



**GARFIELD COUNTY  
QUARTERLY MONITORING REPORT**

**FIRST QUARTER  
JANUARY 1 THROUGH MARCH 31, 2012**

Prepared for:

**Garfield County Public Health Department**  
195 West 14th Street  
Rifle, CO 81650

Prepared by:

**Air Resource  
Specialists, Inc.**  
1901 Sharp Point Drive, Suite E  
Fort Collins, CO 80525  
Phone: 970-484-7941  
[www.air-resource.com](http://www.air-resource.com)

June 30, 2012

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
<b>1.0 INTRODUCTION</b>	<b>1-1</b>
1.1 Background	1-1
<b>2.0 DATA COLLECTION STATISTICS</b>	<b>2-1</b>
<b>3.0 METEOROLOGICAL SUMMARIES</b>	<b>3-1</b>
<b>4.0 CRITERIA POLLUTANT SUMMARIES</b>	<b>4-1</b>
4.1 Ozone	4-3
4.2 Particulate Matter (PM <sub>10</sub> and PM <sub>2.5</sub> )	4-7
<b>5.0 SNMOC AND CARBONYL SUMMARIES</b>	<b>5-1</b>
5.1 SNMOC	5-1
5.2 Carbonyls	5-5
<b>APPENDIX A</b> Garfield County Stackplots, January 1, 2012 - March 31, 2012	A-1
<b>APPENDIX B</b> Garfield County SNMOC Concentrations, January 1, 2012 - March 31, 2012	B-1
<b>APPENDIX C</b> Garfield County Carbonyl Concentrations, January 1, 2012 - March 31, 2012	C-1

## LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1-1 Map of Garfield County Monitoring Sites	1-2
3-1 Quarterly Wind Rose for the Parachute Monitoring Site	3-2
3-2 Quarterly Wind Rose for the Rifle Monitoring Site	3-3
3-3 Quarterly Wind Rose for the Bell-Melton Monitoring Site	3-4
3-4 Quarterly Wind Rose for the Battlement Mesa Monitoring Site	3-5
4-1 Daily Maximum 8-Hour Averages of Ozone Monitored at the Rifle Site	4-3
4-2 Quarterly Ozone Pollutant Rose for the Rifle Monitoring Site	4-5
4-3 Quarterly Ozone Diurnal Plot for the Rifle Monitoring Site	4-6
4-4 Quarterly PM <sub>10</sub> Pollutant Rose for the Rifle Monitoring Site	4-8
4-5 Quarterly PM <sub>2.5</sub> Pollutant Rose for the Rifle Monitoring Site	4-9

### LIST OF FIGURES (continued)

<u>Figure</u>		<u>Page</u>
4-6	Quarterly PM <sub>10</sub> Diurnal Plot for the Rifle Monitoring Site	4-10
4-7	Quarterly PM <sub>2.5</sub> Diurnal Plot for the Rifle Monitoring Site	4-11
5-1	24-Hour SNMOC Measurements by Category in Units of ppbV	5-3
5-2	24-Hour SNMOC Measurements by Category in Units of ppbC	5-4
5-3	24-Hour Major Carbonyl Compound Concentrations in Units of ppbV	5-6

### LIST OF TABLES

<u>Table</u>		<u>Page</u>
1-1	Garfield County Parameters Monitored by Site	1-3
2-1	Data Collection Statistics for Parachute Site	2-1
2-2	Data Collection Statistics for Rifle Site	2-2
2-3	Data Collection Statistics for Bell-Melton Site	2-3
2-4	Data Collection Statistics for Battlement Mesa Site	2-4
4-1	Rifle Site, Standards Summary	4-2
4-2	Parachute Site, Standards Summary	4-2
4-3	Rifle Site, Ten Highest Daily Maximum 8-Hour Ozone Averages	4-4

## 1.0 INTRODUCTION

This air quality data summary report has been prepared by Air Resource Specialists, Inc. (ARS) for the Garfield County Public Health Department (GCPHD). This report summarizes data collected from January 1, 2012 through March 31, 2012 at the Garfield County monitoring sites, including metrological characteristics, criteria pollutant levels, and levels of volatile organic compounds (VOCs). Any questions regarding the contents of this report should be addressed to:

Cassie Archuleta

**Air Resource Specialists, Inc.**  
1901 Sharp Point Drive, Suite E  
Fort Collins, Colorado 80525  
Telephone: 970-484-7941  
Fax: 970-484-3423  
[carchuleta@air-resource.com](mailto:carchuleta@air-resource.com)

## 1.1 BACKGROUND

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 have grown regarding air quality impacts of oil and gas development in Garfield County. The Garfield County Public Health Department (GCPHD) is committed to protecting the health and welfare of its citizens. In 2005, the GCPHD enhanced air quality monitoring efforts to evaluate levels of particulate matter  $\leq 10$  microns ( $PM_{10}$ ) and VOCs in the area. In 2008, the monitoring network was modified to encompass speciated non-methane organic compounds (SNMOCs) and carbonyl compounds. Also, the regulatory monitoring network expanded from  $PM_{10}$  to include particulate matter  $\leq 2.5$  microns ( $PM_{2.5}$ ) and ozone ( $O_3$ ). These changes were designed to serve a wide range of purposes, including monitoring of criteria pollutant levels, ozone formation potential, toxics assessments, and source attribution.

The 2012 monitoring network in Garfield County consists of four (4) monitoring locations. Characteristics of the monitoring locations are described below.

- Parachute (PACO): Parachute is a small urban center of approximately 1,300 people within very close proximity to oil and development and production activities. The town is located along Interstate 70 and is the transportation hub for heavily traveled roads which service the surrounding canyons.
- Rifle (RICO): Rifle is a rapidly growing urban center on the Interstate 70 corridor with estimated population of about 9,200 people. Rifle is in close proximity to oil and gas development activities, and is also central to industrial support for the oil and gas industry.
- Bell-Melton (BRCO): The Bell-Melton site is a rural homestead approximately four miles south of the town of Silt, in close proximity to moderate oil and gas development and heavy natural gas production.

- Battlement Mesa (BMCO): Battlement Mesa is a rural community located about 1.5 miles southeast of Parachute. The town takes its name from Battlement Mesa, a basalt-topped mesa that sits to the south of the town. This site began operation in September 2010 as substantial natural gas development and production activities began increasing in the immediate area.

Figure 1-1 is a map of the monitoring sites in Garfield County and Table 1-1 lists the parameters monitored. The Garfield County Public Health Department (GCPHD) monitors pollutants and meteorology at these stations with technical support from several agencies. Filter based PM<sub>10</sub> monitors in Rifle and Parachute are operated by the GCPHD, with filter analysis supported by the Colorado Department of Public Health and Environment (CDPHE). SNMOC and carbonyl compounds are sampled at all sites and analyzed by the Eastern Research Group, Inc. (ERG). The GCPHD monitors meteorology at the Bell-Melton sites and Battlement Mesa sites. Air Resource Specialists, Inc. (ARS) supports monitoring, data collection and data validation for continuous PM<sub>10</sub> and PM<sub>2.5</sub>, O<sub>3</sub>, and meteorology at the Rifle site, and meteorology at the Parachute site. GCPHD also operates a digital Web camera at the Rifle site, where camera images are collected every 15-minutes and displayed on the Garfield County Air Quality Monitoring Web site (<http://www.garfieldcounty.net>), along with associated meteorological and air quality data.

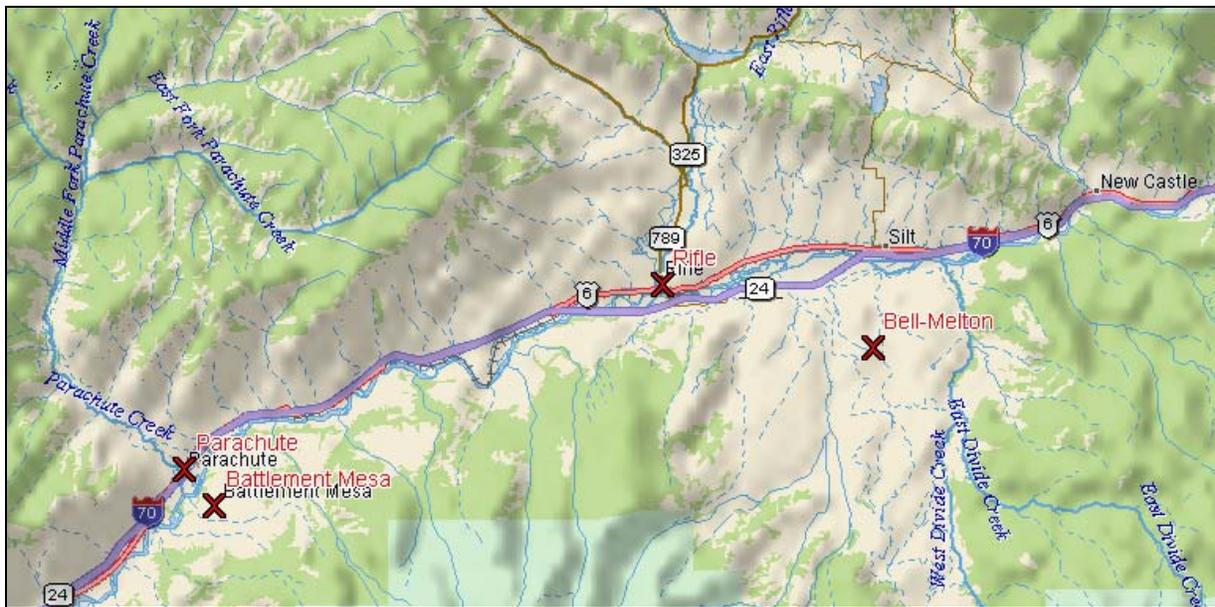


Figure 1-1. Map of Garfield County Monitoring Sites.

Table 1-1

Garfield County  
Parameters Monitored by Site

<b>Component</b>	<b>Method</b>	<b>Sampling Frequency</b>	<b>Reporting Agency</b>
<b>Rifle, Colorado</b>			
SNMOC	TO-12	24-hour (1/6 day)	ERG
Carbonyls	TO-11A	24-hour (1/12 day)	ERG
PM <sub>10</sub>	FRM	24-hour (1/3 day)	CDPHE
PM <sub>10</sub>	TEOM	Hourly	ARS
PM <sub>2.5</sub>	TEOM	Hourly	ARS
Ozone	42C	Hourly	ARS
Meteorology	Various	Hourly	ARS
Visibility Web Camera	Digital	15-min	ARS
<b>Parachute, Colorado</b>			
SNMOC	TO-12	24-hour (1/6 day)	ERG
Carbonyls	TO-11A	24-hour (1/12 day)	ERG
PM <sub>10</sub>	FRM	24-hour (1/3 day)	CDPHE
Meteorology	Various	Hourly	ARS
<b>Bell-Melton, Colorado</b>			
SNMOC	TO-12	24-hour (1/6 day)	ERG
Carbonyls	TO-11A	24-hour (1/12 day)	ERG
Meteorology	Various	Hourly	GCPHD
<b>Battlement Mesa, Colorado</b>			
SNMOC	TO-12	24-hour (1/6 day)	ERG
Carbonyls	TO-11A	24-hour (1/12 day)	ERG
Meteorology	Various	Hourly	GCPHD

## 2.0 DATA COLLECTION STATISTICS

Tables 2-1 through 2-4 list the data collection statistics by site for the quarter. Continuous gas, particulate and meteorological data are reported as hourly averages, SNMOC samples are reported as 24-hour averages every sixth day, and carbonyl averages are reported as 24-hour averages every twelfth day.

Table 2-1

Data Collection Statistics for Parachute Site  
1/1/2012 – 3/31/12

Parameter	Interval	Data Recovery			Comments
		No. Possible	No. Valid	% Valid	
Relative Humidity	hourly	2184	2182	99.9	
Precipitation	Hourly	2184	2181	99.9	
Scalar Wind Direction	hourly	2184	2176	99.6	
Scalar Wind Speed	hourly	2184	2176	99.6	
Ambient Temperature	hourly	2184	2179	99.8	
PM <sub>10</sub>	1/3 day	27	27	100	
SNMOCs	1/6 day	15	14	93.3	
Carbonyls	1/12 day	8	6	75	

Table 2-2

Data Collection Statistics for Rifle Sites  
1/1/2012 – 3/31/12

Parameter	Interval	Data Recovery			Comments
		No. Possible	No. Valid	% Valid	
Ozone	hourly	2184	2174	99.5	
PM <sub>2.5</sub>	hourly	2184	2146	98.3	
PM <sub>10</sub>	hourly	2184	2146	98.3	
Relative Humidity	hourly	2184	2171	99.4	
Precipitation	hourly	2184	2170	99.4	
Scalar Wind Direction	hourly	2184	2171	99.4	
Scalar Wind Speed	hourly	2184	2167	99.2	
Vector Wind Direction	Hourly	2184	2167	99.2	
Vector Wind Speed	Hourly	2184	2167	99.2	
Ambient Temperature	hourly	2184	2171	99.4	
PM <sub>10</sub>	1/3 day	27	27	100	
SNMOCs	1/6 day	15	14	93.3	
Carbonyls	1/12 day	8	7	87.5	

Table 2-3

Data Collection Statistics for Bell-Melton Site  
1/1/2012 – 3/31/12

Parameter	Interval	Data Recovery			Comments
		No. Possible	No. Valid	% Valid	
Barometric Pressure	hourly	2184	2184	100%	
Relative Humidity	hourly	2184	2184	100%	
Scalar Wind Direction	hourly	2184	2184	100%	
Scalar Wind Speed	hourly	2184	1451	66.4%	
Ambient Temperature	hourly	2184	2184	100%	
SNMOCs	1/6 day	15	14	93.3	
Carbonyls	1/12 day	8	7	87.5	

Table 2-4

Data Collection Statistics for Battlement Mesa Site  
1/1/2012 – 3/31/12

Parameter	Interval	Data Recovery			Comments
		No. Possible	No. Valid	% Valid	
Barometric Pressure	hourly	2184	2008	91.9%	
Relative Humidity	hourly	2184	1457	66.7%	
Scalar Wind Direction	hourly	2184	1457	66.7%	
Scalar Wind Speed	hourly	2184	1457	66.7%	
Ambient Temperature	hourly	2184	1457	66.7%	
SNMOCs	1/6 day	15	13	82.1	
Carbonyls	1/12 day	8	7	87.5	

### **3.0 METEOROLOGICAL SUMMARIES**

Meteorological data collected along with air quality parameters are used to better understand the local conditions and transport of air pollutants. Meteorological data collected at these sites includes wind speed, wind direction, temperature, relative humidity, and precipitation. Time series plots for all parameters collected between January 1, 2012 and March 31, 2012 are presented in Appendix A.

Figures 3-1 through 3-3 present quarterly wind roses for all monitoring sites. A wind rose shows the frequency of wind direction and uses different shading to represent wind speeds.

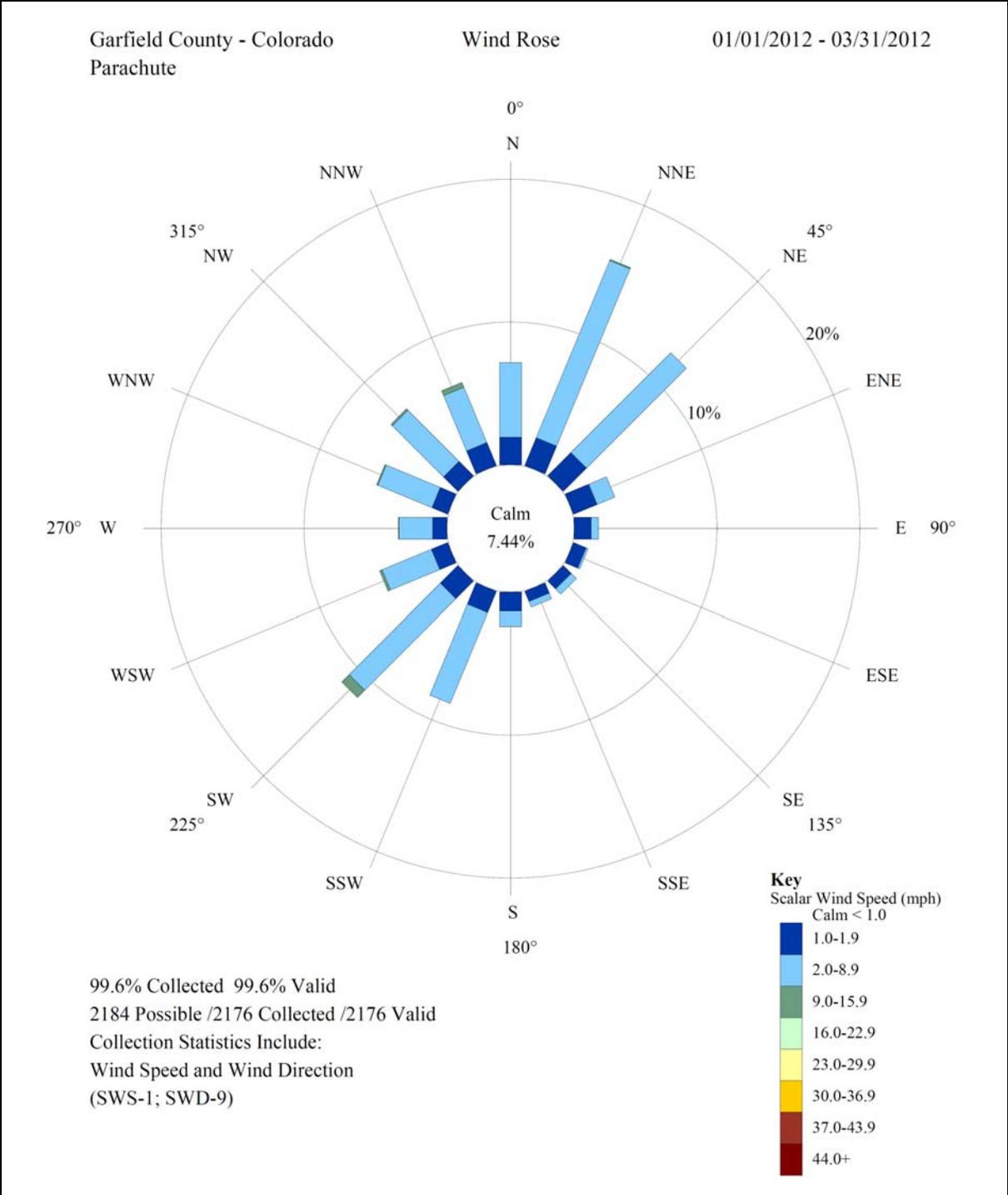


Figure 3-1. Quarterly Wind Rose for the Parachute Monitoring Site.

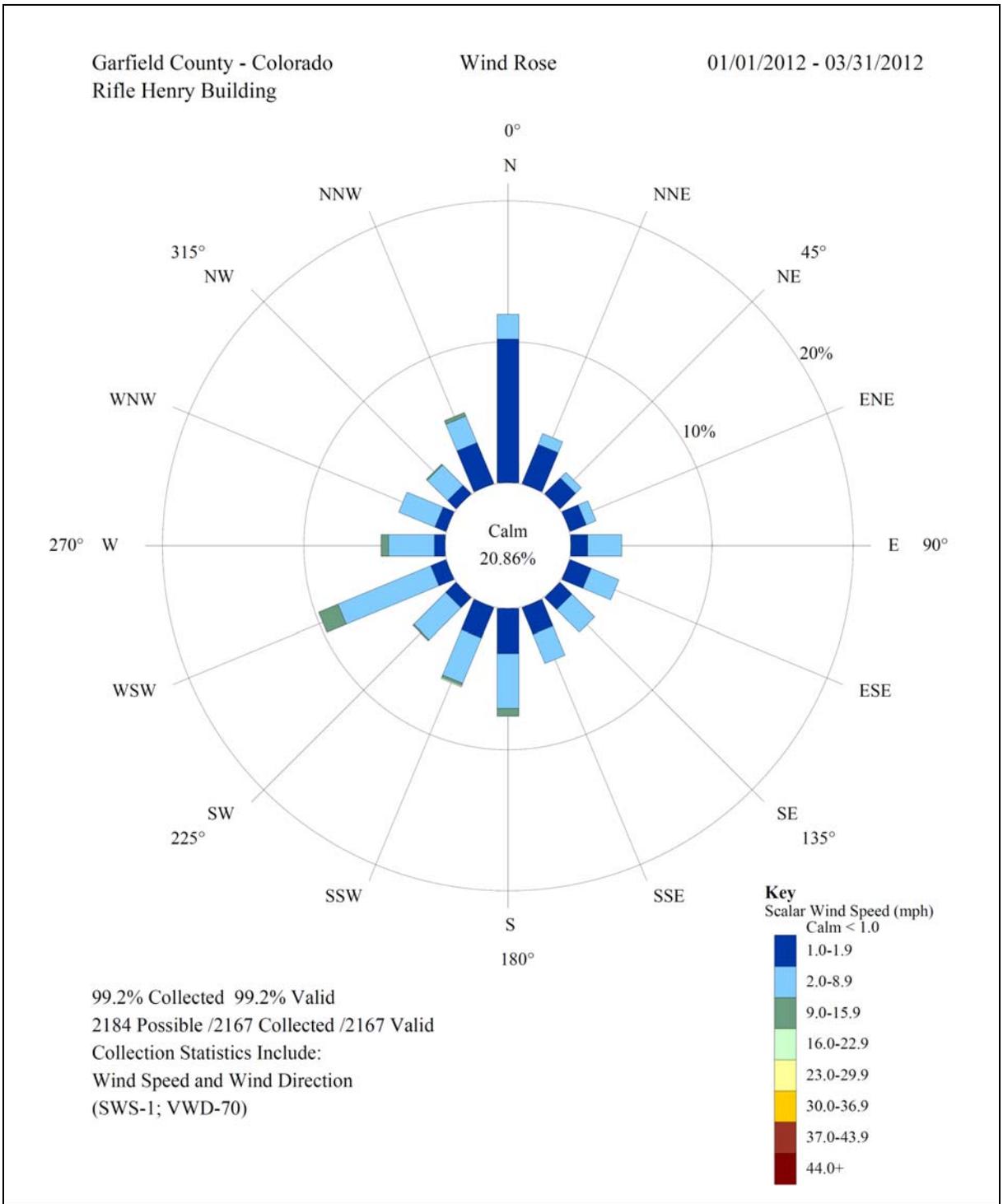


Figure 3-2. Quarterly Wind Rose for the Rifle Monitoring Site.

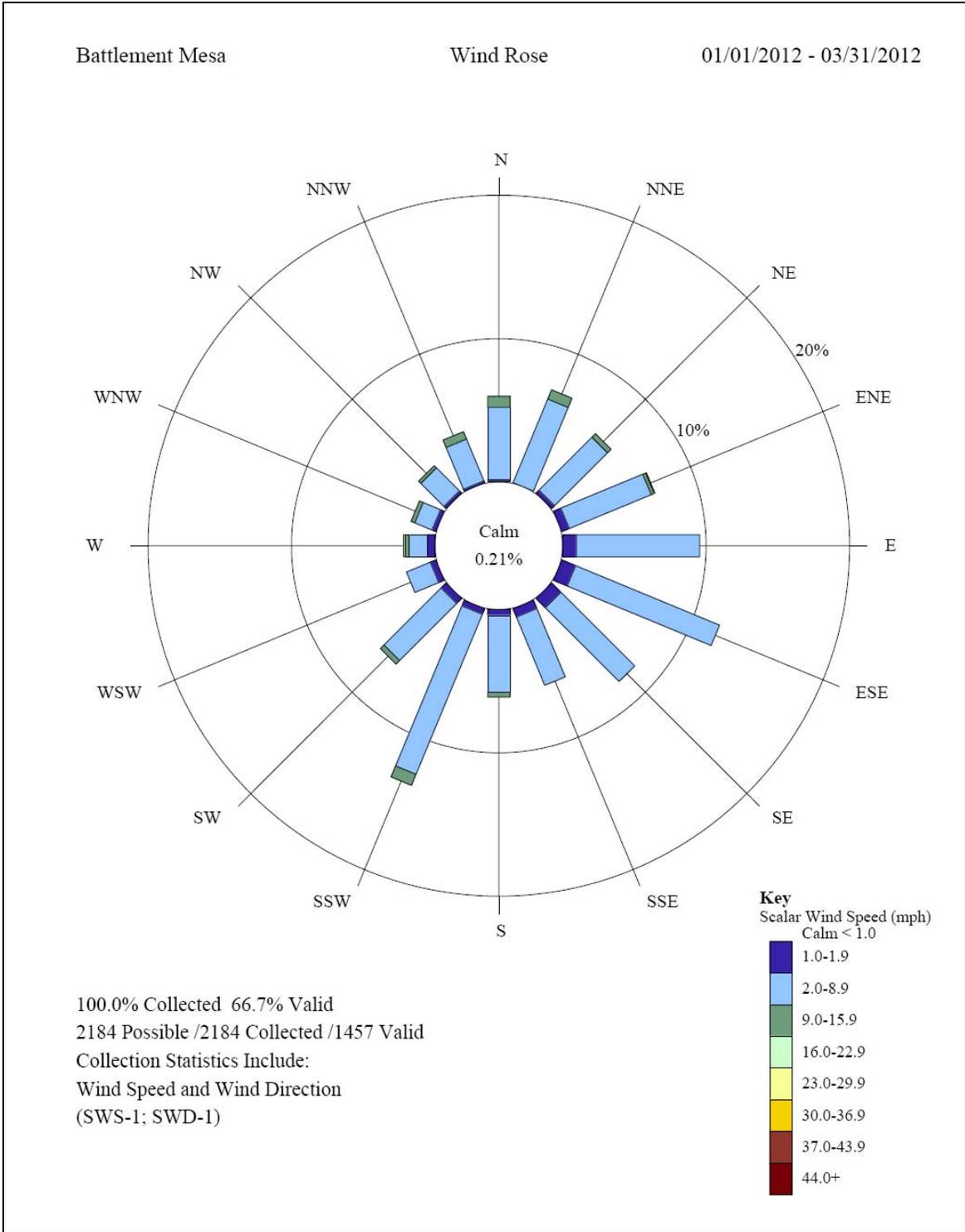


Figure 3-3. Quarterly Wind Rose for the Bell-Melton Monitoring Site.

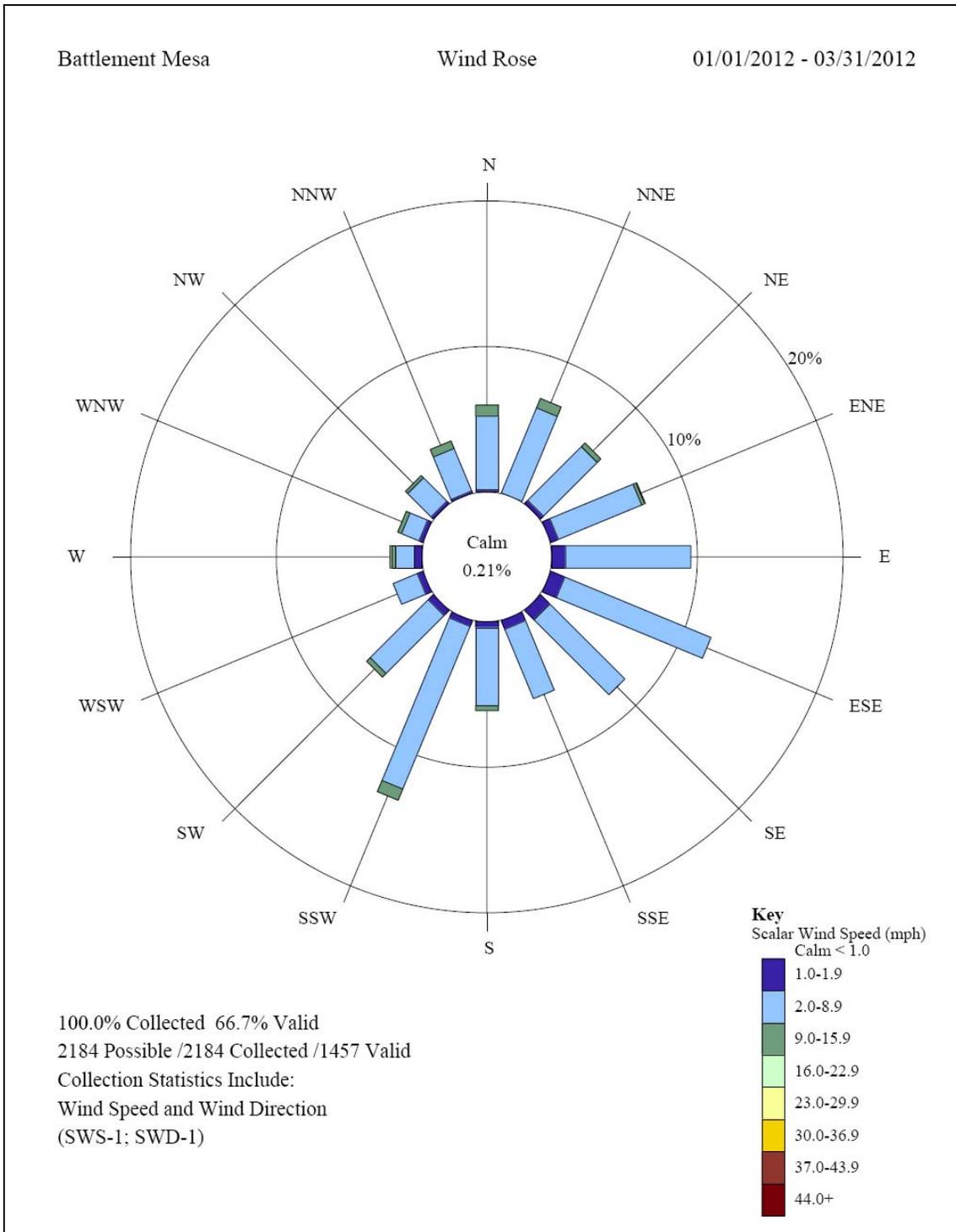


Figure 3-4. Quarterly Wind Rose for the Battlement Mesa Monitoring Site.

## 4.0 CRITERIA POLLUTANT SUMMARIES

The Clean Air Act requires the Environmental Protection Agency (EPA) to set two (2) types of National Ambient Air Quality Standards (NAAQS) for ground-level O<sub>3</sub>, particle pollution (PM<sub>2.5</sub> and PM<sub>10</sub>), lead, nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), and sulfur dioxide (SO<sub>2</sub>). The types of standards are as follows:

- 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<sub>10</sub> is monitored using filter-based Federal Reference Method (FRM) samplers at the Parachute and Rifle sites. Continuous PM<sub>2.5</sub> and PM<sub>10</sub> are also monitored at the Rifle site. The level of the national primary and secondary ambient air quality standards for PM<sub>10</sub> is a 24-hour average concentration of 150 micrograms per cubic meter (µg/m<sup>3</sup>). A violation of the standard occurs when the number of days with a 24-hour average concentration above 150 µg/m<sup>3</sup> over a three (3) year period is equal to or less than one. The standards for PM<sub>2.5</sub> are an annual arithmetic mean of 15 µg/m<sup>3</sup>, and a 24-hour average of 35 µg/m<sup>3</sup>. A violation of the PM<sub>2.5</sub> standard occurs when the three (3) year average of the weighted annual mean exceeds that annual standard, or the three (3) year average of the 98th percentile 24-hour average value exceeds the 24-hour standard.

Continuous O<sub>3</sub> is monitored at the Rifle site. The NAAQS for O<sub>3</sub> is currently 0.075 ppm (75 ppb) over an 8-hour period. An exceedance of the standard occurs when an 8-hour average O<sub>3</sub> concentration is greater than or equal to 76 ppb. A violation of the standard occurs when the three (3) year average of the fourth highest daily maximum 8-hour average ozone concentration equals or exceeds 76 ppb.

Values measured for O<sub>3</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub> measured year-to-date in 2012 at the Rifle site are presented with corresponding NAAQS in Table 4-1. PM<sub>10</sub> measured at the Parachute site is presented in Table 4-2. At present, air quality measurements in Garfield County do not violate air quality standards for these criteria pollutants.

Table 4-1

Rifle Site  
Standards Summary  
January 1, 2012 – March 31, 2012

Parameter	NAAQS		Measured	
	Averaging Time	Standard	Measured Value	Date(s)
Ozone (O <sub>3</sub> )	Rolling 8-hour	0.075 ppm/ 75 ppb	Highest Daily Max.: 63 ppb	3/26
			4 <sup>th</sup> Highest Daily Max.: 53 ppb	3/24
Particulate Matter ≤2.5µm* (PM <sub>2.5</sub> )	Annual	15 µg/m <sup>3</sup>	Arithmetic Mean: 9.5 µg/m <sup>3</sup>	1/1-3/31
	24-hour	35 µg/m <sup>3</sup>	Highest Daily Max.: 18.7 µg/m <sup>3</sup> 2 <sup>nd</sup> Highest Daily Max.: 17.5 µg/m <sup>3</sup>	3/24 3/4
Particulate Matter ≤10µm** (PM <sub>10</sub> )	24-hour	150 µg/m <sup>3</sup>	Highest Daily Max.: 41 µg/m <sup>3</sup>	3/7
			2 <sup>nd</sup> Highest Daily Max.: 41 µg/m <sup>3</sup>	1/4

\*Calculated using continuous TEOM measurements

\*\*Calculated using 1/3 day filter-based measurements

Table 4-2

Parachute Site  
Standards Summary  
January 1, 2012 – March 31, 2012

Parameter	NAAQS		Measured	
	Averaging Time	Standard	Measured Value	Date(s)
Particulate Matter ≤10µm (PM <sub>10</sub> )	24-hour	150 µg/m <sup>3</sup>	Highest Daily Max.: 65 µg/m <sup>3</sup>	3/7
			2 <sup>nd</sup> Highest Daily Max.: 39 µg/m <sup>3</sup>	1/4

## 4.1 OZONE

Ozone is measured at the Rifle site. Figure 4-1 presents daily maximum 8-hour averages of ozone measured year-to-date in 2012 along with the NAAQS. Table 4-3 presents the highest daily maximum 8-hour O<sub>3</sub> measurements in 2012.

Figure 4-2 presents a quarterly O<sub>3</sub> pollutant rose for the Rifle site. The highest ozone values were associated with winds between the south and west. Figure 4-3 presents the quarterly diurnal cycle of measured hourly O<sub>3</sub> at the Rifle station. The cycle shows lowest concentrations in the early morning hours and maximum concentrations in the late afternoon. This pattern results from daytime photochemical production from oxides of nitrogen (NO<sub>x</sub>, NO + NO<sub>2</sub>) and VOC precursors, and ozone loss by dry deposition and reaction with NO at night.

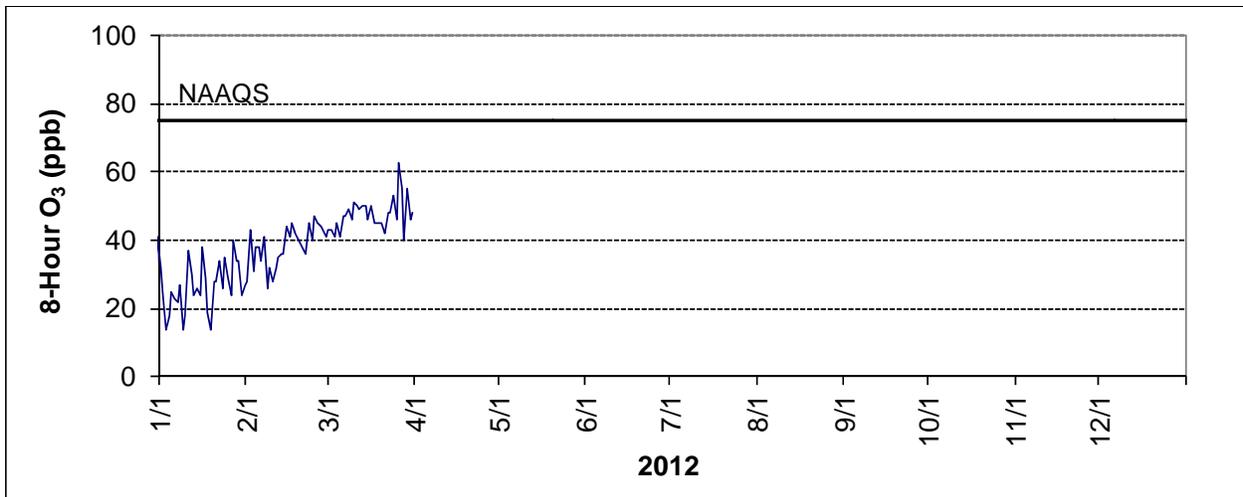


Figure 4-1. Daily Maximum 8-Hour Averages of Ozone Monitored at the Rifle Site.

Table 4-3

Rifle Site  
 Ten Highest Daily Maximum 8-Hour Ozone Averages  
 January 1, 2012 – March 31, 2012

<b>Level</b>	<b>Date</b>	<b>Daily Maximum 8-Hour Ozone (ppb)</b>
1	03/26/2012	63
2	03/27/2012	55
3	03/29/2012	55
<b>4*</b>	03/24/2012	<b>53</b>
5	03/10/2012	51
6	03/11/2012	50
7	03/13/2012	50
8	03/24/2012	50
9	03/16/2012	50
10	03/08/2012	49

\* The 3-year average of the 4th highest daily maximum is used to determine attainment status.

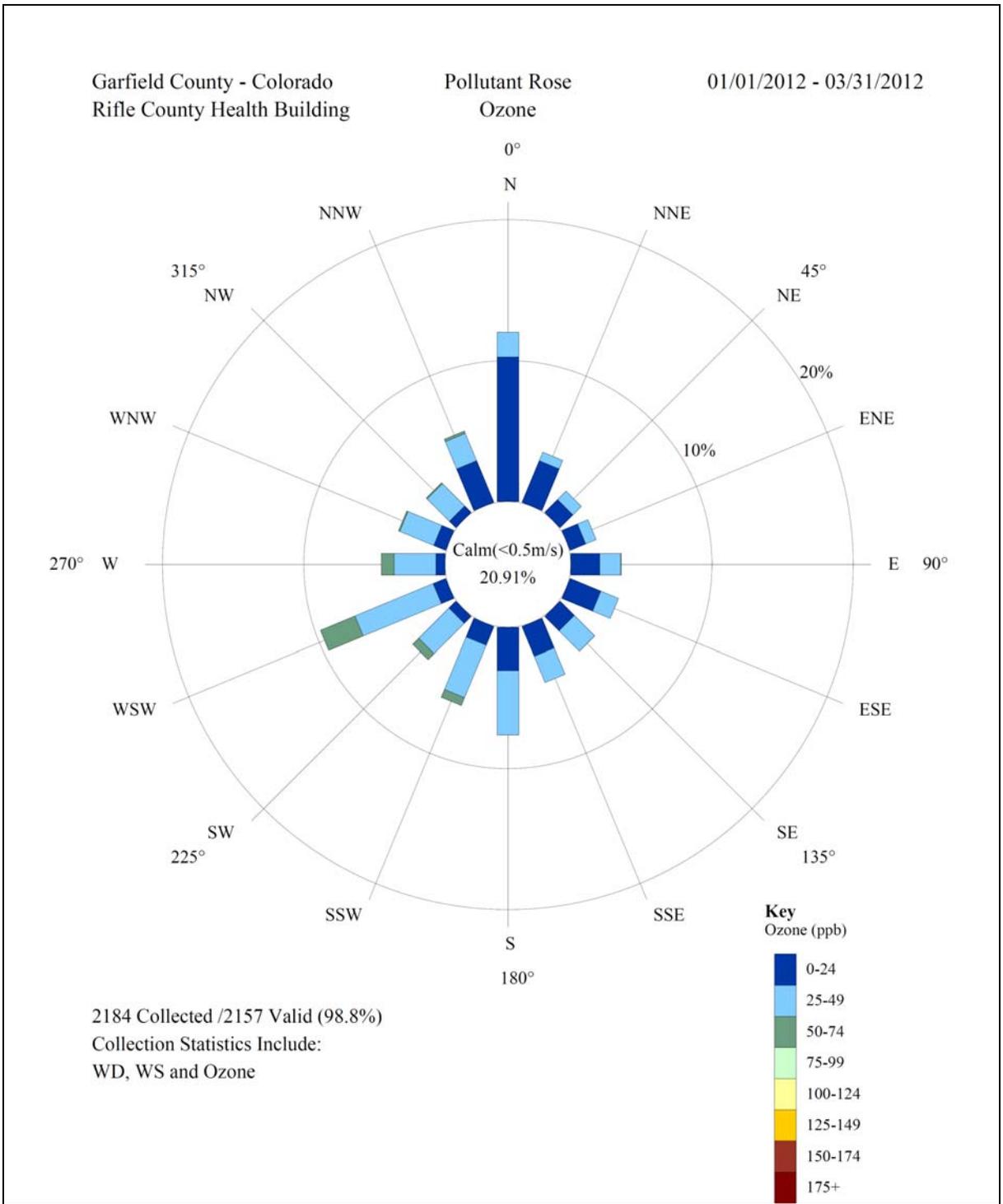


Figure 4-2. Quarterly Ozone Pollutant Rose for the Rifle Monitoring Site.

Garfield County- Colorado  
Rifle County Health Building

Diurnal Plot  
Ozone

01/01/2012 - 03/31/2012

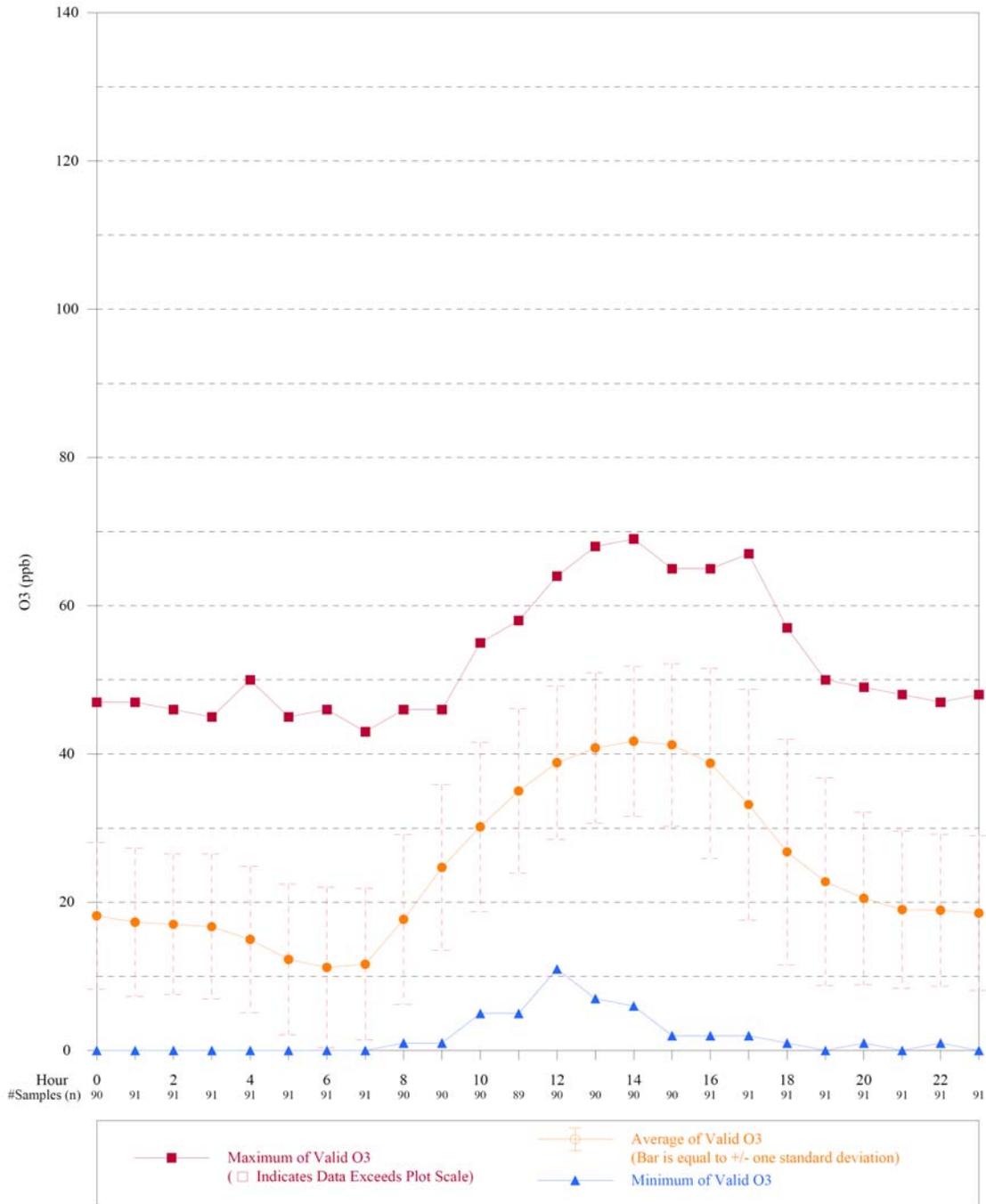


Figure 4-3. Quarterly Ozone Diurnal Plot for Rifle Monitoring Site.

## 4.2 PARTICULATE MATTER (PM<sub>10</sub> AND PM<sub>2.5</sub>)

Filter based 24-hour PM<sub>10</sub> samples are collected every third day at the Parachute and Rifle sites, and continuous hourly PM<sub>10</sub> and PM<sub>2.5</sub> concentrations are collected at the Rifle site.

Figures 4-4 and 4-5 present quarterly PM<sub>10</sub> and PM<sub>2.5</sub> pollutant roses constructed from the continuous hourly data measured at the Rifle site. Highest particulate concentrations were measured when winds were out of the south-southwest. Figures 4-6 and 4-7 present quarterly diurnal plots for continuous PM<sub>10</sub> and PM<sub>2.5</sub>.

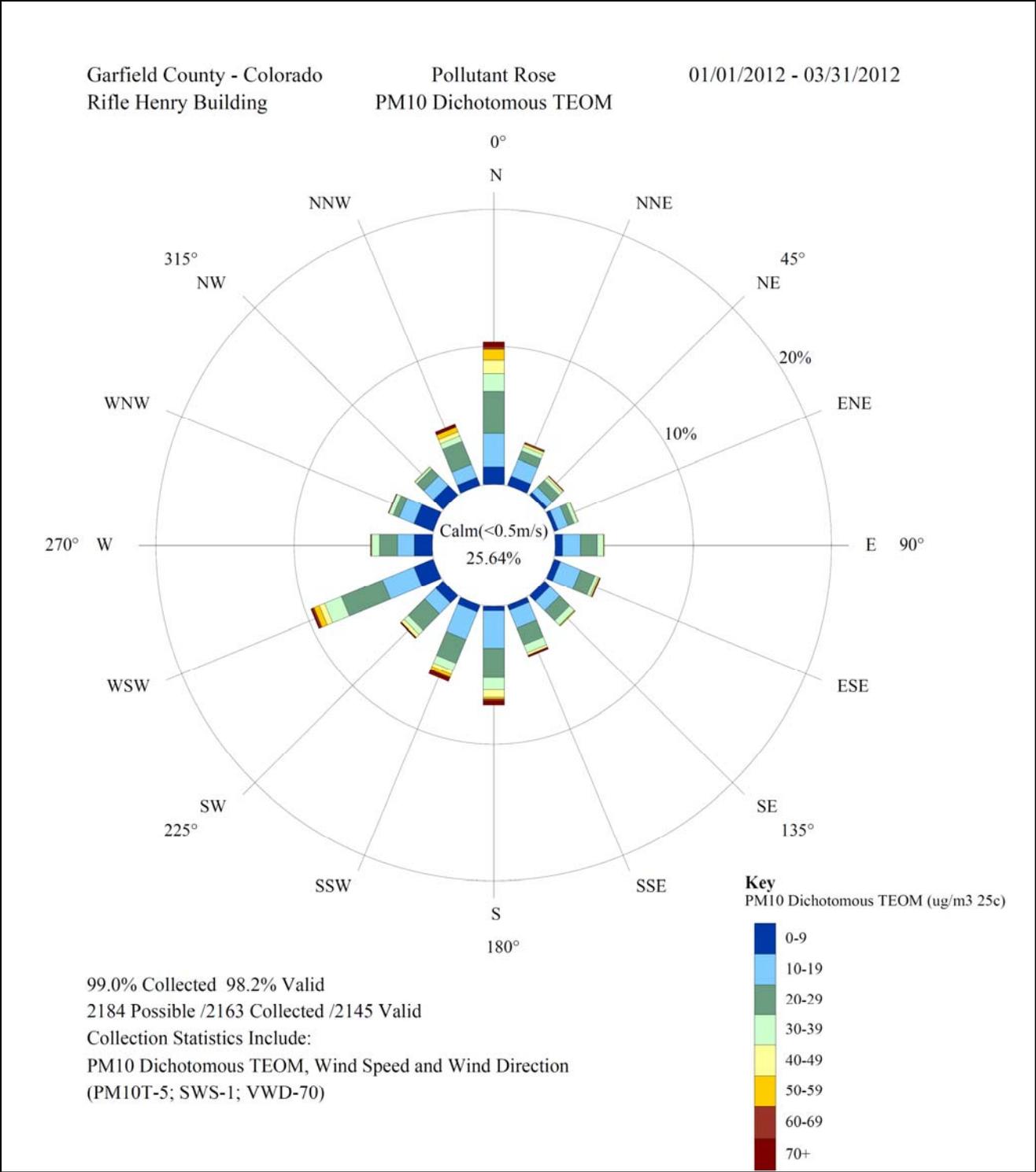


Figure 4-4. Quarterly PM<sub>10</sub> Pollutant Rose for the Rifle Monitoring Site.

Garfield County - Colorado  
Rifle Henry Building

Pollutant Rose  
PM<sub>2.5</sub> Dichotomous TEOM

01/01/2012 - 03/31/2012

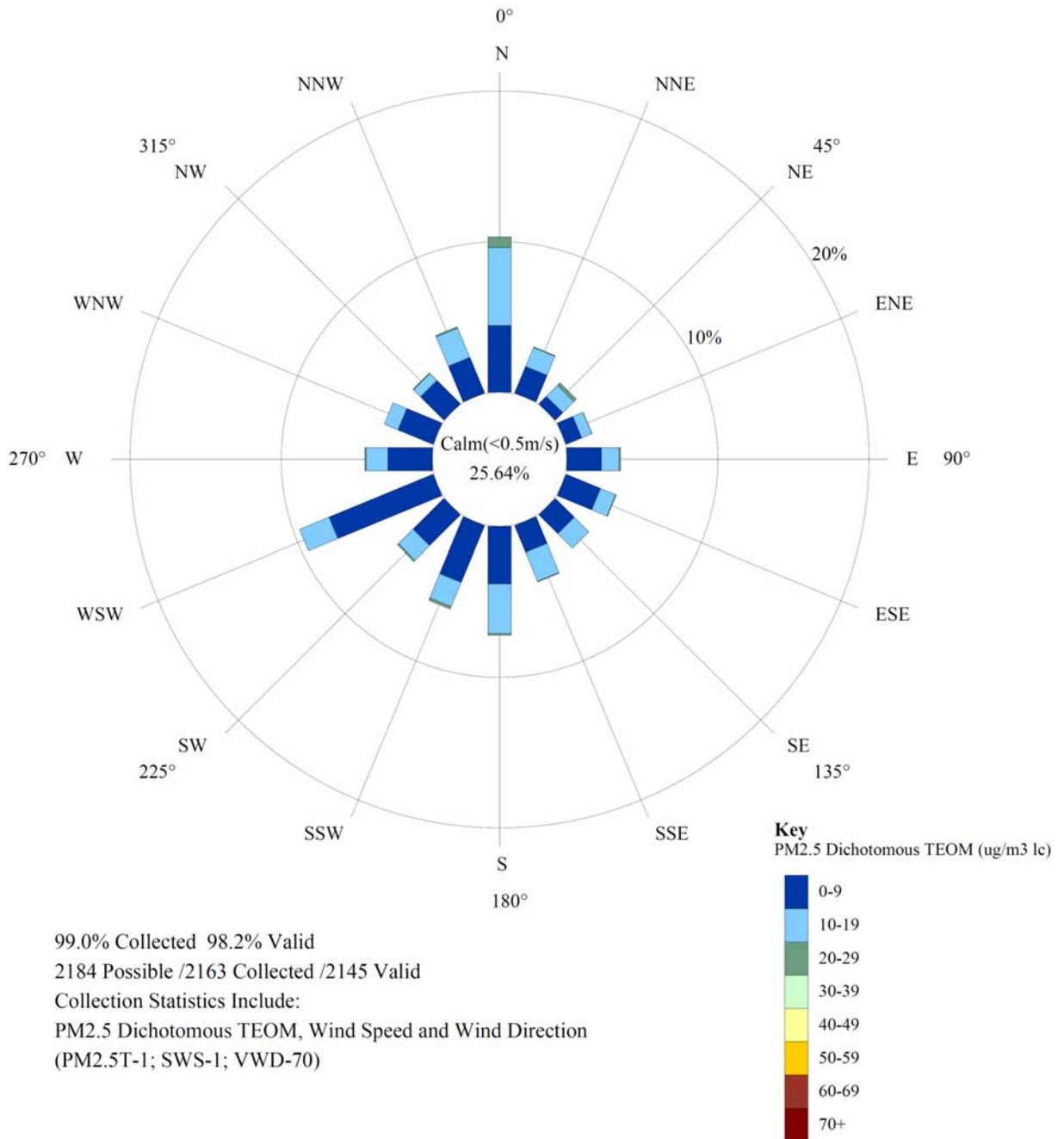


Figure 4-5. Quarterly PM<sub>2.5</sub> Pollutant Rose for the Rifle Monitoring Site.

Garfield County- Colorado  
Rifle Henry Building

Diurnal Plot  
PM10 Dichotomous TEOM

01/01/2012 - 03/31/2012

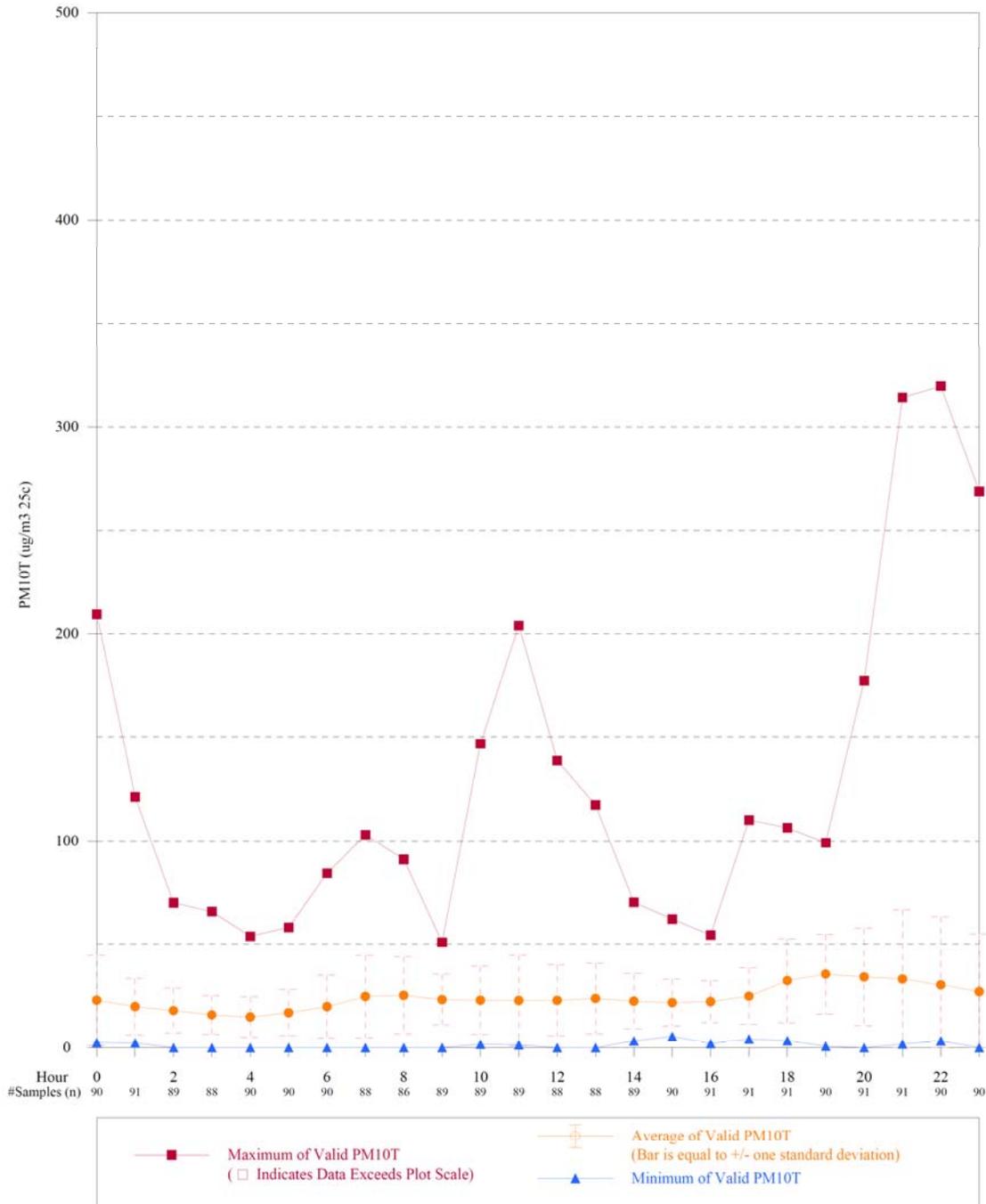


Figure 4-6. Quarterly PM<sub>10</sub> Diurnal Plot for the Rifle Monitoring Site.

Garfield County- Colorado  
Rifle Henry Building

Diurnal Plot  
PM2.5 Dichotomous TEOM

01/01/2012 - 03/31/2012

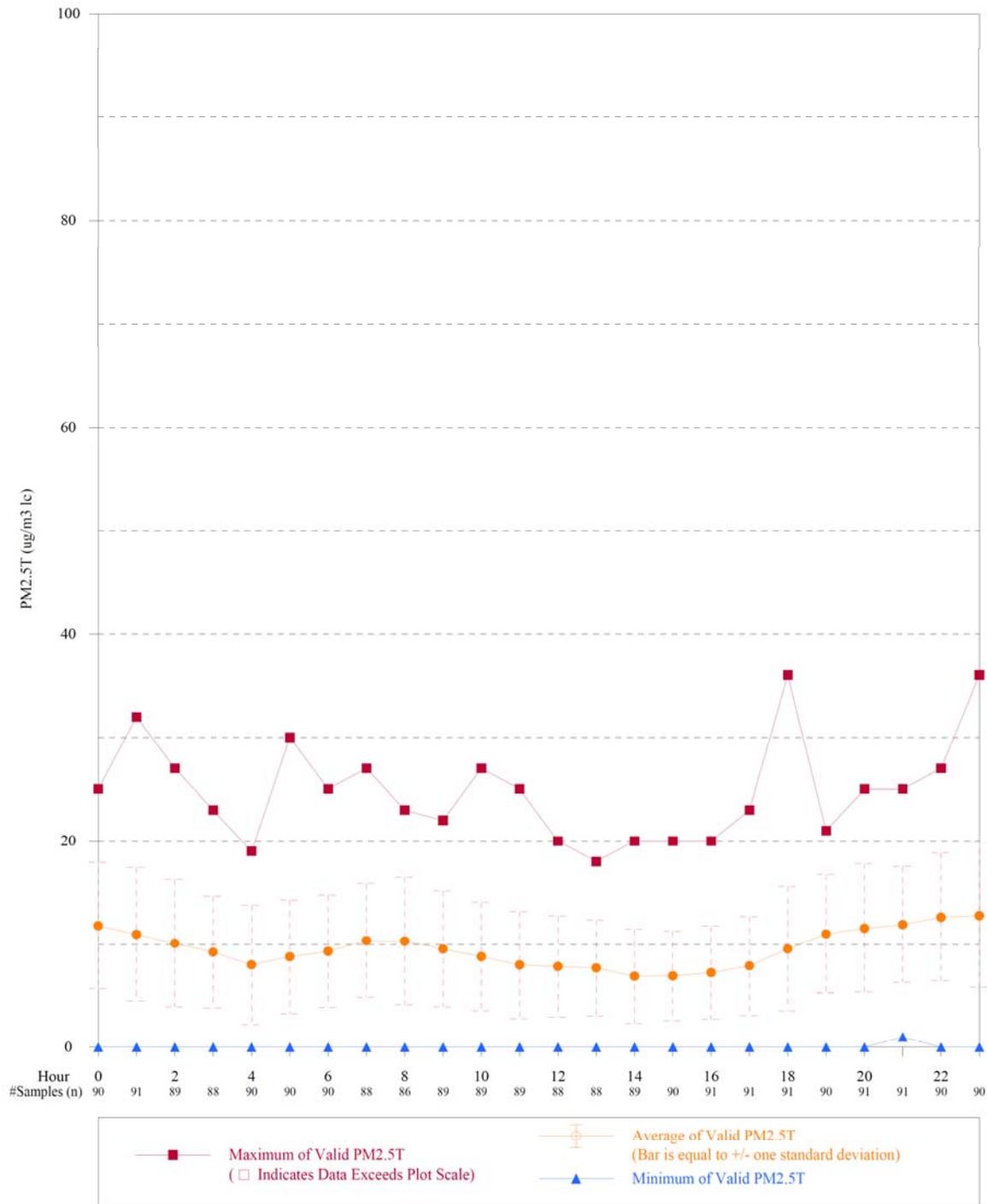


Figure 4-7. Quarterly PM<sub>2.5</sub> Diurnal Plot for Rifle Monitoring Site.

## 5.0 SNMOC AND CARBONYL SUMMARIES

Speciated Non-Methane Organic Compounds (SNMOCs) and carbonyl compounds are monitored each site in Garfield County. SNMOCs 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. Levels of HAPs will be analyzed in a separate annual risk assessment report prepared by the CDPHE. Summaries of SNMOC and carbonyl monitoring are presented in this section.

### 5.1 SNMOC

SNMOC compounds were collected and analyzed according to EPA Compendium Method TO-12, with 24-hour samples collected at all four sites on a 1-in-6 day schedule. This method includes analyses for 81 different compounds. Appendix B lists minimum, maximum, and average concentrations of all detected SNMOC compounds by site.

SNMOC compounds can be grouped into classifications with similar characteristics. For these summaries, measured SNMOC compounds were grouped into the following categories:

- **Light Alkanes:** Alkanes are the simplest hydrocarbons, consisting of only carbon and hydrogen with single bonds. Light alkanes, which here include alkanes with up to five carbon atoms (ethane, propane, iso/n-butane and iso/n-pentane) are the primary components of natural gas.
- **Heavy Alkanes:** The hydrocarbons in crude oil are mostly heavy alkanes, which here include alkanes with more than five carbon atoms (C5). Crude oil products include gasoline, a refined mix of predominantly C6 to C10 hydrocarbons, and diesel, which is a refined mix ranging from approximately C10 to C15.
- **Alkenes:** Alkenes are more complex than alkanes, with at least one carbon to carbon double bond. These compounds are not generally found in crude oil. Alkenes are much more reactive than alkanes, and will deplete quickly in the atmosphere. Alkenes are produced in refineries when larger alkane molecules are dissociated (or cracked) into smaller compounds. Some alkene compounds, including terpenes such as isoprene and  $\alpha$ - and  $\beta$ -pinene, are naturally emitted from vegetation.
- **Aromatics:** Aromatic compounds are the most abundant compounds emitted from gas-fired engines. These compounds include the BTEX parameters (benzene, toluene, ethylbenzene and m/p-xylenes), which are commonly associated with motor vehicles and condensate.

Figure 5-1 presents categories of measured SNMOCs in units of ppbV (parts per billion by volume) measured in 2012 at each site. In general, compounds measured were dominated by light alkanes.

Figure 5-2 presents the year to date daily measurements by category in units of ppbC, where ppbC is results in ppbV multiplied by the number of carbons in each compound. Carbon content in a molecule is related to the compound reactivity, which contributes to ozone formation potential. Heavier alkanes and aromatics are more significant sources of carbon, especially at the more urban Parachute and Rifle sites. The unknown category indicates the part of the total carbon measurements where individual species were not identified.

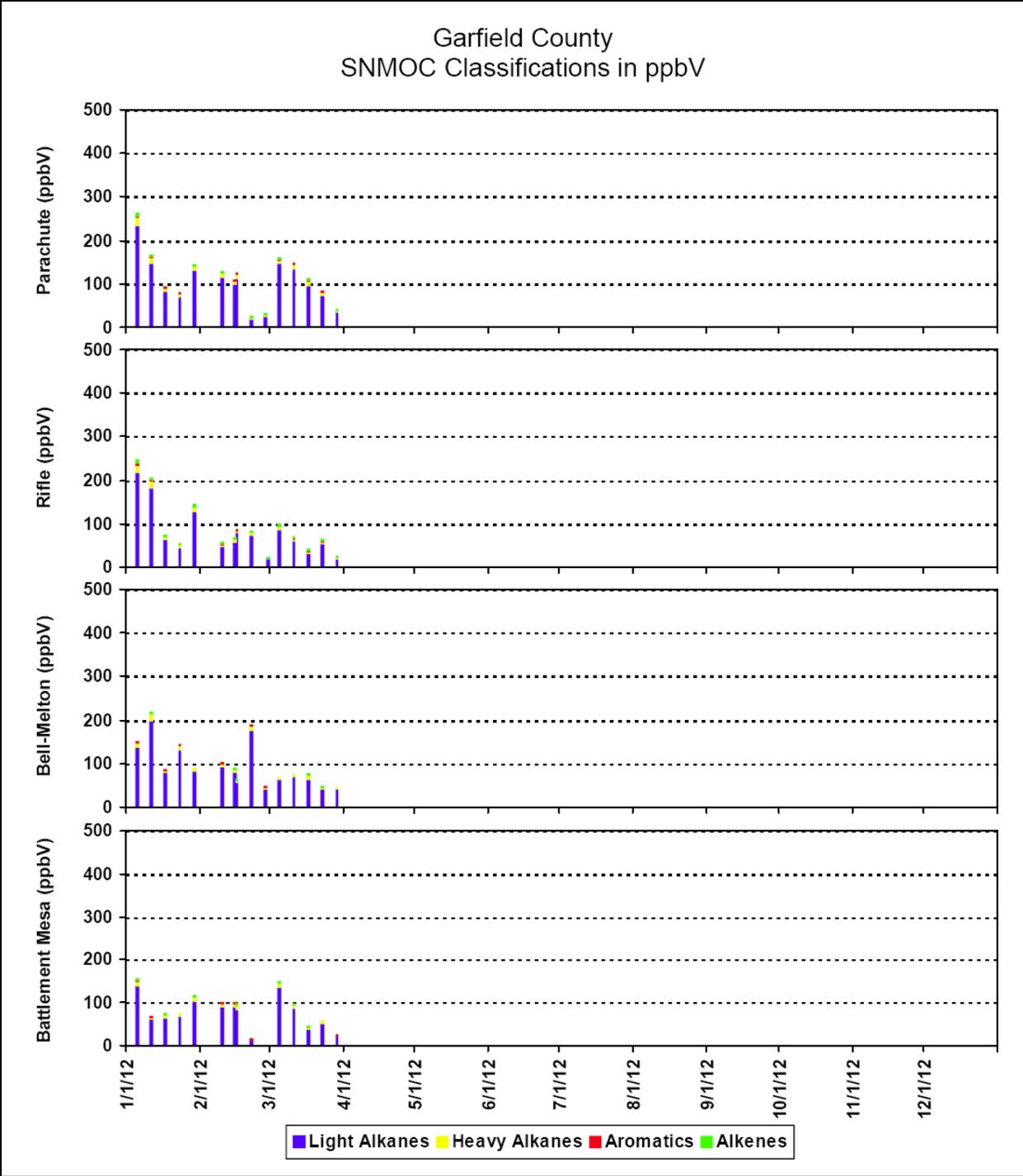


Figure 5-1. 24-Hour SNMOC Measurements by Category in Units of ppbV.

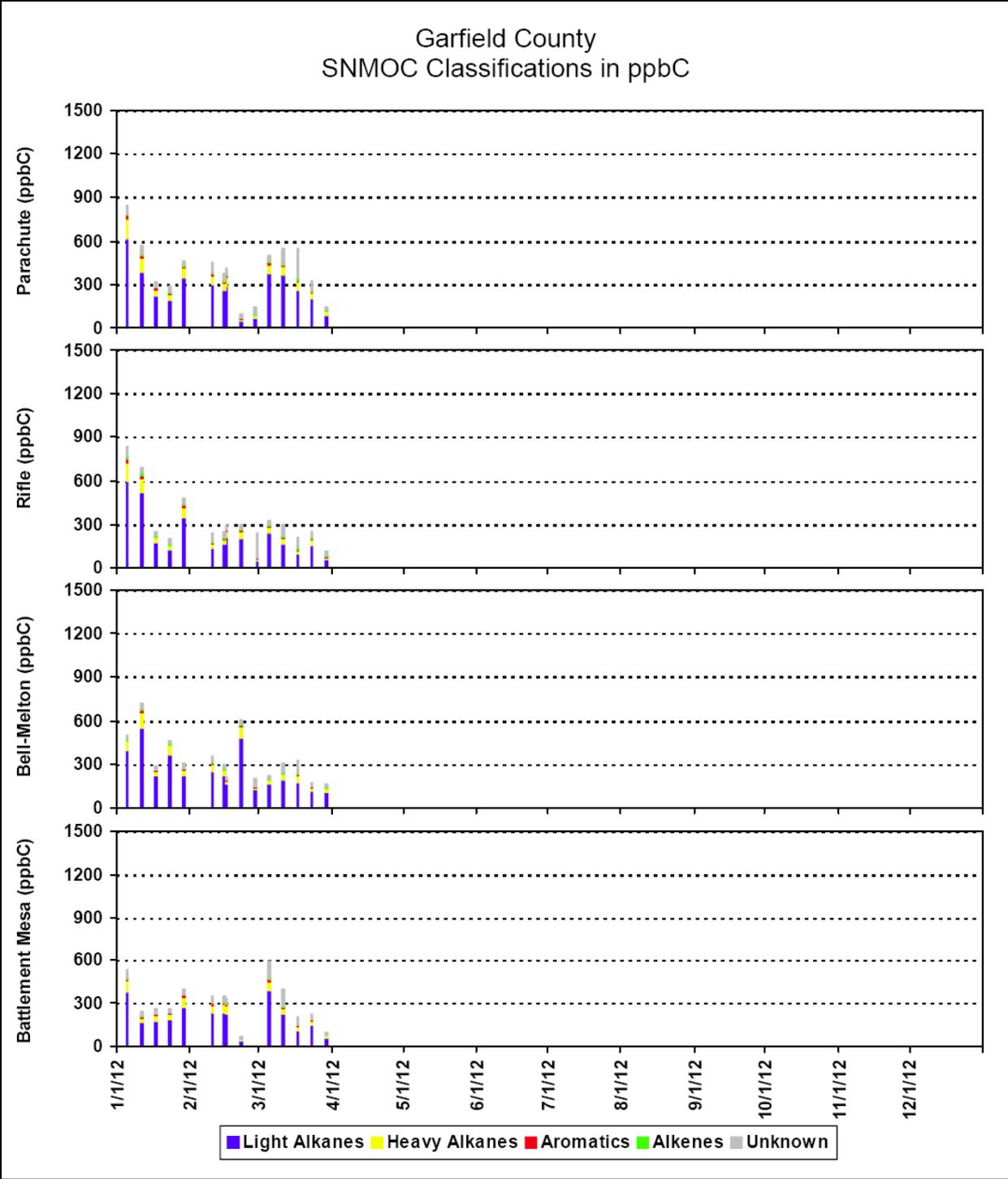


Figure 5-2. 24-Hour SNMOC Measurements by Category in Units of ppbC.

## 5.2 CARBONYLS

Carbonyl compounds were collected and analyzed according to EPA Compendium Method TO-11A, with 24-hour samples collected at all four sites on a 1-in-12 day schedule. This method includes analysis for twelve (12) different carbonyl compounds.

Carbonyls are highly reactive and play a critical role in the formation of ozone. Some carbonyls, including formaldehyde and acetaldehyde, also have adverse chronic and acute health effects. The major sources of directly emitted carbonyls are fuel combustion, mobile sources, and process emissions from oil refineries (CARB, 2009).

Appendix C lists minimum, maximum, and average concentrations of all detected carbonyl compounds. Major compounds included formaldehyde, acetaldehyde, and acetone. Figure 5-3 presents a time series of the major compounds measured at each site in 2012.

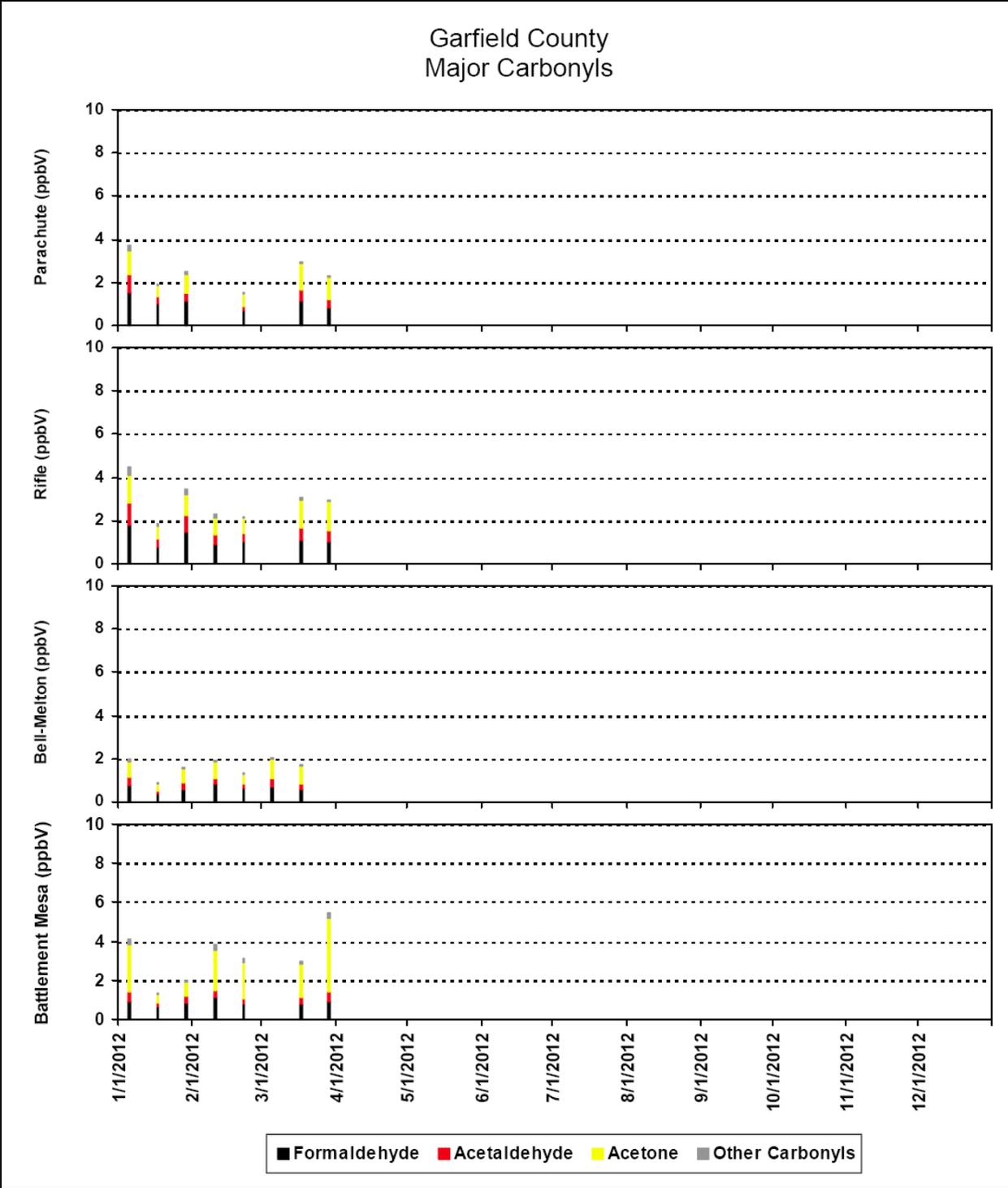


Figure 5-3. 24-Hour Major Carbonyl Compound Concentrations in Units of ppbV.

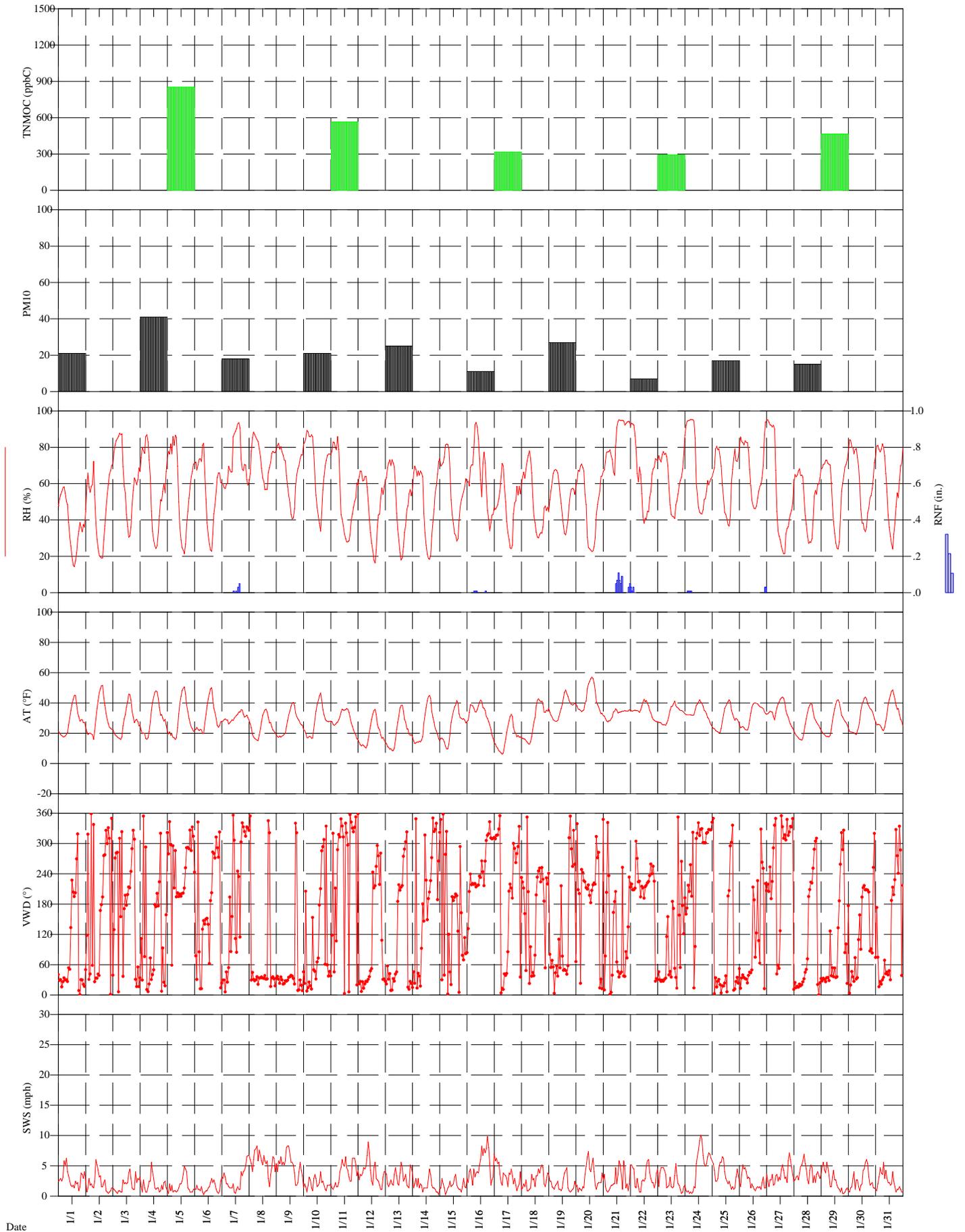
**APPENDIX A**

**Garfield County**

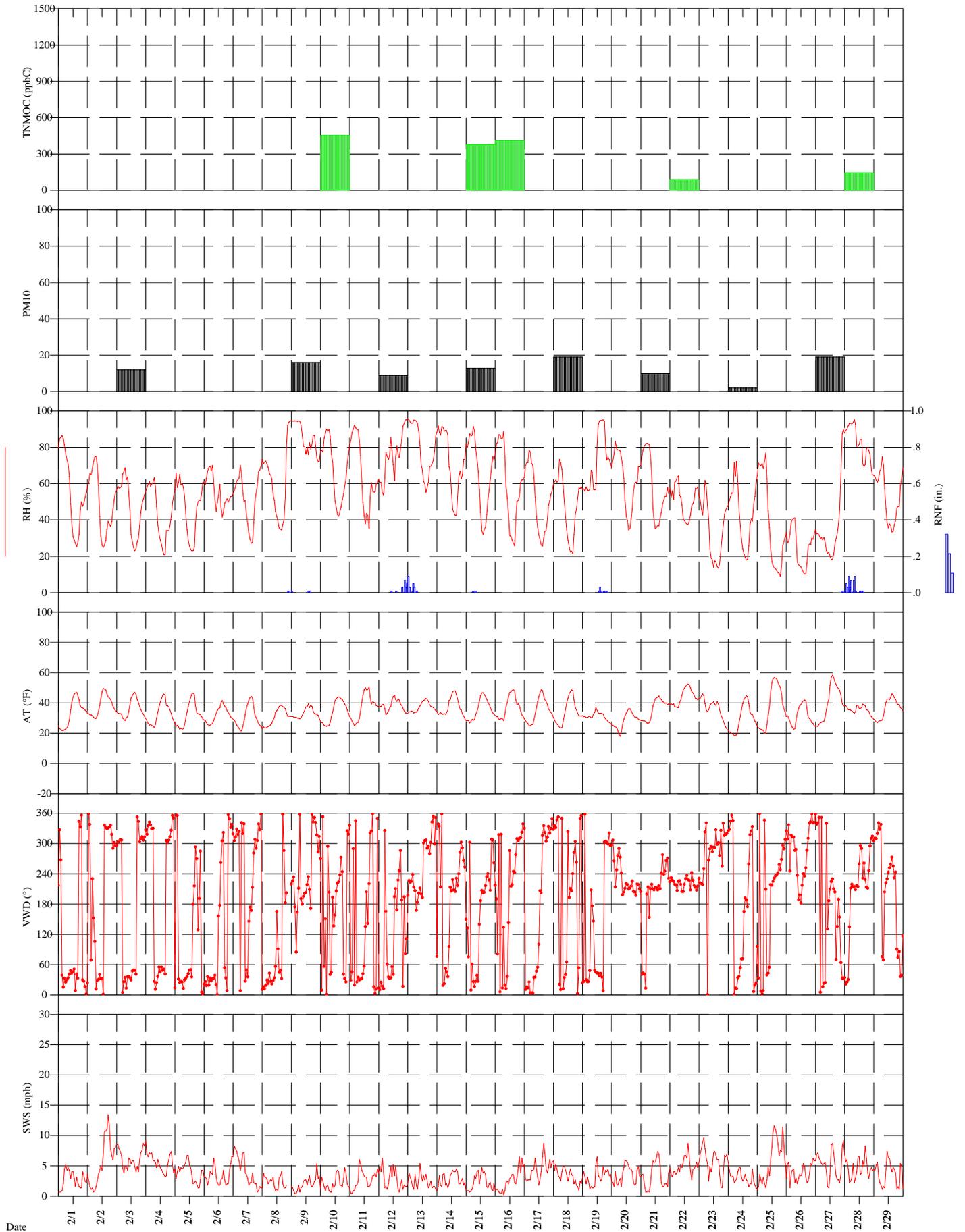
**Stackplots**

**January 1, 2012 – March 31, 2012**

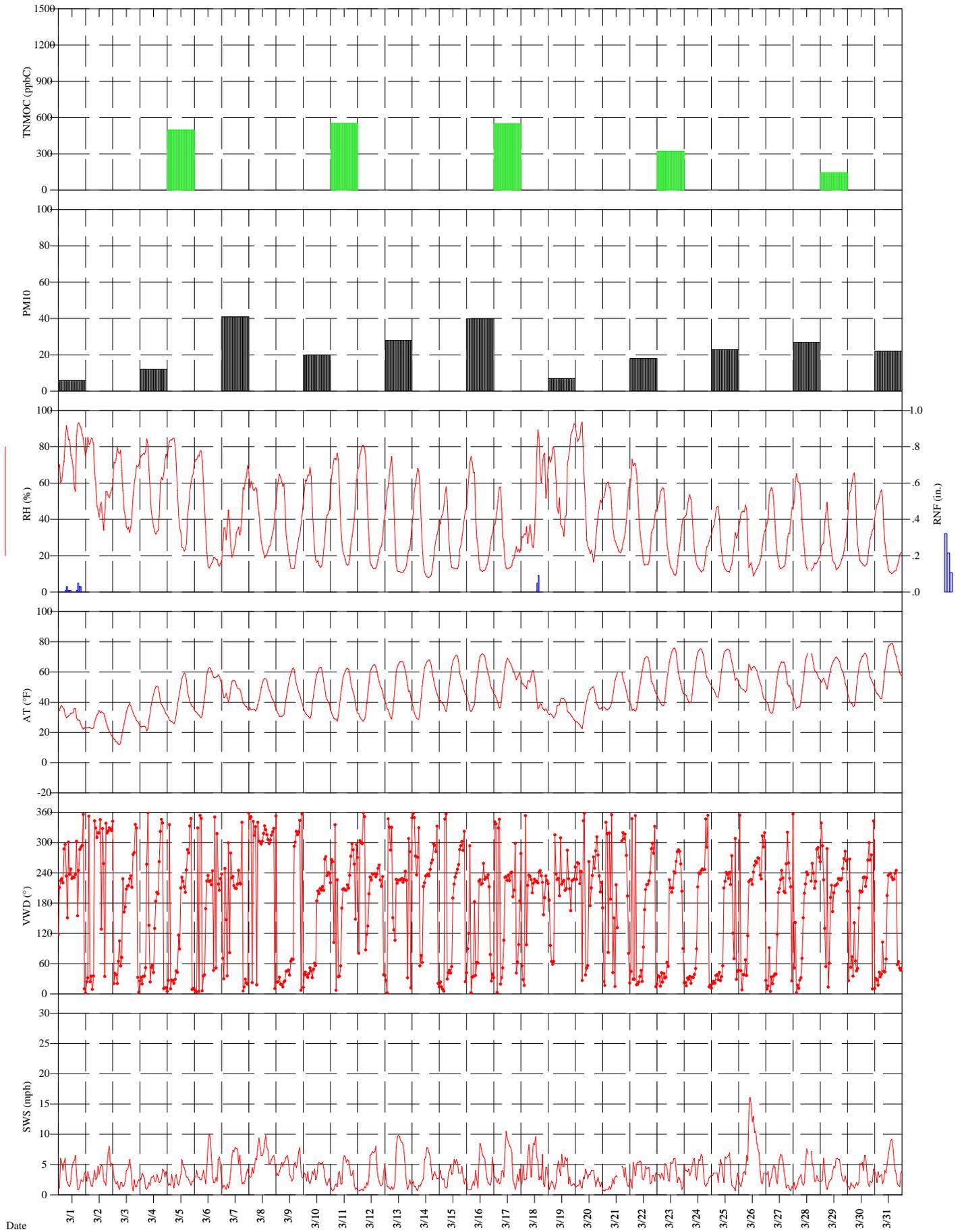
Garfield County, CO  
Parachute Site



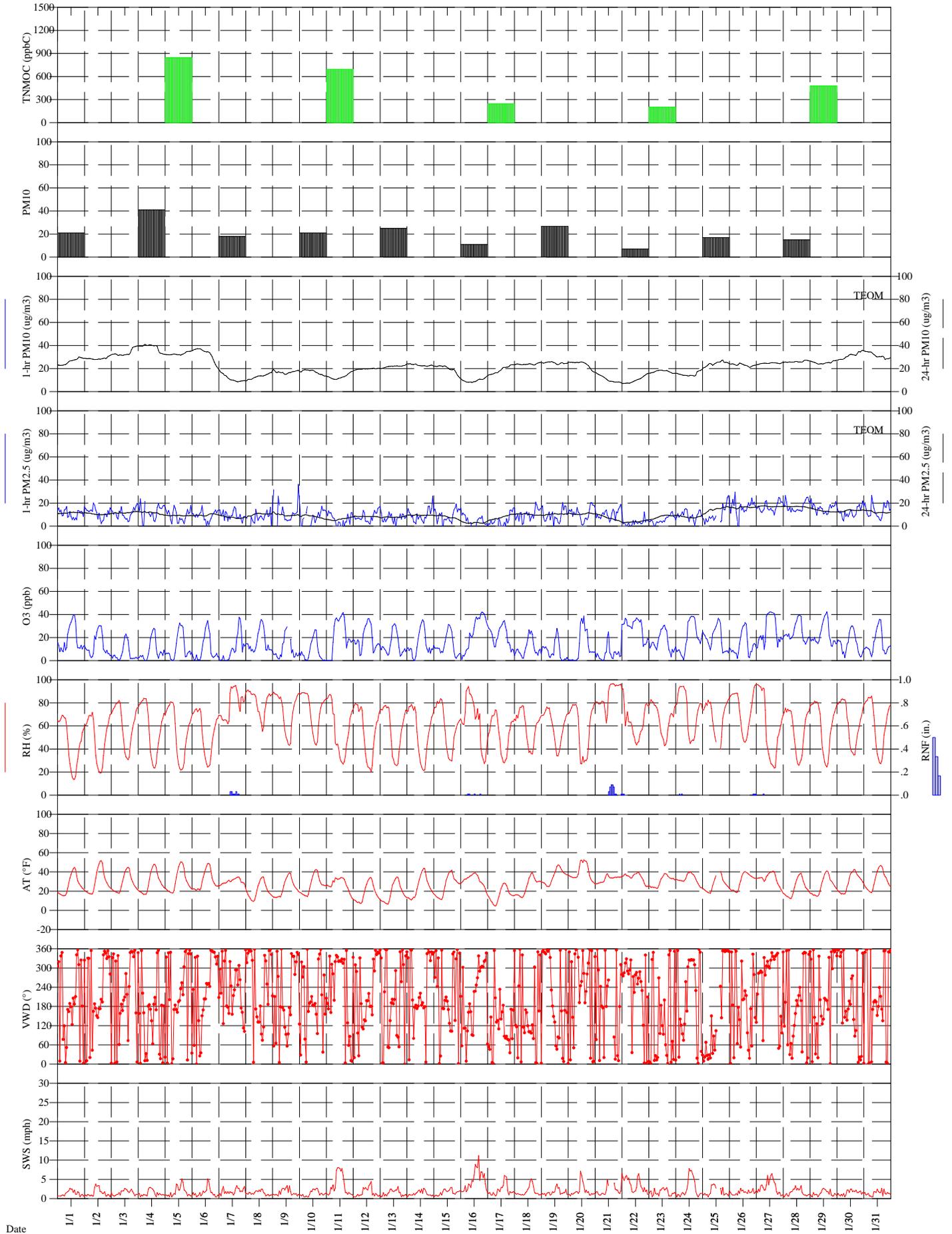
Garfield County, CO  
Parachute Site



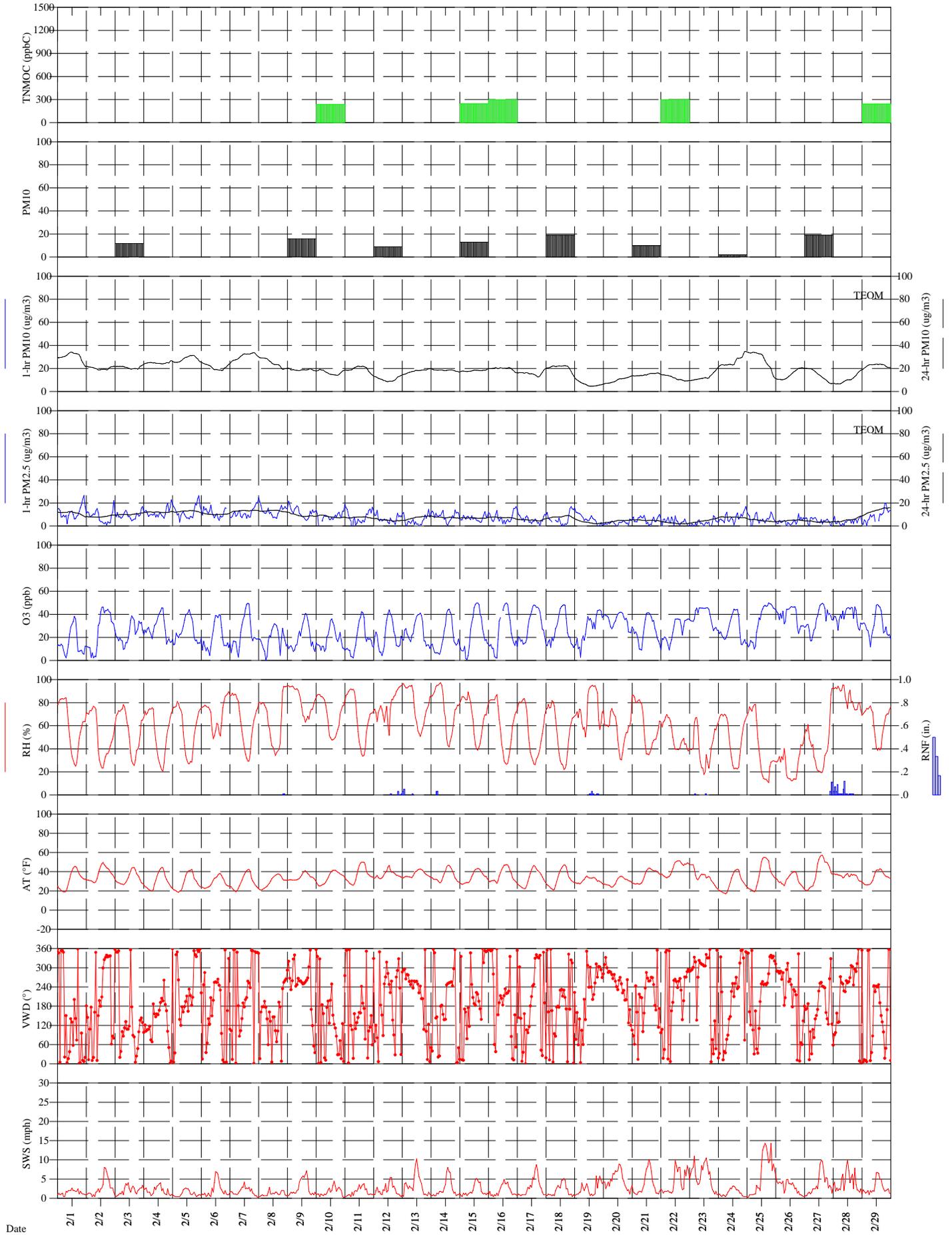
Garfield County, CO  
Parachute Site



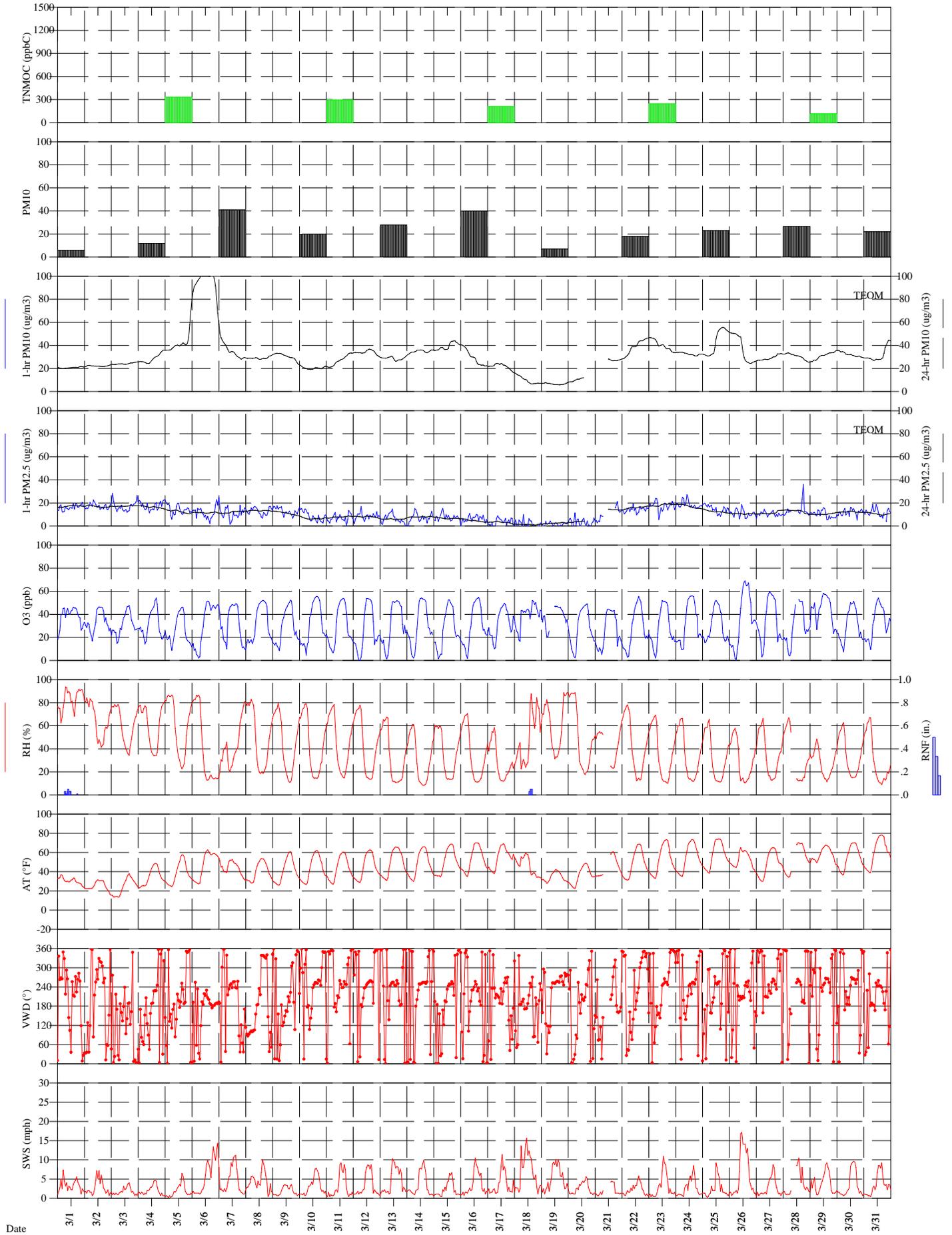
Garfield County, CO  
Rifle Site



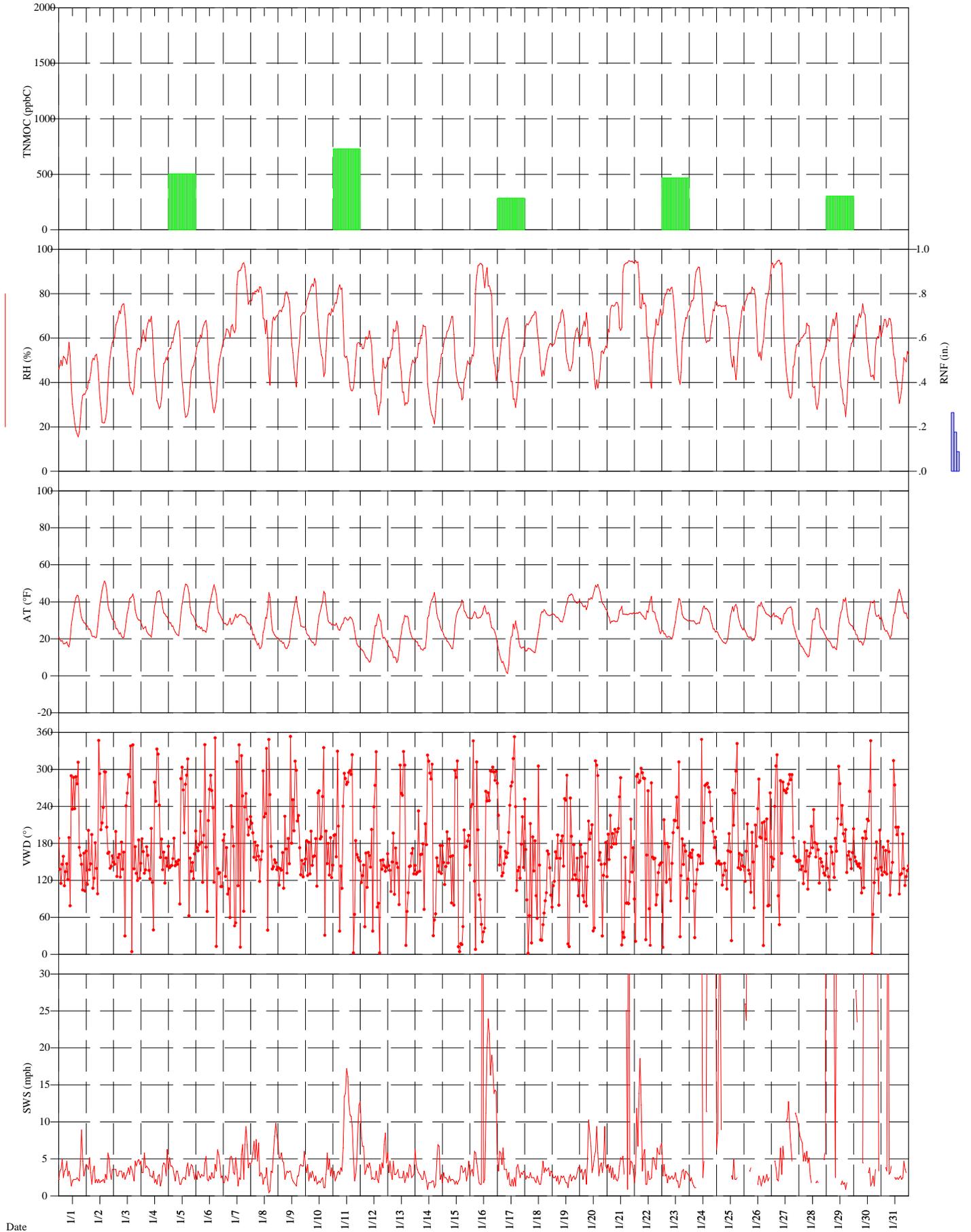
Garfield County, CO  
Rifle Site



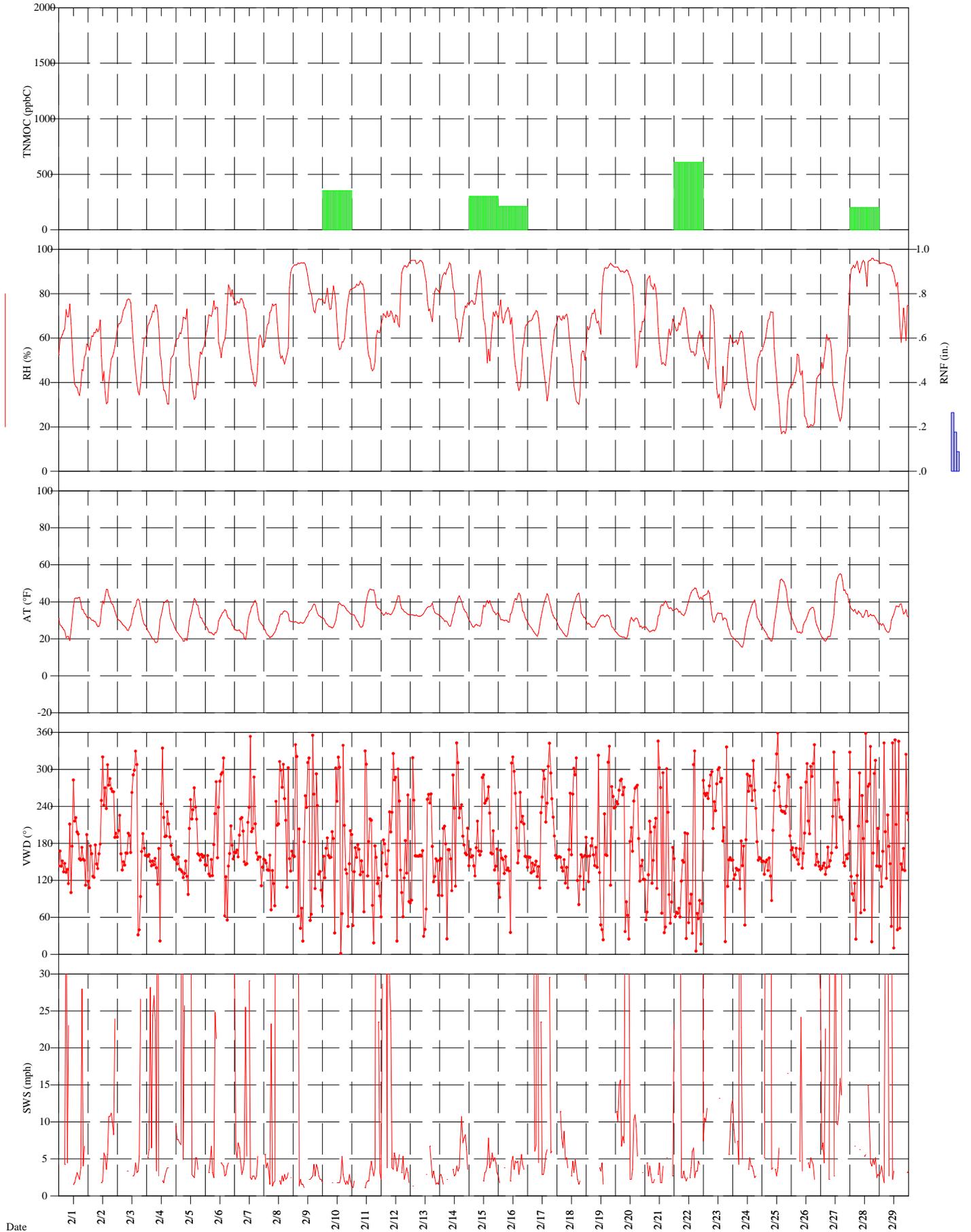
Garfield County, CO  
Rifle Site



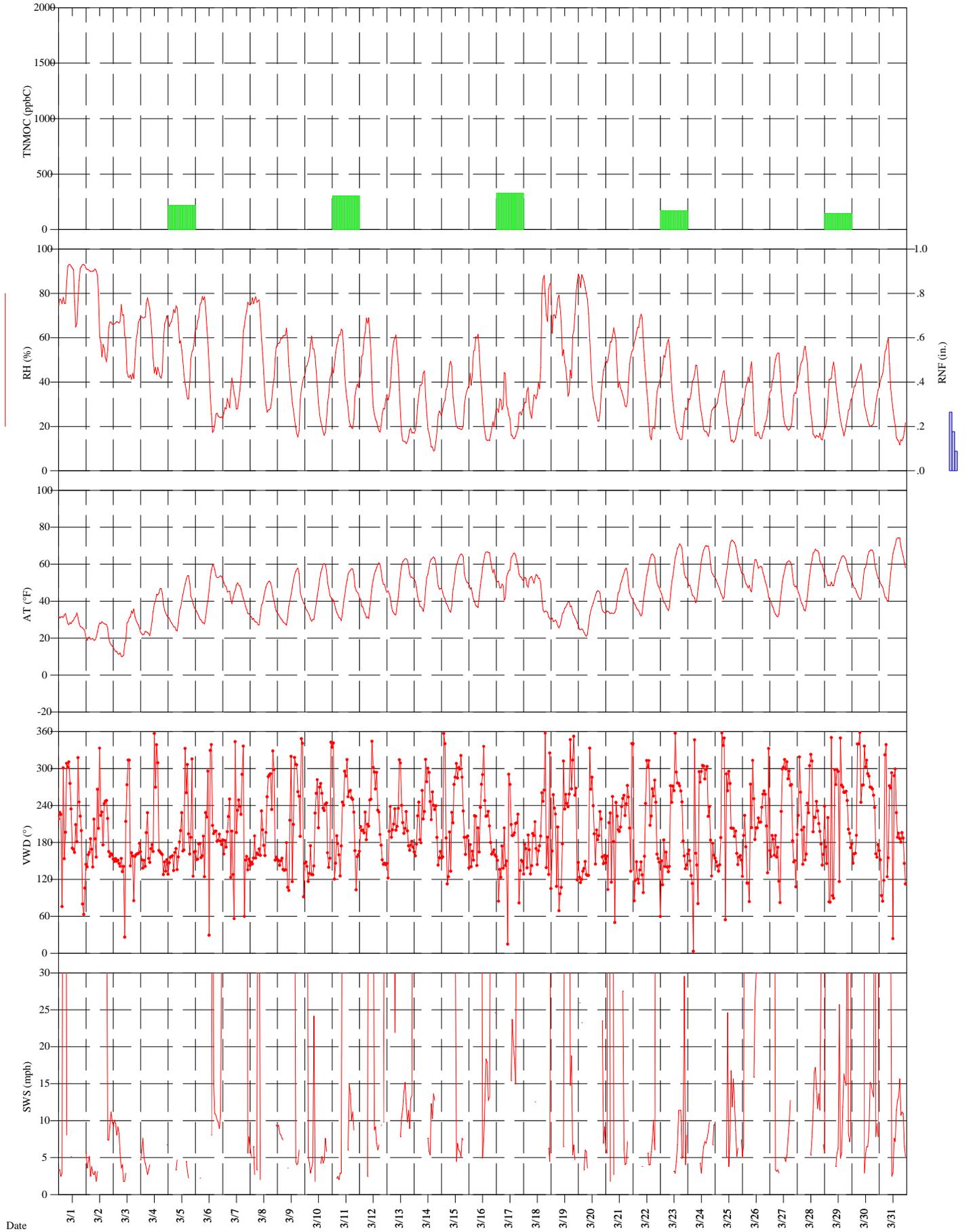
Garfield County, CO  
Bell Melton Site



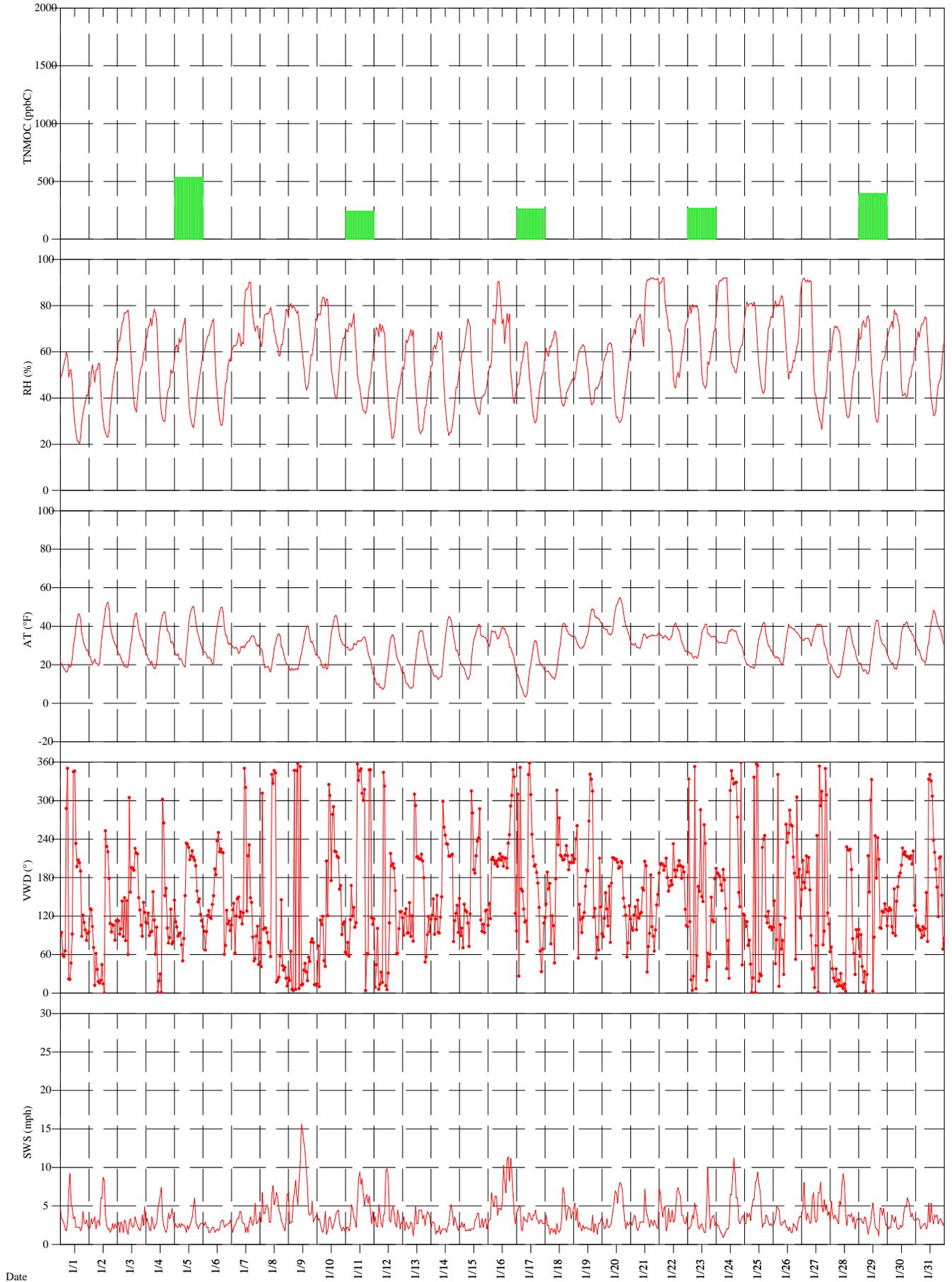
Garfield County, CO  
Bell Melton Site



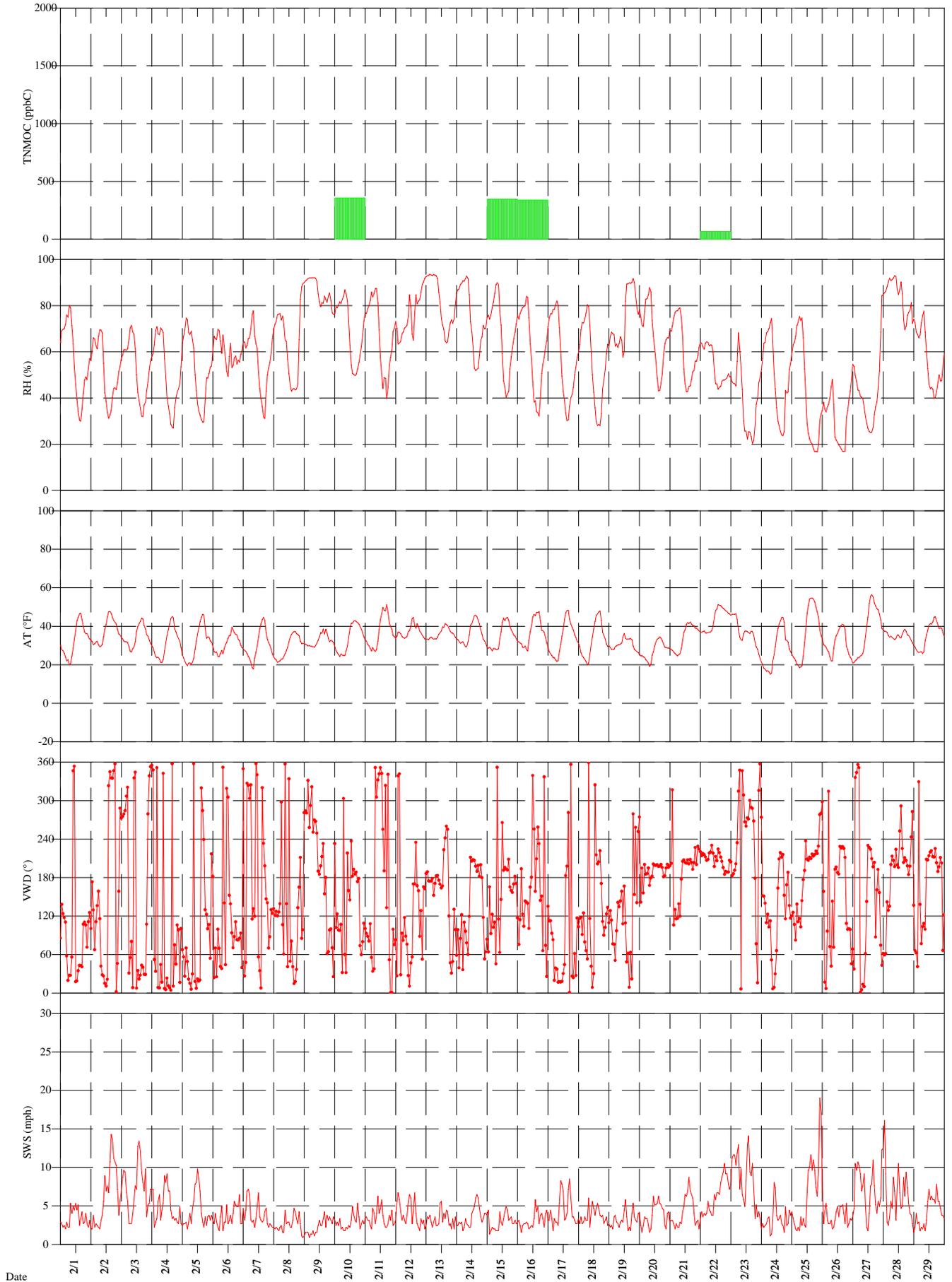
Garfield County, CO  
Bell Melton Site



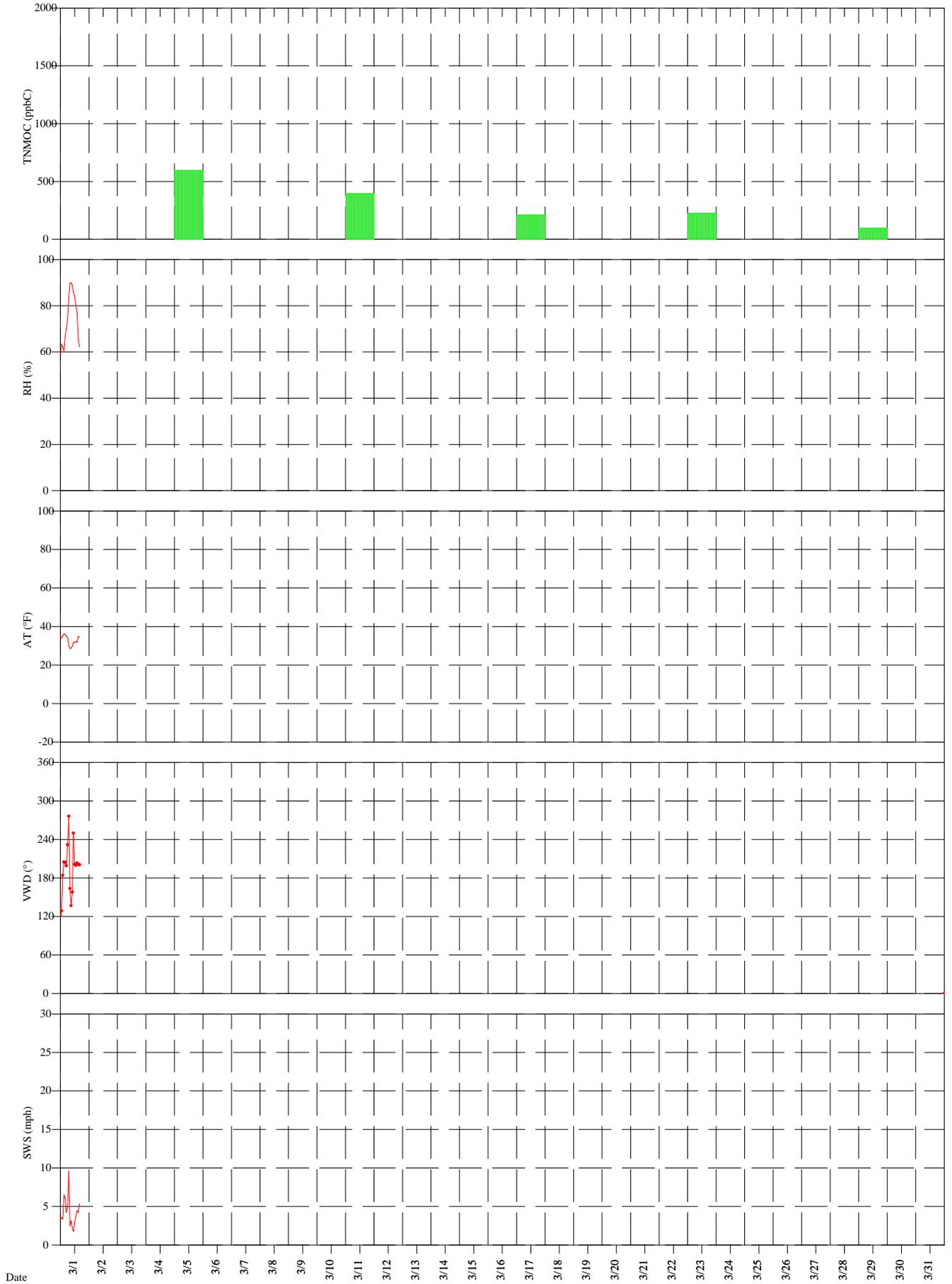
Garfield County, CO  
Battlement Mesa Site



Garfield County, CO  
Battlement Mesa Site



Garfield County, CO  
Battlement Mesa Site



**APPENDIX B**

**Garfield County**

**SNMOC Concentrations  
January 1, 2012 – March 31, 2012**

Table B-1  
Garfield County SNMOC Monitoring  
Parachute (PACO)  
1/5/2012-3/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
1,2,3-Trimethylbenzene (526-73-8)	15	5	0.01	0.02	0.01
1,2,4-Trimethylbenzene (95-63-6)	15	15	0.02	0.12	0.06
1,3,5-Trimethylbenzene (108-67-8)	15	10	0.01	0.10	0.04
1,3-Butadiene (106-99-0)	15	14	0.02	0.13	0.05
1-Dodecene (112-41-4)	15	4	0.01	0.06	0.02
1-Heptene (592-76-7)	15	15	0.04	0.34	0.16
1-Hexene (592-41-6)	15	4	0.03	0.05	0.03
1-Nonene (124-11-8)	15	2	0.01	0.01	0.01
1-Octene (111-66-0)	15	3	0.02	0.03	0.02
1-Pentene (109-67-1)	15	13	0.03	0.10	0.04
1-Undecene (821-95-4)	15	1	0.02	0.02	0.01
2,2,4-Trimethylpentane (540-84-1)	15	4	0.01	0.04	0.01
2,2-Dimethylbutane (75-83-2)	15	15	0.03	0.33	0.15
2,3,4-Trimethylpentane (565-75-3)	15	7	0.01	0.03	0.01
2,3-Dimethylbutane (79-29-8)	15	3	0.12	0.31	0.06
2,3-Dimethylpentane (565-59-3)	15	15	0.02	0.22	0.11
2,4-Dimethylpentane (108-08-7)	15	15	0.02	0.17	0.08
2-Methyl-1-butene (563-46-2)	15	3	0.07	0.14	0.04
2-Methyl-2-butene (513-35-9)	15	3	0.02	0.18	0.04
2-Methylheptane (592-27-8)	15	15	0.03	0.33	0.14
2-Methylhexane (591-76-4)	15	15	0.11	0.67	0.32
2-Methylpentane (107-83-5)	15	15	0.21	2.58	1.07
3-Methyl-1-butene (563-45-1)	15	1	0.09	0.09	0.03
3-Methylheptane (589-81-1)	15	15	0.02	0.25	0.11
3-Methylhexane (589-34-4)	15	15	0.06	0.66	0.31
3-Methylpentane (96-14-0)	15	15	0.12	1.46	0.60
Acetylene (74-86-2)	15	15	0.42	1.48	0.78
Benzene (71-43-2)	15	15	0.18	0.93	0.45
b-Pinene (127-91-3)	15	10	0.02	0.16	0.05
cis-2-Butene (590-18-1)	15	12	0.02	0.54	0.07
cis-2-Pentene (627-20-3)	15	5	0.02	0.06	0.03
Cyclohexane (110-82-7)	15	15	0.14	1.92	0.78
Cyclopentane (287-92-3)	15	15	0.05	0.38	0.18
Ethane (74-84-0)	15	15	12.40	138.00	60.35
Ethylbenzene (100-41-4)	15	15	0.01	0.10	0.04
Ethylene (74-85-1)	15	15	0.62	3.47	1.52
Isobutane (75-28-5)	15	15	0.88	14.15	5.98
Isopentane (78-78-4)	15	13	0.53	7.98	3.03
Isoprene (78-79-5)	15	5	0.02	0.04	0.03
Isopropylbenzene (98-82-8)	15	4	0.01	0.03	0.01
m-Diethylbenzene (141-93-5)	15	9	0.01	0.03	0.02
Methylcyclohexane (108-87-2)	15	15	0.27	3.30	1.38

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-1 (continued)  
Garfield County SNMOC Monitoring  
Parachute (PACO)  
1/5/2012-3/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
Methylcyclopentane (96-37-7)	15	15	0.14	1.61	0.67
m-Ethyltoluene (620-14-4)	15	15	0.01	0.07	0.04
m-Xylene/p-Xylene (108-38-3 / 106-42-3)	15	15	0.08	0.82	0.34
n-Butane (106-97-8)	15	15	1.03	14.52	6.07
n-Decane (124-18-5)	15	15	0.02	0.24	0.10
n-Dodecane (112-40-3)	15	13	0.01	0.05	0.03
n-Heptane (142-82-5)	15	15	0.11	1.22	0.53
n-Hexane (110-54-3)	15	15	0.22	2.85	1.15
n-Nonane (111-84-2)	15	15	0.03	0.38	0.16
n-Octane (111-65-9)	15	15	0.07	0.84	0.34
n-Pentane (109-66-0)	15	15	0.42	5.90	2.43
n-Propylbenzene (103-65-1)	15	7	0.01	0.03	0.01
n-Tridecane (629-50-5)	15	2	0.01	0.02	0.01
n-Undecane (1120-21-4)	15	15	0.01	0.13	0.05
o-Ethyltoluene (611-14-3)	15	10	0.01	0.06	0.02
o-Xylene (95-47-6)	15	15	0.02	0.14	0.07
p-Diethylbenzene (105-05-5)	15	3	0.01	0.02	0.01
p-Ethyltoluene (622-96-8)	15	13	0.01	0.06	0.03
Propane (74-98-6)	15	15	4.13	51.33	23.14
Propylene (115-07-1)	15	15	0.20	0.61	0.32
Styrene (100-42-5)	15	1	0.16	0.16	0.02
Toluene (108-88-3)	15	15	0.20	1.59	0.70
trans-2-Butene (624-64-6)	15	13	0.02	0.60	0.08
trans-2-Pentene (646-04-8)	15	6	0.02	0.12	0.03

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-2  
Garfield County SNMOC Monitoring  
Rifle (RICO)  
1/5/2012-3/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
1,2,3-Trimethylbenzene (526-73-8)	15	7	0.01	0.03	0.01
1,2,4-Trimethylbenzene (95-63-6)	15	15	0.03	0.19	0.07
1,3,5-Trimethylbenzene (108-67-8)	15	11	0.01	0.10	0.03
1,3-Butadiene (106-99-0)	15	15	0.02	0.26	0.09
1-Dodecene (112-41-4)	15	5	0.01	0.02	0.02
1-Heptene (592-76-7)	15	15	0.03	0.34	0.12
1-Hexene (592-41-6)	15	4	0.03	0.05	0.03
1-Nonene (124-11-8)	15	1	0.01	0.01	0.01
1-Octene (111-66-0)	15	3	0.01	0.02	0.01
1-Pentene (109-67-1)	15	14	0.03	0.09	0.05
1-Undecene (821-95-4)	15	2	0.02	0.03	0.01
2,2,4-Trimethylpentane (540-84-1)	15	14	0.01	0.07	0.03
2,2-Dimethylbutane (75-83-2)	15	15	0.03	0.30	0.12
2,3,4-Trimethylpentane (565-75-3)	15	12	0.01	0.04	0.02
2,3-Dimethylbutane (79-29-8)	15	3	0.10	0.24	0.05
2,3-Dimethylpentane (565-59-3)	15	15	0.03	0.26	0.10
2,4-Dimethylpentane (108-08-7)	15	15	0.02	0.18	0.07
2-Methyl-1-butene (563-46-2)	15	10	0.03	0.14	0.07
2-Methyl-2-butene (513-35-9)	15	13	0.03	0.13	0.07
2-Methylheptane (592-27-8)	15	15	0.03	0.26	0.09
2-Methylhexane (591-76-4)	15	15	0.08	0.70	0.26
2-Methylpentane (107-83-5)	15	15	0.26	2.92	1.01
3-Methylheptane (589-81-1)	15	15	0.02	0.19	0.07
3-Methylhexane (589-34-4)	15	15	0.08	0.71	0.26
3-Methylpentane (96-14-0)	15	15	0.15	1.58	0.55
Acetylene (74-86-2)	15	15	0.72	3.30	1.40
a-Pinene (80-56-8)	15	2	0.02	0.02	0.01
Benzene (71-43-2)	15	15	0.17	0.96	0.37
b-Pinene (127-91-3)	15	13	0.02	0.10	0.04
cis-2-Butene (590-18-1)	15	14	0.03	0.40	0.12
cis-2-Pentene (627-20-3)	15	10	0.02	0.05	0.03
Cyclohexane (110-82-7)	15	15	0.13	1.72	0.58
Cyclopentane (287-92-3)	15	15	0.06	0.43	0.17
Cyclopentene (142-29-0)	15	3	0.04	0.08	0.03
Ethane (74-84-0)	15	15	8.95	113.00	40.33
Ethylbenzene (100-41-4)	15	15	0.02	0.16	0.06
Ethylene (74-85-1)	15	15	1.04	5.20	2.19
Isobutane (75-28-5)	15	15	1.11	15.30	5.61
Isopentane (78-78-4)	15	15	0.77	9.24	3.46
Isoprene (78-79-5)	15	13	0.02	0.08	0.04
Isopropylbenzene (98-82-8)	15	4	0.01	0.02	0.01
m-Diethylbenzene (141-93-5)	15	6	0.01	0.03	0.01

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-2 (continued)  
Garfield County SNMOC Monitoring  
Rifle (RICO)  
1/5/2012-3/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
Methylcyclohexane (108-87-2)	15	15	0.18	2.57	0.87
Methylcyclopentane (96-37-7)	15	15	0.14	1.53	0.54
m-Ethyltoluene (620-14-4)	15	15	0.01	0.11	0.04
m-Xylene/p-Xylene (108-38-3 / 106-42-3)	15	15	0.12	0.77	0.28
n-Butane (106-97-8)	15	15	1.37	17.40	6.34
n-Decane (124-18-5)	15	15	0.02	0.13	0.05
n-Dodecane (112-40-3)	15	13	0.00	0.03	0.02
n-Heptane (142-82-5)	15	15	0.10	1.17	0.40
n-Hexane (110-54-3)	15	15	0.23	3.17	1.06
n-Nonane (111-84-2)	15	15	0.03	0.19	0.08
n-Octane (111-65-9)	15	15	0.06	0.56	0.21
n-Pentane (109-66-0)	15	15	0.59	6.98	2.58
n-Propylbenzene (103-65-1)	15	9	0.01	0.04	0.01
n-Tridecane (629-50-5)	15	1	0.00	0.00	0.01
n-Undecane (1120-21-4)	15	15	0.01	0.06	0.03
o-Ethyltoluene (611-14-3)	15	11	0.01	0.05	0.02
o-Xylene (95-47-6)	15	15	0.04	0.20	0.08
p-Diethylbenzene (105-05-5)	15	2	0.01	0.02	0.01
p-Ethyltoluene (622-96-8)	15	14	0.01	0.06	0.03
Propane (74-98-6)	15	15	3.90	51.00	17.87
Propylene (115-07-1)	15	15	0.15	1.30	0.52
Styrene (100-42-5)	15	4	0.02	0.05	0.02
Toluene (108-88-3)	15	15	0.22	1.60	0.60
trans-2-Butene (624-64-6)	15	14	0.04	0.50	0.15
trans-2-Hexene (4050-45-7)	15	1	0.02	0.02	0.03
trans-2-Pentene (646-04-8)	15	14	0.02	0.10	0.05

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-3  
Garfield County SNMOC Monitoring  
Bell-Melton (BRCO)  
1/5/2012-3/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
1,2,3-Trimethylbenzene (526-73-8)	15	3	0.01	0.01	0.01
1,2,4-Trimethylbenzene (95-63-6)	15	14	0.01	0.04	0.03
1,3,5-Trimethylbenzene (108-67-8)	15	7	0.01	0.04	0.01
1,3-Butadiene (106-99-0)	15	6	0.03	0.07	0.03
1-Dodecene (112-41-4)	15	2	0.02	0.04	0.02
1-Heptene (592-76-7)	15	14	0.06	0.26	0.12
1-Hexene (592-41-6)	15	3	0.03	0.05	0.03
1-Nonene (124-11-8)	15	1	0.01	0.01	0.01
1-Octene (111-66-0)	15	3	0.01	0.03	0.01
1-Pentene (109-67-1)	15	9	0.02	0.06	0.03
1-Undecene (821-95-4)	15	2	0.03	0.03	0.01
2,2,4-Trimethylpentane (540-84-1)	15	2	0.02	0.06	0.01
2,2-Dimethylbutane (75-83-2)	15	15	0.05	0.26	0.11
2,3,4-Trimethylpentane (565-75-3)	15	4	0.01	0.03	0.01
2,3-Dimethylbutane (79-29-8)	15	3	0.13	0.21	0.05
2,3-Dimethylpentane (565-59-3)	15	15	0.04	0.19	0.09
2,4-Dimethylpentane (108-08-7)	15	15	0.03	0.14	0.06
2-Methyl-1-butene (563-46-2)	15	2	0.04	0.07	0.03
2-Methyl-2-butene (513-35-9)	15	2	0.01	0.03	0.02
2-Methylheptane (592-27-8)	15	15	0.04	0.16	0.08
2-Methylhexane (591-76-4)	15	15	0.14	0.54	0.25
2-Methylpentane (107-83-5)	15	15	0.42	2.80	1.10
3-Methylheptane (589-81-1)	15	15	0.02	0.11	0.05
3-Methylhexane (589-34-4)	15	15	0.08	0.54	0.24
3-Methylpentane (96-14-0)	15	15	0.24	1.48	0.58
Acetylene (74-86-2)	15	15	0.42	1.18	0.73
Benzene (71-43-2)	15	15	0.14	0.47	0.25
b-Pinene (127-91-3)	15	11	0.01	0.09	0.04
cis-2-Butene (590-18-1)	15	3	0.03	0.05	0.03
cis-2-Pentene (627-20-3)	15	3	0.02	0.03	0.02
Cyclohexane (110-82-7)	15	15	0.26	1.64	0.68
Cyclopentane (287-92-3)	15	15	0.09	0.41	0.18
Ethane (74-84-0)	15	15	21.95	101.00	47.89
Ethylbenzene (100-41-4)	15	15	0.01	0.03	0.02
Ethylene (74-85-1)	15	15	0.52	1.71	1.05
Isobutane (75-28-5)	15	15	2.46	14.02	6.20
Isopentane (78-78-4)	15	14	1.63	8.34	3.34
Isoprene (78-79-5)	15	3	0.03	0.04	0.03
Isopropylbenzene (98-82-8)	15	3	0.01	0.02	0.01
m-Diethylbenzene (141-93-5)	15	5	0.01	0.03	0.01
Methylcyclohexane (108-87-2)	15	15	0.42	2.30	1.02
Methylcyclopentane (96-37-7)	15	15	0.24	1.40	0.57

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-3 (continued)  
Garfield County SNMOC Monitoring  
Bell-Melton (BRCO)  
1/5/2012-3/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
m-Ethyltoluene (620-14-4)	15	12	0.01	0.02	0.02
m-Xylene/p-Xylene (108-38-3 / 106-42-3)	15	15	0.07	0.29	0.15
n-Butane (106-97-8)	15	15	2.68	15.90	6.94
n-Decane (124-18-5)	15	15	0.02	0.11	0.04
n-Dodecane (112-40-3)	15	9	0.01	0.02	0.01
n-Heptane (142-82-5)	15	15	0.20	1.06	0.44
n-Hexane (110-54-3)	15	15	0.47	3.28	1.25
n-Nonane (111-84-2)	15	15	0.03	0.13	0.07
n-Octane (111-65-9)	15	15	0.10	0.43	0.20
n-Pentane (109-66-0)	15	15	0.93	6.94	2.84
n-Propylbenzene (103-65-1)	15	3	0.01	0.01	0.01
n-Undecane (1120-21-4)	15	12	0.01	0.04	0.02
o-Ethyltoluene (611-14-3)	15	5	0.01	0.02	0.01
o-Xylene (95-47-6)	15	15	0.02	0.05	0.03
p-Diethylbenzene (105-05-5)	15	3	0.01	0.01	0.01
p-Ethyltoluene (622-96-8)	15	11	0.01	0.02	0.01
Propane (74-98-6)	15	15	9.80	49.67	22.59
Propylene (115-07-1)	15	15	0.14	0.26	0.18
Styrene (100-42-5)	15	1	0.08	0.08	0.02
Toluene (108-88-3)	15	15	0.16	0.69	0.33
trans-2-Butene (624-64-6)	15	2	0.02	0.03	0.02
trans-2-Pentene (646-04-8)	15	3	0.02	0.02	0.02

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-4  
Garfield County SNMOC Monitoring  
Battlement Mesa (BMCO)  
1/5/2012-3/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
1,2,3-Trimethylbenzene (526-73-8)	14	4	0.01	0.03	0.01
1,2,4-Trimethylbenzene (95-63-6)	14	14	0.02	0.11	0.05
1,3,5-Trimethylbenzene (108-67-8)	14	10	0.03	0.06	0.03
1,3-Butadiene (106-99-0)	14	8	0.03	0.05	0.03
1-Dodecene (112-41-4)	14	4	0.01	0.03	0.02
1-Heptene (592-76-7)	14	14	0.02	0.22	0.12
1-Hexene (592-41-6)	14	3	0.04	0.05	0.03
1-Nonene (124-11-8)	14	2	0.02	0.02	0.01
1-Octene (111-66-0)	14	3	0.01	0.05	0.02
1-Pentene (109-67-1)	14	13	0.02	0.05	0.03
1-Undecene (821-95-4)	14	1	0.01	0.01	0.01
2,2,4-Trimethylpentane (540-84-1)	14	6	0.01	0.08	0.02
2,2-Dimethylbutane (75-83-2)	14	14	0.03	0.20	0.12
2,3,4-Trimethylpentane (565-75-3)	14	9	0.01	0.04	0.02
2,3-Dimethylbutane (79-29-8)	14	3	0.10	0.28	0.06
2,3-Dimethylpentane (565-59-3)	14	14	0.02	0.15	0.09
2,4-Dimethylpentane (108-08-7)	14	13	0.04	0.11	0.06
2-Methyl-1-butene (563-46-2)	14	4	0.02	0.07	0.03
2-Methyl-2-butene (513-35-9)	14	7	0.03	0.06	0.04
2-Methylheptane (592-27-8)	14	14	0.01	0.16	0.10
2-Methylhexane (591-76-4)	14	14	0.07	0.44	0.27
2-Methylpentane (107-83-5)	14	14	0.22	1.77	0.89
3-Methylheptane (589-81-1)	14	14	0.01	0.12	0.08
3-Methylhexane (589-34-4)	14	14	0.08	0.47	0.26
3-Methylpentane (96-14-0)	14	14	0.12	0.96	0.49
Acetylene (74-86-2)	14	14	0.35	6.50	1.08
a-Pinene (80-56-8)	14	3	0.01	0.03	0.01
Benzene (71-43-2)	14	14	0.13	0.74	0.38
b-Pinene (127-91-3)	14	12	0.01	0.12	0.05
cis-2-Butene (590-18-1)	14	13	0.02	0.07	0.04
cis-2-Pentene (627-20-3)	14	4	0.02	0.04	0.02
Cyclohexane (110-82-7)	14	14	0.09	1.22	0.62
Cyclopentane (287-92-3)	14	13	0.08	0.27	0.15
Cyclopentene (142-29-0)	14	2	0.03	0.08	0.03
Ethane (74-84-0)	14	14	7.00	75.50	43.01
Ethylbenzene (100-41-4)	14	14	0.02	0.08	0.04
Ethylene (74-85-1)	14	14	0.46	1.46	1.05
Isobutane (75-28-5)	14	14	0.62	8.95	4.26
Isopentane (78-78-4)	14	14	0.63	8.12	3.02
Isoprene (78-79-5)	14	4	0.02	0.06	0.03
Isopropylbenzene (98-82-8)	14	3	0.01	0.02	0.01
m-Diethylbenzene (141-93-5)	14	5	0.01	0.02	0.01

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

Table B-4 (continued)  
Garfield County SNMOC Monitoring  
Battlement Mesa (BMCO)  
1/5/2012-3/29/2012 (every sixth day)

Detected Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
Methylcyclohexane (108-87-2)	14	14	0.15	1.89	1.06
Methylcyclopentane (96-37-7)	14	14	0.12	1.02	0.54
m-Ethyltoluene (620-14-4)	14	14	0.01	0.07	0.03
m-Xylene/p-Xylene (108-38-3 / 106-42-3)	14	14	0.08	0.43	0.26
n-Butane (106-97-8)	14	14	0.96	10.10	4.92
n-Decane (124-18-5)	14	14	0.02	0.12	0.07
n-Dodecane (112-40-3)	14	11	0.01	0.03	0.02
n-Heptane (142-82-5)	14	14	0.08	0.73	0.42
n-Hexane (110-54-3)	14	14	0.24	1.95	0.97
n-Nonane (111-84-2)	14	14	0.02	0.16	0.10
n-Octane (111-65-9)	14	14	0.04	0.38	0.25
n-Pentane (109-66-0)	14	14	0.54	10.36	2.55
n-Propylbenzene (103-65-1)	14	4	0.02	0.03	0.01
n-Tridecane (629-50-5)	14	1	0.01	0.01	0.01
n-Undecane (1120-21-4)	14	13	0.01	0.07	0.03
o-Ethyltoluene (611-14-3)	14	9	0.01	0.05	0.02
o-Xylene (95-47-6)	14	14	0.02	0.11	0.06
p-Diethylbenzene (105-05-5)	14	2	0.01	0.01	0.01
p-Ethyltoluene (622-96-8)	14	13	0.01	0.05	0.02
Propane (74-98-6)	14	14	2.74	33.67	16.02
Propylene (115-07-1)	14	14	0.12	0.45	0.22
Styrene (100-42-5)	14	1	0.15	0.15	0.02
Toluene (108-88-3)	14	14	0.19	1.07	0.55
trans-2-Butene (624-64-6)	14	13	0.03	0.10	0.05
trans-2-Hexene (4050-45-7)	14	1	0.01	0.01	0.03
trans-2-Pentene (646-04-8)	14	10	0.02	0.07	0.03

\*Samples reported as non-detects (ND) were included in averages as 1/2 minimum detection limits.

**APPENDIX C**

**Garfield County**

**Carbonyl Concentrations  
January 1, 2012 – March 31, 2012**

Table C-1  
Garfield County Carbonyl Monitoring  
Parachute (PACO)  
1/5/2012-3/29/2012 (every twelfth day)

Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
2,5-Dimethylbenzaldehyde (5779-94-2)	6	0	ND	ND	0.00
2-Butanone ()	6	6	0.21	0.64	0.50
Acetaldehyde (75-07-0)	6	6	0.23	0.86	0.44
Acetone (67-64-1)	6	6	0.54	1.21	0.88
Benzaldehyde (100-52-7)	6	6	0.00	0.02	0.01
Butyraldehyde (123-72-8)	6	6	0.01	0.06	0.03
Crotonaldehyde (123-73-9)	6	6	0.01	0.04	0.02
Formaldehyde (50-00-0)	6	6	0.68	1.51	1.07
Hexaldehyde (66-25-1)	6	6	0.00	0.02	0.01
Isovaleraldehyde (590-86-3)	6	0	ND	ND	0.00
Propionaldehyde (123-38-6)	6	5	0.01	0.06	0.03
Tolualdehydes (NA)	6	6	0.01	0.02	0.02
Valeraldehyde (110-62-3)	6	5	0.01	0.02	0.01

\*Samples reported as non-detects (ND) are included in averages as 1/2 minimum detection limits.

Table C-2  
Garfield County Carbonyl Monitoring  
Rifle (RICO)  
1/5/2012-3/29/2012 (every twelfth day)

Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
2,5-Dimethylbenzaldehyde (5779-94-2)	7	0	ND	ND	0.00
2-Butanone ()	7	7	0.24	0.68	0.46
Acetaldehyde (75-07-0)	7	7	0.35	1.01	0.59
Acetone (67-64-1)	7	7	0.59	1.37	0.99
Benzaldehyde (100-52-7)	7	7	0.01	0.04	0.02
Butyraldehyde (123-72-8)	7	7	0.01	0.09	0.03
Crotonaldehyde (123-73-9)	7	7	0.01	0.05	0.03
Formaldehyde (50-00-0)	7	7	0.79	1.81	1.15
Hexaldehyde (66-25-1)	7	7	0.00	0.03	0.01
Isovaleraldehyde (590-86-3)	7	1	0.01	0.01	0.00
Propionaldehyde (123-38-6)	7	6	0.01	0.11	0.04
Tolualdehydes (NA)	7	7	0.01	0.08	0.03
Valeraldehyde (110-62-3)	7	6	0.01	0.03	0.01

\*Samples reported as non-detects (ND) are included in averages as 1/2 minimum detection limits.

Table C-3  
Garfield County Carbonyl Monitoring  
Bell-Melton (BRCO)  
1/5/2012-3/17/2012 (every twelfth day)

Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
2,5-Dimethylbenzaldehyde (5779-94-2)	7	0	ND	ND	0.00
2-Butanone ()	7	7	0.14	0.57	0.41
Acetaldehyde (75-07-0)	7	7	0.14	0.40	0.27
Acetone (67-64-1)	7	7	0.32	0.89	0.65
Benzaldehyde (100-52-7)	7	6	0.00	0.01	0.01
Butyraldehyde (123-72-8)	7	7	0.01	0.03	0.02
Crotonaldehyde (123-73-9)	7	7	0.00	0.02	0.01
Formaldehyde (50-00-0)	7	7	0.40	0.85	0.65
Hexaldehyde (66-25-1)	7	6	0.00	0.01	0.01
Isovaleraldehyde (590-86-3)	7	0	ND	ND	0.00
Propionaldehyde (123-38-6)	7	7	0.01	0.03	0.02
Tolualdehydes (NA)	7	6	0.01	0.02	0.01
Valeraldehyde (110-62-3)	7	5	0.00	0.01	0.00

\*Samples reported as non-detects (ND) are included in averages as 1/2 minimum detection limits.

Table C-4  
 Garfield County Carbonyl Monitoring  
 Battlement Mesa (BMCO)  
 1/5/2012-3/29/2012 (every twelfth day)

Compound (CAS Number)	Sample Count		Concentration (ppbV)		
	# Samples	# Detects	Minimum	Maximum	Average*
2,5-Dimethylbenzaldehyde (5779-94-2)	7	0	ND	ND	0.00
2-Butanone ()	7	7	0.13	0.57	0.35
Acetaldehyde (75-07-0)	7	7	0.19	0.49	0.35
Acetone (67-64-1)	7	7	0.46	3.79	1.86
Benzaldehyde (100-52-7)	7	6	0.00	0.09	0.04
Butyraldehyde (123-72-8)	7	7	0.01	0.04	0.03
Crotonaldehyde (123-73-9)	7	7	0.00	0.02	0.01
Formaldehyde (50-00-0)	7	7	0.66	1.11	0.86
Hexaldehyde (66-25-1)	7	7	0.00	0.06	0.03
Isovaleraldehyde (590-86-3)	7	0	ND	ND	0.00
Propionaldehyde (123-38-6)	7	7	0.01	0.06	0.03
Tolualdehydes (NA)	7	6	0.01	0.05	0.03
Valeraldehyde (110-62-3)	7	7	0.00	0.02	0.01

\*Samples reported as non-detects (ND) are included in averages as 1/2 minimum detection limits.