

# Public Health and Safety Risks of Oil and Gas Facilities in Los Angeles County

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*A tank farm and oil well in the backyard of a house on Firmin Street in Echo Park, California (August 2016)*



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## Table of Contents

Executive Summary	i
I. Introduction	1
II. Epidemiological Literature	3
III. Environmental and Health Impact Assessments	7
IV. Neighborhood Health Investigations	12
A. AllenCo Energy Facility	12
B. Firmin Street	13
V. Consultations with Other Jurisdictions	15
VI. Conclusion	19
VII. Next Steps	21
References	25
Glossary of Selected Terms	28
Appendix A – Public Health Screening Assessment	A-1

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## Executive Summary

Oil and gas development in the Los Angeles Basin presents unique public health and safety concerns, because some oil and gas reserves lie beneath densely populated urban areas. Future production from these natural reserves will primarily come from existing oil fields, with some potential for the development of undiscovered oil and gas resources using conventional or unconventional methods. This report is intended to provide local policy-makers with an overview of relevant public health research and investigations. It concludes with an overview of measures to reduce potential health impacts.

There are currently 68 active oil fields in the Los Angeles Basin, with facilities operating under a wide range of operational and environmental conditions. While some facilities have been subject to stricter design and mitigation measures, others have not been required to conduct health risk assessments or other environmental studies. In some neighborhoods, such as South Los Angeles, residences are located only several feet away from the boundary of a drilling site and as close as 60 feet from an active oil well. Two smaller neighborhood facilities, which the Los Angeles County Department of Public Health (DPH) has responded to concerns or complaints, were found in a state of disrepair with environmental conditions that impact the health of neighboring residents.

In this report, DPH synthesized information from multiple lines of evidence, including a review of epidemiological literature, environmental and health impact assessments, neighborhood health investigations, and consultations with various jurisdictions regarding oil and gas ordinances. The scope of each is described below.

**Epidemiological Literature:** The review of the scientific literature synthesizes information from epidemiological studies and other published reviews on the potential health impacts associated with living near oil and gas activities. These peer-reviewed studies examine a variety of short-term and long-term health indicators such as birth outcomes; cancer; and respiratory neurological, gastrointestinal, dermatological, and psychological effects. While epidemiological studies have found limited associations between adverse health effects and living near oil and gas operations, high-quality exposure data measured over long periods of time is lacking. Therefore, the epidemiological studies are not able to conclude whether or not living near oil and gas activities is associated with long-term health impacts.

**Environmental and Health Impact Assessments:** These impact assessments help to fill data gaps in the literature by predicting potential health and safety impacts from air emissions, odors, noise, vibration, and other environmental hazards associated with oil and gas development projects. However, it should be noted that conventional risk assessment tools can be limited in their ability to anticipate certain risks given the complexity of health and quality-of-life consequences and the need for more robust,

local-level monitoring data. The mitigation measures proposed for specific projects can be used to inform policies and plans involving oil and gas activities and operations that do not require such assessments to avoid or minimize potential adverse impacts.

**Neighborhood Health Investigations:** When DPH is notified of environmental or operational conditions at industrial facilities that may pose a threat to public health, DPH conducts a neighborhood health investigation and recommends action to protect and preserve public health. In response to community health complaints, DPH conducted two neighborhood health investigations of oil and gas facilities located in densely populated communities. In both investigations, DPH responded to resident health complaints of headaches, nausea, vomiting, respiratory irritation, and eye, nose and throat irritation. Such impacts often warrant immediate action to protect health. These two neighborhood health investigations revealed insufficient regulatory oversight and inadequate mitigation measures to reduce exposures and associated impacts in the adjoining community.

**Consultations with Other Jurisdictions:** To understand oil and gas ordinances adopted by other jurisdictions, DPH conducted one-on-one interviews with 10 jurisdictions throughout the nation and convened one joint meeting. These jurisdictions have established requirements, such as setback distances and/or mitigation measures, to limit adverse health and safety impacts of oil and gas production.

DPH determined that there is sufficient evidence to provide the following guidance for oil and gas facilities in order to protect health:

1. Los Angeles County and local jurisdictions within the County should expand the minimum setback distance beyond 300 feet, as currently specified in local zoning code, and apply these requirements to both the siting of new wells and to the development of sensitive land uses near existing operations. It is important to note that a setback distance is not an absolute measure of health protection and additional mitigation measures must also be considered. For existing oil and gas operations, a site-specific assessment at each facility throughout the County is necessary to identify current distances to sensitive land uses and other site characteristics that can be used to inform whether further mitigation measures are warranted to reduce potential public health and safety risks.

Table ES-1 below summarizes various setback distances, mitigation targets, remaining hazards and whether additional mitigation measures could further reduce potential adverse impacts.

**Table ES-1. Review of Key Public Health and Safety Hazards and Setback Distance Guidance**

<b>Setback Distance</b>	<b><i>Air Quality</i></b>	<b><i>Noise</i></b>	<b><i>Odors</i></b>	<b><i>Fires, Explosions, and Other Emergencies</i></b>	<b><i>Additional Mitigation and Assessment Notes</i></b>
<b>300 feet</b>					Some health and safety impacts may still be unavoidable regardless of additional mitigation.
<b>600 feet</b>	✓				Additional mitigation and assessment would likely be needed to avoid most impacts. Odors may be unavoidable, regardless of mitigation. Air monitoring is advised.
<b>1,000 feet</b>	✓	✓			Additional mitigation and assessment may be needed to avoid noise impacts during certain operations, e.g. well advancement. Odors may be unavoidable in loss of containment events, regardless of additional mitigation.
<b>1,500 feet</b>	✓	✓	✓		Additional mitigation not likely to be needed. Some uncertainty remains due to gaps in long-term health and exposure data.

This table is based on information compiled from scientific publications,<sup>13,37,51,52</sup> environmental impact assessments,<sup>27-33</sup> other environmental studies,<sup>10,16,20,34,35,36,46</sup> and experiences in other jurisdictions.

✓ Represents the distance at which the impact is likely mitigated

2. In coordination with the California Air Resources Board (CARB) and the South Coast Air Quality Management District (SCAQMD), Los Angeles County should require the operators of facilities within urban areas of the County to implement continuous air monitoring systems around oil and gas operations to:
  - Measure air pollutants released by oil and gas operations;
  - Ensure oil and gas sites comply with environmental regulations;
  - Evaluate the impact of releases from oil and gas sites on surrounding neighborhoods; and
  - Monitor setbacks for these sites regularly, based on air monitoring and emerging science, and revise setback distances and/or other mitigation requirements when necessary to protect public health.

It should be noted that SCAQMD has imposed some requirements related to public notification and monitoring, but only after concerns are identified at a particular oil and gas operation, such as odor complaints. Current monitoring and enforcement activities can be sporadic, and it is difficult to understand long-term exposure risks for people living near oil and gas operations in the absence of continuous monitoring. To better characterize air quality in communities near oil and gas operations, SCAQMD completed a fence-line monitoring study and CARB launched the Study of Neighborhood Air near Petroleum Sources (SNAPS); results from these efforts should be used to inform air monitoring policies.

3. A variety of state and federal regulations require routine inspections, maintenance, testing and leak detection systems for oil and gas facilities; however, local oversight of these regulations is limited. Optimal local oversight would reduce public health and safety risks associated with aging infrastructure, and should include a local auditing and certification process, streamlined coordination, and data sharing among agencies. A local auditing program would confirm that operators are complying with federal, state and local regulations.
4. Operators should prepare and make available to the public a comprehensive Community Safety Plan, in coordination with City and County departments, including Fire, Building and Safety, and Law Enforcement. These plans should include information on hazardous chemicals stored onsite; air emission monitoring efforts; and health-based thresholds to identify the need for additional mitigation. For operations to plug wells permanently or to perform well maintenance, the responsible party should also prepare and implement a Community Safety Plan. The Community Safety Plan should facilitate communication and input from local stakeholders, and be submitted to DPH for review and approval. The Plan should include protocols and procedures for immediate notification to the County Health Officer in the event of odor or health complaints.

5. Operators should maintain enhanced Emergency Preparedness Plans that account for proximity to sensitive land uses. These plans must include communication procedures to immediately notify local government agencies of any emergencies, such as spills or other releases.

To further inform health-protective policies and regulations, DPH will collaborate with County partners, local and state enforcement agencies, and interested stakeholders. DPH recommends site-specific assessments at existing oil and gas operations located near sensitive land use to determine the appropriate combination of setback distance and additional mitigation measures, as well as the extent to which these measures are sufficient to protect public health.

## I. Introduction

Oil and gas development in the Los Angeles Basin presents unique public health and safety concerns, because some oil and gas reserves lie beneath densely populated urban areas. Future production from these natural reserves will primarily come from its 68 active oil fields, with some potential for the development of undiscovered oil and gas resources using conventional or unconventional methods.<sup>1,2</sup> Public concern has led to recent legislation and rules to assess the health and safety risks of oil and gas production, including California Senate Bill 4 to assess unconventional well stimulation treatments<sup>3</sup> and South Coast Air Quality Management District (SCAQMD) Rule 1148.2 requiring oil and gas operators to report chemicals used in drilling, rework, or completion processes.<sup>4</sup>

Health and safety risks of oil and gas production are particularly relevant to residents of Los Angeles County, which is the second largest oil producing county in California.<sup>5</sup> There are 3,468 active and 1,850 inactive oil and gas wells countywide.<sup>5</sup> Although oil and gas production in Los Angeles County occurs in both rural and urban areas, the potential public health impacts of oil and gas sites located in densely populated areas are concerning, particularly to those who experience disproportionate economic and health inequities.

Some communities within Los Angeles County have developed and adopted ordinances to regulate oil and gas drilling within their jurisdictions. One example is the Baldwin Hills Community Standards District that was adopted in 2008 for the Inglewood Oil Field, the largest urban oil field in the U.S. This site has undergone extensive environmental review and operates under a set of regulatory requirements to ensure ongoing monitoring of air quality, groundwater, noise, and seismic activity; establish setback distances from sensitive areas and emergency response protocols; and hold monthly meetings with a community advisory panel.<sup>6</sup> Wells in other parts of the county are not subject to the same level of oversight, and operate with various permit conditions and regulations depending on the project.<sup>7</sup>

On March 29, 2016, the Board passed a motion instructing the departments of Regional Planning, Fire, Public Health, and Public Works to convene an Oil and Gas Strike Team to assess the conditions, regulatory compliance, and potential public health and safety risks associated with existing oil and gas facilities in the unincorporated areas of Los Angeles County.<sup>7</sup> DPH participated in site assessments with regulatory agencies as an active member of the Oil and Gas Strike Team. A key component of the motion is an assessment of the potential public health and safety risks using a Public Health Screening Assessment (Appendix A). This is a complex task, considering (1) the wide variety of oil and gas operations encountered across the County; (2) the proximity of people living, working and going to school near operations; (3) the multitude of potential chemical and physical hazards if operations and storage are not properly managed; and (4) uncertainties with regards to a lack of long-term exposure and health data.

The Oil and Gas Strike Team conducted site visits to 15 oil and gas facilities currently operating in unincorporated Los Angeles County, including 68.5% of wells identified for review (557 out of 813 wells). An additional nine facilities operating in the unincorporated County were not inspected by the Oil and Gas Strike Team because access was not granted by the operators. The Public Health Screening Assessment based public health, safety, and environmental risks primarily on four priority areas: the facility's hydrogen sulfide gas content in production, operating pressures of wells and equipment, drilling frequency, and proximity to nearby populations.

Among the sites visited by the Oil and Gas Strike Team, the final report notes that public health risk levels were considered "low" for risks associated with hydrogen sulfide gas, operating pressures, and drilling frequency.<sup>8</sup> Several facilities were ranked "high" by the Public Health Screening Assessment for proximity to residences or sensitive receptor locations. Notably, the Oil and Gas Strike Team found that six of the 15 facilities had wells or tanks less than 300 feet from the nearest residence or school; two of those sites had more than 60 wells situated less than 300 feet from occupied structures.<sup>8</sup> The County Zoning Ordinance requires a 300-foot setback from residences for drilling oil wells in certain land-use zones;<sup>9</sup> however, the ordinance does not apply to wells drilled prior to its adoption or to wells that preceded construction of nearby structures.

The final report<sup>8</sup> by the Oil and Gas Strike Team recommended that Los Angeles County further evaluate the following key areas:

- Removal of "by right" permitting (as required by the Board Motion)<sup>7</sup>
- Setback distances
- Well stimulation techniques (to reflect state regulations)
- Air quality and odor monitoring
- Transportation of chemicals in residential areas
- Pipeline monitoring and leak detection
- Abandonment of long idle wells
- Emergency Response Plans
- Communication with surrounding community

In addition to participating on the Oil and Gas Strike Team, DPH also consulted with the City of Los Angeles' Petroleum Administrator who is currently assessing the public health and economic impacts of requiring a buffer distance around oil and gas facilities in its jurisdiction. This DPH report is intended to provide local policy-makers with an overview of public health research and investigations to inform potential revisions to local oil and gas ordinances and land use zoning codes.

## II. Epidemiological Literature

The epidemiological literature on public health and safety impacts of oil and gas activities has been increasing in recent years; however, data gaps and uncertainties remain. A growth in research over the last decade has been driven by public concern regarding potential environmental and health impacts of specific oil and gas production techniques, such as hydraulic fracturing (i.e. fracking), used to increase output from oil and gas reserves. It is estimated that 26% of active wells in the Los Angeles Basin have been stimulated by methods such as hydraulic fracturing, frac-packing, or high-rate gravel packing.<sup>1</sup>

Future development of the Los Angeles Basin is expected to mainly come from conventional oil reserves in existing fields. Unlike unconventional resources such as “shale oil,” hydraulic fracturing is not routine practice for oil production from conventional resources.<sup>1</sup> However, the public health risks associated with oil and gas operations are not unique to activities that use well stimulation such as hydraulic fracturing. For example, all oil and gas wells use hazardous chemicals and emit toxic air emissions such as benzene, a known human carcinogen.<sup>2</sup> A study of chemical usage data related to oil and gas activities in Southern California found substantial overlap between chemicals used in hydraulic fracturing and those used in routine oil and gas activities such as well maintenance, well completion, or rework.<sup>10</sup> Therefore, this literature review is comprised of epidemiological studies of health impacts from both conventional and unconventional drilling activities.

DPH compiled information from six comprehensive literature reviews<sup>11-16</sup> of epidemiological studies evaluating population health effects from oil and gas activities from peer-reviewed journals and grey literature. These literature reviews focused on evaluating short-term and long-term health indicators such as birth outcomes; cancer; and respiratory, neurological, gastrointestinal, dermatological, and psychological effects. These reviews included studies of oil and gas activities with a wide range of operational and environmental conditions.

A summary of findings from the available literature is described below.

### **Birth Outcomes**

Particulate matter and other toxic air pollutants, such as volatile organic compounds (VOCs), have been associated with adverse reproductive and developmental effects.<sup>17,18</sup> A systematic review of 45 studies found strong evidence for the disruption of human sex steroid hormone receptors; and moderate evidence for increased risk of preterm birth, miscarriage, birth defects, decreased semen quality, and prostate cancer.<sup>12</sup> The majority of the studies included in the review examined individual chemicals, complex mixtures of chemicals, and waste products related to conventional oil and gas operations. Other epidemiological studies have evaluated whether living near oil and gas operations during pregnancy is associated with adverse birth outcomes (e.g. preterm birth, low birthweight, or low APGAR scores), but the findings are mixed, with some studies showing an association and others no association.<sup>19</sup> Many of the epidemiological studies

have methodological limitations, but given that some of the findings suggest potentially serious health impacts such as birth defects,<sup>17</sup> further study is warranted.

### **Cancer**

Oil and gas activities may expose individuals to airborne emissions of VOCs, such as benzene. Studies have shown that exposure to elevated levels of benzene over many years may increase the risk of developing cancer, particularly acute myelogenous leukemia.<sup>11</sup> However, studies examining associations between oil and gas activities and other cancers in adults and children have resulted in mixed findings or null associations. There is insufficient evidence to quantify the contribution of oil and gas operations to incidence of childhood cancers. Studies are limited in both the ability to determine such an association due to methodological challenges to quantify an individual's exposure over time, and the ability to control for other environmental and genetic factors that may contribute to overall risk of developing cancer. For further information on VOC air emissions and potential cancer health risks, refer to Section III.

### **Respiratory Effects**

Air emissions from local oil and gas wells have been shown to contribute substantially to the pollution burden from stationary sources in Los Angeles County.<sup>20</sup> Particulate matter and VOCs are often associated with oil and gas extraction activities, and can lead to harmful human health effects, including eye, nose and throat irritation; exacerbations of asthma; and other respiratory conditions. These emissions are known to present a more significant health threat to infants and children.<sup>14</sup> A recent review reported mixed evidence of an association between proximity to oil and gas operations and self-reported respiratory symptoms.<sup>16</sup> On the other hand, acute adverse respiratory health effects (e.g. cough, wheezing, breathlessness), have been well documented in emergency response and disaster events, such as oil spills.<sup>21,22</sup> Less is known about long-term health effects after disaster events, but one study found respiratory effects among clean-up workers of an oil spill persisted five years later.<sup>23</sup> There is need for further study of potential respiratory health effects of long-term exposure to air emissions during normal operations, using study methods that do not rely solely on self-reported measures.

### **Neurological Effects**

Inhalation of VOCs emitted during improperly regulated oil and gas activities can lead to neurological effects such as headaches, dizziness, and other impacts to the central nervous system. Studies examining neurological symptoms and exposure to VOCs have relied on hospitalizations and self-reported data, with some studies finding an association and others reporting no association. In a large survey-based study, Tustin et al. found an association between people living near natural gas development activities and migraine headaches.<sup>24</sup> The likelihood of reporting migraines was 43 times greater in the area with the most natural gas development activity compared to an area with no natural gas activity. Although there are major limitations to this study, including bias in self-reported symptoms and other factors that

contribute to migraines, the results suggest a potential relationship between natural gas activity and adverse neurological effects.

### **Gastrointestinal Effects**

A limited number of studies have examined gastrointestinal effects, such as nausea or abdominal pain, and proximity to oil and gas activities. Studies of oil spill clean-up workers have documented gastrointestinal symptoms (nausea and vomiting) among the acute health problems related to duration of work and working in a highly polluted zone.<sup>21</sup> These studies have not demonstrated an association or have provided insufficient evidence to rule out an association between proximity to oil and gas operations and gastrointestinal symptoms.

### **Dermatological Effects**

Direct contact with petroleum product, such as crude oil, is known to cause skin irritation.<sup>25</sup> A limited number of studies have found associations between living near oil and gas operations and self-reported dermal symptoms.<sup>11</sup> Oily mist releases of crude oil from oil and gas operations<sup>26</sup> may result in oily residue on surfaces that can lead to skin irritation if people come in direct contact with the impacted areas.

### **Psychological Effects**

Oil and gas activities can adversely affect the mental health, well-being, and quality of life for nearby residents. Multiple factors, including both chemical and non-chemical stressors, may contribute to increased risk of suffering from depression, anxiety, fatigue, and sleep deprivation. Hays et al. reviewed health impacts of noise exposure near oil and gas activities and found a link between noise levels from such operations and increases in reported sleep disturbance.<sup>13</sup> Tustin et al. found an association between living near oil and gas activities and symptoms of fatigue.<sup>24</sup> Studies examining associations between proximity to oil and gas activities and self-reported psychological effects have offered mixed results.

### **Limitations of Health Studies**

Determining a link between oil and gas production and health impacts based on reviews of the literature is challenging because of the inherent limitations of epidemiological studies. The analyses in these studies typically cannot confirm whether past exposures to chemicals from oil and gas activities are associated with health effects among nearby residents, because of the limitations associated with small sample sizes, and the inability to reliably detect small increases in risk. There is also typically a lack of information on individual levels of exposure to emissions to establish dose-response curves and temporal relationships, as well as other factors that could cumulatively influence health risk, including exposure to the same chemicals from other sources, such as local vehicle traffic.

## Summary

Epidemiological studies are observational, and by themselves cannot determine causal relationships between exposures from oil and gas production and specific health effects; however, they provide useful information to guide future research. Studies with well-designed exposure monitoring and measurements are needed to elucidate the actual health implications for populations near oil and gas sites. Meanwhile, acute adverse health effects have been well documented in emergency response and disaster events involving oil and gas operations such as oil spills.<sup>9,21,22</sup> The literature to date provides limited evidence to link adverse health effects to living near oil and gas operations; however, quality exposure data that measures people's exposure over long periods of time is missing. Findings from existing epidemiological studies are not able to conclude whether or not living near oil and gas activities is associated with long-term health effects, but rather highlight the need for further research. Given the limitations of epidemiological studies, comprehensive exposure monitoring of oil and gas activities is needed, and precautionary measures are appropriate to minimize exposures to substances that may adversely affect health.

### III. Environmental and Health Impact Assessments

DPH evaluated seven Environmental Impact Reports (EIRs)<sup>27-33</sup> and two Health Impact Assessments (HIAs)<sup>34,35</sup> conducted for conventional and unconventional oil and gas production sites primarily in California from 2008 to 2017. Additionally, DPH reviewed a comprehensive health risk assessment recently completed by the Colorado Department of Public Health and Environment (CDPHE).<sup>16</sup> EIRs and HIAs are particularly helpful in providing an indication of potential public health risks until more comprehensive exposure monitoring and high-quality health studies can be conducted.

#### Air pollution

The release of chemicals into the air from oil and gas activities can occur from surface operations, wells and pipelines, operation of diesel or gas-powered equipment and vehicles, as well as accidental releases. Primary air pollutants include nitrogen oxides, particulate matter, benzene, toluene, ethylbenzene, xylene, hexane, and polycyclic aromatic hydrocarbons. Over 300 chemicals associated with drilling fluids present public health concerns ranging from respiratory health effects to development of cancer, if not properly monitored and controlled.

Data on air emissions from oil and gas sites at the local level are limited. One air monitoring study looked at particulate matter, heavy metals, and VOCs near Los Angeles' Inglewood Oil Field, noted a "marginal" contribution of particulate matter and "negligible" contribution of metals as compared to air emissions monitored throughout the Los Angeles region.<sup>36</sup> Note that the VOC sampling duration was only two weeks, making interpretation limited for comparison with annual averages used in regional air monitoring data. The CARB is launching a Study of Neighborhood Air near Petroleum Sources (SNAPS) to better characterize emissions of VOCs and other air pollutants from oil and gas wells throughout California.

Some studies indicate that oil and gas wells are substantial contributors to the local air pollution burden from VOCs in the Los Angeles area.<sup>20,37</sup> In the 2015 FluxSense Study, the SCAQMD monitored air quality around 61 sites and estimated that oil and gas wells contribute to more than half of the estimated VOC emissions from stationary sources.<sup>20</sup> This differs from previous estimates presented in the SCAQMD 2016 Air Quality Management Plan that utilized emission inventory data and concluded oil and gas wells contribute to 1% of VOCs from stationary sources.<sup>38</sup> While the 2015 FluxSense project notes uncertainties associated with its method of scaling data to represent the Los Angeles Basin as a whole, it suggests that emissions of VOCs from oil and gas sites may be considerably underestimated compared to emission inventories, and further study is warranted.

The Colorado Department of Public Health and Environment recently conducted a comprehensive health risk assessment using statewide air emissions data.<sup>16</sup> Non-cancer\* and cancer<sup>†</sup> health risk estimates were calculated for 62 priority chemicals measured at distances of 500 feet or greater from oil and gas operations with a wide range of conditions and mitigation measures. Although the Colorado study concluded that non-cancer and cancer health risks were below regulatory thresholds, they exceeded risk management levels typically used in the state of California. For non-cancer health effects from long-term exposures, the risk estimates exceeded the U.S. Environmental Protection Agency (EPA) hazard index of 1.0 for three health effect categories: neurological; eye, nose and throat; and respiratory. In addition, the combined exposure to four cancer-causing substances (benzene, ethylbenzene, formaldehyde and acetaldehyde) reached the EPA risk management level of 1 excess cancer per 10,000 people exposed and exceeded the California EPA Proposition 65 risk threshold of 1 excess cancer per 100,000.<sup>39‡</sup> The study did not calculate health risks at distances of less than 500 feet because Colorado requires a 500-foot minimum buffer distance between oil and gas activities and buildings. These findings suggest that mitigation controls may be needed in addition to the existing setback distance in order to reduce the potential health risks from air emissions from local oil and gas operations.<sup>40,41</sup>

Many of the project-specific EIRs for oil and gas development reviewed for this report predicted significant impacts from not only the drilling of new wells but also from construction, traffic, and other activities related to the project. The EIRs also include project-specific mitigation measures or alternatives that could be used to reduce or eliminate toxic air emissions associated with the project. Examples of mitigation measures included requiring emission controls for operational equipment and vehicles, as well as air monitoring to evaluate the effectiveness of those measures.

The Air Toxics “Hot Spots” Information and Assessment Act enacted in California in 1987 (Assembly Bill 2588) requires Health Risk Assessments for “high-priority” facilities that emit toxic air pollutants, including prioritized oil and gas facilities. SCAQMD prioritizes facilities based on toxicity and volume of hazardous materials released from a facility, as well as the proximity of a facility to sensitive populations such as residences, schools, daycare centers and hospitals.<sup>42</sup> However, not all oil and gas development projects are required to conduct a Health Risk Assessment.

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\* For non-cancer health effects, the health-based reference value is the exposure level below which health effects are not expected to occur, even for potentially sensitive people in the general population.

† For cancer causing substances, there are no safe levels of exposure.

‡ CDPHE reported the combined cancer risk estimate was  $9.7 \times 10^{-5}$ .

## Odors

Hydrogen sulfide (H<sub>2</sub>S) occurs naturally in crude petroleum and natural gas and is also a by-product of desulfurization processes in oil and gas industries. It is an odor with a “rotten-egg” smell that may be associated with some oil fields in the Los Angeles Basin. Hydrogen sulfide has a low odor threshold, defined as the lowest concentration perceivable by human smell, ranging 0.008 to 0.13 parts per million (ppm).<sup>43</sup> Detection of odors due to hydrogen sulfide varies considerably in the human population and can lead to symptoms such as headaches and nausea, as well as eye, nose, throat and respiratory irritation, in addition to being able to adversely impact overall quality of life and wellbeing. California Environmental Protection Agency (CalEPA) has adopted a threshold of 0.008 ppm for long-term exposure to hydrogen sulfide.<sup>44</sup>

Odors may also be the first indication of accumulation of gases which may reach hazardous levels in confined spaces if left unchecked. Historical case studies serve as reminders of the potential for hydrogen sulfide gases to migrate to the surface. For example, the Edward R. Roybal Learning Center (formerly known as the Belmont Learning Center) was developed over part of what was once the Los Angeles City Oil Field and required extensive monitoring and mitigation for hydrogen sulfide from gas migration.<sup>45</sup>

The Oil and Gas Strike Team reported hydrogen sulfide levels are absent or low at the 15 facilities in unincorporated Los Angeles County, based on available data; and no odor complaints were reported for those facilities in SCAQMD’s database.<sup>8</sup> The presence of hydrogen sulfide seems to vary depending on specific oil field conditions, and more environmental data are needed to characterize the extent of hydrogen sulfide in the Los Angeles Basin. Depending on the type of operations and proximity of people nearby, some EIRs and HIAs reviewed for this report concluded that odor events would lead to significant and unavoidable impacts to residents living nearby while others provided evidence that odor mitigation plans would alleviate odor impacts for nearby residents.

## Noise

There are a number of activities associated with oil and gas that can increase noise levels. The Los Angeles County Code (Section 12.08.390) exempts oil and gas operations from exterior noise standards during routine maintenance work and drilling activities. The primary sources of noise evaluated in the seven EIRs were construction machinery and drilling operations. Specifically, workover of oil and gas wells and well pump operation could elevate noise levels above exterior noise standards. Additionally, health impacts from noise can result from exposure to pure tones and low frequency noise sources.<sup>§</sup>

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<sup>§</sup> Pure tones result when a flare burns residual gas into the atmosphere, or when metal-to-metal contact occurs in oil equipment. Low-frequency noise is associated with power-generating plants. Processes within odorization plants can induce pure tones.

An extensive noise study conducted by Kern County estimated setback distances based on noise of 1,550 feet during well advance and 930 feet during well workover activities.<sup>46</sup> The majority of the EIRs found noise to be a significant impact that could be effectively mitigated. Furthermore, projects subject to the Los Angeles County zoning ordinance and permitted by the Department of Regional Planning with noise impacts are required to be mitigated.

### **Vibration**

Along with noise, drilling operations may increase vibration for nearby residents. Various equipment used in oil and gas drilling operations have established vibration levels, which inform the EIRs and HIAs that have been conducted. While some EIRs reported less than significant impacts from vibrations, vibrations associated with certain oil and gas operations can have significant environmental and structural impacts.

### **Hazardous Materials**

Chemicals are routinely used as part of oil and gas operations for a variety of processes, including corrosion control, wellbore cleanouts, repairs, and cementing of well casing. Hazardous chemicals may be added to drilling fluids and drilling muds, and used for enhanced oil recovery (e.g. hydraulic fracturing) as well as routine well maintenance activities (e.g. maintenance acidizing, gravel packing, and well drilling). In a comprehensive assessment of the SCAQMD database of chemicals used for routine oil and gas activities and those used for well stimulation in the Southern California, Stringfellow et al. inventoried the most frequently used chemicals – solvents, petroleum products, salts and strong acids.<sup>10</sup> Notably, hydrochloric acid and hydrofluoric acid (with concentrations of 0-15% and 0-3%, respectively) were used extensively in large quantities for routine activities such as acid cleaning for well maintenance. For each routine maintenance activity, the average mass of hydrochloric acid and hydrofluoric acid used was 1,791 and 161 kg, respectively. Stringfellow et al. concluded that there is substantial overlap between chemicals used for routine oil and gas activities and those used in hydraulic fracturing in the Southern California.

In the event of an accidental release, some of these chemicals used for routine maintenance activities could cause immediate environmental and health impacts. For example, acute symptoms of exposure to strong acids include irritation to the eyes, skin, nose and throat; pulmonary edema; eye and skin burns; rhinitis; and bronchitis. There is a lack of hazard information on the utilization of many chemicals in oil and gas operations, thus preventing emergency personnel and regulatory agencies from understanding the full scope of potential health and safety risks. The toxicity of known chemicals, combined with the gaps in health information on other chemicals, underscores the importance of robust emergency management plans to prepare for or prevent significant casualties if a large-scale incident were to occur.

## **Oil and Gas Seepage**

Oil and gas seepage has the potential to impact many environmental concerns, including subsidence, seismic activity, releases and explosions, and aquifer contamination. Continued production and leaking oil wells can result in near-surface gas accumulation, which may pose an explosive hazard. Oil and gas seepages have been documented across Los Angeles City, including the Fairfax area, south La Brea, Playa del Rey, Santa Fe Springs, and Echo Park. In 1985, an explosion in the Fairfax area demolished a Ross department store as a result of subsurface gas accumulation. One report links the gas accumulation to a nearby oil well;<sup>45</sup> however, there is still debate as to the root cause of the explosion.

Poor well completion and/or abandonment procedures can result in oil and gas leaks that negatively impact air quality in residential neighborhoods (see DPH neighborhood health investigation in Section IV). A comprehensive study of 41,000 conventional and unconventional oil and gas wells in Pennsylvania raises the issue of compromised structural integrity of well casing and cement as one mechanism likely leading to gas migration into the air (i.e. fugitive emissions) or underground drinking water sources (i.e. aquifer contamination).<sup>47</sup>

### **Summary**

Many of the EIRs and HIAs for oil and gas development projects predicted significant impacts from air emissions, odors, noise, vibration and safety hazards; and provided site-specific mitigation measures to try to reduce or eliminate those impacts. In particular, effective mitigation measures were designed to substantially reduce or eliminate impacts from air emissions and noise. Depending on operational and environmental conditions, odor impacts from routine operations and/or emergency events may not be possible to mitigate with currently available measures. Community Safety Plans and enhanced Emergency Response Plans should be developed to address the significant possible safety hazards associated with oil and gas activities and to prepare for leaks, seepage and other potential disasters. Alongside preparedness plans and mitigation measures, environmental monitoring that is both comprehensive and continuous will allow operators and regulatory agencies to develop evidence-based strategies to protect public health.

## IV. Neighborhood Health Investigations

### A. AllenCo Energy Facility

On October 18, 2013, the SCAQMD asked DPH to assess whether conditions at the AllenCo Energy Facility (AllenCo), located at 814 W. 23rd Street in the City of Los Angeles, were adversely affecting the health of nearby residents in the University Park Community of South Los Angeles.

According to regulatory records, the AllenCo facility appeared to have operated in “general compliance” with permit conditions; however, a comprehensive EIR or HIA was not required to establish permit conditions. Odor and health complaints from the public persisted over several years. Health complaints included headaches, nausea, as well as symptoms associated with irritation to the eyes, nose, throat and airways. Symptoms were recurrent and seemed to arise in conjunction with odor complaints.

The AllenCo facility consisted of seven operational oil production wells at 814 W. 23rd Street, with an additional 14 wells at several other nearby locations. An active well at the facility is located 60 feet from multi-unit housing in the adjacent community, and its property shares borders with a local high school and a college dormitory.

The AllenCo facility was in “general compliance,” meaning that it complied with the terms of the regulating agencies and the petroleum-based compounds emitted at the facility appeared to be well below levels that would lead to long-term systemic health effects. However, intermittent exposure to low level emissions can cause recurrent short-term health effects with symptoms consistent with those reported by neighboring residents.

#### Conclusion

The DPH neighborhood health investigation concluded that the emissions from the AllenCo oil operations at the facility were associated with the reported health effects by community members and that conditions were unlikely to resolve without the company modifying or curtailing facility operations. Recommendations were made to the regulatory agencies regarding a facility-wide audit to identify sources of equipment and process-related emissions within the facility. One further recommendation was that regulatory agencies should continue to explore opportunities to further mitigate emissions using the best available technology when feasible at oil production facilities situated in urban areas with the goal of minimizing odor emissions.

A study of households near AllenCo found that many residents were not aware of their proximity to the oil production site (45.8%) and the majority would not know how to report a complaint to SCAQMD or other agency (78.5%).<sup>48</sup> Given the lack of awareness and the duration of odor complaints, protocols to improve interagency coordination and data sharing are needed to promptly identify potential issues and address community concerns.

## **B. Firmin Street**

On July 15, 2016, the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR) in cooperation with the City of Los Angeles, began working to permanently plug and abandon two orphan wells located at 323 and 324 Firmin Street, in the neighborhood of Echo Park, Los Angeles. Both orphan wells were located in the front yards of residential properties. The permanent plugging and abandonment process required operation of large, industrial stationary equipment (e.g. workover rigs and cement pumps) as well as mobile equipment (e.g. power rigs and heavy trucks) within feet of residential homes.

On July 30, 2016, the City of Los Angeles referred to DPH a resident who was experiencing acute symptoms during the plugging and abandonment operations at the two orphan wells. The resident identified concerns regarding “rotten egg” and strong petroleum odors, as well as the appearance of black soot-like dust inside her home and on her property during well plugging activities. DPH officials conducted a neighborhood health investigation to observe plugging operations at the orphan wells, to document environmental conditions, and to conduct interviews with nearby residents.

During the DPH investigation, health and safety hazards (e.g. particulate matter and noise from well workover activities) were observed in proximity to at least seven households, including the complainant. Residents included young children and elderly people, as well as a high school located two blocks away. The majority of households that reported symptoms to DPH had pre-existing chronic health conditions. Additionally, residents reported that “rotten egg” odors had been intermittent in their neighborhood for many years.

DPH was advised that outdoor air was monitored by the SCAQMD, which reported that levels of methane and hydrogen sulfide did not pose a health threat. However, noise, odor, dust, and diesel emissions associated with the permanent plugging and abandonment procedures taking place in proximity to homes did pose risks to the community, including safety hazards, as well as short-term and long-term health effects.

### **Short-term Health Impacts**

During DPH’s neighborhood health investigation, all seven interviewed households reported short-term health symptoms that began when work started to permanently plug and abandon the two orphan wells on Firmin Street. In some cases, residents reported that their medical providers prescribed new medication as a result of worsened respiratory conditions. The most common symptoms included headaches, nausea, vomiting, eye and throat irritation, skin rashes, and exacerbation of pre-existing respiratory conditions such as asthma. These complaints are consistent with exposure to strong petroleum odors, increased levels of airborne particulate matter, or direct contact with crude oil.

Additionally, DPH heard loud rig drilling noise at the front porches of nearby residential properties. Conversations were inaudible at times during resident interviews. Some residents

reported extended work hours on the orphan wells, such as beginning at 6:30am or ending at 9:00pm without prior public notification, or working on weekends. One resident who worked night shifts had difficulty sleeping during the day.

### **Long-term Health Risks**

During the neighborhood health investigation of the two orphan wells, DPH also identified the presence of a third well (Patel 2) located at 314 Firmin Street in the backyard of two residential properties that was considered idle, meaning that it is not currently being used for oil production but it has yet to be determined if the operator will reactivate it or if it needs to be permanently plugged and abandoned. DOGGR issued a notice of violation to the operator of Patel 2 on June 21, 2016 for eight violations, including lack of proper signage, unremediated spills and leaks, and lack of fencing and floor grating to prevent trip and fall safety hazards to people and animals.

The noncompliant Patel 2 idle well poses an ongoing source of direct exposure to petroleum, particularly to children or pets who may inadvertently come into contact with it and also presents long-term health risks to residents from fugitive emissions, such as increased risk of nervous system problems and reproductive system effects. Unfortunately, the violations DOGGR made to the operator for Patel 2 a year prior were not enough to ensure public health and safety, and on November 4, 2017 there was another hazardous release of crude oil from a pipe connecting this well to the tank farm.<sup>49</sup>

### **Conclusion**

DPH concluded that exposure to dust, odor, noise, and vehicle exhaust emissions from the permanent plugging and abandonment of orphan wells led to significant symptoms in some residents, and these symptoms persisted until the operations were complete. In order to protect public health, DPH recommended implementing additional safety measures and offering temporary relocation assistance to affected residents in the area. Based on DPH recommendations, DOGGR provided timely and regular project updates to the residents through face-to-face communications in order to disseminate pertinent information such as project timelines, health resources, and planned changes to resident access.

## V. Consultations with Other Jurisdictions

In California, DOGGR has jurisdiction over subsurface oil and gas activities, including drilling, operation, maintenance, and abandonment of oil and gas wells. Los Angeles County officials may regulate zoning and land use to reduce impacts from surface operations on the surrounding communities. Current Los Angeles County Zoning Ordinance regulations require a Conditional Use Permit for the drilling of oil and gas wells on certain land use zones within 300 feet from sensitive land uses such as residential zones, public schools or parks.<sup>9</sup> However, the requirement does not apply to oil and gas wells operating prior to the adoption of the ordinance and it does not establish similar requirements for the development of sensitive land uses such as residences near existing oil and gas wells (Timothy Stapleton, Los Angeles County Department of Regional Planning, personal communication, November 15, 2017).

Some cities within Los Angeles County have ordinances established to regulate oil and gas drilling within their jurisdictions. For example, the City of Carson established a 750-foot setback distance after conducting a review of other setback distances and potential environmental impacts.<sup>50</sup> Within Los Angeles County, the Baldwin Hills Community Standard District was established to regulate oil and gas activities in the Inglewood Oil Field.<sup>6</sup> Wells in other parts of the county are not subject to the same level of oversight, and operate with various permit conditions and regulations depending on the project.<sup>7</sup>

In order to better understand oil and gas ordinances adopted by other jurisdictions, DPH consulted with ten jurisdictions that have established requirements, such as setback distances, in order to limit the potential negative health and safety impacts of oil and gas production. These ten jurisdictions have various setback requirements, ranging from 210 to 1,500 feet (Table 1).

**Table 1. Summary of Setback Distances for New Wells in Other Jurisdictions\*\***

State	Jurisdiction	Year Adopted	Setback Distance (feet)	Setback Target
California	City of Carson	2015	750	Housing, schools, hospitals
California	Kern County	2015	210	Housing, schools, hospitals
Colorado	State	2013	500	Housing
Maryland	State	2016	1,000	Housing, schools, faith institutions
			2,000	Private drinking water well
New Mexico	Santa Fe County	2008	750	Housing, schools
			1,000	Groundwater and surface water resources
Oklahoma	Oklahoma City	2015	300	Housing, fresh water well
			600	Faith institutions
Texas	City of Arlington	2011	200	Fresh water well
			600	Housing, schools, faith institutions, hospitals
Texas	City of Dallas	2013	1,500	Housing, schools, faith institutions
Texas	City of Flower Mound	2011	1,500	Housing, schools, faith institutions, hospitals, existing water wells
Texas	City of Fort Worth	2010	200	Fresh water well
			600	Housing, schools, faith institutions, hospitals

\*\* The setback distances are for protected or sensitive land use areas defined as: housing, schools, faith institutions, hospitals, and water wells (and other sources of water). Other jurisdictions not included in the table may have differing setback distances (e.g. Huntington Beach, Long Beach, and Signal Hill have setback distances of 300 feet).

When DPH asked each jurisdiction about the supporting rationale and available evidence for each of the setback distances, there were two key themes:

- Flammability and other safety concerns (e.g. explosions) related to minimum distance between industrial operations and structures, based on Fire Code.
- Air quality impacts, with supporting data from both direct measurements and modeled estimates. In a few cases, jurisdictions have established extensive monitoring networks to estimate and enforce the air emissions released by oil and gas activities (Fort Worth and Flower Mound, Texas).

When further asked about the approach used to develop the setback distances, jurisdictions responded with a wide variety of different processes. Some jurisdictions formed a task force with academic researchers, oil industry representatives and other independent experts, while others focused on community-based participatory processes to reach a consensus. Jurisdictions sometimes took a systematic research-based approach by conducting lengthy and comprehensive assessments, looked to other jurisdictions for guidance, or chose distances reflecting information gaps on chemicals utilized, air and fugitive emissions, and impacts to public health for oil and gas sites within their purview.

Two published review studies of setback distances for oil and gas activities suggest that setback distances alone may not be enough to protect public health from unconventional oil and gas operations (e.g. hydraulic fracturing). One study surveyed expert scientists, public health professionals and medical professionals regarding setback distances, and found that 89% of participants agreed that a minimum safe distance to unconventional oil and gas operations was a quarter of a mile (1,320 feet).<sup>51</sup> Another study reviewed whether setback distances from hydraulic fracturing ranging from 150 to 1,500 feet are protective from air pollution, blowouts or other safety risks and concluded that a combination of a reasonable setback distance with mitigation process controls is the best method for reducing the potential threats to public health.<sup>52</sup>

The setback distances adopted by various jurisdictions apply to future development of oil and gas sites such as drilling new wells or through land use permitting processes. The setback requirements typically do not apply to existing oil and gas wells that are operating prior to the adoption of the ordinance. Some jurisdictions have additionally established requirements for mitigation measures when operations are less than the specified distance in order to reduce public health and safety risks. For example, Kern County's ordinance requires mitigation to reduce potential noise impacts from certain oil and gas activities. After conducting an extensive noise study in an environmental impact report, Kern County found that noise impacts from certain operational activities were significant unless mitigated (e.g. 1,550 feet for well advancement, 930 feet for well workovers).<sup>46</sup> Another example is the City of Carson's Oil and Gas Ordinance that requires mitigation to reduce noise impacts from facilities within 1,000 feet of

sensitive land use zones, and requires an odor minimization plan for facilities within 1,500 feet of sensitive land use zones.<sup>50</sup>

Setback distances combined with appropriate mitigation measures can reduce many of the public health and safety risks associated with oil and gas operations for new and existing oil and gas operations in proximity to sensitive populations. An assessment of each oil and gas facility is necessary to identify current distances from existing operations to sensitive land uses and whether current mitigation measures sufficiently address the potential safety and environmental hazards and are protective of public health. Expanded monitoring of oil and gas operations will enable prudent guidance for reducing the health and safety risks from toxic air emissions, gas migration, subsidence, soil and groundwater contamination, and aging infrastructure. In addition, zoning requirements should restrict future development of sensitive land uses close to existing oil and gas operations in order to further protect public health.

## VI. Conclusion

Overall, epidemiological studies have found limited associations between certain kinds of adverse health effects and living near oil and gas operations; however, quality exposure data to accurately assess risk is lacking. The vast majority of studies have not assessed people's exposure over long periods of time and highlight the need for future research to include studies with large sample sizes and more precise measurement of an individual's exposure to a myriad of chemicals that have potential to adversely affect health. The epidemiological literature is unable to conclude at this time whether or not living, working, or going to school near oil and gas facilities is associated with long-term negative health impacts.

In addition to epidemiological studies, this report includes evidence from EIRs and HIAs of oil and gas operations primarily in California. Such reports and assessments help fill some information gaps from available epidemiological studies. Evidence from numerous potential impact areas ranging from air pollution to catastrophic releases, compels the need for public health intervention to protect against potential negative environmental and health impacts from oil and gas operations located in densely populated urban areas. Many EIRs proposed mitigation measures to reduce potential risks and hazards. In the absence of such controls, or if the impacts are unable to be mitigated (e.g. odors), potential public health risks are likely to remain, and may be particularly heightened for vulnerable populations such as young children. Depending on land use, some environmental and site conditions may be incompatible with oil and gas operations, regardless of mitigation controls.

The oil and gas development projects described in the reviewed EIRs and HIAs have assessed environmental and health hazards, and in many cases propose mitigation measures for reducing the identified risks. However, such assessments are not required for every operating oil and gas facility and for some facilities, health and safety risks are identified only after residents' complaints gain the attention of regulators and other agencies. As observed during DPH's two neighborhood health investigations in response to health complaints from residents near oil and gas operations (refer to Section IV for more information), health effects may occur with the detection of odor emissions, even when those emissions are within regional air quality standards. Routine occurrences of odor and noise emissions from operations can lead to recurrent short-term health problems, which may negatively impact the long-term wellbeing and quality of life of nearby residents. Conventional risk assessment methodologies can be limited in their ability to address these factors and to anticipate other kinds of complex health and quality-of-life consequences. In addition, the lack of monitoring data to estimate potential exposures to such emissions from oil and gas operations creates further uncertainty regarding long-term health impacts to nearby residents.

DPH's experience with health complaints from a neighborhood health investigation involving the permanent plugging and abandonment of two orphan wells, as well as one idle well located nearby, highlighted several issues with old, abandoned wells that are found across Los Angeles County:

- Orphan wells are often improperly abandoned, or left idle, which may result in communities being impacted by hydrogen sulfide and petroleum odors.
- Workover rig equipment and related abandonment operations produce dust, odor, and noise that may lead to symptoms among people living nearby.
- Mitigation measures were successfully implemented to reduce the health and safety risks identified by DPH.
- Residents were empowered to take health protective measures through enhanced communication.

Aging oil and gas infrastructure in Los Angeles County, not only at abandoned wells, but also at active wells, pipelines, and associated infrastructure, raises an important public health concern. Regulatory agencies and operators should explore opportunities to utilize the best available technology at oil production facilities in order to prevent public health impacts.

DPH identified a number of gaps in information, highlighting the need for further monitoring and health research. Primarily, the following are needed to more completely estimate the potential health risks from oil and gas operations in Los Angeles County: 1) air monitoring data to estimate potential exposures to chemical emissions from oil and gas operations, 2) proactive odor surveillance systems to identify hydrogen sulfide releases from active, idle, and abandoned wells, and 3) toxicity testing of chemicals and chemical mixtures used in oil and gas operations. In the absence of more robust exposure and health data, it is not possible to reliably quantify potential health risks.

Based on the available scientific evidence, other local and state agencies have established setback distances ranging from 210 to 1,500 feet in order to protect public health and safety amidst oil and gas operations; these setbacks were based primarily on the potential for safety concerns and air quality impacts. In addition to setback distances, particularly in cases of existing oil and gas operations within the minimum setback, alternative measures (e.g. engineering controls, monitoring, closure) combined with monitoring are necessary to protect the health and safety of the surrounding communities.

## VII. Next Steps

The potential for adverse health effects from exposure to chemicals found at oil and gas facilities, combined with the need for more research and monitoring, warrants precautions in policy-making. The two DPH neighborhood health investigations suggest the need for immediate actions to protect health at oil and gas facilities located immediately adjacent to sensitive populations. Oil and gas facilities across the Los Angeles Basin would benefit from periodic review to assess the effectiveness of existing mitigation measures, monitoring requirements, and impacts on the surrounding community.

DPH has determined through its literature review, discussions with other jurisdictions, and neighborhood health investigations that there is sufficient evidence to provide health-based guidance in five areas – setback distances, air monitoring, preventative maintenance and testing, community safety planning, and emergency response planning. DPH will collaborate with County partners, enforcement agencies and interested stakeholders to further inform the development of health-protective policies and regulations.

The findings in this report support the recommendations set forth by the interagency Oil and Gas Strike Team.<sup>8</sup> The final report by the Oil and Gas Strike Team recommended that Los Angeles County further evaluate the following key areas:

- Removal of “by right” permitting (as required by the Board Motion)<sup>7</sup>
- Setback distances
- Well stimulation techniques (to reflect state regulations)
- Air quality and odor monitoring
- Transportation of chemicals in residential areas
- Pipeline monitoring and leak detection
- Abandonment of long idle wells
- Review of Emergency Response Plans
- Community communication

### 1) Setback Distances

Los Angeles County and local jurisdictions within the County should expand the minimum setback distance beyond 300 feet, as currently specified in local zoning code, and apply these requirements to both the siting of new wells and to the development of sensitive land uses near existing operations. It is important to note that a setback distance is not an absolute measure of health protection and additional mitigation measures must also be considered. For existing oil and gas operations, a site-specific assessment at each facility throughout the County is necessary to identify current distances to sensitive land uses and other site characteristics that can be used to inform whether further mitigation measures are warranted to reduce potential public health and safety risks.

The table below summarizes various setback distances, mitigation targets, remaining hazards and whether additional mitigation measures could further reduce potential adverse impacts (Table 2). This table is based on information compiled from scientific publications,<sup>13,37,51,52</sup> environmental impact assessments,<sup>27-33</sup> other environmental studies,<sup>10,16,20,34,35,36,46</sup> and experiences in other jurisdictions.

**Table 2. Review of Key Public Health and Safety Hazards and Setback Distance Guidance**

<b>Setback Distance</b>	<b><i>Air Quality</i></b>	<b><i>Noise</i></b>	<b><i>Odors</i></b>	<b><i>Fires, Explosions, and Other Emergencies</i></b>	<b><i>Additional Mitigation and Assessment Notes</i></b>
<b>300 feet</b>					Some health and safety impacts may still be unavoidable regardless of additional mitigation.
<b>600 feet</b>	✓				Additional mitigation and assessment would likely be needed to avoid most impacts. Odors may be unavoidable, regardless of mitigation. Air monitoring is advised.
<b>1,000 feet</b>	✓	✓			Additional mitigation and assessment may be needed to avoid noise impacts during certain operations, e.g. well advancement. Odors may be unavoidable in loss of containment events, regardless of additional mitigation.
<b>1,500 feet</b>	✓	✓	✓		Additional mitigation not likely to be needed. Some uncertainty remains due to gaps in long-term health and exposure data.

✓ Represents the distance at which the impact is likely mitigated

## **2) Air Monitoring**

In coordination with the California Air Resources Board (CARB) and the South Coast Air Quality Management District (SCAQMD), Los Angeles County should require the operators of facilities within urban areas of the County to implement continuous air monitoring systems around oil and gas operations to:

- Measure air pollutants released by oil and gas operations;
- Ensure oil and gas sites comply with environmental regulations;
- Evaluate the impact of releases from oil and gas sites on surrounding neighborhoods; and
- Monitor setbacks for these sites regularly, based on air monitoring and emerging science, and revise setback distances and/or other mitigation requirements when necessary to protect public health.

It should be noted that SCAQMD has imposed some requirements related to public notification and monitoring, but only after concerns are identified at a particular oil and gas operation, such as odor complaints. Current monitoring and enforcement activities can be sporadic, and it is difficult to understand long-term exposure risks for people living near oil and gas operations in the absence of continuous monitoring. To better characterize air quality in communities near oil and gas operations, SCAQMD completed a fence-line monitoring study (refer to Section III for more information) and CARB launched the Study of Neighborhood Air near Petroleum Sources (SNAPS); results from these efforts should be used to inform air monitoring policies.

## **3) Preventative Testing and Monitoring**

A variety of state and federal regulations require routine inspections, maintenance, testing and leak detection systems for oil and gas facilities; however, local oversight of these regulations is limited. Optimal local oversight would enhance monitoring for public health and safety risks associated with aging infrastructure, and should include a local auditing and certification process, streamlined coordination, and data sharing among agencies. A local auditing program would confirm that operators are complying with federal, state and local regulations.

## **4) Community Safety Plan**

Operators should prepare and make available to the public a comprehensive Community Safety Plan, in coordination with City and County departments, including Fire, Building and Safety, and Law Enforcement. These plans should include information on hazardous chemicals stored onsite; air emission monitoring efforts; and health-based exposure thresholds to identify the need for additional mitigation. For operations to plug wells permanently or to perform well maintenance, the responsible party should also prepare and

implement a Community Safety Plan. The Community Safety Plan should facilitate communication and input from local stakeholders, and be submitted to DPH for review and approval. The Plan should include protocols and procedures for immediate notification to the County Health Officer in the event of odor or health complaints.

#### **5) Emergency Preparedness Plan**

Operators should maintain enhanced Emergency Preparedness Plans that account for proximity to sensitive land use. These plans must include communication procedures to immediately notify local government agencies of any emergencies, such as spills or other releases.

To further inform health-protective policies and regulations, DPH will collaborate with County partners, local and state enforcement agencies, and interested stakeholders. DPH recommends site-specific assessments at existing oil and gas operations near sensitive land use to determine the appropriate combination of setback distance and additional mitigation measures, as well as the extent to which these measures are sufficient to protect public health.



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## Glossary of Selected Terms

**Casing** is a metal tube used during drilling an oil well in combination with cement to sequentially stabilize recently drilled formation as well as providing strong upper foundation and isolating separate zones.

**Drilling** is to dig or bore in the earth for the purpose of exploring for, developing, or producing oil, gas, or other hydrocarbons, or for the purpose of injecting water, steam, or any other fluid or substance into the earth.

**Environmental Impact Report (EIR)** is an informational document which provides public agencies and the general public with detailed information about the effect that a proposed project is likely to have on the environment. The EIR also lists the ways in which these environmental effects might be minimized and whether there are any alternatives to such a project.

**Epidemiology** is the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems.

**Frack-pack** is commonly used to re-direct the flow to prevent sand from entering a well and to bypass damaged zones near a well. As opposed to hydraulic fracturing intended to open permeable fracture pathways in unconventional reservoirs to enable oil or gas production, frac-packs are employed to deal with formation damage around a production well and/or sand production into the well.

**Gravel pack** is a method of controlling sand production that involves installation of a cylindrical metal screen in a production zone of a well in with the annulus between the screen and the casing (or formation if not cased) is filled with fluid slurry containing gravel. Gravel pack pressures are kept below fracture pressures.

**Grey literature** consists of materials and research produced by organizations outside of the traditional commercial or academic publishing and distribution channels, e.g. reports, working papers, government documents, etc.

**Hazard** is any biological, chemical, mechanical, environmental, or physical stressor that is reasonably likely to cause harm or damage to humans, other organisms, the environment, and/or engineered systems in the absence of control.

**Health Risk Assessment (HRA)** is a technical study that evaluates how toxic emissions are released from a facility, how they disperse throughout the community, and the potential for those toxic pollutants to impact human health.

**Hydraulic fracturing** is a process to produce fractures in the rock formation that stimulates the flow of natural gas or oil, increasing the volumes that can be recovered. Fractures are created by pumping large quantities of fluids at high pressure down a wellbore and into the target rock formation.

**Idle well** is any that has not been used for the production of oil and gas, the production of water for the purposes of enhanced oil recovery or reservoir pressure management, or injection for a period of 24 consecutive months.

**Impact** (or consequence) is the particular harm, loss, or damage that is experienced if the risk-based scenario occurs.

**Mitigation** is ongoing and sustained action to reduce the probability of, or lessen the impact of, an adverse incident.

**Orphan** is a well, pipeline, facility or associated site which has been investigated and confirmed as not having any legally responsible and/or financially able party to deal with its abandonment and reclamation responsibilities.

**Risk** incorporates the likelihood that a given hazard plays out in a scenario that causes a particular harm, loss, or damage. In quantitative risk assessments, risk is calculated as likelihood multiplied by impact.

**Unconventional** oil and gas operations allow for drilling down, drilling horizontally, and/or fracking to allow oil and gas to be explored, developed and produced. This compares to conventional processes that use the natural pressure of the wells, or water/gas injection, and pumping or compression operations to extract oil and gas resources.

**Well** is any oil or gas well or well drilled for the discovery of oil or gas; any well on lands producing or reasonably presumed to contain oil or gas; any well drilled for the purpose of injecting fluids or gas for stimulating oil or gas recovery, repressuring or pressure maintenance of oil or gas reservoirs, or disposing of waste fluids from an oil or gas field; any well used to inject or withdraw gas from an underground storage facility; or any well drilled within or adjacent to an oil or gas pool for the purpose of obtaining water to be used in production stimulation or repressuring operations.

**Well stimulation treatment** means a treatment of a well designed to enhance oil and gas production or recovery by increasing the permeability of the formation. Examples of well stimulation treatments include hydraulic fracturing, acid fracturing, and acid matrix stimulation.

**Workover** means to perform one or more of a variety of remedial operations on a producing well to try to increase production, e.g. deepening, plugging back, pulling and resetting liners, squeeze cementing, etc.



## Appendix A – Public Health Screening Assessment

<b>Facility:</b>			
<b>Issue</b>	<b>Checklist Code</b>	<b>Determinations Contributing to Higher Degree of Public Health and Safety Impact Ranking</b>	<b>Findings</b>
<b>Public Health Risk</b>			
<b>High Priority Risk Items</b>			
Land Use and Zoning		Proximity to residential or other public receptor locations (multiple receptors within 300')	
Hydrogen Sulfide		High H <sub>2</sub> S levels (>500 ppm within process systems)	
Wellhead Pressures		High well head pressures (>250 psig)	
Historical Activities		High levels of drilling onsite (> 4/year) contributing to noise, traffic and accident risk	
<b>Risk Contributing Items</b>			
<b>Public Health</b>			
Sensitive Populations and children		Proximity to residential areas or other sensitive populations (e.g. schools, hospitals, senior communities, homeless)	
Socioeconomic Status and health disparities	CalEnviroscreen	Surrounding community faces socioeconomic or health disparities and challenges	
<b>Environmental</b>			
<b>General Facility Operations</b>			
History		Older facilities (> 25 years)	
Gas treatment		The use of gas treatment equipment onsite	
Steam recovery		The use of steam generation onsite	
Gas pipeline pressure		High gas pipeline pressures	
<b>General/Other</b>			
PRV to atmosphere	G.2-3	Venting to atmosphere	
Flares availability	G.8	Flares not available	
<b>Noise</b>			
Sound proofing for drilling closer than 500'	N.2	No soundproofing for facilities within 500'	
Pure tones		Pure tones or low frequency	
Deliveries time limits	N.4	No time limits on deliveries	



<b>Facility:</b>			
<b>Issue</b>	<b>Checklist Code</b>	<b>Determinations Contributing to Higher Degree of Public Health and Safety Impact Ranking</b>	<b>Findings</b>
<i>Aesthetics/Infrastructure</i>			
Derricks removed, unused equipment	FI.2, FI.3, FW.4	Presence of older equipment	
Sumps: hazard to people, screening	SM.4, SM.6, SM.10, SM.11	Hazardous, no screening on top, electrical/trip fall hazards	
<i>Air Quality</i>			
Air Toxics		Part of the AQMD AB2588 program	
Monitoring systems within 1500' of residences	AQ.7	No monitoring systems	
<b>Safety</b>			
<i>Drilling</i>			
Drill sites 75' from boundary, 100' from buildings, 300' of a residence	D.2	Closer than prescribed distances	
Drill sites within 500' of a residence	D.5, N.2, N.3	Closer than 500' and not using sound proofing methods	
<i>Setbacks</i>			
Critical wells	SB.3, SB.4	Critical well and free-flowing production	
Wells 20' highway, 75' street, 100' building, 300' school, 25' of ignition sources?	SB.6, SB.7, SB.8, SB.9, SB.10	Closer than setback distances or close to powerlines due to rig height	
<i>Gas Pipelines</i>			
Inspection history	PL.1	No internal inspection history	
Alarms and shutdown	PL.5 – PL.8	No procedures or systems, manual shutdown, no 24 hr attendance	
Pipeline signs and labeling		No markings or warning signs posted along visible pipelines going through private driveways, parking spaces, other traffic roads	
<i>Fire</i>			
Sufficient clearance	F.3	Poor fire preparation	
Fire water capabilities	F.4 – F.5	Inadequate fire water	
Hazardous Materials	HM.8	Transportation of highly hazardous materials through residential areas	
ERP: Drills	ER.2 - ER.3	Inadequate ERP and drills	
Security: Fencing	S.1-S.5	Inadequate fencing	



<b>Facility:</b>			
<b>Issue</b>	<b>Checklist Code</b>	<b>Determinations Contributing to Higher Degree of Public Health and Safety Impact Ranking</b>	<b>Findings</b>
<b>Documentation</b>			
AQMD 1173 reports: odors, GHG, toxics emissions		High numbers of leaking components	
AQMD Odor Complaints		Multiple odor complaints	
AQMD NOV/NTC		Multiple NOV/NTC	
Fire: annual inspection		Inspection report findings	
Public Health: complaints		Multiple complaints	
DOGGR: inspection reports		Inspection report findings	
ERP		ERP not available or inadequate	
<b>Wells/facilities within 100' feet of waterways</b>			
Wells/facilities within 100' feet of waterways	SB.3	Located closer than 100' to waterways	
Could a release affect nearby creeks?	SC.5	Could affect nearby creeks	
Adequate secondary containment?	SC.2 – SC.5	Lack of secondary containment/berms	
Sufficient onsite spill cleanup and control equipment?	SP.17	Lack of onsite control equipment and personnel responsible for cleanup	
Crude/Emulsion Pipelines: Inspection	PL.1	No internal inspection history	
Crude/Emulsion Pipelines: Alarms and shutdown	PL.5 – PL.8	No procedures or systems, manual shutdown, no 24 hr attendance	
SPCC	SP.1 – SP.21	SPCC inadequate	
<b>Site Contamination Risk</b>			
Does the site history indicate the potential for site contamination?	G.12	Potential history of tank farm or other activity indicating potential for contamination	