

STRESSOR AND EXPOSURE CHARACTERIZATION

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Issues reviewed by the Committee

- **Potential total human exposure**
 - Multiple types of possible OGD-related stressors
 - Multiple potential pathways and media of exposure
 - Separate research questions prepared for two potential media of exposure: “local air quality” and “water quality”
- **Potential total ecological exposure**
 - Later this morning in the ecological presentation
- **Chemical toxicity (human and ecological)**
 - The need for toxicity studies of OGD wastewater or fracturing fluid depends on the type and magnitude of potential exposure



Cross-cutting themes important to characterizing stressors and exposures

- **Background** – many other (anthropogenic and biogenic) sources of the same stressors
- **Variability** in the degree and type of exposure experienced among people in nearby communities
 - temporal, spatial, facility design and operation, geology, industry operations
- **Permitted vs. accidental vs. unauthorized** releases



Total Human Exposure

Research Questions

- **Are there human exposures of concern to OGD stressors and, if so, how can total human exposure be estimated?**
- **What exposure pathways and phases of OGD should be considered in estimating the exposure?**

Relationship to ongoing research: Much has been written about the potential for exposure (e.g., Maryland Institute for Applied Environmental Health 2014, Penning et al. 2014, Adgate et al. 2014, National Research Council 2014, and EPA 2015), but strong measures of human exposure are sparse. The recommended research would expand on initial efforts to quantify exposure, with carefully selected study populations and high-quality study designs that incorporate improved exposure metrics.



Total Human Exposure

Research Goals and Examples of Research Activities

- **Goals:** Identify and quantify health stressors associated with OGD to which people might be exposed.
- **Example activities:**
 - Perform exposure assessments that incorporate findings from recommended air and water quality research
 - Conduct rigorous monitoring of exposures with the potential to adversely affect health
 - Quantify exposures to multiple health stressors and by multiple exposure pathways in some cases.

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Local Air Quality

Research Question

- **What are the effects of OGD emissions on local air quality?**

Relationship to ongoing research: Some previous research has examined local air quality issues (e.g., McKenzie et al. 2012, Zielinska et al. 2010; Moore et al. 2014; Roy et al. 2014; Goetz et al. 2015; Olaguer et al. 2012; Petron et al. 2012, Warneke et al. 2013). Need to expand and improve on past studies to better understand exposures – high temporal resolution, more diverse set of sites, broader spatial patterns. The recommended research would provide a framework for understanding potential effects and whether any are attributable to OGD.



Local Air Quality

Research Goals and Examples of Research Activities

- **Goals:** Quantify the contribution of emissions from OGD to the local concentrations of a wide range of chemicals in outdoor air.
- **Example activities:**
 - Quantify short- and long-term concentrations during the life cycle of a well (i.e., development and production) and across the production system (e.g., well pads, gathering facilities, compressor stations, and processing plants).
 - Study multiple sites, including those with intermittent or unusually high emission rates.
 - Compare the impacts of activities related to OGD with those from unrelated activities.

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Water Quality

Research Questions

- **What are the surface water and groundwater quality conditions before, during, and after OGD?**

Relationship to ongoing research: A great deal of research and scientific debate has focused on the potential for OGD to affect groundwater and surface water quality (e.g. Rodriguez and Soeder 2015; Vidic et al. 2014; Parker et al. 2014; Hladik et al. 2014; Warner et al. 2013; Ferrar et al. 2013; Llewellyn et al. 2015; Darrah et al. 2014; Jackson et al. 2014; Osborn et al. 2011; Molofsky et al. 2013). The recommended research would provide a framework for understanding potential effects and whether any are attributable to OGD.



Water Quality

Research Goals and Examples of Research Activities

- **Goals:** Quantify the contribution of OGD on short- and long- term trends in the quality of water.
- **Example activities:**
 - Design the optimal framework for determining baseline conditions and assessing impacts on water resources with the broadest possible geographic applicability
 - Implement the framework at a variety of sites that represent the variability encountered across the Appalachian region
 - Analyze and interpret the resulting data to identify short- and long-term trends in the quality of water resources.



Chemical Toxicity

Research Questions

- **What are the composition and toxicity of chemical mixtures unique to OGD and how can their toxicities be determined?**

Relationship to ongoing research: Research continues on understanding the composition and toxicity of OGD wastewater and hydraulic fracturing fluid (e.g., US EPA 2015, Ziemkiewicz and He 2015, Stringfellow et al. 2014); the proposed work would build on past efforts by improving understanding of the toxicity of these mixtures and prioritizing study of mixtures/exposure levels most relevant to understanding risk to people and the environment.



Chemical Toxicity

Research Goals and Examples of Research Activities

- **Goals:** Improve understanding of the composition and toxicity of OGD wastewater and hydraulic fracturing fluid, as well as exposure levels.
- **Example activities:**
 - Conduct toxicological evaluations where they would be helpful in decision-making about the protection of human and ecological health.
 - Such testing could be useful in some contexts, for example, to help local public health and other authorities if they need to respond to accidental releases to the environment.

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