

Healthy Air Questionnaire Final Report

Clean Air & Healthy Communities

I. Introduction

Sublette County, in the center of the Upper Green River Valley in Western Wyoming, was once known for its exceptionally clean, clear air, with one hundred-mile views that reached to the surrounding Wind River, Wyoming, Gros Ventre and Uinta mountain ranges. Sublette's clean air was primarily due to a very low human population, with the principal economic activities centered on federal agency employment, cattle ranching and tourism.

Today, the Upper Green River Valley is a proposed, U.S. Environmental Protection Agency (EPA) non-attainment area for ozone, and has received the state's first Wyoming Dept. of Environmental Quality (DEQ) "ozone advisories" ever issued. The main constituents of Sublette's high ozone levels are Volatile Organic Compounds (VOCs) and nitrogen oxides (NOx) which come from natural gas field emissions rapidly developing within the valley.

Ground-level ozone is dangerous not only for healthy residents, but especially for those with existing breathing problems, children, and the elderly.

- Experts writing in the respected *New England Journal of Medicine* conclude that people are at risk of premature death from respiratory causes in association with increases in ozone concentration.¹
- Sublette County air quality has received an ozone grade of "F" from the American Lung Association.² Of Sublette residents, more than 2,300 people are at greater risk for cardiovascular disease, and 2,255 children, more active when they are outdoors, face greater risk of infection, coughing and bronchitis from air pollution. They may even suffer from lower lung function, putting them at greater risk of lung disease as they age. Over 770 older residents also face a greater risk of respiratory and cardiovascular problems from breathing ozone.
- DEQ air quality monitors registered 13 days between January and March when ozone levels exceeded the eight-hour health standard of 75 parts per billion (ppb). That includes a March 2 ozone reading of 166 ppb -- higher than the worst ozone levels recorded last year in Los Angeles.

¹ Jerrett, Michael, Ph.D., Richard T. Burnett, Ph.D., C. Arden Pope III, Ph.D., et al. Long-Term Ozone Exposure and Mortality. *N Engl J Med* 2009; 360:1085-95.

² American Lung Association: <http://www.stateoftheair.org/2011/states/wyoming/sublette-56035.html>

II. Background

The Wyoming Dept. of Environmental Quality (DEQ) maintains air quality monitors at sites around the Upper Green River Valley, and has recorded meteorological information and levels of particulate matter, ozone, and nitrogen dioxide since 2005.³

According to the DEQ, ozone is created at ground level generally during the months of Feb. through April in the Upper Green River Basin.⁴ Ozone forms when NO_x and VOCs from local natural gas field infrastructure is met with snow cover, sunlight, and low winds under the lid of wintertime, valley inversions. This unusual phenomenon is in contrast to ozone formation that normally occurs during summer months in urban areas. Not to be confused with atmospheric ozone, excessive amounts of ground-level ozone can increase the risk of premature death from respiratory causes.

Sublette County ozone has become the subject of several research and monitoring projects and intense interest by the scientific community. However, the studies have focused primarily on the causes and levels of wintertime ozone, with little attention to the direct human impacts and physical symptoms experienced by Sublette County residents.

During early February, 2011 Citizens for Responsible Energy Development (CURED) and the Upper Green River Alliance (UGRA) distributed a *Healthy Air Questionnaire* to Sublette County residents, with relevant questions about the air they breathe as they live, work and recreate in Sublette County.

The *Healthy Air Questionnaire* was designed to serve two main purposes:

1. To educate residents and increase public awareness of the potential health risks associated with local air pollution.
2. To assess whether people are experiencing documented symptoms associated with breathing ozone and Toxic Air Contaminants.

Additionally, a “Sublette County Human Health Risk Assessment Air Toxics Inhalation” project workplan (see Appendix A) conducted by Sublette County, the Wyoming Dept. of Health, and the Wyoming DEQ was intended to examine the broad question of “whether air pollutant emissions from gas extraction activities pose any significant risk of adverse health effects.”

The Upper Green River Alliance and Citizens United for Responsible Energy Development were contacted by citizens expressing health concerns about breathing ground-level ozone and Toxic Air Contaminants. The two organizations

³ <http://www.wyvisnet.com/all.aspx>

⁴ <http://deq.state.wy.us/aqd/Ozone/Pinedale%20Public%20Meeting%20on%20January%202010%20EI%20v4.pdf>

were interested in physical symptoms that concerned citizens may have experienced during ozone events that were not considered in other scientific studies, and so asked randomly-selected Sublette County residents about their reactions during the winter “ozone season.”

III. Procedures

A two-page *Healthy Air Questionnaire* (see Appendix B) was developed by UGRA and CURED, based on health risk information from the American Lung Association and EPA. Prior to finalizing the survey, two individuals in the medical field were asked to review the survey and make corrections and/or suggestions.

The survey was sent to 105 households in the areas of Boulder, Pinedale, Cora, and Daniel using mailing addresses obtained from the Sublette County GPS system. The surveys were mailed, along with a cover letter and contact information, during the week of Feb. 7, 2011 and recipients had two weeks to return the survey. All information was to be kept confidential. Recipients were given the opportunity to provide their names if they wanted a copy of the survey results.

Data was compiled using Microsoft Excel and analyzed using descriptive statistics. Comments made by individuals were also recorded (see Appendix C).

IV. Results

Completed surveys were received from 23 households, constituting a 22% return rate. The households reported on a total of 43 people (22 females and 21 males). The age range was one (1) to 83 years of age, with a mean of 56.44 and a standard deviation of 15.93.

None of the 43 individuals reported they were current smokers. Three males and one female indicated they had been a smoker five or more years ago.

Fifty-one percent (51%) of all individuals in the survey work out-of-doors and 89% recreate out-of-doors.

No established patterns or relationships were detected between where respondents lived, worked or recreated.

Sixty-seven percent (67%) of all respondents reported that they had one or more of the following symptoms: persistent irritation in throat/nasal passage/chest; persistent cough; watery/itchy eyes; uncomfortable sensation in chest; rapid and shallow breaths while exercising or working out-of-doors; sudden onset of headache; dizziness; and nausea. Other symptoms experienced by respondents are listed in Table A. Thirty-eight percent (38%) of these people indicated they had three or more symptoms.

**Table A
Health Effects**

	Female	Male	Total
Persistent irritation in throat/nasal passage/chest	6	7	13
Persistent cough	4	5	9
Uncomfortable sensation in chest	2	2	4
Breathing in uncomfortable painful	1	1	2
Rapid and shallow breaths while exercising or working out-of-doors	3	2	5
Watery/Itchy eyes	10	6	16
Skin irritation	4	3	7
Decreased sense of taste and/or smell	1	1	2
Irregular heart rate	3	1	3
Sudden onset of headache	7	3	10
Dizziness	6	1	7
Nausea	3	0	3
Depression or mood swings	4	3	7

The three most-noted symptoms were:

1. Watery/itchy eyes: 37%
2. Persistent irritation in throat/nasal passages/chest: 30%
3. Sudden onset of headache: 23%

Eleven survey respondents reported smelling an uncommon odor, and the most noted description was that of a chemical smell. Four people felt the odor was coming from the gas fields, and one identified the Pinedale sewer lagoon as a source of odor.

V. Discussion

The *Questionnaire* was administered during what has become known as Sublette County's "ozone season" to attempt to identify physical effects felt by local residents as they recreate and work outdoors when high ozone levels are present. However, we acknowledge that the *Healthy Air Questionnaire* is a limited study in both sample size and length of sampling time.

The response rate was approximately 22% of all *Questionnaires* sent. Had the study extended into March when ozone levels far exceeded health standards, we may have received more responses. The return rate may also have been influenced by a perception of bias against local natural gas development, or by a general attitude about any survey's usefulness.

Nonetheless, we were able to discern a pattern among respondents, which corresponds with symptoms recognized in the scientific literature that are associated with inhaling either ozone or Toxic Air Contaminants.

Scientific studies on breathing ozone have shown increased hospitalization from respiratory causes.⁵ The *Questionnaire* respondents reported increases in respiratory and eye, nose and throat irritation.

While Sublette County doesn't have a hospital, the local medical clinic reported an increase in visitation for respiratory causes during the high ozone episodes of this past winter.⁶

It should be noted that gas field workers and others who work or recreate outdoors may experience greater exposure to pollutants than those who stay indoors, not only through inhalation, but also through dermal exposure. However, it is difficult to track health impacts on the oil and gas industry workforce because it is typically transient.

Smokers may be especially at risk due to the synergistic effects of ozone exposure and cigarette smoke.⁷ Individual responses to air pollutants may vary depending on age, gender, and lifestyle.

The "Sublette County Human Health Risk Assessment Air Toxics Inhalation" project, which in the final report was re-named, "Screening Health Risk Assessment, Sublette County, Wyoming,"⁸ "did not address a detailed analysis of ozone data collected

⁵ Koken PJ, Piver WT, Ye F, Elixhauser A, Olsen LM, Portier CJ. 2003. Temperature, air pollution, and hospitalization for cardiovascular diseases among elderly people in Denver. *Environ Health Perspec*; 111: 1312-1317

⁶ Casper Star Tribune: "Sublette ozone spikes continue." http://trib.com/news/local/state-and-regional/article_02afbccc-66cc-5178-84a6-d4644c3ff1c7.html

⁷ <http://toxsci.oxfordjournals.org/content/65/1/1.full.pdf> (Bhalla 2002)

⁸ <http://www.sublettewyo.com/DocumentView.aspx?DID=438>

during the monitoring program,” even though the work plan “intended to describe a proposed study of the risks to human health for citizens of Sublette County who are exposed to air toxics and ozone as they live and work in the County.” (Appendix A). The “Health Risk Assessment” final report mentions ozone only briefly: “the lack of an exceedance during the air toxics monitoring program discussed herein, and the infrequent wintertime excursions of ozone concentrations above the 75 ppb 8-hour NAAQS observed in the Upper Green Winter Ozone Study, suggests that such health effects are not expected to occur in Sublette County.”⁷ This conclusion was released just prior to the worst ozone levels ever recorded in the Upper Green River Valley. The “Health Risk Assessment” did not attempt to determine physical impacts or symptoms felt by local residents.

The “Screening Health Risk Assessment” did find low levels of Toxic Air Contaminants which were listed in the final report.⁸ For each of the chemicals listed, there are Material Safety Data Sheets available on the internet that indicate physical symptoms associated with exposure. The *Questionnaire* found some correlation between MSDS sheet symptoms and those reported by respondents.

For example, acetaldehyde, which was detected in the “Screening Health Risk Assessment” report⁹ at the Bargerville site, “Causes severe eye irritation and is a lachrymator (substance which increases the flow of tears).”¹⁰ “Watery/itchy eyes” was the most-reported physical symptom among survey respondents. Acetaldehyde also causes respiratory tract irritation, and breathing vapors may cause dizziness: a symptom reported by seven survey respondents.

The Material Safety Data Sheet (MSDS) for formaldehyde¹¹, a chemical also found in the “Screening Health Risk Assessment” report indicates that potential health effects include “irritation and sensitization of the respiratory tract.” Persistent irritation in the throat/nasal passages/chest was the second-most reported physical symptom among *Questionnaire* respondents.

Table B assembles the human health symptoms listed in MSDS sheets which are associated with exposure to the Toxic Air Contaminants found in the Bargerville site of the “Screening Health Risk Assessment” study. Many of these human health symptoms were also reported by respondents of the *Questionnaire*.

Ten of 23 households, or 43%, reported both symptoms and uncommon odors. While association between symptoms and odors are difficult to attribute, those who are smelling uncommon odors are likely also inhaling them.

⁹ Sublette County Air Toxics Monitoring: http://deq.state.wy.us/aqd/Ozone/Sublette_Final_Report.pdf

¹⁰ Thermo Fisher Scientific Inc.: <http://fscimage.fishersci.com/msds/91732.htm>

¹¹ Mallinckrodt Baker, Inc.: <http://www.jtbaker.com/msds/englishhtml/f5522.htm>

Table B
“Sublette County Human Health Risk Assessment”
Chemicals detected in Bargerville and corresponding exposure symptoms

Symptom	Chemicals found at Bargerville associated w/symptom
Respiratory tract irritant	Formaldehyde, Acetaldehyde, 1,1,1-Trichloroethane, 1,2,4-Trimethylbenzene, 1,2-Dichloroethane, 1,3,5-Trimethylbenzene, 2-Butanone, 2-Propanol, 4-Ethyltoluene, Acetone, Bromomethane, Carbon Disulfide, Ethanol, Ethyl Benzene, Methylene Chloride, Propylbenzene, Toluene
Eye irritant	Acetaldehyde, 1,1-Dichloroethene, 2-Propanol, 4-Ethyltoluene, Ethyl Benzene, Freon 12, m,p-Xylene, o-Xylene, Propylbenzene
Causes eye, skin, and respiratory tract irritation	1,1,1-Trichloroethane, 1,2-Dichloroethane, 1,3,5-Trimethylbenzene, 2,2,4-Trimethylpentane, 4-Ethyltoluene, 4-Methyl-2-pentanone, Acetone, Benzene, Cyclohexane, Heptane, Hexane, m,p-Xylene, Propylbenzene, Styrene, Tetrahydrofuran, Toluene, Trichloroethylene
May cause sore throat	1,3,5-Trimethylbenzene, 2-Butanone, Ethyl Benzene
May cause shortness of breath	2-Butanone, Ethyl Benzene, Trichloroethylene
Carcinogen (causes cancer)	1,2-Dichloroethane, Benzene, Bromomethane, Methylene Chloride, Propylbenzene, Trichloroethylene
May cause lung damage	m,p-Xylene, o-Xylene
May cause respiratory stimulation	Formaldehyde
May cause pulmonary edema	Formaldehyde, 1,2,4-Trimethylbenzene, o-Xylene, Styrene, Tetrahydrofuran
May cause damage to central nervous system	1,2-Dichloropropane, 1,3,5-Trimethylbenzene, 2-Butanone, 2-Propanol, Acetone, Benzene, Carbon Disulfide, Chloromethane, Cyclohexane, Ethanol, Ethyl Benzene, Freon 12, m,p-Xylene, Methylene Chloride, o-Xylene, Propylbenzene, Styrene, Toluene, Trichloroethylene
May cause allergic reactions	Trichloroethylene
May damage cardiovascular system	Freon 12
May cause liver and/or kidney damage	4-Methyl-2-pentanone, Bromomethane, Chloromethane, o-Xylene, Toluene, Trichloroethylene
May cause heart damage/irregular heart beat	Chloromethane, Freon 11, Freon 12, Trichloroethylene

Harmful by ingestion, inhalation or skin absorption.	1,1-Dichloroethene, 1,2-Dichloroethane, 1,2-Dichloropropane
May cause narcotic effects	1,1,1-Trichloroethane, 1,2-Dichloroethane, 2,2,4-Trimethylpentane, 2-Propanol, Cyclohexane, Heptane, Hexane
May lead to irreversible bone marrow injury	Benzene
Decreased sense of taste and/or smell	Formaldehyde
Sudden onset of headache	1,1,1-Trichloroethane, 1,2,4-Trimethylbenzene, 1,2-Dichloroethane, 1,2-Dichloropropane, 1,3,5-Trimethylbenzene, 2-Butanone, 2-Propanol, Acetone, Benzene, Carbon Disulfide, Freon 11, Hexane, Methylene Chloride, o-Xylene, Tetrachloroethene, Tetrahydrofuran, Toluene, Trichloroethylene
May cause dizziness/fatigue	1,1,1-Trichloroethane, 2,2,4-Trimethylpentane, 2-Butanone, 2-Propanol, Acetone, Benzene, Carbon Disulfide, Chloromethane, Ethanol, Freon 11, Heptane, Hexane, Methylene Chloride, o-Xylene, Tetrachloroethene, Tetrahydrofuran, Toluene
May cause nausea/vomiting	1,2,4-Trimethylbenzene, 1,2-Dichloroethane, 1,2-Dichloropropane, 1,3,5-Trimethylbenzene, 2-Butanone, 4-Ethyltoluene, Benzene, Carbon Disulfide, Ethanol, Ethyl Benzene, Heptane, Methylene Chloride, Tetrachloroethene, Tetrahydrofuran, Trichloroethylene
May cause depression/mood swings	Acetone, Benzene, Chloromethane, Trichloroethylene
Immediately dangerous to life or health	1,2-Dichloropropane, Heptane, Hexane, Tetrachloroethene, Toluene, Trichloroethylene
May cause death	1,1-Dichloroethene, 1,2-Dichloroethane, Carbon Disulfide, Ethanol, Freon 11, Hexane, m,p-Xylene, Methylene Chloride, Tetrachloroethene, Toluene

I. Conclusions

The *Healthy Air Questionnaire* found a pattern of responses which corresponds with symptoms recognized in the scientific literature that are associated with breathing ozone and Toxic Air Contaminants. The relationship between scientific studies, Sublette County ozone monitoring data, and results of the *Healthy Air Questionnaire* suggests that breathing in Sublette County may be hazardous to long-term and short-term human health.

One in three individuals is impacted by breathing ground-level ozone.¹² Not all individuals may be affected in the same manner. Of all *Healthy Air Questionnaire* respondents, 67% reported one or more of the symptoms associated with breathing ozone that are reported in the scientific literature, and 38% of respondents reporting experiencing at least three symptoms.

Eighty-three percent (83%) of households were supportive of continual assessment of health risks associated with air pollution in Sublette County. None of the *Questionnaire* respondents have had their health care provider discuss the subject of ozone or other air pollutants when being evaluated for upper respiratory symptoms.

Scientific studies clearly indicate that breathing ground-level ozone, even for short periods, results in numerous and long-lasting human health impacts. Short-term increases in ozone concentrations increase the risk of hospitalization for COPD and pneumonia, and cause a decline in lung function.

Studies also show that newborns breathing ozone are increasingly admitted to hospitals for respiratory disease, and children with asthma are especially vulnerable.

Short-term increases in ozone are found to increase premature deaths from heart and lung disease.

VII. Recommendations

Because the vast majority (83%) of responding households supported continual assessment of health risks associated with air pollution; and due to exceedingly high ozone levels recently recorded in Sublette County, we recommend that continual assessment of health risks associated with air pollution be conducted by health care professionals.

Based on *Questionnaire* responses, we also recommend and that health care providers begin to discuss the subject of ozone or other toxic air pollutants when being evaluated for upper respiratory symptoms.

It may be advisable for local schools and day care centers to utilize this *Questionnaire* and be aware that all children should be protected during an ozone alert rather than just those with known respiratory conditions.

Residents may also benefit from knowing *Questionnaire* results that show that area residents have experienced symptoms that are associated with breathing ozone: an awareness that make help them make better decisions to protect their health during future DEQ ozone advisories.

¹² <http://www.airnow.gov/index.cfm?action=smog.page1>

Finally, we note that Upper Green River Alliance and Citizens United for Responsible Energy Development, along with other conservation groups, petitioned the Wyoming Environmental Quality Council (EQC) to lower the Sublette County ozone standard to 65 ppb due to our unique ozone conditions. While the EQC denied our request, the extreme ozone levels during the winter of 2011 serve to emphasize the importance of an ozone standard that truly protects human health. We believe a lower ozone standard for Sublette County is justified and appropriate.

Acknowledgements

We wish to thank all Sublette County residents who participated in the *Healthy Air Questionnaire*, and members and supporters of the Upper Green River Alliance and Citizens United for Responsible Energy Development.

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Further Reading

1. Brunekreef (1994): The study examined effects of ozone in amateur bicyclists in the Netherlands. Researchers collected lung function measurements before and

after summer training sessions or competitive races. Ozone concentrations were low on most occasions, with an average of 0.043 parts per million. These low ozone concentrations were significantly associated with a decline in lung function and an increase in respiratory symptoms, especially shortness of breath. The effect persisted even after removing all observations with hourly ozone concentrations greater than 0.060 parts per million.¹³

2. Medina-Ramon (2006): A very large study of Medicare recipients in 36 U.S. cities evaluated the effect of ozone and particulate matter on respiratory hospital admissions in the elderly over a 13-year period. The analysis found that the risk of daily hospital admissions for chronic obstructive pulmonary disease (COPD) and pneumonia increased with short-term increases in ozone concentrations during the warm season. Eight-hour mean ozone concentrations in the warm season ranged from 0.015 ppm in Honolulu to 0.063 ppm in Los Angeles, with most cities in the 0.040-0.055 ppm range.¹⁴

3. Dales (2006): This research study examined 15 years of data on newborns in 11 large Canadian cities to determine the influence of gaseous air pollutants on daily hospitalizations for respiratory causes. Ozone concentrations were extremely low, ranging from a 24-hour mean of 0.013 parts per million in Vancouver to 0.023 parts per million in Saint John. Although hospital admissions for respiratory disease are relatively uncommon in newborns compared with adults, this study found a strong association with ozone. In fact, the study suggests that air pollution at ambient levels seen in Canada could account for 15 percent of hospital admissions in newborns.¹⁵

4. Naeher (1999): Scientists examined the relationship between air pollution and daily changes in lung function in about 500 nonsmoking women in Roanoke, Virginia over the summers of 1995-1996. A 0.030 parts per million increment in 24-hour average ozone was associated with a decrease in evening peak expiratory flow. Ozone concentrations in this study were well below the current eight-hour ozone standard. The mean daily maximum 8-hour ozone concentration was 0.054 parts per million, and concentrations never exceeded 0.088 parts per million.¹⁶

5. Brauer (1996): A study of the effect ozone exposure on lung function of outdoor farm workers was undertaken in British Columbia. The mean work shift

¹³ Brunekreef B, Hoek G, Breugelmans O, Leentvaar M. 1994. Respiratory Effects of Low-level Photochemical Air Pollution in Amateur Cyclists. *Am J Respir Crit Care Med*; 150: 962-966.

¹⁴ Medina-Ramón M, Zanobetti A, Schwartz J. 2006. The Effect of Ozone and PM10 on Hospital Admissions for Pneumonia and Chronic Obstructive Pulmonary Disease: A National Multicity Study. *American Journal of Epidemiology*; 163: 579-588.

¹⁵ Dales RE, Cakmak S, Doiron MS. 2006. Gaseous Air Pollutants and Hospitalization for Respiratory Disease in the Neonatal Period. *Environ Health Perspect*; 114: 1751-1754.

¹⁶ Naeher LP, Holford TR, Beckett WS, Belanger K, Triche EW, Bracken MB, Leaderer BP. 1999. Healthy Women's PEF Variations with Ambient Summer Concentrations of PM10, PM2.5, SO4 2-, H+, and O3. *Am J Respir Crit Care Med*; 160: 117-125.

concentrations were low, just 0.026 parts per million, with a maximum of 0.054 parts per million. The study found that exposures were associated with decreased lung function over the day, which persisted to the following day. Even after excluding all days when the ozone was greater than 0.040 parts per million, investigators still observed reduced lung function.¹⁷

6. Chan (2005): This study in Taiwan reported acute lung function decline in mail carriers exposed to ozone concentrations below the current air quality standard. The average eight-hour concentration of ozone in this study was 0.036 parts per million, and the maximum concentration was 0.065 parts per million. Each 0.010 parts per million increase in the eight-hour ozone concentration, decreased the night-time peak expiratory flow rate.¹⁸

7. Mortimer (2002): The effect of daily ambient air pollution was examined in a cohort of 864 asthmatic children in eight urban areas of the U.S. in a long-term study. Eight-hour average daytime ozone concentrations were 0.048 parts per million, with a range across cities of 0.034 to 0.058 parts per million. Adverse effects were observed in all cities. Summertime ozone at levels below the current air quality standards was significantly related to respiratory symptoms and decreased pulmonary function in children with asthma.¹⁹

8. Bell (2004): This is a large 14-year study of residents of 95 U.S. cities, in which short-term increases in ozone were found to increase deaths from heart and lung disease. Even when days exceeding 0.060 parts per million were excluded from the analysis, the mortality effect was evident.²⁰

9. Adams (2002, 2006): Controlled human exposure studies offer the most compelling evidence of the effects of ozone on lung health. EPA has undertaken a careful re-analysis of the underlying data in the Adams studies to assess the change in lung function following exposure to ozone while exercising. The pre- to post-exposure analysis shows that 6.6 hour exposures to 0.060 parts per million ozone causes a statistically significant decrease in group mean lung function compared to filtered air, in healthy young adults.²¹

¹⁷ Brauer M, Blair J, Vedal S. 1996. Effect of Ambient Ozone Exposure on Lung Function in Farm Workers. *Am J Respir Crit Care Med*; 154: 981-987.

¹⁸ Chan C-C, Wu T-H. 2005. Effects of Ambient Ozone Exposure on Mail Carriers. Peak Expiratory Flow Rates. *Environ Health Perspect*; 113: 735-738.

¹⁹ Mortimer, KM, Neas LM, Dockery DW, Redline S, Tager IB. 2002. The effect of air pollution on inner-city children with asthma. *Eur Respir J*; 19: 699-705.

²⁰ Bell ML, McDermott A, Zeger SL, Samet JM, Dominici F. 2004. Ozone and short-term mortality in 95 US urban communities, 1987-2000. *JAMA*; 292: 2372-2378.

²¹ U.S. EPA Memorandum from James S. Brown, EPA, NCEA-RTP Environmental Media Assessment Group, Thru Mary Ross, EPA, NCEA-RTP, EMAG Branch Chief and Ila Cote, EPA, NCEA-RTP, Director, To Ozone NAAQS Review Docket (OAR-2005-0172), The Effects of Ozone on Lung Function at 0.06 ppm in Healthy Adults, June 14, 2007.

10. Mauderly (2009): Environmental air pollutants are inhaled as complex mixtures, but the dominant focus on monitoring and research on individual pollutants has provided insight into pollutant interactions that may be important to health. This study attempted to determine whether synergistic effects from combinations of pollutants on human health have actually been demonstrated. Synergisms involving ozone have been demonstrated by laboratory studies of humans and animals. Authors conclude that the plausibility of synergisms among environmental pollutants has been established.²²

²² Mauderly, Joe L., Jonathan M. Samet. 2009. "Is There Evidence for Synergy Among Air Pollutants in Causing Health Effects?" *Environmental Health Perspectives*; 117: 1

Appendix A

**SUBLETTE COUNTY
HUMAN HEALTH RISK ASSESSMENT
AIR TOXICS INHALATION**

DRAFT WORK PLAN

JULY 25, 2008

Overall Plan

This work plan, as requested by the Sublette County Commissioners, is intended to describe a proposed study of the risks to human health for citizens of Sublette County who are exposed to air toxics and ozone as they live and work in the County. The work plan is intended to be responsive to a citizen petition submitted in March 22, 2008, to a number of agencies including the office of Governor Dave Freudenthal, the Sublette County Commission, the Wyoming Department of Health, and the Wyoming Department of Environmental Quality.

The process of conducting an air toxics risk assessment will start by selection of chemicals of potential concern to be evaluated. These chemicals will include chemicals known to be produced and emitted during drilling, completion and production of natural gas and from activities ancillary to such industrial processes. Most air samples collected during the study will be analyzed for the identified chemicals of potential concern, and a subset of samples will be analyzed for a broader range of constituents to ensure that the study does not miss a particular air toxic. Samples will also be collected for ozone for evaluation in the risk assessment.

The study will also determine the exposure patterns for residents and sensitive subpopulations, and will then assess the expected human health risk resulting from exposure of those residents to air toxics and ozone measured in the ambient air throughout the County. The risk assessment will be conducted in accord with EPA guidance for how screening level air toxics risk assessments should be performed, and will also consider the risk assessment methods used in a recently completed risk assessment which evaluated residents' risks due to exposure to similar air contaminants in Garfield County, Colorado.

Appendix B

HEALTHY AIR QUESTIONNAIRE

Please complete this questionnaire as thoroughly as possible. All information will be kept confidential. Identity of participants and individual responses will not be revealed in any publication or presentation of questionnaire results.

Please provide the following information for each person in your household. If more space is needed please put information on a separate sheet of paper.

Person	M / F	age	Smoking History		Outdoor Employment / work		Outdoor Recreation / skiing, gardening, etc.		Comments
			current (Y/N)	5+ yrs ago (Y/N)	avg hrs/wk	Location (map code)	avg hrs/wk	Location (map code)	
A									
B									
C									
D									
E									

For each individual in your household, please make a \checkmark if they have experienced any of the following symptoms while in Sublette County within the last five years. Do not include common cold or flu symptoms.

Symptom*	Person A	Person B	Person C	Person D	Person E	Comments
Persistent irritation in throat/ nasal passages/ chest						
Persistent Cough						
Uncomfortable sensation in chest						
Breathing is uncomfortable/ painful						
Rapid and shallow breaths while exercising or working out-of-doors						
Watery/ itchy eyes						
Skin Irritation (e.g., rash, itchy)						
Decreased sense of taste and / or smell						
Irregular Heart Beat						
Sudden onset of headache						
Dizziness						

Nausea					
Depression / mood swings					
Other (specify) _____					
Other (specify) _____					

*References: www.lungusa.org/; www.epa.gov/; [http://deq.state.wy.us/aqd/Ozone Air Toxics_Sublette County.asp](http://deq.state.wy.us/aqd/Ozone_Air_Toxics_Sublette_County.asp)

Has anyone in your household been diagnosed with cancer in the last 5 years? Yes No
Type _____

Has anyone in your household been diagnosed with any of the following conditions?
Please identify by using person A, B, C, D, or E.

	Asthma	COPD	Chronic Bronchitis
Person(s)			
How Long?			
Has condition been aggravated in last 5 years? If so, explain below.			
Has any person gone to the emergency room because of this condition?			

Explanation and/or Comments _____

Has any health care provider discussed with you the subject of ozone or other air pollutants when being evaluated for upper respiratory symptoms? Yes No

Odors

Have individuals in your household experienced uncommon odors in the outside air?
Yes No

If yes, please describe timing of the odor events, to the best of your recall
(season, frequency per week or month, duration of odor event, etc.) _____

Please describe the odor(s) to the best of your ability: _____

Did you experience an uncommon taste(s) when you smelled the odor(s)? Yes No
If yes, please describe the taste to the best of your ability: _____

Is the odor stronger with different wind directions? Yes No

When/if odors were present; did you note the wind direction, and whether it was weak, moderate, or strong? Did you note the weather conditions? Please describe: _____

Please list the suspected / possible source(s) of uncommon odors described above: _____

Would you be in favor of continual assessment of health risks associated with air pollution in our county? Yes No

Please mail this questionnaire in the enclosed, self-addressed stamped envelope by Monday, FEBRUARY 28, 2011.

If you would like a copy of the compiled results of this questionnaire mailed to you, please fill out the following:

Name (optional) _____ P.O. Box # (required) _____
Town _____ Zip _____

ALL INFORMATION WILL BE KEPT CONFIDENTIAL

For questions regarding this questionnaire, please contact the Upper Green River Alliance at 367-3670 or Citizens United for Responsible Energy Development at 367-4309.

Thank You for taking the time to answer this questionnaire!

Appendix C

Respondent Comments

1. Looking at valley air quality from White Pine is very disheartening. Why not print it in the papers so everyone can see and save you both postage & paper?
2. Having lived in major cities, our air here is wonderful.
3. I have noticed a haziness while walking in Pinedale.
4. Pregnant
5. My granddaughter has had a cough most of this winter.
6. Retired.