GARFIELD COUNTY
2025 AIR QUALITY MONITORING REPORT

Prepared for:

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LIST OF ACRONYMNS AND ABBREVIATIONS

ARS	Air Resource Specialists, Inc.
ATSDR	Agency for Toxic Substances and Disease Registry
BMCO	Battlement Mesa, Colorado Air Quality Monitoring Site
BRCO	Bell Ranch, Colorado Air Quality Monitoring Site
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CDPHE	Colorado Department of Public Health and Environment
CH_4	Methane
EPA	U.S. Environmental Protection Agency
FRM	Federal Reference Method
GCPH	Garfield County Public Health
GHG	Greenhouse Gas
GSCO	Glenwood Springs, Colorado Air Quality Monitoring Site
HAPs	Hazardous Air Pollutants
NAAQS	National Ambient Air Quality Standards
NATTS	National Air Toxics Trends Stations
NIOSH	National Institute for Occupational Safety and Health
NMOC	Non-Methane Organic Compounds
NO	Nitric Oxide
NO2	Nitrogen Dioxide
NO_X	Oxides of nitrogen
O_3	Ozone
PACO	Parachute, Colorado Air Quality Monitoring Site
PAH	Polycyclic aromatic hydrocarbons
$PM_{2.5}$	Particulate matter $\leq$ 2.5 microns in diameter
PM_{10}	Particulate matter $\leq$ 10 microns in diameter
PPB	Parts per billion
PPM	Parts per million
PPBC	Parts per billion carbon
RECO	Rifle, Colorado Air Quality Monitoring Site (formerly RICO)
RFCO	Carbondale, Colorado (Roaring Fork) Air Quality Monitoring Site
SNMOC	Speciated non-methane organic compounds
THC	Total Hydrocarbons
TNMOC	Total non-methane organic compounds
UATMP	Urban Air Toxics Monitoring Program
VOC	Volatile organic compounds

EXECUTIVE SUMMARY

This report summarizes air quality monitoring data collected through 2025 in Garfield County, Colorado. Ambient air quality was monitored at four locations in the County in 2025. Collected pollutants and parameters are described below.

Criteria Air Pollutants are subject to National Ambient Air Quality Standards (NAAQS) under the Clean Air Act. Air quality standards are based on human health and/or environmental impacts.

Parameter	NAAQS	Parameter Description
Ozone (O_3)	Rolling 8-hour average not to exceed 70 ppb	Ozone is not emitted directly into the air, but is formed by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NOx and VOCs. Breathing ozone can trigger a variety of health problems, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma. Ground level ozone can also have harmful effects on sensitive vegetation and ecosystems.
Nitrogen Dioxide (NO_2)	Annual average not to exceed 53 ppb or 1-hour average not to exceed 100 ppb	Nitrogen dioxide (NO_2) is one of a group of highly reactive gases known as "oxides of nitrogen," or "nitrogen oxides (NOx)." NO_2 forms quickly from emissions from cars, trucks, and buses, power plants, and off-road equipment. In addition to contributing to the formation of ground-level ozone and fine particle pollution, NO_2 is linked with a number of adverse effects on the respiratory system.
Particulate Matter (PM_{10}) **and** **($PM_{2.5}$)**	24-hour PM_{10} average not to exceed 150 µg/m^3 Annual $PM_{2.5}$ average not to exceed 9 µg/m^3 and/or 24-hour average not to exceed 35 µg/m^3	Particulate Matter describes a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. Types of particulate matter include: • **PM_{10}** : inhalable particles, with diameters that are generally 10 micrometers and smaller; and • **$PM_{2.5}$**: fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller.

Air Toxics are gaseous, aerosol or particle pollutants present in the air in varying concentrations with characteristics such as toxicity or persistence that can be hazardous to human, plant or animal life. These compounds include Volatile Organic Compounds, (VOCs), including methane (CH_4), subsets of speciated non-methane organic compounds (SNMOCs), carbonyls, and hazardous air pollutants (HAPs).

Parameter	NAAQS	Parameter Description
VOC	No ambient air quality standards exist for toxic air pollutants	Volatile organic compounds (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions.
SNMOC		Identical to VOCs with methane excluded, including compounds associated with natural gas and gasoline vapors, crude oil products, and gas-fired engines.
HAP		Hazardous air pollutants are those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects.

Meteorological data consist of physical parameters that are measured directly by instrumentation. The following data are collected to better understand the local conditions and transport of air pollutants:

- Wind speed
- Wind direction
- Ambient temperature
- Relative humidity
- Barometric pressure
- Precipitation

Monitoring results through 2025 indicate that:

- Several air quality measurements in Garfield County such as $PM_{2.5}$ and O_3 were lower than recent years that saw a lot of wildfire activity. $PM_{2.5}$ showed an increase in the highest 24-hour average concentrations compared to recent years, however 98th percentile values remained low.
- Light alkanes (e.g., ethane, propane, iso/n-butane, and iso/n-pentane), which are commonly associated with natural gas, made up roughly 90% of the total SNMOC compounds measured at the Mobile Station (Battlement Mesa). These light alkanes may contribute to ozone formation and odor issues but are not considered HAPs.
- Many SNMOC compounds concentrations were lower at the Mobile Station (Battlement Mesa) compared to previous years.

Detailed air quality monitoring summaries for data collected through 2025 are presented in this report. Additional information, including real-time air quality data, previous air quality data reports, educational materials, air quality management plans, emissions inventories, and health risk assessments are available on the Garfield County Air Quality Management website (http://www.garfield-county.com/air-quality/. Any questions regarding this report or air quality in Garfield County should be addressed to:

Garfield County Public Health
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1.0 INTRODUCTION

Garfield County Public Health (GCPH) has implemented and maintains a network of air quality monitors designed to serve a wide range of purposes related to public health and environmental concerns. This annual air quality data report presents air quality data collected in Garfield County through 2025. The 2025 monitoring network in Garfield County consisted of four monitoring locations, as shown on a map in Figure 1-1 and described below.

- Parachute (PACO): Parachute is a small urban center of approximately 1,300 people within very close proximity to natural gas development activities. The town is located along Interstate 70 and is the transportation hub for heavily traveled roads which service natural gas development in the surrounding area.
- Rifle (RECO): Rifle is a growing urban center on the Interstate 70 corridor with an estimated population of approximately 10,000 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. In 2017, the Rifle equipment moved to the roof of the Rifle Library, necessitating a change in the site ID.
- Battlement Mesa (BMCO): Battlement Mesa is an unincorporated community located about 1.5 miles southeast of Parachute. A VOC sampler was located here in September 2010, and the Garfield County mobile monitoring station was located here in November 2012. This was in response to proposed natural gas development within the community, and to begin developing baseline data in advance of potential large scale production. This mobile monitor was relocated to Glenwood Springs in February 2015, and back to Battlement Mesa in March 2016. Annual average data for the Glenwood Springs site were presented in the 2015 Annual Data report. Monitoring was discontinued at the Battlement Mesa station in 2022 but resumed in February 2023. Monitoring was discontinued again at the end of 2025.
- Carbondale (RFCO): Carbondale is a small town located about 12.5 miles southeast of Glenwood Springs at the confluence of the Roaring Fork and Crystal River valleys. The Carbondale, or Roaring Fork, site began monitoring in March 2012. The site was discontinued in 2022 but resumed in February 2023. Monitoring was discontinued again at the end of 2025.

Table 1-1 lists the pollutants and other parameters monitored at each site. Monitoring at these stations is performed by GCPH with technical support from several agencies, as noted in Table 1-1. Real-time data are displayed on the Garfield County Air Quality website (http://www.garfield-county.com/air-quality/).

Figure 1-1. Map of 2025 Garfield County air quality monitoring sites.

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Table 1-1

Garfield County
Parameters Monitored by Site

Component	Method	Sampling Frequency	Technical Analysis
Rifle, Colorado			
$PM_{2.5}$	BAM	Hourly	ARS
Ozone	42C	Hourly	ARS
Meteorology	Various	Hourly	ARS
Visibility Web Camera	Digital	15-min	ARS
Parachute, Colorado			
Meteorology	Various	Hourly	ARS
Mobile Monitor (Battlement Mesa, Colorado)[a,b]			
SNMOC	TO-12	24-hour (1/6 day)	EnthalpyAnalytical
PM_{10}	EBAM	Hourly	ARS
$PM_{2.5}$	BAM	Hourly	ARS
Ozone	API	Hourly	ARS
$NO/NO_2/NO_X$	API	Hourly	ARS
CH_4/NMHC/THC	Baseline MOCON	Hourly	ARS
Meteorology	Various	Hourly	ARS
Carbobndale, Colorado			
Ozone	2B	Hourly	ARS
Meteorology	Various	Hourly	ARS

[a] The mobile monitor operated in Glenwood Springs February 2015 through February 2016 and returned to Battlement Mesa in March 2016.
[b] Monitoring was discontinued at the Battlement Mesa monitoring station on December 16, 2025.
[c] Monitoring was discontinued at the Carbondale monitoring station on December 16, 2025.

2.0 METEOROLOGICAL SUMMARIES

Meteorological data are collected along with other air quality parameters to better understand the local conditions and transport of air pollutants. Meteorological data collected in Garfield County includes wind speed, wind direction, temperature, relative humidity, barometric pressure and precipitation.

Figure 2-1 presents a map overlaid with wind roses from each of the Garfield County monitoring sites. Wind roses depict wind direction and wind speed. The direction of the bar signifies the direction the wind is coming from, the length of the bars indicates the cumulative frequency from each direction, and the colors indicate wind speed. The map shows that winds at the Garfield County sites are influenced by flow along the Colorado River Basin, where Interstate 70 crosses through the county. Airflow is also influenced by drainage flows through valleys along various Colorado River tributaries.

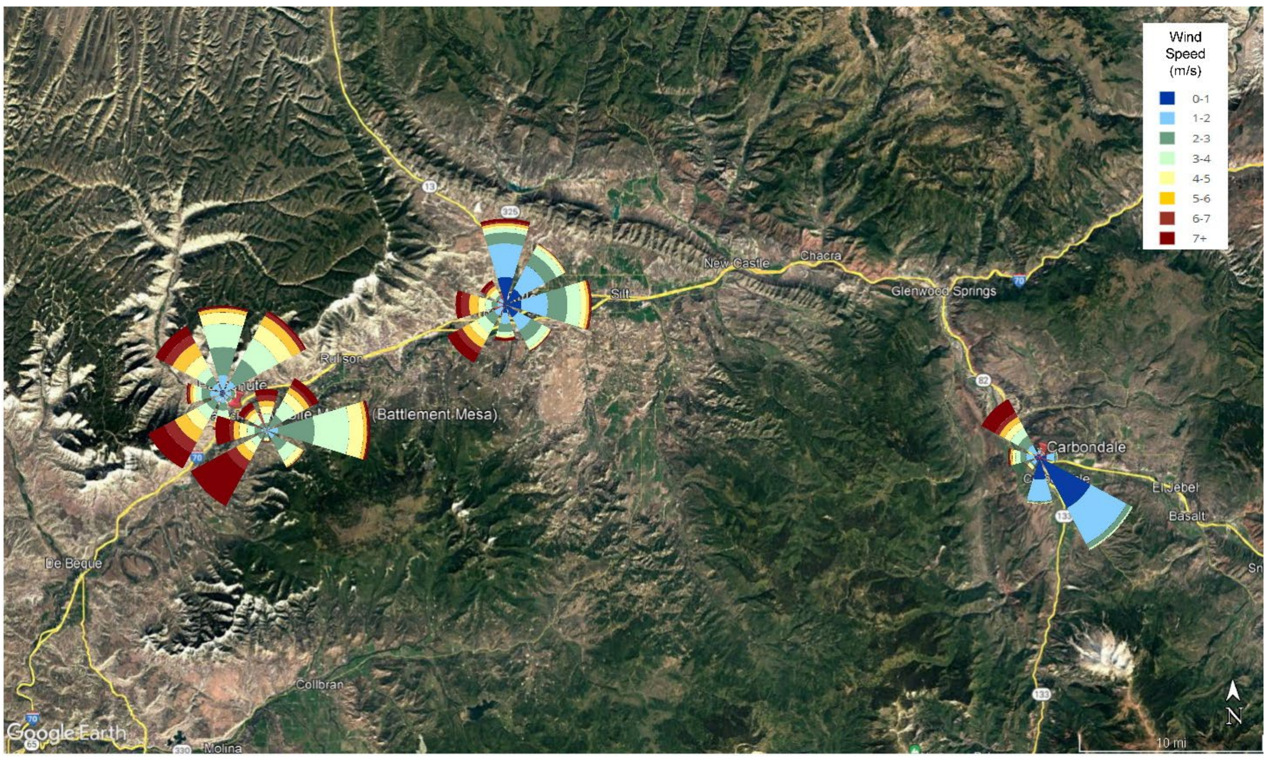


Figure 2-1. Map with wind roses depicting 2025 wind speed and direction measured at the Garfield County air quality monitoring sites.

3.0 CRITERIA POLLUTANT SUMMARIES

The Clean Air Act requires the Environmental Protection Agency (EPA) to set two types of National Ambient Air Quality Standards (NAAQS) for pollutants that include ground-level ozone (O_3), particle matter ($PM_{2.5}$ and PM_{10}), lead (Pb), nitrogen dioxide (NO_2), carbon monoxide (CO), and sulfur dioxide (SO_2). 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 pollution effects, including visibility impairment and effects on the environment (e.g., vegetation, soils, water, and wildlife).

Each standard is defined by an averaging time, a concentration level, and a period of evaluation. Note that a measured value which exceeds the concentration level may be termed an "exceedance", but the concentration measured is not considered a "violation" of the standard unless all criteria are considered, including the period of evaluation.

Criteria pollutant monitoring in Garfield County includes PM_{10}, $PM_{2.5}$, O_3 and NO_2. This section includes summaries for each of these pollutants and comparisons to the relevant NAAQS. Note that, to date, air quality measurements in Garfield County have not violated NAAQS for any of the criteria pollutants measured.

Significant events that occurred at the monitoring stations during 2025 include the following:

Rifle

- The ozone analyzer was turned off from January 17 – 20, 2025 while the site operator waited for a replacement filter.
- Annual data review revealed ozone concentrations were about 30% lower than the historical average for this location beginning in May 2025. A site visit occurred in April 2026 to investigate and it was discovered measurements were compromised due to a seal on the roof that had come loose, likely when the tubing was last replaced. As a result, ozone data were invalidated from May 22, 2025 through April 17, 2026.

Parachute

- Wind direction were invalid intermittently throughout the year due to unexplained dropouts to zero.
- All data were affected by a power failure for several hours from October 14 – 15, 2025.
- The wind direction sensor failed an audit on December 3 as well as the maintenance visit on December 15. A large dead band was found and the sensor was replaced during the maintenance visit on December 15. All wind direction data were invalid from the last passing check on August 27 until the sensor was replaced on December 15, 2025.

Mobile Monitor – Battlement Mesa

- All hydrocarbon data were invalid from December 26, 2024 through February 27, 2025 due to what appeared to be a failed pump in the analyzer. Both the pump and the sample restrictor tubing were replaced on February 26, 2025 as the sample flow appeared to be the main issue. Data were invalid for 24 hours following the pump replacement for instrument warm-up.
- $PM_{2.5}$ data were invalid from January 22 – February 25, 2025. The instrument quit working during this time and was removed for servicing.
- PM_{10} data were invalid from February 7 – 21, 2025 due to a bad pump.
- $PM_{2.5}$ data were invalid from March 18 – 19, 2025 because the instrument needed to be power cycled.
- NO_X data were invalid from March 21 – April 4, 2025 due to a broken valve set for the analyzer that needed to be replaced.
- Ozone data were invalid from May 8 – 22, 2025 due to a bad power supply to the analyzer during this time.
- Ozone, NO_X, and hydrocarbon data were invalid during intermittent periods throughout June, July, and August due to station temperatures that exceeded the allowable limits for the analyzers.
- $PM_{2.5}$ data were invalid during intermittent periods throughout June and July because the BAM was locking up during these times.
- NO_X data were invalid from July 29 – August 14, 2025 due to a valve failure.
- NO_X monitoring was discontinued on August 14, 2025.
- PM_{10} data were invalid beginning October 11, 2025 due to a temperature sensor failure within the instrument.
- $PM_{2.5}$ data were invalid from December 14 – 15, 2025 due to a tape break.
- All monitoring was discontinued on December 16, 2025.

Carbondale

- Ozone data were invalid intermittent hours throughout the year due to extreme noise in the minute trace.
- A power failure affected all data for several hours on June 5, 11, 21 and 22 and again on August 14, 15 and 21.
- All monitoring was discontinued on December 16, 2025.

3.1 OZONE

Ozone is a secondary pollutant, meaning it is not emitted directly from sources, but is formed from photochemical interactions of volatile organic compounds (VOCs) and oxides of nitrogen (NO_X) in the presence of sunlight. The basic formation and depletion equations for O_3 are presented below:

NO_2 + sunlight $\rightarrow$ NO + O

O + O_2 + M $\rightarrow$ O_3 + M (where M is a non-reactive molecule required for this process)

NO + O_3 $\rightarrow$ NO_2 + O_2

Without the presence of VOCs, the diurnal cycle is a balanced reaction, with equal production and depletion of O_3. When VOCs are present, they can react with nitric oxide (NO) to produce NO_2 as follows:

NO + RO $\rightarrow$ NO_2 + RO_2 (where R represents a reactive VOC)

This effectively creates competition for NO, allowing O_3 to build up instead of being depleted by NO. Also, when NO reacts with hydrocarbons, additional NO_2 is produced without consuming O_3, and the produced NO_2 can further react to produce more O_3. A diurnal cycle will generally show lowest O_3 concentrations in the early morning hours and maximum concentrations in the late afternoon. This pattern results from daytime photochemical production from NO_X (NO + NO_2) and VOC precursors, and O_3 loss by dry deposition and reaction with NO at night.

The NAAQS for O_3 was lowered in 2015 by the Environmental Protection Agency (EPA) to 70 ppb (previously 75 ppb) over an 8-hour period. An exceedance of the standard occurs when an 8-hour average O_3 concentration is greater than 70 ppb. A violation of the standard occurs when the three-year average of the fourth highest daily maximum 8-hour average ozone concentration exceeds 70 ppb.

Ozone measurements began in June 2008 at the Rifle site, in March 2012 at the Carbondale site, and in November 2012 at the mobile site in Battlement Mesa (located in Glenwood Springs in 2015). Figures 3-1 through 3-4 show annual trends for O_3 monitored at all Garfield County sites through 2025. At the Rifle site, the highest recorded 8-hour averages exceeded the standard in 2008, 2012, 2018, and 2024, but the 3-year average of the 4th highest values did not, so this was not considered a violation of the standard. The Mobile monitor at Battlement Mesa and the non-regulatory site at Carbondale have also recorded O_3 values above the standard in certain years, but no violations have occurred.

Figures 3-5 through 3-7 present daily maximum 8-hour averages of O_3 monitored at the Rifle, Mobile, and Carbondale sites, respectively, in 2025.

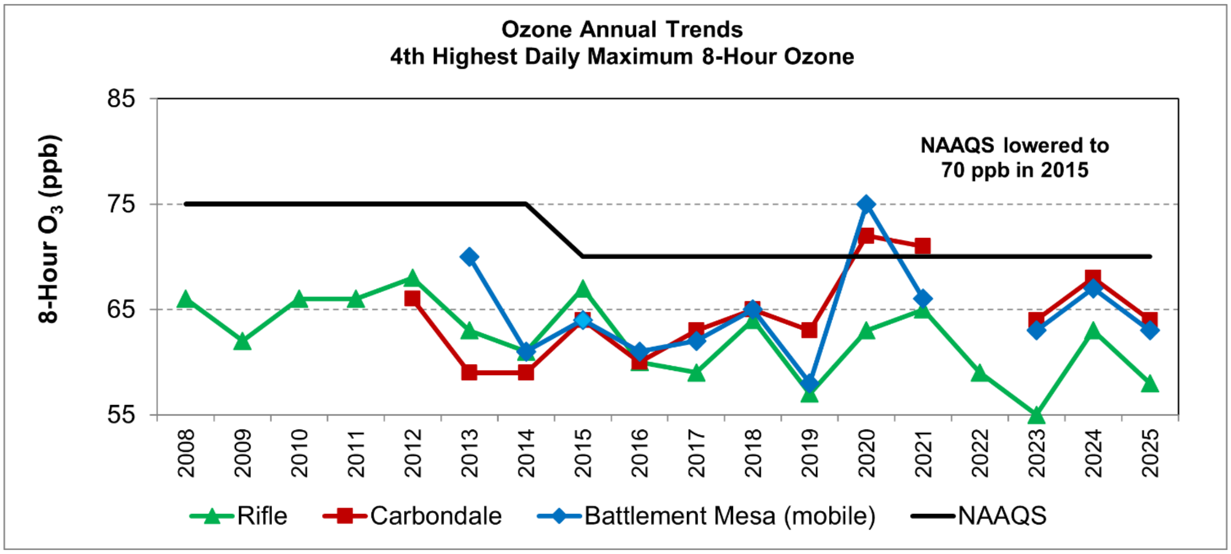


Figure 3-1. Fourth Highest 8-Hour ozone averages measured at all Garfield County sites in comparison to the NAAQS.

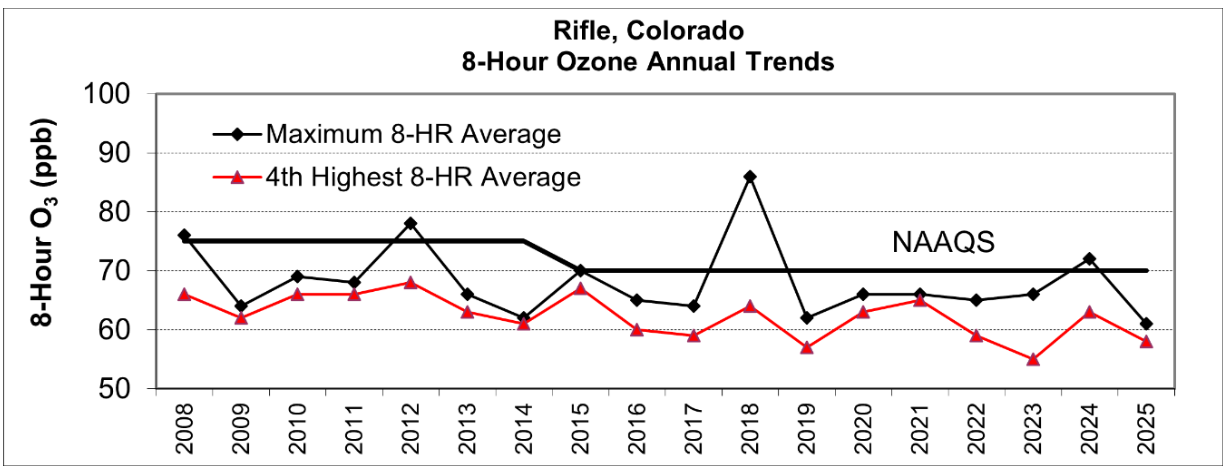


Figure 3-2. Fourth highest and maximum 8-Hour ozone averages measured at the Rifle site in comparison to the NAAQS. (Note that an exceedance of the standard is not considered a violation unless the annual fourth-highest daily maximum 8-hr concentration averaged over three years exceeds 70 ppb.)

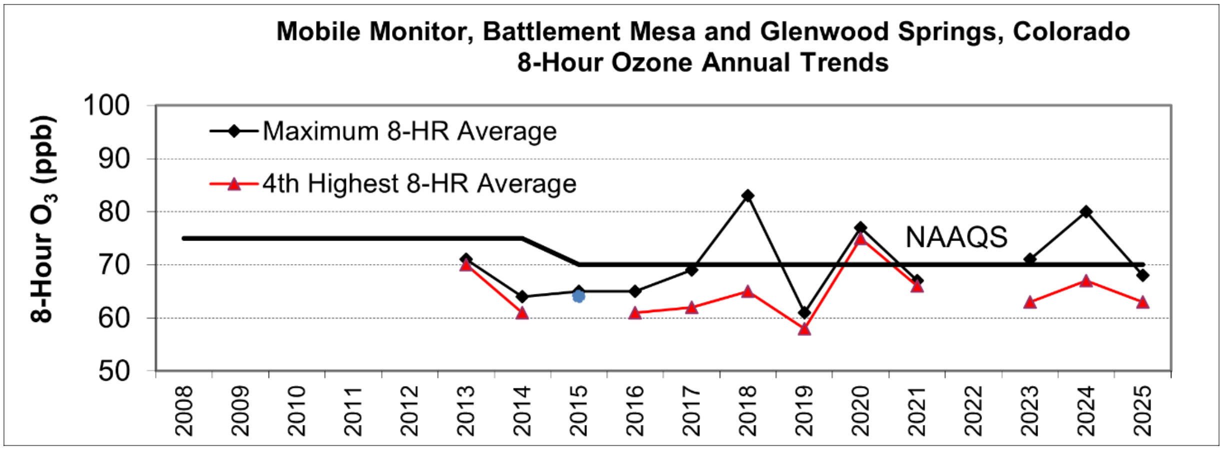


Figure 3-3. Fourth highest and maximum 8-Hour ozone averages measured at the mobile monitor in comparison to the NAAQS. (Red indicates data from the Battlement Mesa location, Blue indicates Glenwood Springs)

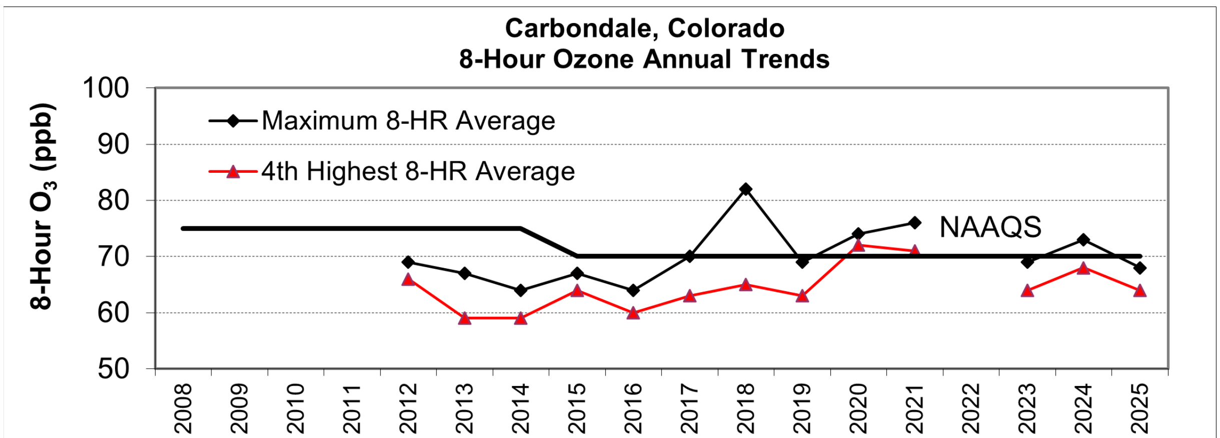


Figure 3-4. Fourth highest and maximum 8-Hour ozone averages measured at the Carbondale site in comparison to the NAAQS.

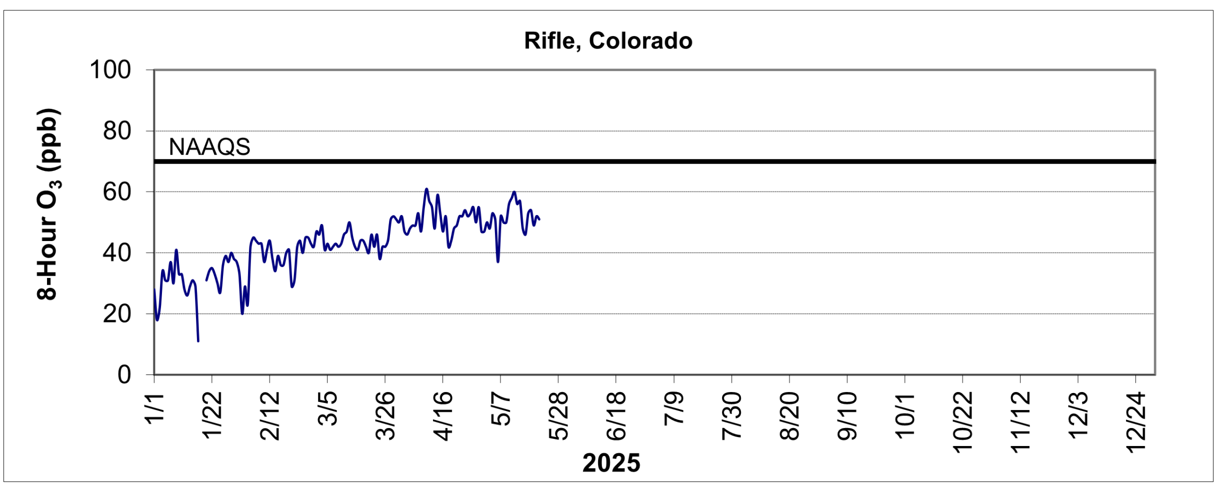


Figure 3-5. Daily maximum 8-hour averages of ozone monitored at the Rifle site in 2025 in comparison to the NAAQS.

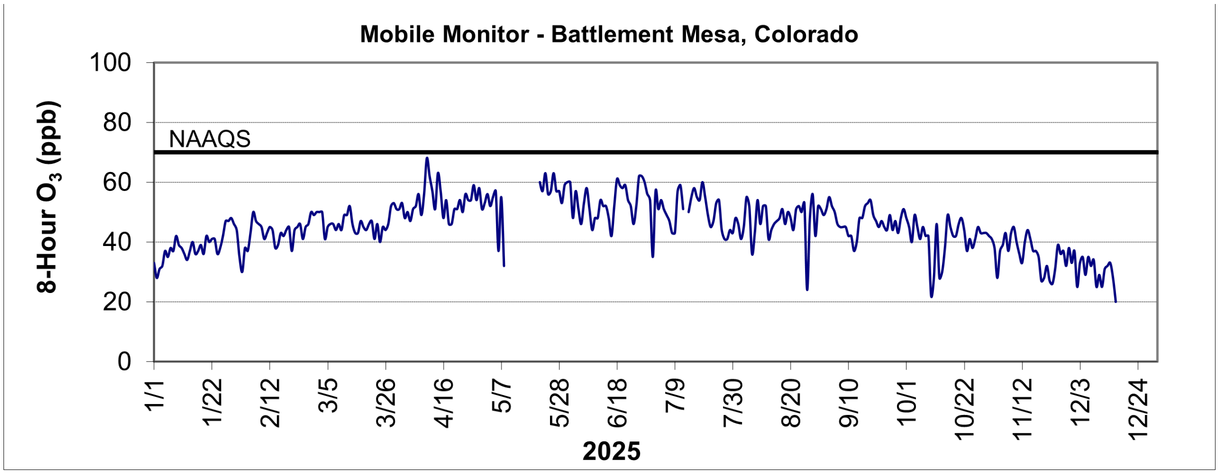


Figure 3-6. Daily maximum 8-hour averages of ozone monitored at the mobile monitor (Battlement Mesa site) in 2025 in comparison to the NAAQS.

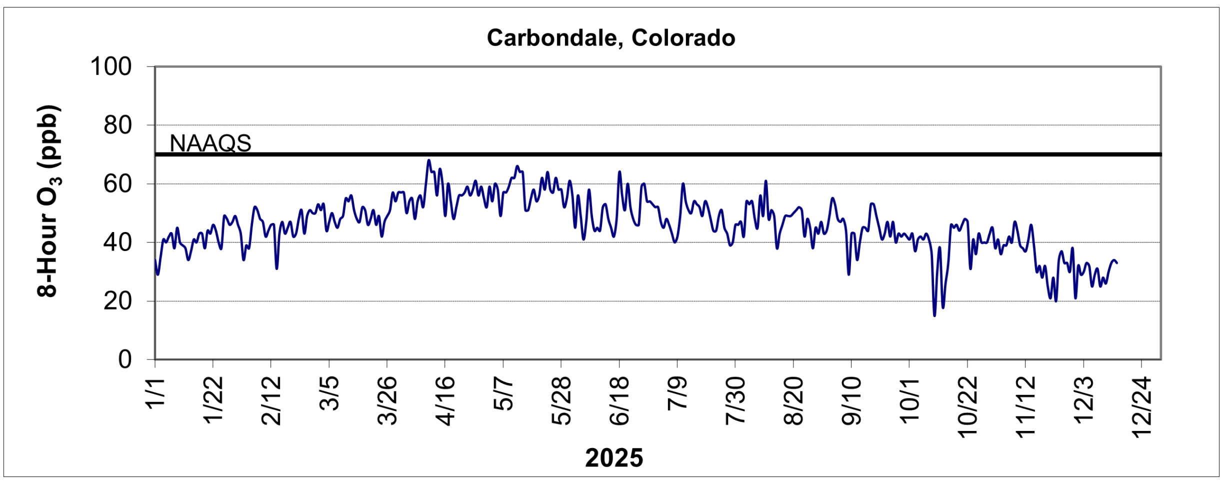


Figure 3-7. Daily maximum 8-hour averages of ozone monitored at the Carbondale site in 2025 in comparison to the NAAQS.

3.2 NITROGEN DIOXIDE

Nitrogen Dioxide (NO_2) is generally measured alongside nitric oxide (NO), where NO and NO_2 are the primary components of Oxides of Nitrogen (NOx). Only NO_2 is considered a regulated pollutant, but all components of NO_X have been identified as precursors for both O_3 and particulate matter. NO is a colorless and odorless gas which, in the presence of O_3, will react to form NO_2. NO_2 is a reddish-brown gas which is partially responsible for the "brown haze" observed near large cities.

The NAAQS for NO_2 include an annual arithmetic mean of 53 ppb and a 1-hour daily maximum of 100 ppb. A violation of the 1-hour standard occurs when the 3-year average of the 98th percentile of the daily maximum 1-hour averages is greater than the standard.

NO_2 is measured at the mobile station, which began at the Battlement Mesa site in late 2012. The mobile site operated at the Glenwood Springs location from February 2015 through February 2016. In March 2016 the mobile monitor returned to the Battlement Mesa monitoring location. Figure 3-8 presents annual averages of NO_2 recorded at the mobile monitoring site, and Figure 3-9 presents daily maximum 1-hour averages of NO_2. Plots indicate that measured NO_2 values are well below the NAAQS standards.

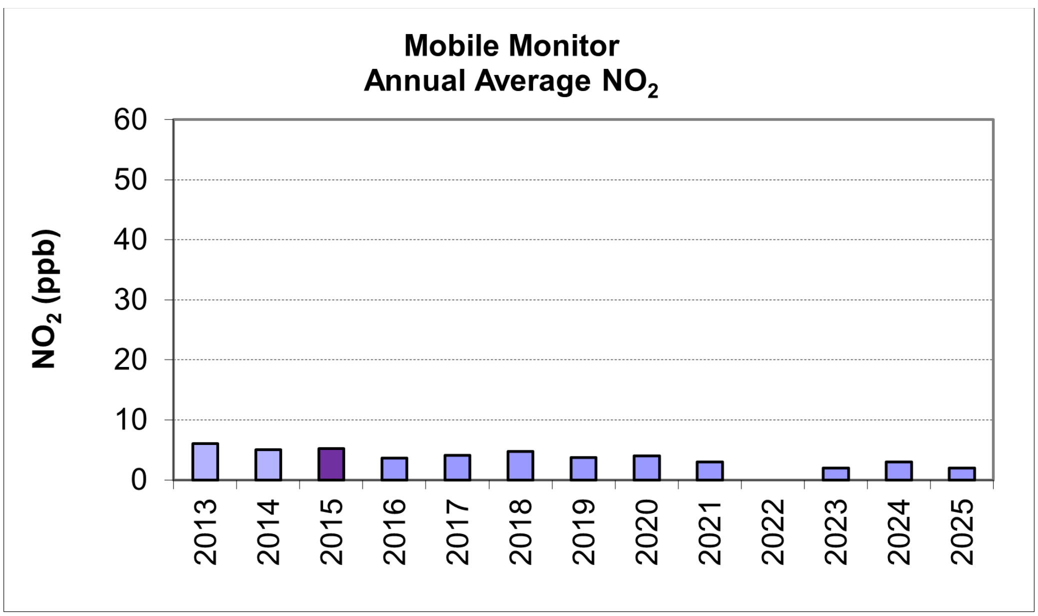


Figure 3-8. Annual average nitrogen dioxide monitored at the mobile monitoring station (Battlement Mesa and Glenwood Springs) in comparison to the NAAQS.

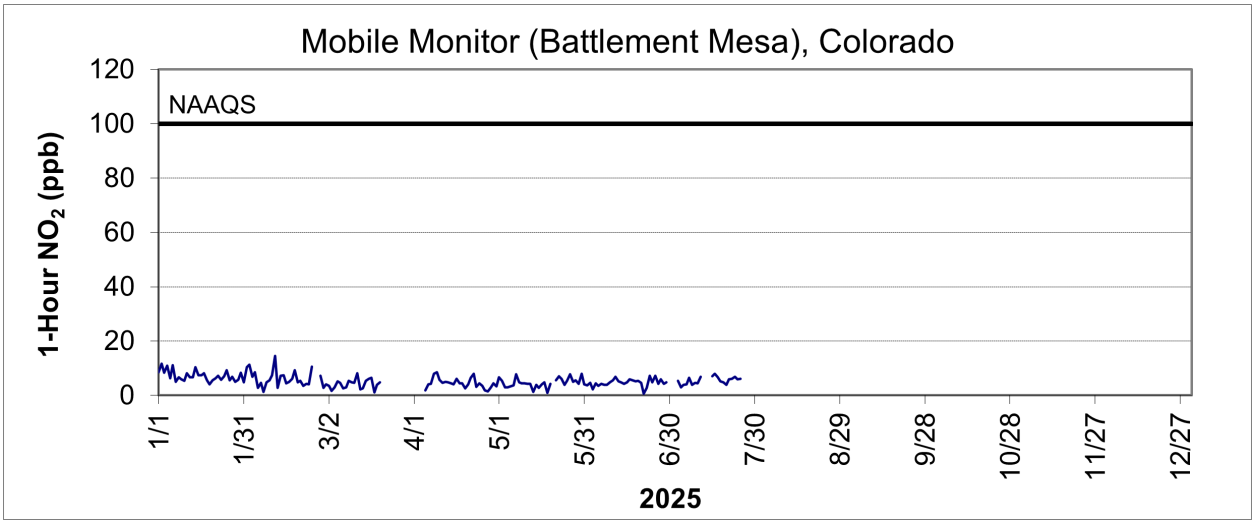


Figure 3-9. Daily maximum 1-hour averages of nitrogen dioxide monitored at the Battlement Mesa site in 2025 in comparison to the NAAQS.

3.3 PARTICULATE MATTER

Particulate matter (PM) consists of solid particles and liquid droplets that are small enough to be inhaled. Particles smaller than 10 micrometers in diameter (PM_{10}), are approximately 1/7th the width of a human hair, and pose a health concern because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers in diameter ($PM_{2.5}$) are referred to as "fine" particles and are believed to pose the greatest health risks. Because of their small size, approximately 1/30th the average width of a human hair, fine particles can lodge deeply into the lungs. Particulate matter can be emitted directly into the air or can be formed in the atmosphere through complex chemical reactions from emissions of sulfur dioxides, nitrogen oxides, and other compounds. Larger particulate matter (PM_{10}) can come from sources such as road dust, construction, and crushing or grinding operations. Fine particulate matter ($PM_{2.5}$) can come from all kinds of combustion, including motor vehicles, power plants, residential wood burning, and forest fires; as well as from some industrial processes that may contain organic compounds and metals. $PM_{2.5}$ particles are the main cause of reduced visibility or haze. Particulate sources associated with natural gas development may include grading and leveling of well pads, construction of facilities, construction of access roads to well pads, and subsequent vehicle traffic. Naturally occurring emissions such as forest fires can also contribute to particulate matter.

Continuous PM_{10} and $PM_{2.5}$ monitoring began at the Rifle site in September 2008. The Rifle site stopped collecting PM_{10} measurements at the end of 2014. Continuous PM_{10} and $PM_{2.5}$ instruments operated at the mobile monitor beginning in November 2012 and continuous $PM_{2.5}$ monitoring began at the Carbondale site in March 2012. Filter-based 24-hour PM_{10} monitoring conducted by CDPHE was discontinued as of December 31, 2018. Summaries for both continuous PM_{10} and $PM_{2.5}$ measurements are provided below.

3.3.1 PM$_{10}$ Measurements

Figure 3-10 presents the highest and second highest 24-hour average values measured at the mobile site. 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 (µg/m^3). A violation of the standard occurs when the average number of days with a 24-hour average concentration above 150 µg/m^3 over a 3-year period is greater than one.

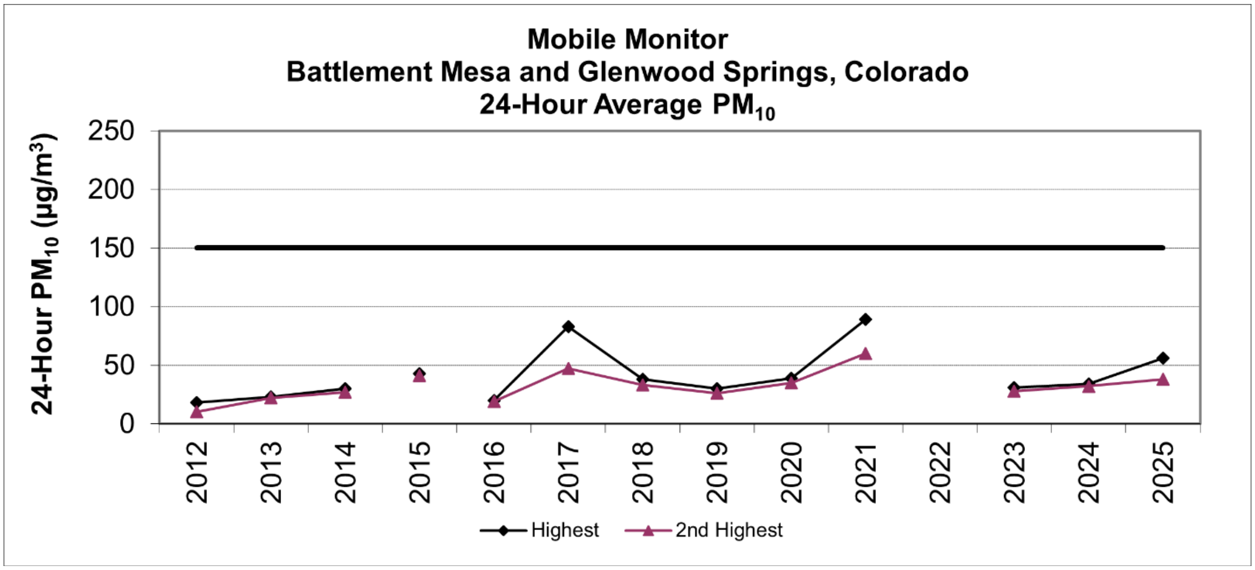


Figure 3-10. Highest and second highest 24-hour average PM$_{10}$ measured at the Mobile Monitor (Battlement Mesa and Glenwood Springs in 2015) site in comparison to the NAAQS.

3.3.2 $PM_{2.5}$ Measurements

Continuous $PM_{2.5}$ data have been monitored at the Rifle site since mid-2008. Continuous PM_{10} and $PM_{2.5}$ data have been monitored at the Mobile Monitor (Battlement Mesa and Glenwood Springs) site since November 2012. Continuous $PM_{2.5}$ data were monitored at the Carbondale site until December 2019, at which point this measurement was discontinued.

Figure 3-11 presents the annual average of continuous $PM_{2.5}$ measured at all Garfield County sites since 2008. Figures 3-12 through 3-13 present the highest and 98th percentile 24-hour average values measured at the sites. The NAAQS for $PM_{2.5}$ is an arithmetic mean of 12 $\mu g/m^3$ annually and a 24-hour average of 35 $\mu g/m^3$. A violation of the $PM_{2.5}$ standard occurs when the 3-year average of the weighted annual mean exceeds that annual standard, or the 3-year average of the 98th percentile 24-hour average value exceeds the 24-hour standard. The highest 24-hour $PM_{2.5}$ values measured in 2008, 2009, 2012, 2020, 2021, and 2025 at the Rifle site were above the standard, but these are not considered violations because the 98th percentile values averaged over a 3-year period were below the standard.

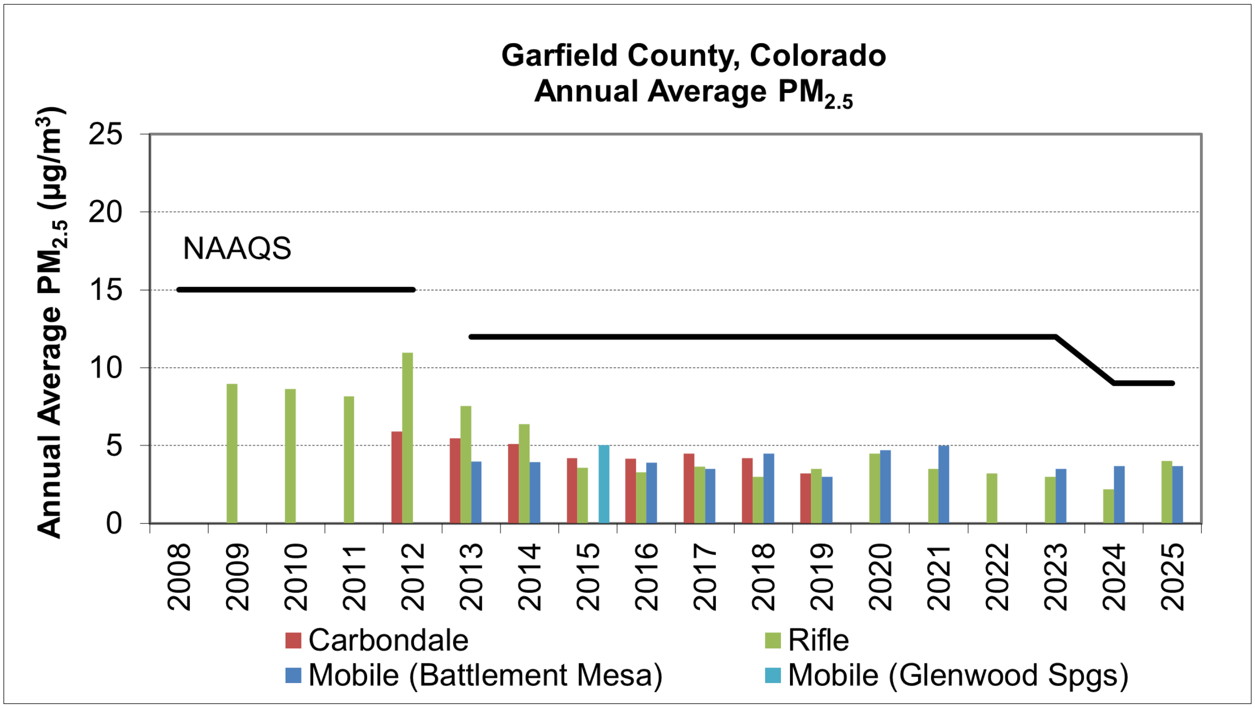


Figure 3-11. Annual average $PM_{2.5}$ measured at the Garfield County sites in comparison to the NAAQS.

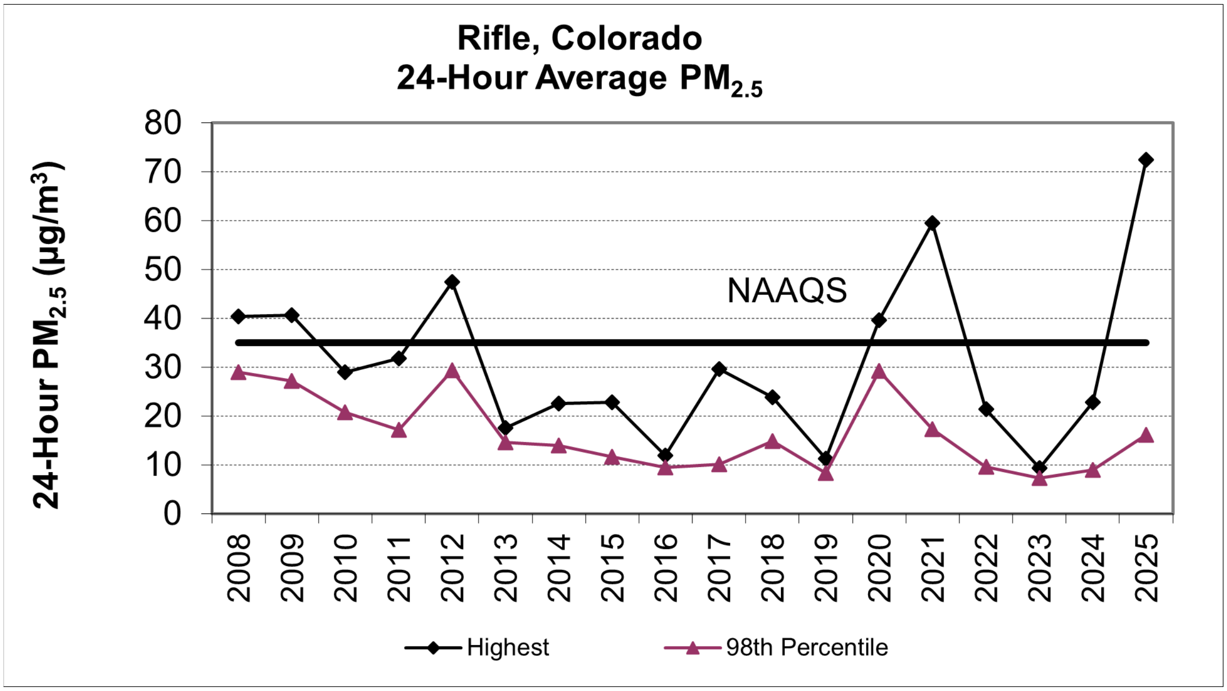


Figure 3-12. Highest and 98th percentile 24-hour average $PM_{2.5}$ measured at the Rifle site. (Note that exceedances of the NAAQS are not considered a violation until the 3-year average of the 98th percentile value exceeds the NAAQS.)

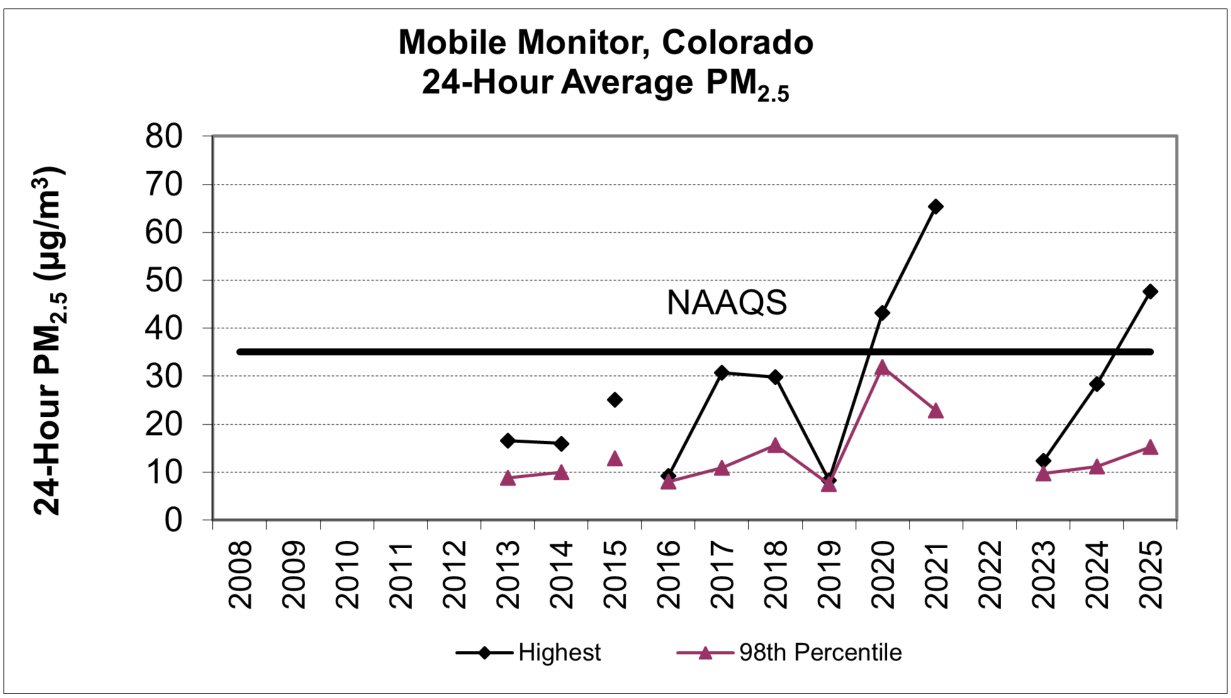


Figure 3-13. Highest and 98th percentile 24-hour average $PM_{2.5}$ measured at the Mobile Monitor (Battlement Mesa, 2013-2014, 2016-2023, and Glenwood Springs, 2015, sites) in comparison to the NAAQS.

4.0 VOLATILE ORGANIC COMPOUNDS

Volatile organic compounds (VOCs) include some hazardous air pollutants (HAPs), polycyclic aromatic hydrocarbons (PAHs), heavy metals, and speciated non-methane organic compounds (SNMOC); which are known or believed to cause human health effects. Methane and SNMOCs are subsets of volatile organic compounds (VOCs), which are carbon-based and hydrogen-based chemicals that exist in the gas phase or can evaporate from liquids. VOCs can react in the atmosphere to form ozone (O_3) and particulate matter.

Garfield County has measured speciated non-methane organic compounds (SNMOCs) using a 1-in-6 day sampling schedule since 2008. The County added continuous measurements of methane (CH_4), non-methane, and total hydrocarbons as a part of the Mobile Monitor, which began operation at the Battlement Mesa site in late 2012. The Mobile Monitor operated in Glenwood Springs from February 2015 through February 2016 (data for this location were summarized in the 2015 Annual Data Report). The Mobile Monitor returned to the Battlement Mesa site in March 2016. Summaries of methane and SNMOCs levels measured in 2025 are presented in this section.

4.1 Continuous Methane and Non-Methane Hydrocarbons

Continuous methane (CH_4) and non-methane organic compounds (NMOC) measurements are collected along with the canister based SNMOC measurements at the mobile monitor. Figure 4-1 presents daily maximum 1-hour concentrations of methane measured at the site in units of ppm. Methane is a pollutant that persists in the atmosphere for long periods of time (~12 years), so there is generally a background concentration of methane present globally even in very remote locations. Methane is also the primary component in natural gas, and can be elevated in oil and gas development areas. Methane is not considered a hazardous air pollutant, but it is a major greenhouse gas and can contribute to climate change. The plot shows a baseline slightly above the global background methane reported by the EPA (~1.8 ppm, see https://19january2017snapshot.epa.gov/climatechange_.html) during the 2025 monitoring period.

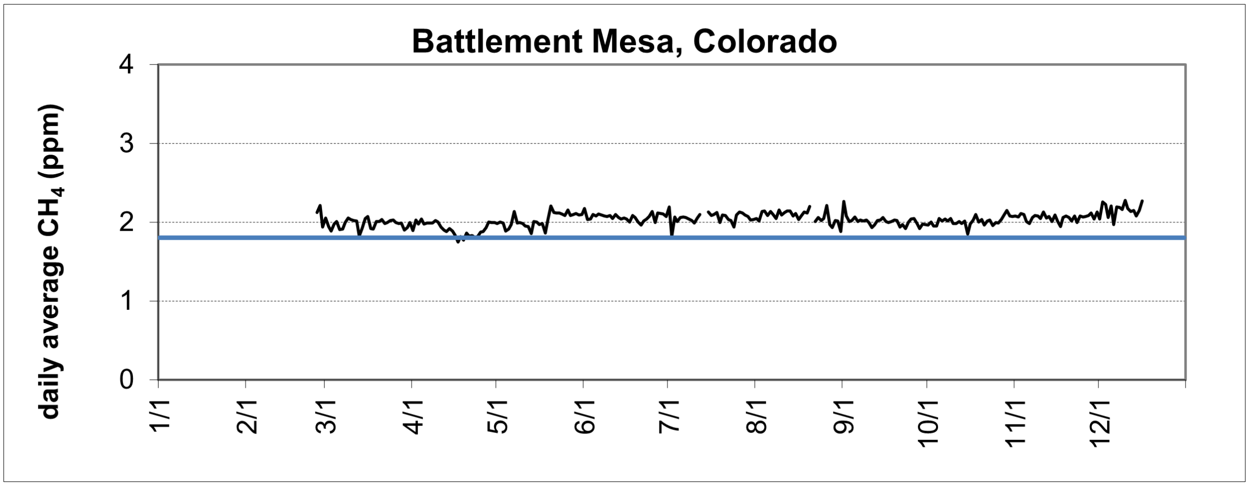


Figure 4-1. Daily average methane measured at the Mobile Monitor (Battlement Mesa site) in 2025. (Note – The blue line on the chart represents the worldwide background concentration for methane.)

Concentrations of speciated non-methane organic compounds (SNMOC) are available from the canister sample analysis and continuous measurements of total NMOCs are collected at the Mobile Monitoring station. Continuous total NMOC measurements are useful along with canister measurements because continuous measurements are available on an hourly basis in near real-time, while canister samples are only available every sixth day as 24-hour averages. Figure 4-2 presents a time series plot of total SNMOCs from the continuous measurements. A comparison to the canister data is no longer available due to differences in the data reported from the new lab, which started in 2024.

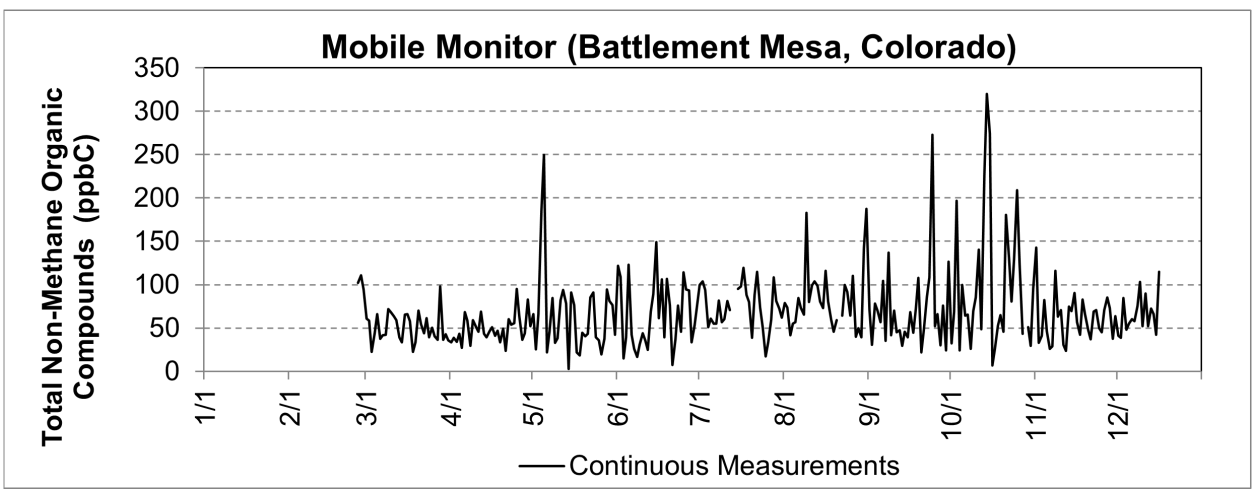


Figure 4-2. Continuous measurements of non-methane organic compounds measured at the Mobile Monitor (Battlement Mesa site) in 2025.

4.2 Speciated Non-Methane Organic Compounds

Garfield County began collecting speciated non-methane organic compounds (SNMOC) data at the Parachute (PACO), Rifle (RECO), and Bell Ranch (BRCO) sites in 2008, at the Mobile Monitor (Battlement Mesa (BMCO) and Glenwood Springs (GSCO)) in September 2010, and at the Carbondale (RFCO) site in 2012. During the 2025 monitoring period, SNMOC compounds were only collected and analyzed from the Mobile Monitor (BMCO) in accordance with EPA Compendium Method TO-12, with 24-hour samples collected on a 1-in-6 day schedule. Annual averages are presented here, and Appendix B lists minimum, maximum, and average concentrations of all detected SNMOC compounds.

SNMOC compounds can be grouped into classifications with similar characteristics. For summary purposes, measured SNMOC compounds are grouped into the following categories:

- Light Alkanes: Alkanes are the simplest hydrocarbons, consisting of only carbon and hydrogen with single bonds. Light alkanes, which include alkanes with up to five carbon atoms (ethane, propane, iso/n-butane and iso/n-pentane), along with methane, are primary components of natural gas and gasoline vapors.

- 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 a- and b-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 other engine sources such as those associated with oil and gas production.

Figure 4-3 presents annual average SNMOC data collected between 2011 and 2025 at the Mobile Monitor (BMCO). Figure 4-4 presents categories of measured SNMOCs in units of ppbV (parts per billion by volume) measured in 2025. In general, measured compounds consisted mostly of light alkanes. Light alkanes represented roughly 90% of total SNMOCs measured at sites near natural gas development. These trends can be influenced by the variations in temperature, as VOCs can be trapped under inversion layers during the colder months, especially if wind conditions are stagnant. Also, some emissions, including cold-start engine emissions and residential wood burning, are higher in the winter.

Figure 4-5 presents measurements by category in units of ppbC, where ppbC represents the number of carbon molecules measured (ppbV multiplied by the number of carbons in each compound). Heavier alkanes and aromatics are more significant sources of carbon than the lighter alkanes.

Carbon content in a molecule is important because it is related to compound reactivity, which contributes to O_3 formation potential. O_3 is formed from photochemical interactions of VOCs and NO_X in the presence of sunlight, as described in Section 3.1. The light alkanes that dominate measurements by volume are the least reactive compounds but could theoretically contribute significantly to O_3 formation potential. Highly reactive compounds including aromatics such as toluene and m/p-xylenes are less abundant, but have greater potential to contribute to the O_3 formation due to their higher reactivity. Currently, Garfield County is not in violation of the NAAQS for O_3. However, if O_3 levels become more of a concern in Garfield County, it would be useful to target further controls for emissions of VOCs that have the greatest potential to contribute to O_3 formation.

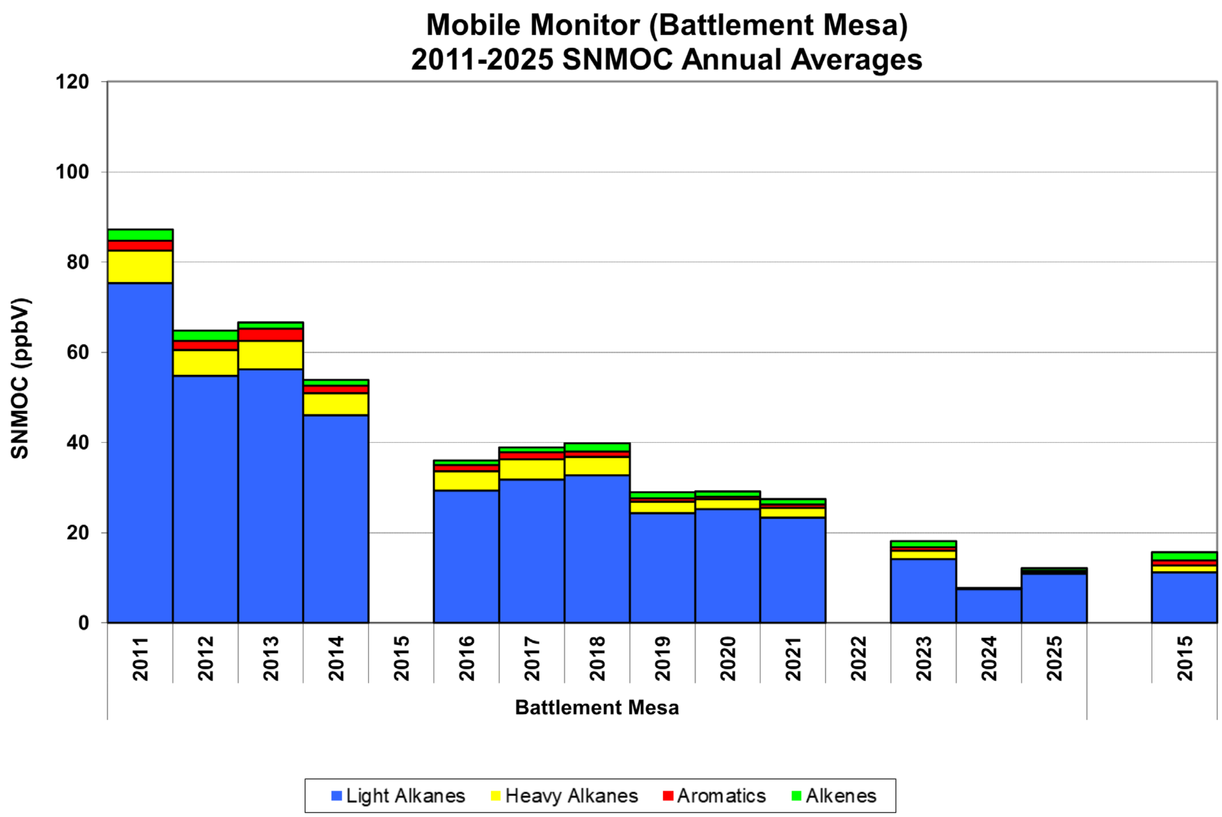


Figure 4-3 Average SNMOC concentrations measured at the Mobile Monitor (Battlement Mesa) site between 2011 and 2025.

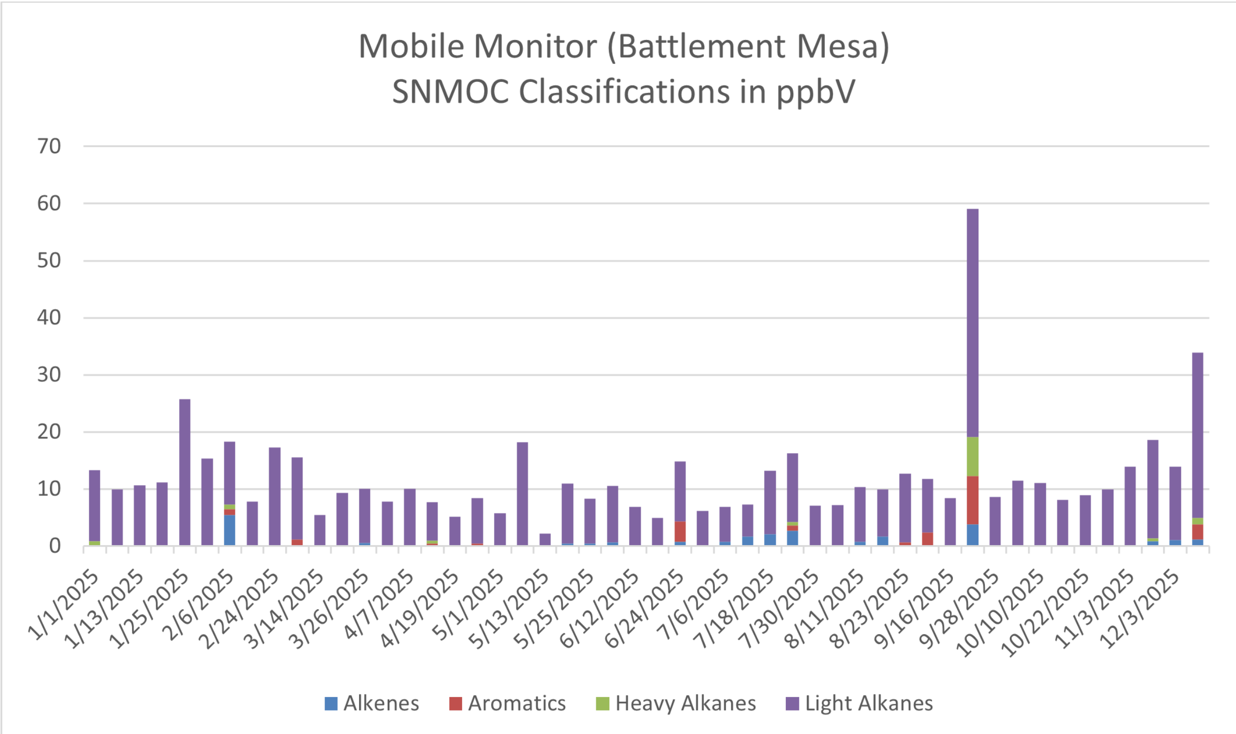


Figure 4-4. 2025 24-hour SNMOC measurements by category in units of ppbV.

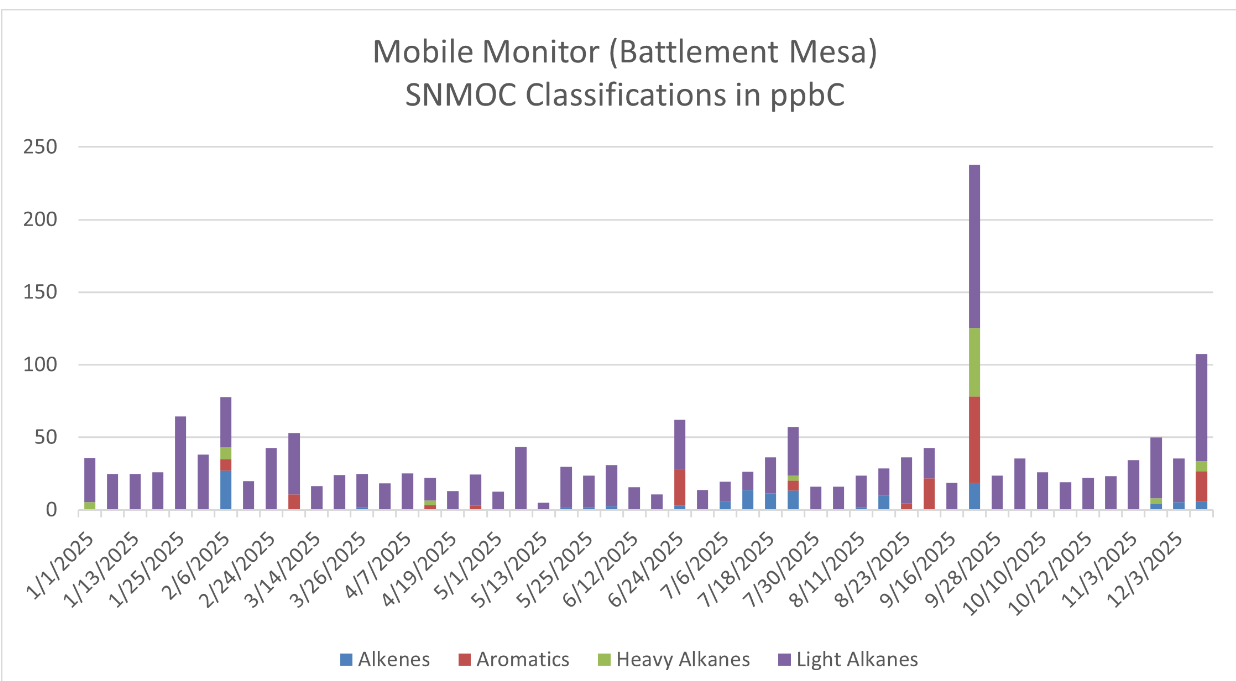


Figure 4-5. 2025 24-hour SNMOC measurements by category in units of ppbC.

4.3 HAZARDOUS AIR POLLUTANTS (HAPS)

The EPA has designated approximately 190 compounds as HAPs, including benzene, toluene, ethyl-benzene and xylenes (also known as the BTEX compounds). No NAAQS or any other ambient air standards exist for HAPs. Instead, emissions limits on industrial sources have been set, and the 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 can be used to determine potential risks from exposure to VOCs.

Of the 78 SNMOC and 12 carbonyl compounds measured in Garfield County, 21 compounds are considered HAPs. *The Garfield County Air Toxics Inhalation Screening Level Human Risk Assessment* (CDPHE 2010) assessed data collected in 2008. Risk assessments based on 2008 through 2012 VOC levels were assessed in a separate risk assessment report prepared by the CDPHE Disease Control and Environmental Epidemiology Division in 2015. Findings of the 2010 report indicated that, individually, the HAP components were below risk assessment criteria, but cumulative effects approached chronic (70 year exposure period) non-hazard levels. The largest contributors to the cumulative levels were benzene and formaldehyde. Findings of the 2015 report indicate a trend toward decreasing cumulative cancer risk estimates and noncancer hazards for all contaminants of potential concerns except 1,2-butadiene at all monitoring sites. Definitive conclusions cannot be drawn regarding the magnitude of cancer and noncancer risks associated with emissions from oil and gas operations because of the major uncertainties and knowledge gaps.

Summaries in this report include annual averages for the HAPs measured in Garfield County, but do not address health effects of these compounds. It is important to note that annual average values summarized here do not necessarily indicate a health risk, as actual magnitudes of these HAP compounds related to possible health risk are evaluated separately in the CDPHE risk assessment reports.

4.3.1 Annual Average HAP Concentrations

Annual trends were calculated for each HAP, with a trend defined as the slope derived from Theil statistics. This is a nonparametric regression technique commonly applied to environmental data to determine statistically significant trends. The significance of the trend is represented with p-values calculated using Mann-Kendall trend statistics. Determining a significance level helps to distinguish random variability in data from a real tendency to increase or decrease over time, where lower p-values indicate higher confidence levels in the computed slopes.

Table 4-1 presents annual averages and trends for HAP concentrations measured between 2011 and 2025 at the Battlement Mesa site. For purposes here, regional trends are considered statistically significant if the p-value statistic is less than 0.10 (90% confidence level). Statistically significant decreasing trends are indicated in blue, and statistically significant increasing trends are depicted in red. Data collected since 2011 indicate that nearly all HAPs compounds have measured statistically significant decreasing annual average trends.

Table 4-1
Mobile Monitor – Battlement Mesa Site
Annual Average Mass Trends (HAPs Parameters) 2011-2025

Parameter	Average Mass (µg/m^3)														Slope (µg/m^3 per year)	p-Value
	2010	2011	2012	2013	2014	2016	2017	2018	2019	2020	2021	2023	2024	2025		
1,2,4-Trimethylbenzene	0.32	0.44	0.35	0.40	0.26	0.23	0.37	0.22	0.18	0.19	0.27	0.36	0.03	0.06	-0.02	0.01
1,3,5-Trimethylbenzene	0.24	0.22	0.15	0.16	0.14	0.14	0.16	0.14	0.06	0.05	0.09	0.06	0.03	0.03	-0.02	0.00
1,3-Butadiene	0.06	0.06	0.10	0.05	0.05	0.03	0.02	0.03	0.02	0.02	0.06	0.02	0.08	0.06	0.00	0.10
Benzene	1.48	1.56	1.09	1.24	0.88	0.79	0.85	0.66	0.48	0.55	0.57	0.40	0.03	0.03	-0.11	0.00
Cyclohexane	2.51	2.09	1.77	2.40	1.74	1.49	1.57	1.36	0.80	0.66	0.68	0.55	0.03	0.05	-0.19	0.00
Ethylbenzene	0.28	0.37	0.19	0.14	0.11	0.09	0.35	0.14	0.08	0.05	0.09	0.08	0.02	0.03	-0.02	0.00
Isopropylbenzene	0.06	0.08	0.05	0.05	0.05	0.03	0.04	0.02	0.04	0.05	0.02	0.02	0.02	0.04	0.00	0.00
Methylcyclohexane	5.13	4.23	3.57	5.06	3.64	3.37	3.69	3.40	1.78	1.43	1.56	1.13	0.02	0.03	-0.37	0.00
m-Xylene/p-Xylene	1.44	1.12	1.06	1.23	0.94	0.82	0.91	0.98	0.42	0.37	0.52	0.44	0.04	0.03	-0.10	0.00
n-Hexane	4.02	3.34	2.89	2.42	2.35	1.91	1.95	1.73	1.31	1.21	1.10	0.78	0.02	0.06	-0.26	0.00
n-Nonane	0.59	0.68	0.43	0.62	0.48	0.48	0.57	0.64	0.23	0.20	0.31	0.26	0.02	0.04	-0.04	0.00
n-Propylbenzene	0.10	0.14	0.09	0.05	0.09	0.03	0.08	0.05	0.05	0.05	0.04	0.08			-0.01	0.02
o-Xylene	0.35	0.46	0.27	0.26	0.19	0.18	0.45	0.21	0.10	0.08	0.12	0.10	0.02	0.03	-0.02	0.00
Propylene	0.51	0.42	0.44	0.36	0.40	0.33	0.33	0.32	0.42	0.34	0.32	0.38	0.03	0.05	-0.02	0.00
Styrene	0.07	0.08	1.54	0.18	0.15	0.24	0.27	0.07	0.01	0.05	0.22	0.06	0.03	0.07	-0.01	0.08
Toluene	2.87	2.99	4.07	5.58	2.54	2.63	2.68	2.19	1.21	0.98	1.08	1.38	0.02	0.20	-0.27	0.00

* Annual average data for the Glenwood Springs site were presented in the 2015 Annual Data report

5.0 REFERENCES

Colorado Department of Public Health and Environment (CDPHE). 2010. *Garfield County Air Toxics Inhalation: Screening Level Human Health Risk Assessment*. Available online at http://www.garfield-county.com/public-health/documents/.

Colorado Department of Public Health and Environment (CDPHE). 2015. *Garfield County Air Toxics Inhalation: Screening Level Human Health Risk Assessment: Trends in Air Quality from 2008 to 2012*. Available online at http://www.garfield-county.com/air-quality/2008-12-health-risk-assessment.aspx/.

Environmental Protection Agency (EPA). 2011. *2008-2009 National Monitoring Programs Annual Report (UATMP, NATTS, and CSATAM)*. Available online at http://www.epa.gov/ttnamti1/uatm.html.

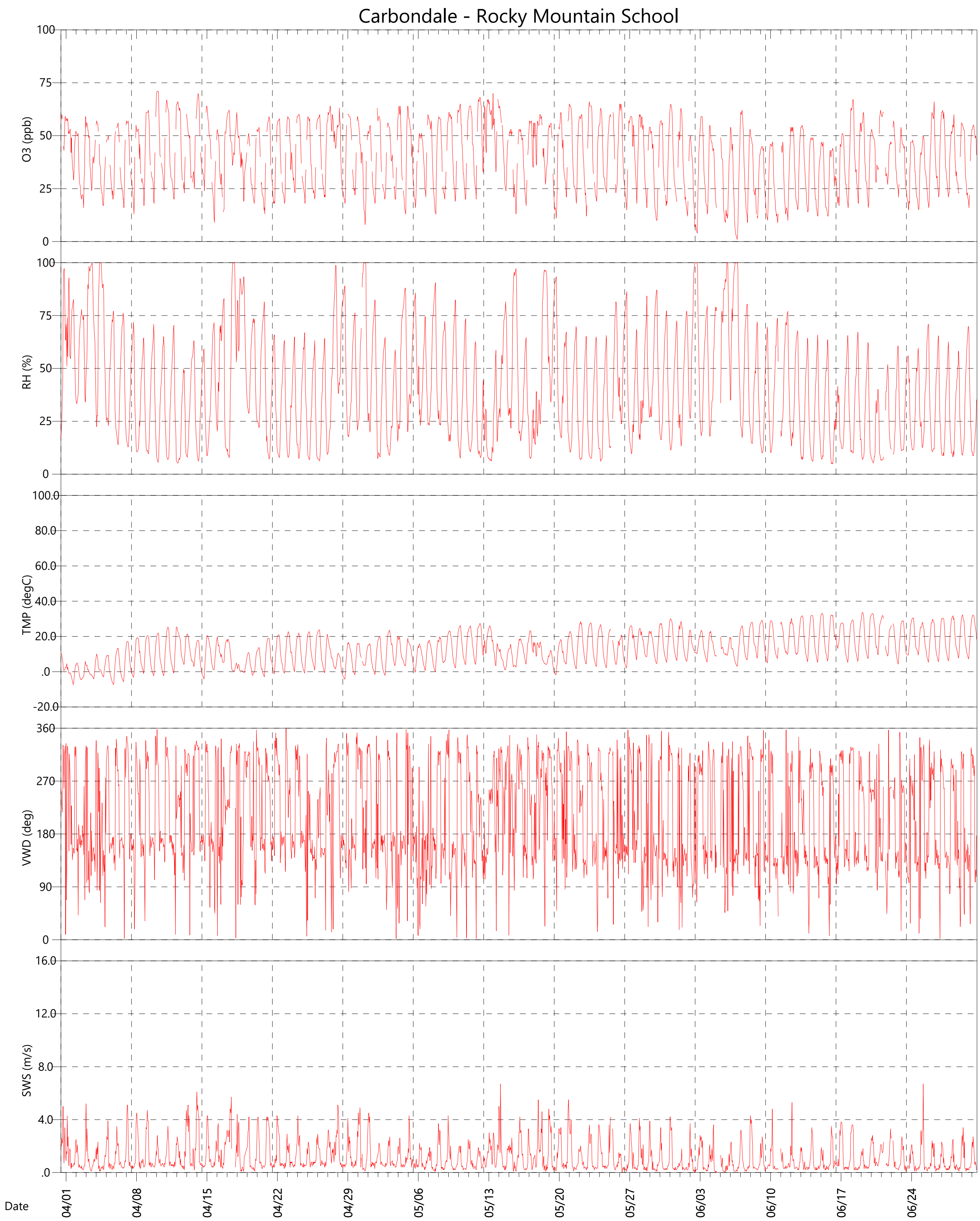
APPENDIX A

Quarterly Time Series Plots

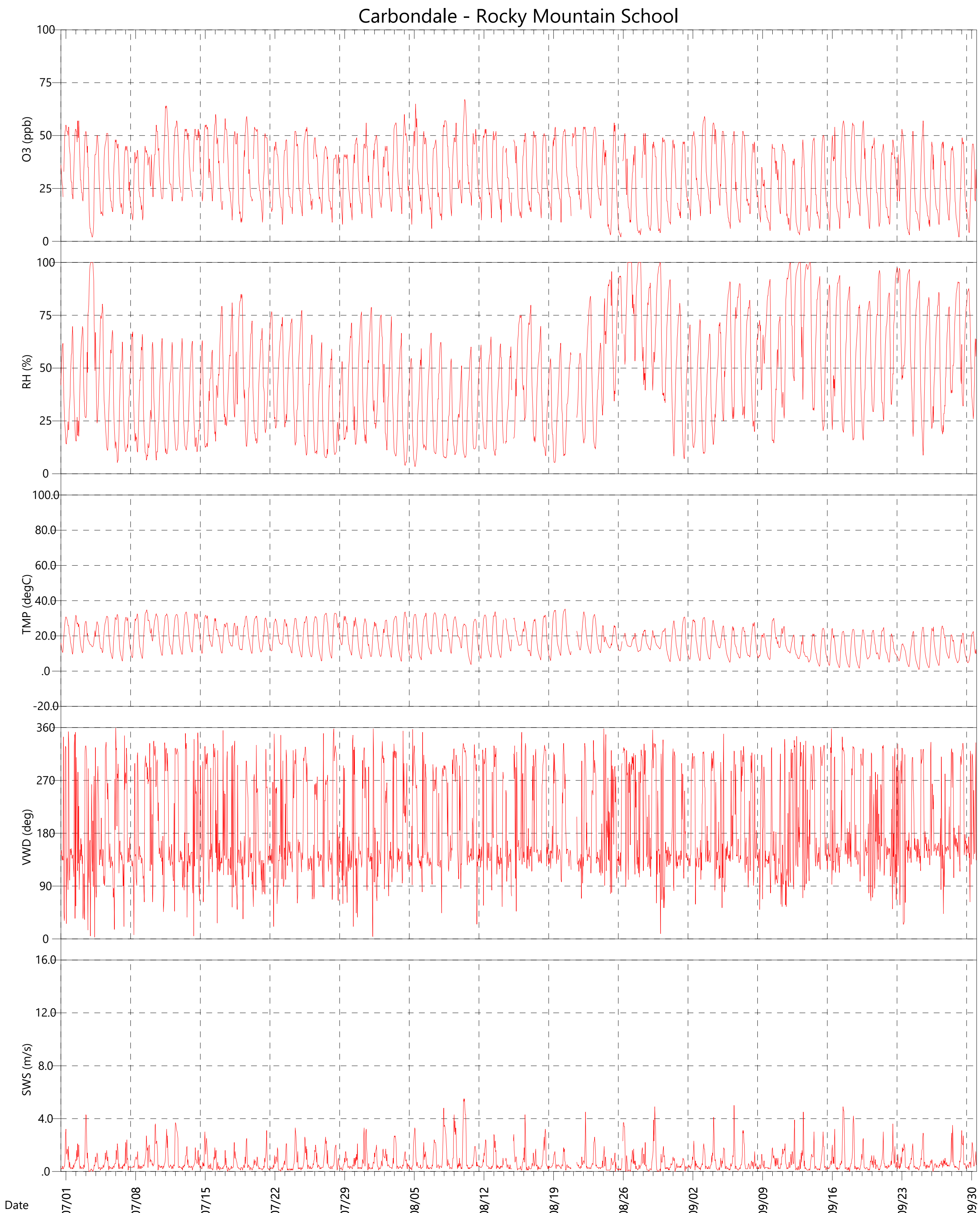
Acronyms Used on Plots:

TNMOC = Total Non-Methane Organic Carbon
CH4 = Methane
NMHC = Continuous Non-Methane Hydrocarbons
O_3 = Ozone
NO = Nitric Oxide
NO_2 = Nitrogen Dioxide
NOx = Oxides of Nitrogen
PM_{10} = Particulate Matter $\leq$ 10 µm
$PM_{2.5}$ = Particulate Matter $\leq$ 2.5 µm
RH = Relative Humidity
TMP = Atmospheric Temperature
VWD = Vector Wind Direction
SWS = Scalar Wind Speed

January - March 2025

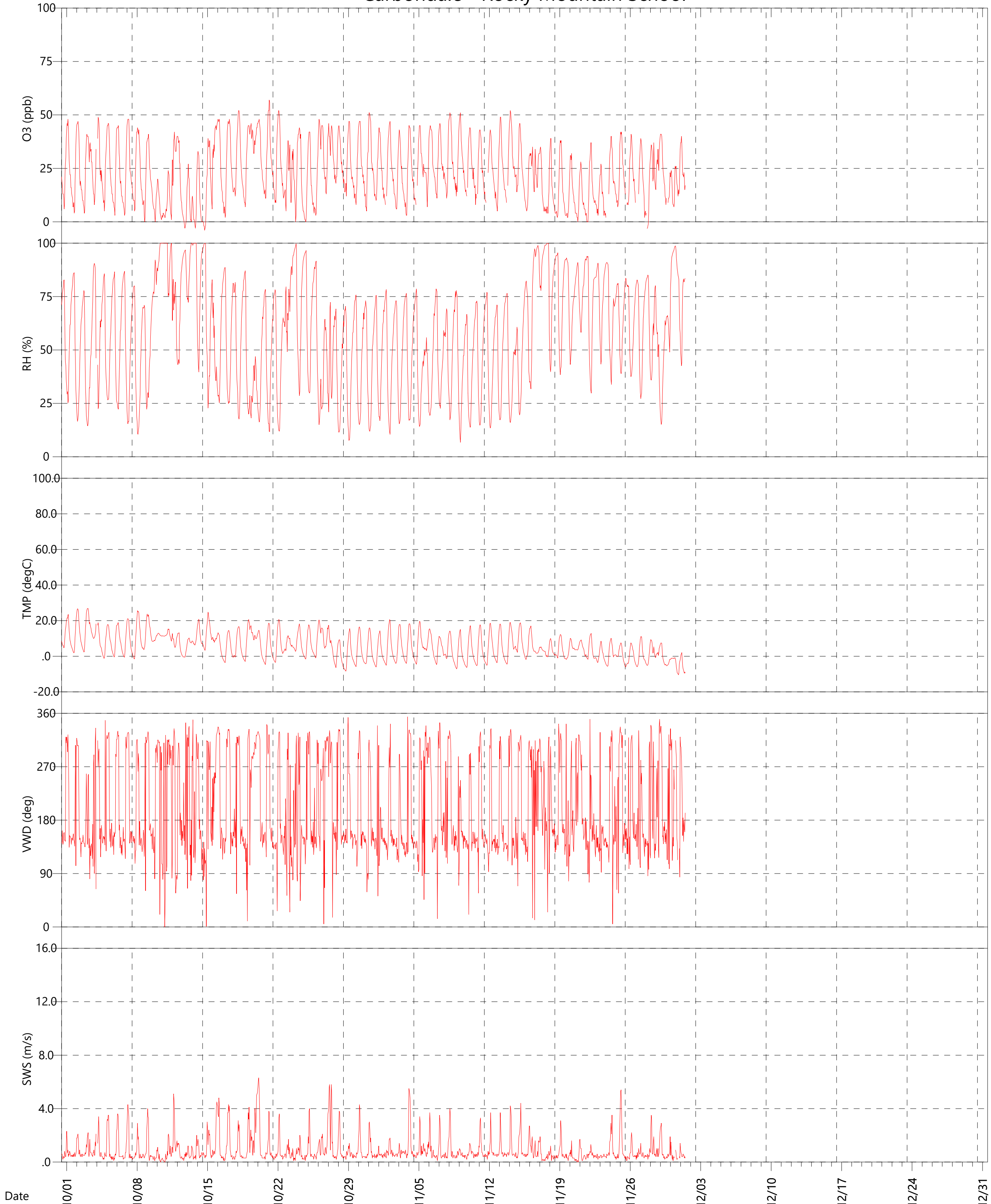


April - June 2025

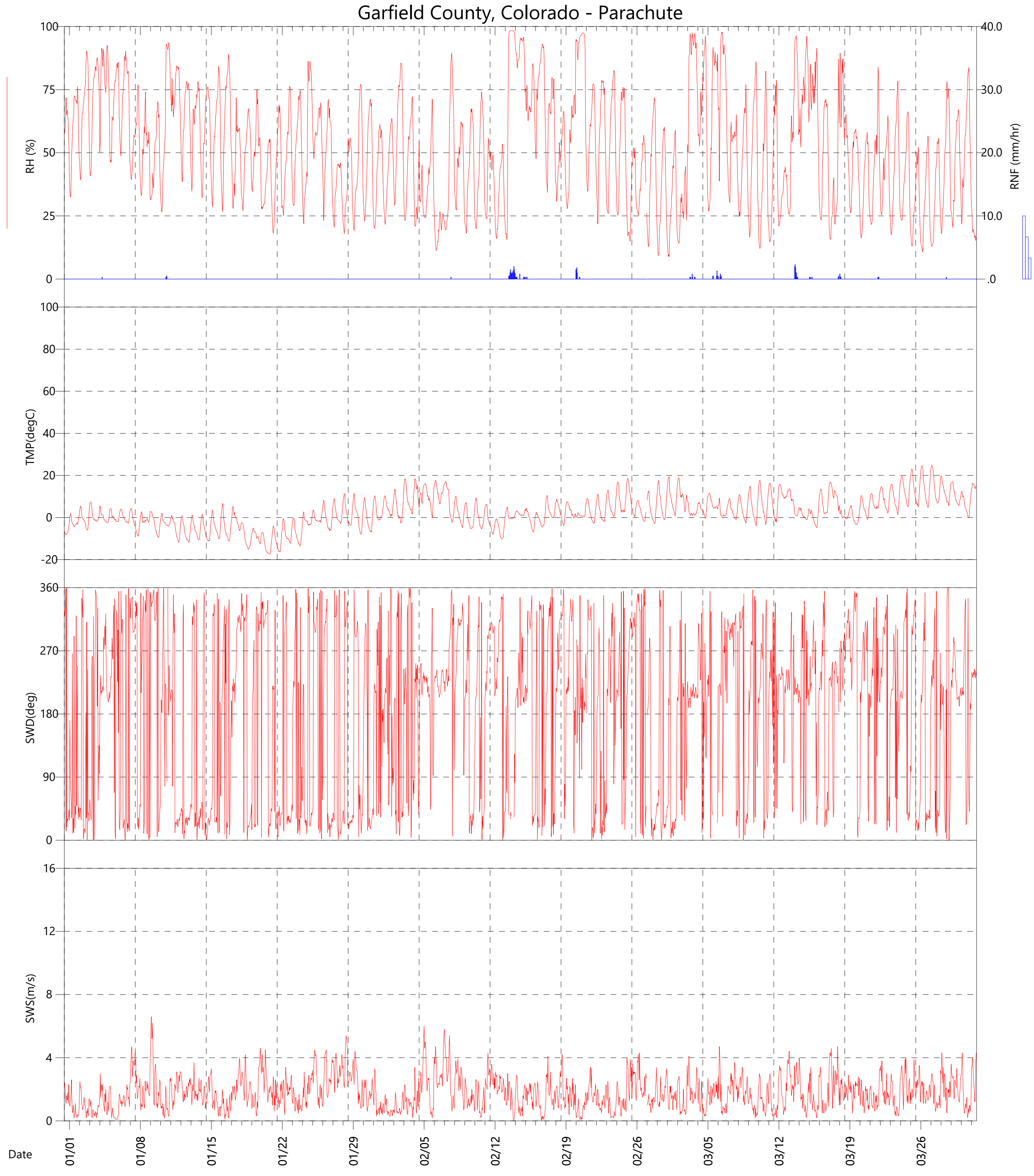


July - September 2025

Carbondale - Rocky Mountain School



October - December 2025



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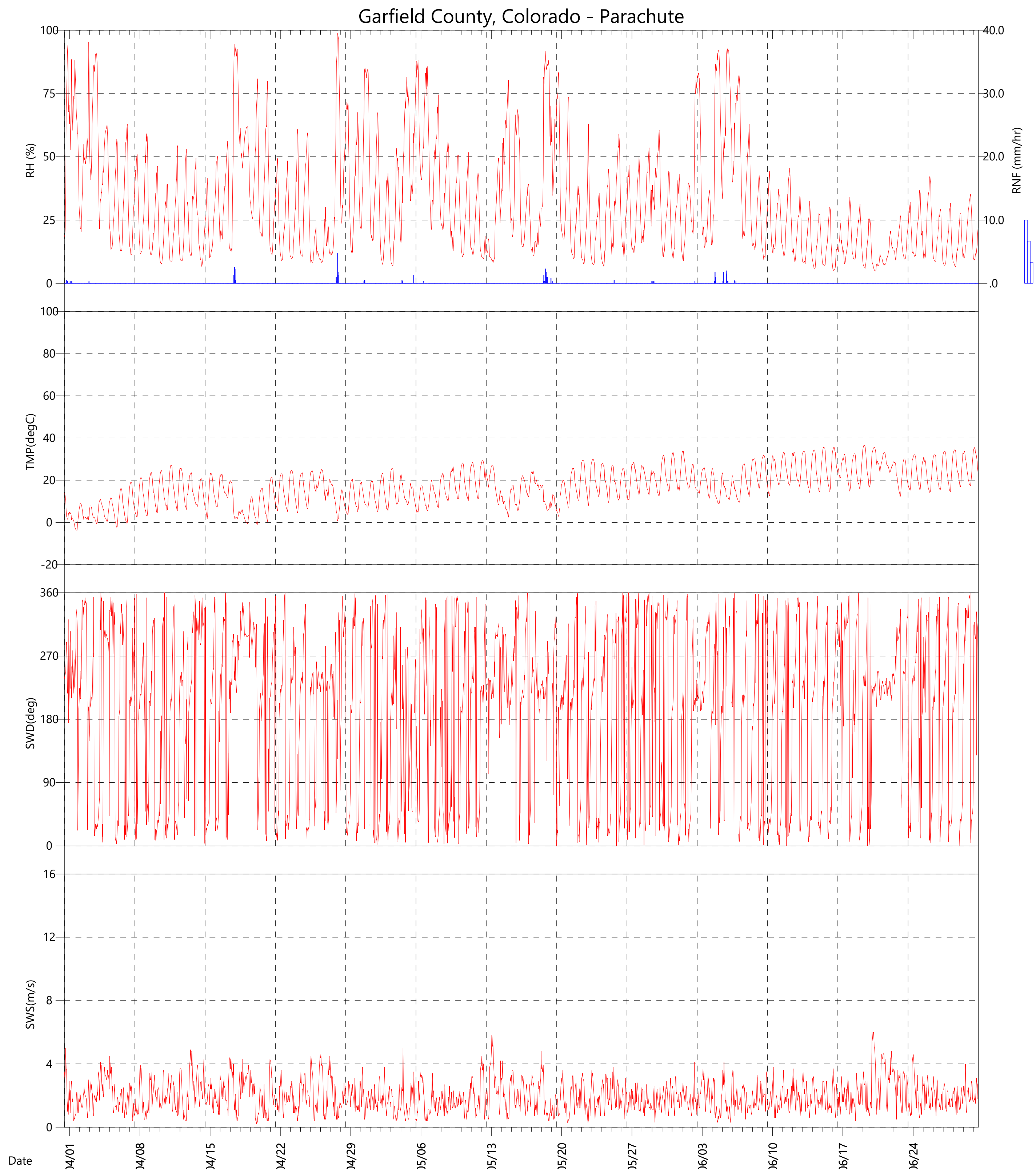
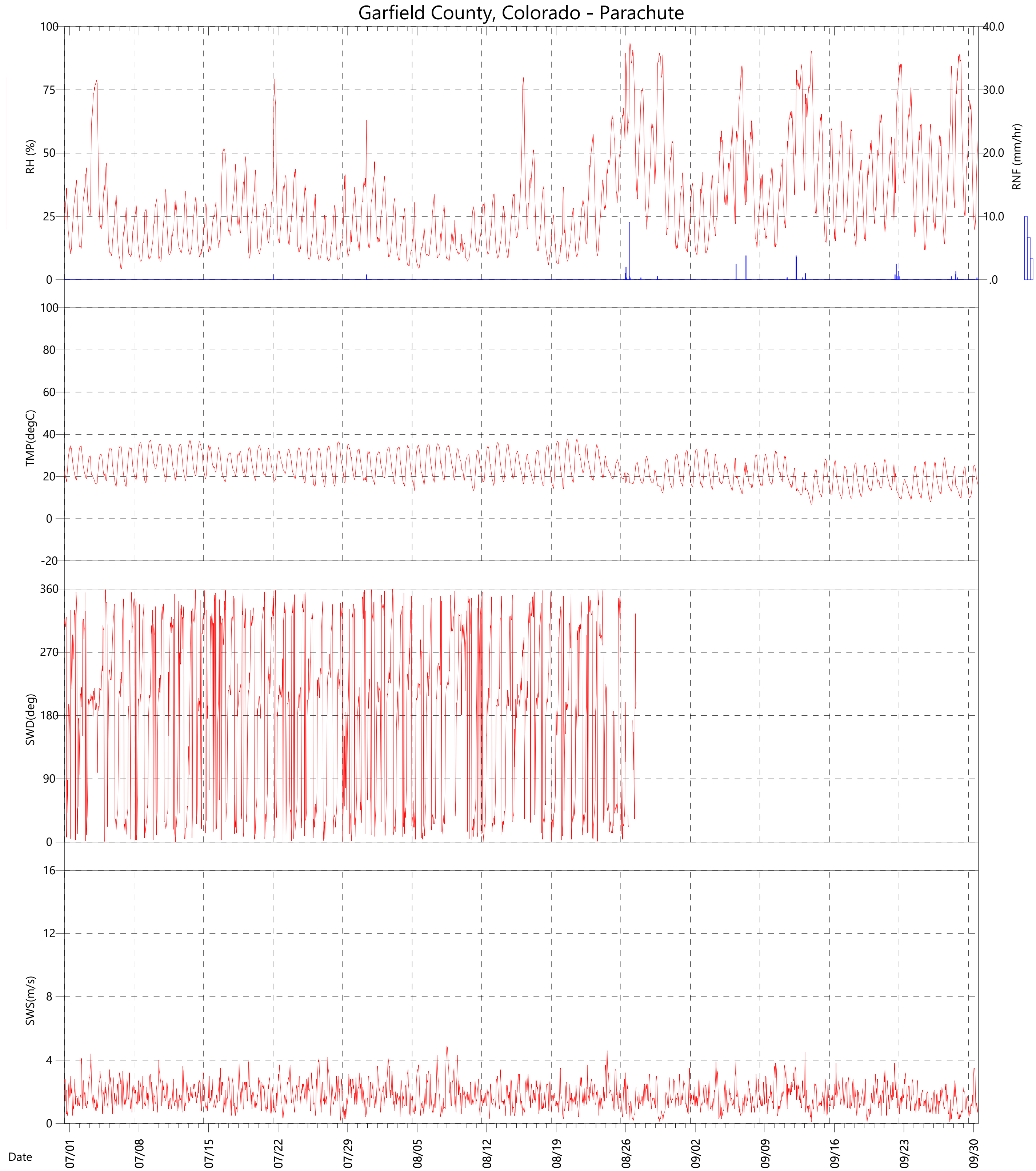


April - June 2025



July - September 2025

Garfield County, Colorado - Parachute

October - December 2025

Garfield County Rifle Sites

January - March 2025

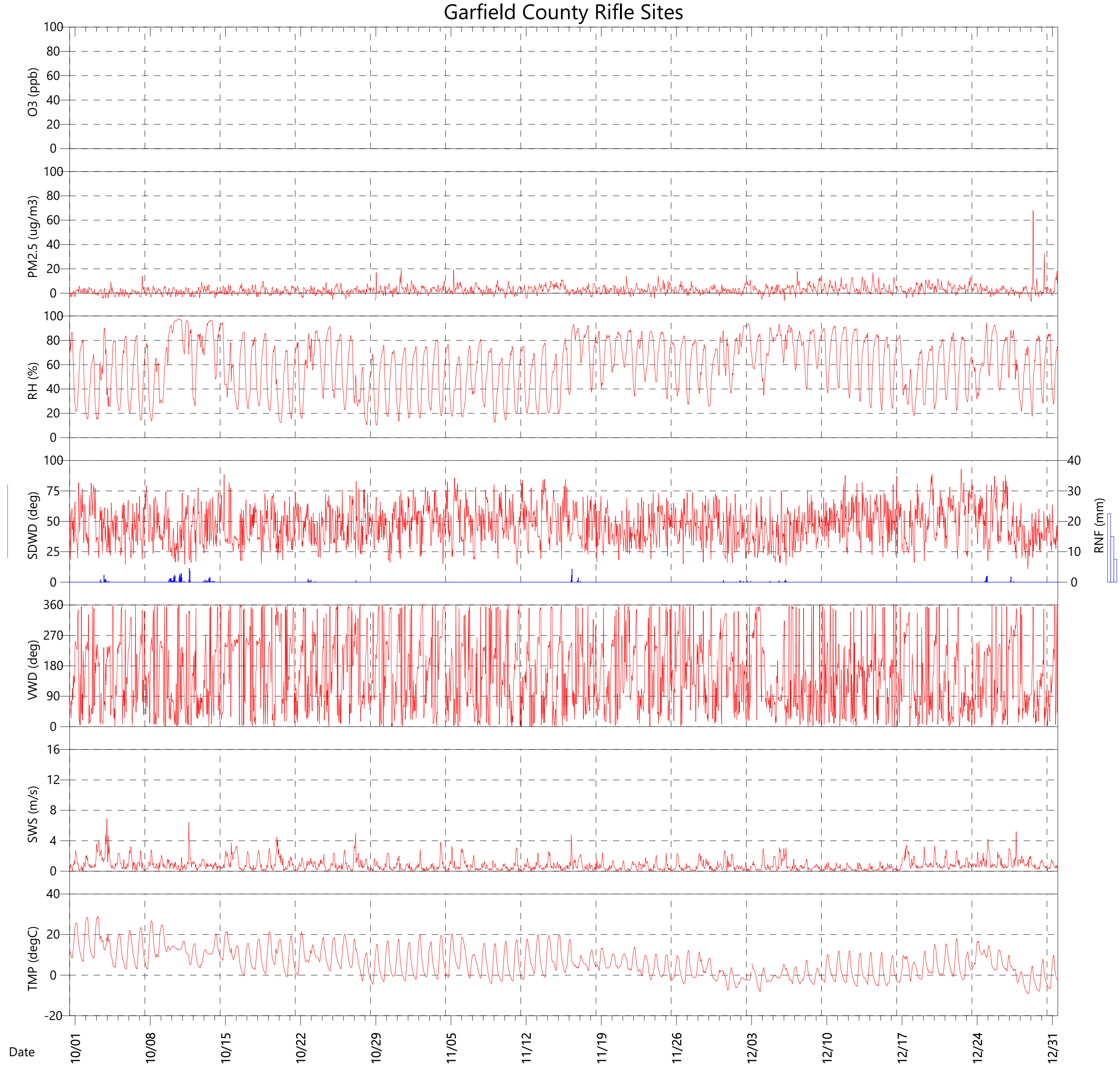
Garfield County Rifle Sites

April - June 2025

Garfield County Rifle Sites

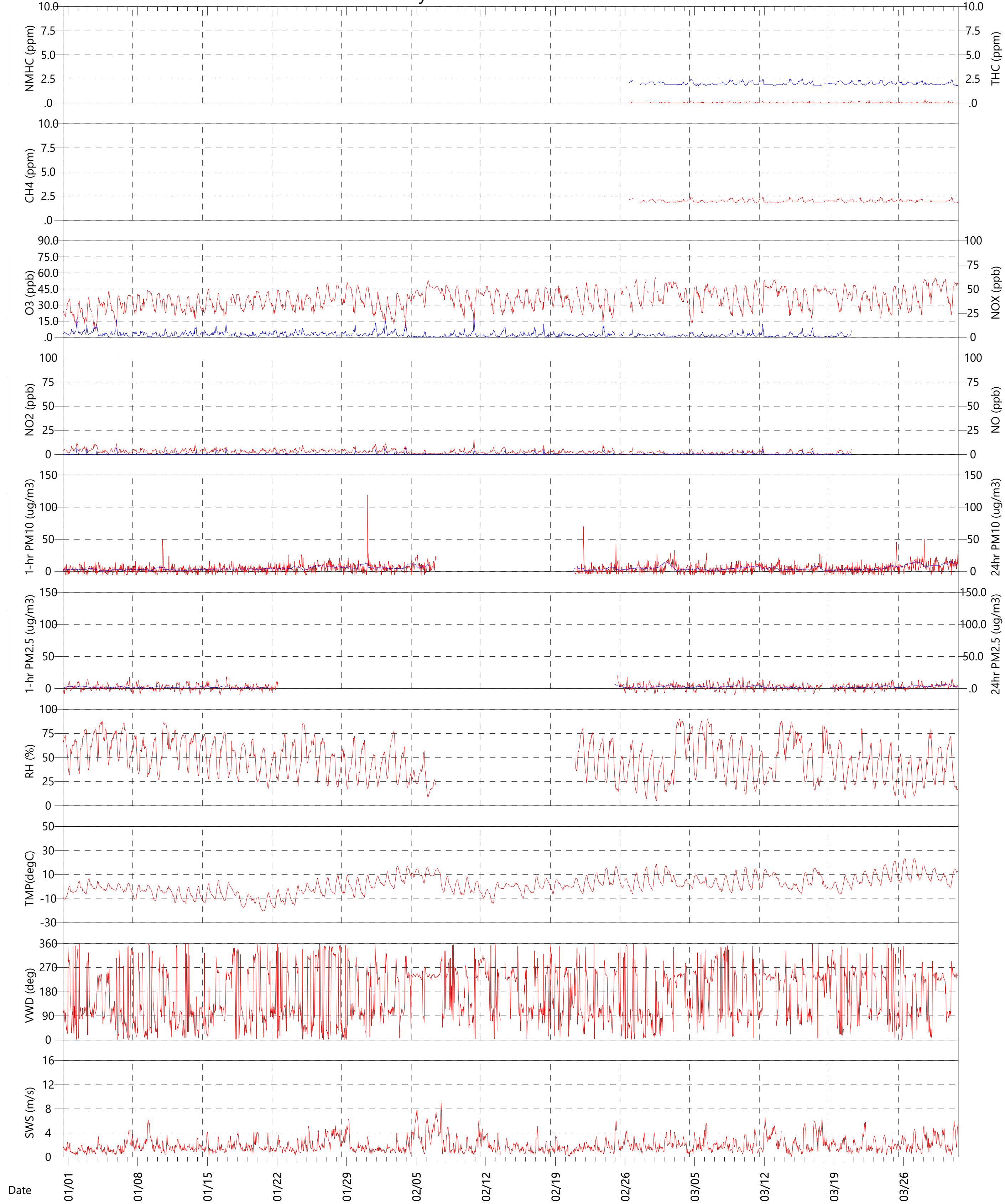
July - September 2025

Garfield County Rifle Sites



October - December 2025

Garfield County Mobile Monitor - Battlement Mesa

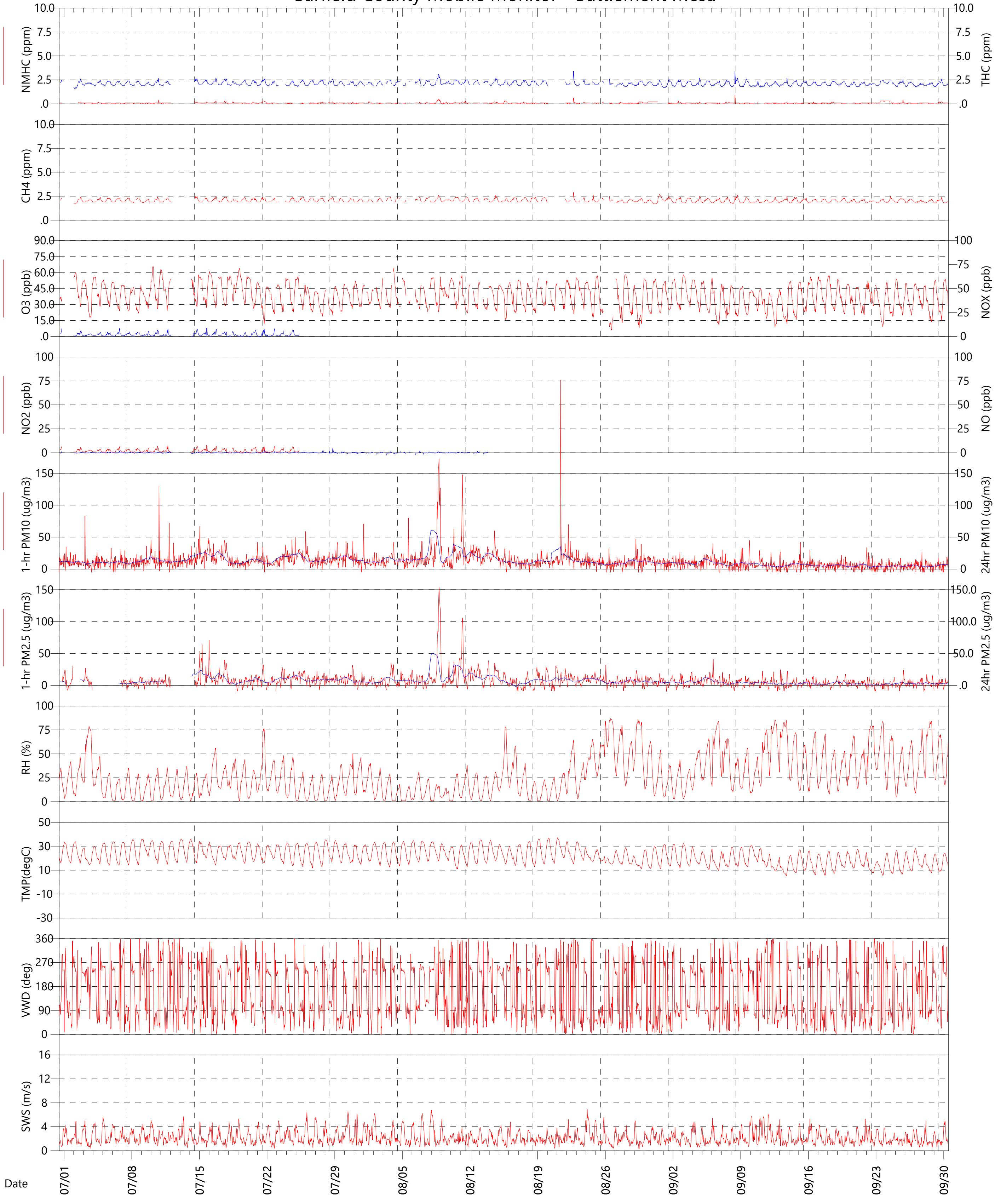


January - March 2025

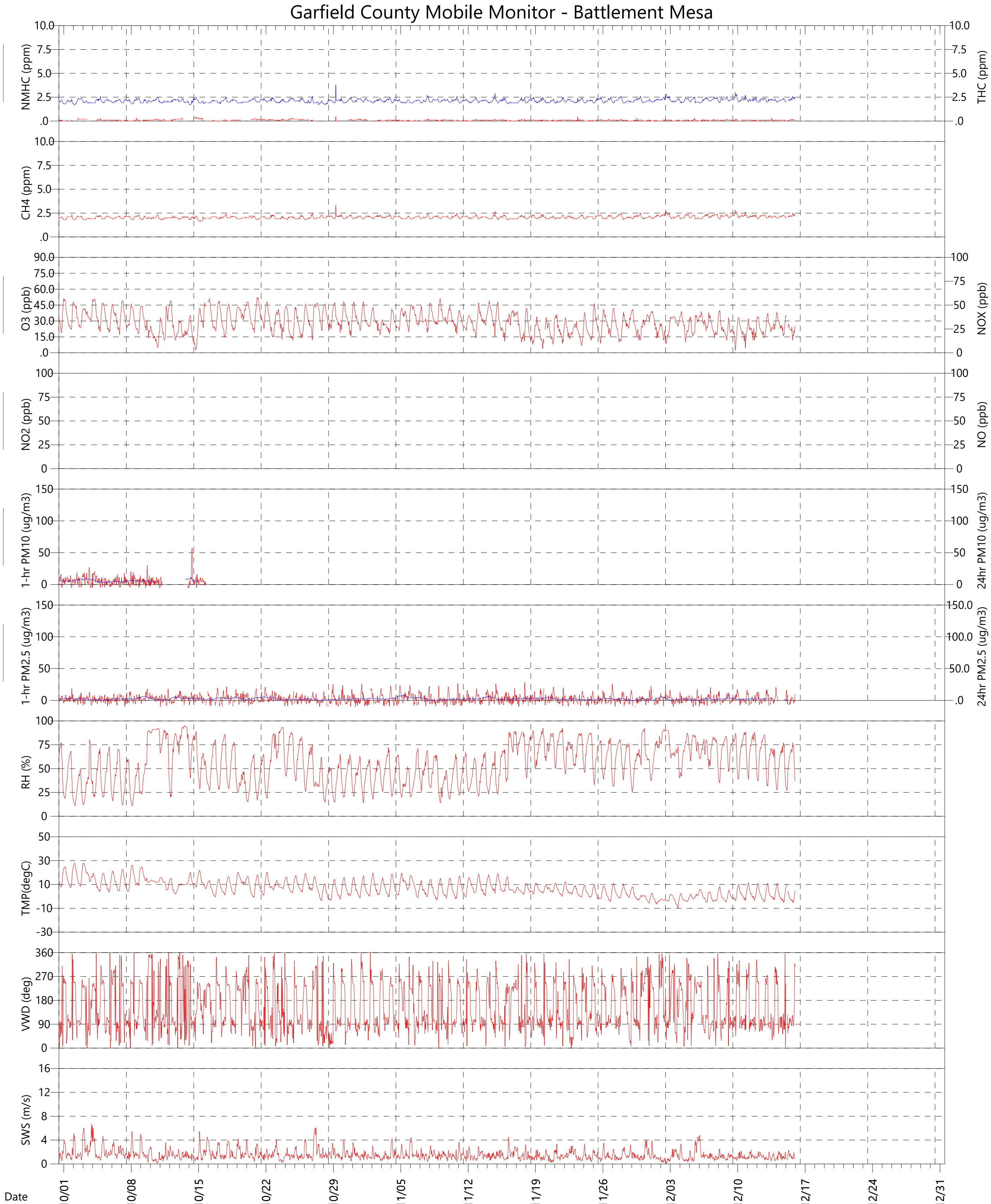
Garfield County Mobile Monitor - Battlement Mesa

April - June 2025

Garfield County Mobile Monitor - Battlement Mesa



July - September 2025



October - December 2025

APPENDIX B

SNMOC Concentrations

Garfield County SNMOC Monitoring
Battlement Mesa (BMCO)
1/1/2025 - 12/31/2025 (every sixth day)

		Sample Count		Concentration (ppbV)		
Detected Compound	**CAS Number**	**# Samples**	**# Detects**	**Minimum**	**Maximum**	**Average**
1,2,4-Trimethylbenzene	95-63-6	50	2	1.2	1.2	0.01
1,3-Butadiene	106-99-0	50	4	0.41	0.75	0.03
1,3-Diethylbenzene		50	1	0.65	0.65	
1-Pentene	109-67-1	50	6	0.75	4.9	0.05
2,3-Dimethylpentane	565-59-3	50	1	0.51	0.51	0.01
2,4-Dimethylpentane	108-08-7	50	1	0.45	0.45	0.01
3-Methylpentane	96-14-0	50	3	0.50	1.2	0.02
Acetylene	74-86-2	50	2	0.40	0.46	0.05
Alpha pinene		50	1	0.68	0.68	
Butane		50	38	0.45	4.5	
Cyclohexane	110-82-7	50	1	0.86	0.86	0.01
Ethane	74-84-0	50	50	1.7	9.4	3.60
Ethene		50	37	0.40	2.1	
Isobutane	75-28-5	50	33	0.43	4.8	0.16
Isobutylene	115-11-7	50	1	0.51	0.51	0.02
Isopentane	78-78-4	50	19	0.49	4.1	0.10
Isoprene	78-79-5	50	1	0.52	0.52	0.01
Isopropylbenzene	98-82-8	50	1	0.41	0.41	0.01
m-Ethyltoluene	620-14-4	50	1	2.4	2.4	0.01
n-Decane	124-18-5	50	1	0.83	0.83	0.01
n-Heptane	142-82-5	50	2	0.56	1.6	0.01
n-Hexane	110-54-3	50	2	0.64	1.7	0.02
n-Nonane	111-84-2	50	1	0.71	0.71	0.01
n-Octane	111-65-9	50	1	1.1	1.1	0.01
n-Pentane	109-66-0	50	18	0.43	2.9	0.06
Propane	74-98-6	50	50	0.46	8.3	0.79
Propylbenzene		50	1	1.6	1.6	
Propylene	115-07-1	50	2	0.66	0.70	0.03
p-Xylene	108-38-3	50	1	0.43	0.43	0.00
Styrene	100-42-5	50	4	0.65	1.7	0.02
Toluene	108-88-3	50	7	0.44	8.5	0.05
Total Non-Target VOCs as Propane		50	17	100	9.8	
trans-2-Butene	624-64-6	50	1	0.49	0.49	0.02
trans-2-Pentene	646-04-8	50	3	1.2	3.3	0.04