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California Air Resources Board
Study of Neighborhood Air near Petroleum Sources

February 2024 Update

What is the SNAPS program?

The communities near the Inglewood Oil Field (IOF) have been selected to host air monitoring as part of the *Study of Neighborhood Air near Petroleum Sources (SNAPS) program*, conducted by the California Air Resources Board (CARB) and Office of Environmental Health Hazard Assessment (OEHHA). The purpose of SNAPS is to characterize air quality in communities near oil and gas production facilities in California. SNAPS quantifies a wide range of criteria pollutants, volatile organic compounds (VOCs), metals, and toxic air contaminants from air pollution sources (e.g., oil and gas-related, vehicles, and others) potentially impacting air quality in communities.

Where is SNAPS air monitoring equipment located?

Air quality is being measured at two stationary trailers, one located west of the IOF (Marycrest Manor (MCM) from June-August 2023, presently at West Los Angeles College), with the second on the eastern edge of the IOF near Kenneth Hahn Recreational Park (SPR). Stationary monitoring began in June 2023; staff hosted two community meetings, one virtually and one in-person, to kick off the beginning of more than one year of air monitoring in these communities. Measurements are also periodically made in neighborhoods around the IOF using a Toyota Highlander Hybrid vehicle equipped with air monitoring equipment (Figure 1, right). Measurements at both sites and the mobile monitoring vehicle (Figure 1) provide an opportunity to characterize air quality in a novel and ground-breaking effort.

More information on air monitoring methods, stationary monitoring equipment and data collection, as well as prospective mobile monitoring areas in IOF communities can be found in the *Draft Air Monitoring Plan*.

Figure 1. SNAPS stationary monitoring trailer at Marycrest Manor (left) and mobile monitoring vehicle as it was located near the IOF (right).

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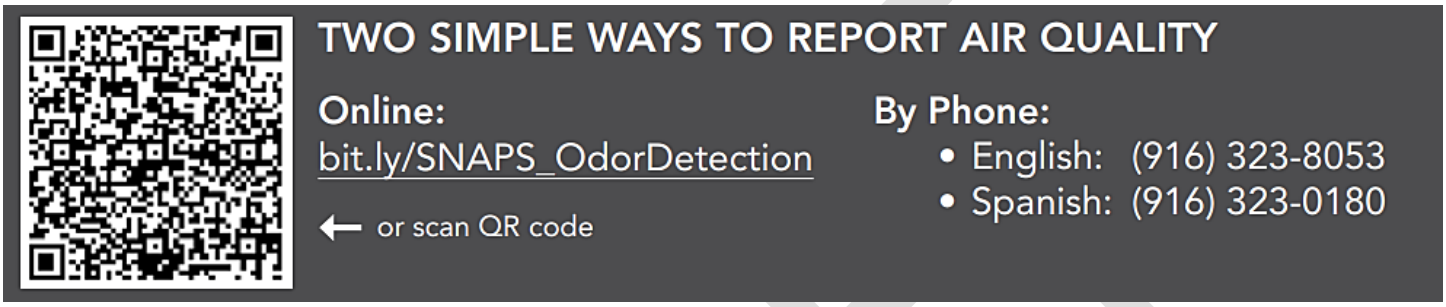
Air Quality and Odor Reports

In June 2023, SNAPS staff launched a tool for those living and/or working near the IOF to submit air quality and odor reports. These reports will be used by CARB staff to inform mobile monitoring timing/locations and aid in SNAPS data analysis; however, CARB does not intend to use these reports for enforcement purposes. For emergencies, call 911. For potential enforcement action, please contact the South Coast Air Management District at 800-288-7664 (1-800-CUT-SMOG).

Through December 31, 2023, CARB has received zero air quality/odor reports. SNAPS staff enourage residents to report air quality/odor concerns as they are experienced.



Online Data Display

A small subset of measured pollutants is *displayed in real-time on our website*. We show hourly data for ozone (O_3), $PM_{2.5}$, hydrogen sulfide (H_2S), carbon monoxide (CO), methane (CH_4), and black carbon (BC). The display includes:

- a site map showing $PM_{2.5}$ and O_3 concentrations measured at the SNAPS sites compared to concentrations measured at other regional air monitoring sites,[1]
- where applicable, comparisons to corresponding National and California Ambient Air Quality Standards, i.e., health-based thresholds, over the past 10 days,
- hourly pollutant concentrations for the six pollutants listed above over the past 10 days

SNAPS staff want this display to be accessible and informed by community members. We have been actively working with residents since the June kickoff meetings to improve the data display and welcome recommendations for improving the display via the contact information located at the end of this update.

Overview of Pollutants Analyzed in this Update

$PM_{2.5}$: Airborne particulate matter (PM) is a complex mixture of many chemical species and may contain inorganic ions, metallic compounds, elemental carbon, organic compounds, and compounds from the earth's crust.[2] Particles vary widely in size, shape, and chemical composition.

Fine particulate matter is defined as particles with a diameter of 2.5 microns or less ($PM_{2.5}$), which is

[1] CARB. Air Quality and Meteorological Information System. https://www.arb.ca.gov/aqmis2/aqmis2.php?_ga=2.80675856.662451024.1699895925-1520501560.1603206950.
[2] CARB. Common Air Pollutants. https://ww2.arb.ca.gov/resources/common-air-pollutants/

about 20 times smaller than the diameter of a human hair. $PM_{2.5}$ can reach deep into the lungs, and the smallest particles can even enter the bloodstream. $PM_{2.5}$ can damage tissue in the respiratory tract and blood vessels throughout the body. $PM_{2.5}$ is emitted directly from various sources, including vehicle exhaust, smoke from fires, agriculture, and industry. $PM_{2.5}$ is also formed in the atmosphere through photochemical reactions from gases, such as sulfur dioxide (SO_2) and nitrogen oxides (NO_x), and certain organic compounds. These organic compounds can be emitted by both natural sources, such as trees and vegetation, as well as from man-made sources, such as industrial processes and motor vehicle exhaust.

O_3: Ozone, a component of smog, is a highly reactive and unstable gas capable of damaging living cells, such as those in the lung.[2] Ground level ozone is formed in the atmosphere through chemical reactions between sunlight and pollutants emitted from vehicles, factories and other industrial sources, fossil fuel combustion, consumer products, evaporation of paints, and many other sources.

CH_4: Methane is an important greenhouse gas, responsible for about 20 percent of current global warming associated with climate change. According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), methane has 28 times greater warming impact than carbon dioxide over a 100-year timespan, and 84 times greater warming impact than carbon dioxide over a 20-year timespan.[3] Potential sources of methane include oil and gas production and natural gas transmission and distribution, but also agriculture (dairy, livestock, and rice-growing methods) and landfills.[4] Methane is relevant to SNAPS because other pollutants are often co-emitted with methane, including those originating from oil fields and other oil and gas sources. However, methane does not have direct health effects at levels typically seen outdoors (≈2 ppm).

H_2S: Hydrogen sulfide is a colorless gas with the odor of rotten eggs.[2] The most common sources of H_2S emissions are oil and natural gas extraction and processing, and natural emissions from geothermal fields. It is also formed during bacterial decomposition of human and animal wastes and is present in emissions from sewage treatment facilities and landfills. Hydrogen sulfide can have a strong and foul odor at concentrations observed in the air.

BC: Black Carbon is a component of PM resulting from the incomplete combustion of fossil fuels. BC concentrations can be used to estimate diesel particulate matter (diesel PM), which is a known carcinogen. BC is known to contribute to climate change, with potential sources including motor vehicles (on-road and off-road), fireplaces and woodstoves, wildfires, and industrial fuel combustion.[4]

CO: Carbon monoxide is a colorless, odorless gas that results from the incomplete combustion of carbon-containing fuels such as natural gas, gasoline, or wood, and is emitted by a wide variety of combustion sources, including motor vehicles, power plants, wildfires, and incinerators.[2]

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[3] CARB. California Methane Research Program. https://ww2.arb.ca.gov/our-work/programs/methane-research/

[4] CARB. GHG Short-Lived Climate Pollutant Inventory. https://ww2.arb.ca.gov/ghg-slcp-inventory/

Statewide, the majority of outdoor CO emissions come from vehicles.[5] While levels of CO generally found in the atmosphere have been largely under control for decades, CARB is interested in CO because there is substantial evidence that it can adversely affect human health and participate in atmospheric chemical reactions that result in formation of ozone air pollution, which can contribute to climate change.[2] CO can indicate and be a good tracer of mobile sources (vehicles).

VOCs (including benzene, toluene, 1,3-Butadiene, and carbon tetrachloride): Volatile organic compounds (VOCs) include a wide range of compounds emitted as gases from a variety of sources including consumer products, natural sources (e.g., trees), vehicles, and oil and gas infrastructure.[6] VOCs are known to increase the formation of smog. BTEX (benzene, toluene, ethylbenzene, and xylenes) are a group of VOCs that are often present in petroleum products and can have negative health effects. Benzene, a carcinogen, and toluene are components of BTEX, and can be found in ambient air from a wide range of potential sources, including oil and gas production, motor vehicles, gas stations, and wildfires. 1,3-butadiene, a carcinogen, has also been associated with emissions from oil and gas production and processing.[7] 1,3-butadiene is an industrial chemical, used in the production of commercial plastics and synthetic rubbers, and large amounts are released to the atmosphere from commercial processes.[8] It is also found in vehicle exhaust, cigarette smoke, and wood smoke.[8] Carbon tetrachloride, also a carcinogen, is a volatile, synthetic chlorinated compound and solvent that was produced in large quantities to make refrigerants and propellants for aerosol cans.[9] However, because carbon tetrachloride was found to deplete the ozone layer, its production and most uses have been phased out.[9] Although emissions have declined substantially, carbon tetrachloride degrades very slowly in the atmosphere.[9,8]

Preliminary Stationary Monitoring Results – June 2023 through August 2023

Below are results from approximately the first three months of air monitoring near the IOF.

Note: all hourly H_2S measurements for this time period were below the method detection limit (MDL) of the associated instrument (~2.1 ppb). As such, these statistics for H_2S do not hold statistical significance and are not shown here.

[5] CARB. 2016 SIP Emission Projection Data, 2012 Estimated Annual Average Emissions, Statewide. https://www.arb.ca.gov/app/emsinv/2017/emseic1_query.php?F_DIV=-4&F_YR=2012&F_SEASON=A&SP=SIP105ADJ&F_AREA=CA

[6] CARB. Consumer Products Program. https://ww2.arb.ca.gov/our-work/programs/consumer-products-program/.

[7] Garcia-Gonzales DA, Shonkoff SBC, Hays J, Jerrett M. 2019. Hazardous Air Pollutants Associated with Upstream Oil and Natural Gas Development: A Critical Synthesis of Current Peer-Reviewed Literature. Annu Rev Public Health 40:283-304.

[8] ATSDR. 2012. Toxicological Profile for 1,3-Butadiene. https://www.atsdr.cdc.gov/ToxProfiles/tp28.pdf.

[9] ATSDR. 2005. Toxicological Profile for Carbon Tetrachloride. https://www.atsdr.cdc.gov/toxprofiles/tp30.pdf.

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Stationary Monitoring Statistics (mean, median, maximum concentrations)

Table 1. Mean (average), median, and maximum hourly concentrations of several measured pollutants from June-August 2023.[10]

	MCM (west of IOF)	MCM (west of IOF)	MCM (west of IOF)	SPR (eastern edge of IOF)	SPR (eastern edge of IOF)	SPR (eastern edge of IOF)
	Mean	**Median**	**Maximum**	**Mean**	**Median**	**Maximum**
$PM_{2.5}$ (ug/m^3)[11,12]	7.5	7.0	30	7.2	6.0	34
O_3 (ppb)[13]	28	28	63	28	29	67
CH_4 (ppm)[14]	2.0	2.0	2.9	2.0	2.0	4.1
H_2S (ppb)	Data Below MDL	Data Below MDL	Data Below MDL	Data Below MDL	Data Below MDL	Data Below MDL
CO (ppm)	0.13	0.12	0.45	0.15	0.13	0.49
BC (ug/m^3)	0.27	0.21	2.7	0.29	0.22	2.3
1,3-Butadiene (ppb)	Analysis in Progress	Analysis in Progress	Analysis in Progress	0.07	0.07	0.30
Benzene (ppb)	Analysis in Progress	Analysis in Progress	Analysis in Progress	0.07	0.06	0.40
Carbon Tetrachloride (ppb)	Analysis in Progress	Analysis in Progress	Analysis in Progress	0.05	0.06	0.14
Toluene (ppb)	Analysis in Progress	Analysis in Progress	Analysis in Progress	0.12	0.09	1.1

[10] Statistics for all pollutants in Table 1 were calculated using hourly averages of measured concentrations. Data for O_3, $PM_{2.5}$, H_2S, CO, CH_4, and BC range from June 1-August 20, 2023; data for 1,3-Butadiene, benzene, carbon tetrachloride, and toluene range from June 22-August 20, 2023.

[11] ug/m^3: micrograms of pollutant per cubic meter of ambient air.

[12] $PM_{2.5}$ concentrations at the MCM site had ~37% missing timepoints. As such, for $PM_{2.5}$ only, the matched hours of data between the two sites were included (i.e., timepoints when data were missing at either site were not included in this statistical analysis).

[13] ppb: parts per billion; analogy of 1 ppb to one star in the Milky Way Galaxy.

[14] ppm: parts per million; analogy of 1 ppm to one drop of liquid in an Olympic-sized swimming pool.

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Mean (average), median, and maximum concentrations of O_3, $PM_{2.5}$, CO, CH_4, and BC measured at both MCM and SPR monitoring sites are shown in Table 1, with mean, median, and maximum concentrations of several volatile organic compounds also displayed for the SPR site. In general, average and median concentrations of O_3, $PM_{2.5}$, CO, CH_4, and BC were similar at both sites, with maximum concentrations of four of these five pollutants (O_3, $PM_{2.5}$, CO, CH_4) higher at the SPR site than at the MCM site.

While, in general, average concentrations for these pollutants were similar at the two sites, there were small but noticeable differences in average methane (CH_4) concentrations (Figure 2).

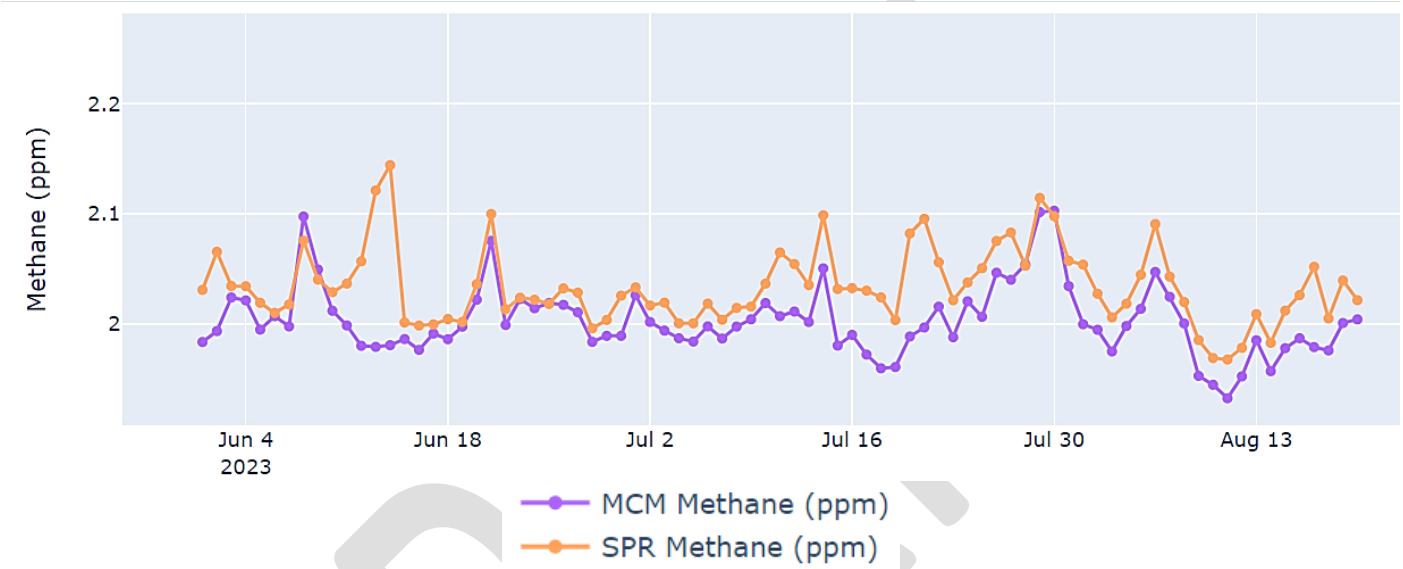

Figure 2. Time series showing daily mean (average) methane concentrations at Marycrest Manor (MCM) and Sentinel Peak Resources (SPR) SNAPS monitoring sites from June-August 2023.

Daily average methane concentrations were slightly higher at the SPR site on the eastern edge of the IOF on a near daily basis compared to the MCM site west of the IOF. These trends alone cannot confirm attribution of methane to any one source alone. However, source apportionment analysis will be completed at a later date. *Note: methane does not have direct health effects at levels typically seen outdoors (about 2 ppm).*

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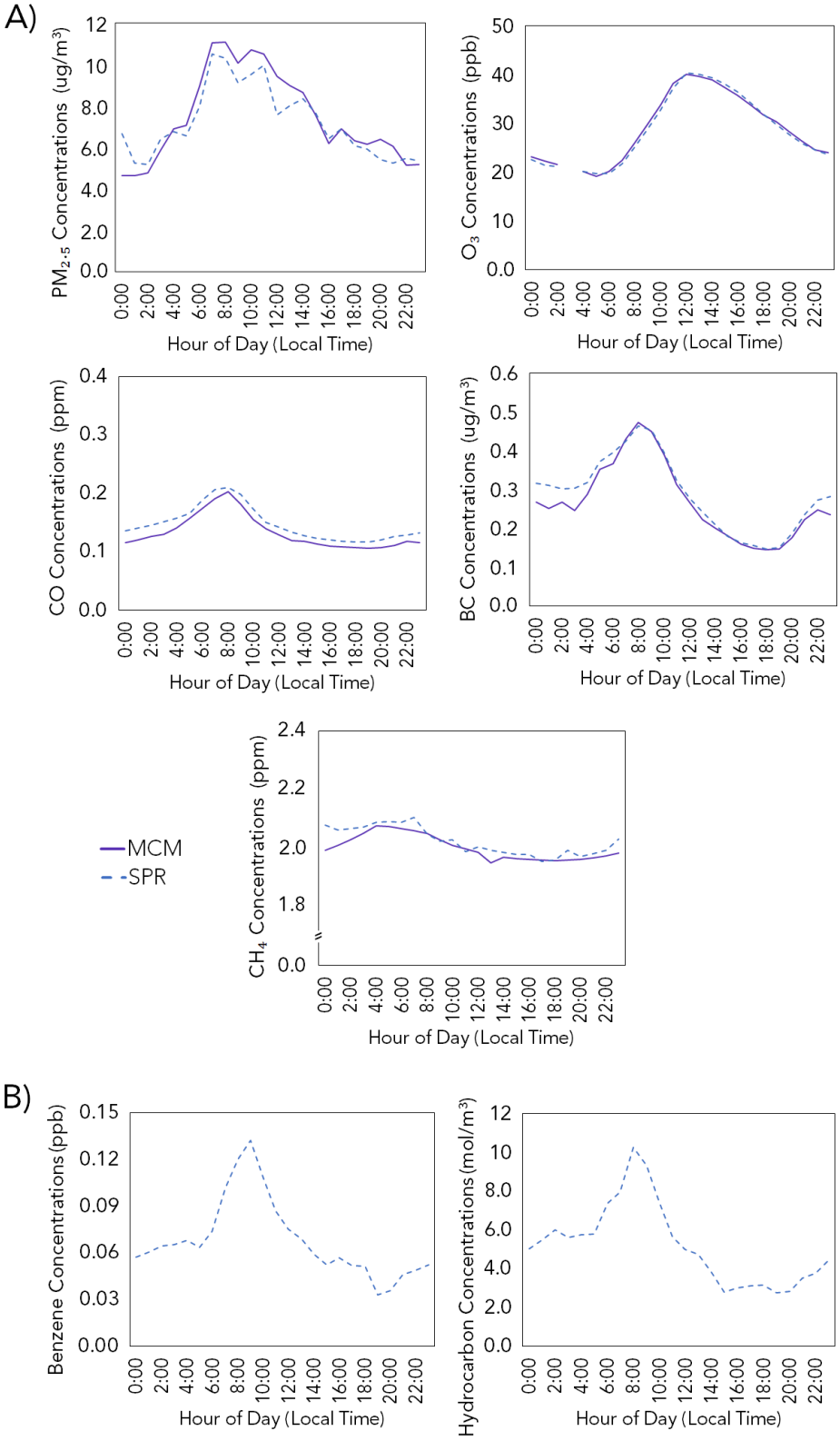

Figure 3. Average pollutant concentrations based on time of day at A) each monitoring site and B) at the SPR site only from June-August 2023.

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Figure 3 illustrates how average concentrations of measured pollutants varied based on time of day. Preliminary findings from the first three months of SNAPS monitoring near the IOF indicate:

- Concentrations of BC, CO, CH_4, benzene, and hydrocarbons were most elevated in the early-mid morning hours. These trends were the most pronounced for BC, CO, benzene, and hydrocarbons,
- O_3 concentrations were elevated during the afternoon and evening hours, likely an indication of typical photochemical processes (i.e., reactions brought upon by sunlight),
- $PM_{2.5}$ concentrations were elevated from the early morning through early afternoon,
- Hour-by-hour trends for all pollutants in Figure 3A were similar at both the MCM and SPR monitoring sites.

Note: Results for additional pollutants, e.g., other VOCs and toxic air contaminants, as well as comparisons to concentrations observed at regional monitors, may be included in subsequent updates.

Comparison of Stationary Monitoring Data to Health Standards

Preliminary real-time data through August 2023 reveal that, where applicable, all detected compounds were below the Environmental Protection Agency's National Ambient Air Quality Standards (NAAQS) or OEHHA's acute health reference values (RELs). CH_4 and BC do not have associated NAAQS or RELs and are excluded from this health analysis.

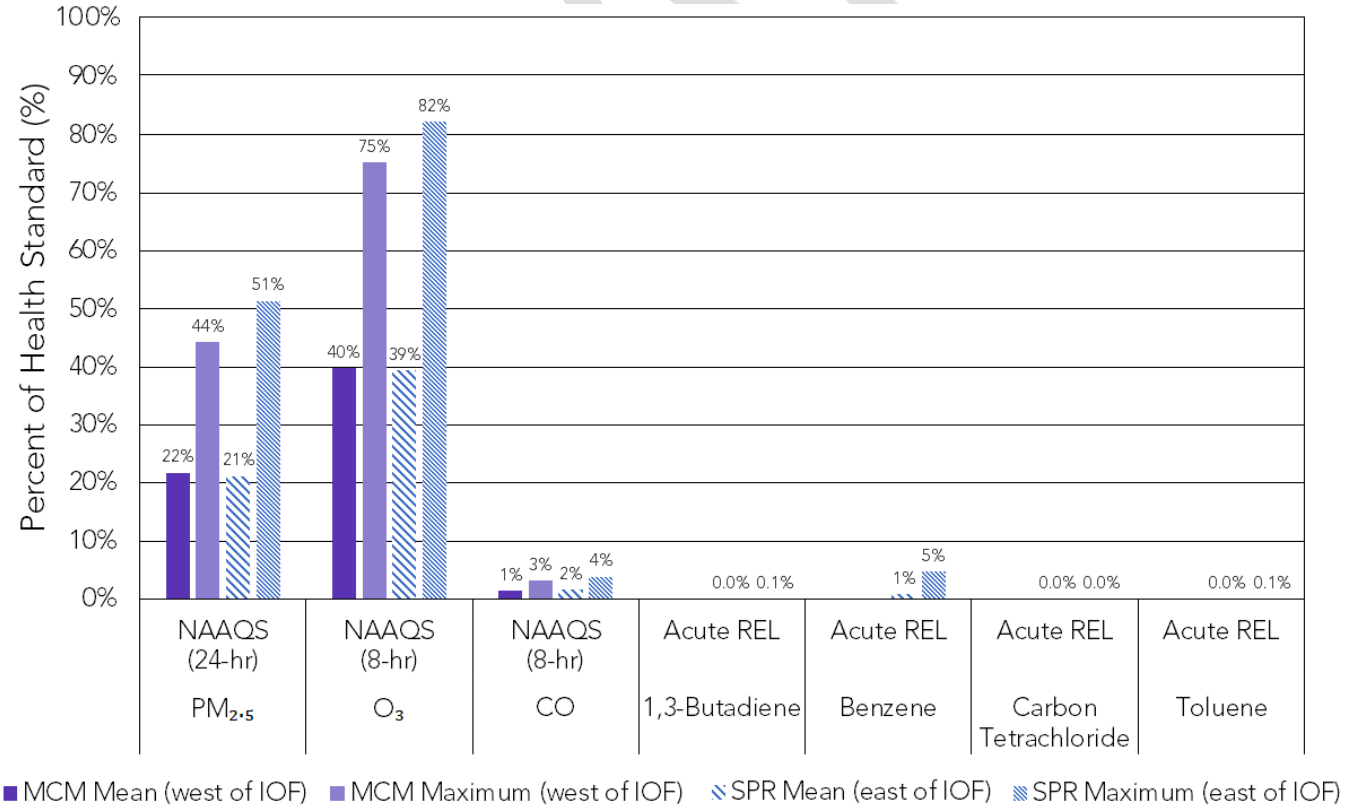

Figure 4. Average and maximum concentrations of eight pollutants measured during June-August 2023 under the SNAPS program, as percent (%) of the relevant ambient air quality standard or

health reference value: NAAQS ($PM_{2.5}$, O_3, CO) or OEHHA's RELs (1,3-butadiene, benzene, carbon tetrachloride, toluene).[12,15]

Both mean (average) and maximum concentrations of all pollutants detailed in Figure 4 were below their respective health standards. This indicated that, based on preliminary data, the ambient air in the community was at levels that met state and federal standards from June-August 2023.

OEHHA will evaluate potential chronic (long-term) health concerns, cancer and noncancer, as additional data are collected.

Mobile Monitoring Results – June and September 2023

CARB staff conducted mobile monitoring for BTEX, H_2S, BC, Nitrogen Oxides (NO_x), O_3, CH_4, and ethane in neighborhoods surrounding the IOF in June and September 2023. Mobile monitoring in both June and September consisted of three consecutive days of monitoring, with roughly 5-6 hours of measurements per day. Monitoring took place during day and night and on various days of the week. The mobile platform traversed streets on all sides of the IOF multiple times per day.

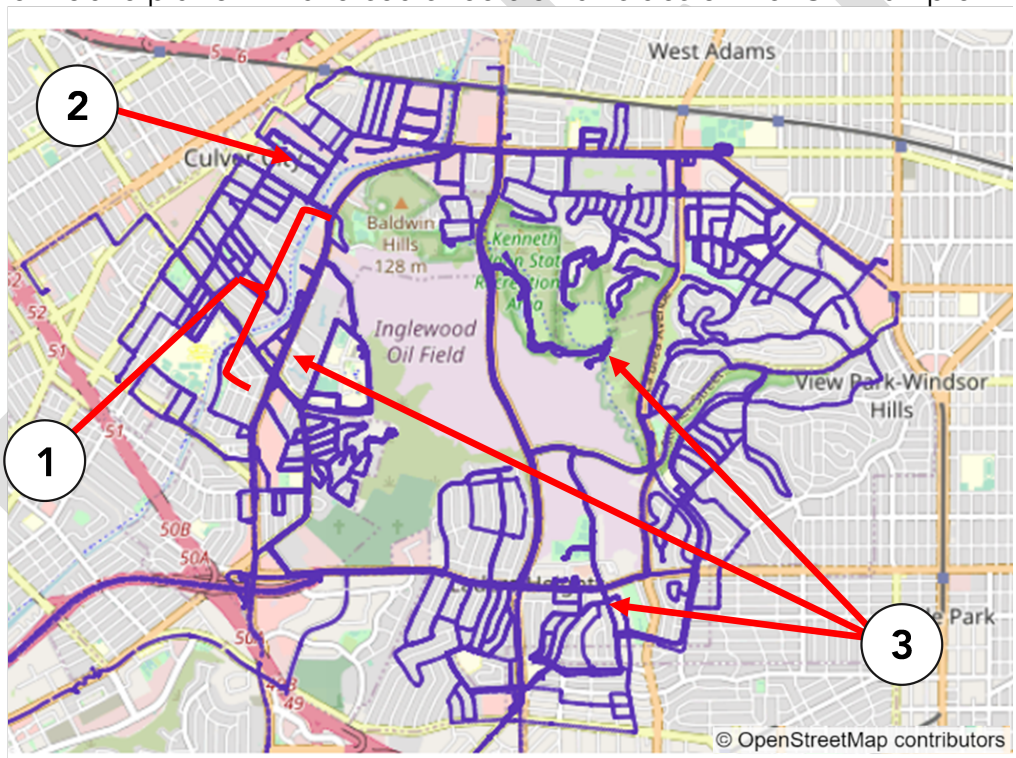

Figure 5. Locations of mobile monitoring measurements, around the Inglewood Oil Field. Numbers in circles correspond to the bullets below.

[15] For comparison with NAAQS standards, $PM_{2.5}$ concentrations were converted to 24-hour daily averages and both O_3 and CO concentrations were converted to 8-hour rolling averages. 1-hr averages were used for all other pollutants. Data for $PM_{2.5}$, O_3, and CO range from June 1-August 20, 2023; data for 1,3-butadiene, benzene, carbon tetrachloride, and toluene range from June 22-August 20, 2023.

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1. Elevated CH_4 along Jefferson and Obama Blvds.
    - CH_4 was found to be biogenic (e.g., from natural sources) by comparing ambient CH_4:Ethane ratios.
        - Biogenic sources contain less ethane than oil and gas-related sources, making the likely source of these measurements biogenic.
    - Odors in the area suggest the biogenic source is likely decaying organic matter in Ballona Creek.
2. Elevated CH_4 near the intersection of Ince Blvd and Lucerne Ave in Culver City.
    - Source identified to be natural gas pipeline access point.
    - CARB reported this leak to SoCal Gas for repair, and staff will follow-up on this location in future monitoring.
3. Several instances of elevated traffic-related pollutants.
    - Elevated BC and NO_x were measured at intersections while the platform was near vehicle activity (e.g., lawn mowers, heavy-duty trucks).
    - Elevated CH_4 was observed when the platform was traveling behind Compressed Natural Gas (CNG) vehicles.

New Phase of SNAPS Monitoring: Community Sensors

As recommended by members of the community, SNAPS will provide a limited number of air quality sensors for deployment in neighborhoods near the IOF. There are three types of sensors: total volatile organic compounds (tVOCs), black carbon, and meteorology. We will be working with nine residents in nearby communities to install these sensors, hosting a training for those who volunteered in early 2024.

Sensor data may be useful in determining mobile monitoring locations, particularly if sensor concentrations are consistently elevated in certain areas. Sensor data might also help determine where potential emission plumes are originating and can be compared to measurements at the two SNAPS stationary monitoring sites near the IOF. Data will be streamed on our website once deployed. Exact locations of sensors will not be shared publicly.

We are excited to launch this new phase of the SNAPS program and look forward to streaming these data soon.

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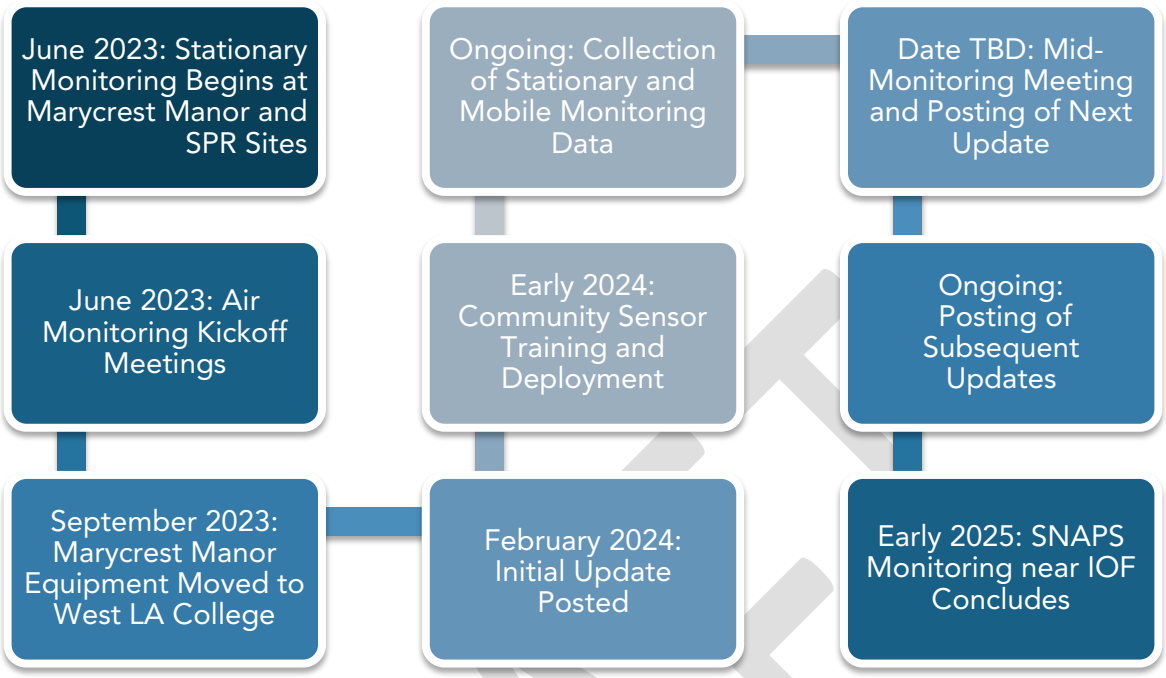
Timeline and Next Steps



Contact & Additional Information

Program Website: *https://ww2.arb.ca.gov/our-work/programs/study-neighborhood-air-near-petroleum-sources*

Data Display: *https://ww2.arb.ca.gov/applications/snaps-data-display*

If you have any questions about the SNAPS program, please feel free to contact:

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