another map shows Michigan's air monitors and what they measure. Helpful links to air sensor information are also listed below.

Your Health and Wildfire Smoke

PDF **Protect Yourself from Wildfire Smoke**

Real-Time Air Quality Information

EPA's Air Now - Air Quality Index

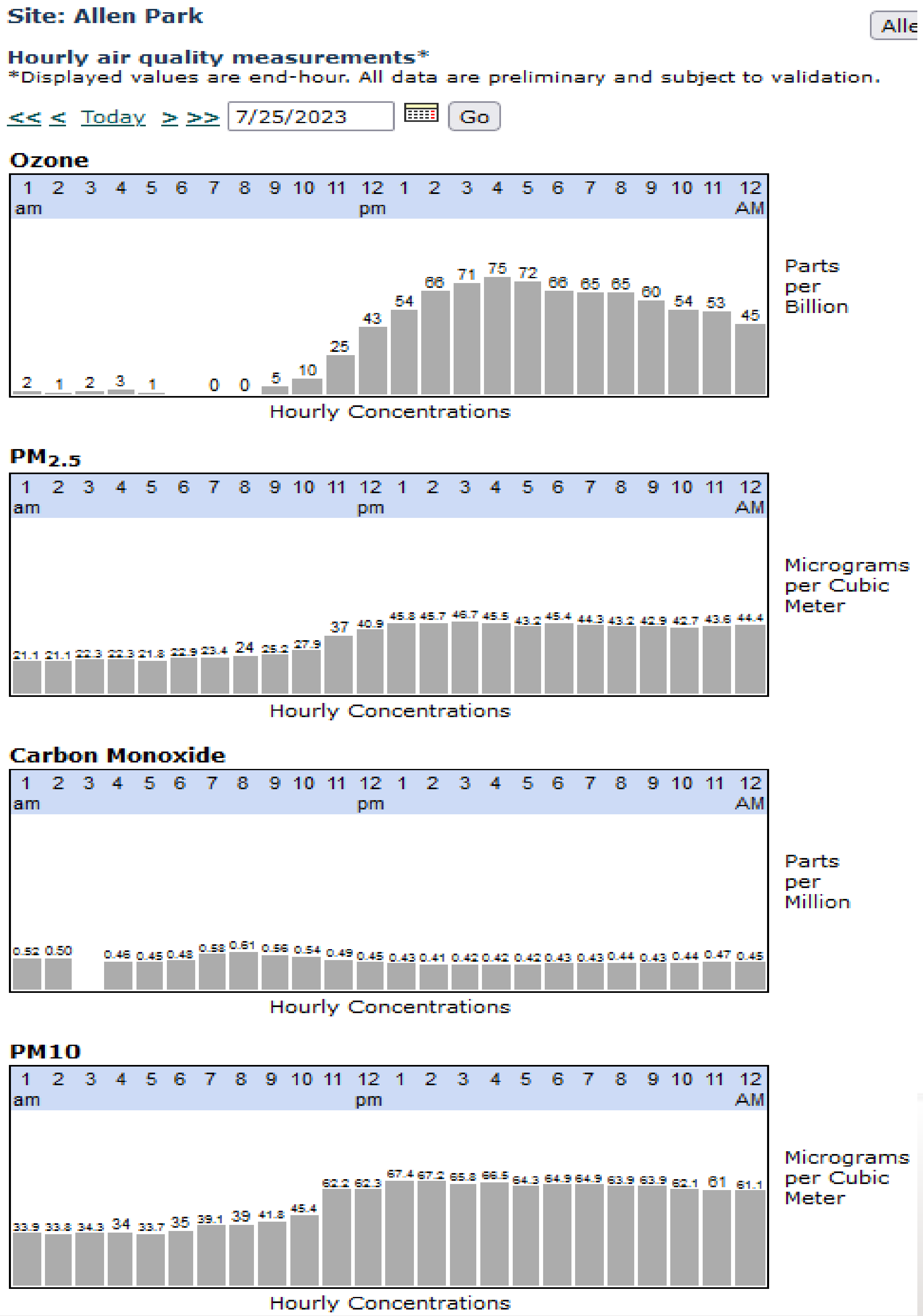
PDF **2023 Air Quality Action Days**

Past Air Quality Action Days

Interactive air monitoring map

Citizen Science - Air Sensors

PurpleAir: Air Sensor information



Select Map: Detroit Area **Go**

Click on **monitors near me**

Select **PM** or ozone

Select **Monitor** (circle)

Select **Plot Data** (shows last few hours)

Can change date using

<< < Today > >> 1/14/2024 Go

Try **July 25, 2023 Go**

Can change site at top right:
try **Allen Park Go**
try **E7 Mile Go**

AP & E7M sites have ozone and other pollutants

https://www.michigan.gov/egle/public/learn/air-quality **Try it!** ☺

Scroll way down to get to menu

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EGLE

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

Welcome to the Air Monitoring Sites Web Map.

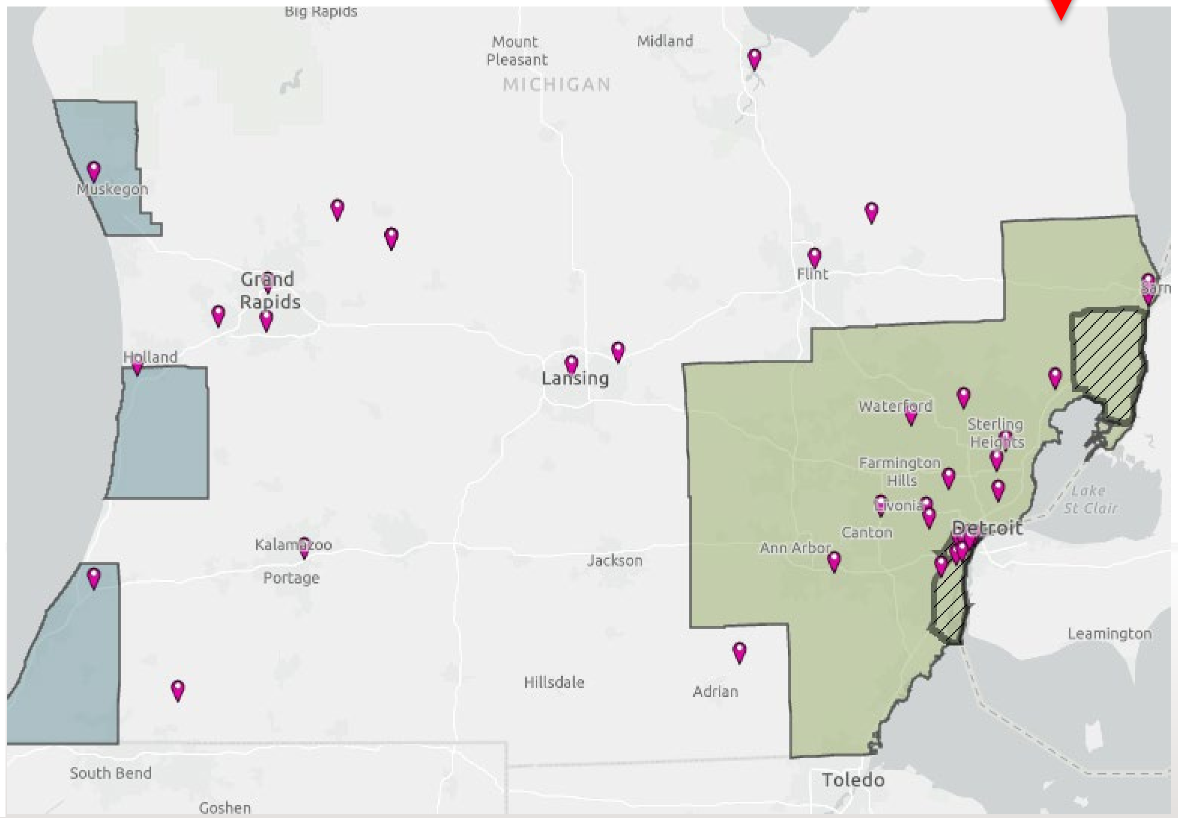
Revision: June 21, 2021

This map is intended to show general information for the Air Monitoring Sites and Nonattainment Areas in Michigan.

For information on how to use this map, select the "How to Use This Map" button in the top right corner.

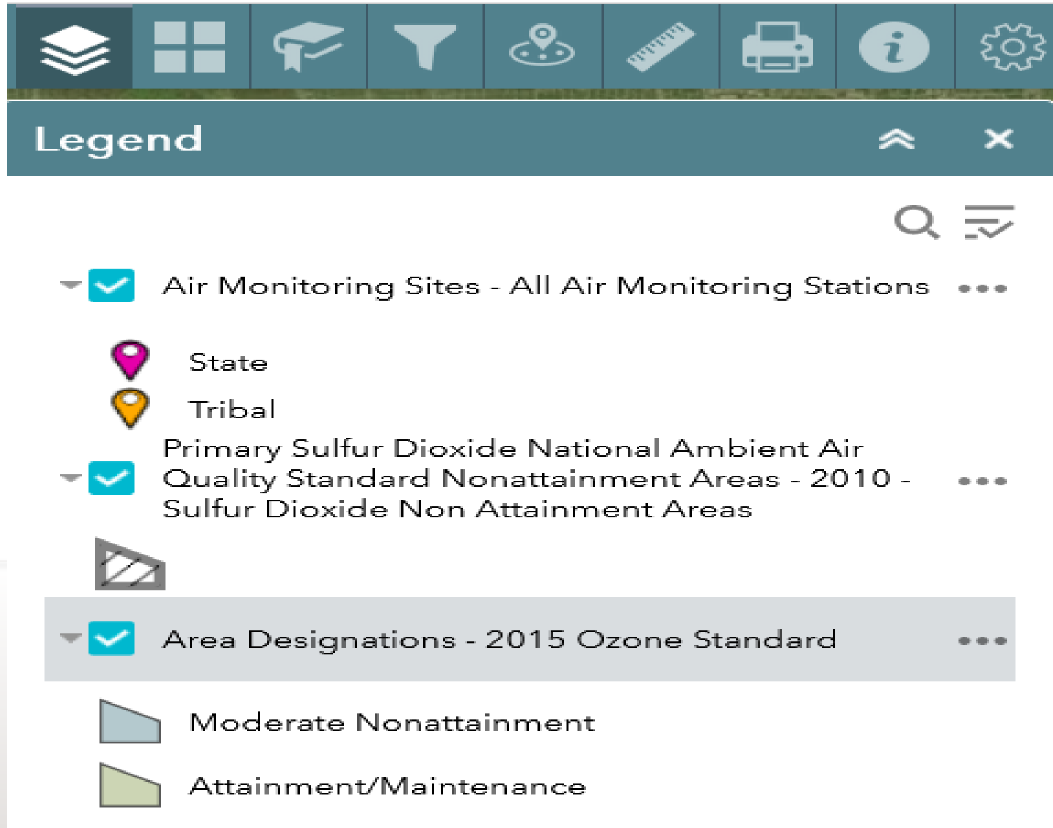
For additional information on this subject, view the "About" button at the top right corner.

Select **OK**, zoom in.
Msp shows non-attainment areas

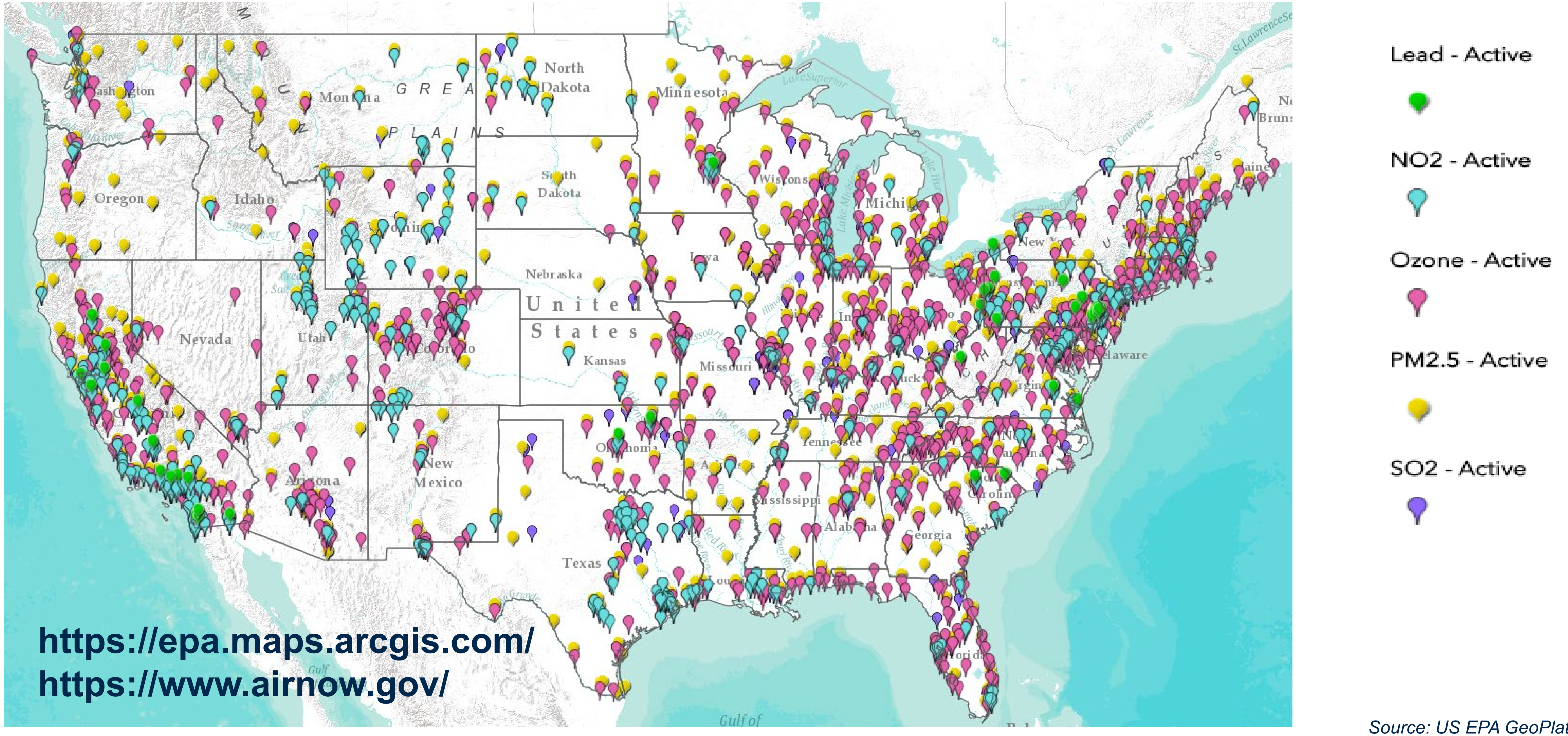


Select site (purple pin) to get some site information, photo of site and hourly monitoring data (MIAIR)

Select **Legend, Basemap, More**



EPA monitoring sites in US



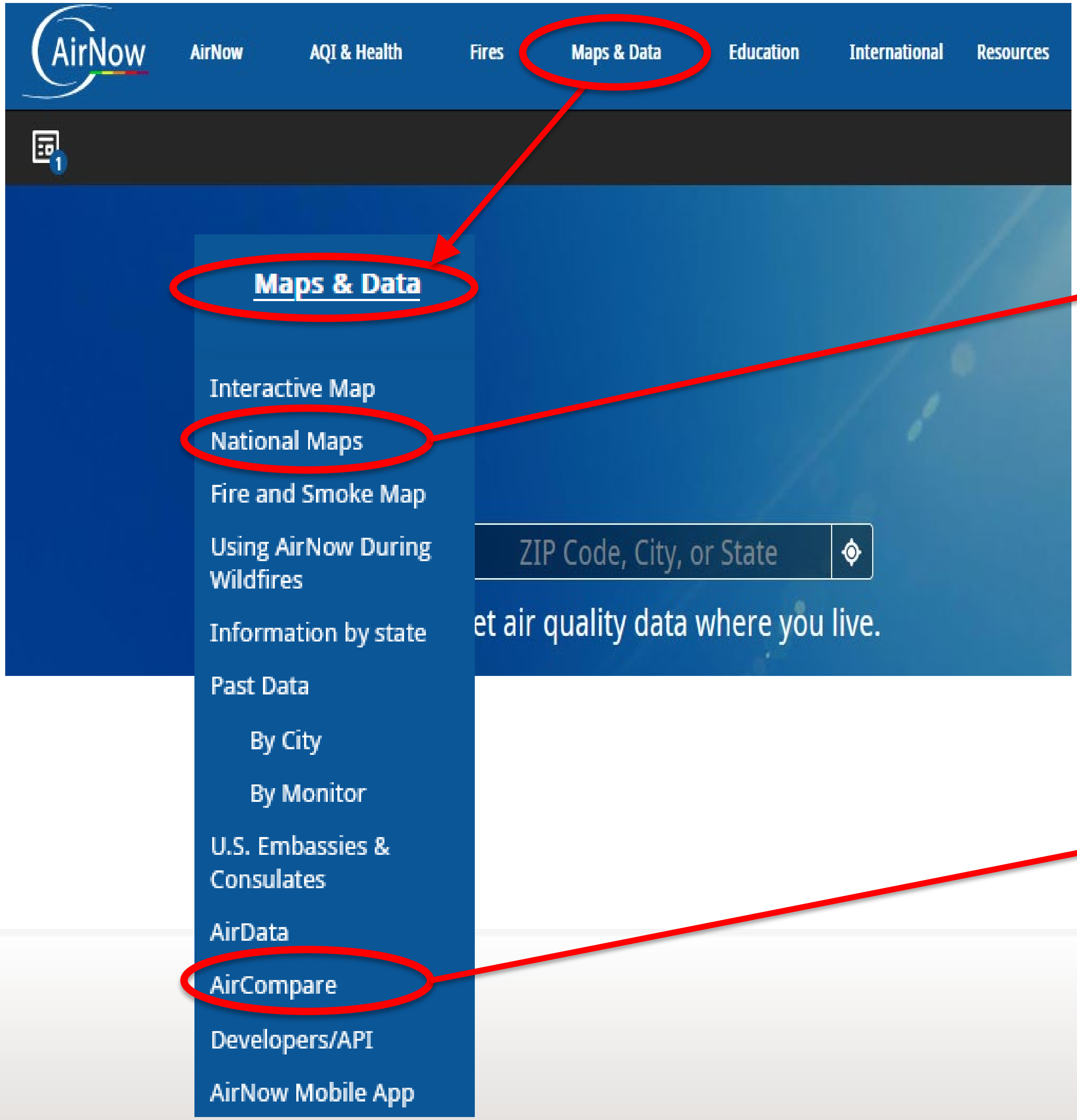
Source: US EPA GeoPlatform. AirNow.gov

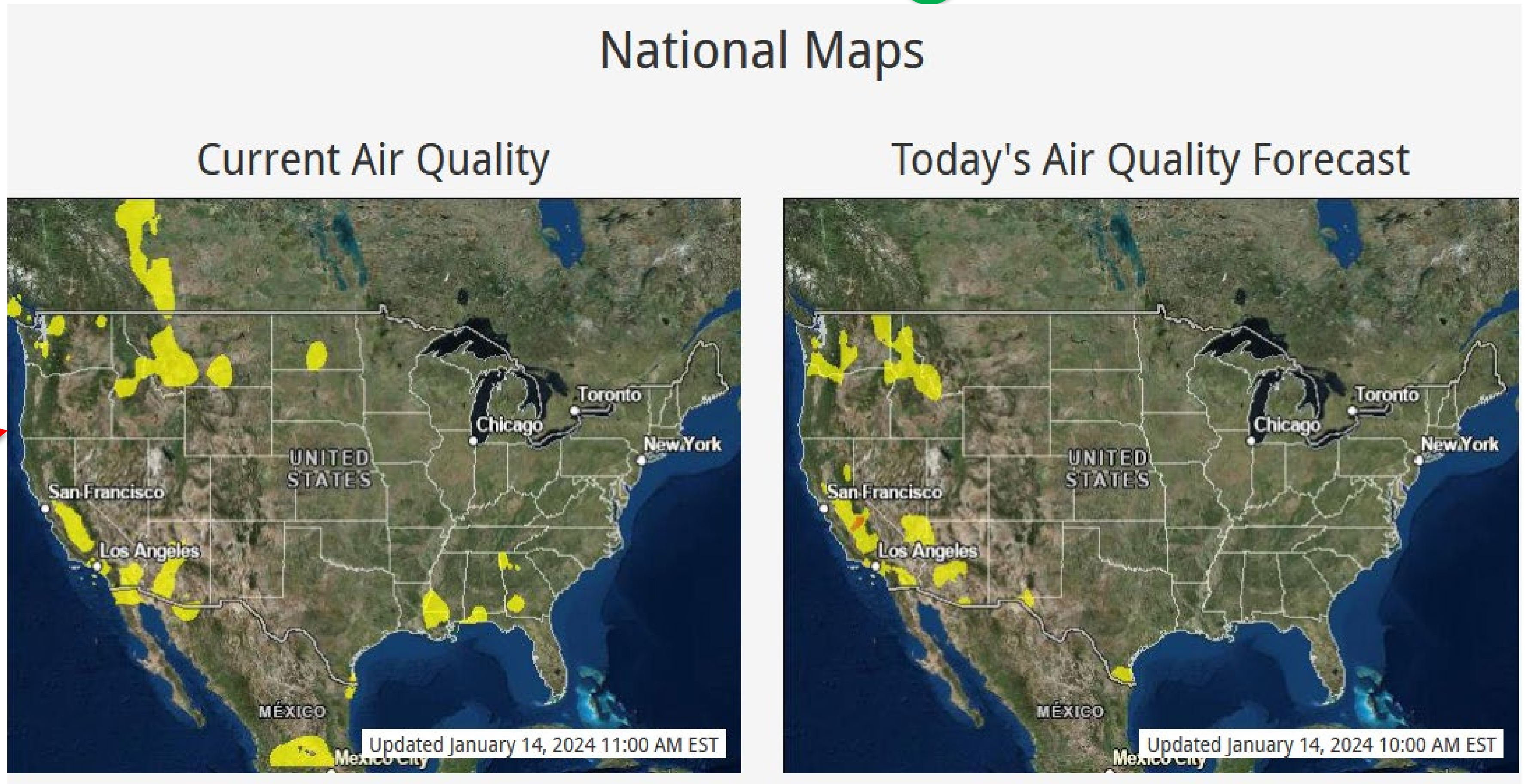
US EPA data are generally easily available (AIRNOW)

https://www.airnow.gov/

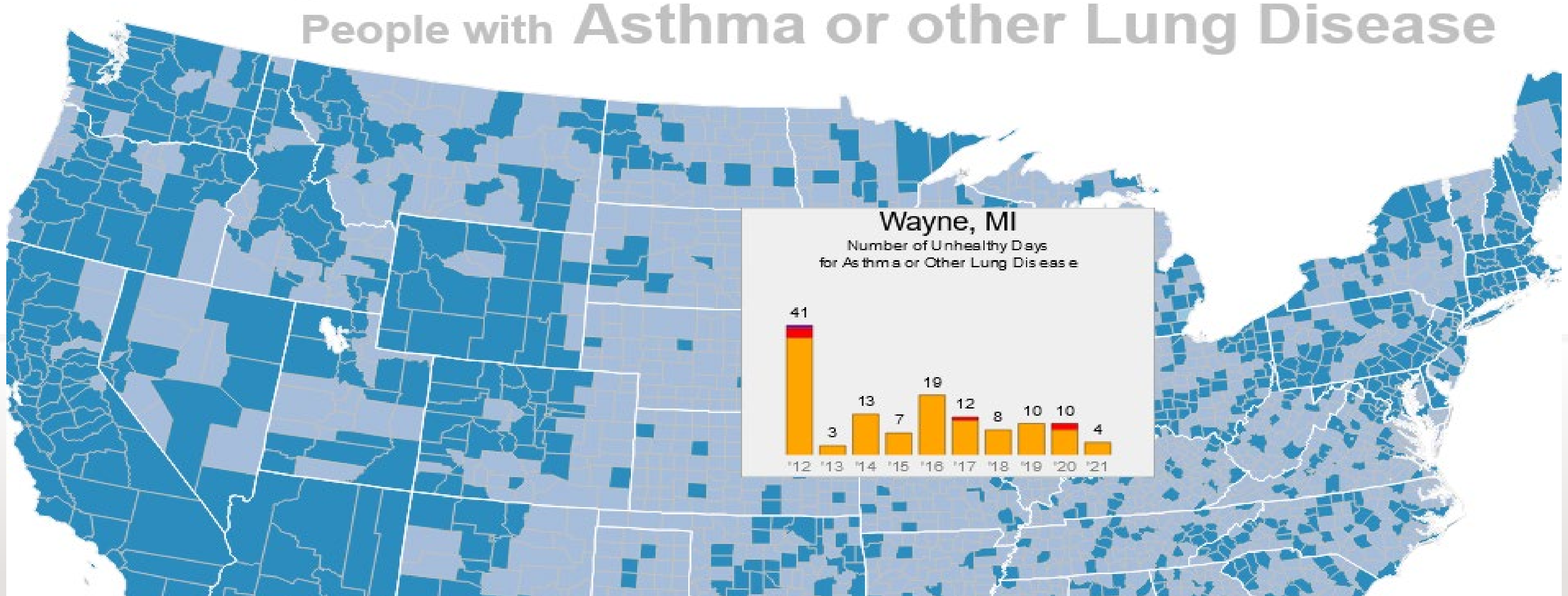
Try it!

MAPS & Data Or *http://www.deqmiair.org/*





Use this Map to See Trends for Pollutants that Affect People with **Asthma or other Lung Disease**



Questions and key points

Why are EPA/state monitoring networks important?

Determine compliance with the National Ambient Air Quality Standards (NAAQS)

Measure background, population and maximum impact sites

Consistent, well established, and high quality methods allow analysis of trends

What are the biggest limitations of these networks?

Monitoring sites are sparse in most areas and may not reflect exposure given an individual's movement and spatial variation

Only a subset of pollutants are measured

Questions?

Air quality sensors

Small, direct reading, and inexpensive devices to measure air quality

- Outdoor sensors: roof/wall mount, some with WiFi, phone modem, solar power
- Indoor/desktop sensors
- Personal sensors: small, easy to transport, unobtrusive. Some have built-in GPS, accelerometer, Bluetooth to phone

What do they measure?

- PM – light scattering or particle counts
- Gases: O_3, CO, NO_x, SO_2 – metal oxide or electrochemical sensors
- Carbon dioxide (CO_2) – IR absorption
- VOCs – photoionization or IR sensors

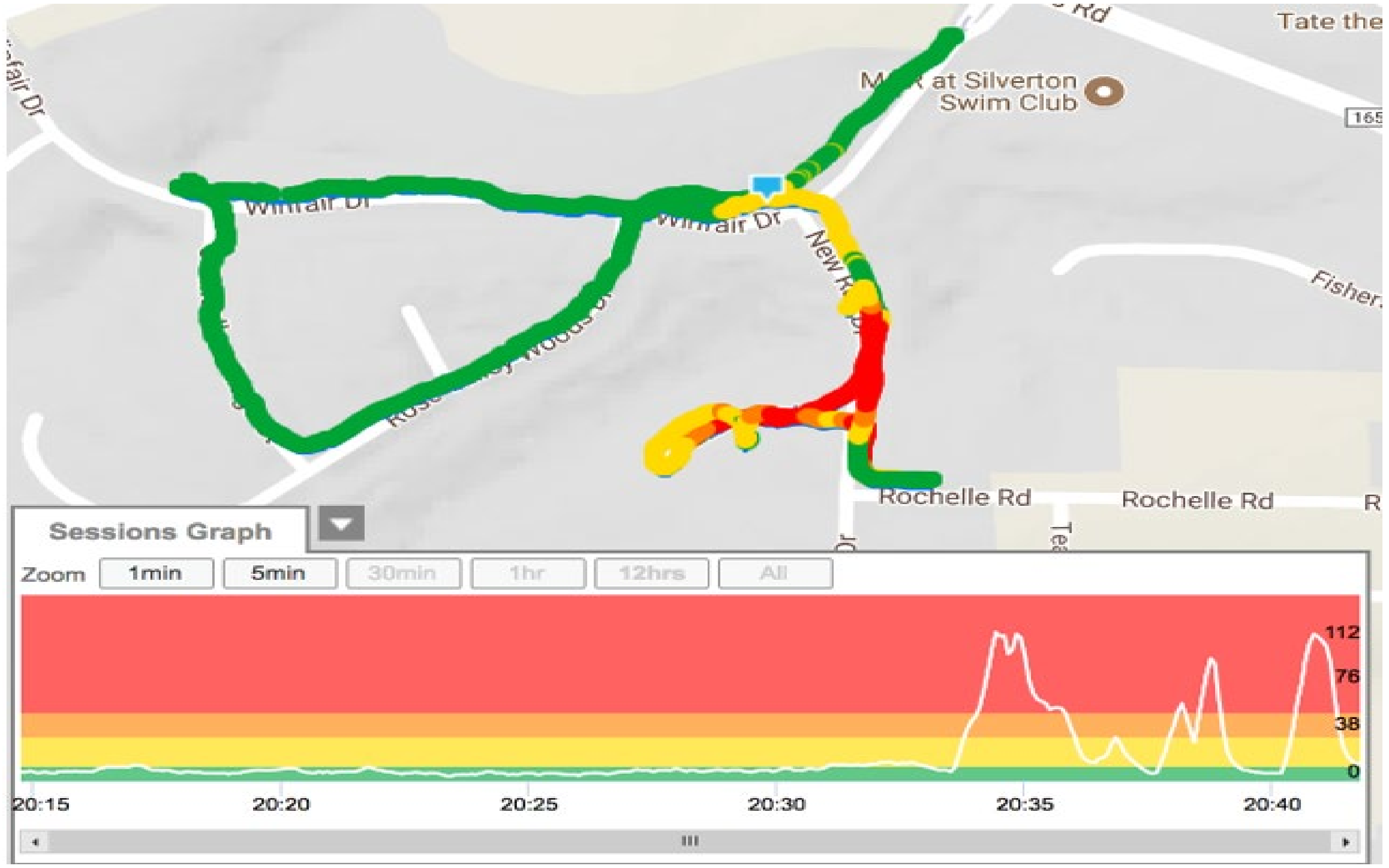
Need for sensors

Data gaps identified by community

- Sees/smells dust, odors, smoke, visible emissions, traffic, fires
- No nearby monitors
- Available data does not reflect an individual's (perceived) risk
- Existing monitors do not track pollutant from specific sources

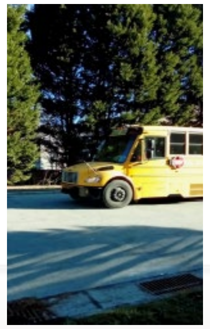
Obtain "hyperlocal" information

- Protect public health
- Get timely and relevant information
- Build awareness & engage public, decision makers
- Build STEM skill
- Do community science - Scientific investigations by amateur or non-professional scientists



Sensor on backpack

School bus

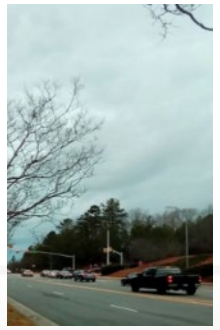


School yard

Yard waste

Backyard fire pit

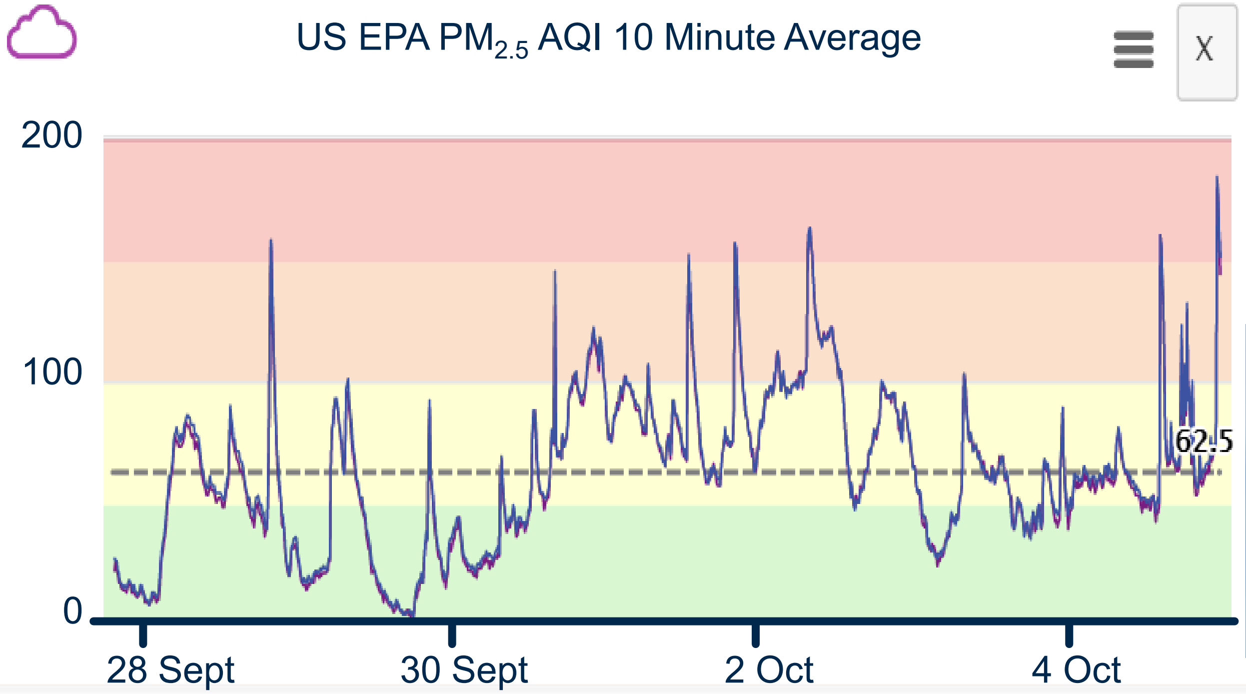
Traffic

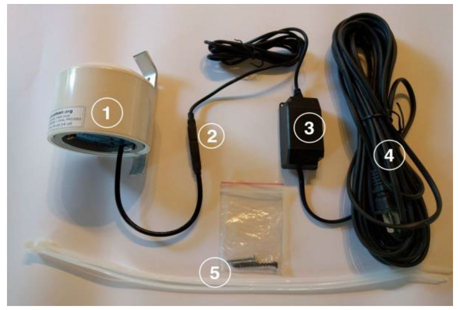


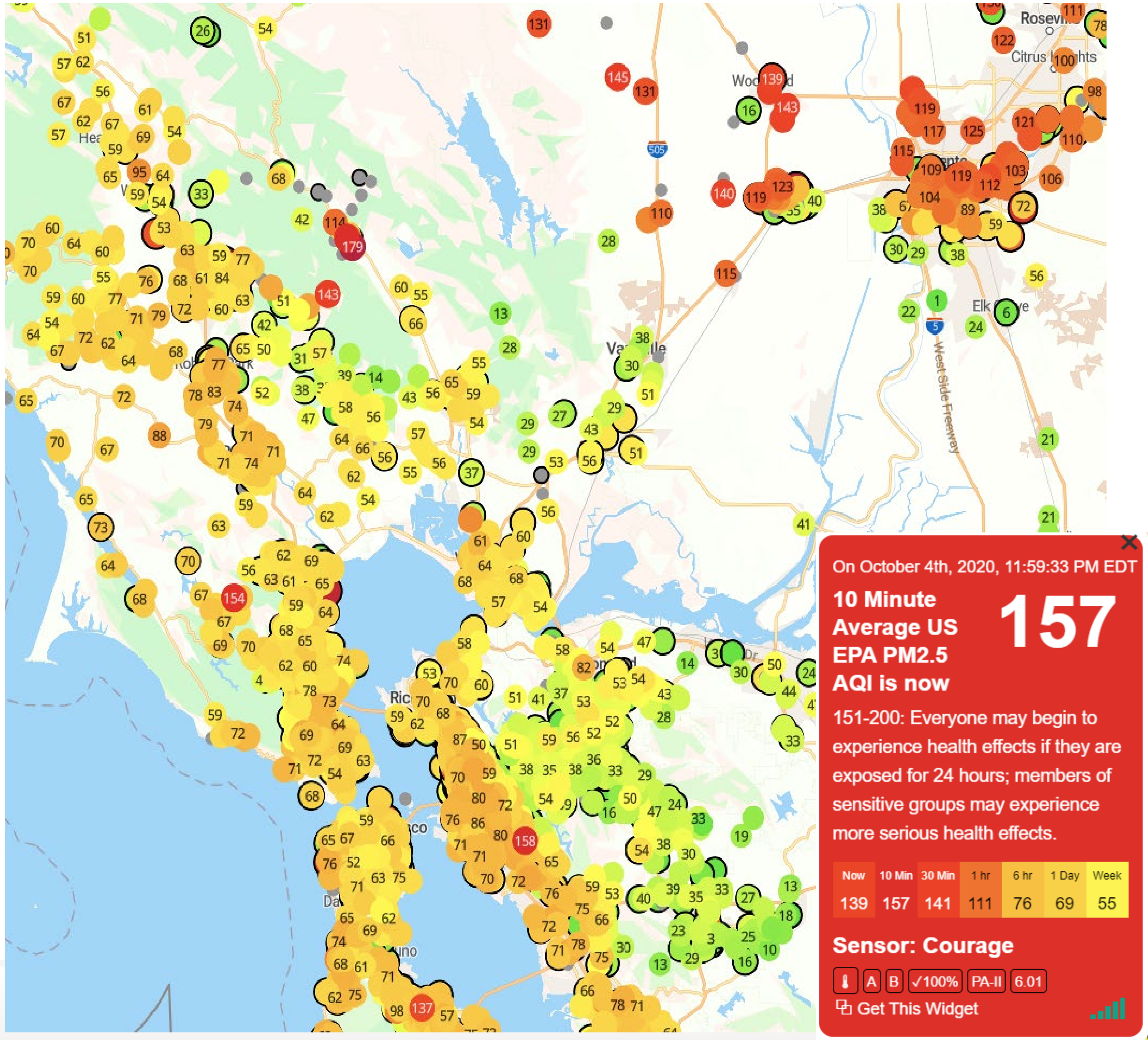
Using Flow2 (PM, NO_2, VOCs, O_3) with "Real Time Geospatial Data Viewer" (RETIGO)

Example of outdoor sensor – Purple Air

- Built in WiFi for logging to the cloud
- Real time map display and historical data
- Dual laser counters for PM_1, $PM_{2.5}$, PM_{10}
- Temperature, humidity, pressure sensor
- Fugitive dust – particle releases by wind entrainment and resuspension



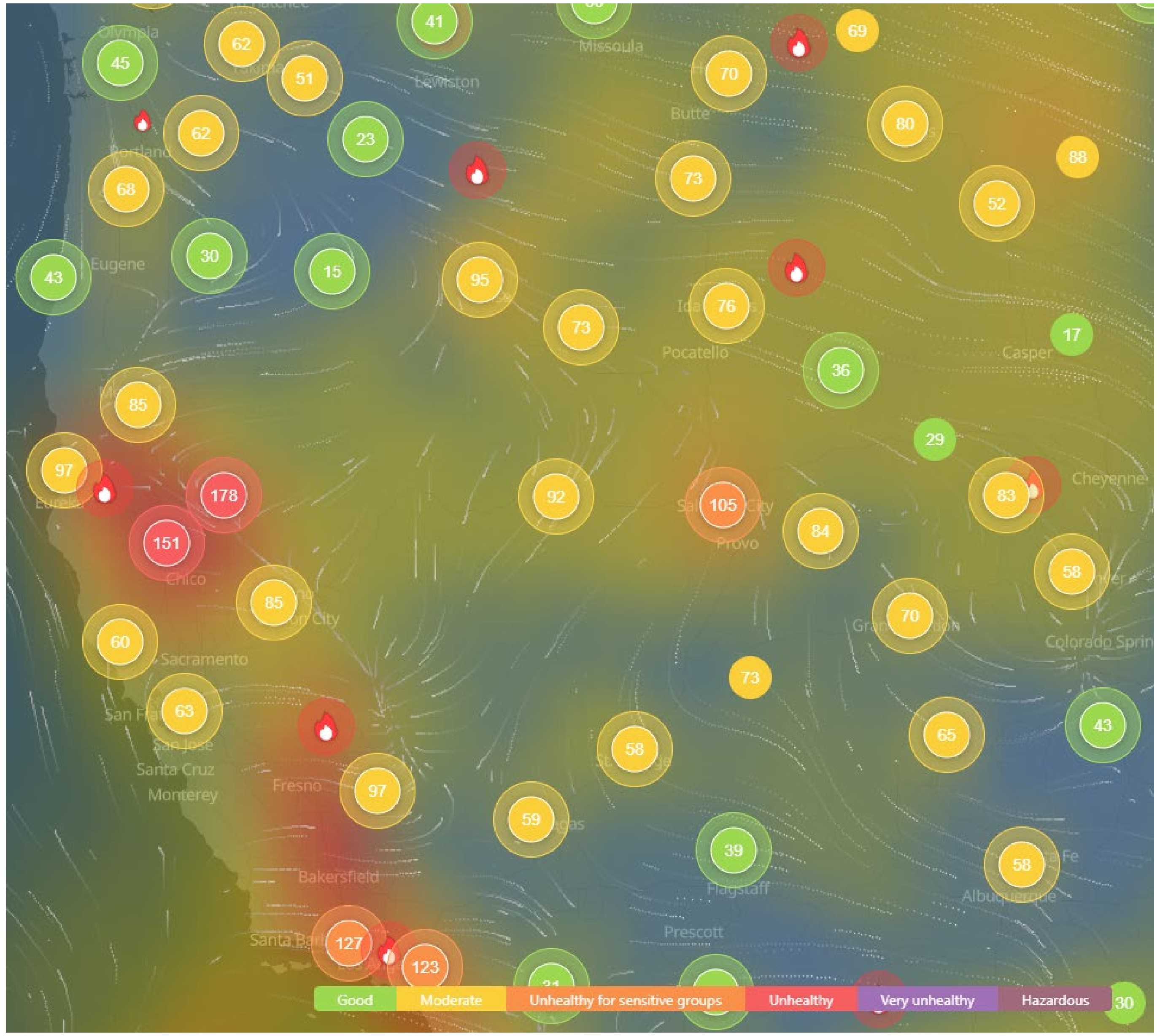




https://map.purpleair.com

Example of indoor sensor - IQAir

- Built in WiFi for logging to the cloud
- Real time map display and historical data
- Laser counter for PM
- Temperature, humidity, pressure sensor
- CO_2
- Forecasts
- Health recommendations



Pollutants	Concentration
PM2.5	82.8 µg/m^3

HEALTH RECOMMENDATIONS

How to protect from air pollution in Weaverville?

Wear a mask outdoors
GET A MASK

Run an air purifier
GET AN AIR PURIFIER

Close your windows to avoid dirty outdoor air

Avoid outdoor exercise

Source: IQAir.com

Pros and cons of sensors

Next-gen samplers with tremendous potential

- Sensors provide complementary approach to fixed site regulatory monitors
- Community is excited, educated and empowered
- Becoming integrated into environmental health, health care, community science

Data quality

- Quality assurance/quality control (detection limits, accuracy, interferences, drift, failures)
- Reasonably reliable measurements for PM & CO_2, but other pollutants may be questionable

Siting representativeness

- Site may not be spatially representative
- Unknown and unspecific monitoring objectives

Application interpretation issues

- Incorrect pollutants and averaging times – typically display instantaneous levels not averages
- Can be hard to compare with traditional networks – site specific calibration needed
- False positives and false negatives

Differences between sensors and regulatory monitors

	Reference Monitors	Low-Cost Sensors
Typical Purchase Cost	$15,000 to $40,000 (USD)	$200 to $5,000 (USD)
Staff Training	Highly trained technical staff.	Little or no training to operate. May need more training to interpret data.
Operating Expense	Expensive – shelter, technical staff, maintenance, repair, quality assurance.	May be less expensive – replacement, data streaming, data management.
Siting Location	Fixed Location. (Climate controlled building / trailer needed)	More portable. May require weather shielding. Siting can be easier due to lower flow rates but more tricky because of data streaming.
Data Quality	Known and consistent quality in a variety of conditions.	Unknown. Can vary from sensor to sensor, in different weather conditions, and in different pollution environments.
Operating Lifetime	10+ Years (calibrated and operated to maintain accuracy).	Short (1 year) or Unknown (may become less sensitive over time).
Regulatory Monitoring?	Yes	No

Source: A. Clements et al. EPA Tools and Resources Webinar FRMs/FEMs and Sensors: Complementary Approaches for Determining Ambient Air Quality. P. 13. 2019. EPA.gov

Questions and key points

How might you use air quality sensors?

Hyperlocal monitoring of $PM_{2.5}$ and possibly other pollutants at:

- critical environments: schools, homes, hospitals, elsewhere

- near emission sources: roads and industry

Track plumes from fires and other emission sources

Compare indoor, personal and outdoor exposure

Many more

Questions?