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AIR QUALITY MANAGEMENT IN GARFIELD COUNTY: COLORADO'S MOST ACTIVE ENERGY DEVELOPMENT REGION

Task 3: Assessment and Analysis of Issues Facing Garfield County

Prepared for:

Garfield County Public Health
195 W. 14th Street
Rifle, Colorado 81650

Prepared by:

Cassie Archuleta
Joe Adlhoch

AIR RESOURCE SPECIALISTS, INC.
1901 Sharp Point Drive, Suite E
Fort Collins, Colorado 80525
Telephone: 970/484-7941
Fax: 970/484-3423

E-mail: CArchuleta@air-resource.com
JAdlhoch@air-resource.com

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF TABLES

EXECUTIVE SUMMARY

Oil and gas exploration and production within the Piceance Basin in Colorado, and elsewhere in the Rocky Mountain region, has undergone rapid growth over the last decade. In response to this growth, concerns regarding the impacts of oil and gas development in Garfield County have increased. Development hit a high point in 2008, and in early 2009 activity began to slow down. Although the pace has slowed, the Piceance Basin remains a tremendous gas resource that will likely experience development for a long time.

Garfield County Public Health (GCPH) is committed to addressing citizen concerns about activities in the community that affect air quality related values. There has been a great deal of technical and regulatory activity to support the development of air quality programs in Garfield County over the past few years. From meager beginnings, the county has seen a significant expansion of technical activity in monitoring, emissions analysis, and compliance. Also, there have been significant developments at the state and regional levels that should benefit air quality in Garfield County. These efforts are summarized below and described in more detail in the following report.

Analysis of Current and Historical Emissions Inventories and Monitoring Data

Emissions Inventories:

Emissions inventories developed by the Colorado Department of Public Health and Environment (CDPHE) and other stakeholders, including the Western Regional Air Partnership (WRAP) and Independent Petroleum Association of Mountain States (IPAMS), indicate that oil and gas emissions are significant contributors to oxides of nitrogen (NO_X) and volatile organic compounds (VOC). Major particulate matter (PM) sources include construction and road dust, which are associated with the recent growth and development related to the energy boom in Garfield County.

VOC Monitoring:

VOC monitoring began in 2005, and identified some toxic compounds of potential concern. In 2008, VOC monitoring was modified to serve a wider range of purposes including toxics assessments, source attribution, and ozone formation potential for VOCs. A special study of VOCs in the summer of 2008 was also performed near well drilling and completion operation. General conclusions are as follows:

- Results of the 2008 summer intensive study indicate VOCs were not elevated during drilling activities but were elevated down wind of completion sites during completion activities.

- In 2008, light alkanes, a subset of VOCs which are associated with natural gas, were elevated at the four (4) sites in Garfield County.

- Analysis of O_3 formation potential shows that, under ideal conditions, the potential contribution of VOCs to O_3 formation is substantially higher than actual O_3 measured. This may indicate that O_3 formation is limited by the availability of oxides of nitrogen (NO_X).

- Analysis of hazardous air pollutants (HAPs) indicated that, in 2008, most HAPs were not notably higher than concentrations measured at other sites across the U.S. Concentrations of benzene and m/p-xylenes measured at the Parachute and Rifle sites did average higher than those reported across the U.S. This might indicate that local sources for these compounds are higher in Garfield County than in a typical urban or rural environment.

Criteria Pollutants and Air Quality Standards:

Criteria pollutants, which are pollutants subject to the National Ambient Air Quality Standards (NAAQS), include PM_{10} monitored in Parachute and Rifle, and the recent addition of $PM_{2.5}$ and O_3 in Rifle in September 2008. PM_{10} levels at the Parachute site were shown to increase over the last several years. At present, air quality measurements in Garfield County do not violate air quality standards for O_3, PM_{10}, or $PM_{2.5}$, but PM_{10} levels are increasing and limited data are available for O_3 and $PM_{2.5}$.

Presentation of Monitoring Data for Public Information

Garfield County's efforts to create a community-based air quality program include numerous educational outreach efforts, real-time data availability, and the availability of monitoring and assessment reports. Educational resources and monitoring reports are available in online in Garfield County's outdoor air quality information center (http://www.garfield-county.com/index.aspx?page=1086). Real-time monitoring data and live images are also available on an air quality web site (http://www.garfieldcountyaq.net).

Another important outreach tool is the "Citizens Guide to Air Quality in Garfield County" brochure. This guide has been designed to communicate some of the key points presented in this report, and will be widely distributed to help provide a basis for more informed and effective community involvement in Garfield County's Air Quality Management Plan.

Identification of concerns regarding air quality in Garfield County

Citizen concerns regarding the impacts of oil and gas development in Garfield County have expanded in recent years as production has increased. Primary complaints involve odor and air pollution concerns. The state and county are also concerned with compliance with air quality regulations described in the Environmental Protection Agency (EPA) Clean Air Act (CAA). The CAA is the law that defines EPA's responsibilities for protecting and improving the nation's air quality. Global climate change impacts related to emissions in Garfield County have also been identified as an issue that will need to be addressed. Gases that trap heat in the atmosphere (i.e., greenhouse gases), include methane, which is a primary constituent of natural gas.

Available measures for addressing concerns

Concerns in Garfield County are primarily focused on the rapid pace development in the area. Available measures for addressing concern include effectively enforcing compliance with current regulations, promoting voluntary measures (for both citizens and industry) that exceed current requirements, and continuing to pursue new options and advocating for regulatory reform as additional mitigation options are developed and proven feasible.

Recommendations to the county for protecting air quality in Garfield County

Ultimately, this effort is designed to create a comprehensive community-based Air Quality Management Plan and implementation strategy that enjoys broad support. Recommendations are organized into a blueprint for a community air program designed around the Center for Disease Control's Ten Essential Public Health Services. In general, these services include:

1. **Monitoring Program:** In the past few years, Garfield County has undertaken extensive monitoring efforts to understand air quality in the county. Continuation and enhancement of the monitoring program will be important to continue to ascertain the air quality issues that need to be addressed.

2. **Investigation of Hazards**: Garfield County has been aggressively collecting data and mobilizing personnel to analyze air quality data and associated risk. Ongoing efforts should include continued investigation of hazardous pollutants, updated emissions inventories, and more in-depth source apportionment studies.

3. **Inform and Educate the Community:** Garfield County has made substantial efforts to build a foundation of public knowledge. Ongoing efforts to inform and educate the community will provide for more effective involvement in a community-based Air Quality Management Plan.

4. **Mobilization of Partnerships:** Most of Garfield County's efforts to date have focused on understanding the air quality issues facing the county. In order to apply this understanding towards solutions and action, it is recommended that Garfield County establish an advisory board capacity that involves citizens, environmentalists, municipalities, Federal Land Managers (FLMs), and industry to evaluate potential policy and action items and to make recommendations to governing bodies.

5. **Development of Policies to Support Efforts:** A comprehensive Air Quality Management Plan, including a policy plan and an action plan, should be developed and regularly updated to reflect changing needs of the county. The advisory board could evaluate specific policy issues and address them individually.

6. **Compliance Assistance:** The number of permits issued under existing authorities has increased substantially with the rapid growth of oil and gas exploration. It will continue to be important to ensure that resources are available for adequate compliance monitoring and enforcement.

7. **Increased Awareness of Activities and Services:** Ongoing efforts by the county, including educational opportunities, public hearings, compliance efforts, and efforts to increase voluntary emission reduction (both by industry and the public) should continue to be well publicized.

8. **Assure Competency:** As Garfield County progresses with an Air Quality Management Plan, ongoing quality assurance/quality control (QA/QC) procedures and professional development opportunities will be important.

9. **Evaluation:** Action items developed in an Air Quality Management Plan should be regularly assessed and revised to assure effectiveness and progress towards any stated goals.

10. **Look for New Options:** Efforts described in this report have been driven by the commitment of GCPH to look for new options to address air quality health issues with a community-based Air Quality Action Plan. Any action items supporting an air quality management plan should be continually evaluated in consideration of the best available management practices.

1.0 INTRODUCTION

Oil and gas exploration and production in this region has undergone rapid development over the last decade, which has also contributed to the rapid growth of local communities. In response to this growth, there is increasing concern that the air pollutants associated with oil and gas operations, and the increase in pollution associated with population growth, are adversely affecting air quality in our area.

Garfield County Public Health (GCPH) is committed to addressing citizen concerns about activities in the community that affect air quality. Since 2005, there has been a great deal of technical and regulatory activity to support the development of air quality programs in Garfield County. These efforts are summarized in the following sections:

- Analysis of current and historical emissions inventories and monitoring data
- Evaluation of data related to air quality standards
- Presentation of monitoring data for public information
- Identification of concerns regarding air quality in Garfield County
- Available measures for addressing concerns
- Recommendations of the County for protecting air quality in Garfield County

2.0 ANALYSIS OF CURRENT AND HISTORICAL EMISSIONS INVENTORIES AND MONITORING DATA

2.1 EMISSIONS INVENTORIES

The Colorado Department of Public Health and Environment (CDPHE) has developed comprehensive emissions inventories for Garfield County through the year 2007. Results for were summarized in the document "Garfield County Emissions Inventory" (CDPHE 2009b). Inventories include the pollutants carbon monoxide (CO), nitrogen dioxide (NO_2), volatile organic compounds (VOCs), particulate matter (PM), sulfur dioxide (SO_2), and benzene.

Additional oil and gas inventories for the year 2006 were developed for the Piceance Basin by ENVIRON in an effort sponsored by the Western Regional Air Partnership (WRAP) and the Independent Petroleum Association of Mountain States (IPAMS) (ENVIRON 2009). The WRAP is a regional planning organization that was primarily established to develop technical and policy tools to assist western states and tribes to comply with the U.S. Environmental Protection Agency's (EPA) Regional Haze Rule (RHR). Development of oil and gas emissions estimates, referred to here as WRAP Oil and Gas, involved a wide range of both industry and non-industry stakeholders to assure that inventories were more understood and universally accepted by those parties interested in and affected by oil and gas development. These estimates include point and area sources of VOCs and oxides of nitrogen (NO_X) from a combination of permitted and unpermitted sources related to oil and gas development. Permitted sources included sources downloaded from the Air Pollution Emission Notice (APEN) database. Unpermitted source information was based on producer survey results in each basin and based on information about number and type of equipment and activity levels.

Ongoing work by the WRAP includes development of mobile sources inventories related to oil and gas, which were outside the point and area source scope of the original 2006 emission inventory. Development of these inventories will include quantification of the emission totals of mobile on-road and non-road emissions sources present in oil and gas field operations to distinguish these emissions from mobile sources.

Some key results for PM_{10}, VOC and NO_X emissions are summarized here. Although 2007 inventories were available from the CDPHE, 2006 results are summarized here because they are more easily combined with 2006 oil and gas inventories provided by the WRAP. Results for PM_{10} include only CDPHE inventories, while results for VOCs and NO_X combine 2006 inventories provided by CDPHE with 2006 oil and gas inventories developed by the WRAP.

2.1.1 PM_{10} Emissions

Particles in the air contain a complex mixture of components (including dust, soot, smoke, etc.), and may be directly emitted as particles, or formed in the atmosphere through reactions involving gaseous emissions. Contributions of PM_{10} emissions by source category for Garfield County in 2006 are presented in Figure 2-1. Significant PM_{10} sources include road dust (32%), construction (29%), and wood-burning (14%). The CDPHE reports that area source

emissions of PM have remained fairly constant over the past ten (10) years, with agricultural sources decreasing and construction sources increasing (CDPHE 2008b).

Oil and gas point and area sources do not directly contribute substantially to PM_{10}, but construction and road dust sources are impacted by energy development in the area. The most visible surface disturbances associated with natural gas production involve grading and leveling of well pads, construction of facilities, construction of access roads to well pads, and subsequent vehicle traffic.

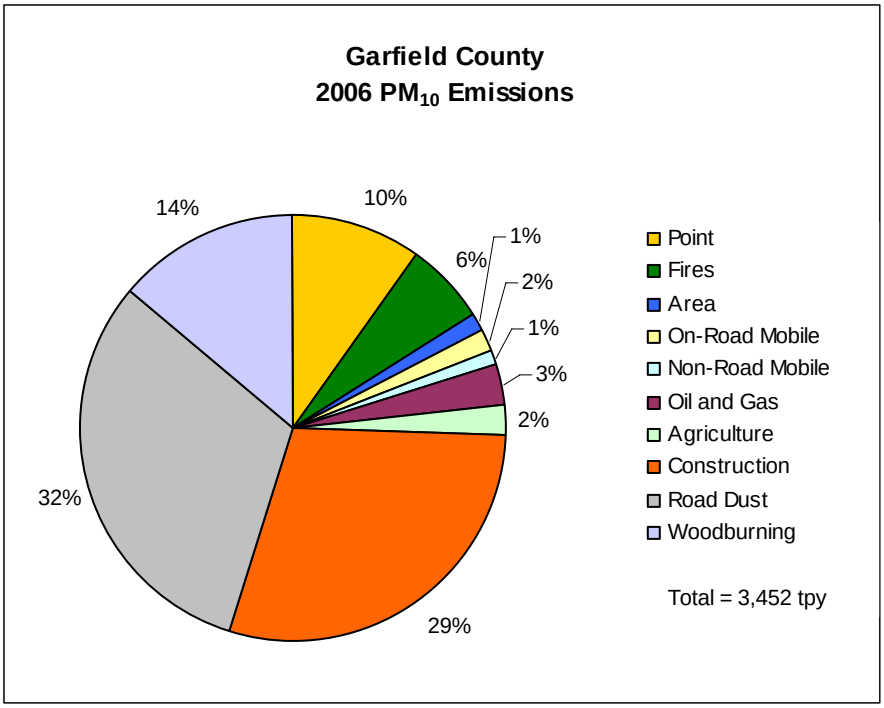

Figure 2-1. 2006 PM_{10} Emissions by Source Category in Garfield County.

2.1.2 NO_x Emissions

Figure 2-2 presents the contributions of NO_X emissions by source category for Garfield County for 2006. Oil and gas sources emissions estimates were provided by the WRAP, and all other estimates were provided by the CDPHE.

NO_X emissions are dominated by oil and gas (62%) and highway vehicles (also called on-road mobile) sources (22%). Despite increasing population, NO_X on-road vehicle emissions in Garfield County are 92% lower in 2006 than reported in 1996 (CDPHE 2008b). This has been largely attributed to tightened vehicle fuel standards.

Oil and gas emissions have increased substantially with increased development in the area. Figure 2-3 presents oil and gas sources of NO_X broken out by category. Major oil and gas NO_X categories include:

- **Drill Rigs (59%)** – Drill rigs are generally powered by stationary diesel engines.

- **Compressor Engines (31%)** – Compressor engines are often fired with raw or processed natural gas, and are used to pressurize natural gas from wells.

The WRAP also generated NO_X emissions for other counties in the Piceance Basin. Figure 2-4 presents emissions for surrounding counties for perspective on the scale of Garfield County emissions. Overall, the results show that most oil and gas NO_X emissions are concentrated in Garfield and Rio Blanco Counties. Garfield County accounts for the majority of gas and condensate production in the basin, while Rio Blanco County accounts for the majority of oil production.

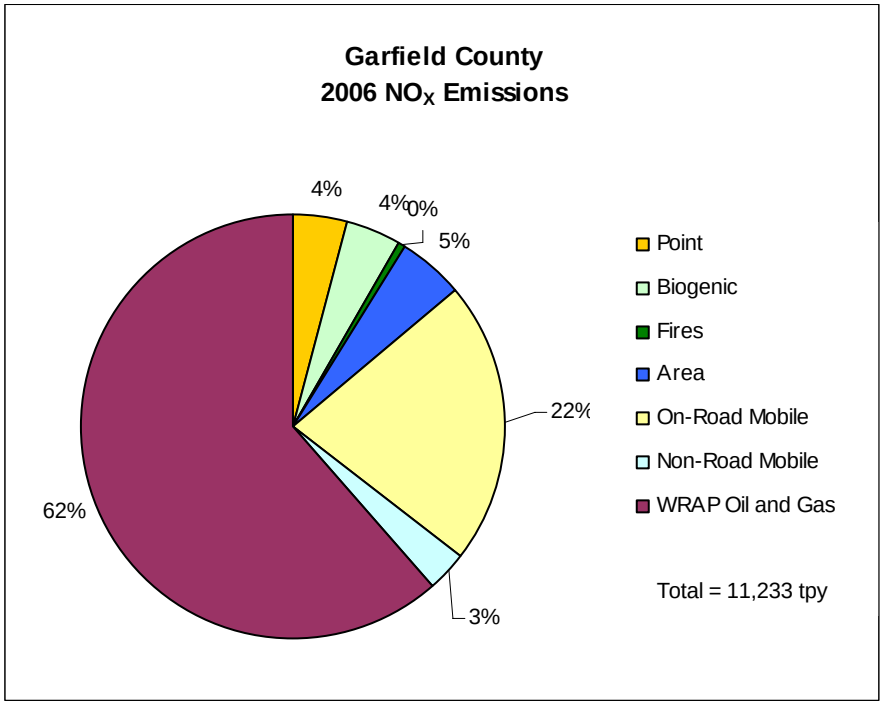

Figure 2-2. 2006 NO_X Emissions by Source Category in Garfield County.

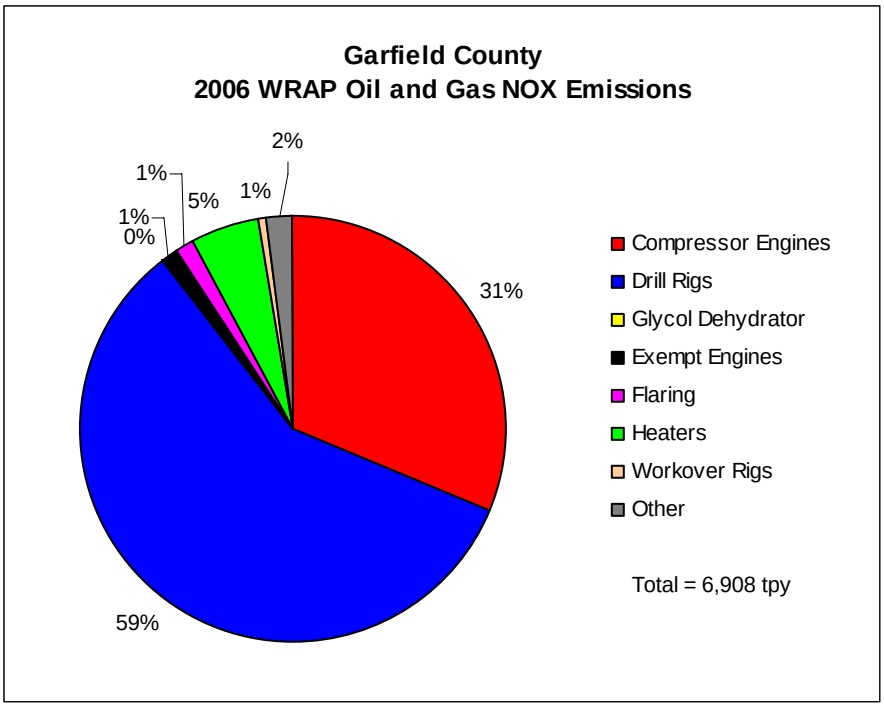

Figure 2-3. 2006 WRAP Oil and Gas NO_X Emissions by Source Category in Garfield County.

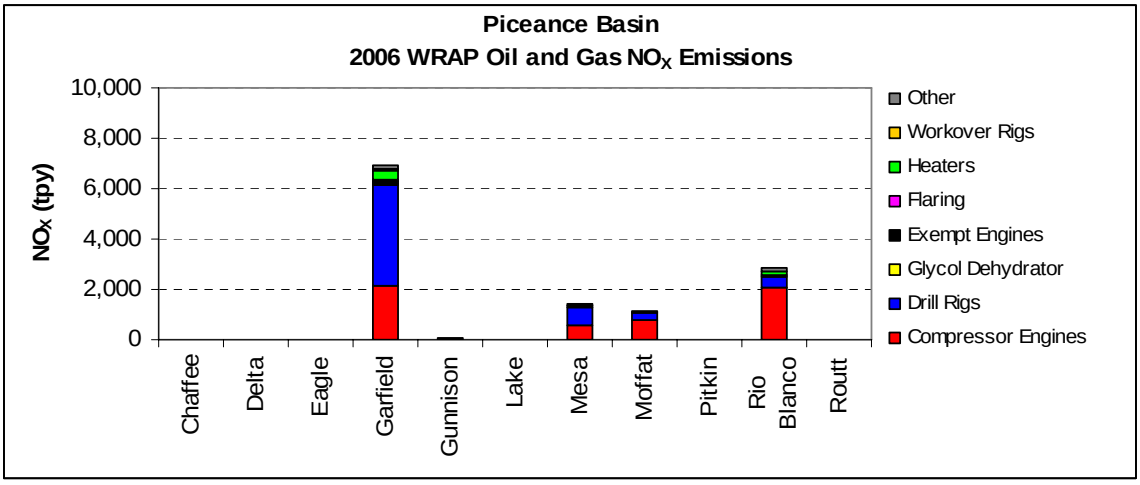

Figure 2-4. 2006 WRAP Oil and Gas NO_x Emissions by Source Category and by County in the Piceance Basin.

2.1.3 VOC Emissions

Figure 2-5 presents the contributions of VOC emissions by source category for Garfield County for 2006. Oil and gas sources emissions estimates were provided by the WRAP, and all other estimates were provided by the CDPHE.

VOC emissions are estimated to be dominated by biogenic emissions (55%), followed by oil and gas emissions (37%). Biogenic emissions are attributed to natural sources such as trees and shrubs and are not subject to controls.

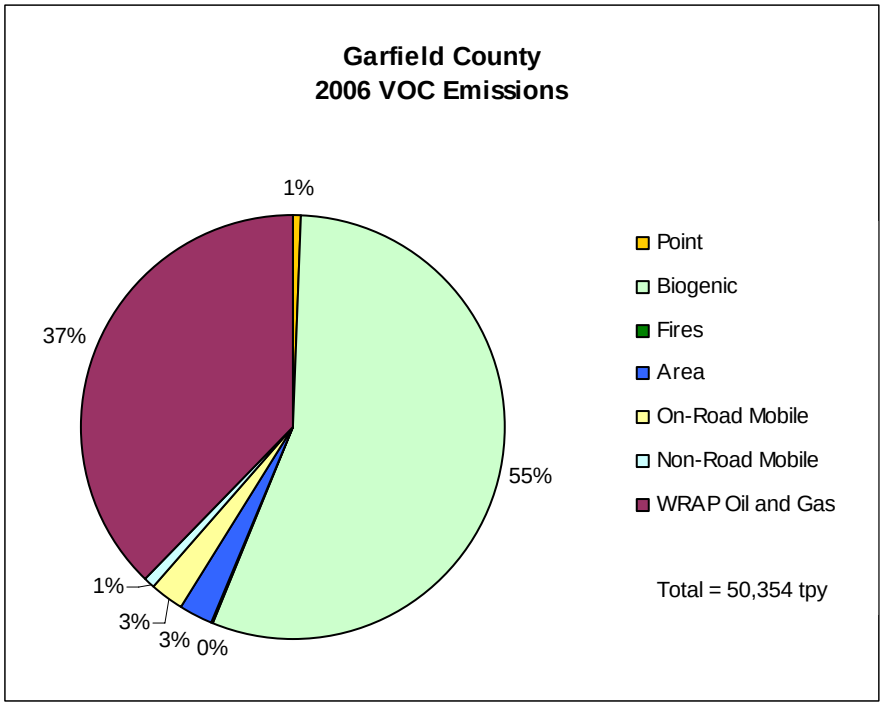

Figure 2-5. Percent Contribution by Category to 2006 VOC Emissions in Garfield County.

Emissions estimates of VOCs have increased substantially with increased oil and gas development in the area. A variety of activities potentially create VOC emissions during oil and gas production. Figure 2-6 presents oil and gas sources of VOCs broken out by category. Major categories include the following:

- **Venting; initial, blowdown and recompletion (58%) -** Venting results when an initial mixture of gas, hydrocarbon liquids, water, sand, or other material comes to the surface during well completion or recompletion processes.

- **Condensate Tanks (14%)** – Condensate tanks contain fluids brought to the surface that are a mixture of natural gas, other gases, water, and hydrocarbon liquids.

- **Glycol Dehydrator (8%)** – Glycol dehydrators remove water from natural gas, along with some VOCs and HAPs. Conventional glycol dehydrators vent directly to the atmosphere when the dehydrator is recharged.

- **Pneumatic pumps and devices (8%)** – These devices are used throughout oil and gas production, processing and transmissions systems to regulate temperature, pressure, flow, and other parameters. Most of the pneumatic devices at production wells and along transmission systems are powered by natural gas, which can release or "bleed" gas into the atmosphere.

- **Compressor Engines (5%)** - Compressor engines fired by natural gas emit both NO_x and VOCs into the atmosphere.

- **Fugitive Sources (4%) -** Natural gas wells contain a large number of components which can introduce leak and result in large VOC emissions.

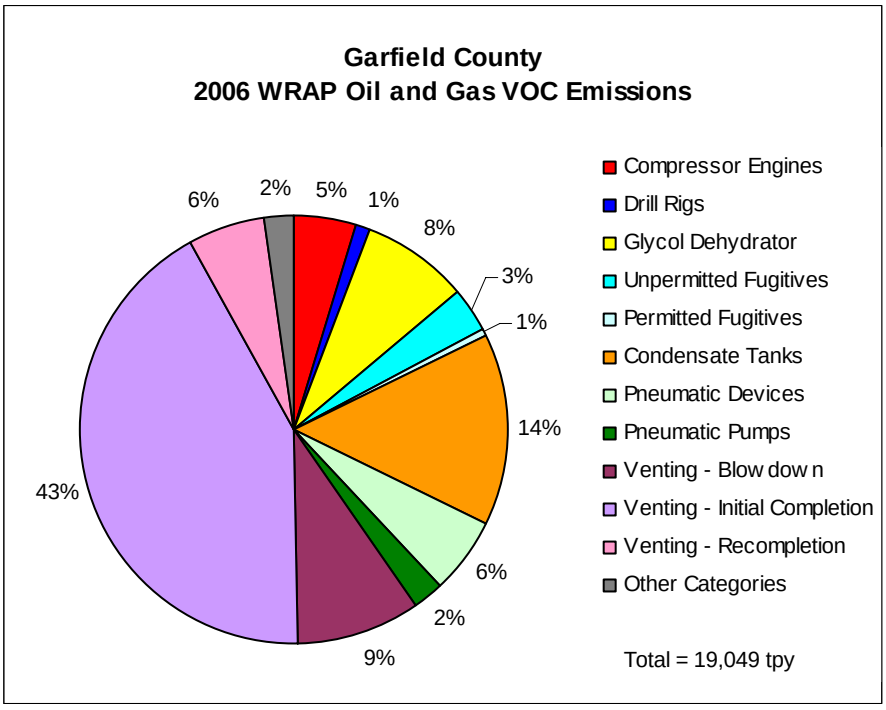

Figure 2-6. Percent Contribution by 2006 VOC Oil and Gas Emissions in Garfield County.

Figure 2-7 presents emissions provided by the WRAP for surrounding counties in the Piceance Basin. Overall, the results show that most oil and gas VOC emissions are concentrated in Garfield County where most of the gas and condensate production in basin occurs.

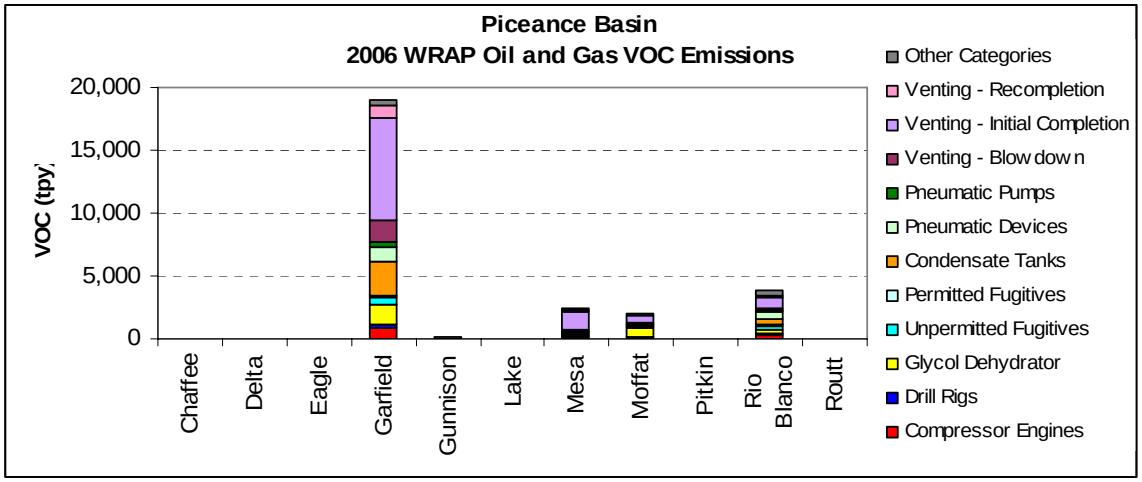

Figure 2-7. 2006 WRAP Oil and Gas VOC Emissions by Source Category and by County in the Piceance Basin.

2.2 MONITORING DATA

In 2005, Garfield County began a two-year ambient air quality study to evaluate levels of PM_{10} and VOC in the area. In 2008, year-round monitoring was focused at a fewer number of monitoring sites for more frequent days, and modified to encompass additional non-methane organic compounds (NMOCs) and carbonyl compounds. This monitoring was designed to serve a wide range of purposes including toxics assessments, source attribution, and ozone formation potential. An additional study in summer of 2008 included the evaluation of NMOCs near well drilling and completion operations. In 2008, monitoring of criteria pollutants was also expanded from PM_{10} to include $PM_{2.5}$ and ozone.

2.2.1 Particulate Matter (PM_{10} and $PM_{2.5}$)

PM_{10} is currently monitored at two (2) sites in Garfield County, including a site in Parachute, and a site in Rifle. Continuous $PM_{2.5}$ monitoring began at the Rifle site in September 2008.

Figure 2-8 presents the annual average PM_{10} measured at the Parachute site since 2000, and Figure 2-9 presents annual average PM_{10} measured at the Rifle site since 2005. PM_{10} at the Parachute site shows an increasing trend beginning in 2004, with average PM_{10} measured in 2008 about 55% higher than recorded in 2007. At the Rifle site, 2008 was the highest average recorded, but an increasing trend is not as apparent.

Figures 2-10 and 2-11 present the highest and second highest 24-hour average values measured at the Parachute and Rifle sites, respectively. The NAAQS for PM_{10} is also included on these charts. The NAAQS for PM_{10} is a 24-hour average of 150 $\mu g/m^3$, which was exceeded at the Parachute site in 2008 on 9/24/08 with a measurement of 210 $\mu g/m^3$. This exceedance was most likely caused by construction of a new school near the PM_{10} site. An exceedance of the standard does not constitute a violation until the average number of annual exceedances over a

three-year period is greater than or equal to 1. NAAQS for PM_{10} are described in more detail in Section 4.0 At the Rifle site, the standard has not been exceeded, but highest and 2nd highest averages are higher in 2008 than previous years.

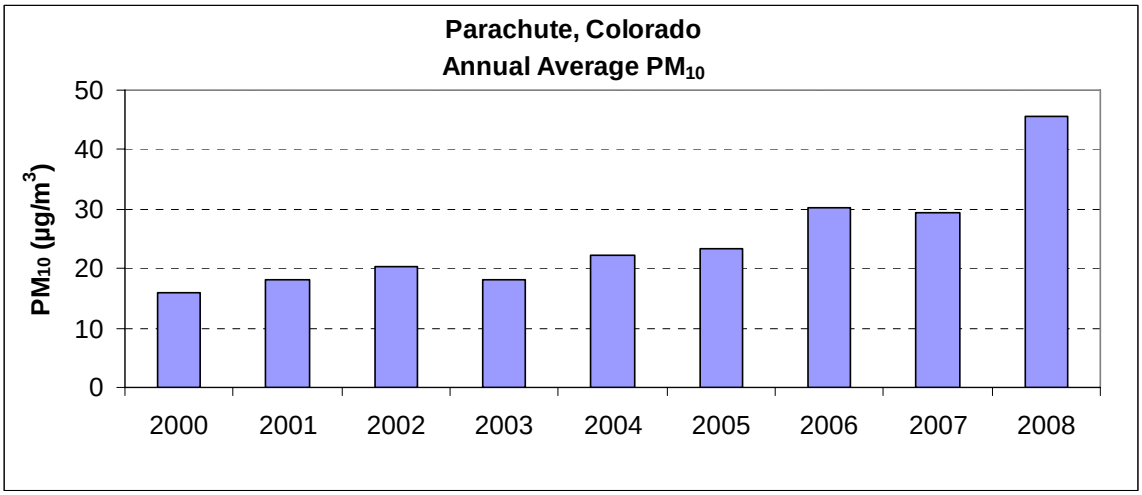

Figure 2-8. Annual Average PM_{10} Measured at the Parachute Site.

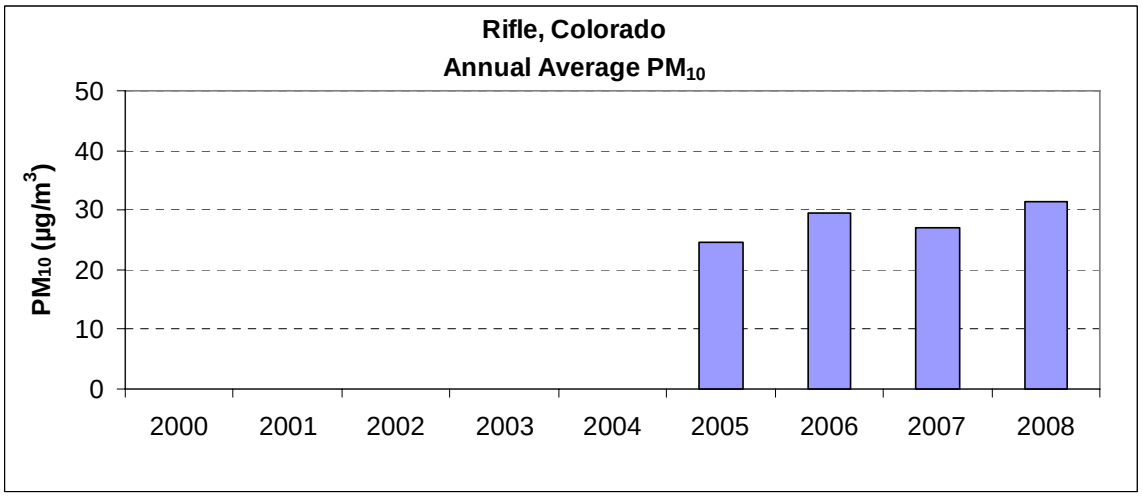

Figure 2-9. Annual Average PM_{10} Measured at the Rifle Site.

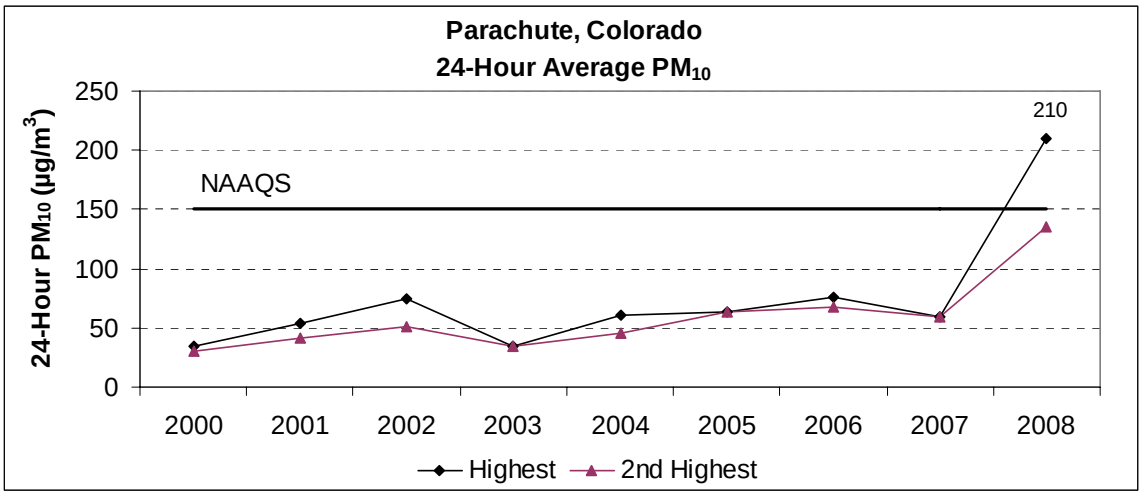

Figure 2-10. Highest and Second Highest 24-Hour Average PM_{10} Measured at the Parachute Site.

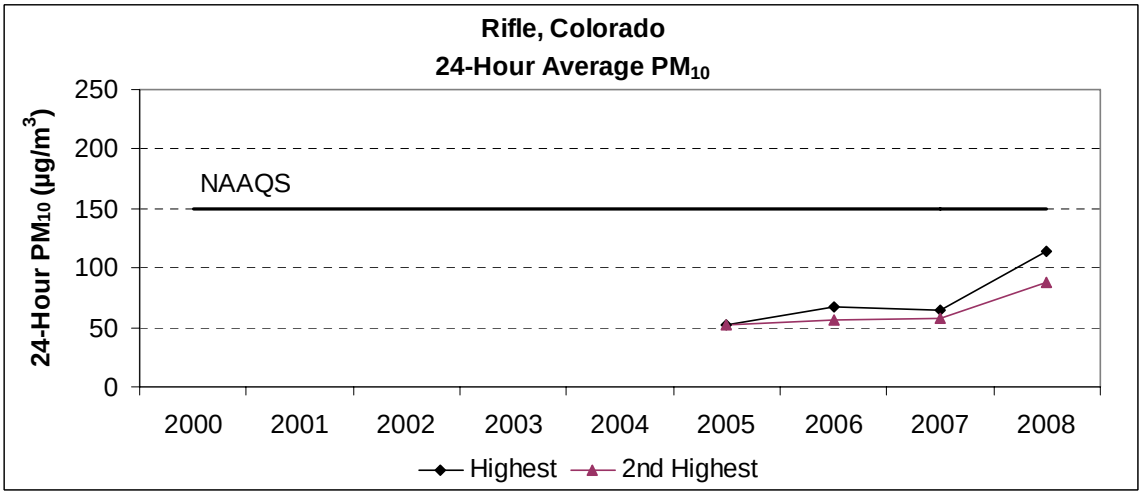

Figure 2-11. Highest and Second Highest 24-Hour Average PM_{10} Measured at the Rifle Site.

2.2.2 Non-Methane Organic Compounds and Carbonyl Monitoring

NMOCs and carbonyl compounds are subsets of VOCs. VOCs are generally carbon- and hydrogen-based chemicals that exist in the gas phase or can evaporate from liquids. VOCs can react in the atmosphere to form ozone and fine particulate matter. Hazardous Air Pollutants (HAPs) are a subset of VOC compounds, and include compounds that are known or believed to cause human health effects at low doses. No NAAQS or any other ambient air standards exist for VOCs. Instead, emissions limits on industrial sources have been set. EPA has developed a set of risk factors for both acute and chronic exposures for HAPs. In addition, risk factors from the Agency for Toxic Substances and Disease Registry (ATSDR), the California Air Resources

Board (CARB), the National Institute for Occupational Safety and Health (NIOSH), and others may be used to determine potential risks from exposure to VOCs.

In 2005, Garfield County began a two (2) year ambient air quality study which included an evaluation of toxic pollutant levels in the area. Between 2005 and 2007, 24-hour samples were collected monthly from ten (10) monitoring sites and quarterly from four (4) monitoring sites in Garfield County. The CDPHE Disease Control and Environmental Epidemiology Division prepared a screening level risk assessment for these monitoring data in 2007 (CDPHE 2007). Screening level analysis is a very conservative first look at HAPs concentrations, designed to identify compounds that may require further investigation. Results indicated that estimated exposures are not likely to result in significant health effects, but that continued monitoring was necessary because some compounds indicated were identified as chemicals of potential concern (COPC) based on an EPA screening level analysis following guidelines in EPA's Air Toxics Risk Assessment Library (EPA 2007). Results also indicated that specific COPC at sites nearest to oil and gas development were different than the specific COPC at the more urban sites.

A summer intensive study was also conducted in 2008 to identify NMOCs during well completion activities and drilling activities (CDPHE 2009a). Results of the summer intensive study indicated NMOCs were not elevated during drilling activities, but were elevated down wind of completion sites during completion activities. Primary pollutants measured included ethane, propane, iso- and n-butane, and iso- and n-pentane, which are all components of natural gas.

In 2008, VOC monitoring expanded to encompass additional NMOCs and carbonyl compounds. Samples at four (4) sites were collected year-round, with NMOC sampled on a 1-in-6 day schedule, and carbonyls on a 1-in-12 day schedule. This monitoring was designed to serve a wider range of purposes, including toxics assessments, source attribution and ozone formation potential. Specific results for these analyses are listed below.

- **Toxics Assessment -** In 2008, several hazardous air pollutants (HAPs), including formaldehyde, acetaldehyde, 1,3-butadiene, benzene and m/p-xylenes, were higher than very conservative preliminary screening standards developed by the EPA. Comparisons of these HAPs to average concentrations at other sites across the U.S. indicated that formaldehyde, acetaldehyde and 1,3-butatdiene were not notably higher than the other sites, as reported by the EPA for sites in the national Urban Air Toxics Monitoring Program (UATMP) and National Air Toxics Trends Stations (NATTS) Network. Annual average concentrations of benzene and m/p-xylenes at the Parachute and Rifle sites in 2008 were higher than most averages reported across the U.S. This might indicate that local sources for these compounds are higher in Garfield County than in a typical urban environment. More detailed toxics assessments are planned for these sites.

- **Source Apportionment** – Results indicate elevated levels of light alkanes (subset of VOCs), which are associated with natural gas. BTEX parameters (benzene, toluene, ethylbenzene and xylenes), which are generally associated with motor vehicles, were measured in highest concentrations at the more urban sites.

- **Ozone Formation Potential** – The Maximum Incremental Reactivity (MIR) is a measure of effect of individual VOC compounds on O_3 formation under ideal conditions. Limited O_3 measurements indicate that ozone levels are far below VOC formation potential, indicating that O_3 formation is likely limited by NO_X availability. This might indicate that more NO_X in the area could increase O_3, and that the most effective way to reduce O_3 is to reduce NO_X.

2.2.3 Ozone

O_3 is a secondary pollutant, meaning it is not emitted directly from sources, but is formed from photochemical interactions of VOCs and NO_X in the presence of sunlight. Some VOCs are more reactive than others, so potential ozone formation is affected by both reactivity and availability. Some of the most abundant compounds measured at the sites are the least reactive, and some compounds measured in small quantities are of interest because they are highly reactive. Quantification of measured VOC reactivity and future measurements of NO_X will help determine the degree that NO_X or VOCs are limiting factors in O_3 reactions, and what controls would be most effective.

Ozone measurements began in June 2008 at the Rifle site. Figure 2-12 presents daily maximum 8-hour averages in 2008, and Figure 2-13 presents values measured to date in 2009. Table 2-1 presents the highest daily maximum O_3 measurements in 2008. The NAAQS for O_3 is an 8-hour average of 75 ppb. The daily maximum 8-hour average O_3 exceeded the standard at 76 ppb on both July 9 and July 10, 2008, but the 4th highest daily 8-hour average was lower than the standard at 66 ppb. A violation of the standard does not occur until the three-year average of the 4th highest daily maximum values is greater than 75 ppb. NAAQS for O_3 are described in more detail in Section 4.0.

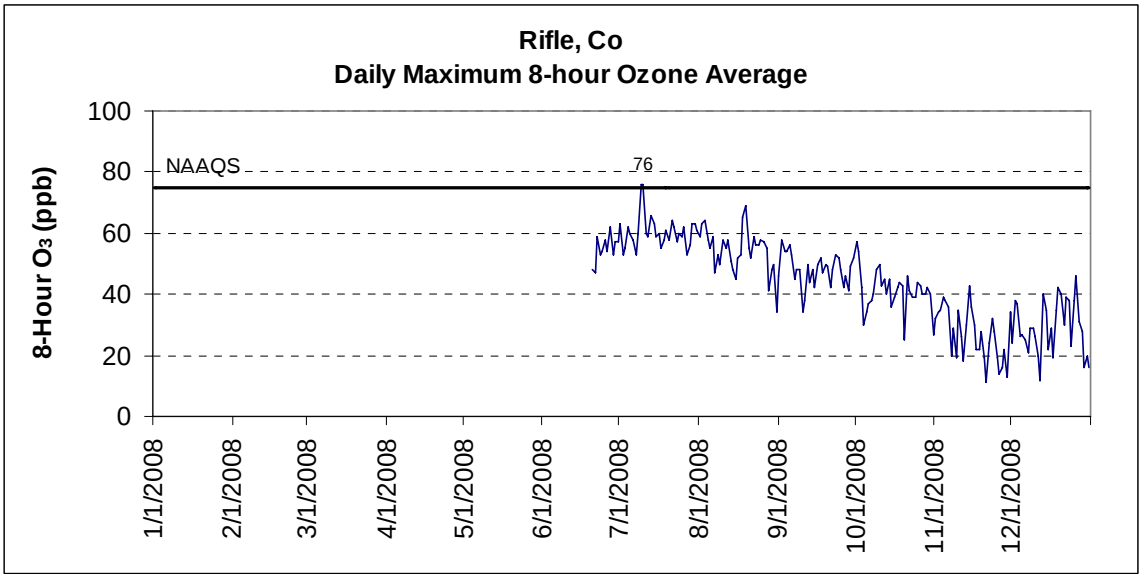

Figure 2-12. 2008 Daily Maximum 8-Hour Averages of Ozone Monitored at the Rifle Site.

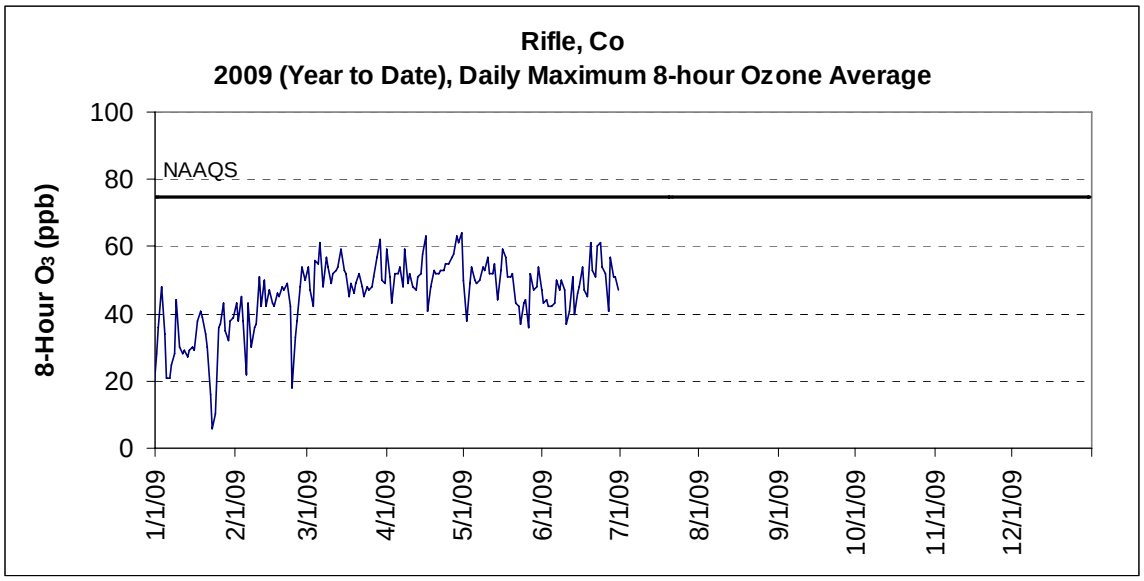

Figure 2-13. 2009 (Year to Date), Daily Maximum 8-Hour Averages of Ozone Monitored at the Rifle Site.

Table 2-1. Ten Highest Daily Maximum 8-Hour Ozone Averages Measured at the Rifle Site in 2008

Level	Date	Daily Maximum 8-Hour Ozone (ppb)
1	7/09/2008	76
2	7/10/2008	76
3	8/19/2008	69
4*	**7/13/2008**	**66**
5	8/18/2008	65
6	8/03/2008	64
7	7/21/2008	64
8	8/02/2008	63
9	7/14/2008	63
10	7/29/2008	63

*The NAAQS for O3 is an 8-hour average of 75 ppb. To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year must not exceed the standard. A year of O_3 data is only considered if valid daily maximums are available for at least 75 percent of the ozone season.

3.0 MONITORING DATA RELATED TO AIR QUALITY STANDARDS

The Clean Air Act requires EPA to set two (2) types of National Ambient Air Quality Standards (NAAQS) for ground-level ozone (O_3), particle pollution ($PM_{2.5}$ and PM_{10}), lead, nitrogen dioxide (NO_2), carbon monoxide (CO), and sulfur dioxide (SO_2). The types of standards are:

- **Primary standards** – These standards are designed to protect public health with an adequate margin of safety, including the health of sensitive populations such as asthmatics, children, and the elderly.

- **Secondary standards** – These standards are designed to protect public welfare from adverse effects, including visibility impairment and effects on the environment (e.g., vegetation, soils, water, and wildlife).

PM_{10} is monitored at the Parachute and Rifle sites, with $PM_{2.5}$ at the Rifle site beginning in September 2008. The level of the national primary and secondary ambient air quality standards for PM_{10} is a 24-hour average concentration of 150 micrograms per cubic meter ($\mu g/m^3$), with an average of no more than one exceedance over a three year period. The standards for $PM_{2.5}$ are an annual arithmetic mean of 15 $\mu g/m^3$, and a 24-hour average of 35 $\mu g/m^3$. A violation of the standard occurs when the 3-year average of weighted annual mean is greater than 15 $\mu g/m^3$, or the 3-year average of 98th percentile 24-hour value is greater than 35 $\mu g/m^3$.

O_3 monitoring began at the Rifle site in June 2008. The NAAQS for O_3 is 0.075 ppm (75 ppb) over an 8-hour period. An exceedance of the standard occurs when an 8-hour average O_3 concentration is greater than or equal to 76 ppb. A violation of the standard occurs when the 3-year average of the fourth highest daily maximum 8-hour average ozone concentration equals or exceeds 76 ppb.

Values measured for O_3, $PM_{2.5}$, and PM_{10} in 2008 at the Rifle site are presented with corresponding NAAQS in Table 3-1. PM_{10} measured at the Parachute site is presented in Table 3-2. One PM_{10} exceedance was recorded at the Parachute site on September 24, 2008, but an exceedance is not a violation unless the number of exceedances averaged over three years is more than one. At present, air quality measurements in Garfield County do not violate air quality standards for O_3, PM_{10}, or $PM_{2.5}$.

Table 3-1. 2008 Standards Summary for the Rifle Site

Parameter	NAAQS		Measured	
	Averaging Time	Standard	Measured Value	Date(s)
Ozone (O_3)	Rolling 8-hour	0.075 ppm/ 75 ppb	Highest Daily Max.: 76* ppb	7/9, 7/10
			4th Highest Daily Max.: 66* ppb	7/13
Particulate Matter ≤ 2.5 µm ($PM_{2.5}$)	Annual	15 µg/m^3	Arithmetic Mean: 11.2* µg/m^3	9/1-12/31
	24-hour	35 µg/m^3	Highest Max: 40* µg/m^3	12/31
			2nd Highest Max.: 30* µg/m^3	12/30
Particulate Matter ≤ 10µm (PM_{10})	24-hour	150 µg/m^3	Highest Daily Max.: 114 µg/m^3	4/15
			2nd Highest Daily Max.: 88 µg/m^3	4/21

* Values for O_3 and $PM_{2.5}$ at the Rifle site do not represent complete years**.**

Table 3-2. 2008 Standards Summary for the Parachute Site

Parameter	NAAQS		Measured	
	Averaging Time	Standard	Measured Value	Date(s)
Particulate Matter ≤ 10µm (PM_{10})	24-hour	150 µg/m^3	Highest Daily Max.: 210* µg/m^3	9/24
			2nd Highest Daily Max.: 136 µg/m^3	4/24

* An exceedance of the standard is not a violation until the average number of exceedances over a 3-year period is greater than one**.**

4.0 PRESENTATION OF MONITORING DATA FOR PUBLIC INFORMATION

The goal of the Garfield County Public Health is to create a community-based air quality program. Both the EPA and the State of Colorado recognize the importance of environmental protection actions taken by communities where there may be gaps in traditional regulatory approaches. People who live and work in a community have common interests in clean air as well as other environmental values. Through increased public awareness and education about air quality matters, citizens become more informed on a variety of air quality issues and will make more informed decisions about their activities and what goes on in the community.

Garfield County's efforts to create a community-based air quality program include numerous educational outreach efforts, real-time data availability, and the availability of monitoring and assessment reports.

Educational resources include an online outdoor air quality information center (http://www.garfield-county.com/index.aspx?page=1086). This includes general information about air quality, and links to various programs, reports and services, including:

- Data summary reports, including quarterly and annual monitoring reports, and other assessment reports including toxics analysis.

- Presentations to date for a "Smart Citizen Series" sponsored by the Garfield County Energy Advisory Board along with Garfield County Public Health and Colorado Mountain College (http://www.garfield-county.com/Index.aspx?page=1119). This series summarizes some of the monitoring and emissions data collected in the county and also includes presentations on the basics of air pollution, associated risks, and how pollution is managed.

- Information and links regarding open burning in Garfield County (http://www.garfield-county.com/Index.aspx?page=1120)

Real-time monitoring data in Garfield County is available on an air quality Web site (http://www.garfieldcountyaq.net). Real-time images and data collected from instrumentation in Rifle, Colorado, are posted on the site. Figure 4-1 presents an image of the Garfield County Air Quality Data Home Page. The parameters displayed include:

- Current air quality conditions, including 1-hour and 8-hour average ground level O_3, and 1-hour and 24-hour average PM_{10} and $PM_{2.5}$.

- Visual conditions, including current image (updated every 15 minutes), and archived images.

- Current meteorological conditions, including temperature, humidity, wind speed, and wind direction.

Data review tools include 7-day timeline plots, image archives, and links to basic information explaining each of the measured parameters and an overview heath effects related to each pollutant.

In addition to the information and resources described above, the “Citizens Guide to Air Quality in Garfield County” brochure, has been designed to communicate some of the key points presented in this report. This brochure will be widely distributed and help to provide a basis for more informed and effective community involvement.

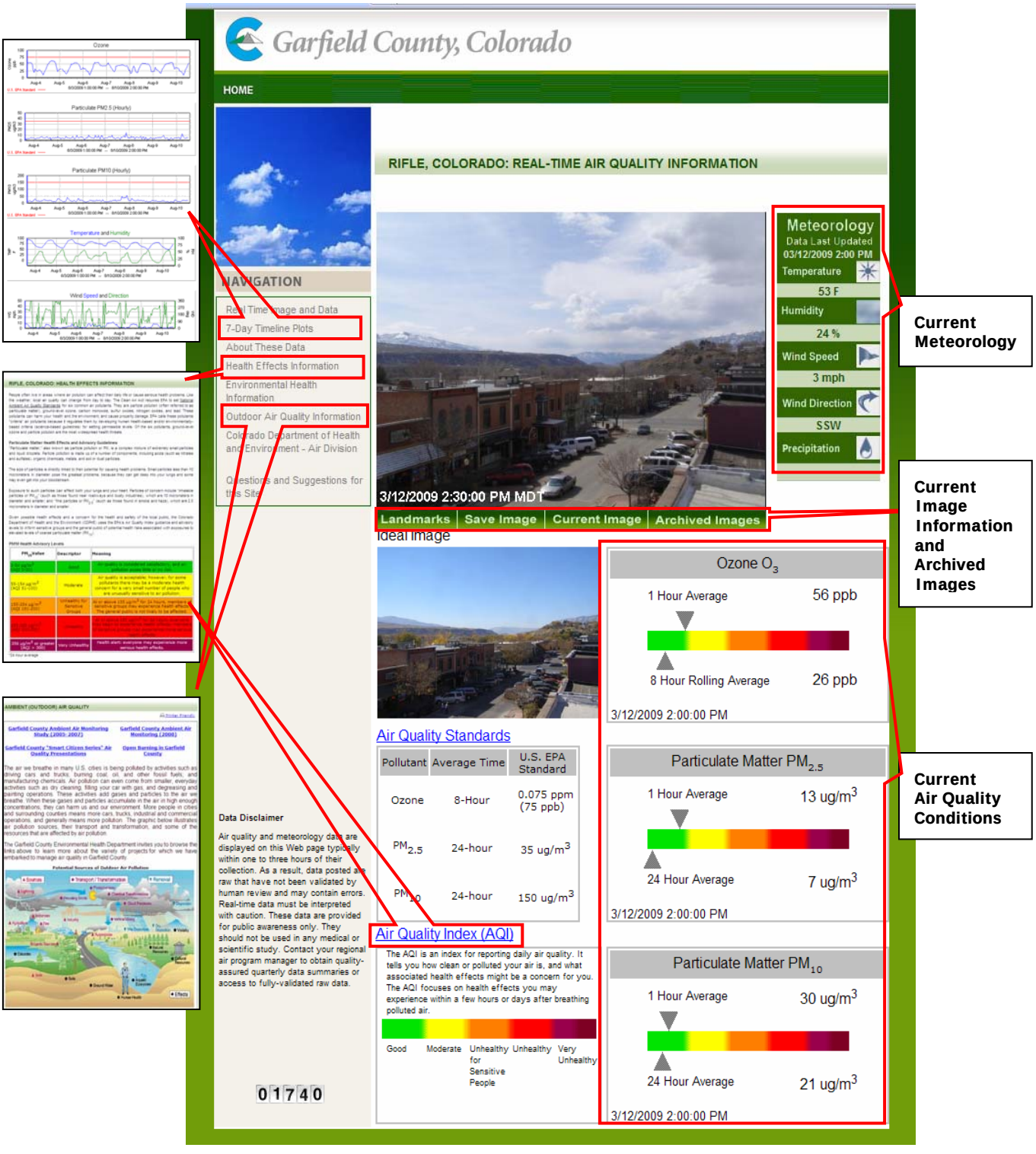

Figure 4-1. Garfield County Air Quality Monitoring Web Site (www.garfieldcountyaq.net).

5.0 IDENTIFICATION OF CONCERNS REGARDING AIR QUALITY IN GARFIELD COUNTY

Citizen concerns regarding air quality in Garfield County have increased in recent years as oil and gas production has grown. Among it's many responsibilities, the Oil and Gas Department of Garfield County serves as a liaison between the citizens and the energy industry, and facilitates the Energy Advisory Board (EAB), which investigates citizen complaints and attempts to work with energy companies to resolve complaints.

Table 5-1 lists a total count for each type of complaint related to air quality received by the county between June 2003 and May 2009. Odor is the primary complaint listed. Some complaints, including road conditions, traffic, and speeding, are related to air quality indirectly due to vehicle emissions and dust impacts. Other complaints are related to the visual impacts of development, spills, and environmental or health concerns.

Table 5-1. Summary of Complaints Made to Garfield County
June 2003 – May 2009

Category	Number of Complaints
Odor	171
Road Conditions	39
Dust	37
Spills	31
Traffic	21
Health	17
Speeding	15
Visual	14
Environmental	13
Flaring	10
Smoke	2

The state and county are also required to comply with air quality regulations described in the EPA Clean Air Act (CAA). The CAA is the law that defines EPA's responsibilities for protecting and improving the nation's air quality. Categories in the CAA include:

- Criteria air pollutants (O_3, CO, SO_2, PM, NO_2 and Pb). Precursors of these pollutants include NO_x and VOCs
- Emissions of HAPs

- Regional Haze - Regional haze is regulated in protected environments (Class I Areas). Haze precursors include NO_x, SO_2, VOCs, and particulates.

Global climate change impacts are also issues of concern. Gases that trap heat in the atmosphere (i.e., greenhouse gases), include methane, a primary constituent of natural gas. Methane has been estimated to be more than 20 times more effective in trapping heat in the atmosphere than carbon dioxide (CO_2) (http://epa.gov/methane/scientific.html).

6.0 AVAILABLE MEASURES FOR ADDRESSING CONCERNS

Concerns in Garfield County are primarily focused on the rapid pace of oil and gas development in the area. Development hit a high point in 2008, and in early 2009 activity began to slow down. Although the pace has slowed, the Piceance Basin remains a tremendous gas resource that will likely experience development for a long time. Sectors outside of oil and gas, including vehicle emissions and wood-burning, also contribute to air quality management issues. Effective ways to address air quality concerns include:

- Effectively enforcing compliance with current regulations
- Promoting voluntary measures that exceed current regulations
- Continuing to pursue new options and advocating for regulatory reform as additional mitigation options are proven feasible

Oil and gas operations, and other pollution sources, currently fall under a number of federal, state, county, and municipal laws. In some cases, mitigation options are available, but actual application of these options is voluntary. The State of Colorado has recently adopted a number of regulations specific to oil and gas sources that should have a significant impact on air quality in Garfield County (COGCC 2009), which include odor and dust control measures. Also, the Denver Metro Area and North Front Range Ozone Action Plan also includes some statewide implications which are applicable in Garfield County.

Measures for addressing concern include timely inspection to determine compliance with permit requirements. Formal enforcement actions for compliance issues related to sources operating in Colorado, as applied by the Field Services Unit of the Stationary Sources Section of CDPHE's Air Pollution Control Division, are published online at http://www.cdphe.state.co.us/ap/enforcerept.html. The reports summarize enforcement actions for each quarter for violations of Air Quality Control Regulations.

Existing control technologies continually become more accessible and cost effective as new technologies are developed and evaluated. Numerous resources are available which describe and evaluate mitigation strategies. The Denver Metro Area and North Front Range Ozone Action Plan lists strategies for ozone mitigation currently applicable in the Denver Metro Area and North Front Range (DMA/NFP) Nonattainment Area. For particulate sources, the WRAP Fugitive Dust Handbook (WGA 2006) lists a variety of control options. Also, several fairly comprehensive resources are also available describing mitigation options for various oil and gas sources. Examples of these include:

- The Natural Gas STAR program, which is a voluntary partnership between U.S. EPA and the oil and gas industry. The Gas STAR program identifies cost-effective technologies and measures to reduce methane emissions (http://www.epa.gov/gasstar/tools/recommended.html).

- The Four Corners Air Quality Task Force Report of Mitigation Options (FCAQTF, 2007), prepared by the Oil & Gas Work Group of the Four Corners Air Quality Task Force analyzes numerous emission mitigation strategies for the oil and gas sector.

- The Natural Resources Law Center houses a searchable database website of BMPs for oil and gas development in the Intermountain West (http://www.oilandgasbmps.org/browse.php?cat=1).

- Eathworks' Oil & Gas Accountability Project provides extensive information on best management practices and progressive oil and gas regulations (http://www.earthworksaction.org/oil_and_gas.cfm).

Some examples of existing and possible measures for mitigating environmental impacts of PM, NO_X, and VOCs in Garfield County are listed in Tables 6-1 through 6-3. These are prioritized and listed in order of the largest impact by category, as determined using the 2006 emissions estimates for Garfield County. It should be noted that 2006 emissions estimates do not reflect more recent control measures implemented, including the significant measures recently adopted for oil and gas sources by the COGCC (COGCC, 2009). Control options listed here are specific to PM_{10}, NO_X, and VOCs, but controls of VOC and NO_X precursors have the added benefits of reduced O_3 and associated HAPs. This summary is not comprehensive, and mitigation options and control strategies are continually changing as technology advances and regulations are updated.

Table 6-1. Emissions Categories and Control Options for PM Sources in Garfield County

PM Sources (PM_{10} and $PM_{2.5}$)	Control Options	Comments
Road Dust	Unpaved road dust programs have significantly decreased PM_{10} nationwide (Roe, et al, 2005). Examples of controls for unpaved road dust can include: • Paving • Water/chemical stabilization • Surface improvement (e.g., gravel) • Vehicle speed reduction Other options include centralization and optimization of oil and gas facilities. This would minimize truck traffic, and hence road dust. Centralization options might include: • Automation of wells • Centralized water storage facilities • Directional drilling (multiple wells drilled from a single well-pad).	Fugitive dust, including road dust, is regulated by the CDPHE regulation No. 1 (CDPHE 2007a).
Construction Dust	Mitigation of construction impacts as Garfield County continues to grow can include a number practices from site preparation to landscaping. Examples of controls for construction sources include: • Covering haul trucks • Wet suppression • Re-vegetation	Construction dust, like road dust, is regulated by the CDPHE regulation No. 1 (CDPHE 2007a) under fugitive dust controls.
Wood-Burning	Options to address particle pollution from wood-burning can include restrictive burn days and incentives to exchange wood-burning stoves for more efficient fuel stoves.	Wood-burning is regulated by the CDPHE regulation No. 4 (CDPHE 2006b).

Table 6-2. Emissions Categories and Control Options for NO_X Sources in Garfield County

NO_X Sources	Control Options	Comments
Oil and Gas Sources		
- Drill Rigs	Options may include: • Implementation of cleanest burning engines available (ahead of EPA phase-in schedule) • Replacing diesel-fired drilling rig engines with natural gas-fired drilling engines • Utilization of electric powered drill rigs	EPA non-road engine tier standards (EPA 2008c) require a phase in of standards between 1996 and 2014 for all newly manufactured, modified, and reconstructed engines. These standards do not apply to existing drill rig engines.
- Compressor Engines	At present, most of the work to operate the compressors comes from natural gas-fired internal combustion engines. Additional options may include: • Centralization of compressor sources using larger central compression instead of numerous smaller compressor engines • Electric powered compression • Using gas turbines rather than internal combustion engines	State controls on new and existing reciprocating internal combustion engines (includes natural gas-fired compressor engines) are scheduled to phase in between 2007 and 2011 as per CDPHE Regulation No. 7 (CDPHE 2008b).
On-Road Mobile Sources	Controls for on-road mobile sources might include • Restrictions on vehicle engine exhaust • Operation strategies (e.g., idle reduction, route optimization, facility centralization) • Conversion to natural gas vehicles	Some federal and state restrictions already exist for vehicle exhaust.

Table 6-3. Emissions Categories and Control Options for VOC Sources in Garfield County

VOC Sources	Control Options	Comments
Oil and Gas Sources		
- Venting	Green completion technologies allow natural gas and condensate to be recovered and sold, rather than lost via venting or flaring.	2006 emissions estimates indicated that venting during completion/recompletion and blowdown activities was the largest fraction of oil and gas VOC emissions in Garfield County. As of April 1, 2009, COGCC, Section 805 (COGCC 2009) requires green completion technology for wells that meet certain criteria.
- Condensate Tanks	Examples of options to control these emissions include: • Vapor recovery units • Enclosed flares	COGCC, Section 805 (COGCC 2009), and CDPHE Regulation No. 7 (CDPHE 2008b) include control requirements for condensate tanks.
- Glycol Dehydrators	Conventional glycol dehydrators vent directly to the atmosphere when the dehydrator is recharged. Examples of options to control these emissions include: • Add-on technologies (e.g. thermal oxidizers) to reduce the amount of VOCs vented • Replacement with desiccant dehydrators	COGCC, Section 805 (COGCC 2009), and CDPHE Regulation No. 7 (CDPHE 2008b) include control requirements for glycol dehydrators.
- Pneumatic Devices	Most of the pneumatic devices at production wells and along transmission systems are powered by natural gas. As part of normal operation, most pneumatic devices release or "bleed" gas to the atmosphere. Examples of options to control these emissions include: • Replacement of high-bleed pneumatic devices with low-bleed or no-bleed devices • Power devices with instrument air instead of natural gas	COGCC, Section 805 (COGCC 2009) requires that all new/replaced/repaired pneumatic devices across the state be low-bleed at production sites, but does not require existing devices to be replaced.
- Fugitives	Fugitive emissions can originate from tens of thousands of valves, flanges, pump seals, and numerous other leak points. Leak detection and repair programs can help identify faulty units and greatly reduce fugitive emissions.	The federal government has established New Source Performance Standards for onshore natural gas processing plants requiring leak detection, with inspections on a specified schedule (EPA 1985). These standards do not currently apply to any other facilities, such as fugitive emissions from oil and gas wells, separators, tanks, and metering stations (Armendariz 2009).

7.0 RECOMMENDATIONS FOR PROTECTING AIR QUALITY IN GARFIELD COUNTY

Garfield County Public Health is committed to addressing citizen concerns about activities in the community that affect air quality related values. Work done to date has laid the groundwork for understanding air quality issues in the county, enabling the county to begin the process of developing a plan to address these issues.

Recommendations presented here are designed to support the county's effort to create a comprehensive community-based air quality management plan and implementation strategy. Recommendations are organized into a blueprint for a community air program designed around the Center for Disease Control's Ten Essential Public Health Services (http://www.cdc.gov/od/ocphp/nphpsp/essentialphservices.htm). The essential services provide a guiding framework for the responsibilities of local public health systems.

Table 7-1 presents the general framework of how the county, in partnership with other agencies, is, or could be, addressing these essential services for environmental protection in community.

Table 7-1. Current Activities and Future Needs in Garfield County as Related to the Ten Essential Public Health Services

Essential Services	Current Activities	Future Needs
1. Monitoring Program	Garfield County has undertaken extensive monitoring efforts to understand air quality in the county. These efforts, as described in this report, have included: • Coordinated efforts with the CDPHE and the EPA to monitor VOCs (including HAPS), PM, O_3, and meteorology. • Special studies to monitor VOC levels associated with odor complaints, and time resolved VOCs and PM in close proximity to oil and gas sources. • Work with the CDPHE and the WRAP to update emissions estimates, which has assisted in identifying major source contributors in the county.	Continuation and enhancement of the monitoring program: • Ongoing measurements of O_3 and PM will address compliance with national air quality standards. • Ongoing measurements of VOCs to help understand impacts of regulations and changing production levels. • Additional criteria pollutants should be monitored (e.g., NO_2) • Continuing need for special studies (HAPS, odors, etc.) • Regional haze monitoring including visibility and speciated PM measurements • Emissions projections need to be updated to reflect most recent rules and regulations
2. Investigate Hazards	Garfield County has been aggressively collecting data and mobilizing personnel to analyze air quality data and associated risk. Preliminary risk-based screening for air toxics has been performed for data through 2007. Several studies have been completed or are underway with CDPHE and other participating agencies to evaluate health effects.	Continued monitoring will enable more detailed evaluation of health hazards and trends, and will address compliance issues. Continual updates and refinements to emissions estimates and projections will help the county understand the benefits or impacts of emission control strategies. More in depth source apportionment studies and enhanced regional and sub-regional modeling capability will also assist in investigation of hazards and effectiveness of controls.

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Table 7-1. Current Activities and Future Needs in Garfield County as Related to the Ten Essential Public Health Services (continued)

Essential Services	Current Activities	Future Needs
3. Inform and Educate the Community	As described in this report, Garfield County has made substantial efforts to build a foundation of public knowledge, including: • Monitoring data and summary reports for Garfield County, available on the air quality Web site. • The "Smart Citizen Series," which invited citizens to view presentations and comment on air quality issues. • The "Citizens Guide to Air Quality in Garfield County" brochure, as provided in Task 4 of this report, which was designed to communicate some of the key points presented in this report.	Continued outreach efforts should assist the public in understanding the issues and provide for more effective community involvement.
4. Mobilize Partnerships	A number of groups participate and continue to contribute to managing air quality in Garfield County. Partners have included the CDPHE, the Garfield County Energy Advisory Board (EAB), the Grand Valley Citizens Alliance, the Soccomanno Research Institute of St. Mary's Hospital in Grand Junction, Energy Industry Leaders, Colorado Mountain College, Colorado Mountain News Media, the Chamber of Commerce, Local Governments, and various citizen groups and organizations.	In order to focus on solutions and action concerning air quality issues, Garfield County should establish an Air Quality Advisory Board, or partner with the Mesa County Grand Valley Air Quality Advisory Committee. Representation should include a broad based constituency, including citizens, environmentalists, municipalities, Federal Land Managers, and industry. This advisory board capacity could evaluate potential policy and action items for the county, and make recommendations for inclusion in an Air Quality Management Plan, which could guide decisions in the county.

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Table 7-1. Current Activities and Future Needs in Garfield County as Related to the Ten Essential Public Health Services (continued)

Essential Services	Current Activities	Future Needs
5. Develop Policies to Support Efforts	Garfield County actively supports federal and state legislation to improve air quality in the county. The Oil and Gas Department serves as the local government designee to relay industry, citizen and local government concerns to the Colorado Oil and Gas Conservation Commission (COGCC) (http://oil-gas.state.co.us/), which promulgates the rules that govern oil and gas development. Also, Garfield County is currently working with the EPA Community Action for a Renewed Environment (CARE) grant program to further define the needs of the county and develop policies to implement solutions to reduce releases of toxic pollutants and minimize people's exposure to them.	A comprehensive Air Quality Management Plan should be developed and regularly updated to reflect changing needs of the county. The county can use the data as summarized in this report to begin to evaluate policy recommendations for the management plan. An advisory board could evaluate specific policy issues and address them individually. The Air Quality Management Plan could be made up of components including a policy plan and an action plan: • The policy plan could be a long-term policy document addressing the needs of the county. • The action plan could contain strategies for the county to address these needs, which could be updated more regularly. Potential actions required to meet community concerns will go beyond regulatory actions and require voluntary efforts. This might include aggressive promotion of existing programs like EPA's Natural Gas STAR program, and incorporate a variety of options and incentives targeted at other facets of the community (not just oil and gas).

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Table 7-1. Current Activities and Future Needs in Garfield County as Related to the Ten Essential Public Health Services (continued)

Essential Services	Current Activities	Future Needs
6. Compliance Assistance	The county does not regulate oil and gas drilling directly, but does serves as a liaison between the citizens and the energy industry, relaying regulatory concerns to the Colorado Oil and Gas Conservation Commission (COGCC), where the drilling permits are issued. It is then the responsibility of the COGCC to respond to these concerns. Some county regulations affect the energy industry. For example, oversized vehicles are subject to permits from the Road and Bridge Department and certain facilities must obtain land use and building permit approvals from the Building and Planning Department.	With increasing number of permits issued under existing authorities, the ability to enforce permit conditions becomes more difficult. It will continue to be important to ensure that resources are available for adequate and timely compliance monitoring and enforcement.
7. Increase Awareness of Activities and Services	Activities to date by the county have been published on the county's website, and made available through press releases and citizen forums.	Ongoing efforts by the county, including educational opportunities, public hearings, compliance efforts, and efforts to increase voluntary emission reduction (both by industry and the public) should continue to be well publicized. Increased awareness of these efforts will help build community confidence and support.
8. Assure Competency	Professionalism and integrity are stated values of Garfield County. In 2005, Garfield County reinvested in the environmental health program and hired additional qualified personnel to address the rapid expansion of the oil and gas industry in the county. With the investment of personnel has come enhanced monitoring and analysis, as described in this report. Data integrity is continually checked with routine QA/QC procedures.	As Garfield County progresses with an Air Quality Management Plan, ongoing QA/QC procedures and professional development opportunities for the staff will be important.

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Table 7-1. Current Activities and Future Needs in Garfield County as Related to the Ten Essential Public Health Services (continued)

Essential Services	Current Activities	Future Needs
9. Evaluation	Efforts undertaken by the county, as described in this document, have focused mainly on defining the air quality issues in the county. These processes have involved participation by various federal, state, county, and industry stakeholders, with evaluation through constant review and feedback.	Evaluation of the impact of policies and controls will require continued monitoring, and emissions inventory and risk assessments. Assessment criteria should be developed (such as progress towards stated goals and cost effectiveness), and any air quality policy and action plans developed by the county should be evaluated regularly and revised based on results.
10. Look for New Options	Continuous improvement is one of Garfield County's stated values. Efforts described in this report have been driven by the commitment of GCPH to look for new options to address air quality health issues.	Existing control technologies continually become more accessible and cost effective, and new technologies are continually developed and evaluated. An Air Quality Advisory Board, if created, would be responsible for shaping Garfield County's advocacy for federal and state mandates, and the county's own policy and action decisions around the best available options.

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