Unconventional oil and gas (OG) activity is growing in Colorado, primarily in areas with rapidly growing suburban populations. People living near OG sites have reported multiple acute health symptoms, frequently coinciding with noticeable odors during drilling and completion activities. While Colorado conducts regional air quality monitoring in OG regions, local scale air monitoring of volatile organic compounds (VOCs) near active OG sites is limited. This information is critical to adequately characterize public health risks from OG-related exposures, especially during times when communities report health symptoms and odors.

The Oil and Gas Health Information and Response (OGHIR) program at the Colorado Department of Public Health and Environment (CDPHE) received odor and health concern reports from approximately 50 residents in neighborhoods near a newly operating OG site. Residents reported eye, nose, and throat irritation, nosebleeds, respiratory effects such as lung irritation and difficulty breathing, headaches, and nausea.

OGHIR documented that many of these health and odor concerns occurred at the time when drilling operations were ongoing at the site, and when wind direction was coming from the direction of the well pad.

In response to reported health and odor concerns, we deployed the Colorado Air Monitoring Mobile Laboratory (CAMEL) in the community to collect air data and meteorology for a total of 55 days (Figure 2).

Figure 1. Summary of health symptoms reported to OGHIR

<table>
<thead>
<tr>
<th>Activity</th>
<th>Total Days</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling</td>
<td>12</td>
<td>192</td>
</tr>
<tr>
<td>Fracturing</td>
<td>14</td>
<td>200</td>
</tr>
<tr>
<td>Flowback</td>
<td>22</td>
<td>336</td>
</tr>
</tbody>
</table>

One-hour averages were aggregated to derive means and maximum values of each VOC during each phase.

Acute and chronic non-cancer and cancer risk estimates for the VOCs were evaluated.

Results

Figure 2. The Colorado Air Monitoring Mobile Laboratory (CAMEL) with an onboard GC-MS and meteorological capabilities.

Table 1. Cancer risk estimates for one classified carcinogen. The upper bound IUR estimate of 7.8 x 10^-6 for benzene was conservatively selected for this assessment.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Average Air Concentration (ppbV)</th>
<th>Cancer Risk Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>0.041</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Combined Risk: Flowback > Drilling > Hydraulic Fracturing (Fig. 6)

- High level of variability (5-100-fold) in individual VOC air concentrations
- All VOCs during all development activities were below health guideline levels for acute and chronic non-cancer health effects.
- Benzene, isopropene, hexane, methycyclopentane, and xylenes contribute the greatest proportion of risk during development activities. All other VOCs have negligible contributions.
- Combined Risk: Flowback > Drilling > Hydraulic Fracturing (Fig. 6)
- Average benzene measurements were above the midpoint of EPA’s excess cancer risk range during flowback and below for all other phases.

Conclusions

- The evaluation of the air samples during this time indicated a low risk of acute and chronic health effects due to VOC exposures in the vicinity of these oil and gas operations.
- Evaluation of health concerns reported by residents in the vicinity of the OG site suggest upper respiratory irritation and other physiological responses to odors.
- Many of these concerns occurred temporally with drilling operations on the site when residents reported that wind direction was coming from the direction of the well pad.
- Continued regional air quality monitoring along with additional site-specific community level air sampling is needed to target exposure characterization and risk assessment in potentially exposed communities.
- Air monitoring studies like these that continuously measure concentrations of a sub-set of high priority VOCs during multiple phases of operation, and during times when citizens are experiencing health symptoms will provide additional important exposure information.

Limitations

- This air sampling represents VOC concentrations from all emission sources in the area. Samples collected under different conditions could have different results.
- Other substances that may be emitted from OG or other nearby facilities were not sampled in this study and exposure to these substances may result in additional health risk or contribute to the reported health symptoms and odors.
- Whether the VOCs in the air will have a harmful effect on an individual’s health depends upon many factors that are not all measured in this risk assessment. These include nonchemical factors such as age, family traits (i.e. genetics), and lifestyle behaviors.
- Odor concerns cannot be fully evaluated due to the lack of information regarding odor thresholds associated with physical symptoms and the combined effects of odors from multiple substances.

Study Objective

To evaluate community level health risks from exposures to OG-related VOCs emitted during different development activities.

Methods

- The CAMEL was stationed 1,000 feet downwind from the well pad between the well pad and neighborhood (Figure 3).
- 64 volatile organic compounds (VOCs) and select criteria air pollutants were measured.
- Add methods of collection (GC-MS)

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CDPHE Official Report

The official report from the Oil and Gas Health Information and Response Program can be found at: https://www.colorado.gov/oghealth

Evaluation of Air Exposures and Health Risks in a Community During Oil and Gas Development

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