## Action: Mobile monitoring around oil wells to detect potential leaks

### Background and Objectives

There is a large number of oil and gas wells in the Wilmington, Carson, West Long Beach (WCWLB) community, for which there is concern that they have the potential to develop leaks (fugitive emissions) and impact air quality. In the South Coast Air Basin (and in the WCWLB community in particular) these wells are often located in close proximity to residential neighborhoods and near sensitive receptors. The WCWLB community steering committee (CSC) has identified odors and leaks from operating and abandoned oil wells as an air quality priority. The CSC requested increased air monitoring efforts pertaining to these wells and facilities, particularly when drilling activities are occurring. The CSC also requested that this information be made available to the public to establish a baseline for tracking emission reductions. Using air measurements to identify potential leaks, conducting follow-up investigations, and collaborating with other agencies will help reduce emissions from these facilities.

In addition, South Coast AQMD staff conducts regular inspections, responds to community complaints for oil drilling and production facilities and as part of the AB 617 program, will also respond to complaints and update complaints on an expedited basis. South Coast AQMD staff will also provide the CSC with periodic summaries of findings, such as whether odors and/or leaks were confirmed and traced back to a specific site/source, and any enforcement actions taken. It should be noted that specific or detailed information from ongoing enforcement investigations cannot be shared until Notices of Violation, if any, are settled or closed.

### Method

The CSC requested to use data from South Coast AQMD and CalGEM (formerly DOGGR) to identify active, inactive, and abandoned oil wells in the WCWLB community. Based on this information, South Coast AQMD has been working with the CSC to identify priority locations for air measurements and is aiming to conduct air measurements at these locations during well workover events. Air measurements involve mobile monitoring around active, idle, and abandoned oil drilling sites to identify pollution hotspots and potential leaks. If persistent elevated levels are detected at locations during air measurement activities, South Coast AQMD will conduct follow up inspections at those locations using appropriate field measurement equipment.

In 2015, South Coast AQMD staff conducted a five-week study (Attachment A) to evaluate multiple Optical Remote Sensing (ORS) techniques for characterization and quantification of emissions from small stationary sources, including oil wells. South Coast AQMD acquired a mobile platform equipped with ORS monitors capable of measuring a wide range of gaseous pollutants including several air toxics (e.g. non-methane volatile organic compounds (VOCs), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), ammonia ($NH_3$), benzene, toluene, ethylbenzene,

and xylenes) and has been and will continue to conduct periodic mobile measurements in WCWLB. Priority areas for mobile measurements are selected based on the input from the CSC and considering the status of the oil wells (e.g. active, idle, abandoned), proximity to sensitive receptors, repeat violations, or complaints received. South Coast AQMD has and will continue to develop fact sheets or infographics summarizing findings from air measurement data, complaint response, and inspections of oil drilling and production facilities.

South Coast AQMD will utilize air measurement data to support possible additional emissions reductions, identify areas where annual reporting would be beneficial for establishing a more accurate emissions inventory, or to evaluate additional methods and practices to further reduce leaks, and to determine whether additional pollutants should be added to the required list for emissions reporting.

In addition, South Coast AQMD is working with community members on a pilot project to use community operated hand-held low-cost VOC sensors for area surveys of the community. While the low-cost sensors for VOC measurements may not provide accurate VOC concentrations, they can be utilized to detect spikes and enhancements in concentrations. These observations can guide future mobile surveys, aid with identification of potential emission sources, and enhance the source identification activities.

**Results**

- CalGEM data was used to identify active, idle, and abandoned oil wells in the WCWLB community and the maps were presented to the CSC (Figure 1)
- South Coast AQMD staff provided information to and gathered input from the CSC on factors to be considered for prioritization of areas for targeted mobile measurements
- As of May 2020, mobile monitoring has been conducted in multiple days, on different days of week, and different times of day. When elevated levels of VOCs were detected, follow up investigations were conducted using appropriate field measurement equipment, such as Forward-Looking Infrared (FLIR) cameras
- As of February 2020, persistent instantaneous elevated concentrations of benzene were measured near three oil wells on multiple days during the mobile measurements; follow up inspections were performed, and leaks were confirmed; leaks were fixed by facilities and verified by staff (Attachment B)

**Next steps**

- Establish priority areas for additional mobile measurements based on the input provided by the CSC
- Continue mobile monitoring near oil wells in priority areas to detect leaks and in surrounding communities to assess potential impacts
- Conduct measurements to inform and support compliance and enforcement actions
- Continue to work with the CSC and community members on the pilot study for area surveys using low-cost VOC sensors

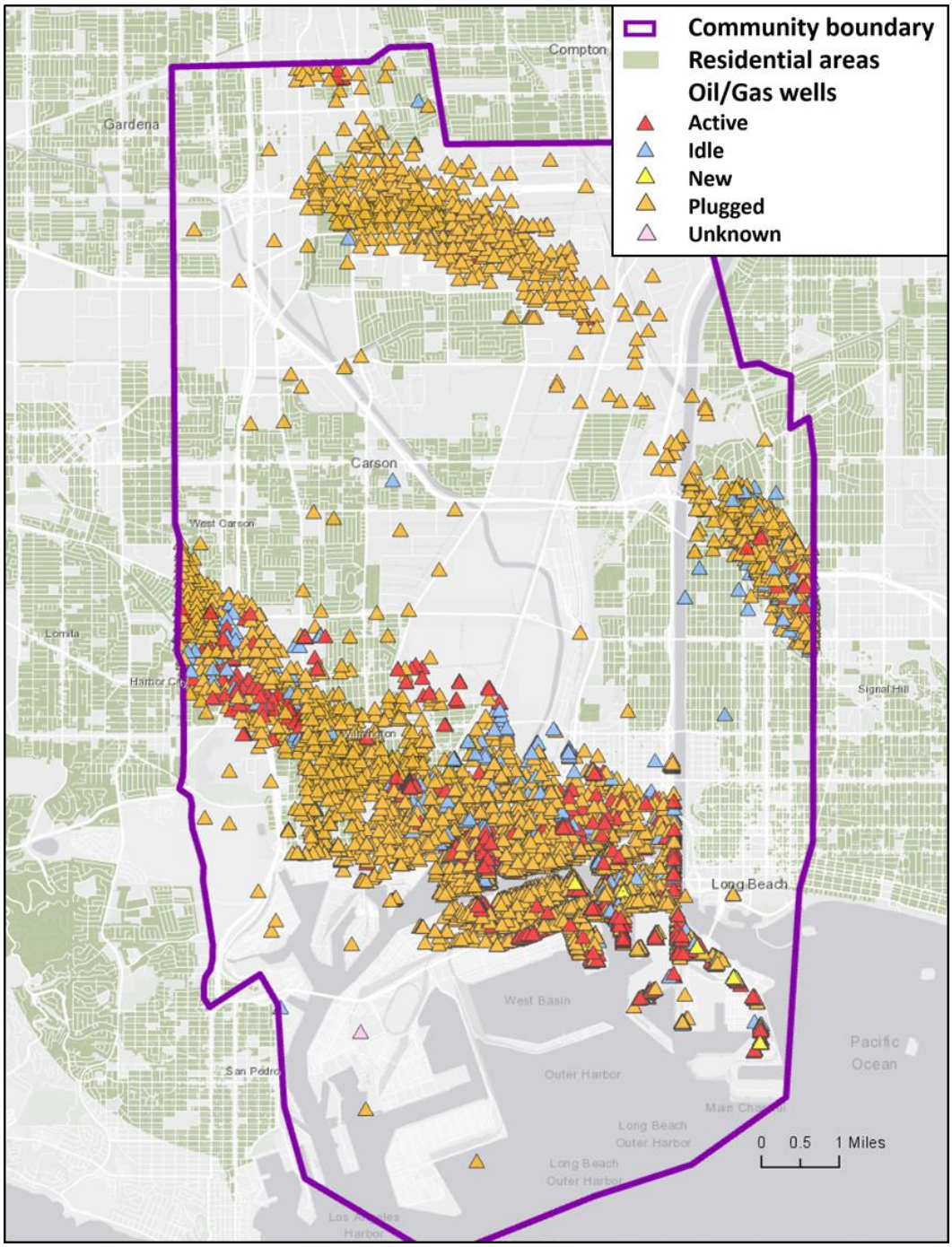


**Figure 1.** Locations of active, idle, new, plugged and abandoned oil wells in the WCWLB. Locations of sensitive receptors, including schools, daycares and hospitals are shown with orange dots.

| | |
|---|---|
| Active | Well has been drilled and completed |
| Idle | Well is idle, not producing for two years or more |
| New | Recently permitted well; in the process of being drilled |
| Plugged | Well has been abandoned to current standards |
| Unknown | Status not known; mostly older wells before 1976 |

# Attachment A

Previous studies indicate that oil and gas wells are substantial contributors to the local volatile organic compounds (VOC) burden in the Los Angeles Air Basin (Basin). In a 2015 study conducted in collaboration with Fluxsense Inc.[1], the South Coast AQMD monitored air quality around 61 different small stationary sources (including oil wells and areas within the WCWLB community), out of which 17 were oil/gas extraction sites with 106 wells. It was determined that small sources are likely to contribute substantially to total VOC emissions from stationary sources, and oil wells may contribute to VOC emissions more than previously thought. FluxSense Inc. scaled-up median emission rates of the wells they surveyed to the total number of wells in the Basin, and estimated that the emission contribution from all active and inactive wells is larger than that of other source categories (e.g. refineries, gas stations, and tank farms). While the 2015 FluxSense Inc. project notes uncertainties associated with scaling data to represent the Basin as a whole, it suggests that emissions of VOCs from oil and gas extraction sites may be considerably underestimated compared to emission inventories, and further studies are warranted. This project demonstrated the usefulness of conducting mobile survey measurements with Optical Remote Sensing (ORS) methods to quickly identify emission and concentration hotspots over a large area with multiple emission sources. It was shown that mobile measurements represent an effective leak detection and repair tool, which can help identify the presence of potential leaks from different parts of a facility. It also demonstrated that mobile measurements can provide the capability for ground concentration mapping of air toxic pollutants (e.g. benzene, toluene, ethylbenzene, and xylenes) and help to assess the impact of localized sources of emissions onto neighboring communities. South Coast AQMD acquired a mobile platform with the same ORS instruments and methods used in the FluxSense study. This platform will be used for addressing potential leaks and fugitive emissions from oil and gas wells in WCWLB as part of AB 617 program.

This was one of the three ORS projects that aimed at characterizing emissions from refineries, small stationary sources, marine vessels, and the ports. A presentation summarizing the main findings of the three 2015 ORS projects can be found here.

For more information on each project, click on the links below:

Project 1: Quantification of Fugitive Emissions from Large Refineries

Project 2: Quantification of Gaseous Emissions from Gas Stations, Oil Wells, and Other Small Point Sources

Project 3: Quantification of Stack Emissions from Marine Vessels

[1] Fluxsense Inc. is subsidiary of Fluxsense AB (www.fluxsense.se; San Diego, CA). Fluxsense started as a spin-off from research conducted at Chalmers University of Technology in Sweden and has been active for more than a decade.

# Attachment B

During the mobile measurements between June to October 2019, persistent instantaneous elevated concentrations of benzene were measured near three oil wells on multiple days (Figure A-1).

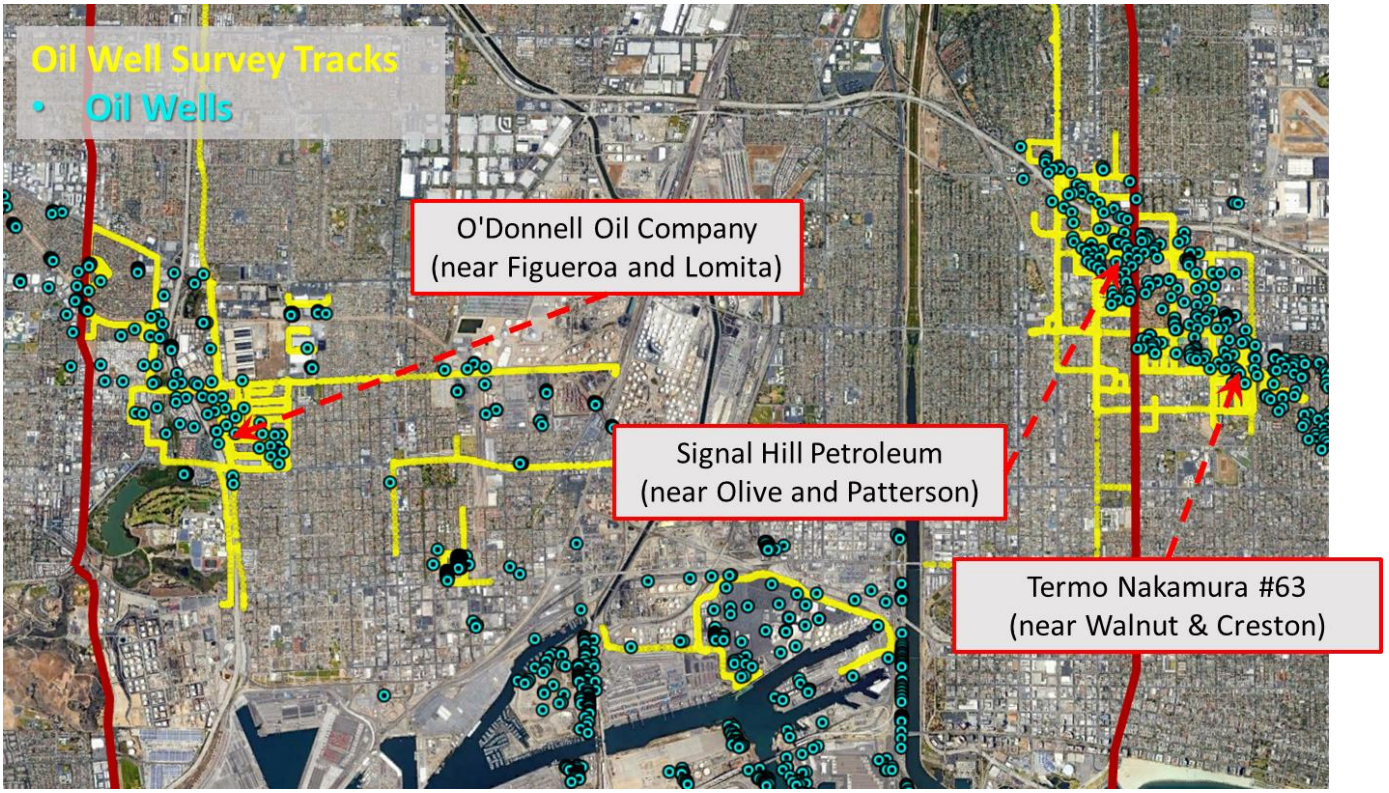


**Figure A-1.** Location of oil wells and the routes taken by the mobile platform as of October 2019.

Benzene concentrations measured at and around these three oil wells were persistently elevated compared to typical ambient levels during mobile surveys that were conducted on different days of week and different times of day. The typical ambient levels of benzene in the South Coast Air Basin (Basin) ranges between 0.1 and 1.8 parts per billion (ppb) based on Multiple Air Toxics Exposure Study (MATES) IV. Table A-1 lists the instantaneous daily maximum concentrations measured directly downwind of the identified oil wells. The comparison of instantaneous measured concentrations with typical ambient levels must be interpreted with caution, as instantaneous measurements conducted by the mobile platform represent concentration levels measured every second, whereas typical ambient levels are based on 24-hour average concentrations. The purpose of this comparison here is to help with the identification of potential source or sources of emissions. Instantaneous measurement values above a typical benzene concentration expected in the Basin can be used as an indication of potential leaks. The leaks can be verified visually using FLIR cameras that can register images of normally invisible emissions.

Measured concentrations are affected by a variety of factors, such as strength and location of a leak, distance from the source, wind speed and wind direction at the time of measurement. Therefore, instantaneously measured benzene concentrations alone cannot be used to gauge the magnitude of each leak. However, the purpose of this mobile surveys were to identify the fugitive leak emissions to aid subsequent compliance and enforcement actions, when appropriate.

**Table A-1.** Summary of mobile monitoring and instantaneous daily maximum benzene concentrations near three identified oil wells.

| Well Site | Measurement Date | Maximum measured benzene*# (ppb) | Number of surveys |
|---|---|---|---|
| **Termo Nakamura #63 (Walnut and Creston)** | 7/2/2019 | 23 | 7 |
| | 8/30/2019 | 20 | 9 |
| | 9/6/2019 | 2 | 5 |
| | 9/13/2019 | 23 | 7 |
| | 9/19/2019 | 18 | 8 |
| | 9/20/2019 | 11 | 12 |
| | 9/26/2019 | 5 | 12 |
| | 10/2/2019 | 2 | 7 |
| **Signal Hill Petroleum (Olive and Patterson)** | 7/11/2019 | 27 | 1 |
| | 8/30/2019 | 70 | 1 |
| | 9/6/2019 | 8 | 2 |
| | 9/13/2019 | 8 | 6 |
| | 9/19/2019 | 19 | 2 |
| | 9/26/2019 | 10 | 3 |
| | 10/2/2019 | 7 | 3 |
| **O'Donnell Oil Company (Lomita and Figueroa)** | 9/6/2019 | 5 | 1 |
| | 9/13/2019 | 2 | 3 |
| | 9/19/2019 | 3 | 1 |
| | 9/26/2019 | 3 | 4 |
| | 10/2/2019 | 10 | 4 |

* Typical benzene range in the Basin: 0.1 - 1.8 ppb

# Instantaneous daily maximum concentration measured directly downwind of the well

During these surveys, elevated levels of benzene (above 1 ppb over the background levels) were detected while driving near the potential sources (e.g. an oil well), and the plume was mapped by driving away from the source and in its proximity. Further source identification was performed by detecting a pollution plume and triangulating from the plumes back to the source using the wind direction. Figures A-2 through A-5 show examples of benzene concentration maps from the measurements conducted around the three identified oil wells on different days. The concentration maps show the instantaneous benzene levels at each location measured by the mobile platform while driving around the target oil well, the predominant wind direction, and marks the locations of the target oil wells and the closest residential homes. The concentrations can vary considerably on different days/times depending on wind speed and direction. Figures A-2, A-3, and A-5, show the concentration maps for the day when the maximum instantaneous benzene concentration was measured at each of the wells. For example, measured benzene levels near Signal Hill Petroleum oil well and the location of the pollution hotpots were significantly different during the surveys on 8/30/19 and 10/2/19, as shown on Figures A-3 and A-4. Please note that the concentration range for each map is scaled differently to highlight concentration gradients and pollution hotpots. It should be noted that mobile surveys were conducted thought the parts of the WCWLB community where majority of oil wells are located. It is not unusual to measure small instantaneous enhancements associated with passing traffic, which would not be reproduced by repeated measurements. For the well sites shown here, however, elevated benzene levels were repeatedly measured downwind the sites, therefore triggering further investigation.

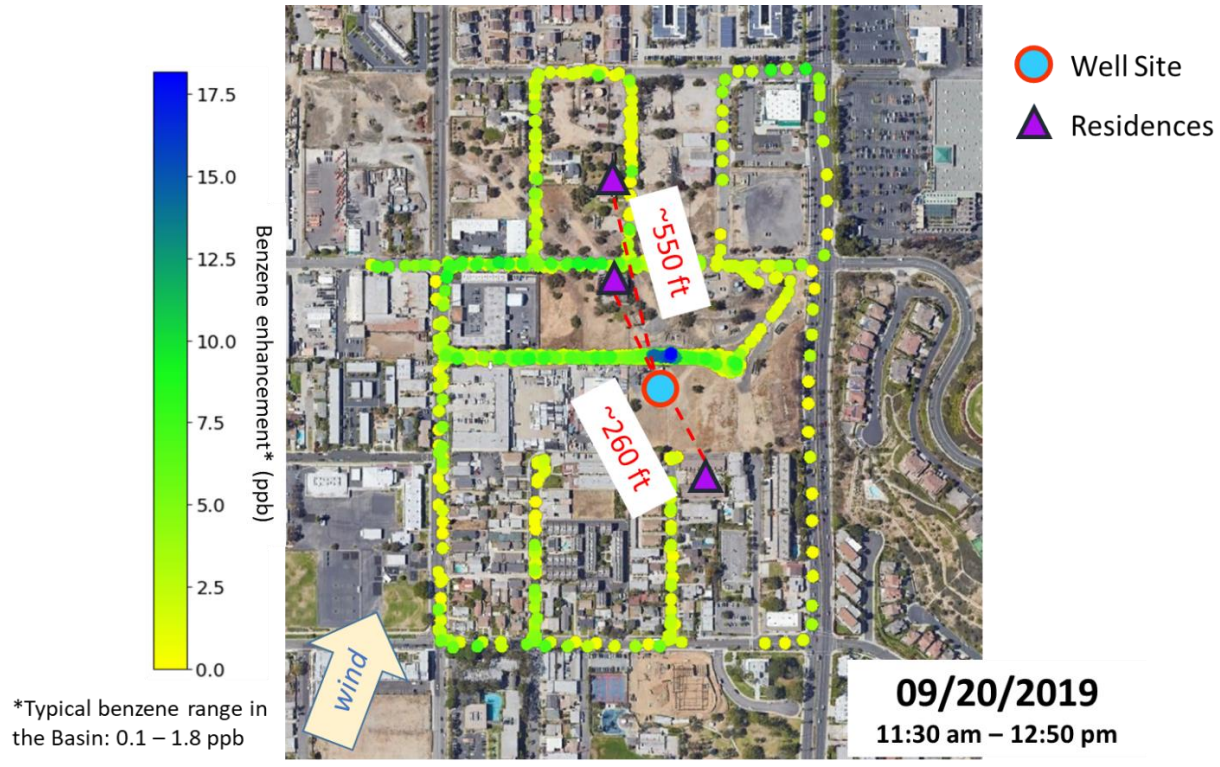


**Figure A-2.** Instantaneous concentration of benzene near *Termo Nakamura #63* oil well

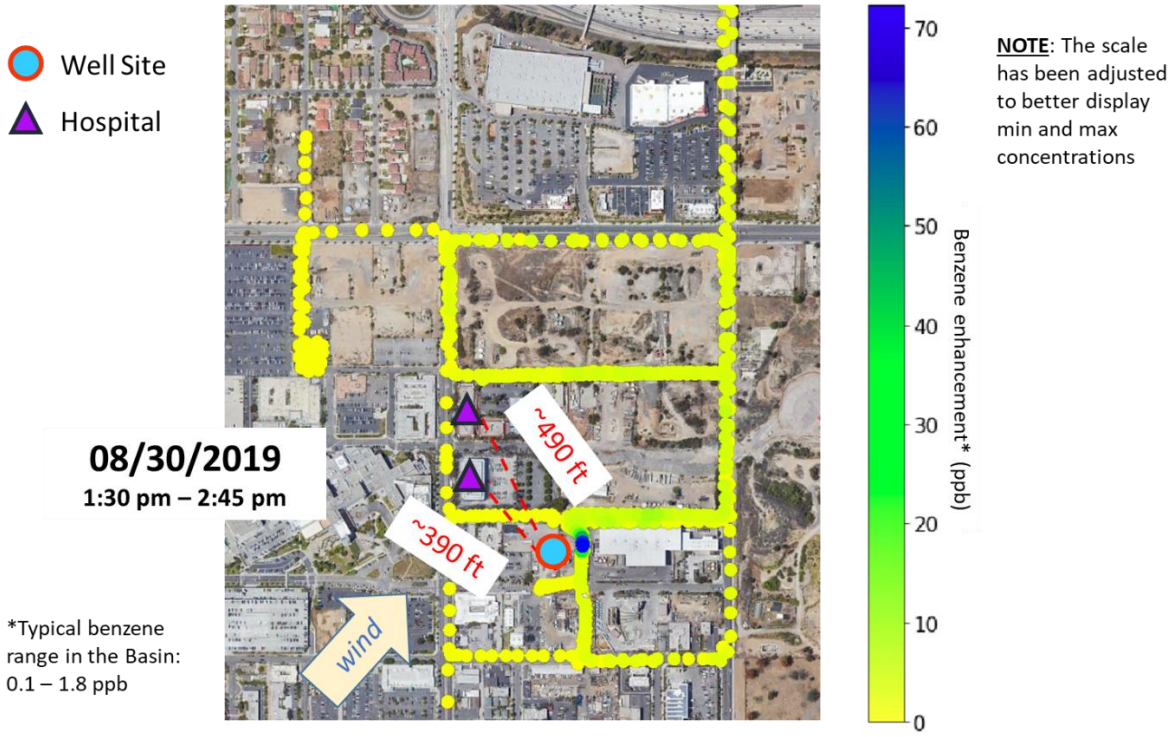


**Figure A-3.** Instantaneous concentration of benzene near *Signal Hill Petroleum* oil well

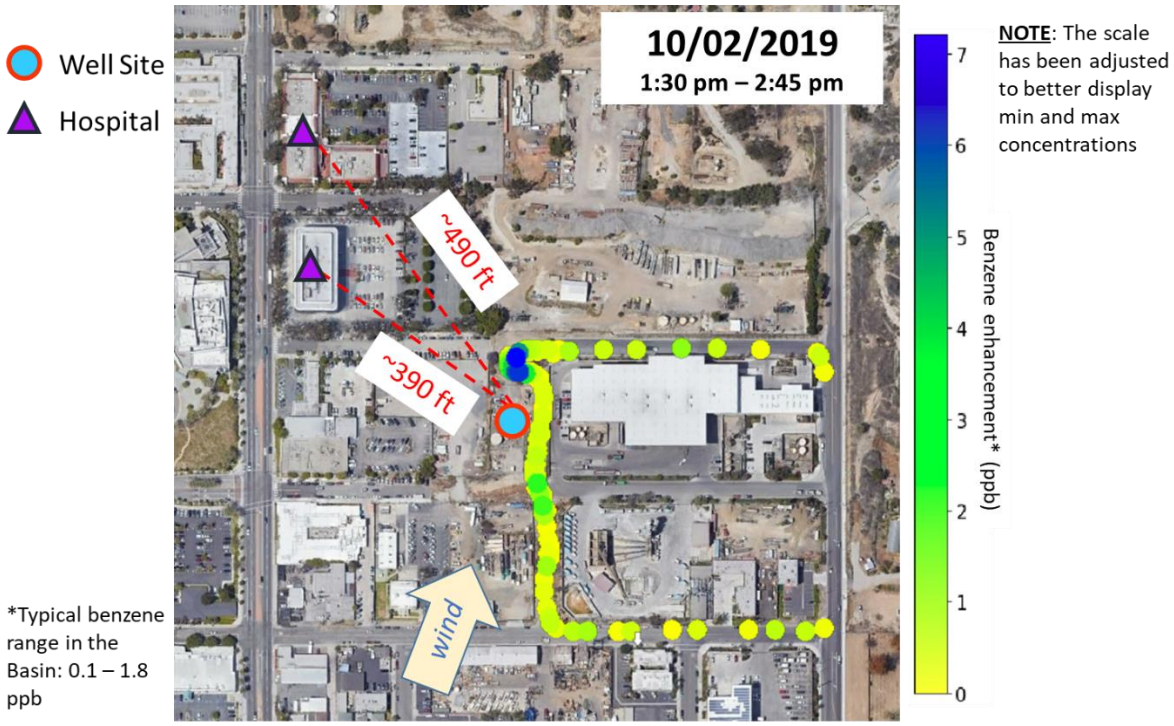

**Figure A-4.** Instantaneous concentration of benzene near *Signal Hill Petroleum* oil well

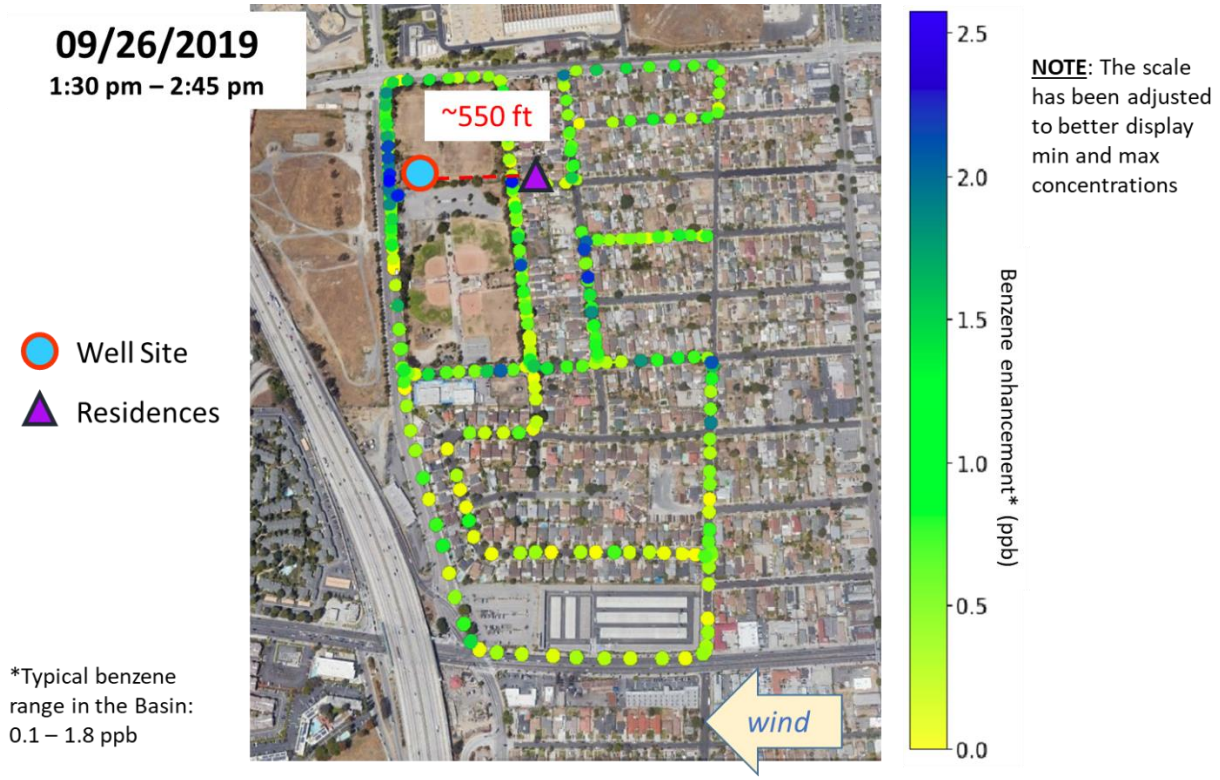


**Figure A-5.** Instantaneous concentration of benzene near *O'Donnell Oil Company* oil well

All three oil wells were inspected by the South Coast AQMD staff and the oil wells were found to be leaking VOC emissions. Inspections were conducted at wellheads, flanges, valves and other equipment that is above ground, using hand-held vapor analyzers and FLIR cameras. The inspections resulted in multiple Notice of Violations (NOV), which are issued by the South Coast AQMD air quality inspectors to inform a business that it is out of compliance with applicable South Coast AQMD, state or federal rule requirements, permit conditions or legal requirements. Through this process, the leaking components were identified by the inspectors and the leaks were repaired by the facility and verified by the South Coast AQMD staff (Table A-2).

**Table A-2.** Enforcement actions taken as a result of high benzene concentrations found during the mobile surveys

| Facility | Violation | Violation Description | NOV#* |
|---|---|---|---|
| O' Donnell Oil Co. | 203(b) | Leak observed at sample hatch on tank | P69258 |
| | 203(b) | Leak at rivet seam on tank | P66844 |
| Signal Hill Petroleum | 203(b) & 463(c)(3)(A) | Multiple (6) leaks observed on stock, wash, and water tank | P66842 |
| Oil Operators Inc. | 203(b) | Open canisters of used carbon | P66843 |
| The Termo Company | 203(b) | Leak from sample hatch on wash tank and from water leg | P69257 |
| *All instances of non-compliance were corrected, and no further violations were observed in relation to these findings. | | | |