



AIR QUALITY IMPACTS OF OIL AND NATURAL GAS DEVELOPMENT: NETL AIR SAMPLING INITIATIVES



Marcellus Shale Summit

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Environmental Impacts of Oil and Gas Development

Energy Policy Act of 2005, Title IX, Subtitle J, Section 999

To ensure that oil and gas development proceeds at a rate that protects the environment while maintaining an adequate domestic supply by researching environmental impacts and developing environment friendly technologies and/or management strategies

- **Air Quality Impacts Research**
 - 1) Conducted targeted, on-site measurement of pollutant concentrations to quantify impact
 - 2) Use the information as input or to verify atmospheric chemistry and transport models



Challenges

- **Establish contributions from background vs. multiple point emission sources**
 - Pollutants vary by activity: diesel drilling rigs, condensate tanks, compressor stations, truck traffic are sources of PM_{2.5}, ozone, NO_x, VOCs
 - Background concentrations in eastern US already high
 - Seasonal and diurnal variation in background emissions
 - Variations in measured species from photochemical and ‘aging’ effects
- **Adapt a combination of predictive models, validated with field data**
- **Determine aggregate effects on regional air quality**

Ambient Air Monitoring



Mobile Air Monitoring Laboratory

- **VOC's** (52 components on the EPA PAMS list)
- **Ozone**
- **SO₂**
- **NO_x** (NO, NO₂ and NO+NO₂)
- **PM_{2.5} and PM₁₀**
- **Ions (particle and gas phase):** Sulfate, Nitrate, Nitrite, Phosphate, Chloride, Bromide, and Fluoride
- **Ammonia**
- **Organic and Elemental Carbon in Aerosols**
- **Meteorological station** (temperature, relative humidity, wind speed, wind direction, rainfall, solar radiation)
- **Radon**
- **Methane and C₁-C₅ Hydrocarbons**

Volatile Organic Compounds (VOCs)

Acetylene

n-Butane

1-Butene

cis-2-Butene

trans-2-Butene

Cyclopentane

2,2-Dimethylbutane

2,3-Dimethylbutane

Ethane

Ethylene

1-Hexene

Isobutane

Isopentane

Isoprene

n-Pentane

1-Pentene

2-Methylpentane

3-Methylpentane

cis-2-Pentene

trans-2-Pentene

Propane

Propylene

Benzene

Cyclohexane

n-Decane

m-Diethylbenzene

p-Diethylbenzene

2,3-Dimethylpentane

2,4-Dimethylpentane

n-Dodecane

Ethyl Benzene

o-Ethyltoluene

m-Ethyltoluene

p-Ethyltoluene

n-Heptane

n-Hexane

Isopropylbenzene

n-Octane

Methylcyclohexane

Methylcyclopentane

2-Methylheptane

3-Methylheptane

2-Methylhexane

3-Methylhexane

n-Nonane

n-Propylbenzene

Styrene

Toluene

1,2,3-Trimethylbenzene

1,2,4-Trimethylbenzene

1,3,5-Trimethylbenzene

2,2,4-Trimethylpentane

2,3,4-Trimethylpentane

n-Undecane

o-Xylene

m/p-Xylene (combined)

Allegheny National Forest Monitoring Campaign

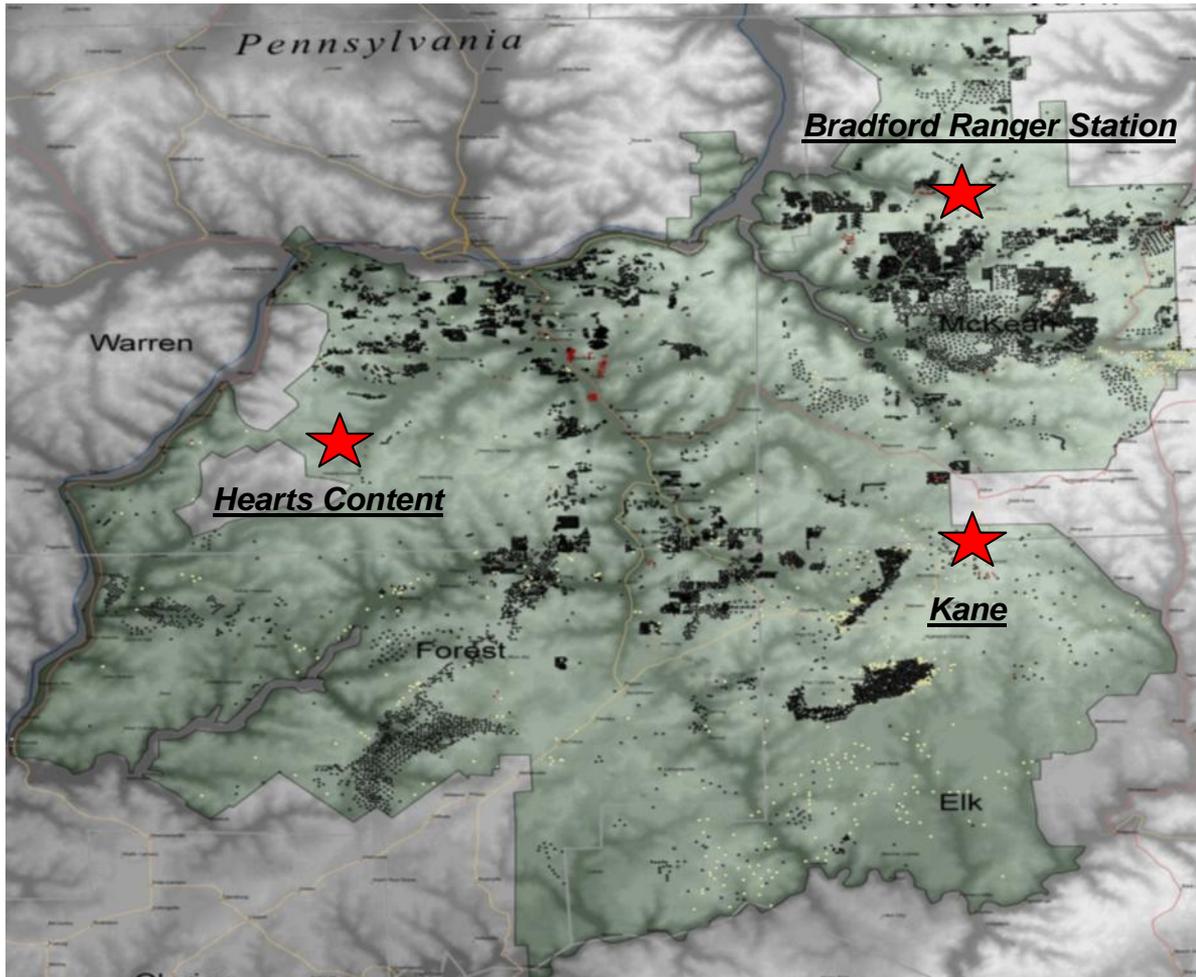
- Air quality monitoring was conducted in the Allegheny National Forest (ANF) in July 2010- June 2011
- ANF is a 513,000 acre forest in northwestern PA
- 8,000 wells in the ANF in 2005; currently >12,000



Allegheny National Forest



Air Monitoring Sites in Allegheny National Forest

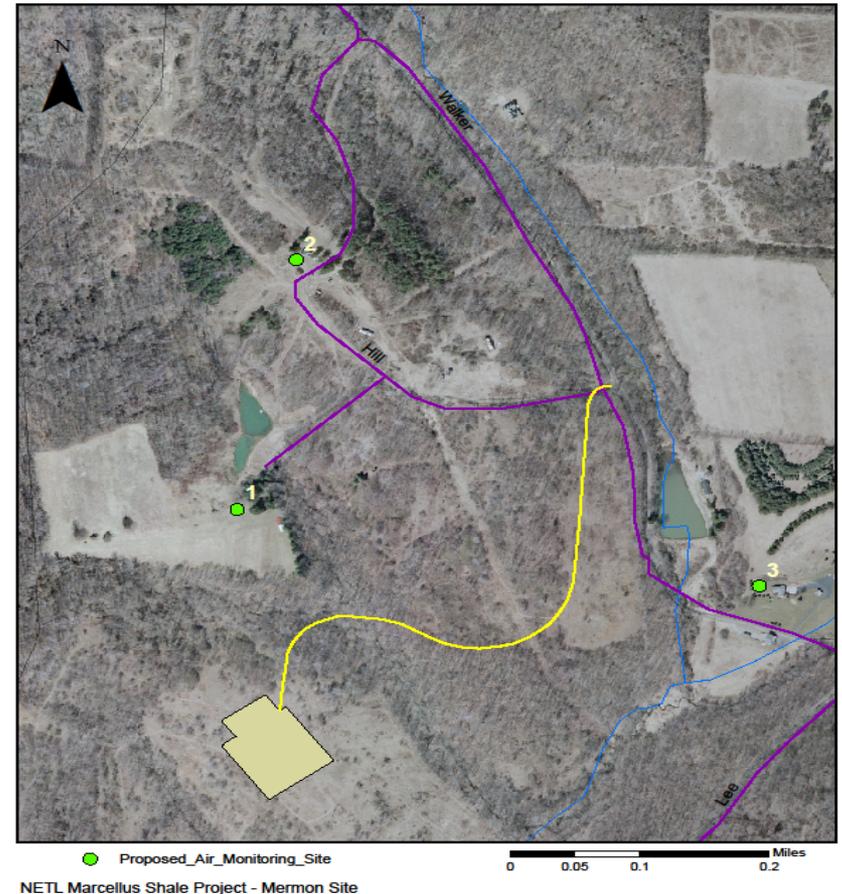


Conclusions

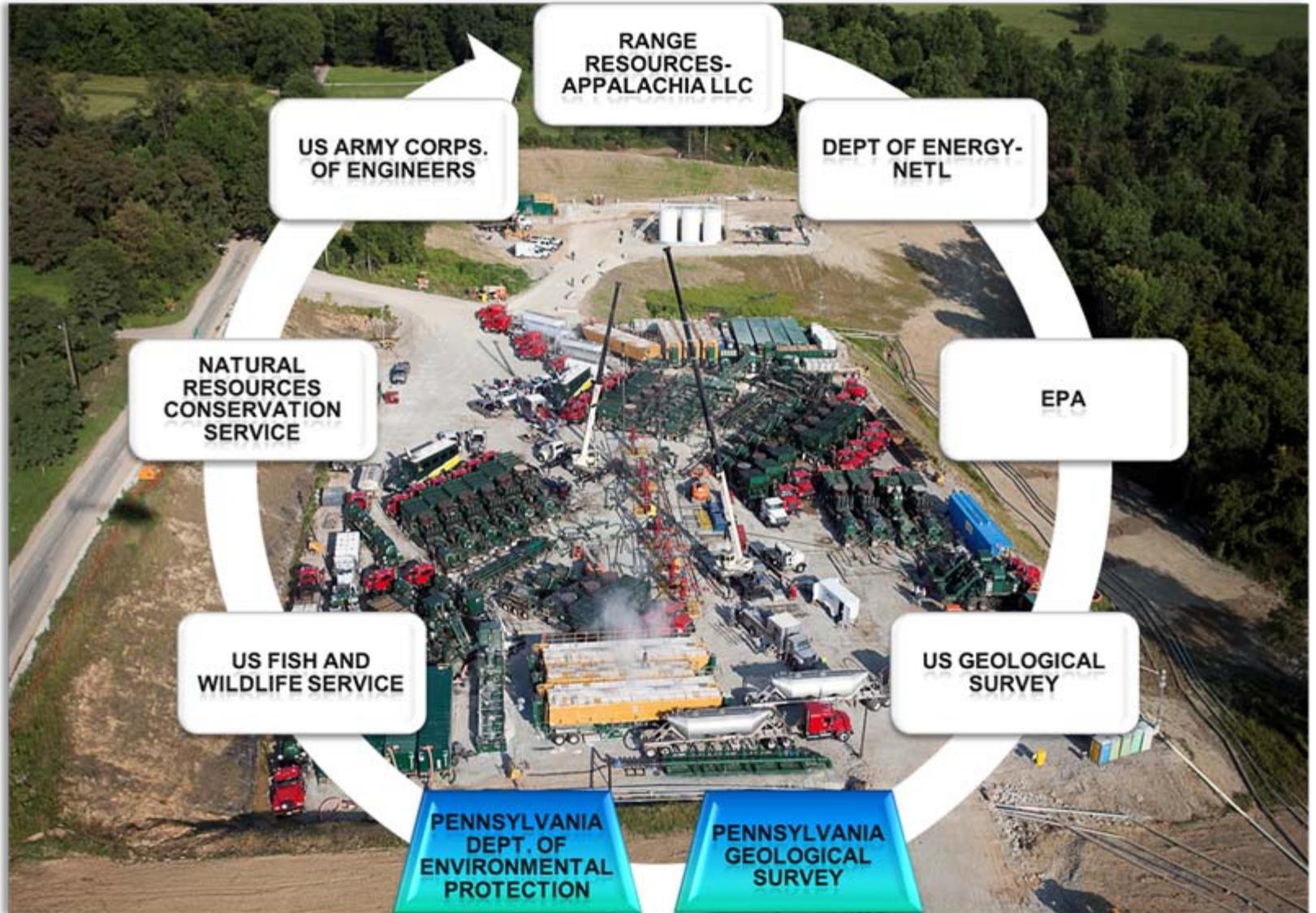
- **Concentrations of NO_x, PM₁₀, PM_{2.5}, and ozone were well below the National Ambient Air Quality Standards**
- **Several VOCs were consistently detected but concentrations were typically less than 10ppb**
- **Not yet apparent if the results from the three sites are significantly different**
- **An analysis of remaining data, along with meteorological data, will be conducted as well as atmospheric modeling to determine the specific sources or source areas of the measured pollutants**

Current Monitoring Effort: Marcellus Test Well Site, Washington County, PA

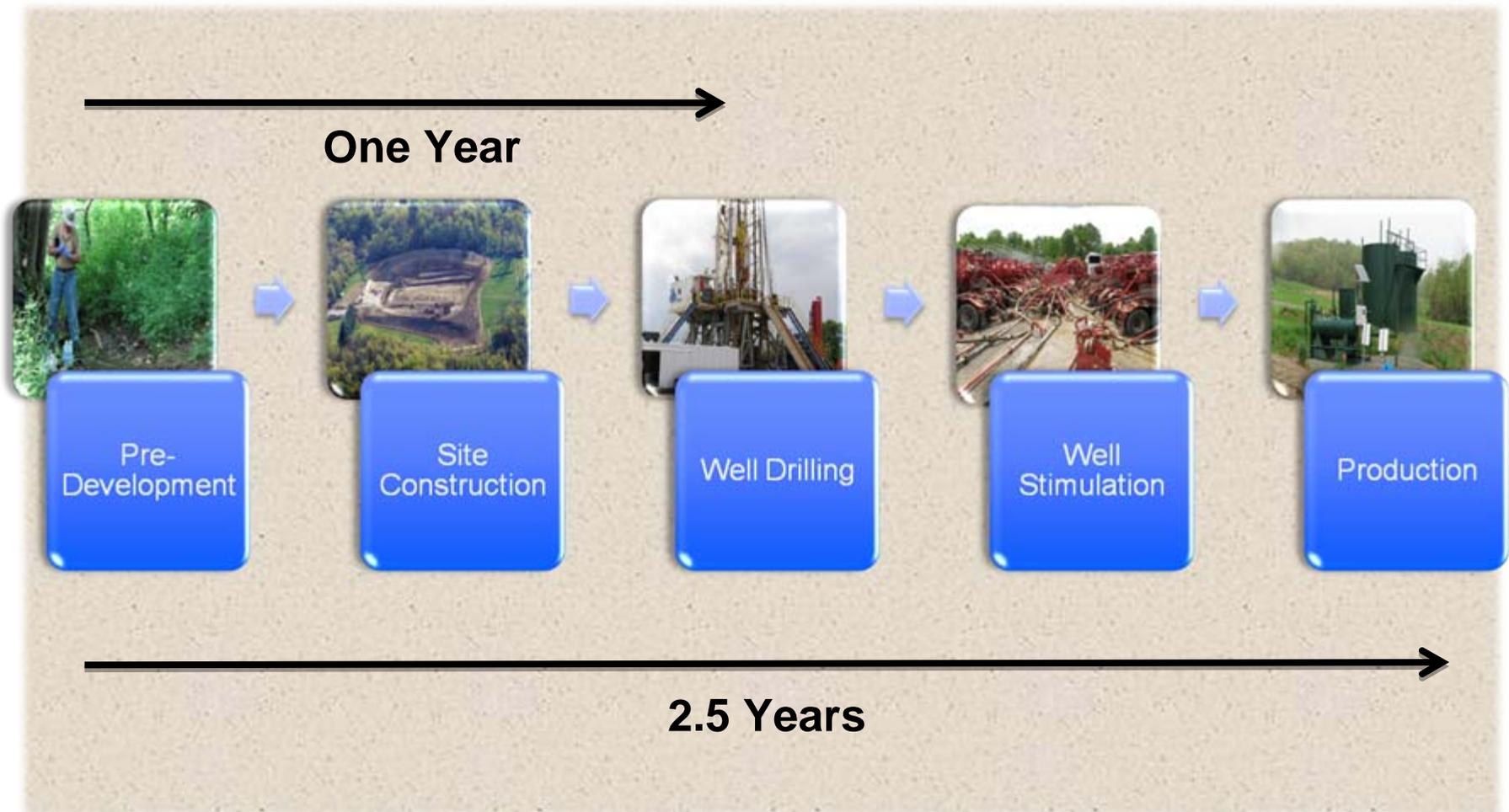
- Site has been designated an EPA Hydraulic Fracturing Task Force Prospective Case Study
- Mobile Air Monitoring Laboratory has been operating at the site since July 2011
- Currently collecting background data prior to any operator activity at the site
- Collection of data will continue through well pad construction, drilling, fracking, and production



Marcellus Test Well Site Monitoring Team



Environmental Monitoring Timeline



Marcellus Test Well Site



Marcellus Test Well Site: NETL Projects

- **NETL has collected water samples from nearby streams; the samples are currently being analyzed**
- **Two baseline electromagnetic surveys to detect unwanted migration of production waters**
- **NETL will perform baseline methane surveys, both in air and in soil gas**



Marcellus Test Well Site: Other Agencies



- **US Fish and Wildlife Service:** Bat listening devices (site is on major bat migration pathway in western Pennsylvania)
- **USGS:** Groundwater monitoring wells
- **Penn State University (funded by Dept of Agriculture NRCS):** soil investigation, including ground penetrating radar surveys
- **PA DEP:** Fish and macroinvertebrate surveys of nearby streams and a large pond below the proposed drill pad

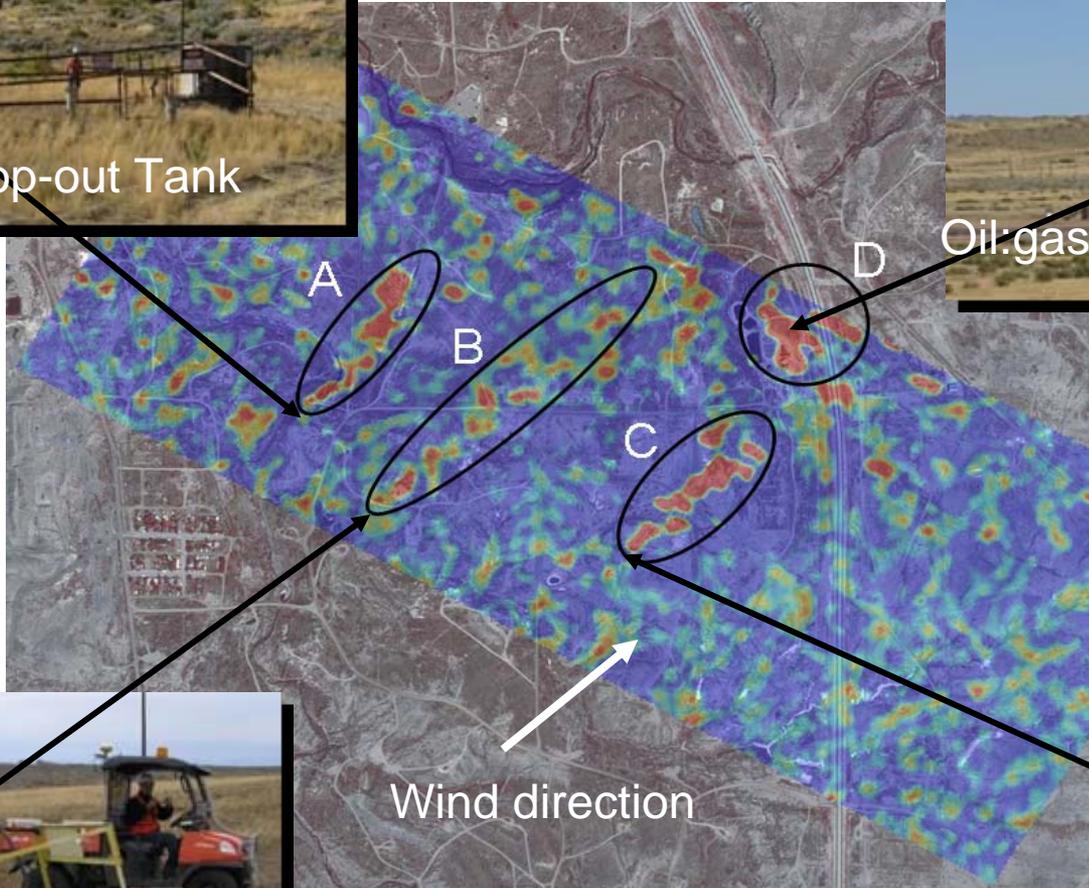
Life Cycle Inventory of Fugitive Emissions From Shale Gas Operations

- **Use a life cycle assessment framework to develop improved characterizations of GHG emissions**
- **Reduce uncertainties associated with emissions from key activities and process elements of site development and resource extraction**
- **Assess emissions performance of alternative operational scenarios**
- **2012: Inventory of methane emissions from select water handling activities associated with shale gas development and production**
- **2013 and beyond: Inventory of emissions from other activities/processes; Conduct life cycle analyses to examine conventional vs. low-emissions shale gas development scenarios**

Methane Surveys



Point Emission Sources



Wireless Air Monitoring Station



