COLORADO

Air Pollution Control Division

Department of Public Health & Environment

Technical Services Program

# 2025 Ambient Air Monitoring Network Assessment

# COLORADO AMBIENT AIR MONITORING NETWORK ASSESSMENT

# 2025

Air Pollution Control Division
APCD-TS-B1
4300 Cherry Creek Drive South
Denver, Colorado
80246-1530
(303) 692-1530

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**GLOSSARY**

| | |
|---|---|
| AADT | Annual Average Daily Traffic |
| APCD | Air Pollution Control Division |
| AQS | Air Quality System (EPA database) |
| AQS ID | 9-digit site identification number used in the AQS database |
| ARS | Air Resources Specialists |
| BLM | Bureau of Land Management |
| CAA | Clean Air Act |
| CAMP | Continuous Air Monitoring Program |
| CAQCC | Air Quality Control Commission |
| CDOT | Colorado Department of Transportation |
| CDPHE | Colorado Department of Public Health and Environment |
| CFR | Code of Federal Regulations |
| CO | Carbon monoxide |
| CSA | Combined Statistical Area |
| DIC | Disproportionately Impacted Community |
| FEM | Federal Equivalent Method |
| FRAPPÉ | Front Range Air Pollution and Photochemistry Experiment |
| FRM | Federal Reference Method |
| GIS | Geographic Information System |
| HEEJ | Health Equity and Environmental Justice collaborative |
| LUR | Land-Use Regression |
| MSA | Metropolitan Statistical Area |
| NAAQS | National Ambient Air Quality Standards |
| NCore | National Core multi-pollutant monitoring stations |
| NO | Nitric oxide |
| $NO_2$ | Nitrogen dioxide |
| $NO_x$ | Reactive nitrogen oxides |
| $NO_y$ | Total reactive nitrogen |
| NOAA | National Oceanic and Atmospheric Administration |
| $O_3$ | Ozone |
| NPS | National Park Service |
| $PM_{2.5}$ | Particulate matter with an equivalent diameter less than or equal to 2.5 µm |
| $PM_{10}$ | Particulate matter with an equivalent diameter less than or equal to 10 µm |
| PMSA | Principal Metropolitan Statistical Area |
| PWEI | Population Weighted Emissions Index |
| QA/QC | Quality Assurance/Quality Control |
| RAQC | Regional Air Quality Council |
| SDoH | Social Determinants of Health index |
| SIP | State Implementation Plan |
| SLAMS | State or Local Air Monitoring Stations |
| $SO_2$ | Sulfur dioxide |
| SPM | Special Purpose Monitor |
| SUIT | Southern Ute Indian Tribe |
| TSP | Total Suspended Particulates |
| µg | Microgram ($10^{-6}$ grams) |
| US EPA | United States Environmental Protection Agency |
| USFS | United States Forest Service |
| VOC | Volatile Organic Compound |
| WLC | Weighted Linear Combination |

## EXECUTIVE SUMMARY

On October 17, 2006, the U.S. Environmental Protection Agency (EPA) amended its ambient air monitoring regulations to include a requirement that all state and local air quality monitoring agencies prepare a technical assessment of their monitoring networks once every five years. This document describes the Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division's (APCD) 2025 Ambient Air Monitoring Network Assessment.

### Purpose of the Assessment

The mission of the APCD is to provide our customers with excellent air quality management services that contribute to the protection of public health, the protection of ecosystems, and continual improvement of air quality related aesthetic values (e.g., visibility). The technical assessment presented here will provide decision-makers with the information needed to maximize the efficiency and effectiveness of Colorado's ambient air monitoring network. The assessment also ensures that APCD and its partners have the information needed to protect human health and the environment for current and future generations in Colorado.

As of May 1, 2025, APCD operated a network of 45 air pollution monitoring stations throughout Colorado. The data obtained from these monitors serves a variety of needs. The APCD has chosen the following eleven objectives as being those that most accurately define the overall purposes of the network:

1. To determine background concentrations,
2. To establish regulatory compliance,
3. To track pollutant concentration trends,
4. To assess population exposure,
5. To evaluate emissions reductions,
6. To evaluate the accuracy of model predictions,
7. To assist with forecasting,
8. To locate maximum pollutant concentrations,
9. To assure proper spatial coverage of regions,
10. To assist in source apportionment, and
11. To address environmental justice concerns.

### Assessment

To relate the value of its monitoring activities to its objectives and priorities, the APCD has evaluated the state network on a pollutant-by-pollutant basis to assess the relative value of each pollutant monitor and to identify areas where the inclusion of new monitoring sites would be most beneficial. This assessment was conducted in broad accordance with EPA guidance; however, the analyses and tools used here were assigned relative weights to reflect the unique objectives and priorities of the APCD within the context of the state of Colorado.

### Findings

Overall, the APCD monitoring network meets all federal requirements and adequately supports APCD monitoring objectives. However, while wholesale changes are not necessary at this time, several targeted modifications are recommended to improve the network's efficiency and effectiveness. These include de-emphasizing monitoring for pollutants with consistently low concentrations, reallocating resources to address emerging priorities (e.g., ozone and $PM_{2.5}$), and expanding monitoring coverage in underserved areas. Resources saved from site closures or network reductions should be reinvested to fill monitoring gaps and support higher-priority needs such as ozone precursor tracking and wildfire smoke impacts.

**Recommendations**

Sites recommended for closure:

1) Discontinue carbon monoxide monitoring (pending SIP expiration) at the Greeley, Fort Collins, and Colorado College (Colorado Springs) sites due to low concentration values and low relative values within the network.
2) Discontinue ozone monitoring in Cortez due to the low relative value of this site.

Recommended new sites/monitors:

1) Add $NO_2$ monitors at Mehaffey Park (Loveland), Fort Collins West, and Chatfield.
2) Consider the addition of a new $NO_2$ monitoring site east of I-25 (location to be determined).
3) Consider the addition of a new $NO_2$ monitoring site in Colorado Springs (location to be determined).
4) Consider the addition of a new $O_3$ monitors in Durango and San Luis.
5) Consider the addition of new particulate monitors in Edwards, Delta, Durango, and San Luis.

# 1 INTRODUCTION

The Air Pollution Control Division (APCD) of the Colorado Department of Public Health and Environment (CDPHE) has prepared the 2025 Ambient Air Monitoring Network Assessment as an examination and evaluation of the APCD's network of air pollution monitoring stations. The Network Assessment is an extension of the Network Plan, which is required to be submitted annually. The Network Assessment is required to be performed and submitted to the U.S. Environmental Protection Agency (EPA) every 5 years, with this fourth assessment due on July 1, 2025. The assessment must include specific analyses of the monitoring network, including: (1) a re-evaluation of the objectives and priorities for air monitoring, (2) an evaluation of the network's effectiveness and efficiency relative to its monitoring objectives, and (3) recommendations for network reconfigurations and improvements.

## 1.1 Background and Key Issues

The priorities and objectives of ambient air monitoring programs can change and evolve over time. Monitoring networks must therefore be re-evaluated and reconfigured on a periodic basis to ensure that objectives are obtained. Monitoring objectives may change for a number of different reasons, such as in response to changes in air quality. Air quality in the United States has improved dramatically since the adoption of the Clean Air Act and National Ambient Air Quality Standards (NAAQS).[1] For example, lead (Pb) concentrations in ambient air declined rapidly during the 1980s due to the phase-out of leaded gasoline (Eisenreich et al., 1986), and Pb monitoring activities were therefore deemphasized by the APCD and many other monitoring agencies. Changes in population and consumption patterns are another factor often motivating the re-evaluation of air monitoring programs. For instance, the U.S. population has become increasingly concentrated in suburban and exurban regions over the past 60 years, and rates of vehicle ownership and average distance driven have increased dramatically as the population has spread away from high-density urban centers (Kahn, 2000). This trend has resulted in the need for increased monitoring downwind of pollution sources due to enhanced production of photochemical smog in exurban and even rural environments (Sillman, 1999). Monitoring objectives may also change in response to the establishment of new air quality rules and regulations. Ambient air quality standards are periodically re-evaluated and reviewed by the EPA to ensure that they provide adequate health and environmental protection. This review process has often resulted in the establishment of new standards, including those that pertain to air toxics, fine particulate matter ($PM_{2.5}$), and regional haze. For example, the EPA revised the NAAQS for $PM_{2.5}$ on February 7, 2024, lowering the primary (health-based) annual $PM_{2.5}$ standard from 12.0 to 9.0 micrograms per cubic meter ($\mu g\ m^{-3}$) to enhance public health protection. Objectives can also change due to improvements in our understanding of air quality processes or enhanced monitoring capabilities. The basic understanding of air quality issues and air quality monitoring capabilities have both improved dramatically over the last five decades.

As a result of such changes, the APCD's air monitoring network may have unnecessary or redundant monitors. Alternatively, the network may be found to have inefficient network configurations for some pollutants, while other regions or pollutants may benefit from enhanced monitoring. This assessment will help the APCD to optimize its current network to help better protect today's population and environment, while maintaining the ability to understand long-term historical air quality trends.

[1] http://www.epa.gov/airtrends/

## 1.2 Study Objectives

The objectives of this network assessment are three-fold: (1) to determine whether the existing network is meeting its intended monitoring objectives, (2) to evaluate the network's adequacy for characterizing current air quality and impacts from future industrial and population growth, and (3) to identify potential areas where new monitors can be sited or existing monitors removed to support network optimization and/or to meet new monitoring goals. To meet these objectives, a suite of analyses were performed to address the following questions:

- How well does the existing monitoring network support current objectives? Which objectives are being met; which objectives are not being met? Are unmet objectives appropriate concerns for APCD? If so, what monitoring is necessary to meet those unaddressed objectives? What are potential future objectives for the monitoring network?
- Are the existing sites collectively capable of characterizing all criteria pollutants? Are the existing sites capable of characterizing criteria pollutant trends (spatially and temporally)? If not, what areas lack appropriate monitoring? If needed, where should new monitors be placed? Does the existing network support future emissions assessment, reconciliation, and modeling studies? Are there parameters at existing sites that need to be added to support these objectives?
- Is the current monitoring network sufficient to adequately assess regional air quality conditions with respect to all criteria pollutants? If not, where should monitors be relocated or added to improve the overall effectiveness of the monitoring network? How can the effectiveness of the monitoring network be maximized?

## 1.3 Guide to this Report

Section 1 resumes with an overview of the Colorado air monitoring network, including some general background on the geography of Colorado and the current state of air quality in the region, and ends with a general description of the assessment methodologies used in this report. Section 2 consists of a quantitative site-to-site comparison of the existing monitoring sites in the APCD network. In this section, a series of assessments are used to assign a relative score to each site to determine its comparative value within the network. Each assessment is assigned a weight and each site within the APCD monitoring network is then ranked by the weighted average of the analyses. Section 3 uses a Geographic Information System (GIS) driven suitability model to locate areas where the existing monitoring network does not adequately represent potential air pollution problems, and where additional sites are potentially needed. This evaluation has been conducted using a series of data maps representing a variety of indicators related to monitoring objectives. The maps are reclassified into a congruous ranking system and organized into three areas: source-oriented, population-oriented, and spatially-oriented. Each area and indicator is then assigned a weight and the spatial average of each weighted indicator is computed. This spatial average is then used to determine the optimal locations at which new monitors should be deployed. Section 4 provides recommendations based upon the evaluations described in the preceding sections. Recommendations concerning the addition of new sites or the relocation/discontinuation of existing sites reflect a variety of factors considered in the preceding evaluations, such as population density, pollution sources, monitoring history, compliance with air quality standards, and environmental justice concerns.

## 1.4 Overview of the Colorado Air Monitoring Network

The APCD currently operates monitors at 45 locations statewide. Ozone ($O_3$) and particulate matter (PM) monitors, including those for particulate matter < 10 µm in diameter ($PM_{10}$), and particulate matter < 2.5 µm in diameter ($PM_{2.5}$), are the most abundant and widespread. Currently, there are $PM_{10}$ monitors at 15 separate locations, $PM_{2.5}$ monitors at 25 locations, $O_3$ monitors at 24 locations, carbon monoxide (CO) monitors at five locations, nitrogen dioxide ($NO_2$) monitors at nine locations, and sulfur dioxide ($SO_2$) monitors at three locations. The APCD also operates 17 meteorological sites statewide.

Within the particulate sampling network, the APCD operates both continuous and filter-based sampling methods for $PM_{2.5}$ and $PM_{10}$. Continuous monitors sample without the need for subsequent filter retrieval and laboratory analysis, which is required for filter-based equipment. Thus, these monitors can continuously record concentrations and send the results back to APCD headquarters on a nearly instantaneous basis. Currently, twelve sites are equipped to measure continuous $PM_{10}$ and, of those twelve sites, one is located at a site that is also equipped with a filter-based $PM_{10}$ monitor. Of the 25 $PM_{2.5}$ monitoring sites, all 25 measure $PM_{2.5}$ on a continuous basis, with four of these sites also having filter-based samplers.

Thirty-two of the 45 current monitoring sites have been in operation for ten or more years, while 23 of these have been in operation for 20 or more years. Four monitoring sites have been in operation for more than 40 years. These sites are: Denver CAMP (59 years), Welby (51 years), Highland Reservoir (46 years), and Fort Collins - Mason (44 years).

Two of the ozone monitoring sites that are located on the Western Slope and have data included in this report are operated and maintained by a third-party contractor, Air Resource Specialists (ARS). These are the Rifle and Cortez ozone monitoring sites. ARS keeps these sites in proper working order and performs regular QC checks and data retrieval, while the APCD conducts the independent auditing of the sites for Quality Assurance (QA) purposes.

### 1.4.1 APCD Monitoring History

The State of Colorado has been monitoring air quality statewide since the mid-1960s when high volume and tape particulate samplers, dustfall buckets, and sulfation candles were the state of the art for defining the magnitude and extent of the very visible air pollution problem (Riehl and Crow, 1962). Monitoring for gaseous pollutants (CO, $SO_2$, $NO_2$, and $O_3$) began in 1965 when the federal government established the Continuous Air Monitoring Program (CAMP) station in downtown Denver at the intersection of 21$^{st}$ Street and Broadway, which was the area that was thought at the time to represent the best probability for detecting maximum levels of most of the pollutants of concern. Instruments were primitive by comparison with those of today and were frequently out of service.

Under provisions of the original Federal Clean Air Act of 1970, the Administrator of the U.S. EPA established National Ambient Air Quality Standards (NAAQS) designed to protect the public's health and welfare. Standards were set for TSP, CO, $SO_2$, $NO_2$, and $O_3$. In 1972, the first State Implementation Plan (SIP) was submitted to the EPA. It included an air quality surveillance system in accordance with EPA regulations of August 1971. That plan proposed a monitoring network of 100 monitors (particulate and gaseous) statewide. The system established as a result of that plan and subsequent modifications consisted of 106 monitors.

The 1977 Clean Air Act Amendments required States to submit revised SIPs to the EPA by January 1, 1979. The portion of the Colorado SIP pertaining to air monitoring was submitted separately on December 14, 1979, after a comprehensive review, and upon approval by the Colorado Air Quality Control Commission. The 1979 EPA requirements, as set forth in 40 CFR 58.20, have resulted in considerable modification to the network. These and subsequent modifications were made to ensure consistency and compliance with Federal monitoring requirements. Station location, probe siting, sampling methodology, quality assurance and quality control practices, and data handling procedures are all maintained throughout any changes made to the network.

### 1.4.2 Network Modification Procedures

The APCD develops changes to its monitoring network in several ways. New monitoring locations have been added as a result of community concerns about air quality, such as the $PM_{10}$ monitors in Cripple Creek and Hygiene established in 1998. Other monitors have been established in support of special studies, such as the $O_3$ monitoring sites in Aurora and Black Hawk.

Changes in property ownership represent the most common factor motivating network reconfigurations. The APCD owns neither the land nor the buildings where most of the monitors are located, and it is becoming increasingly difficult to get property owner's permission for use due to risk management issues. Other common reasons for relocating or removing monitors from the network are that either the land or building is modified in such a way that the site no longer meets current EPA siting criteria, or the area surrounding the monitor is being modified in a way that necessitates a change in the monitoring location. The most current examples of this are the removal of the Auraria meteorological monitoring station and the relocation of the NCore Denver Municipal Animal Shelter (DMAS) site. The Auraria station was removed due to the construction of a tall building in the immediate vicinity of the monitor that obstructed airflow around the monitoring site. The DMAS site was relocated due to a change in property ownership and land use. Monitors are also removed from the network after review of the data shows that pollutant levels have dropped to the point where it is no longer necessary to continue monitoring at a specific location.

Finally, all monitors are reviewed on a regular basis to determine if they are continuing to meet their monitoring objectives. If the population, land use, or vegetation around the monitor change undesirably over time, a more suitable location for the monitor is sought. An example of this is the $O_3$ monitor previously located at the Aspen Park monitoring site. It was shut down in 2019 and relocated to Black Hawk.

Detailed site descriptions of each monitoring location can be found in Table A.1 (Appendix A), which summarizes the locations and monitoring parameters of each site currently in operation, by county, alphabetically. The shaded lines in the table list the site AQS identification numbers, address, site start-up date, elevation, and longitude and latitude coordinates. Beneath each site description, the table lists each monitoring parameter in operation at that site, the orientation and spatial scale, which national monitoring network it belongs to, the type of monitor in use, and the sampling frequency. The parameter date is the date when valid data were first collected.

### 1.4.3 Description of Monitoring Regions in Colorado

The state has been divided into eight multi-county areas that are generally based on topography and have similar airshed characteristics (see Section 1.4.4). These areas are the Central Mountains, Denver

Metro/North Front Range, Eastern High Plains, Pikes Peak, San Luis Valley, South Central, Southwestern, and Western Slope regions. Figure 1 shows the approximate boundaries of these regions.

### *1.4.3.1 Central Mountains*

The Central Mountains region consists of 12 counties in the central area of the state. The Continental Divide passes through much of this region. Mountains and mountain valleys are the dominant landscape features. Leadville, Steamboat Springs, Cañon City, Salida, Buena Vista, and Aspen represent the larger communities. The population of this region is 241,133, according to the 2019-2024 American Community Survey. Skiing, tourism, ranching, mining, and correctional facilities are the primary industries. Black Canyon of the Gunnison National Park is located in this region. All of the area complies with federal air quality standards.

The primary monitoring concern in this region is centered on particulate pollution from wood burning and road dust. Currently, there are three particulate monitoring sites operated by the APCD in the Central Mountains region. These sites are located in Steamboat, Aspen, and Canyon City. APCD does not currently operate any gaseous monitors in this region.

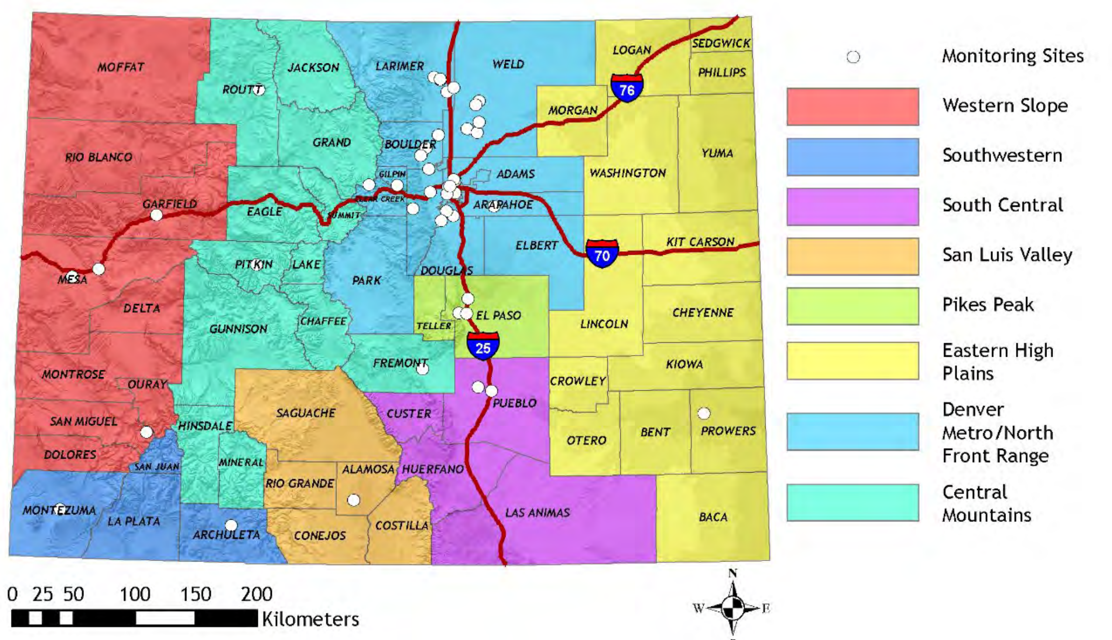


Figure 1. Counties and multi-county monitoring regions discussed in this report. Air quality monitoring sites measuring $O_3$, CO, $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ are symbolized with white circles.

### *1.4.3.2 Denver Metro/North Front Range*

The Denver-Metro/North Front Range region is comprised of 13 counties. It includes the largest population area of the state, with 3.0 million people living in the ten-county Denver-Aurora-Lakewood Metropolitan Statistical Area (MSA) and another 1.0 million living in the northern Front Range areas of Boulder, Larimer, and Weld counties. This area includes Rocky Mountain National Park and several other wilderness areas.

Since 2002, the region complies with all NAAQS, except for ozone. The area has been exceeding the EPA's current ozone standards since the early 2000s, and in 2007 was formally designated as a "nonattainment" area. This designation was re-affirmed in 2012 when the EPA designated the region as a "marginal" nonattainment area after a more stringent ozone standard was adopted in 2008. An even more stringent ozone standard was adopted in 2015.

In the past, the Denver-metropolitan area has violated health-based air quality standards for carbon monoxide and fine particles. In response, the Regional Air Quality Council (RAQC), the Colorado Air Quality Control Commission (CAQCC), and the APCD developed, adopted, and implemented air quality improvement plans to reduce each of these pollutants.

For the rest of the Northern Front Range, Fort Collins, Longmont, and Greeley were nonattainment areas for carbon monoxide in the 1980s and early 1990s but have met the federal standards since 1995. Air quality improvement plans have been implemented for each of these communities.

There are currently 69 air quality and meteorological monitors at 28 individual sites in the Denver-Metro/Northern Front Range Region. There are four CO monitors, 18 $O_3$ monitors, nine $NO_2$ monitors, three $SO_2$ monitors, as well as five $PM_{10}$ monitors, 15 $PM_{2.5}$ monitors, and 14 meteorological towers. There are also two air toxics monitoring sites, one located each in Commerce City and in Platteville. In addition, there is one site that measures visual range by use of a nephelometer and a transmissometer.

#### *1.4.3.3 Eastern High Plains*

The Eastern High Plains region encompasses the counties on the plains of eastern Colorado. The area is semiarid and often windy. The area's population is approximately 132,623 according to the 2019-2023 American Community Survey. Its major population centers have developed around farming, ranching, and trade centers such as Sterling, Fort Morgan, Limon, La Junta, and Lamar. The agricultural base includes both irrigated and dry land farming. All of the area complies with federal air quality standards.

Historically, there have been a number of communities that were monitored for particulates and meteorology but not for any of the gaseous pollutants. In the northeast along the I-76 corridor, the communities of Sterling, Brush, and Fort Morgan have been monitored. Along the I-70 corridor, only the community of Limon has been monitored for particulates. Along the US-50/Arkansas River corridor, the Division has monitored for particulates in the communities of La Junta and Rocky Ford. These monitoring sites were all discontinued in the late 1970s and early 1990s after a review showed that the concentrations were well below the standard and trending downward.

For the Eastern High Plains region, there is currently one $PM_{10}$ and one $PM_{2.5}$ monitor located in Lamar. There are no gaseous pollutant or meteorological monitoring sites in this region.

#### *1.4.3.4 Pikes Peak*

The Pikes Peak region includes El Paso and Teller counties. The area has a population of approximately 760,782 according to the 2019-2023 American Community Survey. Eastern El Paso County is rural prairie, while the western part of the region is mountainous. The U.S. Government is the largest employer in the area, and major industries include Fort Carson and the U.S. Air Force Academy in Colorado Springs, both military installations. Aerospace and technology are also large employers in the area. All of the area is currently in compliance with federal air quality standards.

Currently, there are three gaseous pollutants monitors at three sites and one particulate monitoring site in the Pikes Peak Region. There is one CO monitor and two $O_3$ monitors, as well as one $PM_{10}$ and one $PM_{2.5}$ monitor in the region.

### *1.4.3.5 San Luis Valley*

Colorado's San Luis Valley region is in the south central portion of Colorado and is comprised of a broad alpine valley situated between the Sangre de Cristo Mountains on the northeast and the San Juan Mountains of the Continental Divide to the west. The valley is some 114 km wide and 196 km long, extending south into New Mexico. The average elevation is 2290 km. Principal towns include Alamosa, Monte Vista, and Del Norte. The population of this region is 45,527 according to the 2019-2024 American Community Survey. Agriculture and tourism are the primary industries. The valley is semiarid and croplands of potatoes, head lettuce, and barley are typically irrigated. The valley is home to Great Sand Dunes National Park. All of the area complies with federal air quality standards.

Currently, there is one $PM_{10}$ and one $PM_{2.5}$ monitor in Alamosa.

### *1.4.3.6 South Central*

The South Central region is comprised of Pueblo, Huerfano, Las Animas, and Custer counties. Its population is approximately 195,137 according to the 2019-2023 American Community Survey. Population centers include Pueblo, Trinidad, and Walsenburg. The region has rolling semiarid plains to the east and is mountainous to the west. All of the area complies with federal air quality standards.

In the past the APCD has conducted particulate monitoring in both Walsenburg and Trinidad, but that monitoring was discontinued in 1979 and 1985, respectively, due to low concentrations.

Currently, there is one gaseous and one particulate monitoring station in the South Central Region. There is one $O_3$ monitor, one $PM_{10}$ and one $PM_{2.5}$ monitor located in Pueblo. There is also a meteorological monitor located in Pueblo.

### *1.4.3.7 Southwest*

The Southwestern region includes the Four Corners area counties of Montezuma, La Plata, Archuleta, and San Juan. The population of this region is about 96,712, according to the 2019-2023 American Community Survey. The landscape includes mountains, plateaus, high valleys, and canyons. Durango and Cortez are the largest towns, while lands of the Southern Ute and Ute Mountain Ute tribes make up large parts of this region. The region is home to Mesa Verde National Park. Tourism and agriculture are the dominant industries, although the oil and gas industry is becoming increasingly important. All of the area complies with federal air quality standards.

Currently there is one gaseous and one particulate monitoring station in the region. There is one $O_3$ monitor located in Cortez and one $PM_{10}/PM_{2.5}$ monitor located in Pagosa Springs.

### *1.4.3.8 Western Slope*

The Western Slope region includes nine counties on the far western border of Colorado. A mix of mountains on the east, and mesas, plateaus, valleys, and canyons to the west form the landscape of this region. Grand Junction is the largest urban area, and other cities include Telluride, Montrose, Delta, Rifle, Glenwood Springs, Meeker, Rangely, and Craig. The population of this region is about 329,186, according to the 2019-2024 American Community Survey. Primary industries include ranching, agriculture, mining, energy development, and tourism. Dinosaur and Colorado National Monuments are located in this region.

The Western Slope, along with the central mountains, are projected to be the fastest growing areas of Colorado through 2025 with greater than two percent annual population increases, according to the Colorado Department of Local Affairs. All of the area complies with federal air quality standards.

Currently, there are two gaseous pollutant monitoring sites, one meteorological monitoring site, and two particulate monitoring sites in the Western Slope region. There are $O_3$ monitors located in Rifle and Palisade, a meteorological monitor in Grand Junction, and $PM_{10}$ monitors located in Telluride and Grand Junction.

### 1.4.4 Topography and Air Quality in Colorado

The "airshed" concept has been a useful tool in air quality management. Borrowed from the field of hydrology, the concept is based upon the assumption that topography separates regions of similar air quality and similar sources of air pollution. To the extent that air quality is affected by sources within an airshed, the airshed concept provides an easy way to identify the region of greatest impact associated with a source or group of sources

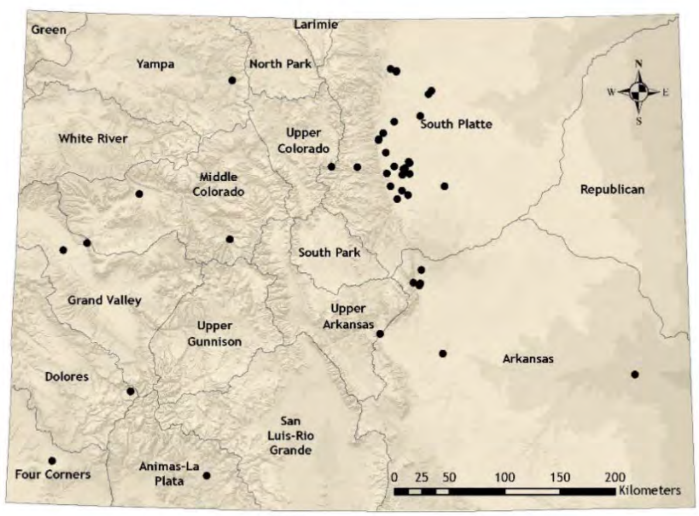


Figure 2. Shaded relief map showing the major airsheds of Colorado. CDPHE monitoring sites are symbolized by black circles.

The airshed concept is particularly relevant in mountainous areas and other regions of complex terrain (Greenland and Carleton, 1982). Daytime heating of elevated terrain creates localized low pressure that draws air up valleys and slopes toward ridge tops. This happens on both sides of an airshed boundary (ridge). In the absence of significant synoptic or regional-scale winds, flows diverge over ridge tops and return in an elevated "current" toward the center of the basin. This tends to isolate the daytime air in each basin. At night, radiational cooling creates slope flows that start at ridge tops (in the absence of synoptic-scale winds) and merge to form drainage flows in the valleys. These fill valleys with cooler air and form inversions that will tend to fill the entire depth of a mountain valley, regardless of the actual depth of the valley in question. Thus, to summarize, as long as larger-scale weather systems do not interfere, a mountain valley system tends to breathe, with thermally-driven upslope flows during the day and down-valley slope and drainage flows at night (Doran, 1996).

The APCD has delineated the major airsheds of Colorado through a detailed examination of wind profiler data and temperature measurements across the state. The Colorado airshed scheme is based on the basin-defining topography of the state and estimated scales of basin flows and dispersion when synoptic-scale winds are minimal. This scheme is shown in Figure 2.

The Colorado airshed scheme will be used in this report in support of certain analytical techniques where it is necessary to account for the presence of distinct meteo-geographical boundaries within the state. These analytical techniques are described in detail in subsequent sections.

### 1.4.5 State-Wide Population Statistics

Colorado population data is obtained from the 2020 U.S. Census and the 2019-2023 American Community Survey (ACS) and is summarized in Table 1. The 2020 column refers to the U.S. Census and the 2023 column refers to the ACS. The counties have been grouped by both MSA and state monitoring region, as defined above. A map of the ACS census tract-level population data is presented in Figure 3.

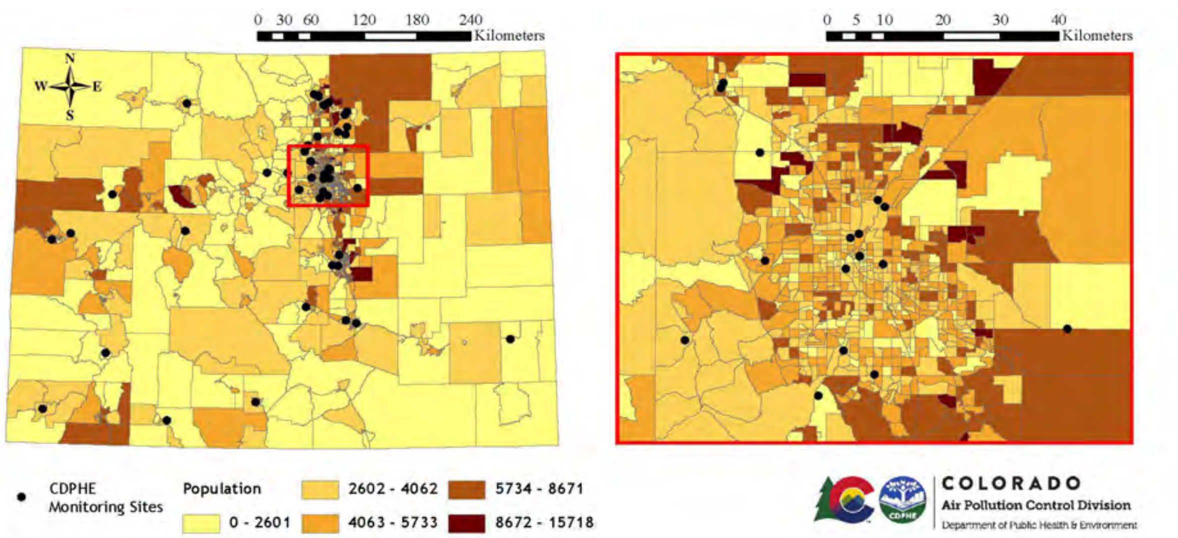


Figure 3. Population by census tract. CDPHE air quality monitoring sites are symbolized by black circles.

Table 1. Population data grouped by county, monitoring region, and Metropolitan Statistical Area (MSA).

| Region | MSA/County | Population 2020 (U.S. Census) | Population 2023 (ACS) | % Change 2020-2023 |
|---|---|---|---|---|
| **Central Mountains** | | **240,376** | **241,133** | **0.3%** |
| | Chaffee | 19,482 | 19,876 | 2.0% |
| | Eagle | 55,671 | 55,374 | -0.5% |
| | Fremont | 48,883 | 49,394 | 1.0% |
| | Grand | 15,749 | 15,794 | 0.3% |
| | Gunnison | 16,947 | 17,158 | 1.2% |
| | Hinsdale | 792 | 939 | 18.6% |
| | Jackson | 1,377 | 1,422 | 3.3% |
| | Lake | 7,412 | 7,411 | 0.0% |
| | Mineral | 871 | 799 | -8.3% |
| | Pitkin | 17,356 | 17,119 | -1.4% |
| | Routt | 24,836 | 24,990 | 0.6% |
| | Summit | 31,000 | 30,857 | -0.5% |
| **Denver Metro / North Front Range** | | **3,992,426** | **4,009,674** | **0.4%** |
| | ***BOULDER MSA (Boulder County)*** | ***330,944*** | ***328,317*** | ***-0.8%*** |
| | ***DENVER-AURORA-LAKEWOOD MSA*** | ***2,970,092*** | ***2,977,085*** | ***0.2%*** |
| | Adams | 520,465 | 524,408 | 0.8% |
| | Arapahoe | 655,260 | 655,709 | 0.1% |
| | Broomfield | 74,499 | 75,110 | 0.8% |
| | Clear Creek | 9,397 | 9,358 | -0.4% |
| | Denver | 717,597 | 713,734 | -0.5% |
| | Douglas | 360,300 | 368,283 | 2.2% |
| | Elbert | 26,222 | 27,152 | 3.5% |
| | Gilpin | 5,823 | 5,877 | 0.9% |
| | Jefferson | 583,111 | 579,715 | -0.6% |
| | Park | 17,418 | 17,739 | 1.8% |
| | ***FORT COLLINS MSA (Larimer County)*** | ***359,943*** | ***363,561*** | ***1.0%*** |
| | ***GREELEY MSA (Weld County)*** | ***331,447*** | ***340,711*** | ***2.8%*** |
| **Eastern High Plains** | | **133,238** | **132,623** | **-0.5%** |
| | Baca | 3,478 | 3,460 | -0.5% |
| | Bent | 5,475 | 5,524 | 0.9% |
| | Cheyenne | 1,745 | 1,732 | -0.7% |
| | Crowley | 5,690 | 5,734 | 0.8% |
| | Kiowa | 1,454 | 1,356 | -6.7% |
| | Kit Carson | 7,068 | 7,015 | -0.7% |
| | Lincoln | 5,662 | 5,561 | -1.8% |
| | Logan | 21,199 | 21,067 | -0.6% |
| | Morgan | 29,080 | 29,186 | 0.4% |
| | Otero | 18,669 | 18,460 | -1.1% |

Table 1. Population data grouped by county, monitoring region, and Metropolitan Statistical Area (MSA).

| Region | MSA/County | Population 2020 (U.S. Census) | Population 2023 (ACS) | % Change 2020-2023 |
|---|---|---|---|---|
| | Phillips | 4,523 | 4,491 | -0.7% |
| | Prowers | 12,013 | 11,931 | -0.7% |
| | Sedgwick | 2,391 | 2,346 | -1.9% |
| | Washington | 4,813 | 4,839 | 0.5% |
| | Yuma | 9,978 | 9,921 | -0.6% |
| **Pikes Peak** | | **757,151** | **760,782** | **0.5%** |
| | ***COLORADO SPRINGS MSA*** | ***757,151*** | ***760,782*** | ***0.5%*** |
| | El Paso | 732,405 | 736,008 | 0.5% |
| | Teller | 24,746 | 24,774 | 0.1% |
| **San Luis Valley** | | **45,256** | **45,527** | **0.6%** |
| | Alamosa | 16,372 | 16,515 | 0.9% |
| | Conejos | 7,455 | 7,536 | 1.1% |
| | Costilla | 3,503 | 3,571 | 1.9% |
| | Rio Grande | 11,536 | 11,394 | -1.2% |
| | Saguache | 6,390 | 6,511 | 1.9% |
| **South Central** | | **194,360** | **195,137** | **0.4%** |
| | Custer | 4,721 | 5,073 | 7.5% |
| | Huerfano | 6,832 | 6,946 | 1.7% |
| | Las Animas | 14,485 | 14,392 | -0.6% |
| | ***PUEBLO MSA (Pueblo County)*** | ***168,322*** | ***168,726*** | ***0.2%*** |
| **Southwest** | | **95,698** | **96,712** | **1.1%** |
| | Archuleta | 13,428 | 13,730 | 2.2% |
| | La Plata | 55,670 | 56,088 | 0.8% |
| | Montezuma | 25,889 | 26,204 | 1.2% |
| | San Juan | 711 | 690 | -3.0% |
| **Western Slope** | | **326,465** | **329,186** | **0.8%** |
| | Delta | 31,054 | 31,353 | 1.0% |
| | Dolores | 2,078 | 2,385 | 14.8% |
| | Garfield | 61,794 | 62,034 | 0.4% |
| | ***GRAND JUNCTION MSA (Mesa County)*** | 156,004 | 157,316 | 0.8% |
| | Moffat | 13,266 | 13,258 | -0.1% |
| | Montrose | 42,814 | 43,272 | 1.1% |
| | Ouray | 4,877 | 5,024 | 3.0% |
| | Rio Blanco | 6,522 | 6,518 | -0.1% |
| | San Miguel | 8,056 | 8,026 | -0.4% |

## 1.5 Assessment Methodology

### 1.5.1 Parameters Assessed

This Network Assessment will address the criteria pollutants monitored by APCD during the period 2020-2024: carbon monoxide (CO), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), ozone ($O_3$), and two size fractions of particulate matter, $PM_{10}$ (particles < 10 µm in diameter), $PM_{2.5}$ (particles < 2.5 µm in diameter), and lead (Pb).

#### *1.5.1.1 Carbon Monoxide (CO)*

CO is a colorless and odorless gas formed when carbon compounds in fuel undergo incomplete combustion. The majority of CO emissions to ambient air originate from mobile sources (i.e., transportation), particularly in urban areas, where as much as 85% of all CO emissions may come from automobile exhaust. CO can cause harmful health effects by reducing oxygen delivery to the body's organs and tissues. High concentrations of CO generally occur in areas with heavy traffic congestion. In Colorado, peak CO concentrations typically occur during the colder months of the year when CO automotive emissions are highest and nighttime temperature inversions are more frequent (Reddy et al., 1995).

The EPA first set air quality standards for CO in 1971. For protection of both public health and welfare, EPA set an 8-hour primary standard at 9 parts per million (ppm) and a 1-hour primary standard at 35 ppm. In a review of the standards completed in 1985, the EPA revoked the secondary standards (for public welfare) due to a lack of evidence of adverse effects on public welfare at or near ambient concentrations. The last review of the CO NAAQS was completed in 2011 and the EPA chose not to revise the standards at that time.

The five CO monitors currently operated by the APCD are associated both with State Maintenance Plan requirements and CFR requirements. However, the EPA has revised the minimum requirements for CO monitoring by requiring CO monitors to be sited near roads in certain urban areas. EPA has also specified that monitors required in CBSAs of 2.5 million or more persons are to be operational by January 1, 2015, and that monitors required in CBSAs of one million or more persons are required to be operational by January 1, 2017. A monitor has been collocated with the near roadway $NO_2$ site (I-25 Denver) to satisfy these requirements.

#### *1.5.1.2 Nitrogen Dioxide ($NO_2$)*

$NO_2$ is one of a group of highly reactive gases known as "oxides of nitrogen," or nitrogen oxides ($NO_x$). Other $NO_x$ species include nitric oxide (NO), nitrous acid ($HNO_2$), and nitric acid ($HNO_3$). The EPA's National Ambient Air Quality Standard uses $NO_2$ as the indicator for the larger group of nitrogen oxides. $NO_2$ 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 (Kampa and Castanas, 2008).

The EPA first set standards for $NO_2$ in 1971, setting both a primary standard (to protect health) and a secondary standard (to protect the public welfare) at 0.053 parts per million (53 ppb), averaged annually. The Agency has reviewed the standards twice since that time but chose not to revise the annual standards at the conclusion of each review. In January 2010, the EPA established an additional primary standard at

100 ppb, averaged over one hour. Together the primary standards protect public health, including the health of sensitive populations; i.e., people with asthma, children, and the elderly (Weinmayr et al., 2010).

The APCD has monitored $NO_2$ at ten locations in Colorado in the past. In 2025, the APCD will operate nine $NO_2$ monitors. The Denver CAMP monitor exceeded the $NO_2$ standard in 1977, though the Welby monitor has never exceeded the standard of 53 ppb as an annual average. $NO_2$ concentrations have exhibited a gradual decline over the past 20 years.

The EPA has established requirements for an $NO_2$ monitoring network that will include monitors at locations where maximum $NO_2$ concentrations are expected to occur, including within 50 meters of major roadways, as well as monitors sited to measure area-wide $NO_2$ concentrations that occur more broadly across communities. Per these requirements, at least one monitor must be located near a major road in any urban area with a population greater than or equal to 500,000 people. A second monitor is required near another major road in areas with either (1) population greater than or equal to 2.5 million people, or (2) one or more road segments with an annual average daily traffic (AADT) count greater than or equal to 250,000 vehicles. In addition to the near-roadway monitoring, there must be one monitoring station in each CBSA with a population of 1 million or more persons to monitor a location of expected highest $NO_2$ concentrations representing the neighborhood or larger spatial scales. The CAMP and Welby sites satisfy this requirement.

#### *1.5.1.3 Sulfur Dioxide ($SO_2$)*

Sulfur dioxide ($SO_2$) is one of a group of highly reactive gasses known as “oxides of sulfur,” or sulfur oxides ($SO_x$). The largest sources of $SO_2$ emissions are from fossil fuel combustion at power plants (73%) and other industrial facilities (20%). Smaller sources of $SO_2$ emissions include industrial processes such as extracting metal from ore, and the burning of high sulfur containing fuels by locomotives, large ships, and non-road equipment. $SO_2$ is linked with a number of adverse effects on the respiratory system (Kampa and Castanas, 2008; Ware et al., 1986). Furthermore, $SO_2$ dissolves in water and is oxidized to form sulfuric acid, which is a major contributor to acid rain, as well as fine sulfate particles in the $PM_{2.5}$ fraction, which degrade visibility and represent a human health hazard.

The EPA first promulgated standards for $SO_2$ in 1971, setting a 24-hour primary standard at 140 ppb and an annual average standard at 30 ppb (to protect health). A 3-hour average secondary standard at 500 ppb was also adopted to protect the public welfare. In 1996, the EPA reviewed the $SO_2$ NAAQS and chose not to revise the standards. However, in 2010, the EPA revised the primary $SO_2$ NAAQS by establishing a new 1-hour standard at a level of 75 parts per billion (ppb). The two existing primary standards were revoked because they were deemed inadequate to provide additional public health protection given a 1-hour standard at 75 ppb.

The APCD has monitored $SO_2$ at eight locations in Colorado in the past. Currently, there are three monitoring sites in operation. No area of the country has been found to be out of compliance with the current $SO_2$ standards.

#### *1.5.1.4 Ozone ($O_3$)*

$O_3$ is an atmospheric oxidant composed of three oxygen atoms. It is not usually emitted directly into the air, but at ground-level is formed via photochemical reactions among $NO_x$ and volatile organic compounds (VOCs) in the presence of sunlight (Monks, 2005). Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of $NO_x$ 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 (Kampa and Castanas, 2008; Lippmann, 1989). Urban areas generally experience the highest ozone concentrations, but even rural areas may be subject to increased ozone levels because air masses can carry ozone and its precursors hundreds of kilometers away from their original source regions (Holland et al., 1999; National Research Council, 1992).

Sunlight and warm weather facilitate the ozone formation process and lead to high concentrations. Ozone is therefore considered to be primarily a summertime pollutant. However, ozone can also be a wintertime pollutant in some areas. Emerging science has indicated that snow-covered oil and gas-producing basins in the western U.S. are subject to wintertime ozone concentrations well in excess of current air quality standards. High ozone concentrations in winter are thought to occur when stable atmospheric conditions allow for a build-up of precursor chemicals, and the reflectivity of the snow cover increases the rate of UV-driven reactions during the day. Ozone and its precursors are then effectively trapped under the inversion. The Upper Green River Basin in Wyoming has been studied to model such effects (Carter and Seinfeld, 2012). Exceptionally high ozone concentrations have also been measured in the Uintah basin in Utah under such conditions (Edwards et al., 2014). To ensure compliance with the 2008 and 2015 $O_3$ standards, the EPA has extended the $O_3$ monitoring requirements for Colorado by 5 months, essentially redefining Colorado's $O_3$ season as January through December.

In 1971, the EPA promulgated the first NAAQS for photochemical oxidants, setting a 1-hour primary standard at 80 pbb ($O_3$ is one of a number of chemicals that are common atmospheric oxidants). The level of the primary standard was then revised in 1979 from 80 ppb to 120 ppb and the chemical designation of the standard was changed from "photochemical oxidants" to "ozone." In 1993, the EPA reviewed the $O_3$ NAAQS and chose not to revise the standards. However, in 1997, the EPA promulgated a new level of the NAAQS for $O_3$ of 80 ppb as an annual fourth-highest daily maximum eight-hour concentration, averaged over three years. The $O_3$ NAAQS was then revised in 2008 when the EPA set an 8-hour standard of 75 ppb. This change had a significant impact on the number of $O_3$ monitors in Colorado that were in violation of the standard, with the APCD then operating 5 sites out of 19 that had three-year design values (2012 - 2014) in excess of the current eight-hour $O_3$ NAAQS standard of 75 ppb (only three of these sites had design values in excess of 80 ppb). On October 26, 2015, the EPA again revised the $O_3$ NAAQS standard from its current value of 75 ppb to a level of 70 ppb. During 2024, there were 19 sites that exceeded the NAAQS standard of 70 ppb.

The EPA's monitoring requirements for $O_3$ include placing certain numbers of monitors in areas with high populations. For example, in Metropolitan Statistical Areas (MSAs) with a population greater than ten million people, the EPA recommends the placement of at least four monitors in areas with design value concentrations that are greater than or equal to 85% of the $O_3$ standard. The largest MSA in Colorado is the Denver-Aurora-Lakewood MSA. This MSA includes the counties of Adams, Arapahoe, Broomfield, Denver, Douglas, Elbert, Gilpin, Jefferson, and Park, and has a population of approximately 3.0 million. Table 2 lists EPAs $O_3$ monitoring requirements.

Table 2. EPA's minimum ozone monitoring requirements.

| MSA population | Most recent 3-year design value concentrations ≥ 85% of any $O_3$ NAAQS | Most recent 3-year design value concentrations < 85% of any $O_3$ NAAQS |
|---|---|---|
| > 10 million | 4 | 2 |
| 4 - 10 million | 3 | 1 |
| 350,000 - 4 million | 2 | 1 |
| 50,000 - 350,000 | 1 | 0 |

### *1.5.1.5 Particulate Matter (PM)*

Atmospheric particulate matter (PM) is microscopic solid or liquid mass suspended in the air. PM can be made up of a number of different components, including acidic aerosols (i.e., nitrates and sulfates), organic carbon, metals, soil or dust particles, and allergens (such as fragments of pollen or mold spores). Some of these particles are carcinogenic and others have health effects due to their size, morphology, or composition.

Particle size is the factor most directly linked to the health impacts of atmospheric PM. Particles of less than 10 micrometers (µm) in diameter ($PM_{10}$) are inhalable and thus pose a health threat. Particles less than 2.5 µm in diameter ($PM_{2.5}$) can penetrate deeply into the alveoli, while the smallest particles, such as those less than 0.1 µm in diameter (ultrafine particles), can penetrate all the way into the bloodstream. Exposure to such particles can affect the lungs, the heart, and the cardiovascular system (Pope III and Dockery, 2006). Particles with diameters between 2.5 µm and 10 µm ($PM_{10-2.5}$) represent less of a health concern, although they can irritate the eyes, nose, and throat, and cause serious harm due to inflammation in the airways of people with respiratory diseases such as asthma, chronic obstructive pulmonary disease, and pneumonia (Weinmayr et al., 2010). Note that $PM_{10}$ encompasses all particles smaller than 10 microns, including the $PM_{2.5}$ and ultrafine fractions.

EPA first established standards for PM in 1971. The reference method specified for determining attainment of the original standards was the high-volume sampler, which collects PM up to a nominal size of 25 to 45 µm (referred to as total suspended particulates or TSP). The primary standards, as measured by the indicator TSP, were 260 µg $m^{-3}$ (as a 24-hour average) not to be exceeded more than once per year, and 75 µg $m^{-3}$ (as an annual geometric mean). In October 1979, the EPA announced the first periodic review of the air quality criteria and NAAQS for PM, and significant revisions to the original standards were promulgated in 1987. In that decision, the EPA changed the indicator for particles from TSP to $PM_{10}$. EPA also revised the level and form of the primary standards. The EPA promulgated significant revisions to the NAAQS again in 1997. In that decision, the EPA revised the PM NAAQS in several respects. While it was determined that the PM NAAQS should continue to focus on particles less than or equal to 10 µm in diameter (i.e., $PM_{10}$), the EPA also decided that the fine and coarse fractions of $PM_{10}$ should be considered separately. The Agency's decision to modify the standards was based on evidence that serious health effects were associated with short- and long-term exposure to fine particles in areas that met the existing $PM_{10}$ standards (Heal et al., 2012). The EPA added new standards, using $PM_{2.5}$ as the indicator for fine particles and using $PM_{10}$ as the indicator for the $PM_{10-2.5}$ fraction. The EPA established two new $PM_{2.5}$ standards: an annual standard of 15 µg $m^{-3}$, based on the 3-year average of annual arithmetic mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors, and a 24-hour standard of 65 µg $m^{-3}$, based on the 3-year average of the 98th percentile of 24-hour $PM_{2.5}$ concentrations at each population-oriented monitor within an area. These standards were modified again in 2006, 2012, and 2024. The current NAAQS for $PM_{10}$ is a primary 24-hour standard of 150 µg $m^{-3}$ not to be exceeded more than once per year on average over 3 years. There are currently three NAAQS for $PM_{2.5}$: (1) a primary annual standard of 9 µg $m^{-3}$, based on the 3-year average of annual arithmetic mean $PM_{2.5}$ concentrations, (2) a secondary annual standard of 15 µg $m^{-3}$, based on the 3-year average of annual arithmetic mean $PM_{2.5}$ concentrations, and (3) and a 24-hour standard of 35 µg $m^{-3}$, based on the 3-year average of the 98th percentile of 24-hour $PM_{2.5}$ concentrations.

*$PM_{10}$*

In 2025, the APCD will operate $PM_{10}$ monitors at 15 different locations. Three of these sites use manual filter-based $PM_{10}$ samplers and 12 are equipped with continuous (i.e., "hourly") monitors. There is one site with collocated filter-based samplers (La Casa).

*$PM_{2.5}$*

In 2025, the APCD will operate $PM_{2.5}$ monitors at 25 different locations. All of these sites are equipped with continuous (i.e., "hourly") monitors and four of these sites are collocated with filter-based samplers. Four of these sites began monitoring in January 2025 and, as such, do not yet have data available for comparison to other sites. Therefore, they are not explicitly evaluated in this report.

#### *1.5.1.6 Lead (Pb)*

Lead is a metal found naturally in the environment and in manufactured products. The major sources of lead in ambient air have historically been motor vehicles (such as cars and trucks) and industrial sources (such as lead smelters). Due to the phase out of leaded gasoline for automobiles, piston engine aircraft and metals processing are now the major sources of lead emissions in the air today. The highest levels of airborne lead are generally found near lead smelters and general aviation airports. Other stationary sources include waste incinerators, utilities, and lead-acid battery manufacturers. Exposure to lead occurs mainly through inhalation of air and ingestion of lead in food, water, soil, or dust. Exposure to lead is linked to neurological impairments such as seizures, intellectual disability, and behavioral disorders.

On October 15, 2008, EPA strengthened the National Ambient Air Quality Standards for lead. The level for the previous lead standard was 1.5 µg $m^{-3}$, not to be exceeded as an average for a calendar quarter, based on an indicator of lead in total suspended particulates (TSP). The new standard, measured in either TSP or low-volume $PM_{10}$ samples, has a level of 0.15 µg $m^{-3}$, not to be exceeded as an average for any rolling three-month period within three years. Monitoring for lead is required at non-airport sources which emit 0.50 or more tons per year and from each airport which emits 1.0 or more tons per year based on either the most recent National Emission Inventory or other scientifically justifiable methods and data.

The last lead-specific sampling in Colorado, at the La Casa NCore site, was discontinued on December 31, 2015 due to low concentrations and not being required. Lead monitoring was also performed at Centennial Airport in the past, but was discontinued due to low concentrations and due to lead emissions being below 1 ton per year. Lead does continue to be monitored as part of National Air Toxics Trends Stations project on $PM_{10}$ samplers in Grand Junction and via three $PM_{2.5}$ Speciation Trends Network sites.

### 1.5.2 Current State of Air Quality in Colorado

Table 3 summarizes the 2024 criteria pollutant design value data for all sites operated by the APCD. For the purposes of determining compliance with regulatory standards, three-year average design values are compared to the NAAQS value for many of the criteria pollutants evaluated here (see Table 19). Three-year average design values are presented in Section 2 of this report and are used in various analyses. The 2024 values are presented in Table 3 to provide a summary of the most recent data. Detailed site information is provided in subsequent sections of this Introduction and in Table A-1 of Appendix A.

Currently, all State and Local Air Monitoring Station (SLAMS) and Special Purpose Monitor (SPM) sites are in attainment for CO, $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$. During 2024, there were 20 $O_3$ monitoring sites in the APCD network that had three-year average fourth-highest daily maximum eight-hour concentrations in excess of the $O_3$ NAAQS.

Table 3. Summary of 2024 CO, $NO_2$, $SO_2$, $O_3$, $PM_{10}$, and $PM_{2.5}$ design values.

| AQS ID | Pollutant | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | CO (ppm) | | $NO_2$ (ppb) | | $SO_2$ (ppb) | $O_3$ (ppb) | $PM_{10}$ (µg $m^{-3}$) | $PM_{2.5}$ (µg $m^{-3}$) | |
| | 8-Hr | 1-Hr | Annual | 1-Hr | 1-Hr | 4th Max 8-Hr | 24-Hr | Annual | 24-Hr |
| 080010010 | | | | | | | 142 | 7.1 | 21.5 |
| 080013001 | | | 14.4 | 51.4 | 4.1 | 83 | 139 | 7.0 | 21.6 |
| 080030001 | | | | | | | 150 | 5.1 | 12.8 |
| 080050002 | | | | | | 73 | | | |
| 080050005 | | | | | | | | 5.4 | 17.5 |
| 080050006 | | | | | | 81 | | | |
| 080070001 | | | | | | | 76 | | |
| 080130003 | | | | | | | 92 | 7.0 | 24.4 |
| 080130014 | | | | | | 84 | | | |
| 080131001 | | | | | | | 72 | 4.8 | 17.2 |
| 080190006 | | | | | | 77 | | | |
| 080310002 | | | 13.6 | 57.0 | 4.9 | 79 | | 5.9 | 17.8 |
| 080310013 | | | | | | | | 6.0 | 18.5 |
| 080310026 | 1.8 | 2.0 | 14.6 | 50.0 | 5.2 | 84 | | 5.6 | 18.3 |
| 080310027 | 2.7 | 2.9 | 20.3 | 56.3 | | | | 7.8 | 21.2 |
| 080310028 | | | 23.3 | 59.6 | | | | 7.6 | 19.2 |
| 080350004 | | | | | | 88 | | 4.5 | 16.8 |
| 080410013 | | | | | | 78 | | | |
| 080410016 | | | | | | 82 | | | |
| 080410017 | 0.7 | 1.1 | | | | | | 5.7 | 16.5 |
| 080430003 | | | | | | | 72 | | |
| 080450012 | | | | | | 63 | | | |
| 080470003 | | | | | | 79 | | | |
| 080590006 | | | 2.5 | 17.6 | | 88 | | | |
| 080590011 | | | | | | 86 | | | |
| 080590014 | | | | | | 85 | | | |
| 080690009 | | | | | | | | 6.4 | 20.5 |
| 080690011 | | | | | | 83 | | | |
| 080690015 | | | 5.4 | 32.3 | | 84 | | | |
| 080690016 | | | 6.6 | 31.7 | | 78 | | 4.9 | 13.4 |
| 080691004 | 1.2 | 1.8 | | | | 82 | | | |
| 080770017 | | | | | | | | 4.9 | 14.1 |
| 080770018 | | | | | | | | | |
| 080770020 | | | | | | 67 | | | |
| 080830006 | | | | | | 65 | | | |
| 080970008 | | | | | | | 81 | 4.3 | 13 |
| 080990002 | | | | | | | 100 | 5.5 | 18.6 |
| 081010015 | | | | | | | 78 | 4.7 | 12.5 |
| 081010016 | | | | | | 76 | | | |
| 081070003 | | | | | | | 59 | | |
| 081130004 | | | | | | | 72 | | |
| 081230006 | | | | | | | | 6.8 | 20.6 |
| 081230008 | | | | | | | | 8.5 | 24.8 |
| 081230009 | 1.1 | 1.2 | | | | 81 | 142 | | |
| 081230015 | | | 6.3 | 36.0 | | 79 | 139 | | |

### 1.5.3 Technical Approach

A number of different quantitative indicators are used in this report to compare sites within the existing network and to identify areas where the inclusion of new monitoring sites would be most beneficial. The indicators were chosen to represent a number of variables relevant to air pollution: population density, traffic volume, stationary source density, modeled and measured concentrations, etc. However, each indicator is not necessarily of equal importance to the overall analysis, and the relative importance of each indicator should be expected to vary among pollutants. For example, while traffic volume and point source density (i.e., “source-oriented” indicators) may be good predictors of CO, $SO_2$, and $NO_2$ concentration, these indicators are less relevant for $O_3$, a secondary pollutant whose concentration is often reduced via $NO_x$ titration in areas immediately surrounding pollution sources. To reflect this variability among the factors addressed in the assessment, APCD has determined weights of relative importance to use when combining the individual indicators for each parameter assessed.

Decisions regarding the types of indicators used and their weights of relative importance were ultimately based on the purposes, objectives, and priorities of the APCD monitoring network as decided by technical experts and program managers at the APCD. Before beginning the network assessment, the objectives of the network were reviewed and prioritized. The APCD has chosen the following eleven objectives as being those that most accurately define the overall purposes of the network:

1. To determine background concentrations,
2. To establish regulatory compliance,
3. To track pollutant concentration trends,
4. To assess population exposure,
5. To evaluate emissions reductions,
6. To evaluate the accuracy of model predictions,
7. To assist with forecasting,
8. To locate maximum pollutant concentrations,
9. To assure proper spatial coverage of regions,
10. To assist in source apportionment, and
11. To address environmental justice concerns.

Each analytical technique used in the technical assessment was selected to support a specific objective of the overall network. This technical assessment consists of two phases: site-to-site comparisons and suitability modeling. These two assessment phases are briefly described below.

#### *1.5.3.1 Phase I: Site-to-Site Comparisons*

Site-by-site comparison analyses, described in detail in Section 2, assign a score to individual monitors according to a specific monitoring purpose. These analyses are good for assessing which monitors might be candidates for modification or removal.

Several steps are involved in a site-by-site analysis:

1. Determine which monitoring purposes are most important,
2. Assess the history of the monitor (including original purposes),
3. Select a list of site-by-site analysis indicators based on purposes and available resources,
4. Weight indicators based on the importance of their related purpose,
5. Score monitors for each indicator,
6. Sum scores and rank monitors, and
7. Examine lowest ranking monitors for possible resource reallocation.

The low-ranking monitors should be examined carefully on a case-by-case basis. There may be regulatory or historical reasons to retain a specific monitor. Also, the site could be made potentially more useful by monitoring a different pollutant or using a different technology.

Table 4 describes the site-to-site comparison analyses used in Section 2 of the assessment.

Table 4. Site-to-site comparison analyses used in this report.

| Analysis | Description | Objectives Assessed |
|---|---|---|
| Number of Parameters Monitored | Multiple pollution parameters monitored at a site make that site more cost-effective. This analysis is the primary indicator of economic value of a site. | Evaluate model predictions<br>Source apportionment |
| Trends Impact | This analysis ranks sites by the length of their continuous monitoring records. Monitors that have longer historical records are more valuable for tracking long-term trends. | Track concentration trends<br>Evaluate emissions trends |
| Measured Concentration | This analysis ranks sites by their design value. Sites measuring higher concentrations are more important from a regulatory perspective. | Locate max concentrations<br>Establish regulatory compliance |
| Deviation from the NAAQS | This analysis ranks sites by the difference between their design value and the NAAQS. Sites near the NAAQS are considered more important. Sites well above or below the NAAQS do not provide as much information in terms of regulatory compliance. | Establish regulatory compliance<br>Assist with forecasting |
| Monitor-to-Monitor Correlation | Measured concentrations at one monitor are compared to those measured at other monitors to determine if concentrations correlate temporally. Monitors with lower correlations have more unique value and are ranked higher. | Assure proper spatial coverage |
| Removal Bias | Measured values for each individual pollutant are interpolated across the entire study area. Sites are systematically removed and the interpolation is repeated. The difference between the measured concentration and the predicted concentration is the site's removal bias. The greater a site’s bias, the higher its ranking. | Assure proper spatial coverage<br>Evaluate model predictions |
| Area Served | Sites are ranked based on their spatial coverage. Sites serving larger areas are ranked higher. | Assure proper spatial coverage<br>Determine background |
| Population Served | Using the Area Served polygons, the number of people living within each polygon is calculated. Sites serving higher populations are ranked higher. | Assess population exposure |
| DIC Population Served | The raw Population Served is multiplied by the Disproportionately Impacted Community (DIC) percentile score. Sites serving higher DIC populations are ranked higher. | Assess population exposure<br>Environmental justice |
| Emissions Inventory | Total annual emissions are aggregated by site using the Area Served polygons. Sites with higher emissions are ranked higher. | Evaluate emissions reductions Locate maximum concentrations |
| Traffic Counts | Uses current Annual Average Daily Traffic (AADT) data from both highways and major roads within the study area. Area Served polygons are used to assign a traffic volume to each monitoring site. A second indicator of road density is also calculated for each polygon, and a weighted average is created. Sites with higher traffic counts are ranked higher. | Evaluate emissions reductions Locate maximum concentrations |

#### *1.5.3.2 Phase II: Suitability Modeling*

Suitability modeling, which is described in detail in Section 3, has been conducted to determine areas where the existing monitoring network does not adequately represent potential air pollution problems, and where additional sites are potentially needed. This is considered a “bottom-up” technique, as it examines directly the phenomena that are thought to cause high pollutant concentrations and/or population exposure, such as emissions (traffic and stationary) and population density. For example, emissions inventory data can be used to determine the areas of maximum expected concentrations of pollutants directly emitted (i.e., primary emissions). Emission inventory data are less useful to understand secondary pollutants formed in the atmosphere (i.e., $O_3$, $PM_{2.5}$). Suitability models are developed using a series of data maps representing a variety of indicators. The maps are reclassified into a congruous ranking system and organized into three purpose areas: source-oriented, population-oriented, and spatially-oriented. Each area and indicator is then assigned a weight, and the spatial average of each weighted indicator is computed. This spatial average is then used to determine the optimal locations at which new monitors should be deployed. In general, the results of these analyses indicate where monitors are best located based on specific objectives and expected pollutant behavior. However, the development of a useful suitability model relies on a thorough understanding of the phenomena that cause air quality problems, including the often complex source/sink relationships that determine pollutant concentrations in ambient air.

Table 5 describes the indicators used in the suitability model, the results of which are described in Section 3 of the assessment.

Table 5. Suitability model indicators used in this report.

| | Analysis | Description | Objectives Assessed |
|---|---|---|---|
| Source - Oriented | Emissions Inventory | Uses the point-source emissions inventory data from Section 2 to identify areas of the highest point source pollution that are least represented by existing monitors. | Evaluate emissions reductions<br>Locate maximum concentrations |
| | Traffic Counts | Uses traffic density and road density maps from Section 2 to identify areas of the highest traffic pollution that are least represented by existing monitors. | |
| Population-Oriented | Population Density | Uses population density maps from Section 2 to identify areas of high population density that are least represented by existing monitors. | Assess population exposure<br>Environmental justice |
| Spatially-Oriented | Distance from an Existing Monitor | Uses the ground distance between existing monitoring sites to identify areas of the state least represented by existing monitors. | Assure proper spatial coverage<br>Determine background |
| | Interpolation Map | Uses interpolation maps generated with monitoring data to identify areas of high pollutant concentration that are least represented by existing monitors. | Locate max concentrations<br>Establish regulatory compliance<br>Evaluate model predictions |

### 1.5.4 Data Sources

Raw air pollution data for all of the analyses were obtained from the EPA’s Air Quality System (AQS) database. Data were extracted for the five-year period 2020-2024. Yearly and five-year averages were derived from the raw data. Other summary statistics were calculated as needed, such as maximum values or the fourth-highest 8-hour $O_3$ concentration at a particular monitoring site. For the monitor-to-monitor correlation study, concentration data was averaged over 24-hour periods for all criteria pollutants. One advantage of averaging data at a single time resolution is that this technique normalizes data that has been collected at differing intervals; e.g., $PM_{10}$ concentrations that had been collected at 24-hour intervals vs. gaseous pollutant concentrations that are typically reported on an hourly basis.

Population data were obtained from the 2020 U.S. Census and the 2019-2023 American Community Survey (ACS).

Point source emissions data was obtained from the 2024 APCD facilities inventory, which lists reported emissions for over 29,000 permitted facilities within Colorado.

Road data and average annual daily traffic (AADT) counts were obtained from the Colorado Department of Transportation (CDOT). The most current available traffic count data from 2023 were used exclusively in this assessment.

### 1.5.5 Sites Considered in this Network Assessment

This network assessment takes into account all monitoring sites included in the AQS database and located within Colorado, including those sites operated by the U.S. Forest Service (USFS), the National Park Service (NPS), the Bureau of Land Management (BLM), the Southern Ute Indian Tribe (SUIT), the EPA, and the city of Aspen. Since most analytical assessments take into account the spatial location of existing monitoring sites, it is logical to include sites operated by other agencies, especially since data from these sites are available in the AQS database. Inclusion of these other sites also greatly increases the power of spatial interpolations, which play an important role in this assessment. However, only APCD sites are explicitly evaluated here. Three APCD-operated sites with data in the AQS database are not assessed in this report. These include the Grand Junction – Pitkin and DESCI sites, which do not monitor any criteria pollutants, and the Mines Peak site, which is not designated as a regulatory monitor.

Table 6 lists all of the APCD sites used in this assessment.

Table 6. APCD monitoring sites evaluated in this assessment. Asterisks denote $PM_{2.5}$ monitoring that was initiated in early 2025.

| AQS Site Number | Site Name | County | Parameters Monitored | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $O_3$ | CO | $NO_2$ | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | Met |
| 08-001-0010 | Birch Street | Adams | | | | | X | X | |
| 08-001-3001 | Welby | Adams | X | | X | X | X | X | X |
| 08-003-0001 | Alamosa - ASC | Alamosa | | | | | X | X | |
| 08-005-0002 | Highland Reservoir | Arapahoe | X | | | | | | X |
| 08-005-0005 | Arapaho Community College | Arapahoe | | | | | | X | |
| 08-005-0006 | Aurora – East | Arapahoe | X | | | | | | X |
| 08-007-0001 | Pagosa Springs School | Archuleta | | | | | X | X* | |
| 08-013-0003 | Longmont - Municipal Bldg. | Boulder | | | | | X | X | |
| 08-013-0014 | Boulder Reservoir | Boulder | X | | | | | | X |
| 08-013-1001 | Boulder – CU | Boulder | | | | | X | X | |
| 08-019-0006 | Mines Peak | Clear Creek | X | | | | | | |
| 08-031-0002 | CAMP | Denver | X | | X | X | | X | |
| 08-031-0013 | National Jewish Health (NJH) | Denver | | | | | | X | |
| 08-031-0026 | La Casa | Denver | X | X | X | X | X | X | X |
| 08-031-0027 | I-25 Denver | Denver | | X | X | | | X | X |
| 08-031-0028 | I-25 Globeville | Denver | | | X | | | X | X |
| 08-035-0004 | Chatfield State Park | Douglas | X | | | | | X | X |
| 08-041-0013 | U.S. Air Force Academy (USAFA) | El Paso | X | | | | | | |
| 08-041-0016 | Manitou Springs | El Paso | X | | | | | | |
| 08-041-0017 | Colorado College | El Paso | | X | | | X | X | |
| 08-043-0003 | Cañon City | Fremont | | | | | X | X* | |
| 08-045-0012 | Rifle – Health Dept. | Garfield | X | | | | | | |
| 08-047-0003 | Black Hawk | Gilpin | X | | | | | | |
| 08-059-0006 | Rocky Flats – N. | Jefferson | X | | X | | | | X |
| 08-059-0011 | NREL | Jefferson | X | | | | | | |
| 08-059-0014 | Evergreen | Jefferson | X | | | | | | X |
| 08-069-0009 | Fort Collins – CSU | Larimer | | | | | | X | |
| 08-069-0011 | Fort Collins – West | Larimer | X | | | | | | X |
| 08-069-0015 | Fossil Creek | Larimer | X | | X | | | | X |
| 08-069-0016 | Bethke | Larimer | X | | X | | | X | |
| 08-069-1004 | Fort Collins – Mason | Larimer | X | X | | | | | X |
| 08-077-0017 | Grand Junction (GJ) – Powell Bldg. | Mesa | | | | | X | X | |
| 08-077-0018 | Grand Junction (GJ) – Pitkin | Mesa | | | | | | | X |
| 08-077-0020 | Palisade - Water Treatment | Mesa | X | | | | | | X |
| 08-083-0006 | Cortez – Health Dept. | Montezuma | X | | | | | | |
| 08-097-0008 | Aspen | Pitkin | | | | | X | X | |
| 08-099-0002 | Lamar - Municipal Bldg. | Prowers | | | | | X | X | |
| 08-101-0015 | Pueblo – Fountain School | Pueblo | | | | | X | X | |
| 08-101-0016 | Pueblo West | Pueblo | X | | | | | | X |
| 08-107-0003 | Steamboat Springs | Routt | | | | | X | X* | |
| 08-113-0004 | Telluride | San Miguel | | | | | X | X* | |
| 08-123-0006 | Greeley – Hospital | Weld | | | | | | X | |
| 08-123-0008 | Platteville – Middle School | Weld | | | | | | X | |
| 08-123-0009 | Greeley – County Tower | Weld | X | X | | | | | X |
| 08-123-0015 | La Salle | Weld | X | | X | | | | |

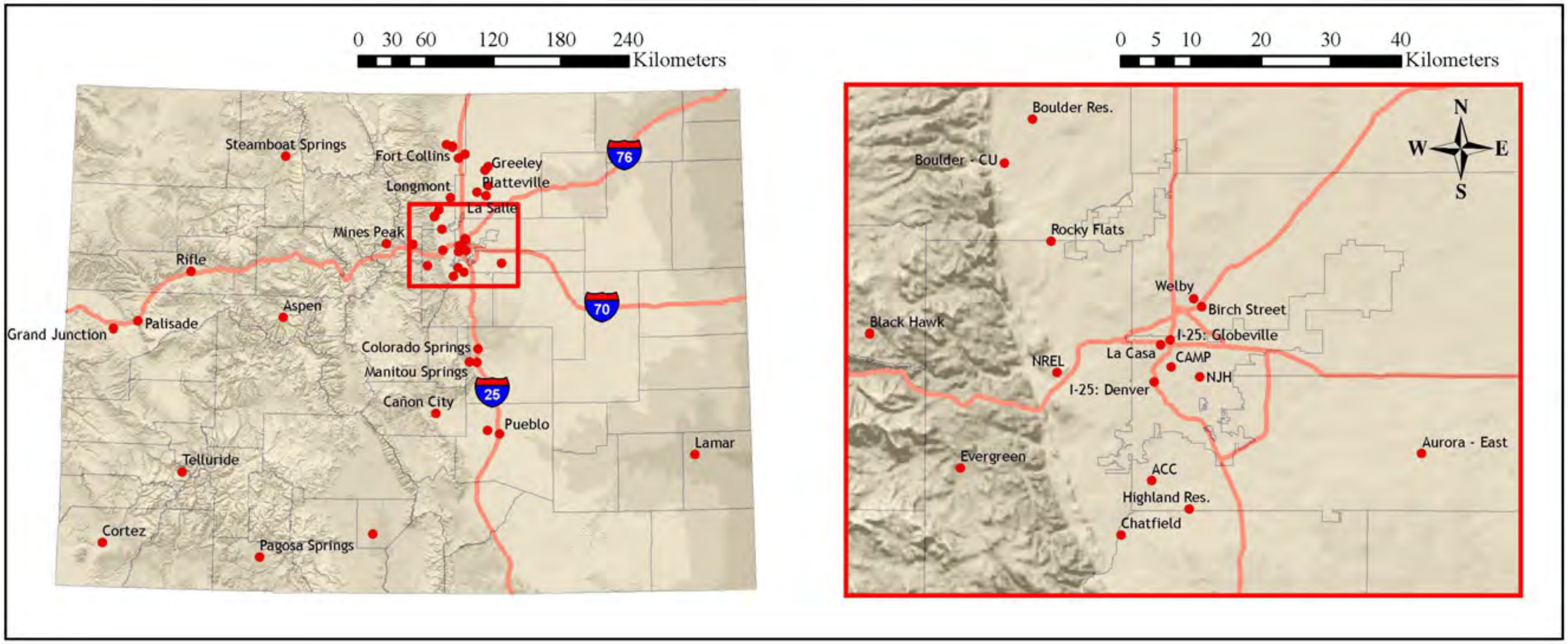


Figure 4. Map of Colorado with an inset map of the Denver metropolitan area showing the location of all monitoring sites operated by the APCD and listed in Table 6. Note that the Mines Peak site is shown on the map, although it has not been assessed in this report on account of its unique monitoring objectives. For the purpose of improving the readability of the map, labels for monitoring sites in Fort Collins, Grand Junction, and Colorado Springs have been combined under a single label. Detailed site information, including AQS identification numbers, site descriptions and histories, addresses and coordinates, monitoring start dates, site elevations, site orientation/scale designations, etc., can be found in Appendix A of this document.

# 2 SITE-TO-SITE COMPARISONS

In this section, the existing APCD monitoring network is assessed in a series of quantitative site-to-site comparison analyses. Each analysis assigns a score to individual monitors within each network based on a particular indicator (see Table 4). Each indicator is assigned a weight that reflects its overall importance relative to APCD's monitoring objectives and each monitor within each APCD monitoring network is then ranked by the weighted average of the analyses. These rankings are then used for subsequent analyses, including assessing which sites may no longer be needed and can be terminated. Indicators have been chosen to represent a number of different variables; e.g., economic cost-effectiveness, proximity to population and pollution sources, measured and modeled pollutant concentrations, etc. The objective of using many different, often competing, indicators is to provide a comprehensive evaluation technique that attempts to address all of the APCD's monitoring objectives, which are themselves often conflicting; e.g., the assessment of population exposure in areas of maximum pollutant concentrations and the determination of background concentrations are fundamentally different objectives requiring separate monitoring strategies. Weighting factors are used to emphasize indicators of particular relevance within each of the APCDs pollutant monitoring networks.

## 2.1 Number of Parameters Monitored

This analysis was performed by simply counting the number of parameters measured at each monitoring site. Sites having the most parameters measured were ranked highest and sites with the same number of parameters measured were ranked equally. The scores were determined using a linear conversion in which the site with the fewest measured parameters was assigned a score of one and the site with the most measured parameters was assigned a maximum score equal to the number of sites in the network (e.g., five for the CO monitoring network).

While criteria pollutants are the primary focus of this analysis, wind speed/direction and temperature difference parameters were also considered, as these data are valuable for forecasting and modeling purposes and thus are entered into the AQS database. Note that many APCD sites also record measurements of other non-criteria pollutants and meteorological parameters such as temperature, barometric pressure, and relative humidity, which have not been considered in this analysis.

By emphasizing the intensity and complementarity of monitoring activities at a given location over the spatial distribution of all monitoring activities, this analysis addresses two of the APCD's monitoring network purposes: model evaluation and source apportionment. Furthermore, sites with collocated measurements of several pollutants are more cost-effective to maintain compared to sites measuring only one or two parameters, making this a good method for assessing a site's relative economic value. The main advantages of this method include its simplicity to perform and its applicability to all pollutant parameters. A disadvantage of the method is that it does not differentiate between different pollutant types and the relative importance of each. For example, it gives the same weight to an $O_3$ monitor as to a CO monitor, even though $O_3$ is of much more regulatory concern within the state of Colorado.

### 2.1.1 Results for All Parameters

Tables 7-12 list each APCD monitoring site in the CO, $NO_2$, $SO_2$, $O_3$, $PM_{10}$, and $PM_{2.5}$ ambient networks, respectively, along with the total number of parameters monitored at each site and the score associated with each site.

Table 7. All APCD CO monitoring sites ranked by total number of parameters monitored.

| Site Name | AQS Number | Total Number of Parameters Monitored | Rank | Score |
|---|---|---|---|---|
| La Casa | 08-031-0026 | 7 | 1 | 5.0 |
| I-25: Denver | 08-031-0027 | 4 | 2 | 2.0 |
| Fort Collins - Mason | 08-069-1004 | 3 | 3 | 1.0 |
| Colorado College | 08-041-0017 | 3 | 3 | 1.0 |
| Greeley - County Tower | 08-123-0009 | 3 | 3 | 1.0 |

Table 8. All APCD $NO_2$ monitoring sites ranked by total number of parameters monitored.

| Site Name | AQS Number | Total Number of Parameters Monitored | Rank | Score |
|---|---|---|---|---|
| La Casa | 08-031-0026 | 7 | 1 | 9.0 |
| Welby | 08-001-3001 | 6 | 2 | 7.4 |
| CAMP | 08-031-0002 | 5 | 3 | 5.8 |
| I-25: Denver | 08-031-0027 | 4 | 4 | 4.2 |
| I-25: Globeville | 08-031-0028 | 3 | 5 | 2.6 |
| Rocky Flats - N. | 08-059-0006 | 3 | 5 | 2.6 |
| Fossil Creek | 08-069-0015 | 3 | 5 | 2.6 |
| Bethke | 08-069-0016 | 3 | 5 | 2.6 |
| La Salle | 08-123-0015 | 2 | 6 | 1.0 |

Table 9. All APCD $SO_2$ monitoring sites ranked by total number of parameters monitored.

| Site Name | AQS Number | Total Number of Parameters Monitored | Rank | Score |
|---|---|---|---|---|
| La Casa | 08-031-0026 | 7 | 1 | 3.0 |
| Welby | 08-001-3001 | 6 | 2 | 2.0 |
| CAMP | 08-031-0002 | 5 | 3 | 1.0 |

Table 10. All APCD $O_3$ monitoring sites ranked by total number of parameters monitored.

| Site Name | AQS Number | Total Number of Parameters Monitored | Rank | Score |
|---|---|---|---|---|
| La Casa | 08-031-0026 | 7 | 1 | 23.0 |
| Welby | 08-001-3001 | 6 | 2 | 19.3 |
| CAMP | 08-031-0002 | 5 | 3 | 15.7 |
| Chatfield State Park | 08-035-0004 | 3 | 4 | 8.3 |
| Rocky Flats - N. | 08-059-0006 | 3 | 4 | 8.3 |
| Fossil Creek | 08-069-0015 | 3 | 4 | 8.3 |
| Bethke | 08-069-0016 | 3 | 4 | 8.3 |
| Fort Collins - Mason | 08-069-1004 | 3 | 4 | 8.3 |
| Greeley - County Tower | 08-123-0009 | 3 | 4 | 8.3 |
| Highland Reservoir | 08-005-0002 | 2 | 5 | 4.7 |
| Aurora - East | 08-005-0006 | 2 | 5 | 4.7 |
| Boulder Reservoir | 08-013-0014 | 2 | 5 | 4.7 |
| Evergreen | 08-059-0014 | 2 | 5 | 4.7 |
| Fort Collins - West | 08-069-0011 | 2 | 5 | 4.7 |
| Palisade Water Treatment | 08-077-0020 | 2 | 5 | 4.7 |
| Pueblo West | 08-101-0016 | 2 | 5 | 4.7 |
| La Salle | 08-123-0015 | 2 | 5 | 4.7 |
| USAFA | 08-041-0013 | 1 | 6 | 1.0 |
| Manitou Springs | 08-041-0016 | 1 | 6 | 1.0 |
| Rifle - Health Dept. | 08-045-0012 | 1 | 6 | 1.0 |
| Black Hawk | 08-047-0003 | 1 | 6 | 1.0 |
| NREL | 08-059-0011 | 1 | 6 | 1.0 |
| Cortez - Health Dept. | 08-083-0006 | 1 | 6 | 1.0 |

Table 11. All APCD $PM_{10}$ monitoring sites ranked by total number of parameters monitored.

| Site Name | AQS Number | Total Number of Parameters Monitored | Rank | Score |
|---|---|---|---|---|
| La Casa | 08-031-0026 | 7 | 1 | 16.0 |
| Welby | 08-001-3001 | 6 | 2 | 13.5 |
| CAMP | 08-031-0002 | 5 | 3 | 11.0 |
| Colorado College | 08-041-0017 | 3 | 4 | 6.0 |
| Birch Street | 08-001-0010 | 2 | 5 | 3.5 |
| Alamosa - ASC | 08-003-0001 | 2 | 5 | 3.5 |
| Longmont - Municipal Bldg. | 08-013-0003 | 2 | 5 | 3.5 |
| Boulder - CU | 08-013-1001 | 2 | 5 | 3.5 |
| Grand Junction - Powell Bldg. | 08-077-0017 | 2 | 5 | 3.5 |
| Lamar - Municipal Bldg. | 08-099-0002 | 2 | 5 | 3.5 |
| Pueblo - Fountain School | 08-101-0015 | 2 | 5 | 3.5 |
| Pagosa Springs School | 08-007-0001 | 1 | 6 | 1.0 |
| Cañon City - City Hall | 08-043-0003 | 1 | 6 | 1.0 |
| Steamboat Springs | 08-107-0003 | 1 | 6 | 1.0 |
| Telluride | 08-113-0004 | 1 | 6 | 1.0 |

Table 12. All APCD $PM_{2.5}$ monitoring sites ranked by total number of parameters monitored.

| Site Name | AQS Number | Total Number of Parameters Monitored | Rank | Score |
|---|---|---|---|---|
| La Casa | 08-031-0026 | 7 | 1 | 21.0 |
| Welby | 08-001-3001 | 6 | 2 | 17.67 |
| CAMP | 08-031-0002 | 5 | 3 | 14.33 |
| I-25: Denver | 08-031-0027 | 4 | 4 | 11.00 |
| I-25: Globeville | 08-031-0028 | 3 | 5 | 7.67 |
| Chatfield State Park | 08-035-0004 | 3 | 5 | 7.67 |
| Colorado College | 08-041-0017 | 3 | 5 | 7.67 |
| Bethke | 08-069-0016 | 3 | 5 | 7.67 |
| Birch Street | 08-001-0010 | 2 | 6 | 4.33 |
| Alamosa - ASC | 08-003-0001 | 2 | 6 | 4.33 |
| Longmont - Municipal Bldg. | 08-013-0003 | 2 | 6 | 4.33 |
| Boulder - CU | 08-013-1001 | 2 | 6 | 4.33 |
| Grand Junction - Powell Bldg. | 08-077-0017 | 2 | 6 | 4.33 |
| Aspen | 08-097-0008 | 2 | 6 | 4.33 |
| Lamar - Municipal Bldg. | 08-099-0002 | 2 | 6 | 4.33 |
| Pueblo - Fountain School | 08-101-0015 | 2 | 6 | 4.33 |
| Arapaho Community College | 08-005-0005 | 1 | 7 | 1.0 |
| National Jewish Health (NJH) | 08-031-0013 | 1 | 7 | 1.0 |
| Fort Collins - CSU | 08-069-0009 | 1 | 7 | 1.0 |
| Greeley - Hospital | 08-123-0006 | 1 | 7 | 1.0 |
| Platteville - Middle School | 08-123-0008 | 1 | 7 | 1.0 |

### 2.2 Trends Impact

In this analysis, monitoring sites in each network were ranked based on the length of their continuous measurement record for the pollutant of interest. Sites possessing an extended historical record are valuable for tracking long-term pollutant trends, and the continuation of these long uninterrupted records is deemed desirable. Therefore, those monitors with the longest uninterrupted historical records were scored the highest, while monitors with records of equal length were scored equally.

This analysis simply considers the number of years that a monitor has been operating continuously. Note that if a monitor had alternating periods of operation, then only the most recent operating period is considered.

This analysis is valuable in that it addresses two of the APCD's monitoring network purposes: trend tracking and emission reduction evaluation. The main advantages of this method are its simplistic analytical approach and its usefulness for identifying sites that provide a basis for assessing long-term trends. The main disadvantages of the method are: (1) the magnitude and direction of past trends are not necessarily good predictors of future trends due to potential changes in population or emissions, and (2) the length of a continuous record does not ensure that data are of good quality throughout the entire time period.

#### 2.2.1 Results for all Parameters

Tables 13-18 list each APCD monitoring site in the CO, $NO_2$, $SO_2$, $O_3$, $PM_{10}$, and $PM_{2.5}$ ambient networks, respectively, along with the total number of years (rounded to the nearest integer) that the site has been monitoring the pollutant of interest and the score associated with each site

Table 13. All APCD CO monitoring sites ranked by length of monitoring record.

| Site Name | Length of Continuous Monitoring Record (years) | Rank | Score |
|---|---|---|---|
| Fort Collins - Mason | 44 | 1 | 5.0 |
| La Casa | 11 | 2 | 2.0 |
| I-25: Denver | 11 | 3 | 2.0 |
| Greeley - Weld County Tower | 9 | 4 | 1.8 |
| Colorado College | 0 | 5 | 1.0 |

Table 14. All APCD $NO_2$ monitoring sites ranked by length of monitoring record.

| Site Name | Length of Continuous Monitoring Record (years) | Rank | Score |
|---|---|---|---|
| CAMP | 59 | 1 | 9.0 |
| Welby | 48 | 2 | 7.5 |
| Rocky Flats - N. | 29 | 3 | 4.9 |
| I-25: Denver | 11 | 4 | 2.5 |
| La Casa | 10 | 5 | 2.4 |
| I-25: Globeville | 9 | 6 | 2.2 |
| Fossil Creek | 0 | 7 | 1.0 |
| Bethke | 0 | 8 | 1.0 |
| La Salle | 0 | 9 | 1.0 |

Table 15. All APCD $SO_2$ monitoring sites ranked by length of monitoring record.

| Site Name | Length of Continuous Monitoring Record (years) | Rank | Score |
|---|---|---|---|
| CAMP | 59 | 1 | 3.0 |
| Welby | 51 | 2 | 2.7 |
| La Casa | 11 | 3 | 1.0 |

Table 16. All APCD $O_3$ monitoring sites ranked by length of monitoring record.

| Site Name | Length of Continuous Monitoring Record (years) | Rank | Score |
|---|---|---|---|
| CAMP | 52 | 1 | 23.0 |
| Welby | 51 | 2 | 22.6 |
| Highland Reservoir | 46 | 3 | 20.5 |
| Fort Collins - Mason | 44 | 4 | 19.6 |
| Rocky Flats - N. | 32 | 5 | 14.5 |
| NREL | 30 | 6 | 13.7 |
| USAFA | 28 | 7 | 12.8 |
| Greeley - Weld County Tower | 22 | 8 | 10.3 |
| Chatfield State Park | 20 | 9 | 9.5 |
| Manitou Springs | 20 | 10 | 9.5 |
| Fort Collins - West | 18 | 10 | 8.6 |
| Rifle - Health Dept. | 16 | 11 | 7.8 |
| Palisade Water Treatment | 16 | 12 | 7.8 |
| Cortez - Health Dept. | 16 | 12 | 7.8 |
| Aurora - East | 15 | 12 | 7.3 |
| La Casa | 11 | 13 | 5.7 |
| Boulder Reservoir | 8 | 14 | 4.4 |
| Black Hawk | 5 | 15 | 3.1 |
| Evergreen | 4 | 16 | 2.7 |
| Pueblo West | 1 | 17 | 1.4 |
| Fossil Creek | 0 | 18 | 1.0 |
| Bethke | 0 | 19 | 1.0 |
| La Salle | 0 | 20 | 1.0 |

Table 17. All APCD $PM_{10}$ monitoring sites ranked by length of monitoring record.

| Site Name | Length of Continuous Monitoring Record (years) | Rank | Score |
|---|---|---|---|
| Pagosa Springs School | 39 | 1 | 16.0 |
| Longmont - Municipal Bldg. | 39 | 1 | 16.0 |
| Welby | 38 | 2 | 15.6 |
| CAMP | 38 | 2 | 15.6 |
| Lamar - Municipal Bldg. | 38 | 2 | 15.6 |
| Steamboat Springs | 38 | 2 | 15.6 |
| Alamosa - ASC | 35 | 3 | 14.4 |
| Telluride | 34 | 4 | 14.0 |
| Grand Junction - Powell Bldg. | 22 | 5 | 9.3 |
| Cañon City - City Hall | 20 | 6 | 8.5 |
| Colorado College | 16 | 7 | 6.9 |
| Pueblo - Fountain School | 15 | 8 | 6.5 |
| La Casa | 12 | 9 | 5.3 |
| Aspen | 9 | 10 | 4.2 |
| Birch Street | 3 | 11 | 1.8 |
| Boulder - CU | 1 | 12 | 1.0 |

Table 18. All APCD $PM_{2.5}$ monitoring sites ranked by length of monitoring record.

| Site Name | Length of Continuous Monitoring Record (years) | Rank | Score |
|---|---|---|---|
| Arapaho Community College (ACC) | 25 | 1 | 21.0 |
| Longmont - Municipal Bldg. | 25 | 1 | 21.0 |
| CAMP | 25 | 1 | 21.0 |
| National Jewish Health (NJH) | 25 | 1 | 21.0 |
| Fort Collins - CSU | 25 | 1 | 21.0 |
| Greeley - Hospital | 25 | 1 | 21.0 |
| Platteville - Middle School | 25 | 1 | 21.0 |
| Grand Junction - Powell Bldg. | 22 | 2 | 18.6 |
| Chatfield State Park | 19 | 3 | 16.2 |
| Colorado College | 16 | 4 | 13.8 |
| Pueblo - Fountain School | 15 | 5 | 13.0 |
| La Casa | 12 | 6 | 10.6 |
| I-25: Denver | 10 | 7 | 9.0 |
| I-25: Globeville | 9 | 8 | 8.2 |
| Birch Street | 3 | 9 | 3.4 |
| Alamosa - ASC | 1 | 10 | 1.8 |
| Boulder - CU | 1 | 10 | 1.8 |
| Lamar - Municipal Bldg. | 1 | 10 | 1.8 |
| Welby | 0 | 11 | 1.0 |
| Bethke | 0 | 11 | 1.0 |
| Aspen | 0 | 11 | 1.0 |

## 2.3 Measured Concentrations

This analysis ranks monitors by the magnitude of pollutant concentrations that they measure. The indicator is based on each monitoring site's design value, which is generally the highest concentration measured over a particular averaging interval in a given year (Table 19). Monitors with higher design values are ranked higher than those with lower design values. The assumption of this analysis is that sites measuring high concentrations are more important for determining NAAQS compliance and assessing population exposure. A drawback of this analysis is that it does not consider monitor siting issues, as a monitor located in a high concentration area may not measure maximum potential concentrations if it has not been sited optimally. Furthermore, because this analysis focuses only on those monitors measuring high concentrations, which are often urban monitors located in high-population areas, it does not take into account low-concentration monitors that are important for other reasons, such as rural monitors that measure background pollutant concentrations and assure appropriate spatial coverage.

Table 19. National Ambient Air Quality Standards (NAAQS) for the criteria pollutants assessed in this report. Primary standards provide public health protection, while secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Units of measure are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter ($\mu g\ m^{-3}$)

| Pollutant | Primary / Secondary | Averaging Time | Level | Form |
|---|---|---|---|---|
| Carbon Monoxide (CO) | Primary | 8-hr | 9 ppm | Not to be exceeded more than once per year |
| | | 1-hr | 35 ppm | |
| Lead (Pb) | Primary and Secondary | Rolling 3-month average | 0.15 $\mu g\ m^{-3}$ | Not to be exceeded |
| Nitrogen Dioxide ($NO_2$) | Primary | 1-hr | 100 ppb | 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years |
| | Primary and Secondary | Annual | 53 ppb | Annual mean |
| Sulfur Dioxide ($SO_2$) | Primary | 1-hr | 75 ppb | 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years |
| | Secondary | 3-hr | 0.5 ppm | Not to be exceeded more than once per year |
| Ozone ($O_3$) | Primary and Secondary | 8-hr | 0.070 ppm | Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years |
| $PM_{10}$ | Primary and Secondary | 24-hr | 150 $\mu g\ m^{-3}$ | Not to be exceeded more than once per year on average over 3 years |
| $PM_{2.5}$ | Primary | Annual | 9 $\mu g\ m^{-3}$ | Annual mean, averaged over 3 years |
| | Secondary | Annual | 15 $\mu g\ m^{-3}$ | Annual mean, averaged over 3 years |
| | Primary and Secondary | 24-hr | 35 $\mu g\ m^{-3}$ | 98th percentile, averaged over 3 years |

### 2.3.1 Results for All Parameters

Tables 20-25 list each APCD monitoring site in the CO, $NO_2$, $SO_2$, $O_3$, $PM_{10}$, and $PM_{2.5}$ ambient networks, respectively, along with the annual design values measured during the period 2022 - 2024, the average design value for that period, and the score associated with each site.

Table 20. All APCD CO monitoring sites ranked by design value.

| Site Name | Max 1-Hour Concentration (ppm) | | | | Rank | Score |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2024 | Three-Year Average | | |
| I-25: Denver | 2.47 | 2.45 | 3.65 | 2.86 | 1 | 5.00 |
| Fort Collins - Mason | 2.33 | 1.83 | 2.02 | 2.06 | 2 | 3.11 |
| La Casa | 1.45 | 2.08 | 2.13 | 1.89 | 3 | 2.71 |
| Greeley - County Tower | 1.27 | 1.15 | 1.52 | 1.31 | 4 | 1.36 |
| Colorado College | - | - | 1.16 | 1.16 | 5 | 1.00 |

Table 21. All APCD $NO_2$ monitoring sites ranked by design value.

| Site Name | 98th Percentile of 1-Hour Daily Max Concentrations (ppb) | | | | Rank | Score |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2024 | Three-Year Average | | |
| I-25: Globeville | 63.4 | 64.5 | 59.6 | 62.5 | 1 | 9.00 |
| CAMP | 58.1 | 65.7 | 57.0 | 60.3 | 2 | 8.52 |
| I-25: Denver | 60.4 | 61.5 | 56.3 | 59.4 | 3 | 8.34 |
| Welby | 57.3 | 56.2 | 51.4 | 55.0 | 4 | 7.40 |
| La Casa | 54.1 | 55.2 | 50.0 | 53.1 | 5 | 7.00 |
| La Salle | - | - | 36.0 | 36.0 | 6 | 3.36 |
| Fossil Creek | - | - | 32.3 | 32.3 | 7 | 2.57 |
| Bethke | - | - | 31.7 | 31.7 | 8 | 2.44 |
| Rocky Flats - N. | 25.7 | 31.5 | 17.6 | 24.9 | 9 | 1.00 |

Table 22. All APCD $SO_2$ monitoring sites ranked by design value.

| Site Name | 99th Percentile of 1-Hour Daily Max Concentrations (ppb) | | | | Rank | Score |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2024 | Three-Year Average | | |
| Welby | 5.7 | 5.6 | 4.10 | 5.1 | 1 | 3.0 |
| La Casa | 4.8 | 4.7 | 5.20 | 4.9 | 2 | 1.9 |
| CAMP | 4.3 | 4.9 | 4.90 | 4.7 | 3 | 1.0 |

Table 23. All APCD $O_3$ monitoring sites ranked by design value.

| Site Name | 4th Highest 8-hr Daily Max Concentration (ppm) | | | | Rank | Score |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2024 | Three-Year Average | | |
| Fossil Creek | - | - | 0.084 | 0.084 | 1 | 23.00 |
| Rocky Flats - N. | 0.078 | 0.077 | 0.088 | 0.081 | 2 | 20.36 |
| Chatfield State Park | 0.078 | 0.076 | 0.088 | 0.080 | 3 | 20.07 |
| NREL | 0.077 | 0.074 | 0.086 | 0.079 | 4 | 18.60 |
| La Salle | - | - | 0.079 | 0.079 | 4 | 18.60 |
| Bethke | - | - | 0.078 | 0.078 | 8 | 17.72 |
| Evergreen | 0.074 | 0.074 | 0.085 | 0.077 | 6 | 17.43 |
| Welby | 0.075 | 0.070 | 0.083 | 0.076 | 7 | 15.96 |
| Boulder Reservoir | 0.072 | 0.071 | 0.084 | 0.075 | 8 | 15.67 |
| Fort Collins - West | 0.073 | 0.071 | 0.083 | 0.075 | 8 | 15.67 |
| La Casa | 0.072 | 0.070 | 0.084 | 0.075 | 9 | 15.37 |
| Aurora - East | 0.070 | 0.073 | 0.081 | 0.074 | 10 | 14.79 |
| Black Hawk | 0.071 | 0.073 | 0.079 | 0.074 | 11 | 14.49 |
| Highland Reservoir | 0.073 | 0.075 | 0.073 | 0.073 | 12 | 13.91 |
| CAMP | 0.071 | 0.070 | 0.079 | 0.073 | 13 | 13.61 |
| Manitou Springs | 0.068 | 0.069 | 0.082 | 0.073 | 14 | 13.32 |
| Fort Collins - Mason | 0.070 | 0.067 | 0.082 | 0.073 | 14 | 13.32 |
| Greeley - Weld County Tower | 0.070 | 0.068 | 0.081 | 0.073 | 14 | 13.32 |
| Pueblo West | - | 0.067 | 0.076 | 0.071 | 15 | 12.00 |
| U.S. Air Force Academy (USAFA) | 0.069 | 0.064 | 0.078 | 0.070 | 16 | 10.97 |
| Palisade Water Treatment | 0.062 | 0.061 | 0.067 | 0.063 | 17 | 4.81 |
| Cortez - Health Dept. | 0.062 | 0.059 | 0.065 | 0.062 | 18 | 3.64 |
| Rifle - Health Dept. | 0.059 | 0.055 | 0.063 | 0.059 | 19 | 1.00 |

Table 24. All APCD $PM_{10}$ monitoring sites ranked by design value.

| Site Name | Max 24-Hour Concentration (µg $m^{-3}$) | | | | Rank | Score |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2024 | Three-Year Average | | |
| Lamar - Municipal Bldg. | 451 | 160 | 101 | 237 | 1 | 16.0 |
| Pagosa Springs School | 373 | 193 | 77 | 214 | 2 | 14.2 |
| Birch Street | 114 | 98 | 142 | 118 | 3 | 6.7 |
| Pueblo - Fountain School | 195 | 64 | 84 | 114 | 4 | 6.4 |
| Welby | 100 | 95 | 140 | 112 | 5 | 6.2 |
| Alamosa - ASC | - | 70 | 150 | 110 | 6 | 6.1 |
| Cañon City - City Hall | 108 | 95 | 73 | 92 | 7 | 4.7 |
| Telluride | 89 | 62 | 72 | 74 | 8 | 3.3 |
| Aspen | 70 | 56 | 82 | 69 | 9 | 2.9 |
| CAMP | 64 | 73 | 68 | 68 | 10 | 2.8 |
| Longmont - Municipal Bldg. | 55 | 41 | 92 | 63 | 11 | 2.4 |
| Grand Junction - Powell Bldg. | 73 | 63 | 50 | 62 | 12 | 2.3 |
| Steamboat Springs | 46 | 69 | 60 | 58 | 13 | 2.0 |
| La Casa | 51 | 49 | 65 | 55 | 14 | 1.8 |
| Boulder - CU | - | 35 | 73 | 54 | 15 | 1.7 |
| Colorado College | 60 | 33 | 42 | 45 | 16 | 1.0 |

Table 25. All APCD $PM_{2.5}$ monitoring sites ranked by design value.

| Site Name | 98th Percentile of 24-Hour Concentrations (µg $m^{-3}$) | | | | Rank | Score |
|---|---|---|---|---|---|---|
| | 2022 | 2023 | 2024 | Three-Year Average | | |
| Platteville - Middle School | 20.4 | 21.9 | 24.8 | 22.4 | 1 | 21.0 |
| Greeley - Hospital | 22.1 | 23.3 | 20.6 | 22.0 | 2 | 20.2 |
| Welby | - | - | 21.6 | 21.6 | 3 | 19.4 |
| Birch Street | 16.4 | 23.7 | 21.5 | 20.5 | 4 | 17.1 |
| I-25: Globeville | 17.2 | 23.0 | 19.2 | 19.8 | 5 | 15.5 |
| Longmont - Municipal Bldg. | 16.2 | 17.8 | 23.5 | 19.2 | 6 | 14.2 |
| Fort Collins - CSU | 17.4 | 18.2 | 20.5 | 18.7 | 7 | 13.2 |
| CAMP | 15.7 | 21.9 | 17.3 | 18.3 | 8 | 12.3 |
| I-25: Denver | 12.6 | 19.2 | 21.2 | 17.7 | 9 | 11.0 |
| La Casa | 14.8 | 16.6 | 18.3 | 16.6 | 10 | 8.6 |
| National Jewish Health (NJH) | 13.9 | 16.3 | 18.5 | 16.2 | 11 | 7.9 |
| Alamosa - ASC | - | 17.8 | 12.8 | 15.3 | 12 | 5.9 |
| Arapaho Community College (ACC) | 11.0 | 16.0 | 17.5 | 14.8 | 13 | 4.9 |
| Boulder - CU | - | 12.3 | 17.2 | 14.8 | 14 | 4.7 |
| Lamar - Municipal Bldg. | - | 9.6 | 18.6 | 14.1 | 15 | 3.3 |
| Colorado College | 12.0 | 13.3 | 16.5 | 13.9 | 16 | 3.0 |
| Chatfield State Park | 11.4 | 13.1 | 16.8 | 13.8 | 17 | 2.6 |
| Bethke | - | - | 13.4 | 13.4 | 18 | 1.9 |
| Grand Junction - Powell Bldg. | 14.8 | 10.2 | 14.1 | 13.03 | 19 | 2.05 |
| Pueblo - Fountain School | 16.2 | 10.4 | 12.5 | 13.03 | 19 | 2.05 |
| Aspen | - | - | 13.0 | 13.00 | 20 | 1.00 |

## 2.4 Deviation from the NAAQS

In this analysis, sites that measure design values close to the NAAQS exceedance threshold (Table 19) are ranked higher than those sites with design values well above or below it. Sites that are closest to the threshold are considered most valuable for the purpose of determining compliance with the NAAQS, whereas sites measuring values well above or below the NAAQS do not provide as much information in this regard. The purpose of this technique is to give weight to those sites that are closest to the standard; therefore, the absolute value of the difference between the measured design value and the standard is used to score each monitor. Monitors with the smallest absolute difference will rank as most important. This analysis has a disadvantage in that monitors with design values higher than the standard (i.e., those in violation of the standard) may be considered more valuable from the standpoint of compliance and public health than those with design values lower than the standard, but with a similar absolute difference. The objectives assessed by this analysis are regulatory compliance and forecasting assistance.

Design values for APCD monitoring sites are typically well below the NAAQS for most criteria pollutants, making this indicator redundant with the Measured Concentrations indicator for those networks. For this reason, the Deviation from the NAAQS indicator was applied only to the $O_3$ monitoring network, as this is the only network having sites with design values both above and below the NAAQS.

### 2.4.1 Results for all Parameters

Table 26 lists each APCD monitoring site in the $O_3$ ambient network, showing the average design value for the period 2022-2024, the difference between the average design values and the level of the NAAQS, and the score associated with each site.

Table 26. All APCD $O_3$ monitoring sites ranked by deviation from the primary $O_3$ NAAQS.

| Site Name | 3-Year Average Design Value (ppm) | NAAQS (ppb) | Deviation | Rank | Score |
|---|---|---|---|---|---|
| U.S. Air Force Academy (USAFA) | 0.070 | 70 | 0.000 | 1 | 23.00 |
| Pueblo West | 0.072 | 70 | 0.002 | 2 | 21.12 |
| Manitou Springs | 0.073 | 70 | 0.003 | 3 | 18.71 |
| Fort Collins - Mason | 0.073 | 70 | 0.003 | 3 | 18.71 |
| Greeley - Weld County Tower | 0.073 | 70 | 0.003 | 3 | 18.71 |
| CAMP | 0.073 | 70 | 0.003 | 4 | 18.17 |
| Highland Reservoir | 0.074 | 70 | 0.004 | 5 | 17.63 |
| Black Hawk | 0.074 | 70 | 0.004 | 6 | 16.56 |
| Aurora - East | 0.075 | 70 | 0.005 | 7 | 16.02 |
| La Casa | 0.075 | 70 | 0.005 | 8 | 14.95 |
| Boulder Reservoir | 0.076 | 70 | 0.006 | 9 | 14.41 |
| Fort Collins - West | 0.076 | 70 | 0.006 | 9 | 14.41 |
| Welby | 0.076 | 70 | 0.006 | 10 | 13.88 |
| Palisade Water Treatment | 0.063 | 70 | 0.007 | 11 | 12.80 |
| Evergreen | 0.078 | 70 | 0.008 | 12 | 11.20 |
| Bethke | 0.078 | 70 | 0.008 | 13 | 10.66 |
| Cortez - Health Dept. | 0.062 | 70 | 0.008 | 13 | 10.66 |
| NREL | 0.079 | 70 | 0.009 | 14 | 9.05 |
| La Salle | 0.079 | 70 | 0.009 | 14 | 9.05 |
| Chatfield State Park | 0.081 | 70 | 0.011 | 15 | 6.37 |
| Rifle - Health Dept. | 0.059 | 70 | 0.011 | 16 | 5.83 |
| Rocky Flats - N. | 0.081 | 70 | 0.011 | 16 | 5.83 |
| Fossil Creek | 0.084 | 70 | 0.014 | 17 | 1.00 |

## 2.5 Monitor-to-Monitor Correlation

In this analysis, sites are ranked based on the correlation of their measured concentrations with those of the other monitors in the network. Monitors measuring concentrations that correlate well with those measured at other sites are considered redundant and are consequently assigned a lower ranking. Monitors with concentrations that do not correlate with other monitors are considered unique, and as such have more value for spatial monitoring objectives and are therefore assigned a higher ranking. The advantages of this method are: (1) it gives a measure of the site's uniqueness and representativeness, and (2) it is useful for identifying redundant sites. The disadvantages are that it requires large amounts of data with a high data completeness rate, and that the correlations are likely pollutant specific. The objectives assessed by this analysis are model evaluation, spatial coverage, and interpolation.

To conduct this analysis, 24-hour average concentration values were compiled for each criteria parameter monitored within Colorado for the period 2020-2024. Data obtained from sites in Colorado operated by other federal, local, and tribal agencies were considered in this analysis to ensure a spatially robust sample; however, the correlations observed between these sites and those in the APCD network are not considered when ranking the APCD monitors. The concentrations measured at each monitoring site were compared to those measured at every other monitoring site in the state using a matrix format, in which each monitoring pair was subjected to linear regression from which a Pearson correlation coefficient ($r^2$) was generated. The maximum correlation was then recorded for each site, as well as the number of sites well-correlated with that site. It is assumed here that sites having an $r^2$ value of 0.6 or greater are well-correlated. Sites were ranked based on both their maximum correlation and the number of sites well-correlated with them. A distance matrix was also developed, and a correlogram plot of distance vs. correlation was created for each parameter.

### 2.5.1 Carbon Monoxide (CO)

Table 27. CO monitor-to-monitor correlation analysis scores.

| Site Name | Max. Correlation | | $r^2 \geq 0.6$ | | Average | Score |
|---|---|---|---|---|---|---|
| | Value | Score | No. of Sites | Score | Rank | |
| Colorado College | 0.607 | 5.0 | 1 | 5 | 1 | 5.00 |
| Greeley - Weld County Tower | 0.745 | 2.4 | 1 | 5 | 2 | 3.71 |
| La Casa | 0.821 | 1.0 | 1 | 5 | 3 | 3.00 |
| I-25: Denver | 0.821 | 1.0 | 1 | 5 | 3 | 3.00 |
| Fort Collins - Mason | 0.745 | 2.4 | 2 | 1 | 4 | 1.71 |

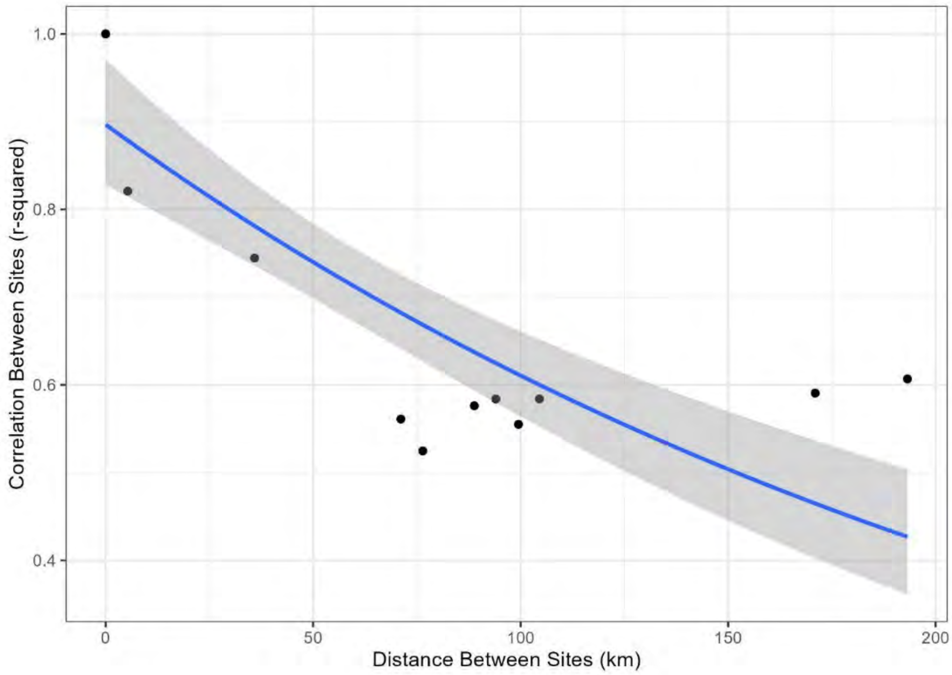


Figure 5. Correlogram for all CO monitoring sites in Colorado.

## 2.5.2 Nitrogen Dioxide ($NO_2$)

Table 28. $NO_2$ monitor-to-monitor correlation analysis scores.

| Site Name | Max. Correlation | | $r^2 \geq 0.6$ | | Average | Score |
|---|---|---|---|---|---|---|
| | Value | Score | No. of Sites | Score | Rank | |
| Rocky Flats - N. | 0.37 | 9.00 | 0 | 9.00 | 1 | 9.00 |
| La Salle | 0.80 | 2.32 | 3 | 5.57 | 2 | 3.95 |
| CAMP | 0.85 | 1.58 | 4 | 4.43 | 3 | 3.00 |
| I-25: Globeville | 0.86 | 1.36 | 5 | 3.29 | 4 | 2.32 |
| Fossil Creek | 0.89 | 1.00 | 5 | 3.29 | 5 | 2.14 |
| La Casa | 0.85 | 1.58 | 6 | 2.14 | 6 | 1.86 |
| I-25: Denver | 0.86 | 1.36 | 6 | 2.14 | 7 | 1.75 |
| Bethke | 0.89 | 1.00 | 6 | 2.14 | 8 | 1.57 |
| Welby | 0.82 | 2.00 | 7 | 1.00 | 9 | 1.50 |

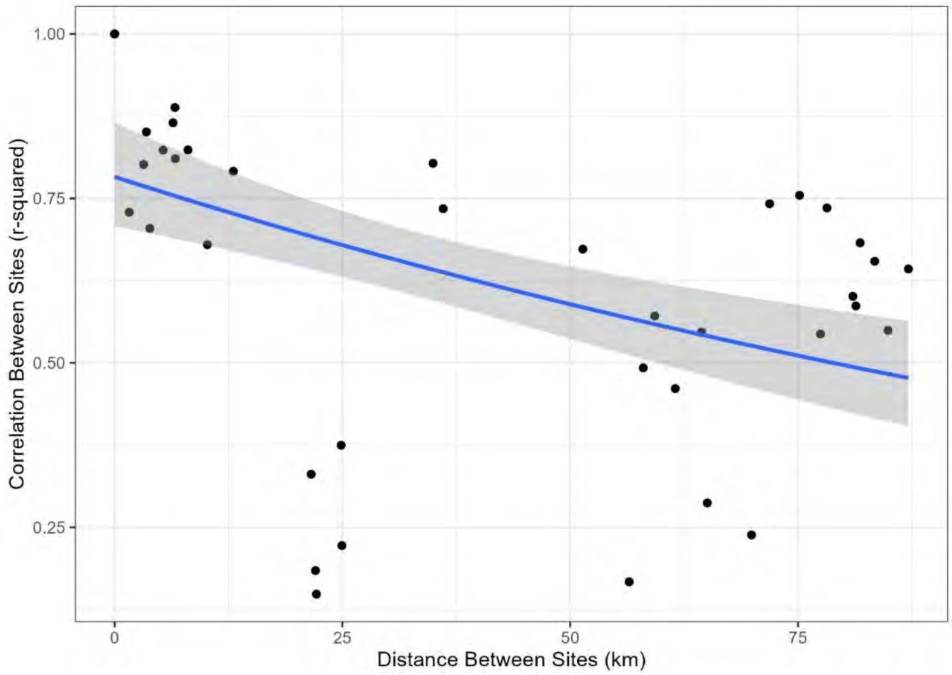


Figure 6. Correlogram for all $NO_2$ monitoring sites in Colorado.

### 2.5.3 Sulfur Dioxide ($SO_2$)

Table 29. $SO_2$ monitor-to-monitor correlation analysis scores.

| Site Name | Max. Correlation | | $r^2 \geq 0.6$ | | Average | Score |
|---|---|---|---|---|---|---|
| | Value | Score | No. of Sites | Score | Rank | |
| Welby | 0.172 | 3.0 | 0 | - | 1 | 3.0 |
| CAMP | 0.424 | 1.0 | 0 | - | 2 | 1.0 |
| La Casa | 0.424 | 1.0 | 0 | - | 2 | 1.0 |

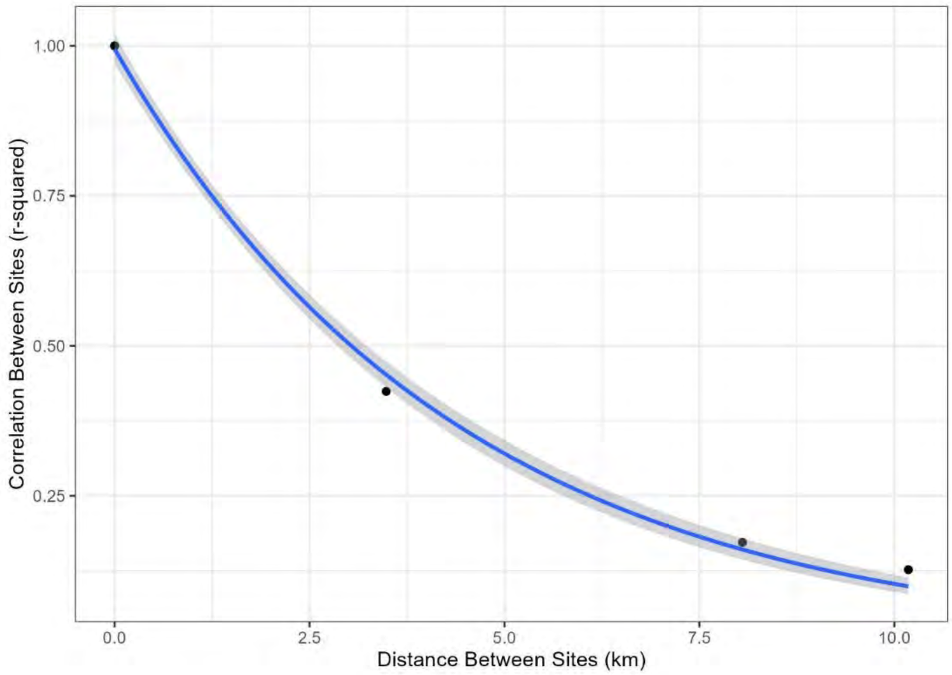

Figure 7. Correlogram for all $SO_2$ monitoring sites in Colorado.

### 2.5.4 Ozone ($O_3$)

Table 30. $O_3$ monitor-to-monitor correlation analysis scores.

| Site Name | Max. Correlation | | $r^2 \geq 0.6$ | | Average | Score |
|---|---|---|---|---|---|---|
| | Value | Score | No. of Sites | Score | Rank | |
| U.S. Air Force Academy (USAFA) | 0.64 | 23.0 | 4 | 18.9 | 1 | 20.9 |
| Evergreen | 0.71 | 18.3 | 1 | 23.0 | 2 | 20.6 |
| Black Hawk | 0.71 | 18.3 | 3 | 20.3 | 3 | 19.3 |
| Cortez - Health Dept. | 0.74 | 16.0 | 2 | 21.6 | 4 | 18.8 |
| Pueblo West | 0.66 | 21.6 | 8 | 13.4 | 5 | 17.5 |
| Palisade Water Treatment | 0.81 | 10.9 | 3 | 20.3 | 6 | 15.6 |
| Rifle - Health Dept. | 0.81 | 10.9 | 4 | 18.9 | 7 | 14.9 |
| Manitou Springs | 0.75 | 15.3 | 10 | 10.6 | 8 | 12.9 |
| Aurora - East | 0.81 | 10.9 | 9 | 12.0 | 9 | 11.5 |
| Welby | 0.83 | 9.3 | 8 | 13.4 | 10 | 11.4 |
| Highland Reservoir | 0.87 | 6.1 | 9 | 12.0 | 11 | 9.1 |
| Fort Collins - Mason | 0.87 | 6.1 | 9 | 12.0 | 12 | 9.0 |
| Greeley - Weld County Tower | 0.89 | 4.7 | 9 | 12.0 | 13 | 8.3 |
| Fort Collins - West | 0.81 | 10.9 | 14 | 5.1 | 14 | 8.0 |
| Fossil Creek | 0.89 | 4.7 | 11 | 9.3 | 15 | 7.0 |
| La Salle | 0.87 | 6.4 | 13 | 6.5 | 16 | 6.4 |
| Chatfield State Park | 0.87 | 6.1 | 13 | 6.5 | 17 | 6.3 |
| Bethke | 0.86 | 7.2 | 14 | 5.1 | 18 | 6.2 |
| Boulder Reservoir | 0.81 | 10.9 | 17 | 1.0 | 19 | 5.9 |
| Rocky Flats - N. | 0.94 | 1.0 | 10 | 10.6 | 20 | 5.8 |
| NREL | 0.94 | 1.0 | 10 | 10.6 | 20 | 5.8 |
| La Casa | 0.89 | 5.0 | 13 | 6.5 | 21 | 5.7 |
| CAMP | 0.89 | 5.0 | 16 | 2.4 | 21 | 3.7 |

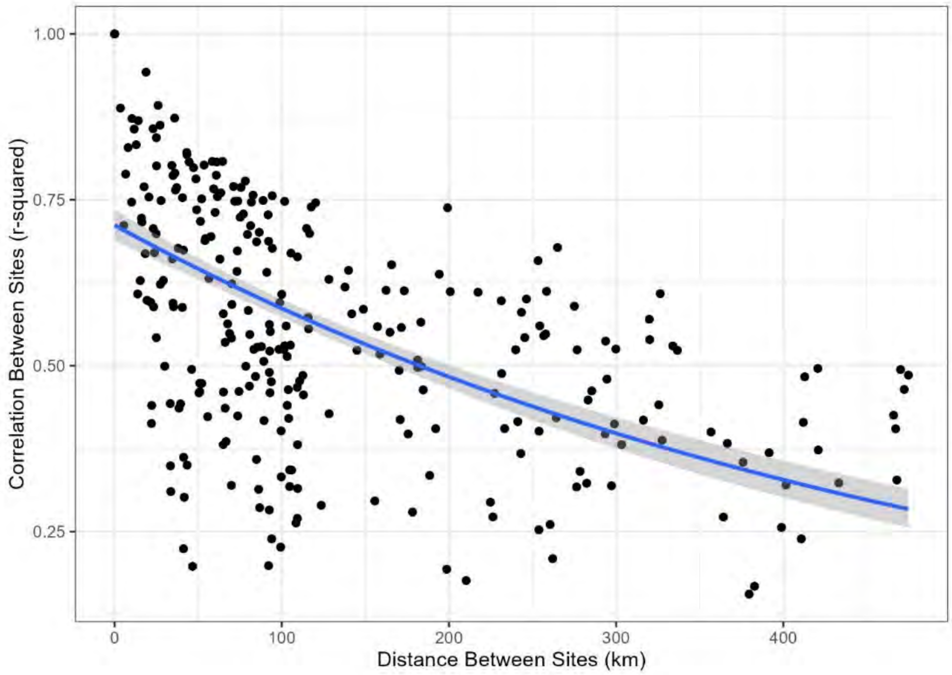


Figure 8. Correlogram for all $O_3$ monitoring sites in Colorado.

### 2.5.5 $PM_{10}$

Table 31. $PM_{10}$ monitor-to-monitor correlation analysis scores.

| Site Name | Max. Correlation | | $r^2 \geq 0.6$ | | Average | Score |
|---|---|---|---|---|---|---|
| | Value | Score | No. of Sites | Score | Rank | |
| Pagosa Springs School | 0.24 | 16.0 | 0 | 16.0 | 1 | 16.0 |
| Alamosa - ASC | 0.32 | 14.0 | 0 | 16.0 | 2 | 15.0 |
| Telluride | 0.41 | 11.6 | 0 | 16.0 | 3 | 13.8 |
| Lamar - Municipal Bldg. | 0.41 | 11.6 | 0 | 16.0 | 3 | 13.8 |
| Grand Junction - Powell Bldg. | 0.43 | 11.0 | 0 | 16.0 | 4 | 13.5 |
| Aspen | 0.45 | 10.5 | 0 | 16.0 | 5 | 13.3 |
| Steamboat Springs | 0.45 | 10.5 | 0 | 16.0 | 5 | 13.3 |
| Pueblo - Fountain School | 0.48 | 9.7 | 0 | 16.0 | 6 | 12.8 |
| Boulder - CU | 0.59 | 6.6 | 0 | 16.0 | 7 | 11.3 |
| Colorado College | 0.59 | 6.5 | 0 | 16.0 | 8 | 11.2 |
| Cañon City - City Hall | 0.59 | 6.5 | 0 | 16.0 | 8 | 11.2 |
| Welby | 0.66 | 4.8 | 1 | 11.0 | 9 | 7.9 |
| CAMP | 0.79 | 1.0 | 2 | 6.0 | 10 | 3.5 |
| Longmont - Municipal Bldg. | 0.67 | 4.5 | 3 | 1.0 | 11 | 2.8 |
| Birch Street | 0.67 | 4.4 | 3 | 1.0 | 12 | 2.7 |
| La Casa | 0.79 | 1.0 | 3 | 1.0 | 13 | 1.0 |

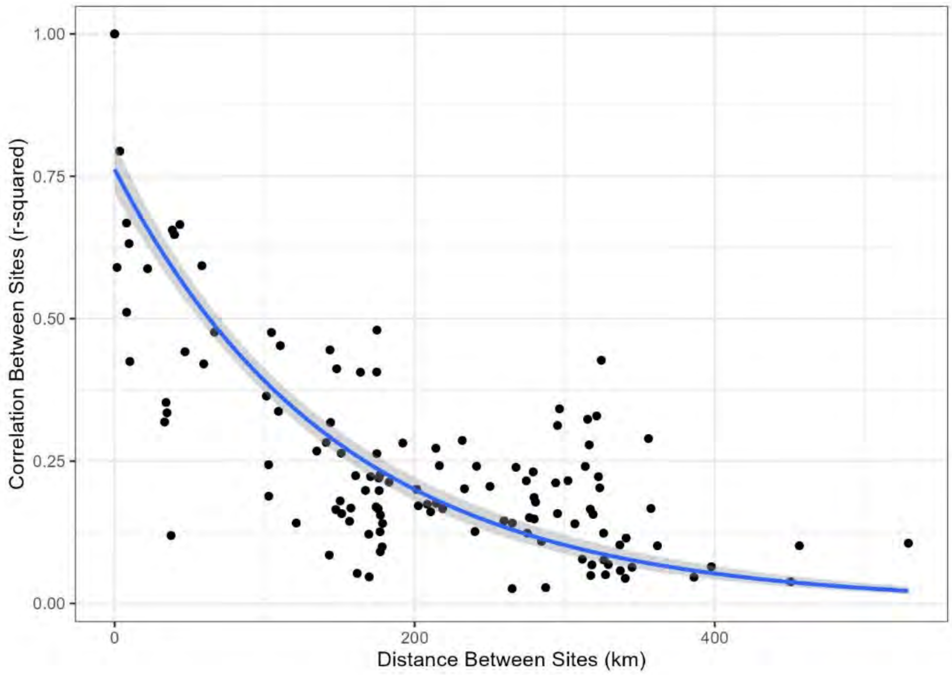


Figure 9. Correlogram for all $PM_{10}$ monitoring sites in Colorado.

### 2.5.6 $PM_{2.5}$

Table 32. $PM_{2.5}$ monitor-to-monitor correlation analysis scores.

| Site Name | Max. Correlation | | $r^2 \geq 0.6$ | | Average | Score |
|---|---|---|---|---|---|---|
| | Value | Score | No. of Sites | Score | Rank | |
| Grand Junction - Powell Bldg. | 0.38 | 21.0 | 0 | 21.0 | 1 | 21.0 |
| Alamosa - ASC | 0.38 | 20.8 | 0 | 21.0 | 2 | 20.9 |
| Aspen | 0.41 | 20.0 | 0 | 21.0 | 3 | 20.5 |
| Pueblo - Fountain School | 0.54 | 15.7 | 0 | 21.0 | 4 | 18.4 |
| Lamar - Municipal Bldg. | 0.60 | 13.7 | 0 | 21.0 | 5 | 17.4 |
| Colorado College | 0.65 | 12.0 | 1 | 19.6 | 6 | 15.8 |
| Bethke | 0.71 | 9.8 | 3 | 16.7 | 7 | 13.3 |
| Greeley - Hospital | 0.73 | 9.3 | 5 | 13.9 | 8 | 11.6 |
| Fort Collins - CSU | 0.80 | 7.0 | 5 | 13.9 | 9 | 10.4 |
| I-25: Denver | 0.77 | 8.0 | 7 | 11.0 | 10 | 9.5 |
| Platteville - Middle School | 0.84 | 5.5 | 6 | 12.4 | 11 | 9.0 |
| Chatfield State Park | 0.86 | 4.8 | 6 | 12.4 | 12 | 8.6 |
| Boulder - CU | 0.83 | 5.8 | 8 | 9.6 | 13 | 7.7 |
| Arapaho Community College (ACC) | 0.86 | 4.8 | 8 | 9.6 | 14 | 7.2 |
| Longmont - Municipal Bldg. | 0.80 | 6.9 | 10 | 6.7 | 15 | 6.8 |
| I-25: Globeville | 0.89 | 3.9 | 8 | 9.6 | 16 | 6.7 |
| CAMP | 0.89 | 3.9 | 10 | 6.7 | 17 | 5.3 |
| National Jewish Health (NJH) | 0.93 | 2.5 | 10 | 6.7 | 18 | 4.6 |
| La Casa | 0.93 | 2.5 | 11 | 5.3 | 19 | 3.9 |
| Birch Street | 0.98 | 1.0 | 10 | 6.7 | 20 | 3.9 |
| Welby | 0.98 | 1.0 | 14 | 1.0 | 21 | 1.0 |

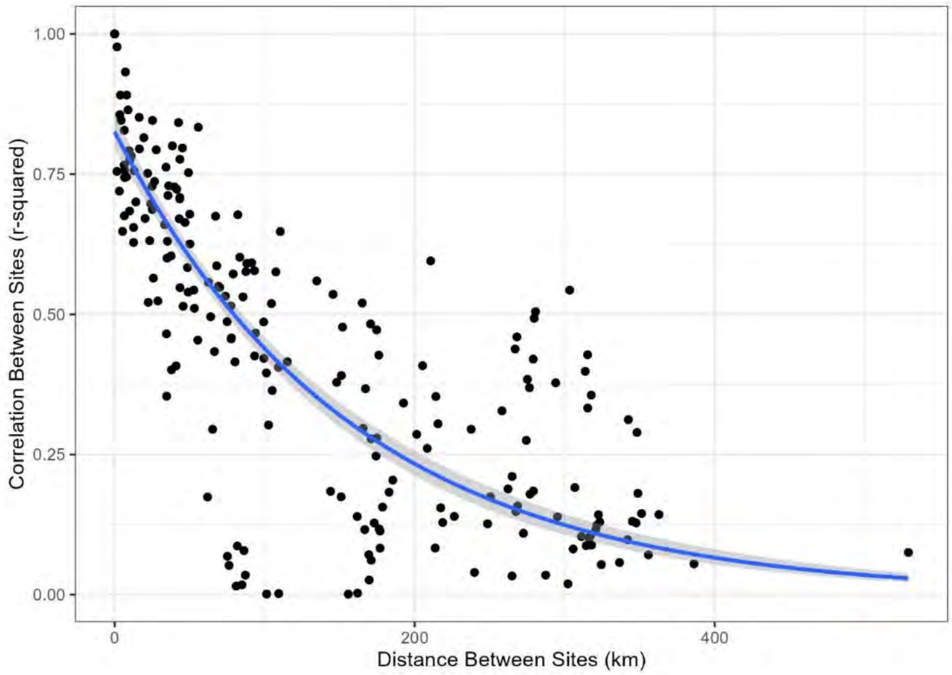


Figure 10. Correlogram for all $PM_{2.5}$ monitoring sites in Colorado.

### 2.6 Removal Bias

This analysis evaluates the contribution of each monitoring site to the creation of an interpolation map. For each pollutant parameter, an interpolation map is created using all CDPHE monitoring data. Each APCD monitoring site is then systematically removed from the dataset and the interpolation map is regenerated. The difference between the actual value measured at the monitoring site and the predicted value from the interpolation once the site was removed is recorded; this is the removal bias. Sites are then ranked using the absolute value of the difference, with higher values being given higher rankings.

Five-year (2020-2024) average concentration values have been used in this analysis for each pollutant parameter, thus this analysis focuses on the long-term contributions that each site makes in determining the monitored pollution surface. The removal bias technique would likely result in a different interpretation if a different temporal scale were used; however, this network assessment has other analysis techniques that focus on shorter averaging periods (e.g., Measured Concentration).

Removal bias is a useful technique for noting redundancies in the monitoring network. Sites with a high removal bias are important for creating an accurate interpolation map, thus their values add a unique perspective to the overall pollution surface. On the other hand, sites with a low removal bias difference could possibly be redundant with other sites, at least in the long-term temporal scale.

In the following sections, an interpolation map of the predicted pollution surface generated using all CDPHE monitoring data is shown for $O_3$, $PM_{10}$, and $PM_{2.5}$, which were the only pollutant networks subjected to this analysis. The accompanying tables show the results of the removal bias analysis and the associated scores and rankings for each site. Note that there are not enough sites in the CO, $NO_2$, and $SO_2$ monitoring networks to apply this analysis.

### 2.6.1 Ozone ($O_3$)

Table 33. $O_3$ monitoring sites ordered and ranked by removal bias.

| Site Name | Avg. Concentration (2020-2024) | Interpolated Concentration | Removal Bias | Rank | Score |
|---|---|---|---|---|---|
| Rifle - Health Dept. | 0.0286 | 0.0381 | 0.0095 | 1 | 23.00 |
| Rocky Flats - N. | 0.0450 | 0.0373 | -0.0076 | 2 | 18.69 |
| Fort Collins - West | 0.0402 | 0.0330 | -0.0073 | 3 | 17.86 |
| Fort Collins - Mason | 0.0321 | 0.0388 | 0.0068 | 4 | 16.70 |
| Black Hawk | 0.0459 | 0.0392 | -0.0067 | 5 | 16.46 |
| Manitou Springs | 0.0432 | 0.0366 | -0.0066 | 6 | 16.40 |
| NREL | 0.0432 | 0.0371 | -0.0061 | 7 | 15.22 |
| U.S. Air Force Academy (USAFA) | 0.0360 | 0.0420 | 0.0059 | 8 | 14.82 |
| Aurora - East | 0.0426 | 0.0369 | -0.0057 | 9 | 14.14 |
| Palisade Water Treatment | 0.0379 | 0.0334 | -0.0045 | 10 | 11.34 |
| Fossil Creek | 0.0381 | 0.0340 | -0.0041 | 11 | 10.50 |
| Bethke | 0.0331 | 0.0370 | 0.0039 | 12 | 10.05 |
| Greeley - Weld County Tower | 0.0329 | 0.0365 | 0.0037 | 13 | 9.49 |
| Welby | 0.0315 | 0.0346 | 0.0031 | 14 | 8.19 |
| Cortez - Health Dept. | 0.0344 | 0.0374 | 0.0030 | 15 | 7.85 |
| La Casa | 0.0314 | 0.0335 | 0.0021 | 16 | 5.87 |
| La Salle | 0.0369 | 0.0349 | -0.0020 | 17 | 5.58 |
| Boulder Reservoir | 0.0377 | 0.0395 | 0.0018 | 18 | 5.16 |
| Chatfield State Park | 0.0398 | 0.0385 | -0.0013 | 19 | 3.93 |
| Highland Reservoir | 0.0391 | 0.0382 | -0.0009 | 20 | 3.00 |
| Evergreen | 0.0407 | 0.0400 | -0.0007 | 21 | 2.72 |
| Pueblo West | 0.0390 | 0.0390 | 0.0000 | 22 | 1.07 |
| CAMP | 0.0327 | 0.0327 | 0.0000 | 23 | 1.00 |

Average $O_3$ concentrations in Colorado are highest at high elevation sites, particularly in the mountainous areas of the Central Mountains and Denver Metro/North Front Range regions, where annual average $O_3$ concentrations reach values as high as 50 ppb (Figure 11). The observation of enhanced $O_3$ concentrations with elevation in Colorado has been attributed to the low availability of nitric oxide (NO), which typically acts to reduce $O_3$ concentrations. High average concentrations are also observed in the suburban and rural regions immediately surrounding the Denver Metro area. Removal bias tends to be highest for these sites due to the steep gradient in average $O_3$ concentration that exists from the city center to the outlying suburban and rural regions. This gradient is a well-known feature of the spatial distribution of $O_3$ concentrations in and around large cities, where concentrations are depressed via $NO_x$ titration in the urban center and reach maximum values along the suburban fringe (Sillman, 1999). In Figure 12, measured values are plotted against modeled (i.e., interpolated) values.

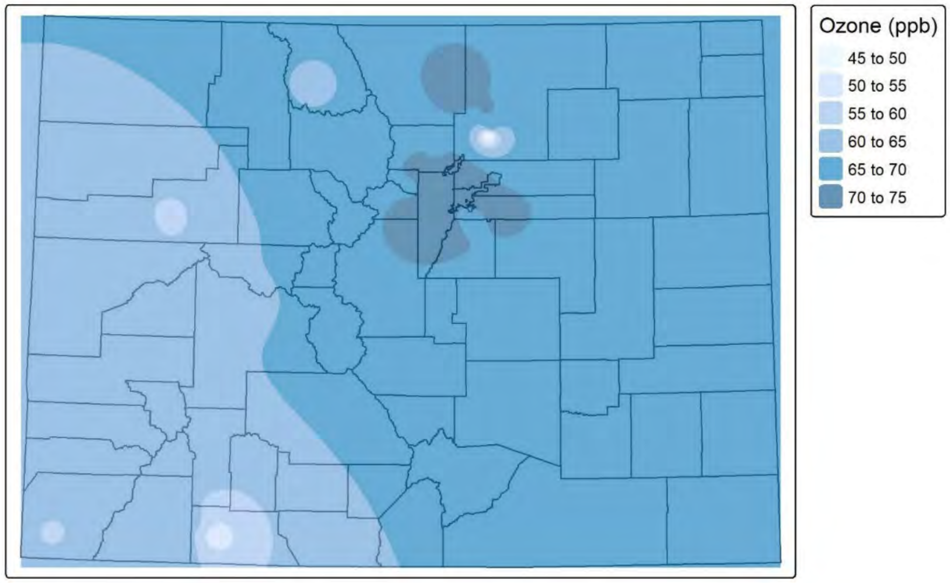


Figure 11. Interpolation map for $O_3$.

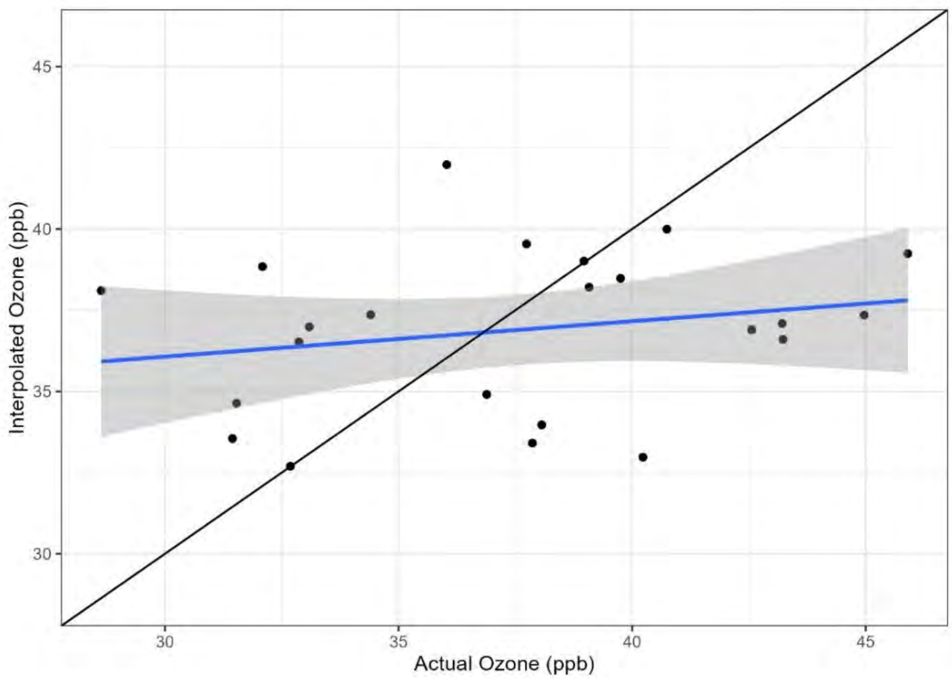


Figure 12. Removal bias for $O_3$ with actual concentration values plotted against modeled (i.e., interpolated) values.

## 2.6.2 $PM_{10}$

Table 34. $PM_{10}$ monitoring sites ordered and ranked by removal bias.

| Site Name | Avg. Concentration (2020-2024) | Interpolated Concentration | Removal Bias | Rank | Score |
|---|---|---|---|---|---|
| Boulder - CU | 15.49 | 27.63 | 12.14 | 1 | 16.0 |
| La Casa | 22.01 | 29.44 | 7.43 | 2 | 9.8 |

| Site Name | Avg. Concentration (2020-2024) | Interpolated Concentration | Removal Bias | Rank | Score |
|---|---|---|---|---|---|
| Steamboat Springs | 15.87 | 22.41 | 6.53 | 3 | 8.6 |
| Aspen | 15.13 | 21.42 | 6.29 | 4 | 8.3 |
| Cañon City - City Hall | 15.84 | 20.89 | 5.06 | 5 | 6.7 |
| Colorado College | 17.46 | 21.88 | 4.41 | 6 | 5.8 |
| Birch Street | 36.00 | 32.41 | -3.59 | 7 | 4.7 |
| Telluride | 16.74 | 20.28 | 3.53 | 8 | 4.7 |
| CAMP | 27.89 | 24.47 | -3.42 | 9 | 4.5 |
| Lamar - Municipal Bldg. | 24.81 | 21.85 | -2.96 | 10 | 3.9 |
| Grand Junction - Powell Bldg. | 16.73 | 19.62 | 2.90 | 11 | 3.8 |
| Longmont - Municipal Bldg. | 25.44 | 23.02 | -2.42 | 12 | 3.2 |
| Welby | 32.97 | 35.20 | 2.23 | 13 | 2.9 |
| Alamosa - ASC | 22.28 | 20.17 | -2.11 | 14 | 2.8 |
| Pagosa Springs School | 21.29 | 19.89 | -1.40 | 15 | 1.9 |
| Pueblo - Fountain School | 20.32 | 19.56 | -0.75 | 16 | 1.0 |

Average annual $PM_{10}$ concentrations in Colorado are typically highest in the Denver Metro/North Front Range region, particularly at monitoring sites located near the city center, where emission density is typically highest (Figure 13).

Although dust storms occur infrequently, these events have a significant effect on the statistics calculated from the data. Sites impacted by dust storms have median values that are 3-7 µg $m^{-3}$ lower than their mean values, and coefficients of variation (CV; the ratio of the standard deviation to the mean) that are greater than or equal to one. In other words, although average $PM_{10}$ concentrations on the Eastern High Plains regions appear high, this is mostly a result of windblown dust events that skew the statistics. In terms of median values, the highest concentrations are observed at the Birch Street and Welby sites in central Denver. There is no apparent spatial trend in the removal bias results, although sites impacted by dust storms do tend to rank high in this analysis.

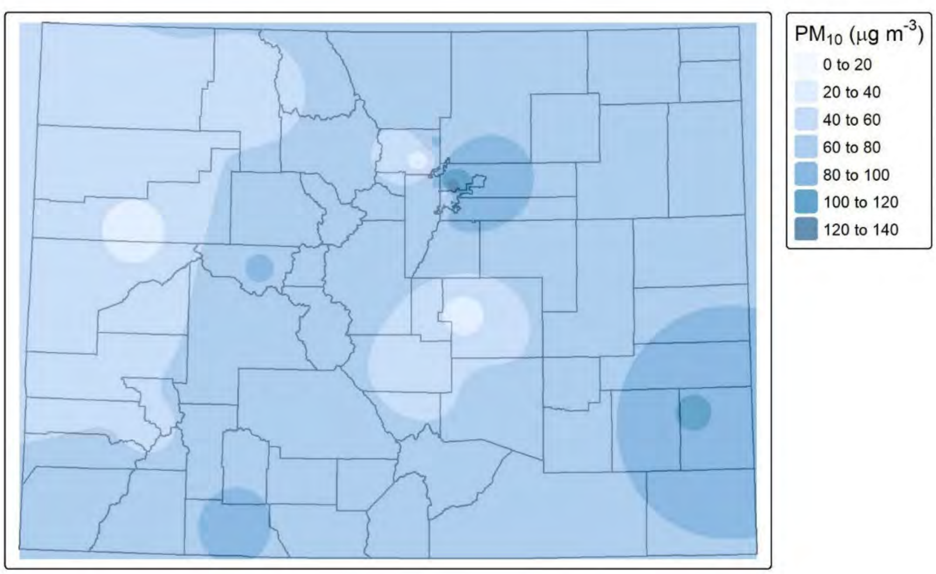


Figure 13. Interpolation map for $PM_{10}$.

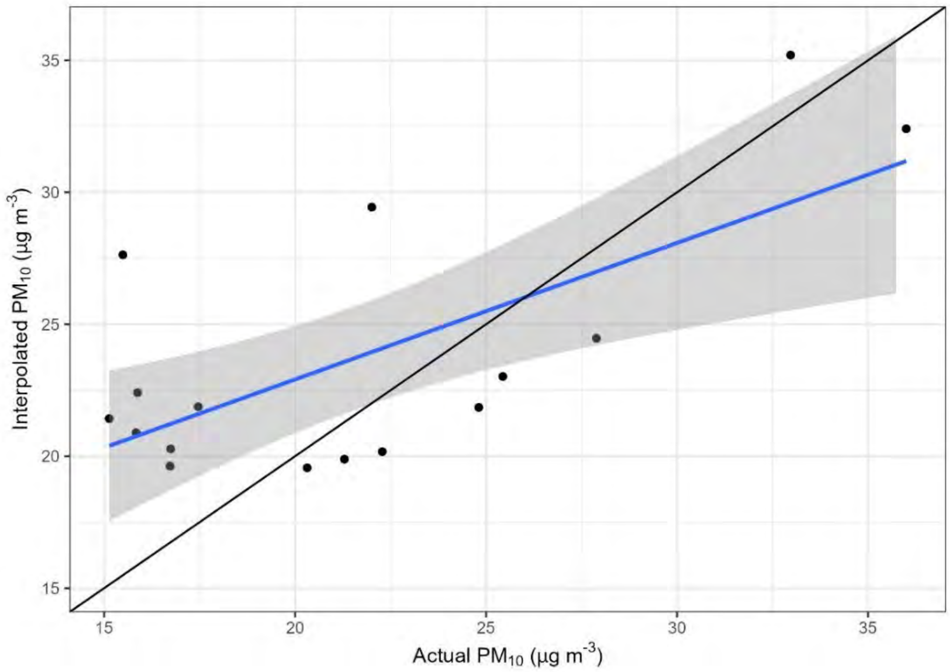


Figure 14. Removal bias for $PM_{10}$ with actual concentration values plotted against modeled (i.e., interpolated) values.

### 2.6.3 $PM_{2.5}$

Table 35. $PM_{2.5}$ monitoring sites ordered and ranked by removal bias.

| Site Name | Avg. Concentration (2020-2024) | Interpolated Concentration | Removal Bias | Rank | Score |
|---|---|---|---|---|---|
| Aspen | 3.24 | 6.46 | 3.22 | 1 | 21.0 |
| Boulder - CU | 4.39 | 7.24 | 2.85 | 2 | 18.6 |
| Bethke | 5.11 | 7.07 | 1.95 | 3 | 12.9 |
| I-25: Globeville | 8.37 | 6.94 | -1.43 | 4 | 9.6 |
| La Casa | 6.78 | 8.06 | 1.28 | 5 | 8.6 |
| Pueblo - Fountain School | 4.87 | 6.14 | 1.26 | 6 | 8.5 |
| Arapaho Community College (ACC) | 5.54 | 6.74 | 1.20 | 7 | 8.1 |
| Colorado College | 5.25 | 6.37 | 1.12 | 8 | 7.6 |
| Greeley - Hospital | 7.73 | 6.66 | -1.07 | 9 | 7.3 |
| Platteville - Middle School | 7.98 | 6.96 | -1.02 | 10 | 7.0 |
| Fort Collins - CSU | 6.83 | 5.81 | -1.02 | 11 | 7.0 |
| Longmont - Municipal Bldg. | 7.59 | 6.60 | -0.99 | 12 | 6.8 |
| Lamar - Municipal Bldg. | 5.38 | 6.30 | 0.93 | 13 | 6.4 |
| Welby | 6.84 | 7.74 | 0.90 | 14 | 6.2 |
| Birch Street | 7.79 | 6.93 | -0.85 | 15 | 5.9 |
| Grand Junction - Powell Bldg. | 5.13 | 5.88 | 0.75 | 16 | 5.2 |
| Chatfield State Park | 5.69 | 6.32 | 0.63 | 17 | 4.5 |
| Alamosa - ASC | 5.67 | 6.00 | 0.33 | 18 | 2.6 |
| National Jewish Health (NJH) | 7.17 | 7.45 | 0.28 | 19 | 2.3 |
| CAMP | 7.56 | 7.38 | -0.18 | 20 | 1.6 |
| I-25: Denver | 7.46 | 7.38 | -0.09 | 21 | 1.0 |

Average annual $PM_{2.5}$ concentrations in Colorado are typically highest at sites located in the Denver Metro/North Front Range region (Figure 15). Due to steep gradients in $PM_{2.5}$ concentrations in and around this area, removal bias also tends to be higher for these sites.

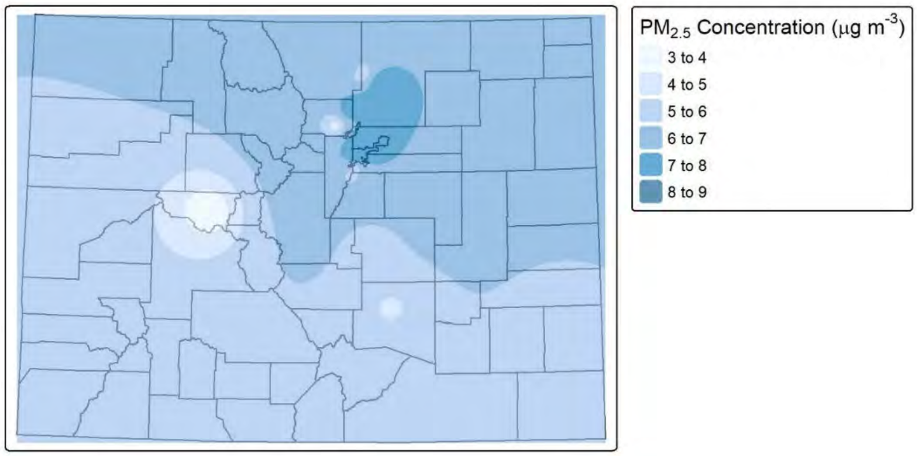


Figure 15. Interpolation map for $PM_{2.5}$.

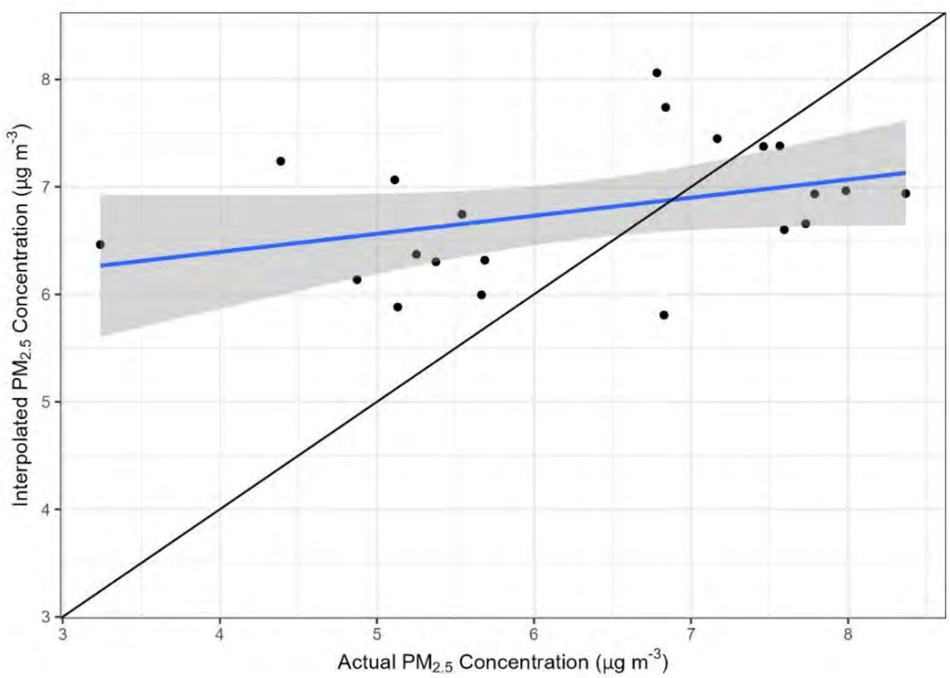


Figure 16. Removal bias results for $PM_{2.5}$.

## 2.7 Area Served

This analysis ranks monitoring sites in each network based on the extent of their spatial coverage, i.e., the size of their Area Served polygons. Conceptually, this zone represents the area around the monitoring site that is close enough to be represented by the concentrations measured at the monitor. The appropriate size and shape of this area is difficult to define precisely. The most common technique used to determine the spatial coverage of an air pollution monitor involves applying Thiessen polygons (also known as Voronoi diagrams) to represent each monitor's area of representation (Pope and Wu, 2014). Thiessen polygons are commonly used in geography to assign a zone of influence around a point or in place of interpolation techniques to generalize a set of sample measurements to the areas closest to them. They are created by delineating an area around a monitoring site in which each point is closer to that monitoring site than any other monitoring site.

The Thiessen polygon technique is a purely spatial construct and does not take into account meteorology, landscape topography, or other factors that may influence the extent of a monitor's spatial coverage. Therefore, while the technique may be appropriate for states with dense monitoring networks (e.g., California) or simple topography (e.g., Florida), its utility is limited in Colorado due to the sparseness of monitoring sites and the complexity of the terrain. For example, the presence of distinct meteo-geographical boundaries within Colorado (e.g., the Continental Divide, Palmer Divide, Cheyenne Ridge, etc.) limits atmospheric transport between airsheds, effectively separating regions of similar air quality and similar sources of air pollution (see Section 1.4.4). This can lead to some unreasonable results in the application of the Thiessen polygon technique, such as polygons that intersect the Continental Divide. Therefore, the Thiessen polygon approach has been modified in the present case: for airsheds possessing only one monitor, Thiessen polygons have not been constructed; rather, the entire area of the airshed has been assigned to that monitor. For airsheds possessing multiple monitors, Thiessen polygons have been drawn to assign coverage areas to each monitor within the airshed; however, the polygons were clipped such that they would not intersect airshed boundaries.

Restricting the Area Served polygons to airshed boundaries produces a more reasonable approximation of the extent of each monitoring site's spatial coverage; however, some polygons are so large that the monitoring point could not be said to adequately represent the entire area. For example, several of the polygons for $PM_{2.5}$ have dimensions of over 100 km, while the monitor-to-monitor correlation study described in Section 2.5.6 suggests that $PM_{2.5}$ concentrations are only weakly correlated over this distance of separation (Figure 10). Therefore, we have imposed a further restriction on the ultimate size of each monitor's area of representation: for each pollutant network, we have used the parameter correlograms presented in Section 2.5 to define a maximum radius of spatial extent as the distance where the correlation coefficient between monitors drops below an $r^2$ value of 0.6 (i.e., the maximum distance at which sites are still well-correlated according to the monitor-to-monitor correlation study). This maximum radius of spatial extent was then used as an upper-limit on the size of each Area Served polygon. The maximum spatial extent values for the CO, $NO_2$, $O_3$, $PM_{10}$, and $PM_{2.5}$ networks are 16.5, 17.1, 91.3, 11.4, and 17.1 km, respectively. The correlogram for $SO_2$ was not robust enough to derive a maximum radius value due to the limited availability of data from within the state; therefore, we have assumed a value of 11.4 km for the $SO_2$ network (i.e., the value obtained from the CO correlogram).

In the following section, maps are presented showing the Area Served polygons derived for each APCD monitoring network. The accompanying tables show the results of the Area Served analysis and the associated scores and rankings for each site. Note that the presence of monitoring sites operated by other agencies in Colorado has not been considered in the delineation of the Area Served polygons for the APCD sites being assessed in this report.

### 2.7.1 Carbon Monoxide (CO)

Table 36. All APCD CO monitoring sites ranked by area served.

| Site Name | Area Served ($km^2$) | Rank | Score |
|---|---|---|---|
| Greeley - Weld County Tower | 855 | 1 | 5.0 |
| Fort Collins - Mason | 855 | 1 | 5.0 |
| Colorado College | 848 | 2 | 4.9 |
| I-25: Denver | 515 | 3 | 1.0 |
| La Casa | 515 | 3 | 1.0 |

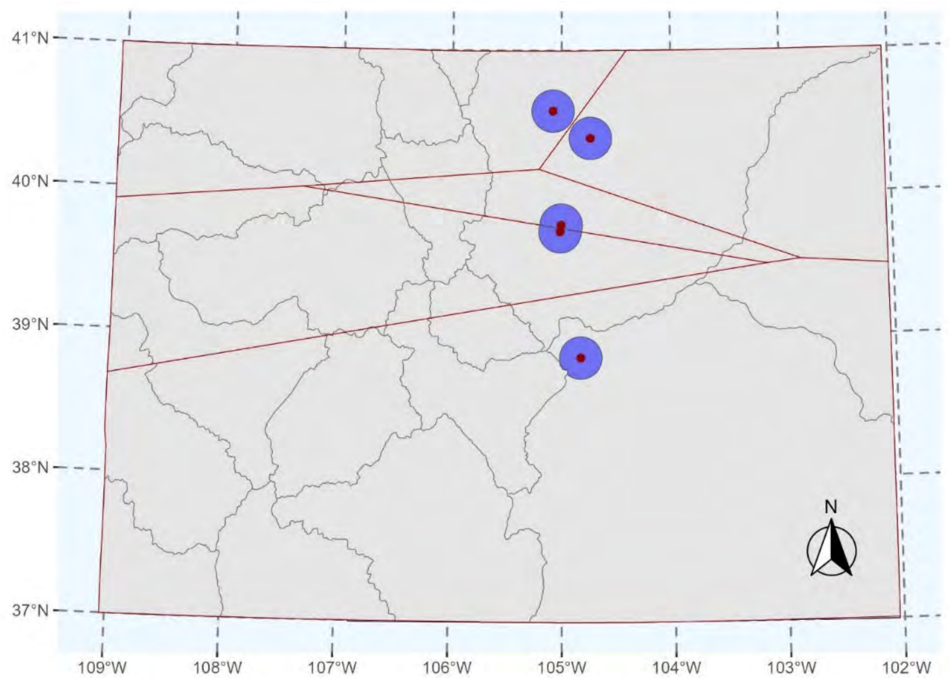


Figure 17. Map of Colorado showing the Area served polygons derived for the CO monitoring network.

## 2.7.2 Nitrogen Dioxide ($NO_2$)

Table 37. All APCD $NO_2$ monitoring sites ranked by area served.

| Site Name | Area Served ($km^2$) | Rank | Score |
|---|---|---|---|
| La Salle | 918 | 1 | 9.00 |
| Rocky Flats - N. | 772 | 2 | 7.67 |
| Fossil Creek | 572 | 3 | 5.84 |
| Bethke | 572 | 3 | 5.84 |
| Welby | 501 | 4 | 5.21 |
| I-25: Denver | 430 | 5 | 4.56 |
| CAMP | 181 | 6 | 2.29 |
| La Casa | 104 | 7 | 1.59 |
| I-25: Globeville | 39 | 8 | 1.00 |

9

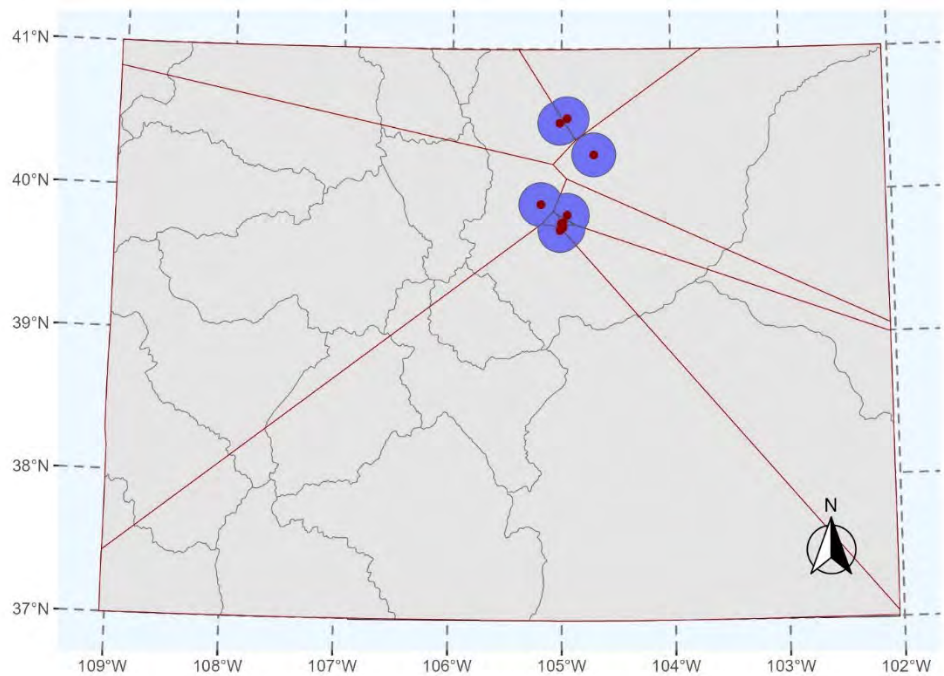


Figure 18. Map of Colorado showing the Area served polygons derived for the $NO_2$ monitoring network.

### 2.7.3 Sulfur Dioxide ($SO_2$)

Table 38. All APCD $SO_2$ monitoring sites ranked by area served.

| Site Name | Area Served (km$^2$) | Rank | Score |
|---|---|---|---|
| Welby | 286 | 1 | 3.0 |
| CAMP | 228 | 2 | 2.2 |
| La Casa | 148 | 3 | 1.0 |

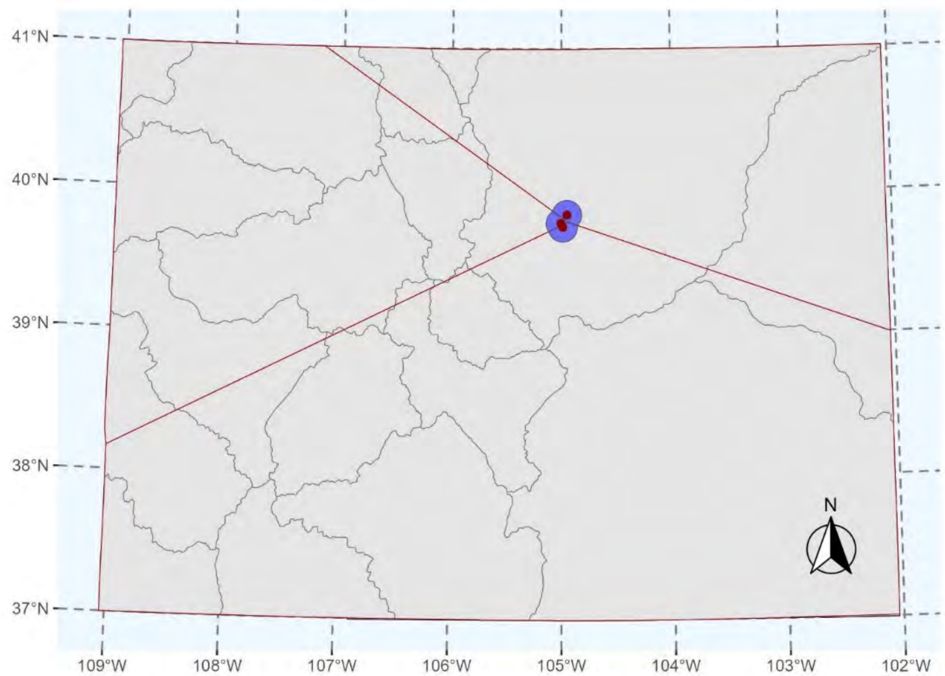


Figure 19. Map of Colorado showing the Area served polygons derived for the $SO_2$ monitoring network.

### 2.7.4 Ozone ($O_3$)

Table 39. All APCD $O_3$ monitoring sites ranked by area served

| Site Name | Area Served (km$^2$) | Rank | Score |
|---|---|---|---|
| Pueblo West | 15,974 | 1 | 23.0 |
| Palisade Water Treatment | 10,145 | 2 | 14.9 |
| Rifle - Health Dept. | 9,505 | 3 | 14.0 |
| Aurora - East | 7,971 | 4 | 11.9 |
| Cortez - Health Dept. | 6,083 | 5 | 9.3 |
| Greeley - Weld County Tower | 4,755 | 6 | 7.4 |
| La Salle | 4,528 | 7 | 7.1 |
| Fort Collins - West | 4,337 | 8 | 6.9 |
| U.S. Air Force Academy (USAFA) | 4,197 | 9 | 6.7 |
| Boulder Reservoir | 2,125 | 10 | 3.8 |
| Evergreen | 1,706 | 11 | 3.2 |
| Black Hawk | 1,664 | 12 | 3.2 |
| Bethke | 1,553 | 13 | 3.0 |
| Manitou Springs | 1,495 | 14 | 2.9 |
| Chatfield State Park | 1,451 | 15 | 2.9 |
| Welby | 960 | 16 | 2.2 |
| Highland Reservoir | 924 | 17 | 2.1 |
| Fort Collins - Mason | 906 | 18 | 2.1 |
| Fossil Creek | 696 | 19 | 1.8 |
| Rocky Flats - N. | 501 | 20 | 1.5 |
| NREL | 376 | 21 | 1.4 |
| CAMP | 289 | 22 | 1.2 |
| La Casa | 111 | 23 | 1.0 |

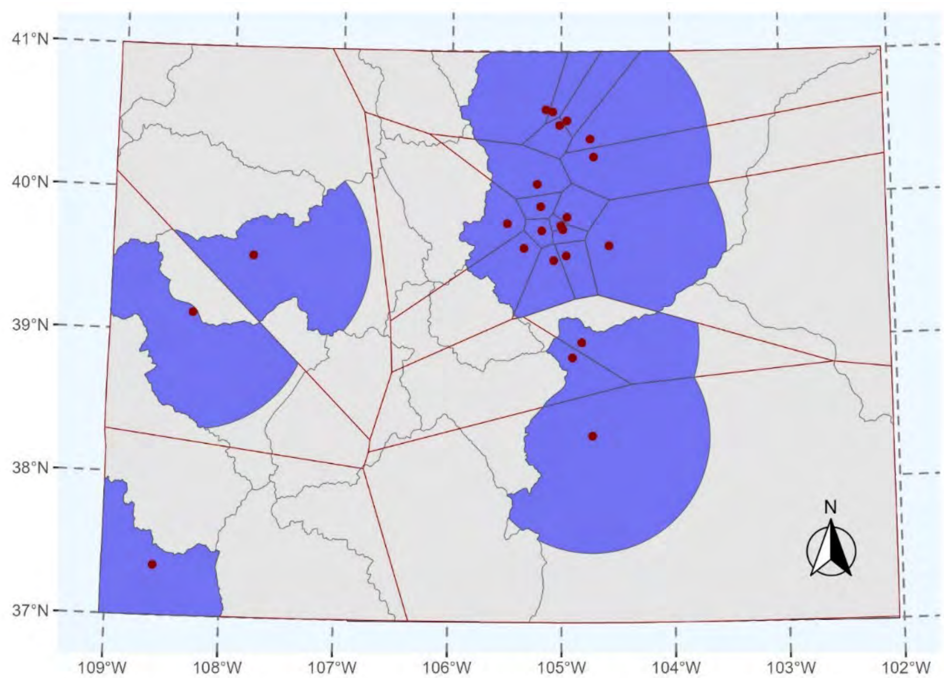


Figure 20. Map of Colorado showing the Area served polygons derived for the $O_3$ monitoring network.

### 2.7.5 $PM_{10}$

Table 40. All APCD $PM_{10}$ monitoring sites ranked by area served.

| Site Name | Area Served ($km^2$) | Rank | Score |
|---|---|---|---|
| Colorado College | 408 | 1 | 16.0 |
| Alamosa - ASC | 408 | 1 | 16.0 |
| Lamar - Municipal Bldg. | 408 | 1 | 16.0 |
| Steamboat Springs | 408 | 1 | 16.0 |
| Pagosa Springs School | 408 | 1 | 16.0 |
| Grand Junction - Powell Bldg. | 408 | 1 | 16.0 |
| Aspen | 408 | 1 | 16.0 |
| Pueblo - Fountain School | 408 | 1 | 16.0 |
| Longmont - Municipal Bldg. | 407 | 2 | 15.9 |
| Boulder - CU | 407 | 2 | 15.9 |
| Telluride | 254 | 3 | 7.2 |
| CAMP | 218 | 4 | 5.1 |
| Cañon City - City Hall | 213 | 5 | 4.8 |
| Welby | 167 | 6 | 2.2 |
| Birch Street | 150 | 7 | 1.2 |
| La Casa | 146 | 8 | 1.0 |

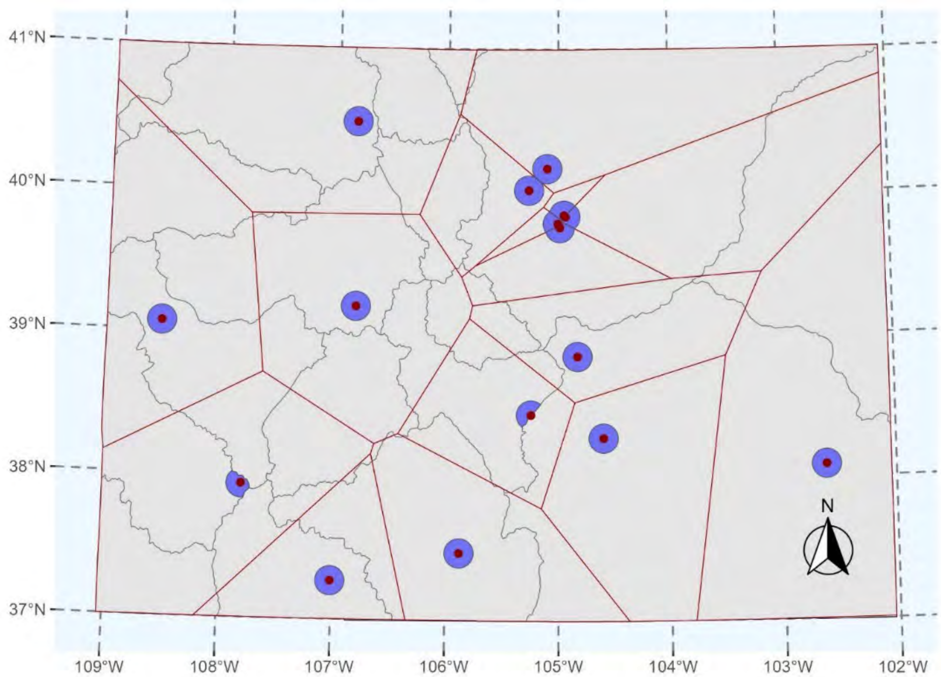


Figure 21. Map of Colorado showing the Area served polygons derived for the $PM_{10}$ monitoring network.

### 2.7.6 $PM_{2.5}$

Table 41. All APCD $PM_{2.5}$ monitoring sites ranked by area served.

| Site Name | Area Served ($km^2$) | Rank | Score |
|---|---|---|---|
| Lamar - Municipal Bldg. | 918 | 1 | 21.0 |
| Alamosa - ASC | 918 | 1 | 21.0 |
| Pueblo - Fountain School | 918 | 1 | 21.0 |
| Aspen | 918 | 1 | 21.0 |
| Grand Junction - Powell Bldg. | 914 | 2 | 20.9 |
| Colorado College | 906 | 3 | 20.7 |
| Boulder - CU | 805 | 4 | 18.5 |
| Platteville - Middle School | 759 | 5 | 17.5 |
| Greeley - Hospital | 750 | 6 | 17.3 |
| Longmont - Municipal Bldg. | 723 | 7 | 16.7 |
| Fort Collins - CSU | 670 | 8 | 15.5 |
| Chatfield State Park | 610 | 9 | 14.2 |
| Bethke | 577 | 10 | 13.4 |
| Arapaho Community College (ACC) | 354 | 11 | 8.5 |
| Welby | 330 | 12 | 7.9 |
| National Jewish Health (NJH) | 290 | 13 | 7.1 |
| Birch Street | 226 | 14 | 5.6 |
| I-25: Denver | 211 | 15 | 5.3 |
| La Casa | 174 | 16 | 4.5 |
| I-25: Globeville | 29 | 17 | 1.3 |
| CAMP | 16 | 18 | 1.0 |

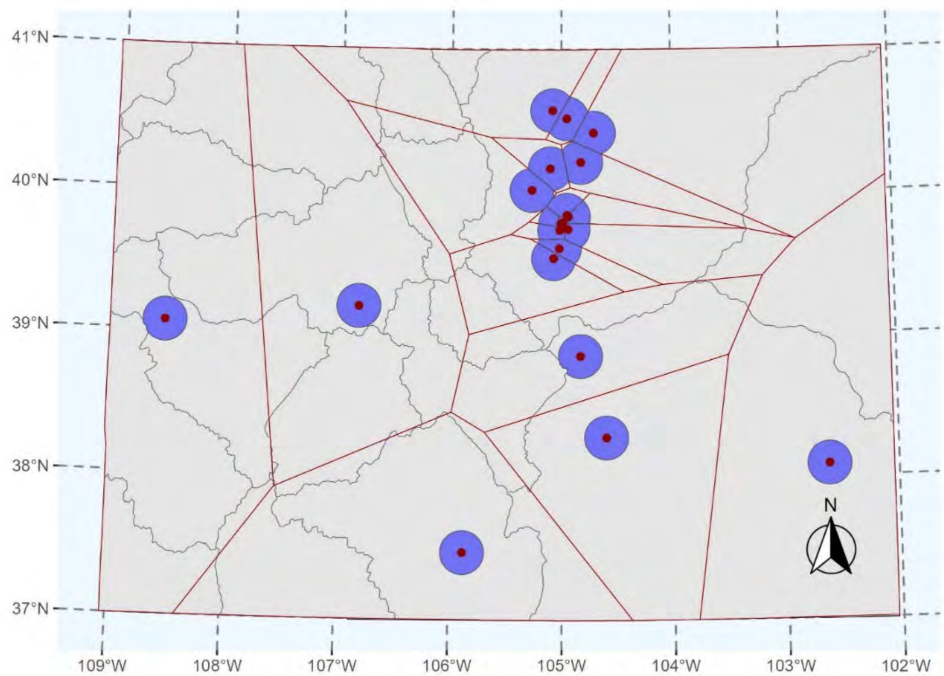


Figure 22. Map of Colorado showing the Area served polygons derived for the $PM_{2.5}$ monitoring network.

## 2.8 Population Served

This analysis attempts to quantify the population represented by each monitoring site. It has been well-established that high population densities are associated with high emissions and high ambient pollutant concentrations; therefore, monitors representing more population will typically be of greater importance in determining regulatory compliance. Furthermore, the collection of data that is representative of the greatest possible number of people is an important monitoring objective; therefore, monitors with the highest population counts are given the highest rank in this analysis.

Calculating the population served by a particular monitor requires two steps: (1) a determination of the area of representation for each monitor, and (2) a determination of the population within each monitor's area of representation. Areas of representation for each monitor were determined using a modified Thiessen polygon approach as described in Section 2.7. Tract-level data from the 2019-2023 ACS was then used within ArcGIS to create a polygon coverage map of census tracts within Colorado, which is presented in Figure 3. The population within each monitor's Area Served polygon was then determined by summing the population count totals for those census tract polygons that intersect each Area Served polygon.

The advantage of this analysis is that it provides a simple technique to quantify the population represented by a particular monitor. This technique will provide more weight to sites located in areas of high population density and sites with large areas of representation.

### 2.8.1 Results for All Parameters

Tables 42-47 list the Population Served and associated score for each APCD monitoring site in the CO, $NO_2$, $SO_2$, $O_3$, $PM_{10}$, and $PM_{2.5}$ ambient networks, respectively.

Table 42. All APCD CO monitoring sites ranked by population served.

| Site Name | Population Served | Rank | Score |
|---|---|---|---|
| I-25: Denver | 1,088,550 | 1 | 5.0 |
| La Casa | 845,672 | 2 | 3.9 |
| Colorado College | 628,817 | 3 | 2.9 |
| Fort Collins - Mason | 316,893 | 4 | 1.5 |
| Greeley - Weld County Tower | 212,972 | 5 | 1.0 |

Table 43. All APCD $NO_2$ monitoring sites ranked by population served.

| Site Name | Population Served | Rank | Score |
|---|---|---|---|
| I-25: Denver | 755664 | 1 | 9.0 |
| CAMP | 580571 | 2 | 6.9 |
| Welby | 573781 | 3 | 6.8 |
| Rocky Flats - N. | 436649 | 4 | 5.1 |
| Fossil Creek | 342969 | 5 | 4.0 |
| La Casa | 246725 | 6 | 2.8 |
| Bethke | 160682 | 7 | 1.7 |
| La Salle | 148706 | 8 | 1.6 |
| I-25: Globeville | 99346 | 9 | 1.0 |

Table 44. All APCD $SO_2$ monitoring sites ranked by population served.

| Site Name | Population Served | Rank | Score |
|---|---|---|---|
| CAMP | 711,562 | 1 | 3.0 |
| Welby | 447,339 | 2 | 1.6 |
| La Casa | 325,576 | 3 | 1.0 |

Table 45. All APCD $O_3$ monitoring sites ranked by population served.

| Site Name | Population Served | Rank | Score |
|---|---|---|---|
| CAMP | 864,191 | 1 | 23.0 |
| Highland Reservoir | 791,196 | 2 | 21.0 |
| Welby | 691,453 | 3 | 18.4 |
| U.S. Air Force Academy (USAFA) | 470,843 | 4 | 12.5 |
| Manitou Springs | 396,734 | 5 | 10.5 |
| Boulder Reservoir | 373,429 | 6 | 9.9 |
| Aurora - East | 327,811 | 7 | 8.7 |
| NREL | 314,675 | 8 | 8.3 |
| Rocky Flats - N. | 286,966 | 9 | 7.6 |
| La Casa | 273,749 | 10 | 7.2 |
| Pueblo West | 269,298 | 11 | 7.1 |
| Chatfield State Park | 245,066 | 12 | 6.5 |
| Palisade Water Treatment | 241,973 | 13 | 6.4 |
| Fossil Creek | 226,348 | 14 | 6.0 |
| Greeley - Weld County Tower | 214,248 | 15 | 5.6 |
| Fort Collins - Mason | 198,945 | 16 | 5.2 |
| La Salle | 159,356 | 17 | 4.2 |
| Rifle - Health Dept. | 126,142 | 18 | 3.3 |
| Bethke | 110,768 | 19 | 2.9 |
| Fort Collins - West | 96,937 | 20 | 2.5 |
| Evergreen | 82,341 | 21 | 2.1 |
| Black Hawk | 54,819 | 22 | 1.4 |
| Cortez - Health Dept. | 41,008 | 23 | 1.0 |

Table 46. All APCD $PM_{10}$ monitoring sites ranked by population served.

| Site Name | Population Served | Rank | Score |
|---|---|---|---|
| CAMP | 697,063 | 1 | 16.0 |
| Colorado College | 453,531 | 2 | 10.7 |
| Welby | 347,325 | 3 | 8.4 |
| La Casa | 321,139 | 4 | 7.8 |
| Boulder - CU | 176,370 | 5 | 4.6 |
| Birch Street | 173,290 | 6 | 4.5 |
| Longmont - Municipal Bldg. | 169,783 | 7 | 4.5 |
| Pueblo - Fountain School | 148,267 | 8 | 4.0 |
| Grand Junction - Powell Bldg. | 140,137 | 9 | 3.8 |
| Cañon City - City Hall | 25,004 | 10 | 1.3 |
| Steamboat Springs | 22,872 | 11 | 1.3 |
| Alamosa - ASC | 16,515 | 12 | 1.1 |
| Lamar - Municipal Bldg. | 14,470 | 13 | 1.1 |
| Pagosa Springs School | 13,730 | 14 | 1.1 |
| Aspen | 13,100 | 15 | 1.0 |
| Telluride | 10,955 | 16 | 1.0 |

Table 47. All APCD $PM_{2.5}$ monitoring sites ranked by population served.

| Site Name | Population Served | Rank | |
|---|---|---|---|
| National Jewish Health (NJH) | 720,679 | 1 | 21.0 |
| Colorado College | 632,169 | 2 | 18.5 |
| Arapaho Community College (ACC) | 548,096 | 3 | 16.1 |
| Welby | 456,245 | 4 | 13.5 |
| I-25: Denver | 418,831 | 5 | 12.5 |
| La Casa | 318,219 | 6 | 9.6 |
| Boulder - CU | 262,420 | 7 | 8.0 |
| Fort Collins - CSU | 255,963 | 8 | 7.8 |
| Longmont - Municipal Bldg. | 221,737 | 9 | 6.9 |
| Bethke | 204,144 | 10 | 6.4 |
| Birch Street | 199,357 | 11 | 6.2 |
| Greeley - Hospital | 196,688 | 12 | 6.2 |
| Chatfield State Park | 193,106 | 13 | 6.1 |
| Pueblo - Fountain School | 168,726 | 14 | 5.4 |
| Grand Junction - Powell Bldg. | 157,316 | 15 | 5.0 |
| CAMP | 120,020 | 16 | 4.0 |
| Platteville - Middle School | 100,429 | 17 | 3.4 |
| I-25: Globeville | 73,745 | 18 | 2.7 |
| Alamosa - ASC | 23,217 | 19 | 1.2 |
| Aspen | 17,119 | 20 | 1.1 |
| Lamar - Municipal Bldg. | 14,470 | 21 | 1.0 |

## 2.9 DIC Population Served

Some communities in Colorado face higher levels of environmental and health risks due to factors like pollution and climate change. In 2021, the state legislature established a definition for disproportionately impacted communities (DICs) to identify these areas. The definition was revised in 2023 based on recommendations from the Environmental Justice Action Task Force, as outlined in Section 24-4-109 of the Colorado Revised Statutes. It is updated annually, with the most recent update in November 2024.

The Colorado EnviroScreen tool, released in June 2022 by the Colorado Department of Public Health and Environment (CDPHE), was developed to support the implementation of C.R.S. 24-4-109. The tool is designed to assist state and local agencies in identifying communities that are disproportionately impacted by environmental and public health stressors. It provides a standardized, data-driven approach to inform resource allocation, policy development, and program implementation in alignment with the state's environmental justice goals.

EnviroScreen[2] operates through an interactive, web-based mapping platform that integrates demographic, health, environmental, and socioeconomic indicators. Each census block group in the state receives a cumulative impact score ranging from 0 to 100. Census block groups scoring at or above the 80th percentile are presumptively identified as disproportionately impacted communities (DICs) under state policy.

The DIC Population Served analysis attempts to quantify the population represented by each monitoring site that resides in a DIC. Calculating the DIC Population Served by a particular monitor requires two steps: (1) a determination of the area of representation for each monitor, (2) a determination of the

[2] https://cdphe.colorado.gov/enviroscreen

population within each monitor's area of representation, and (3) a determination of the average DIC score as calculated by EnviroScreen. Areas of representation for each monitor were determined using a modified Thiessen polygon approach as described in Section 2.7. Tract-level data from the 2019-2023 ACS was then used within ArcGIS to create a polygon coverage map of census tracts within Colorado, which is presented in Figure 3. The population within each monitor's Area Served polygon was then determined by summing the population count totals for those census tract polygons that intersect each Area Served polygon. The total population was then multiplied by the average DIC percentile score for the Area Served polygon, calculated using block-level data from Colorado EnviroScreen.

The advantage of this analysis is that it provides a simple technique to quantify the DIC population represented by a particular monitor. This technique will provide more weight to sites located in DIC communities of high population density and sites with large areas of representation.

### 2.9.1 Results for All Parameters

Tables 48-53 list the DIC Population Served and associated score for each APCD monitoring site in the CO, $NO_2$, $SO_2$, $O_3$, $PM_{10}$, and $PM_{2.5}$ ambient networks, respectively.

Table 48. All APCD CO monitoring sites ranked by DIC population served.

| Site Name | DIC Population Served | Rank | Score |
|---|---|---|---|
| La Casa | 524,308 | 1 | 5.0 |
| I-25: Denver | 494,526 | 2 | 4.7 |
| Colorado College | 279,217 | 3 | 2.6 |
| Greeley - Weld County Tower | 150,549 | 4 | 1.4 |
| Fort Collins - Mason | 108,395 | 5 | 1.0 |

Table 49. All APCD $NO_2$ monitoring sites ranked by DIC population served.

| Site Name | DIC Population Served | Rank | Score |
|---|---|---|---|
| Welby | 394,792 | 1 | 9.0 |
| I-25: Denver | 324,172 | 2 | 7.3 |
| CAMP | 298,666 | 3 | 6.6 |
| La Casa | 143,229 | 4 | 2.8 |
| La Salle | 116,624 | 5 | 2.2 |
| Rocky Flats - N. | 114,985 | 6 | 2.1 |
| Fossil Creek | 114,352 | 7 | 2.1 |
| I-25: Globeville | 81,489 | 8 | 1.3 |
| Bethke | 69,785 | 9 | 1.0 |

Table 50. All APCD $SO_2$ monitoring sites ranked by DIC population served.

| Site Name | DIC Population Served | Rank | Score |
|---|---|---|---|
| CAMP | 365,953 | 1 | 3.0 |
| Welby | 326,800 | 2 | 2.6 |
| La Casa | 191,004 | 3 | 1.0 |

Table 51. All APCD $O_3$ monitoring sites ranked by DIC population served.

| Site Name | DIC Population Served | Rank | Score |
|---|---|---|---|
| CAMP | 490,448 | 1 | 23.0 |
| Welby | 486,625 | 2 | 22.8 |
| Highland Reservoir | 256,632 | 3 | 12.2 |
| Manitou Springs | 193,697 | 4 | 9.3 |

| Site Name | DIC Population Served | Rank | Score |
|---|---|---|---|
| La Casa | 175,633 | 5 | 8.4 |
| U.S. Air Force Academy (USAFA) | 170,245 | 6 | 8.2 |
| Pueblo West | 167,136 | 7 | 8.0 |
| Aurora - East | 163,820 | 8 | 7.9 |
| Greeley - Weld County Tower | 153,063 | 9 | 7.4 |
| Palisade Water Treatment | 150,974 | 10 | 7.3 |
| Boulder Reservoir | 139,869 | 11 | 6.8 |
| NREL | 126,641 | 12 | 6.2 |
| La Salle | 110,660 | 13 | 5.4 |
| Rocky Flats - N. | 75,150 | 14 | 3.8 |
| Fort Collins - Mason | 74,136 | 15 | 3.7 |
| Fossil Creek | 73,321 | 16 | 3.7 |
| Rifle - Health Dept. | 67,943 | 17 | 3.4 |
| Chatfield State Park | 65,818 | 18 | 3.3 |
| Bethke | 43,010 | 19 | 2.3 |
| Fort Collins - West | 36,395 | 20 | 2.0 |
| Cortez - Health Dept. | 23,724 | 21 | 1.4 |
| Evergreen | 15,332 | 22 | 1.0 |
| Black Hawk | 15,146 | 23 | 1.0 |

Table 52. All APCD $PM_{10}$ monitoring sites ranked by DIC population served.

| Site Name | DIC Population Served | Rank | Score |
|---|---|---|---|
| CAMP | 355,087 | 1 | 16.0 |
| Welby | 255,307 | 2 | 11.8 |
| Colorado College | 213,347 | 3 | 10.0 |
| La Casa | 187,891 | 4 | 8.9 |
| Birch Street | 128,680 | 5 | 6.4 |
| Pueblo - Fountain School | 97,326 | 6 | 5.0 |
| Grand Junction - Powell Bldg. | 86,649 | 7 | 4.6 |
| Longmont - Municipal Bldg. | 81,611 | 8 | 4.4 |
| Boulder - CU | 36,855 | 9 | 2.5 |
| Cañon City - City Hall | 15,185 | 10 | 1.5 |
| Alamosa - ASC | 10,588 | 11 | 1.4 |
| Lamar - Municipal Bldg. | 10,584 | 12 | 1.4 |
| Steamboat Springs | 6,846 | 13 | 1.2 |
| Pagosa Springs School | 5,260 | 14 | 1.1 |
| Aspen | 2,868 | 15 | 1.0 |
| Telluride | 2,306 | 16 | 1.0 |

Table 53. All APCD $PM_{2.5}$ monitoring sites ranked by DIC population served.

| Site Name | DIC Population Served | Rank | |
|---|---|---|---|
| National Jewish Health (NJH) | 383,043 | 1 | 21.0 |
| Colorado College | 280,022 | 2 | 15.6 |
| Welby | 276,920 | 3 | 15.4 |
| I-25: Denver | 211,655 | 4 | 12.0 |
| Arapaho Community College (ACC) | 177,985 | 5 | 10.2 |
| La Casa | 159,413 | 6 | 9.2 |
| Greeley - Hospital | 148,439 | 7 | 8.6 |
| Birch Street | 143,650 | 8 | 8.4 |
| Longmont - Municipal Bldg. | 113,143 | 9 | 6.8 |
| Pueblo - Fountain School | 107,733 | 10 | 6.5 |
| Grand Junction - Powell Bldg. | 96,381 | 11 | 5.9 |
| Fort Collins - CSU | 89,835 | 12 | 5.6 |
| Bethke | 72,571 | 13 | 4.7 |
| I-25: Globeville | 64,318 | 14 | 4.2 |
| Platteville - Middle School | 63,954 | 15 | 4.2 |
| Boulder - CU | 56,982 | 16 | 3.8 |
| CAMP | 48,612 | 17 | 3.4 |
| Chatfield State Park | 33,069 | 18 | 2.6 |
| Alamosa - ASC | 14,978 | 19 | 1.6 |
| Lamar - Municipal Bldg. | 10,584 | 20 | 1.4 |
| Aspen | 3,167 | 21 | 1.0 |

## 2.9 Emissions Inventory

This analysis ranks sites based on their proximity to point sources of pollution by giving weight to each monitor according to the sum of emissions within its area of representation. Areas of representation for each monitor were determined using a modified Thiessen polygon approach as described in Section 2.7. Point source emissions data was obtained from the 2025 APCD facilities inventory, which lists reported emissions for over 29,000 permitted sources within Colorado. Emissions data for CO, $NO_x$, $SO_2$, volatile organic compounds (VOCs), $PM_{10}$, and $PM_{2.5}$ were spatially located within ArcGIS and then summed within each monitor's Area Served polygon. Polygons with larger total emissions were ranked higher.

### 2.9.1 Carbon Monoxide (CO)

CO point source emissions density is shown for illustration purposes in Figure 23.

Table 54. CO monitoring sites ranked by total emissions.

| Site Name | Sum of CO Emissions (tons) | Maximum | Rank | Score |
|---|---|---|---|---|
| Greeley - Weld County Tower | 4346 | 282 | 1 | 5.0 |
| La Casa | 1321 | 449 | 2 | 2.0 |
| I-25: Denver | 379 | 90 | 3 | 1.1 |
| Fort Collins - Mason | 331 | 34 | 4 | 1.0 |
| Colorado College | 299 | 71 | 5 | 1.0 |

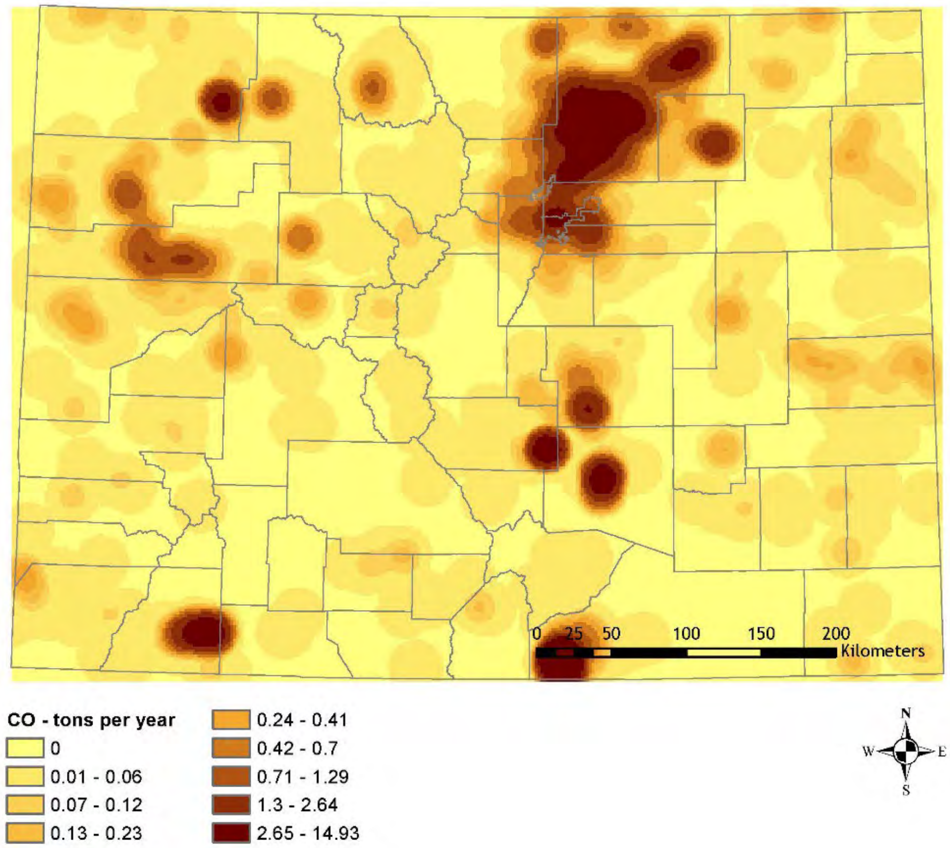


Figure 23. CO emissions density as calculated from point source data using the Kernel Density tool in ArcGIS. Class breaks have been determined using the quantile method.

### 2.9.2 Nitrogen Dioxide ($NO_2$)

$NO_x$ point source emissions density is shown for illustration purposes in Figure 24.

Table 55. $NO_2$ monitoring sites ranked by total $NO_x$ emissions.

| Site Name | Sum of $NO_x$ Emissions (tons) | Max. | Rank | Score |
|---|---|---|---|---|
| La Salle | 2797 | 394 | 1 | 9.00 |
| Bethke | 1143 | 223 | 2 | 4.19 |
| Welby | 894 | 628 | 3 | 3.46 |
| Rocky Flats - N. | 726 | 255 | 4 | 2.97 |
| I-25: Globeville | 516 | 326 | 5 | 2.36 |
| Fossil Creek | 313 | 86 | 6 | 1.77 |
| CAMP | 302 | 76 | 7 | 1.74 |
| I-25: Denver | 290 | 58 | 8 | 1.70 |
| La Casa | 48 | 16 | 9 | 1.00 |

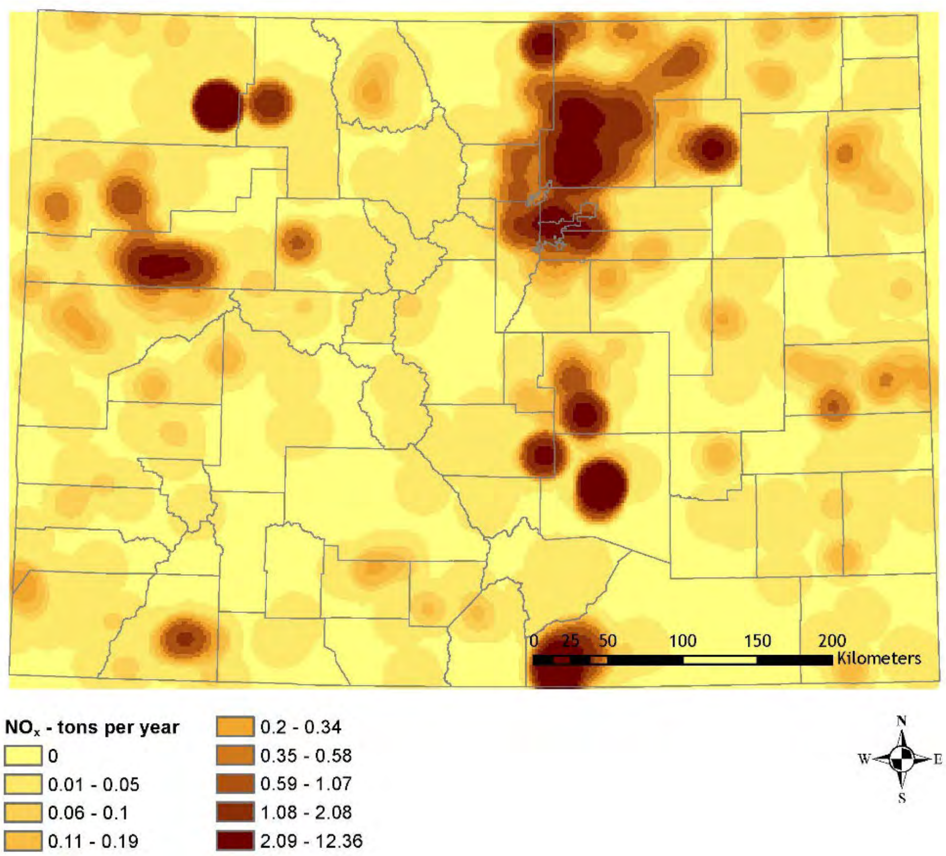


Figure 24. $NO_x$ emissions density as calculated from point source data using the Kernel Density tool in ArcGIS. Class breaks have been determined using the quantile method.

### 2.9.3 Sulfur Dioxide ($SO_2$)

$SO_2$ point source emissions density is shown in Figure 25.

Table 56. $SO_2$ monitoring sites ranked by total emissions.

| Site Name | Sum of $SO_2$ Emissions (tons) | Max. | Rank | Score |
|---|---|---|---|---|
| Welby | 332 | 214 | 1 | 3.00 |
| La Casa | 60 | 27 | 2 | 1.03 |
| CAMP | 57 | 40 | 3 | 1.00 |

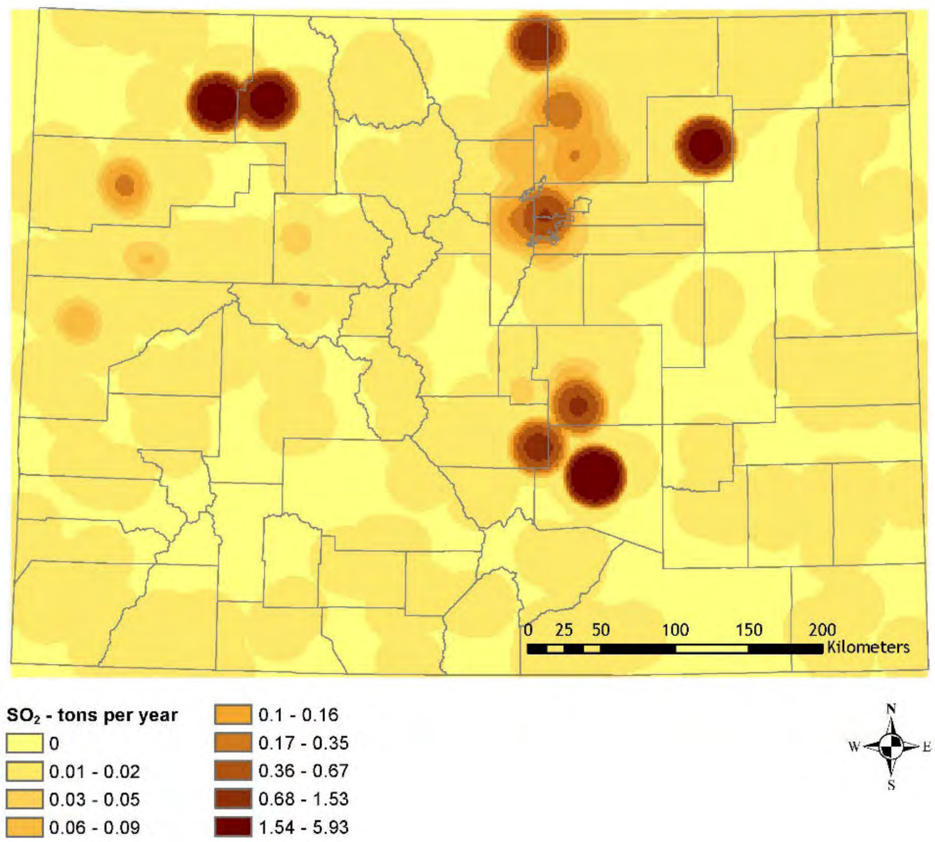


Figure 25. $SO_2$ emissions density as calculated from point source data using the Kernel Density tool in ArcGIS. Class breaks have been determined using the quantile method.

### 2.9.4 Ozone ($O_3$)

Tropospheric $O_3$ is a secondary pollutant, meaning that it is not directly emitted, but formed *in-situ* through photochemical reactions involving VOCs and $NO_x$. Furthermore, although $O_3$ requires the presence of $NO_x$ in its formation reaction, it is also scavenged, or destroyed, by $NO_x$ in the atmosphere (Sillman, 1999). Because of its complex source/sink dynamics, $O_3$ concentrations follow much different patterns than other primary pollutants. In the short-term (i.e., several hours or less), $O_3$ will form near its precursor sources and increase in concentration as the plume moves downwind and has more time to react during daylight hours. At night, when photochemical cycling has ceased, $O_3$ concentrations within the urban area will decrease as $NO_x$ compounds in the area scavenge them. However, outside of the urban areas, where $NO_x$ concentrations are typically low, $O_3$ will persist in the environment and can last for weeks before dissipating. This causes $O_3$ concentrations to be much higher in the rural areas downwind of an urban area, especially when viewing concentrations averaged over long temporal periods.

Because of these dynamics, the methodology of ranking $O_3$ monitors in order of the total VOC and $NO_x$ point sources is not entirely valid. It is still practical to use the method established with the other primary pollutants, as the short-term $O_3$ levels can still be high in the area surrounding precursor point sources. However, another method of ranking that considers $O_3$ averages also needs to be adopted. This will be discussed in the following section.

VOC point source emissions density is shown for illustration purposes in Figure 26, while $NO_x$ emissions have been previously discussed and are shown in Figure 24. The highest VOC emission densities in the state occur in the Denver Metro area and in regions of intensive oil and gas extraction in Weld and Garfield counties.

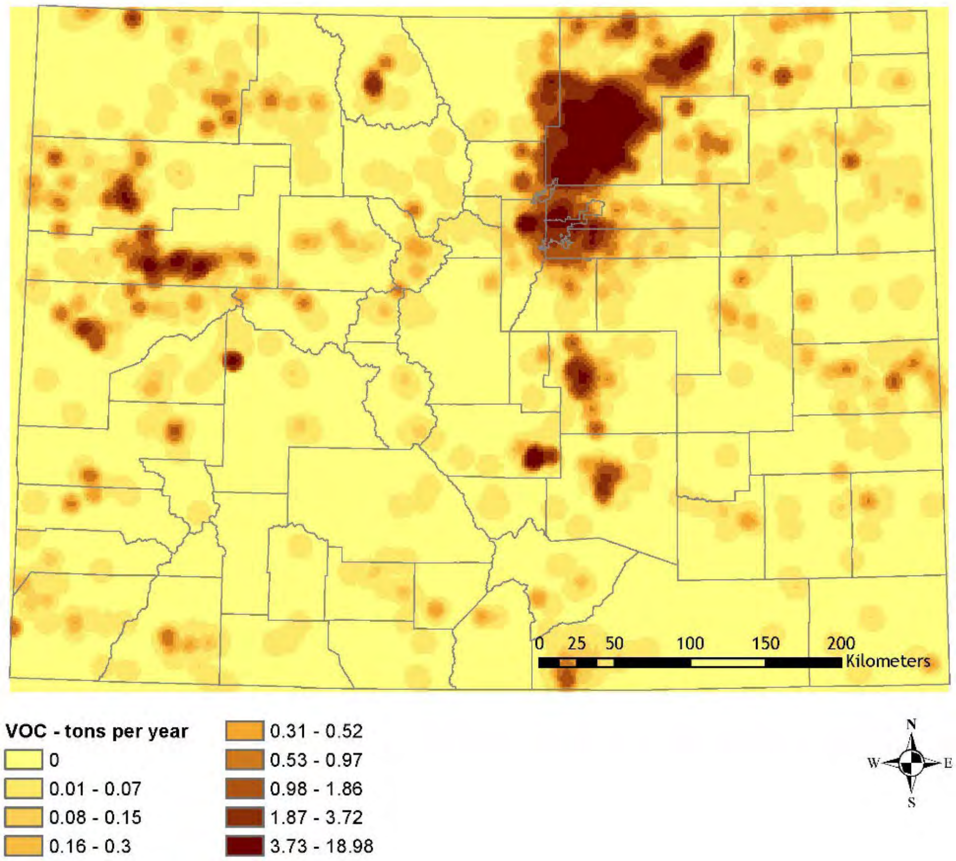


Figure 26. VOC emissions density as calculated from point source data using the Kernel Density tool in ArcGIS. Class breaks have been determined using the quantile method.

The emissions sums and maximum emission sections associated within each $O_3$ monitor are shown for $NO_x$ and VOCs in Table 57and Table 58 respectively. In Table 59, the $NO_x$- and VOC-based rankings have been averaged to determine an overall ranking for each site

Table 57. $O_3$ monitoring sites ranked by total VOC emissions.

| Site Name | Sum of VOC Emissions (tons) | Max. | Rank |
|---|---|---|---|
| La Salle | 12258 | 256 | 1 |
| Greeley - Weld County Tower | 10287 | 165 | 2 |
| Rifle - Health Dept. | 2984 | 166 | 3 |
| Welby | 2936 | 397 | 4 |
| Pueblo West | 1956 | 197 | 5 |
| Bethke | 1831 | 208 | 6 |
| Aurora - East | 1395 | 192 | 7 |
| Boulder Reservoir | 1268 | 74 | 8 |
| NREL | 971 | 338 | 9 |
| Fossil Creek | 852 | 117 | 10 |
| CAMP | 768 | 34 | 11 |
| Palisade Water Treatment | 761 | 121 | 12 |
| U.S. Air Force Academy (USAFA) | 759 | 167 | 13 |
| Fort Collins - Mason | 708 | 253 | 14 |
| Highland Reservoir | 634 | 22 | 15 |
| Manitou Springs | 610 | 46 | 16 |
| La Casa | 546 | 84 | 17 |
| Rocky Flats - N. | 219 | 24 | 18 |
| Cortez - Health Dept. | 182 | 76 | 19 |
| Chatfield State Park | 162 | 17 | 20 |
| Fort Collins - West | 100 | 35 | 21 |
| Evergreen | 64 | 13 | 22 |
| Black Hawk | 22 | 8 | 23 |

Table 58. $O_3$ monitoring sites ranked by total $NO_x$ emissions.

| Site Name | Sum of $NO_x$ Emissions (tons) | Max. | Rank |
|---|---|---|---|
| Pueblo West | 5,904 | 3,312 | 1 |
| La Salle | 5,840 | 878 | 2 |
| Greeley - Weld County Tower | 3,723 | 368 | 3 |
| Rifle - Health Dept. | 3,251 | 176 | 4 |
| Welby | 1,926 | 628 | 5 |
| Manitou Springs | 1,598 | 1,142 | 6 |
| Fort Collins - West | 1,175 | 1,149 | 7 |
| Aurora - East | 1,115 | 291 | 8 |
| Bethke | 926 | 194 | 9 |
| Boulder Reservoir | 632 | 230 | 10 |
| Fort Collins - Mason | 544 | 144 | 11 |
| CAMP | 510 | 76 | 12 |
| NREL | 490 | 255 | 13 |
| Palisade Water Treatment | 425 | 42 | 14 |
| Fossil Creek | 274 | 28 | 15 |
| Cortez - Health Dept. | 264 | 53 | 16 |
| Rocky Flats - N. | 202 | 107 | 17 |
| Highland Reservoir | 181 | 25 | 18 |
| U.S. Air Force Academy (USAFA) | 176 | 33 | 19 |
| La Casa | 152 | 16 | 20 |
| Chatfield State Park | 87 | 30 | 21 |
| Black Hawk | 31 | 21 | 22 |
| Evergreen | 0 | 0 | 23 |

Table 59. Overall emissions inventory rankings for the $O_3$ monitoring network.

| Site Name | Scores | | Average | Rank |
|---|---|---|---|---|
| | VOC | $NO_x$ | | |
| La Salle | 23.0 | 22.8 | 22.9 | 1 |
| Greeley - Weld County Tower | 19.5 | 14.9 | 17.2 | 2 |
| Pueblo West | 4.5 | 23.0 | 13.7 | 3 |
| Rifle - Health Dept. | 6.3 | 13.1 | 9.7 | 4 |
| Welby | 6.2 | 8.2 | 7.2 | 5 |
| Manitou Springs | 2.1 | 7.0 | 4.5 | 6 |
| Bethke | 4.3 | 4.4 | 4.4 | 7 |
| Aurora - East | 3.5 | 5.2 | 4.3 | 8 |
| Boulder Reservoir | 3.2 | 3.4 | 3.3 | 9 |
| Fort Collins - West | 1.1 | 5.4 | 3.3 | 10 |
| NREL | 2.7 | 2.8 | 2.8 | 11 |
| Fort Collins - Mason | 2.2 | 3.0 | 2.6 | 12 |
| CAMP | 2.3 | 2.9 | 2.6 | 13 |
| Palisade Water Treatment | 2.3 | 2.6 | 2.5 | 14 |
| Fossil Creek | 2.5 | 2.0 | 2.3 | 15 |
| U.S. Air Force Academy (USAFA) | 2.3 | 1.7 | 2.0 | 16 |
| Highland Reservoir | 2.1 | 1.7 | 1.9 | 17 |
| La Casa | 1.9 | 1.6 | 1.8 | 18 |
| Cortez - Health Dept. | 1.3 | 2.0 | 1.6 | 19 |
| Rocky Flats - N. | 1.4 | 1.8 | 1.6 | 20 |
| Chatfield State Park | 1.3 | 1.3 | 1.3 | 21 |
| Black Hawk | 1.0 | 1.1 | 1.1 | 22 |
| Evergreen | 1.1 | 1.0 | 1.0 | 23 |

### 2.9.5 $PM_{10}$

$PM_{10}$ point source emissions density is shown in Figure 27.

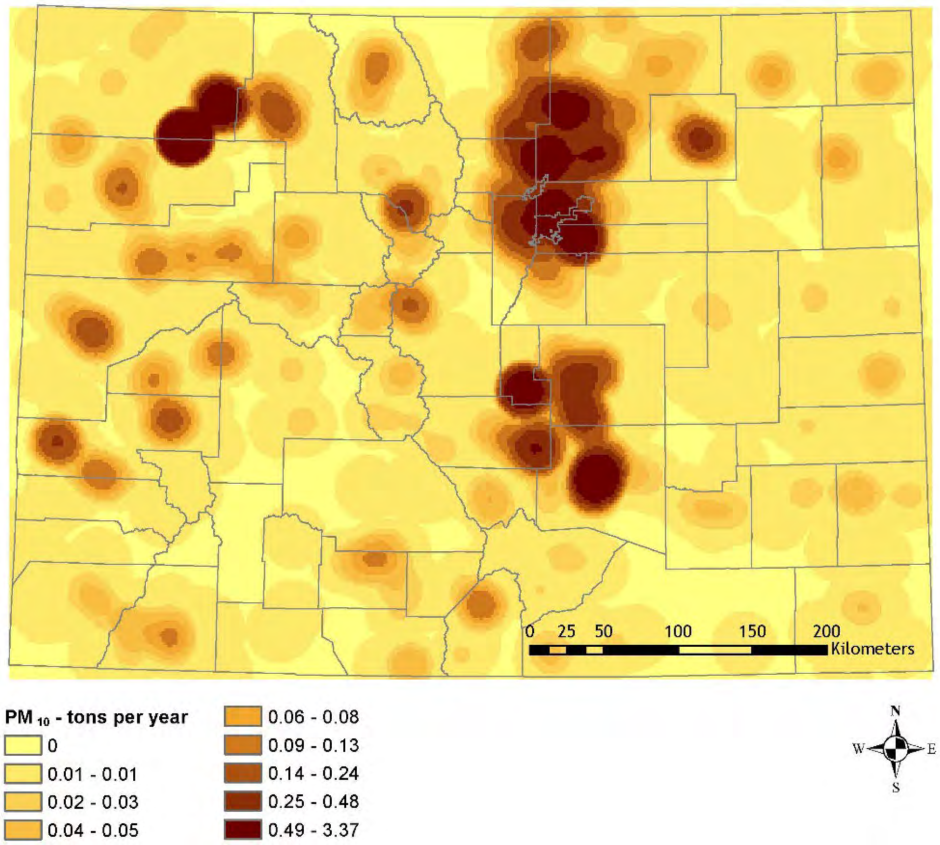


Figure 27. $PM_{10}$ emissions density as calculated from point source data using the Kernel Density tool in ArcGIS. Class breaks have been determined using the quantile method.

Table 60. $PM_{10}$ monitoring sites ranked by total emissions.

| Site Name | Sum of $PM_{10}$ Emissions (tons) | Max. | Rank | Score |
|---|---|---|---|---|
| Pueblo - Fountain School | 648 | 406 | 1 | 16.0 |
| Birch Street | 371 | 122 | 2 | 9.6 |
| Longmont - Municipal Bldg. | 359 | 294 | 3 | 9.3 |
| Colorado College | 167 | 19 | 4 | 4.9 |
| La Casa | 146 | 23 | 5 | 4.4 |
| Grand Junction - Powell Bldg. | 115 | 30 | 6 | 3.7 |
| CAMP | 98 | 24 | 7 | 3.3 |
| Boulder - CU | 48 | 32 | 8 | 2.1 |
| Welby | 34 | 20 | 9 | 1.8 |
| Lamar - Municipal Bldg. | 26 | 7 | 10 | 1.6 |
| Aspen | 14 | 12 | 11 | 1.3 |
| Cañon City - City Hall | 13 | 10 | 12 | 1.3 |
| Alamosa - ASC | 6 | 3 | 13 | 1.1 |
| Steamboat Springs | 5 | 3 | 14 | 1.1 |
| Telluride | 2 | 1 | 15 | 1.0 |
| Pagosa Springs School | 0 | 0 | 16 | 1.0 |

### 2.9.6 $PM_{2.5}$

$PM_{2.5}$, like $O_3$, can be considered a secondary pollutant, although it can also be directly emitted to the atmosphere. Nitrate ($NO_3^-$) and sulfate ($SO_4^{2-}$) are particularly important components of secondary $PM_{2.5}$. Because these chemical species originate from the oxidation of $NO_x$ and $SO_2$, respectively, $NO_x$ and $SO_2$ point source emissions are also considered in the ranking of the $PM_{2.5}$ sites.

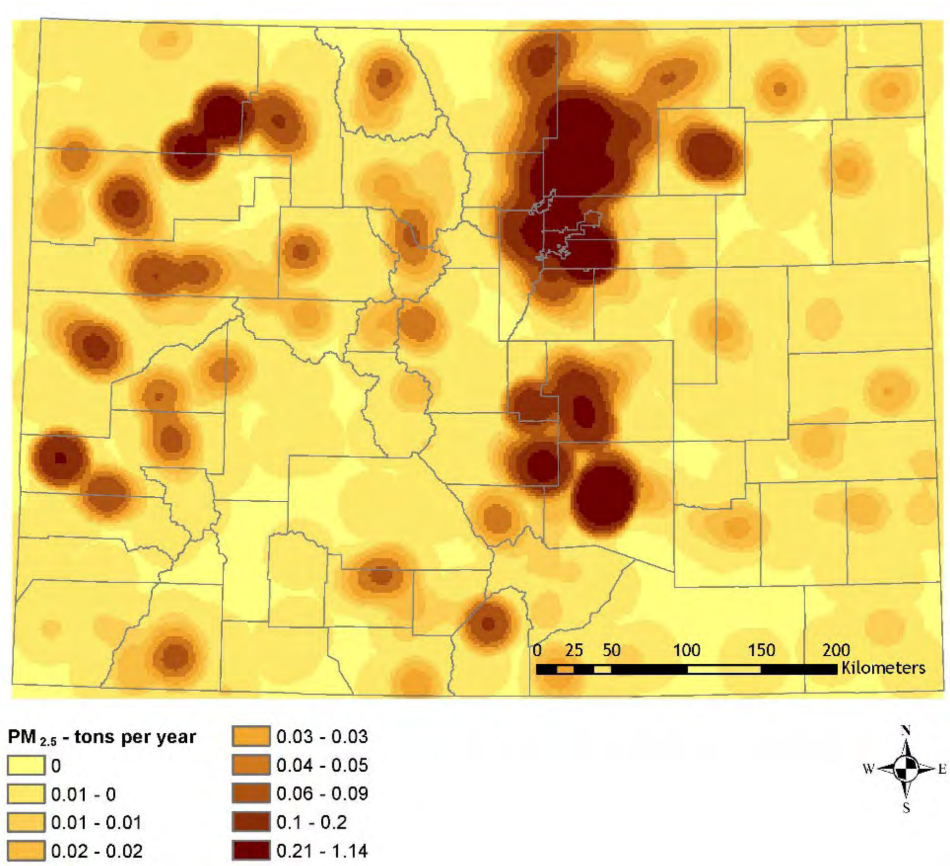


Figure 28. $PM_{2.5}$ emissions density as calculated from point source data using the Kernel Density tool in ArcGIS. Class breaks have been determined using the quantile method.

$PM_{2.5}$ point source emissions density is shown for illustration purposes in Figure 28, while $NO_x$ and $SO_2$ emissions have been previously discussed and are shown in Figure 24 and Figure 25, respectively. The highest $PM_{2.5}$ emission densities in the state occur in the Denver Metro area and in Weld County.

Table 61. $PM_{2.5}$ monitoring sites ranked by total $PM_{2.5}$ emissions.

| Site Name | Sum of $PM_{2.5}$ Emissions (tons) | Max. | Rank |
|---|---|---|---|
| Pueblo - Fountain School | 773 | 392 | 1 |
| Platteville - Middle School | 276 | 60 | 2 |
| Greeley - Hospital | 258 | 57 | 3 |
| Longmont - Municipal Bldg. | 245 | 93 | 4 |
| Bethke | 207 | 90 | 5 |
| Birch Street | 185 | 111 | 6 |
| I-25: Globeville | 137 | 59 | 7 |
| Colorado College | 135 | 19 | 8 |
| Grand Junction - Powell Bldg. | 79 | 30 | 9 |
| I-25: Denver | 67 | 26 | 10 |
| National Jewish Health (NJH) | 60 | 22 | 11 |
| Boulder - CU | 56 | 18 | 12 |
| Chatfield State Park | 56 | 13 | 13 |
| Arapaho Community College (ACC) | 34 | 8 | 14 |
| Fort Collins - CSU | 33 | 6 | 15 |
| Welby | 30 | 6 | 16 |
| La Casa | 25 | 4 | 17 |
| Aspen | 15 | 12 | 18 |
| Lamar - Municipal Bldg. | 9 | 4 | 19 |
| CAMP | 6 | 1 | 20 |
| Alamosa - ASC | 4 | 3 | 21 |

Table 62. $PM_{2.5}$ monitoring sites ranked by total $NO_x$ emissions.

| Site Name | Sum of $NO_x$ Emissions (tons) | Max. | Rank |
|---|---|---|---|
| Pueblo - Fountain School | 4,655 | 3,312 | 1 |
| Platteville - Middle School | 2,625 | 411 | 2 |
| Greeley - Hospital | 1,866 | 368 | 3 |
| Birch Street | 872 | 628 | 4 |
| Bethke | 728 | 194 | 5 |
| Longmont - Municipal Bldg. | 488 | 230 | 6 |
| Colorado College | 482 | 66 | 7 |
| I-25: Globeville | 476 | 326 | 8 |
| Boulder - CU | 390 | 107 | 9 |
| National Jewish Health (NJH) | 292 | 70 | 10 |
| Fort Collins - CSU | 244 | 86 | 11 |
| I-25: Denver | 243 | 58 | 12 |
| Arapaho Community College (ACC) | 195 | 25 | 13 |
| CAMP | 150 | 76 | 14 |
| Grand Junction - Powell Bldg. | 120 | 33 | 15 |
| La Casa | 90 | 27 | 16 |
| Chatfield State Park | 74 | 30 | 17 |
| Welby | 64 | 10 | 18 |
| Alamosa - ASC | 44 | 44 | 19 |
| Aspen | 24 | 13 | 20 |
| Lamar - Municipal Bldg. | 19 | 11 | 21 |

Table 63. $PM_{2.5}$ monitoring sites ranked by total $SO_2$ emissions.

| Site Name | Sum of $SO_2$ Emissions (tons) | Max. | Rank |
|---|---|---|---|
| Pueblo - Fountain School | 3,393 | 3,204 | 1 |
| Birch Street | 335 | 214 | 2 |
| Bethke | 147 | 117 | 3 |
| Platteville - Middle School | 96 | 38 | 4 |
| Longmont - Municipal Bldg. | 77 | 44 | 5 |
| Greeley - Hospital | 59 | 26 | 6 |
| I-25: Globeville | 59 | 27 | 7 |
| Arapaho Community College (ACC) | 59 | 40 | 8 |
| Grand Junction - Powell Bldg. | 46 | 21 | 9 |
| I-25: Denver | 45 | 27 | 10 |
| Colorado College | 40 | 15 | 11 |
| Boulder - CU | 32 | 23 | 12 |
| Aspen | 15 | 14 | 13 |
| La Casa | 11 | 7 | 14 |
| National Jewish Health (NJH) | 9 | 4 | 15 |
| Fort Collins - CSU | 8 | 4 | 16 |
| Chatfield State Park | 7 | 6 | 17 |
| Welby | 5 | 2 | 18 |
| CAMP | 1 | 0 | 19 |
| Lamar - Municipal Bldg. | 0 | 0 | 20 |
| Alamosa - ASC | 0 | 0 | 21 |

Table 64. Overall emissions inventory rankings for the $PM_{2.5}$ monitoring network.

| Site Name | Scores | | | Average | Rank |
|---|---|---|---|---|---|
| | $PM_{2.5}$ | $NO_x$ | $SO_2$ | | |
| Pueblo - Fountain School | 21.0 | 21.0 | 21.0 | 21.0 | 1 |
| Platteville - Middle School | 8.1 | 12.2 | 1.6 | 7.3 | 2 |
| Greeley - Hospital | 7.6 | 9.0 | 1.3 | 6.0 | 3 |
| Birch Street | 5.7 | 4.7 | 3.0 | 4.5 | 4 |
| Bethke | 6.3 | 4.1 | 1.9 | 4.1 | 5 |
| Longmont - Municipal Bldg. | 7.3 | 3.0 | 1.5 | 3.9 | 6 |
| I-25: Globeville | 4.5 | 3.0 | 1.3 | 2.9 | 7 |
| Colorado College | 4.4 | 3.0 | 1.2 | 2.9 | 8 |
| Boulder - CU | 2.4 | 2.6 | 1.2 | 2.0 | 9 |
| I-25: Denver | 2.6 | 2.0 | 1.3 | 2.0 | 10 |
| National Jewish Health (NJH) | 2.5 | 2.2 | 1.0 | 1.9 | 11 |
| Grand Junction - Powell Bldg. | 3.0 | 1.4 | 1.3 | 1.9 | 12 |
| Arapaho Community College (ACC) | 1.8 | 1.8 | 1.3 | 1.6 | 13 |
| Fort Collins - CSU | 1.8 | 2.0 | 1.0 | 1.6 | 14 |
| Chatfield State Park | 2.4 | 1.2 | 1.0 | 1.5 | 15 |
| La Casa | 1.6 | 1.3 | 1.1 | 1.3 | 16 |
| Welby | 1.7 | 1.2 | 1.0 | 1.3 | 17 |
| CAMP | 1.1 | 1.6 | 1.0 | 1.2 | 18 |
| Aspen | 1.3 | 1.0 | 1.1 | 1.1 | 19 |
| Lamar - Municipal Bldg. | 1.1 | 1.0 | 1.0 | 1.0 | 20 |
| Alamosa - ASC | 1.0 | 1.1 | 1.0 | 1.0 | 21 |

### 2.9.7 Lead (Pb)

Lead point sources required for monitoring are based on emissions are listed in the 2020 National Emissions Inventory, which is the most current version. The sources from the inventory with emissions greater than 0.1 tons per year (200 pounds per year) are shown in Table 65. There are no sources in the inventory with emissions greater than 0.5 tons per year

Table 65. Major lead sources in Colorado

| Name | Location | Emissions (tons/year) |
|---|---|---|
| Simon Contractors (Rushmore) | Holyoke | 0.135 |

## 2.10 Traffic Counts

Point sources typically account for only a portion of the pollution emissions within an area. The Traffic Count analysis considers transportation and mobile source emissions. This analysis evaluates the mobile source emissions within the influence of a monitoring site; these data, along with point source data from the Emissions Inventory analysis described in Section 2.9, are used to assess the total effect of emissions within each site's area of representation (i.e., Area Served polygon).

Emissions from mobile sources can vary greatly; factors which can affect the amount of pollution released include road type (e.g., fast-moving vehicles on a freeway generally emit less pollution per unit distance than vehicles on arterial roads and collectors), vehicle type (e.g., diesel vs. gasoline powered vehicles), traffic congestion, age and size of vehicles, etc. Ideally, a method which attempts to account for traffic emissions would account for all of these variables in a spatially resolved model. Unfortunately, such traffic modeling is outside of the scope of this network assessment. Instead, traffic counts and road density are used in this analysis as proxies for mobile source pollution.

Annual average daily traffic (AADT) counts were obtained from the Colorado Department of Transportation for 2023, the most recent year with available data. The dataset includes counts for highways and major roads with comprehensive sample location coverage; however, it is difficult to ascertain if AADT sample locations include all arterial roads with the same density (see Figure 29) and it is likely that additional new roads were not sampled. To account for variations in sampling density in different parts of the state, the total AADT counts within each site's Area Served polygon were normalized by the average distance between sampling locations. The rankings based on normalized AADT counts were then averaged together with rankings based on road density and each site was ranked based on this overall score. To further normalize the AADT counts, this analysis also considers the road density within each site's Area Served polygon when calculating the final rankings.

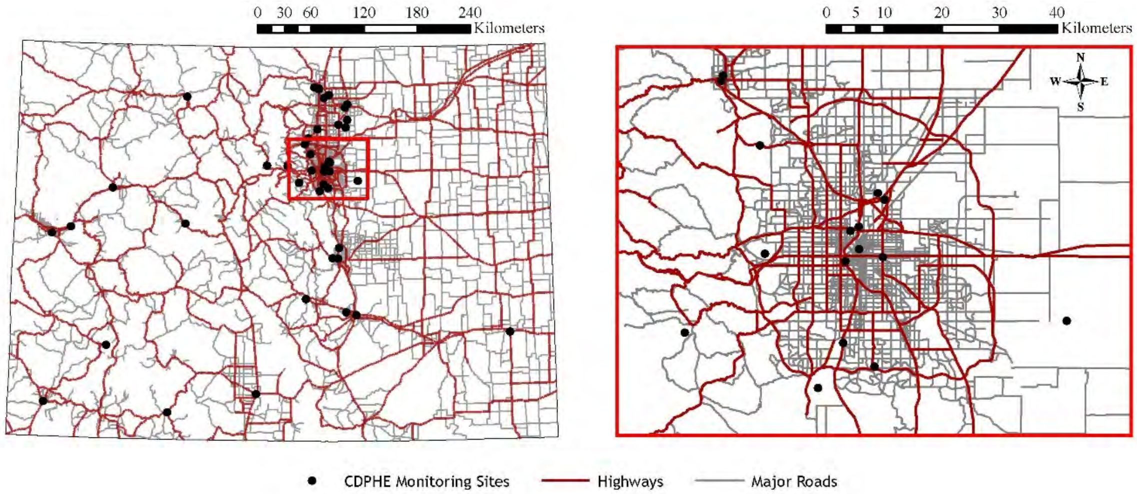


Figure 29. Highways and major roads in Colorado.

### 2.10.1 Carbon Monoxide (CO)

Table 66. CO monitoring sites ranked by traffic counts.

| Site Name | Sum of AADT Counts | | Total Normalized | Score |
|---|---|---|---|---|
| | Major Roads | Highways | AADT Counts | |
| La Casa | 50,963,460 | 216,063,400 | 91,526 | 5.0 |
| I-25: Denver | 74,616,000 | 191,553,300 | 74,629 | 4.0 |
| Colorado College | 51,565,860 | 74,107,100 | 65,906 | 3.5 |
| Fort Collins - Mason | 13,291,830 | 25,074,800 | 33,372 | 1.7 |
| Greeley - Weld County Tower | 6,911,610 | 20,209,420 | 21,422 | 1.0 |

Table 67. CO monitoring sites ranked by road density.

| Site Name | Size of Area Served Polygon ($km^2$) | Total Road Length (km) | Road Density ($m/km^2$) | Score |
|---|---|---|---|---|
| I-25: Denver | 515 | 733 | 1,424 | 5.0 |
| La Casa | 515 | 610 | 1,184 | 4.0 |
| Colorado College | 848 | 543 | 641 | 1.8 |
| Fort Collins - Mason | 855 | 374 | 437 | 1.0 |
| Greeley - Weld County Tower | 855 | 370 | 433 | 1.0 |

Table 68. Overall traffic counts rankings for the CO monitoring network.

| Site Name | Scores | | | Rank |
|---|---|---|---|---|
| | Traffic Counts | Road Density | Average | |
| I-25: Denver | 4.0 | 5.0 | 4.5 | 1 |
| La Casa | 5.0 | 4.0 | 4.5 | 2 |
| Colorado College | 3.5 | 1.8 | 2.7 | 3 |
| Fort Collins - Mason | 1.7 | 1.0 | 1.3 | 4 |
| Greeley - Weld County Tower | 1.0 | 1.0 | 1.0 | 5 |

### 2.10.2 Nitrogen Dioxide ($NO_2$)

Table 69. NO2 monitoring sites ranked by traffic counts.

| Site Name | Sum of AADT Counts | | Total Normalized | Score |
|---|---|---|---|---|
| | Major Roads | Highways | AADT Counts | |
| I-25: Globeville | 4,464,670 | 52,635,300 | 120,780 | 9.00 |
| Welby | 42,492,000 | 121,931,700 | 83,792 | 6.02 |
| CAMP | 46,053,440 | 53,679,000 | 79,962 | 5.71 |
| La Casa | 10,169,200 | 49,331,000 | 76,879 | 5.46 |
| I-25: Denver | 44,604,870 | 173,195,600 | 75,537 | 5.35 |
| Fossil Creek | 14,249,710 | 33,337,800 | 44,538 | 2.85 |
| Rocky Flats - N. | 15,863,560 | 50,576,300 | 34,540 | 2.05 |
| Bethke | 3,488,180 | 17,350,320 | 26,704 | 1.42 |
| La Salle | 3,897,790 | 11,385,000 | 21,525 | 1.00 |

Table 70. $NO_2$ monitoring sites ranked by road density.

| Site Name | Size of Area Served Polygon ($km^2$) | Total Road Length (km) | Road Density ($m/km^2$) | Score |
|---|---|---|---|---|
| CAMP | 181 | 323 | 1782 | 9.0 |
| I-25: Globeville | 39 | 67 | 1703 | 8.6 |
| La Casa | 104 | 166 | 1597 | 8.0 |
| I-25: Denver | 430 | 549 | 1275 | 6.3 |
| Welby | 501 | 411 | 819 | 3.9 |
| Fossil Creek | 572 | 333 | 582 | 2.6 |
| Rocky Flats - N. | 772 | 417 | 540 | 2.4 |
| Bethke | 572 | 213 | 372 | 1.5 |
| La Salle | 918 | 263 | 286 | 1.0 |

Table 71. Overall traffic counts rankings for the $NO_2$ monitoring network.

| Site Name | Scores | | | Rank |
|---|---|---|---|---|
| | Traffic Counts | Road Density | Average | |
| I-25: Globeville | 9.0 | 8.6 | 8.8 | 1 |
| CAMP | 5.7 | 9.0 | 7.4 | 2 |
| La Casa | 5.5 | 8.0 | 6.7 | 3 |
| I-25: Denver | 5.4 | 6.3 | 5.8 | 4 |
| Welby | 6.0 | 3.9 | 4.9 | 5 |
| Fossil Creek | 2.9 | 2.6 | 2.7 | 6 |
| Rocky Flats - N. | 2.0 | 2.4 | 2.2 | 7 |
| Bethke | 1.4 | 1.5 | 1.4 | 8 |
| La Salle | 1.0 | 1.0 | 1.0 | 9 |

### 2.10.3 Sulfur Dioxide ($SO_2$)

Table 72. $SO_2$ monitoring sites ranked by traffic counts.

| Site Name | Sum of AADT Counts | | Total Normalized | Score |
|---|---|---|---|---|
| | Major Roads | Highways | AADT Counts | |
| Welby | 25,271,400 | 99,252,100 | 93,831 | 3.0 |
| CAMP | 62,003,720 | 109,111,000 | 87,299 | 1.9 |
| La Casa | 13,570,330 | 84,674,700 | 81,804 | 1.0 |

Table 73. $SO_2$ monitoring sites ranked by road density.

| Site Name | Size of Area Served Polygon ($km^2$) | Total Road Length (km) | Road Density ($m/km^2$) | Score |
|---|---|---|---|---|
| CAMP | 228 | 458 | 2013 | 3.0 |
| La Casa | 148 | 231 | 1565 | 2.2 |
| Welby | 286 | 265 | 924 | 1.0 |

Table 74. Overall traffic counts rankings for the $SO_2$ monitoring network.

| Site Name | Scores | | | Rank |
|---|---|---|---|---|
| | Traffic Counts | Road Density | Average | |
| CAMP | 1.9 | 3.0 | 2.5 | 1 |
| Welby | 3.0 | 1.0 | 2.0 | 3 |
| La Casa | 1.0 | 2.2 | 1.6 | 2 |

## 2.10.4 Ozone ($O_3$)

Table 75. $O_3$ monitoring sites ranked by traffic counts.

| Site Name | Sum of AADT Counts | | Total Normalized AADT Counts | Score |
|---|---|---|---|---|
| | Major Roads | Highways | | |
| CAMP | 72,722,170 | 121,963,200 | 88,090 | 23.0 |
| La Casa | 11,678,030 | 75,773,700 | 86,036 | 22.5 |
| Highland Reservoir | 37,355,080 | 143,635,200 | 83,713 | 21.8 |
| Welby | 53,885,620 | 150,146,000 | 76,386 | 19.9 |
| NREL | 8,410,270 | 67,299,300 | 48,942 | 12.6 |
| Manitou Springs | 27,137,670 | 55,793,700 | 45,883 | 11.8 |
| Fossil Creek | 7,743,260 | 34,742,200 | 39,800 | 10.2 |
| Rocky Flats - N. | 8,381,130 | 34,830,900 | 35,672 | 9.1 |
| Chatfield State Park | 6,238,620 | 27,632,940 | 34,788 | 8.9 |
| USAFA | 32,421,770 | 47,963,520 | 30,426 | 7.7 |
| Fort Collins - Mason | 7,562,680 | 15,261,400 | 29,144 | 7.4 |
| Boulder Reservoir | 15,765,680 | 49,783,480 | 25,824 | 6.5 |
| Evergreen | 826,200 | 18,424,340 | 18,075 | 4.4 |
| Bethke | 1,573,480 | 9,151,500 | 16,836 | 4.1 |
| Rifle - Health Dept. | 2,794,150 | 40,249,930 | 16,001 | 3.9 |
| Black Hawk | 36,400 | 26,605,430 | 12,758 | 3.0 |
| Aurora - East | 7,167,710 | 21,342,150 | 12,160 | 2.9 |
| La Salle | 1,537,770 | 24,877,720 | 12,079 | 2.9 |
| Greeley - Weld County Tower | 6,761,730 | 18,183,920 | 11,809 | 2.8 |
| Palisade Water Treatment | 12,198,000 | 36,234,590 | 9,890 | 2.3 |
| Pueblo West | 6,813,480 | 55,609,900 | 8,721 | 2.0 |
| Fort Collins - West | 1,298,940 | 6,580,270 | 5,741 | 1.2 |
| Cortez - Health Dept. | 468,100 | 8,353,030 | 5,070 | 1.0 |

Table 76. $O_3$ monitoring sites ranked by road density.

| Site Name | Size of Area Served Polygon (km$^2$) | Total Road Length (km) | Road Density (m/km$^2$) | Score |
|---|---|---|---|---|
| CAMP | 289 | 527 | 1823 | 23.0 |
| La Casa | 111 | 185 | 1670 | 21.1 |
| NREL | 376 | 271 | 722 | 9.1 |
| Welby | 960 | 578 | 602 | 7.6 |
| Highland Reservoir | 924 | 502 | 543 | 6.9 |
| Rocky Flats - N. | 501 | 240 | 480 | 6.1 |
| Fossil Creek | 696 | 283 | 406 | 5.2 |
| Manitou Springs | 1,495 | 474 | 317 | 4.1 |
| Boulder Reservoir | 2,125 | 601 | 283 | 3.6 |
| Fort Collins - Mason | 906 | 238 | 263 | 3.4 |
| USAFA | 4,197 | 926 | 221 | 2.8 |
| Chatfield State Park | 1,451 | 237 | 163 | 2.1 |
| La Salle | 4,528 | 726 | 160 | 2.1 |
| Black Hawk | 1,664 | 257 | 154 | 2.0 |
| Bethke | 1,553 | 226 | 145 | 1.9 |
| Evergreen | 1,706 | 240 | 141 | 1.8 |
| Greeley - Weld County Tower | 4,755 | 658 | 138 | 1.8 |
| Aurora - East | 7,971 | 805 | 101 | 1.3 |
| Palisade Water Treatment | 10,145 | 1022 | 101 | 1.3 |
| Pueblo West | 15,974 | 1593 | 100 | 1.3 |
| Fort Collins - West | 4,337 | 395 | 91 | 1.2 |
| Cortez - Health Dept. | 6,083 | 519 | 85 | 1.1 |
| Rifle - Health Dept. | 9,505 | 709 | 75 | 1.0 |

Table 77. Overall traffic counts rankings for the $O_3$ monitoring network.

| Site Name | Scores | | | Rank |
|---|---|---|---|---|
| | Traffic Counts | Road Density | Average | |
| CAMP | 23.0 | 23.0 | 23.0 | 1 |
| La Casa | 22.5 | 21.1 | 21.8 | 2 |
| Highland Reservoir | 21.8 | 6.9 | 14.4 | 3 |
| Welby | 19.9 | 7.6 | 13.8 | 4 |
| NREL | 12.6 | 9.1 | 10.9 | 5 |
| Manitou Springs | 11.8 | 4.1 | 7.9 | 6 |
| Fossil Creek | 10.2 | 5.2 | 7.7 | 7 |
| Rocky Flats - N. | 9.1 | 6.1 | 7.6 | 8 |
| Chatfield State Park | 8.9 | 2.1 | 5.5 | 9 |
| Fort Collins - Mason | 7.4 | 3.4 | 5.4 | 10 |
| U.S. Air Force Academy (USAFA) | 7.7 | 2.8 | 5.3 | 11 |
| Boulder Reservoir | 6.5 | 3.6 | 5.1 | 12 |
| Evergreen | 4.4 | 1.8 | 3.1 | 13 |
| Bethke | 4.1 | 1.9 | 3.0 | 14 |
| Black Hawk | 3.0 | 2.0 | 2.5 | 15 |
| La Salle | 2.9 | 2.1 | 2.5 | 16 |
| Rifle - Health Dept. | 3.9 | 1.0 | 2.4 | 17 |
| Greeley - Weld County Tower | 2.8 | 1.8 | 2.3 | 18 |
| Aurora - East | 2.9 | 1.3 | 2.1 | 19 |
| Palisade Water Treatment | 2.3 | 1.3 | 1.8 | 20 |
| Pueblo West | 2.0 | 1.3 | 1.6 | 21 |
| Fort Collins - West | 1.2 | 1.2 | 1.2 | 22 |
| Cortez - Health Dept. | 1.0 | 1.1 | 1.1 | 23 |

### 2.10.5 $PM_{10}$

Table 78. $PM_{10}$ monitoring sites ranked by traffic counts.

| Site Name | Sum of AADT Counts | | Total Normalized AADT Counts | Score |
|---|---|---|---|---|
| | Major Roads | Highways | | |
| Welby | 17,673,300 | 66,373,000 | 98,093 | 16.0 |
| Birch Street | 10,424,100 | 41,758,000 | 92,884 | 15.1 |
| CAMP | 60,934,720 | 105,179,000 | 85,671 | 14.0 |
| La Casa | 13,534,430 | 84,449,000 | 83,059 | 13.5 |
| Colorado College | 40,169,490 | 53,779,100 | 76,201 | 12.4 |
| Longmont - Municipal Bldg. | 7,586,740 | 20,435,800 | 37,111 | 6.0 |
| Boulder - CU | 8,005,130 | 22,688,600 | 33,853 | 5.5 |
| Pueblo - Fountain School | 5,119,850 | 25,177,400 | 27,806 | 4.5 |
| Grand Junction - Powell Bldg. | 9,210,410 | 15,506,400 | 23,081 | 3.7 |
| Aspen | 163,740 | 2,735,600 | 15,418 | 2.5 |
| Steamboat Springs | 376,280 | 3,386,000 | 13,856 | 2.2 |
| Cañon City - City Hall | 349,450 | 901,000 | 9,880 | 1.6 |
| Pagosa Springs School | 43,600 | 2,410,000 | 9,842 | 1.6 |
| Alamosa - ASC | 297,140 | 3,196,800 | 8,449 | 1.3 |
| Telluride | 50,500 | 764,900 | 6,474 | 1.0 |
| Lamar - Municipal Bldg. | 251,530 | 1,755,540 | 6,335 | 1.0 |

Table 79. $PM_{10}$ monitoring sites ranked by road density.

| Site Name | Size of Area Served Polygon ($km^2$) | Total Road Length (km) | Road Density ($m/km^2$) | Score |
|---|---|---|---|---|
| CAMP | 218 | 446 | 2051 | 16.0 |
| La Casa | 146 | 229 | 1568 | 12.3 |
| Welby | 167 | 188 | 1121 | 8.8 |
| Colorado College | 408 | 396 | 971 | 7.6 |
| Birch Street | 150 | 108 | 717 | 5.7 |
| Pueblo - Fountain School | 408 | 265 | 649 | 5.1 |
| Longmont - Municipal Bldg. | 407 | 229 | 564 | 4.5 |
| Grand Junction - Powell Bldg. | 408 | 213 | 521 | 4.2 |
| Boulder - CU | 407 | 201 | 495 | 3.9 |
| Alamosa - ASC | 408 | 101 | 248 | 2.0 |
| Lamar - Municipal Bldg. | 408 | 90 | 220 | 1.8 |
| Steamboat Springs | 408 | 78 | 191 | 1.6 |
| Cañon City - City Hall | 213 | 33 | 155 | 1.3 |
| Telluride | 254 | 37 | 147 | 1.3 |
| Aspen | 408 | 47 | 115 | 1.0 |
| Pagosa Springs School | 408 | 46 | 114 | 1.0 |

Table 80. Overall traffic counts rankings for the $PM_{10}$ monitoring network.

| Site Name | Scores | | | Rank |
|---|---|---|---|---|
| | Traffic Counts | Road Density | Average | |
| CAMP | 14.0 | 16.0 | 15.0 | 1 |
| La Casa | 13.5 | 12.3 | 12.9 | 2 |
| Welby | 16.0 | 8.8 | 12.4 | 3 |
| Birch Street | 15.1 | 5.7 | 10.4 | 4 |
| Colorado College | 12.4 | 7.6 | 10.0 | 5 |
| Longmont - Municipal Bldg. | 6.0 | 4.5 | 5.3 | 6 |
| Pueblo - Fountain School | 4.5 | 5.1 | 4.8 | 7 |
| Boulder - CU | 5.5 | 3.9 | 4.7 | 8 |
| Grand Junction - Powell Bldg. | 3.7 | 4.2 | 3.9 | 9 |
| Steamboat Springs | 2.2 | 1.6 | 1.9 | 10 |
| Aspen | 2.5 | 1.0 | 1.7 | 11 |
| Alamosa - ASC | 1.3 | 2.0 | 1.7 | 12 |
| Cañon City - City Hall | 1.6 | 1.3 | 1.5 | 13 |
| Lamar - Municipal Bldg. | 1.0 | 1.8 | 1.4 | 14 |
| Pagosa Springs School | 1.6 | 1.0 | 1.3 | 15 |
| Telluride | 1.0 | 1.3 | 1.1 | 16 |

## 2.10.6 $PM_{2.5}$

Table 81. $PM_{2.5}$ monitoring sites ranked by traffic counts.

| Site Name | Sum of AADT Counts | | Total Normalized AADT Counts | Score |
|---|---|---|---|---|
| | Major Roads | Highways | | |
| I-25: Globeville | 3,373,270 | 44,073,700 | 126,044 | 21.0 |
| CAMP | 12,432,330 | 7,790,000 | 116,087 | 19.4 |
| National Jewish Health (NJH) | 53,008,860 | 101,860,600 | 97,342 | 16.3 |
| Arapaho Community College | 28,416,120 | 109,512,700 | 83,607 | 14.0 |
| Welby | 22,516,120 | 86,942,800 | 74,746 | 12.5 |
| I-25: Denver | 23,545,790 | 93,888,400 | 73,480 | 12.3 |
| La Casa | 12,672,590 | 51,368,900 | 70,154 | 11.8 |
| Colorado College | 52,211,460 | 76,155,100 | 64,553 | 10.9 |
| Birch Street | 19,621,140 | 24,641,300 | 63,221 | 10.6 |
| Longmont - Municipal Bldg. | 9,201,170 | 34,899,000 | 38,126 | 6.5 |
| Bethke | 5,686,970 | 30,231,840 | 37,696 | 6.4 |
| Chatfield State Park | 3,087,700 | 21,572,100 | 33,867 | 5.8 |
| Fort Collins - CSU | 10,373,040 | 14,239,800 | 28,727 | 4.9 |
| Boulder - CU | 10,764,440 | 35,717,000 | 28,290 | 4.9 |
| Pueblo - Fountain School | 5,898,500 | 28,908,300 | 24,597 | 4.3 |
| Platteville - Middle School | 1,248,810 | 12,183,600 | 21,524 | 3.8 |
| Greeley - Hospital | 6,370,350 | 14,616,400 | 20,539 | 3.6 |
| Grand Junction - Powell Bldg. | 9,385,320 | 18,185,030 | 19,620 | 3.4 |
| Aspen | 163,740 | 3,876,000 | 14,403 | 2.6 |
| Alamosa - ASC | 307,220 | 3,618,690 | 6,720 | 1.3 |
| Lamar - Municipal Bldg. | 276,070 | 1,971,900 | 4,830 | 1.0 |

Table 82. $PM_{2.5}$ monitoring sites ranked by road density.

| Site Name | Size of Area Served Polygon ($km^2$) | Total Road Length (km) | Road Density ($m/km^2$) | Score |
|---|---|---|---|---|
| CAMP | 16 | 80 | 4904 | 21.0 |
| I-25: Globeville | 29 | 49 | 1690 | 7.7 |
| I-25: Denver | 211 | 291 | 1377 | 6.4 |
| National Jewish Health (NJH) | 290 | 378 | 1302 | 6.1 |
| La Casa | 174 | 222 | 1276 | 6.0 |
| Arapaho Community College | 354 | 368 | 1039 | 5.0 |
| Welby | 330 | 323 | 979 | 4.8 |
| Colorado College | 906 | 555 | 613 | 3.2 |
| Birch Street | 226 | 137 | 609 | 3.2 |
| Longmont - Municipal Bldg. | 723 | 330 | 456 | 2.6 |
| Greeley - Hospital | 750 | 331 | 442 | 2.5 |
| Fort Collins - CSU | 670 | 288 | 429 | 2.5 |
| Boulder - CU | 805 | 338 | 419 | 2.4 |
| Bethke | 577 | 237 | 410 | 2.4 |
| Pueblo - Fountain School | 918 | 341 | 372 | 2.2 |
| Grand Junction - Powell Bldg. | 914 | 290 | 317 | 2.0 |
| Platteville - Middle School | 759 | 216 | 285 | 1.9 |
| Chatfield State Park | 610 | 174 | 285 | 1.9 |
| Alamosa - ASC | 918 | 161 | 176 | 1.4 |
| Lamar - Municipal Bldg. | 918 | 150 | 163 | 1.4 |
| Aspen | 918 | 64 | 70 | 1.0 |

Table 83. Overall traffic counts rankings for the $PM_{2.5}$ monitoring network.

| Site Name | Scores | | | Rank |
|---|---|---|---|---|
| | Traffic Counts | Road Density | Average | |
| CAMP | 19.4 | 21.0 | 20.2 | 1 |
| I-25: Globeville | 21.0 | 7.7 | 14.4 | 2 |
| National Jewish Health (NJH) | 16.3 | 6.1 | 11.2 | 3 |
| Arapaho Community College (ACC) | 14.0 | 5.0 | 9.5 | 4 |
| I-25: Denver | 12.3 | 6.4 | 9.4 | 5 |
| La Casa | 11.8 | 6.0 | 8.9 | 6 |
| Welby | 12.5 | 4.8 | 8.6 | 7 |
| Colorado College | 10.9 | 3.2 | 7.0 | 8 |
| Birch Street | 10.6 | 3.2 | 6.9 | 9 |
| Longmont - Municipal Bldg. | 6.5 | 2.6 | 4.5 | 10 |
| Bethke | 6.4 | 2.4 | 4.4 | 11 |
| Chatfield State Park | 5.8 | 1.9 | 3.8 | 12 |
| Fort Collins - CSU | 4.9 | 2.5 | 3.7 | 13 |
| Boulder - CU | 4.9 | 2.4 | 3.7 | 14 |
| Pueblo - Fountain School | 4.3 | 2.2 | 3.3 | 15 |
| Greeley - Hospital | 3.6 | 2.5 | 3.1 | 16 |
| Platteville - Middle School | 3.8 | 1.9 | 2.8 | 17 |
| Grand Junction - Powell Bldg. | 3.4 | 2.0 | 2.7 | 18 |
| Aspen | 2.6 | 1.0 | 1.8 | 19 |
| Alamosa - ASC | 1.3 | 1.4 | 1.4 | 20 |
| Lamar - Municipal Bldg. | 1.0 | 1.4 | 1.2 | 21 |

## 2.11 Results

The purpose of using many different, often competing, indicators is to provide a comprehensive evaluation technique that attempts to address all of the APCD's monitoring objectives, which are themselves often conflicting; e.g., the assessment of population exposure in areas of maximum pollutant concentrations and the determination of background concentrations are fundamentally different objectives requiring separate monitoring strategies. However, the various indicators used are not necessarily of equal importance to the overall analysis and the relative importance of each indicator should be expected to vary between pollutants. For example, the Measured Concentration indicator is widely believed to be the most relevant to the Network Assessment (Pope and Wu, 2014). However, in the case of the APCD $PM_{10}$ network, an overreliance on the Measured Concentration indicator would result in an analysis that is highly biased toward sites that are impacted by regional dust storms. Because these are exceptional events beyond the division's control, the APCD feels that the Deviation from the NAAQS indicator is a more appropriate metric by which to assess the $PM_{10}$ network. Furthermore, while traffic volume and point source density (i.e., "source-oriented" indicators) may be highly correlated with $SO_2$ and $NO_2$ concentrations in ambient air (Gulliver et al., 2011; Beelen et al., 2013), these sources are less relevant in determining the concentration of $O_3$, a secondary pollutant whose concentration is often reduced via $NO_x$ titration in areas immediately surrounding pollution sources (Sillman, 1999). Therefore, the APCD feels that these indicators should be deemphasized in the case of $O_3$.

Another point that must be considered is that many of the indicators used in the site-to-site comparsion analysis are spatially collocated and therefore correlated. For example, population density, traffic volume, and point source emissions all tend to be highest in areas of maximum economic activity (e.g., the central business distrcit). To simply combine these indicators without weighting factors would result in an analysis that is biased heavily toward urban areas. This would be particularly problematic in the case of $O_3$, the pollutant of most concern within Colorado, which typically reaches its highest concentrations at suburban, rural, and high elevation sites. To reflect the variability among the factors addressed in the assessment, APCD has determined weights of relative importance to use when combining the individual indicators for each parameter assessed. These weighting factors were then used to produce a weighted score from the raw rankings derived from each analysis.

The weighting factors chosen for the CO, $NO_2$, $SO_2$, $O_3$, $PM_{10}$, and $PM_{2.5}$ networks are shown in the following tables.

Table 84. Weighting factors applied to the site-to-site comparison results for each network.

| **Analysis** | **CO Weight** | $NO_2$ **Weight** | $SO_2$ **Weight** | $O_3$ **Weight** | $PM_{10}$ **Weight** | $PM_{2.5}$ **Weight** |
|---|---|---|---|---|---|---|
| Number of Parameters Monitored | 12.6% | 12.7% | 7.0% | 5.0% | 3.8% | 6.6% |
| Trends Impact | 9.2% | 8.9% | 7.4% | 7.0% | 8.7% | 8.9% |
| Measured Concentration | 24.2% | 23.3% | 25.6% | 21.0% | 25.3% | 21.8% |
| Deviation from the NAAQS | - | - | - | 13.0% | - | - |
| Monitor-to-Monitor Correlation | 7.4% | 2.0% | 2.8% | 16.0% | 8.3% | 6.3% |
| Removal Bias | - | - | - | 12.0% | 8.6% | 7.4% |
| Area Served | 4.4% | 6.0% | 5.7% | 16.0% | 11.0% | 9.7% |
| Population Served | 8.6% | 8.3% | 9.5% | 2.5% | 8.7% | 7.5% |
| DIC Population Served | 8.6% | 8.3% | 9.5% | 2.5% | 8.7% | 7.5% |
| Point Source Emissions | 7.4% | 17.4% | 28.4% | 3.0% | 11.7% | 16.0% |
| Traffic Counts | 17.7% | 13.0% | 4.2% | 2.0% | 5.2% | 8.3% |

### 2.11.1 Parameter Details

In this section, the raw rankings derived from each analysis are converted to scores. For each monitoring network, the number of possible points is equivalent to the number of sites in the network (e.g., for the CO network, the maximum possible score is seven). Sites ranking first in a given analysis are assigned the maximum number of points (e.g., seven for the CO network), while the other sites are given scores that scale linearly between one and the maximum.

The following figures and tables show the results of the overall analysis for each pollutant network. The final rankings are based on the weighted average score, with the highest scoring monitor being given a one, the second highest scoring monitor being given a two, etc.

#### *2.11.1.1 Carbon Monoxide (CO)*

Table 85. Raw scores and weighted averages for the CO site-to-site comparison analyses.

| Site Name | Parameters Monitored | Trends Impact | Measured Concentration | Monitor-to-Monitor Correlation | Area Served | Population Served | DIC Population Served | Point Source Emissions | Traffic Counts | Weighted Total Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I-25: Denver | 2.0 | 2.0 | 5.0 | 3.0 | 1.0 | 5.0 | 4.7 | 1.1 | 4.5 | 3.6 | 1 |
| La Casa | 5.0 | 2.0 | 2.7 | 3.0 | 1.0 | 3.9 | 5.0 | 2.0 | 4.5 | 3.4 | 2 |
| Fort Collins - Mason | 1.0 | 5.0 | 2.8 | 1.7 | 5.0 | 1.5 | 1.0 | 1.0 | 1.3 | 2.1 | 3 |
| Colorado College | 1.0 | 1.0 | 1.0 | 5.0 | 4.9 | 2.9 | 2.6 | 1.0 | 2.7 | 2.0 | 4 |
| Greeley - County Tower | 1.0 | 1.8 | 1.1 | 3.7 | 5.0 | 1.0 | 1.4 | 5.0 | 1.0 | 1.8 | 5 |
| **Weight** | 13% | 9% | 24% | 7% | 4% | 9% | 9% | 7% | 18% | | |

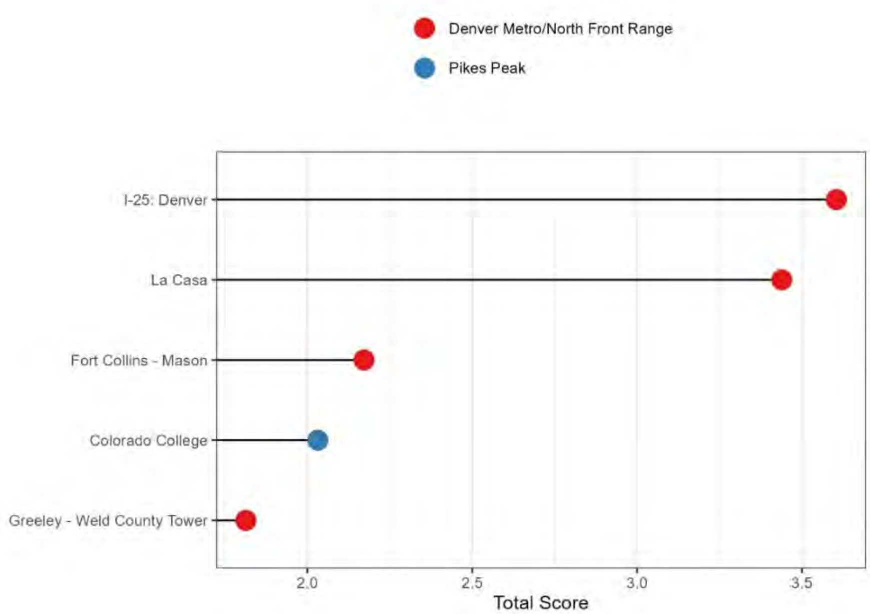


Figure 30. Cleveland dot plot showing the weighted total score for each site in the CO monitoring network.

### *2.11.1.2 Sulfur Dioxide ($SO_2$)*

Table 86. Raw scores and weighted averages for the $SO_2$ site-to-site comparison analyses.

| Site Name | Parameters Monitored | Trends Impact | Measured Concentration | Monitor-to-Monitor Correlation | Area Served | Population Served | DIC Population Served | Point Source Emissions | Traffic Counts | Weighted Total Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Welby | 2.0 | 2.7 | 3.0 | 3.0 | 3.0 | 1.6 | 2.6 | 3.0 | 2.0 | 2.6 | 1 |
| CAMP | 1.0 | 3.0 | 1.0 | 1.0 | 2.2 | 3.0 | 3.0 | 1.0 | 2.5 | 1.8 | 2 |
| La Casa | 3.0 | 1.0 | 1.9 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.6 | 1.6 | 3 |
| **Weight** | 7% | 7% | 26% | 3% | 6% | 10% | 10% | 28% | 4% | | |

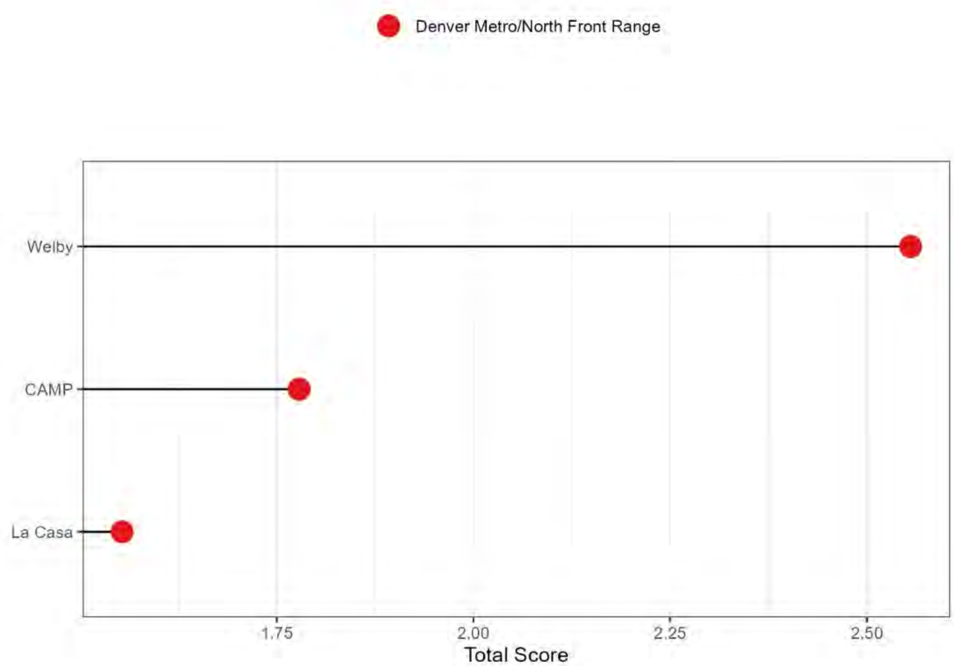


Figure 31. Cleveland dot plot showing the weighted total score for each site in the $SO_2$ monitoring network.

### *2.11.1.3 Nitrogen Dioxide ($NO_2$)*

Table 87. Raw scores and weighted averages for the $NO_2$ site-to-site comparison analyses.

| Site Name | Parameters Monitored | Trends Impact | Measured Concentration | Monitor-to-Monitor Correlation | Area Served | Population Served | DIC Population Served | Point Source Emissions | Traffic Counts | Weighted Total Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Welby | 7.4 | 7.5 | 7.4 | 1.5 | 5.2 | 6.8 | 9.0 | 3.5 | 4.9 | 6.0 | 1 |
| CAMP | 5.8 | 9.0 | 8.5 | 3.0 | 2.3 | 6.9 | 6.6 | 1.7 | 7.4 | 5.5 | 2 |
| I-25: Denver | 4.2 | 2.5 | 8.3 | 1.8 | 4.6 | 9.0 | 7.3 | 1.7 | 5.8 | 5.2 | 3 |
| La Salle | 1.0 | 1.0 | 3.4 | 3.9 | 9.0 | 1.6 | 2.2 | 9.0 | 1.0 | 4.6 | 4 |
| I-25: Globeville | 2.6 | 2.2 | 9.0 | 2.3 | 1.0 | 1.0 | 1.3 | 2.4 | 8.8 | 4.0 | 5 |
| La Casa | 9.0 | 2.4 | 7.0 | 1.9 | 1.6 | 2.8 | 2.8 | 1.0 | 6.7 | 3.8 | 6 |
| Rocky Flats - N. | 2.6 | 4.9 | 1.0 | 9.0 | 7.7 | 5.1 | 2.1 | 3.0 | 2.2 | 3.1 | 7 |
| Bethke | 2.6 | 1.0 | 2.4 | 1.6 | 5.8 | 1.7 | 1.0 | 4.2 | 1.4 | 2.8 | 8 |
| Fossil Creek | 2.6 | 1.0 | 2.6 | 2.1 | 5.8 | 4.0 | 2.1 | 1.8 | 2.7 | 2.5 | 9 |
| **Weight** | 13% | 9% | 23% | 2% | 6% | 8% | 8% | 17% | 13% | | |

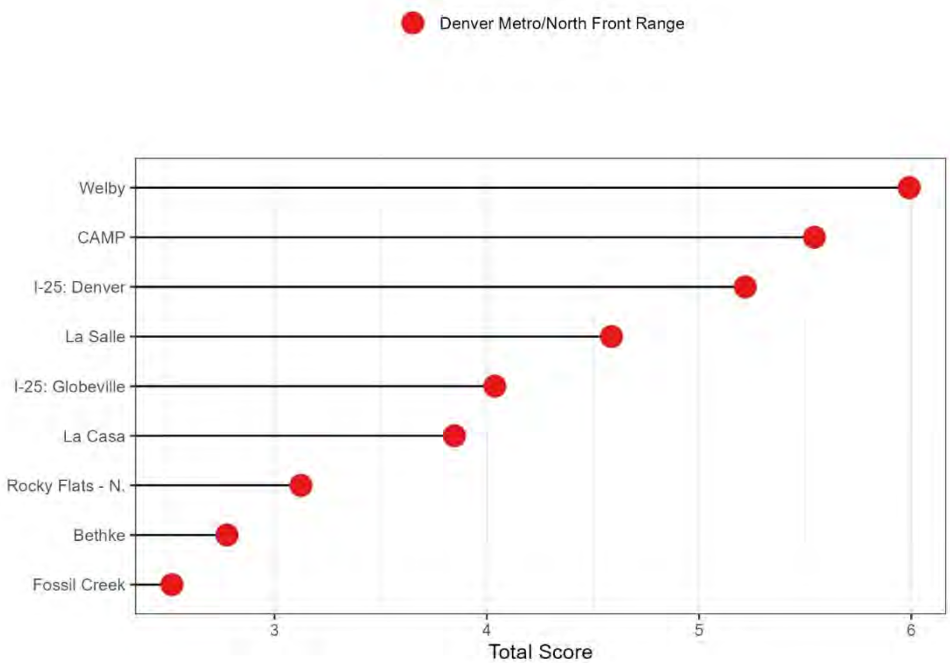


Figure 32. Cleveland dot plot showing the weighted total score for each site in the $NO_2$ monitoring network.

### 2.11.1.4 Ozone ($O_3$)

Table 88. Raw scores and weighted averages for the $O_3$ site-to-site comparison analyses.

| Site Name | Parameters Monitored | Trends Impact | Measured Concentration | Deviation from the NAAQS | Monitor-to-Monitor Correlation | Removal Bias | Area Served | Population Served | DIC Population Served | Point Source Emissions | Traffic Counts | Weighted Total Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U.S. Air Force Academy | 1.0 | 12.8 | 11.0 | 23.0 | 20.9 | 14.8 | 6.7 | 12.5 | 8.2 | 2.0 | 5.3 | 13.1 | 1 |
| Pueblo West | 4.7 | 1.4 | 12.0 | 21.1 | 17.5 | 1.1 | 23.0 | 7.1 | 8.0 | 13.7 | 1.6 | 13.0 | 2 |
| Welby | 19.3 | 22.6 | 16.0 | 13.9 | 11.4 | 8.2 | 2.2 | 18.4 | 22.8 | 7.2 | 13.8 | 12.4 | 3 |
| Aurora - East | 4.7 | 7.3 | 14.8 | 16.0 | 11.5 | 14.1 | 11.9 | 8.7 | 7.9 | 4.3 | 2.1 | 12.0 | 4 |
| Manitou Springs | 1.0 | 9.5 | 13.3 | 18.7 | 12.9 | 16.4 | 2.9 | 10.5 | 9.3 | 4.5 | 7.9 | 11.2 | 5 |
| Fort Collins - Mason | 8.3 | 19.6 | 13.3 | 18.7 | 9.0 | 16.7 | 2.1 | 5.2 | 3.7 | 2.6 | 5.4 | 11.2 | 6 |
| Black Hawk | 1.0 | 3.1 | 14.5 | 16.6 | 19.3 | 16.5 | 3.2 | 1.4 | 1.0 | 1.1 | 2.5 | 11.2 | 7 |
| Greeley - County Tower | 8.3 | 10.3 | 13.3 | 18.7 | 8.3 | 9.5 | 7.4 | 5.6 | 7.4 | 17.2 | 2.3 | 10.9 | 8 |
| Fort Collins - West | 4.7 | 8.6 | 15.7 | 14.4 | 8.0 | 17.9 | 6.9 | 2.5 | 2.0 | 3.3 | 1.2 | 10.8 | 9 |
| Rocky Flats - N. | 8.3 | 14.5 | 20.4 | 5.8 | 5.8 | 18.7 | 1.5 | 7.6 | 3.8 | 1.6 | 7.6 | 10.4 | 10 |
| CAMP | 15.7 | 23.0 | 13.6 | 18.2 | 3.7 | 1.0 | 1.2 | 23.0 | 23.0 | 2.6 | 23.0 | 10.2 | 11 |
| Highland Reservoir | 4.7 | 20.5 | 13.9 | 17.6 | 9.1 | 3.0 | 2.1 | 21.0 | 12.2 | 1.9 | 14.4 | 10.2 | 12 |
| Palisade Water Treatment | 4.7 | 7.8 | 4.8 | 12.8 | 15.6 | 11.3 | 14.9 | 6.4 | 7.3 | 2.5 | 1.8 | 10.1 | 13 |
| Evergreen | 4.7 | 2.7 | 17.4 | 11.2 | 20.6 | 2.7 | 3.2 | 2.1 | 1.0 | 1.0 | 3.1 | 9.9 | 14 |
| NREL | 1.0 | 13.7 | 18.6 | 9.0 | 5.8 | 15.2 | 1.4 | 8.3 | 6.2 | 2.8 | 10.9 | 9.7 | 15 |
| Rifle - Health Dept. | 1.0 | 7.8 | 1.0 | 5.8 | 14.9 | 23.0 | 14.0 | 3.3 | 3.4 | 9.7 | 2.4 | 9.5 | 16 |
| La Casa | 23.0 | 5.7 | 15.4 | 15.0 | 5.7 | 5.9 | 1.0 | 7.2 | 8.4 | 1.8 | 21.8 | 9.4 | 17 |
| La Salle | 4.7 | 1.0 | 18.6 | 9.0 | 6.4 | 5.6 | 7.1 | 4.2 | 5.4 | 22.9 | 2.5 | 9.2 | 18 |
| Bethke | 8.3 | 1.0 | 17.7 | 10.7 | 6.2 | 10.1 | 3.0 | 2.9 | 2.3 | 4.4 | 3.0 | 8.6 | 19 |
| Fossil Creek | 8.3 | 1.0 | 23.0 | 1.0 | 7.0 | 10.5 | 1.8 | 6.0 | 3.7 | 2.3 | 7.7 | 8.6 | 20 |
| Boulder Reservoir | 4.7 | 4.4 | 15.7 | 14.4 | 5.9 | 5.2 | 3.8 | 9.9 | 6.8 | 3.3 | 5.1 | 8.5 | 21 |
| Chatfield State Park | 8.3 | 9.5 | 20.1 | 6.4 | 6.3 | 3.9 | 2.9 | 6.5 | 3.3 | 1.3 | 5.5 | 8.5 | 22 |
| Cortez - Health Dept. | 1.0 | 7.8 | 3.6 | 10.7 | 18.8 | 7.9 | 9.3 | 1.0 | 1.4 | 1.6 | 1.1 | 8.3 | 23 |
| **Weight** | 5% | 7% | 21% | 13% | 16% | 12% | 16% | 3% | 3% | 3% | 2% | | |

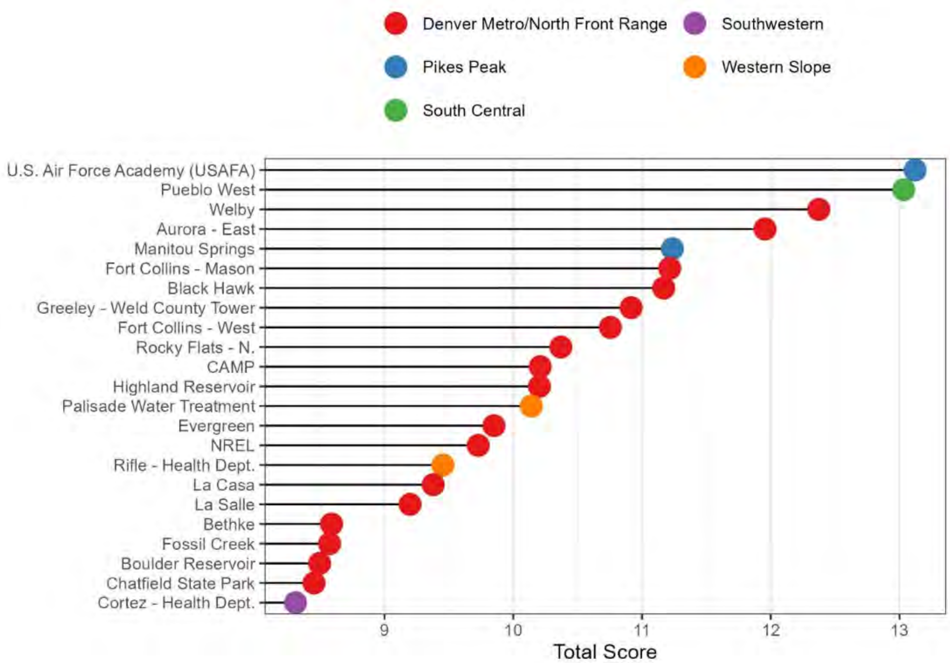


Figure 33. Cleveland dot plot showing the weighted total score for each site in the $O_3$ monitoring network.

### 2.11.1.5 $PM_{10}$

Table 89. Raw scores and weighted averages for the $PM_{10}$ site-to-site comparison analyses.

| Site Name | Parameters Monitored | Trends Impact | Measured Concentration | Monitor-to-Monitor Correlation | Removal Bias | Area Served | Population Served | DIC Population Served | Point Source Emissions | Traffic Counts | Weighted Total Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lamar - Municipal Bldg. | 3.5 | 15.6 | 16.0 | 13.8 | 3.9 | 16.0 | 1.1 | 1.4 | 1.6 | 1.4 | 9.2 | 1 |
| Pagosa Springs School | 1.0 | 16.0 | 14.2 | 16.0 | 1.9 | 16.0 | 1.1 | 1.1 | 1.0 | 1.3 | 8.6 | 2 |
| Pueblo - Fountain School | 3.5 | 6.5 | 6.4 | 12.8 | 1.0 | 16.0 | 4.0 | 5.0 | 16.0 | 4.8 | 8.1 | 3 |
| CAMP | 11.0 | 15.6 | 2.8 | 3.5 | 4.5 | 5.1 | 16.0 | 16.0 | 3.3 | 15.0 | 7.7 | 4 |
| Welby | 13.5 | 15.6 | 6.2 | 7.9 | 2.9 | 2.2 | 8.4 | 11.8 | 1.8 | 12.4 | 7.2 | 5 |
| Colorado College | 6.0 | 6.9 | 1.0 | 11.2 | 5.8 | 16.0 | 10.7 | 10.0 | 4.9 | 10.0 | 7.1 | 6 |
| Alamosa - ASC | 3.5 | 14.4 | 6.1 | 15.0 | 2.8 | 16.0 | 1.1 | 1.4 | 1.1 | 1.7 | 6.6 | 7 |
| Longmont - Municipal | 3.5 | 16.0 | 2.4 | 2.8 | 3.2 | 15.9 | 4.5 | 4.4 | 9.3 | 5.3 | 6.6 | 8 |
| Grand Junction - Powell | 3.5 | 9.3 | 2.3 | 13.5 | 3.8 | 16.0 | 3.8 | 4.6 | 3.7 | 3.9 | 6.1 | 9 |
| Steamboat Springs | 1.0 | 15.6 | 2.0 | 13.3 | 8.6 | 16.0 | 1.3 | 1.2 | 1.1 | 1.9 | 6.0 | 10 |
| Boulder - CU | 3.5 | 1.0 | 1.7 | 11.3 | 16.0 | 15.9 | 4.6 | 2.5 | 2.1 | 4.7 | 5.8 | 11 |
| Birch Street | 3.5 | 1.8 | 6.7 | 2.7 | 4.7 | 1.2 | 4.5 | 6.4 | 9.6 | 10.4 | 5.4 | 12 |
| Aspen | 3.5 | 4.2 | 2.9 | 13.3 | 8.3 | 16.0 | 1.0 | 1.0 | 1.3 | 1.7 | 5.2 | 13 |
| La Casa | 16.0 | 5.3 | 1.8 | 1.0 | 9.8 | 1.0 | 7.8 | 8.9 | 4.4 | 12.9 | 5.2 | 14 |
| Telluride | 1.0 | 14.0 | 3.3 | 13.8 | 4.7 | 7.2 | 1.0 | 1.0 | 1.0 | 1.1 | 4.8 | 15 |
| Cañon City - City Hall | 1.0 | 8.5 | 4.7 | 11.2 | 6.7 | 4.8 | 1.3 | 1.5 | 1.3 | 1.5 | 4.5 | 16 |
| **Weight** | 4% | 9% | 25% | 8% | 9% | 11% | 9% | 9% | 12% | 5% | | |

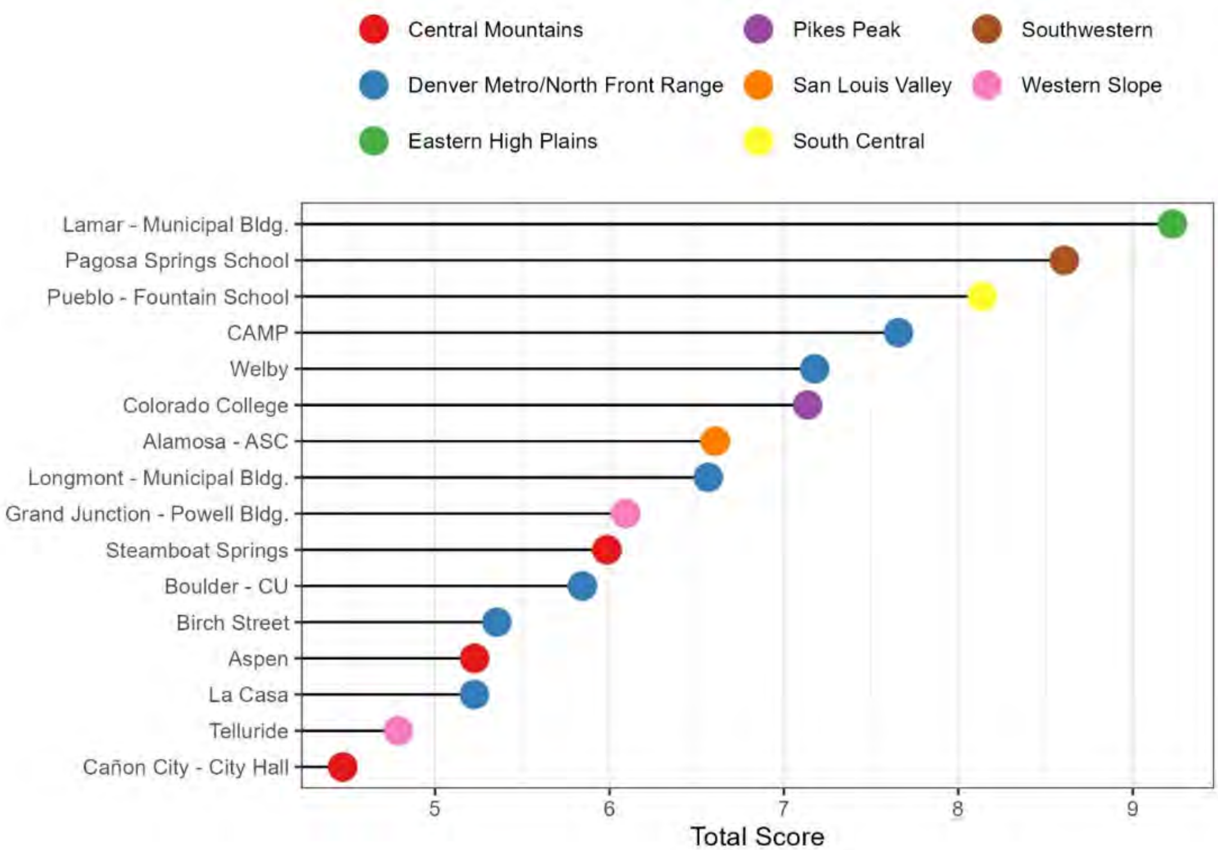


Figure 34. Cleveland dot plot showing the weighted total score for each site in the $PM_{10}$ monitoring network.

### 2.11.1.6 $PM_{2.5}$

Table 90. Raw scores and weighted averages for the $PM_{2.5}$ site-to-site comparison analyses.

| Site Name | Parameters Monitored | Trends Impact | Measured Concentration | Monitor-to-Monitor Correlation | Removal Bias | Area Served | Population Served | DIC Population Served | Point Source Emissions | Traffic Counts | Weighted Total Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greeley - Hospital | 1.0 | 21.0 | 20.2 | 11.6 | 7.3 | 17.3 | 6.2 | 8.6 | 6.0 | 3.1 | 11.7 | 1 |
| Platteville - Middle School | 1.0 | 21.0 | 21.0 | 9.0 | 7.0 | 17.5 | 3.4 | 4.2 | 7.3 | 2.8 | 11.3 | 2 |
| Pueblo - Fountain School | 4.3 | 13.0 | 1.1 | 18.4 | 8.5 | 21.0 | 5.4 | 6.5 | 21.0 | 3.3 | 10.0 | 3 |
| Welby | 17.7 | 1.0 | 19.4 | 1.0 | 6.2 | 7.9 | 13.5 | 15.4 | 1.3 | 8.6 | 9.9 | 4 |
| Longmont - Municipal | 4.3 | 21.0 | 14.2 | 6.8 | 6.8 | 16.7 | 6.9 | 6.8 | 3.9 | 4.5 | 9.9 | 5 |
| Colorado College | 7.7 | 13.8 | 3.0 | 15.8 | 7.6 | 20.7 | 18.5 | 15.6 | 2.9 | 7.0 | 9.6 | 6 |
| NJH | 1.0 | 21.0 | 7.9 | 4.6 | 2.3 | 7.1 | 21.0 | 21.0 | 1.9 | 11.2 | 9.2 | 7 |
| Fort Collins - CSU | 1.0 | 21.0 | 13.2 | 10.4 | 7.0 | 15.5 | 7.8 | 5.6 | 1.6 | 3.7 | 9.1 | 8 |
| CAMP | 14.3 | 21.0 | 12.3 | 5.3 | 1.6 | 1.0 | 4.0 | 3.4 | 1.2 | 20.2 | 8.5 | 9 |
| I-25: Denver | 11.0 | 9.0 | 11.0 | 9.5 | 1.0 | 5.3 | 12.5 | 12.0 | 2.0 | 9.4 | 8.1 | 10 |
| I-25: Globeville | 7.7 | 8.2 | 15.5 | 6.7 | 9.6 | 1.3 | 2.7 | 4.2 | 2.9 | 14.4 | 8.0 | 11 |
| Birch Street | 4.3 | 3.4 | 17.1 | 3.9 | 5.9 | 5.6 | 6.2 | 8.4 | 4.5 | 6.9 | 7.9 | 12 |
| La Casa | 21.0 | 10.6 | 8.6 | 3.9 | 8.6 | 4.5 | 9.6 | 9.2 | 1.3 | 8.9 | 7.9 | 13 |
| ACC | 1.0 | 21.0 | 4.9 | 7.2 | 8.1 | 8.5 | 16.1 | 10.2 | 1.6 | 9.5 | 7.9 | 14 |
| Grand Junction - Powell | 4.3 | 18.6 | 1.1 | 21.0 | 5.2 | 20.9 | 5.0 | 5.9 | 1.9 | 2.7 | 7.3 | 15 |
| Boulder - CU | 4.3 | 1.8 | 4.7 | 7.7 | 18.6 | 18.5 | 8.0 | 3.8 | 2.0 | 3.7 | 6.6 | 16 |
| Chatfield State Park | 7.7 | 16.2 | 2.6 | 8.6 | 4.5 | 14.2 | 6.1 | 2.6 | 1.5 | 3.8 | 6.0 | 17 |
| Bethke | 7.7 | 1.0 | 1.9 | 13.3 | 12.9 | 13.4 | 6.4 | 4.7 | 4.1 | 4.4 | 5.9 | 18 |
| Aspen | 4.3 | 1.0 | 1.0 | 20.5 | 21.0 | 21.0 | 1.1 | 1.0 | 1.1 | 1.8 | 5.9 | 19 |
| Alamosa - ASC | 4.3 | 1.8 | 5.9 | 20.9 | 2.6 | 21.0 | 1.2 | 1.6 | 1.0 | 1.4 | 5.8 | 20 |
| Lamar - Municipal Bldg. | 4.3 | 1.8 | 3.3 | 17.4 | 6.4 | 21.0 | 1.0 | 1.4 | 1.0 | 1.2 | 5.2 | 21 |
| **Weight** | 7% | 9% | 22% | 6% | 7% | 10% | 15% | 15% | 16% | 8% | | |

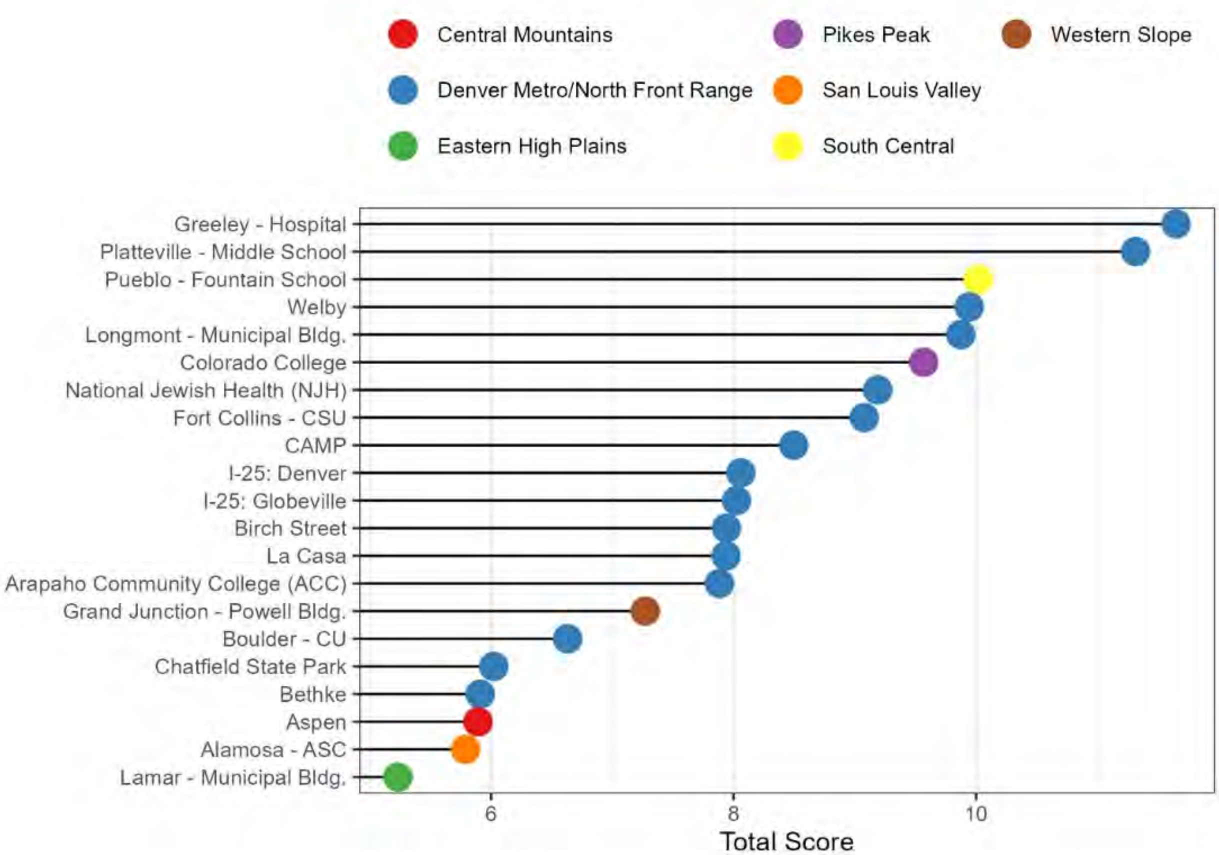


Figure 35. Cleveland dot plot showing the weighted total score for each site in the $PM_{2.5}$ monitoring network.

### *2.11.1.7 Lead (Pb)*

There is no current lead-specific monitoring in Colorado. Based on the 2020 National Emissions Inventory, monitoring is not required, as there are no sources in Colorado that are over 0.5 tons per year of permitted air emissions.

# 3 SUITABILITY MODELING

Suitability modeling and analysis is a common and valuable application of Geographic Information Systems (GIS) in the field of environmental planning and management. Broadly defined, suitability analysis aims to identify the most appropriate spatial pattern for a particular land use or activity according to specific requirements, preferences, or predictors. Suitability analysis is applied in a wide variety of fields including ecology, agriculture, and commerce, but its use is most widespread in environmental management and urban and regional planning (Malczewski, 2004). The most commonly used approaches are based on the concept of overlay analysis, in which multiple evaluation criteria map layers ("input maps") are combined to obtain a composite suitability map ("output map"). For example, an agricultural suitability model may combine data pertaining to elevation, slope, aspect, precipitation, and soil chemistry to identify the most appropriate areas for planting a particular crop. Suitability models in the field of air pollution monitoring typically consider data related to population exposure and the source/sink relationships determining the concentration of pollutants in ambient air (Pope and Wu, 2014).

In this section, suitability analysis is used to identify areas where the existing APCD monitoring network does not adequately represent potential air pollution problems, and where additional sites are potentially needed. This has been accomplished using a weighted linear combination (WLC) technique, which is based on the concept of a weighted average. In this approach, technical experts and program managers at the APCD directly assigned weights of relative importance to a series of attribute map layers ("indicator maps"). The maps were then reclassified into a congruous ranking system (1-10 scale) and organized into three purpose areas: source-oriented, population-oriented, and spatially-oriented. The spatially averaged suitability map was then obtained by the multiplying the importance weight assigned to each attribute by that attribute's value. This spatial average was then used to determine the optimal locations at which new monitors should be deployed.

In general, the results of these analyses indicate where monitors are best located based on specific objectives and expected pollutant behavior. However, the development of a useful suitability model relies on a thorough understanding of the phenomena that cause reduced air quality. The various indicator maps used in this section were introduced in Section 1.5 (see Table 5) and are described below.

## 3.1 Description of Indicators

Indicators maps have been grouped into three categories: source-oriented, population-oriented, and spatially oriented. This categorization has been used to simplify the assignment of weights and to make the weighting process transparent. Different weighting schemes have been used in the evaluation of each network due to the unique characteristics of each pollutant. For example, emissions inventory data can be used to determine the areas of maximum expected concentrations of pollutants directly emitted (i.e., primary emissions). However, emission inventory data are less useful to understand secondary pollutants formed in the atmosphere (i.e., $O_3$ and $PM_{2.5}$). Therefore, the emissions inventory indicator map was assigned a lower weight in the case of secondary pollutants (see Section 3.2).

### 3.1.1 Source-Oriented

#### *3.1.1.1 Emissions Inventory*

In this analysis, raster maps of point emission sources were created for each pollutant network using APCD emissions inventory data (see Section 2.9). Emission sources for each pollutant were spatially aggregated in ArcGIS using a 4 $km^2$ fishnet grid and the sum of emissions in each sector ("emission section") was used as the raster value in the resulting indicator map. For CO, $SO_2$, and $PM_{10}$, only primary emission sources of these species were considered. For $NO_2$, emissions of both NO and $NO_2$ (i.e., $NO_x$) were considered. For $O_3$, both $NO_x$ and VOC emissions were considered. For $PM_{2.5}$, $NO_x$, $SO_2$, and primary $PM_{2.5}$ emissions were considered. When reclassifying the raster maps, the entire distribution of emission sections was divided into 10 classes using the Jenks classification method and assigned a score of 1-10 with 10 being the highest score. This same approach was taken in the reclassification of all the indicator maps described below.

#### *3.1.1.2 Traffic Counts*

The association of road traffic and air pollution, particularly CO and $NO_2$, is a well-known phenomenon (Briggs et al., 2000). In this analysis, the normalized AADT counts derived in Section 2.10 were spatially aggregated using a 4 $km^2$ fishnet grid and the sum of normalized AADT in each sector was then used to create a raster map. The same AADT indicator map was used in the suitability model for each pollutant network.

#### *3.1.1.3 Road Density*

Similar to the approach discussed in Section 2.10, this analysis uses CDOT spatial data for highways and major roads within Colorado to create a raster map of road density using a 4 $km^2$ fishnet grid. The same road density indicator map was used in the suitability model for each pollutant network.

### 3.1.2 Population-Oriented

#### *3.1.2.1 Population Density*

In this analysis, a population density map was created using 2019-2023 ACS data (see Section 1.4.5). The population density of each census tract was calculated as the total population divided by the area of the census tract and this value was used in the resulting raster map. The same population density indicator map was then used in the suitability model for each pollutant network.

#### *3.1.2.1 DIC Population Density*

For this analysis, a DIC population density map was developed using 2019–2023 ACS data (see Section 1.4.5) and socioeconomic data from Colorado EnviroScreen. The DIC population density for each census tract was calculated by multiplying the total population by the average EnviroScreen DIC percentile score, then dividing by the tract's area. This value was used to generate the resulting raster map for input into the suitability model.

### 3.1.3 Spatially-Oriented

#### *3.1.3.1 Distance from an Existing Monitor*

This indicator calculates and spatially assigns scores based on the ground distance between existing monitoring sites. The assumption underlying this analysis is that it is more desirable to have a new monitoring site located farther away from an existing site. The score increases the farther away in space that the location is from existing monitoring sites.

#### *3.1.3.2 Interpolation Map*

This analysis uses pollutant interpolation maps generated with monitoring data to account for actual (i.e., measured) pollutant concentration surfaces.

#### *3.1.3.4 Elevation*

As discussed in Section 2.6.1 Ozone ($O_3$), $O_3$ in Colorado exhibits a strong positive correlation with elevation. The observation of enhanced $O_3$ concentrations with elevation in Colorado has been attributed to the low availability of nitric oxide (NO), which reacts with $O_3$, and the increased importance of stratospheric $O_3$ transport at high elevation (Jaffe, 2010; Musselman and Korfmacher, 2014). Because of this relationship, we have used a digital elevation model (DEM) as a weighted indicator map in the $O_3$ suitability model.

## 3.2 Results for All Parameters

In the following sections, the weights of relative importance assigned to the indicator maps in each pollutant suitability model are presented and a brief justification of the chosen weighting scheme is provided. The final weighted suitability model for each network is then presented in the form of a raster map with a spatial resolution of 4 km. Values of the raster maps are suitability scores, which represent the suitability of the location for the addition of a new monitoring site.

### 3.2.1 Carbon Monoxide (CO)

Table 91. Weights applied in the CO suitability model.

| Analysis | Weight Percentage |
|---|---|
| ***Source-Oriented*** | ***42.5%*** |
| Point Source Emissions | 11.7% |
| Traffic Counts | 18.3% |
| Road Density | 12.5% |
| ***Population-Oriented*** | ***28.2%*** |
| Population Density | 14.1% |
| DIC Population Density | 14.1% |
| ***Spatially-Oriented*** | ***29.3%*** |
| Distance from an Existing Monitor | 11.8% |
| Interpolated Concentration | 17.5% |

CO is generally non-reactive, thus concentrations are directly correlated to emission sources. The source-oriented indicators have therefore been given a large relative weighting in the CO suitability model. The majority of CO emissions to ambient air originate from mobile sources (i.e., transportation), particularly in urban areas, where as much as 85% of all CO emissions may come from automobile exhaust. Therefore, the mobile source indicators (i.e., Traffic Counts and Road Density) have been assigned almost three times the total weight given to the point source indicator.

Correlations between CO monitoring sites decrease rapidly with distance between sites (Figure 5). This suggests that CO sites can be located relatively close together without producing redundant data. Therefore, the Distance from an Existing Monitor indicator was given a relatively low weight. The Interpolated Concentration indicator was given a relatively large weight, as this represents the best available estimate of the spatial variability in CO at unmonitored locations.

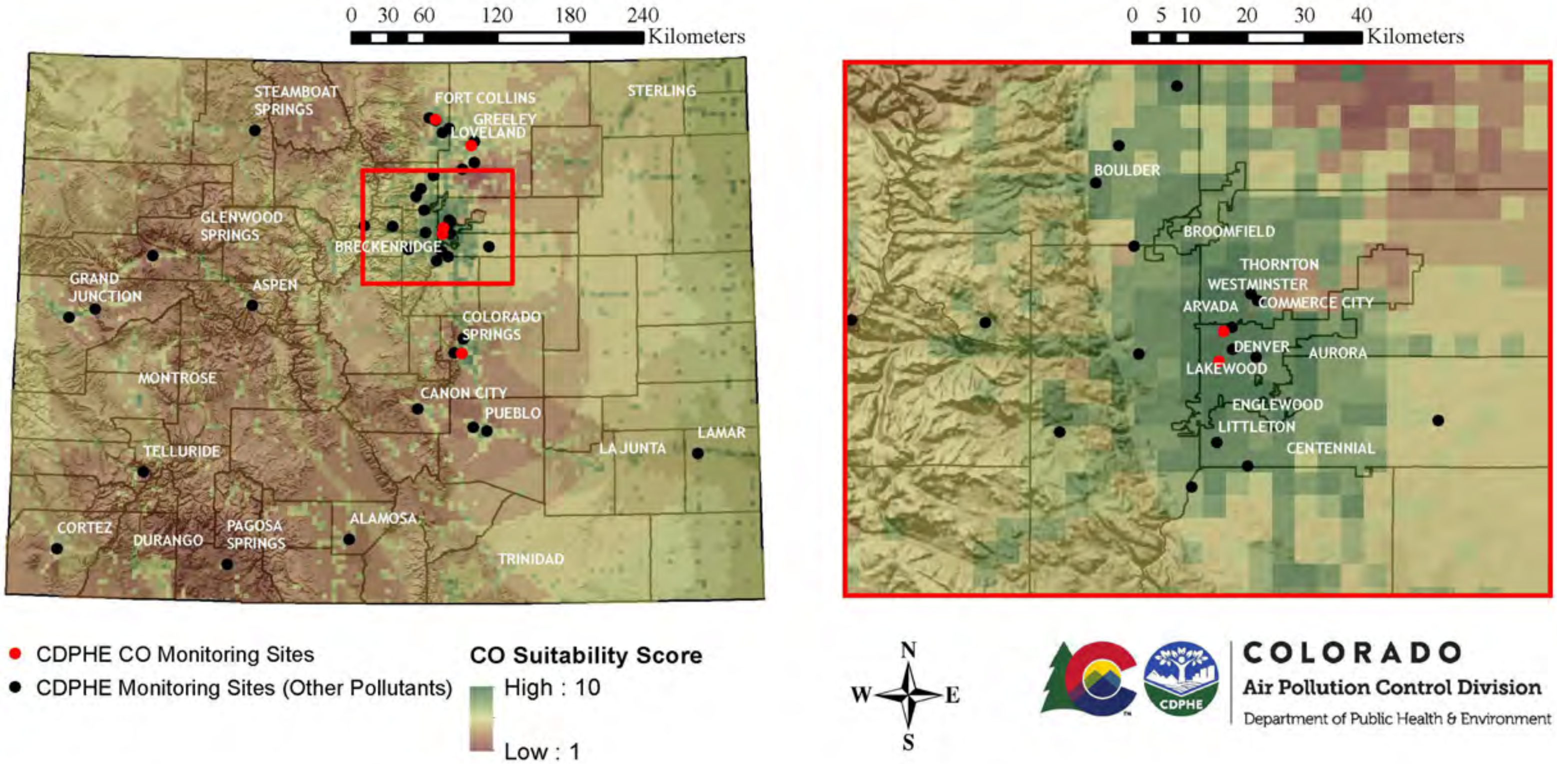


Figure 36. Results of the CO suitability model showing the entire state of Colorado as well as the Denver metropolitan area. Criteria pollutant monitoring sites operated by the APCD and listed in Table 6 are symbolized with black circles. Detailed site information, including AQS identification numbers, site descriptions and histories, addresses and coordinates, monitoring start dates, site elevations, site orientation/scale designations, etc., can be found in Appendix A.

### 3.2.2 Nitrogen Dioxide ($NO_2$)

Table 92. Weights applied in the $NO_2$ suitability model.

| Analysis | Weight Percentage |
|---|---|
| ***Source-Oriented*** | ***48.3%*** |
| Point Source Emissions | 20.8% |
| Traffic Counts | 16.7% |
| Road Density | 10.8% |
| ***Population-Oriented*** | ***19.7%*** |
| Population Density | 9.9% |
| DIC Population Density | 9.9% |
| ***Spatially-Oriented*** | ***32.0%*** |
| Distance from an Existing Monitor | 14.5% |
| Interpolated Concentration | 17.5% |

$NO_2$ emissions are associated with both point sources (mostly fuel combustion) and mobile sources (i.e., transportation), and $NO_2$ concentrations in ambient air are directly correlated with emission sources (Briggs et al., 2000). For this reason, the source-oriented indicators were given almost half of the total weight in the $NO_2$ suitability model, with the mobile source indicators being given a higher total weight (27.5%) than the point source indicator (20.8%).

$NO_2$ is a public health concern and it is an objective of the APCD to maximize the number of citizens represented by each $NO_2$ monitor. However, $NO_2$ is also an important precursor to $O_3$, which tends to have a greater impact on regions of lower population density (see Section 3.1.3.2). The collocation of $NO_2$ and $O_3$ monitors at high $O_3$ sites could provide useful information regarding the balance between ozone production and destruction, which can be used to assess and validate model predictions and further optimize the network's configuration. Therefore, the Population Density indicator was assigned a lower weight in the $NO_2$ suitability model (19.7%) as compared to the CO suitability model (28.2%).

As with CO, the monitor-to-monitor correlation study described in Section 2.5.2 suggests that $NO_2$ sites can be located relatively close together without producing redundant data. Therefore, the Distance from an Existing Monitor indicator was given a relatively low weight. The Interpolated Concentration indicator was given a relatively large weight.

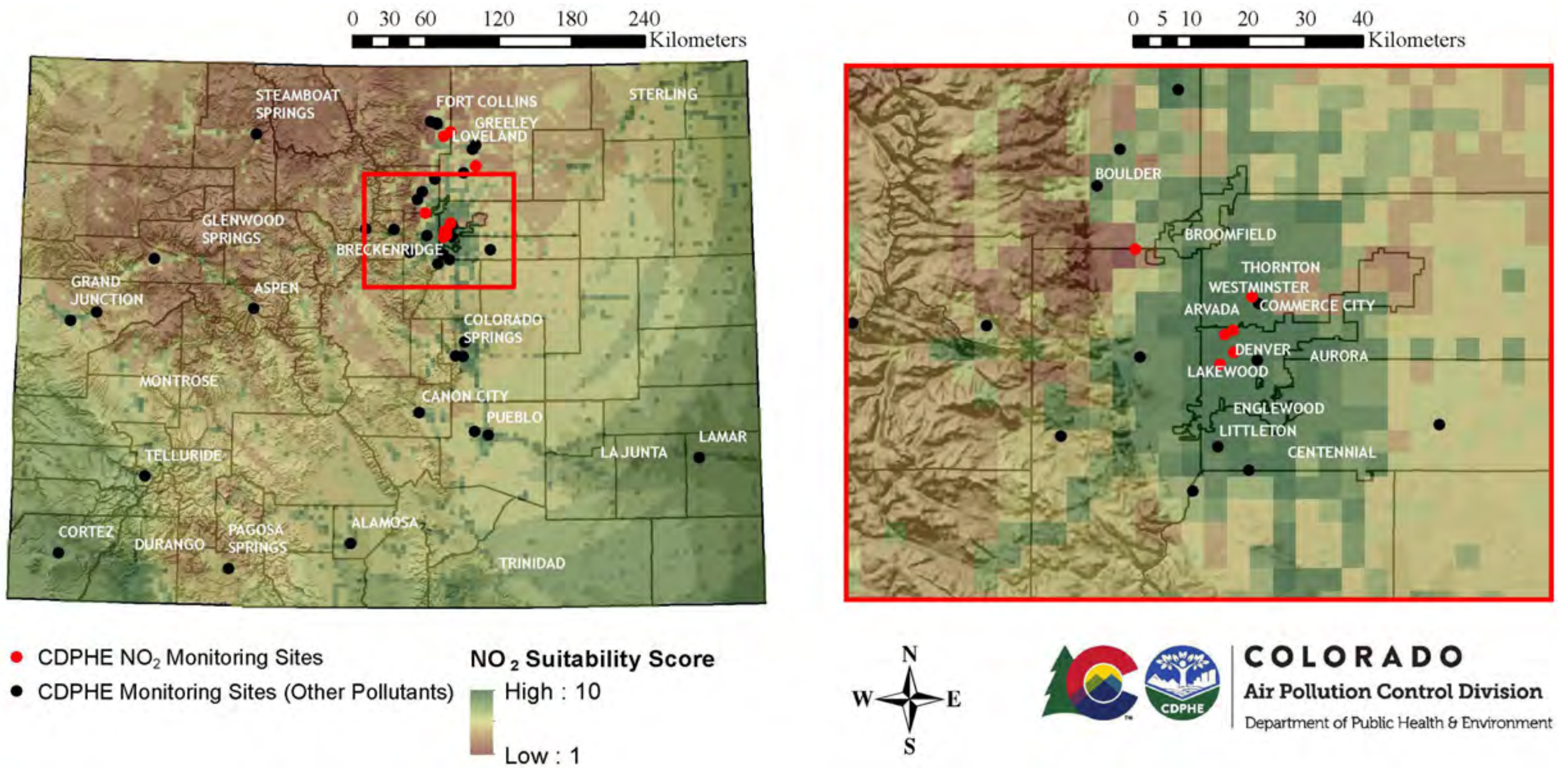


Figure 37. Results of the $NO_2$ suitability model showing the entire state of Colorado as well as the Denver metropolitan area. Criteria pollutant monitoring sites operated by the APCD and listed in Table 6 are symbolized with black circles. Detailed site information, including AQS identification numbers, site descriptions and histories, addresses and coordinates, monitoring start dates, site elevations, site orientation/scale designations, etc., can be found in Appendix A.

### 3.2.3 Sulfur Dioxide ($SO_2$)

Table 93. Weights applied in the $SO_2$ suitability model.

| Analysis | Weight Percentage |
|---|---|
| ***Source-Oriented*** | ***45.8%*** |
| Point Source Emissions | 30.8% |
| Traffic Counts | 8.3% |
| Road Density | 6.7% |
| ***Population-Oriented*** | ***20.8%*** |
| Population Density | 10.4% |
| DIC Population Density | 10.4% |
| ***Spatially-Oriented*** | ***33.3%*** |
| Distance from an Existing Monitor | 10.8% |
| Interpolated Concentration | 22.5% |

The largest sources of $SO_2$ emissions in Colorado are from fossil fuel combustion at power plants, while mobile sources contribute less than 1 percent.[3] For this reason, the point source indicator was assigned a relatively high weight in the $SO_2$ suitability model (30.8%), while the mobile source indicators were assigned a relatively low total weight (15.0%).

The monitor-to-monitor correlation study described in Section 2.5.3 showed very low correlations among the three $SO_2$ sites located in central Denver ($r^2$ = 0.09-0.20), suggesting that $SO_2$ sites can be located relatively close together without producing redundant data. Therefore, the Distance from an Existing Monitor indicator was given a relatively low weight in the $SO_2$ suitability model. The Interpolated Concentration indicator was given a relatively large weight.

[3] http://www.epa.gov/air/emissions/

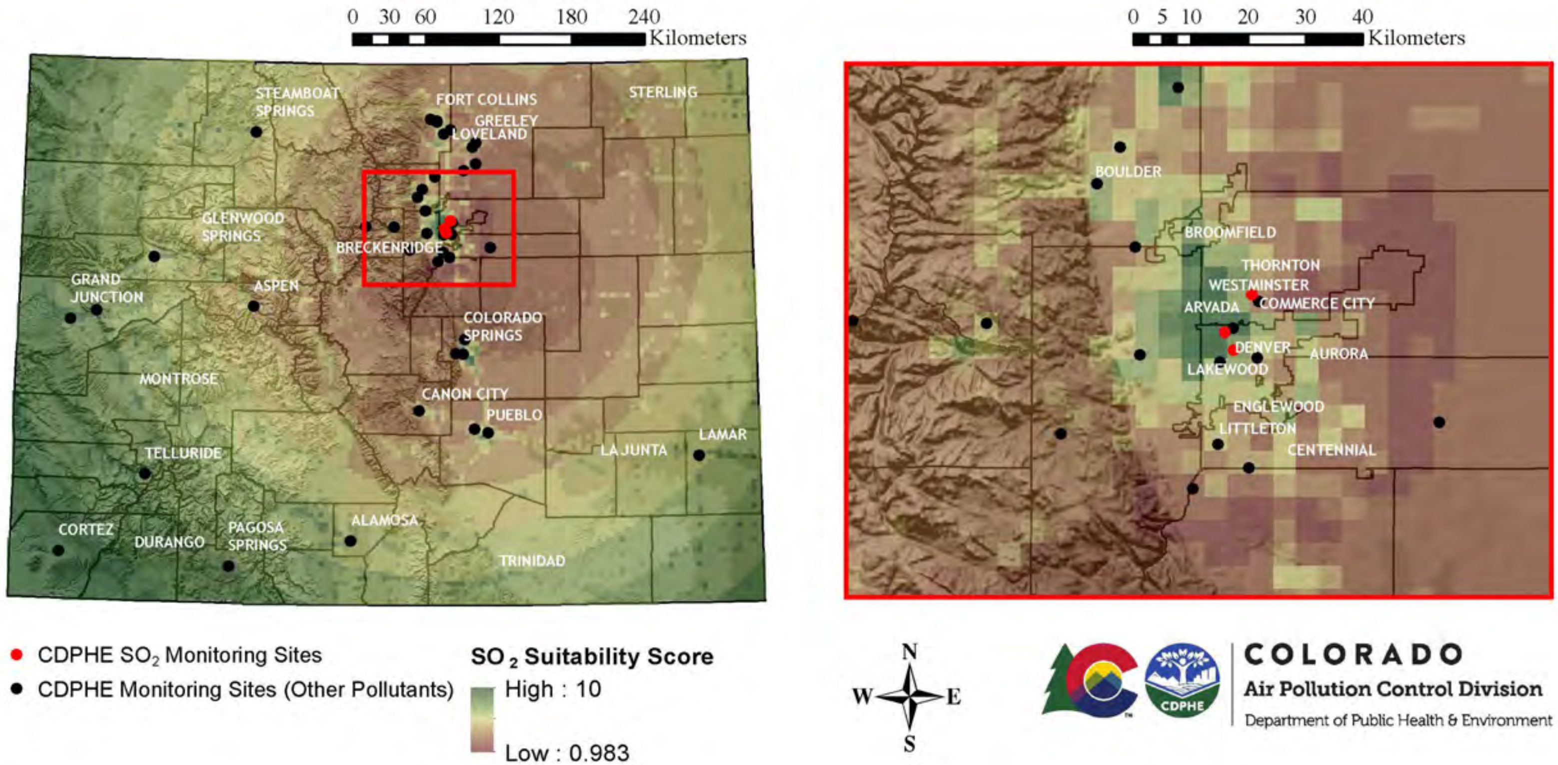


Figure 38. Results of the $SO_2$ suitability model showing the entire state of Colorado as well as the Denver metropolitan area. Criteria pollutant monitoring sites operated by the APCD and listed in Table 6 are symbolized with black circles. Detailed site information, including AQS identification numbers, site descriptions and histories, addresses and coordinates, monitoring start dates, site elevations, site orientation/scale designations, etc., can be found in Appendix A.

### 3.2.4 Ozone ($O_3$)

Table 94. Weights applied in the $O_3$ suitability model.

| Analysis | Weight Percentage |
|---|---|
| ***Source-Oriented*** | ***22.6%*** |
| Point Source Emissions | 10.8% |
| Traffic Counts | 6.5% |
| Road Density | 5.3% |
| ***Population-Oriented*** | ***15.7%*** |
| Population Density | 7.9% |
| DIC Population Density | 7.9% |
| ***Spatially-Oriented*** | ***61.7%*** |
| Distance from an Existing Monitor | 18.4% |
| Interpolated Concentration | 38.0% |
| Elevation | 5.3% |

As discussed in Section 2.9.4 Ozone ($O_3$), $O_3$ is a secondary pollutant and its spatial variability is only indirectly related to precursor emissions sources. Therefore, the source-oriented indicators were assigned a relatively small weight in the $O_3$ suitability model. Similarly, because $O_3$ concentrations tend to be reduced via $NO_x$ titration in heavily populated areas, the population indicator was also assigned a lower weight compared to the other pollutant models.

$O_3$ monitoring sites tend to be well correlated over distances of approximately 90 km (see Section 2.5.4, Figure 8). This suggests that a dense network of $O_3$ monitoring sites is an inefficient use of resources as it will produce redundant data. Therefore, the Distance from an Existing Monitor indicator was given a relatively high weight in the $O_3$ suitability model. Because the Interpolated Concentration indicator in this case is based on maximum 8-hr values (see Section 3.1.3.2), which are more relevant from a regulatory perspective, this input was assigned a higher weight compared to the modeled concentration indicator.

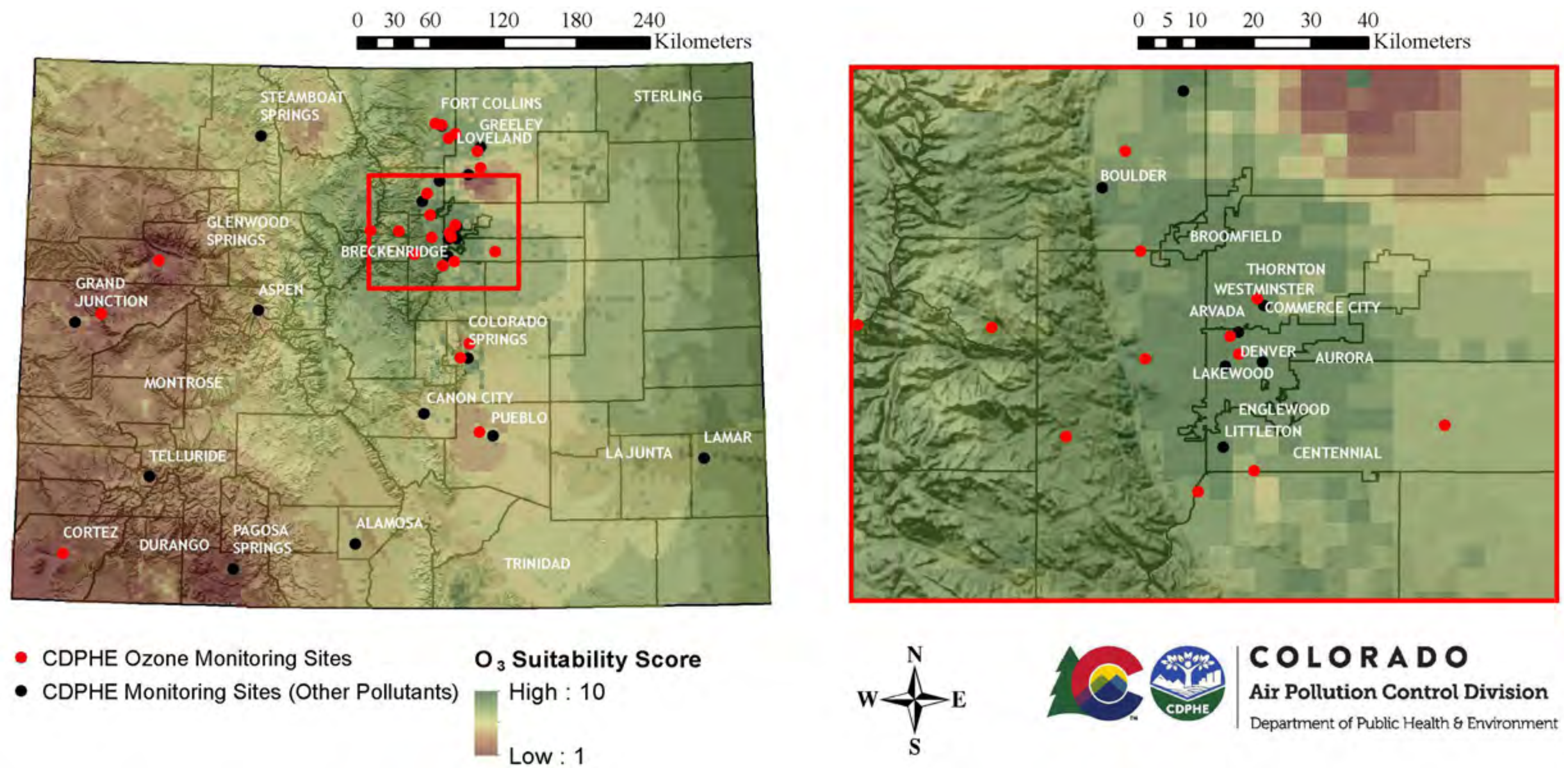


Figure 39. Results of the $O_3$ suitability model showing the entire state of Colorado as well as the Denver metropolitan area. Criteria pollutant monitoring sites operated by the APCD and listed in Table 6 are symbolized with black circles. Detailed site information, including AQS identification numbers, site descriptions and histories, addresses and coordinates, monitoring start dates, site elevations, site orientation/scale designations, etc., can be found in Appendix A.

### 3.2.5 $PM_{10}$

Table 95. Weights applied in the $PM_{10}$ suitability model.

| Analysis | Weight Percentage |
|---|---|
| ***Source-Oriented*** | ***36.2%*** |
| Point Source Emissions | 20.0% |
| Traffic Counts | 8.8% |
| Road Density | 7.4% |
| ***Population-Oriented*** | ***22.8%*** |
| Population Density | 11.4% |
| DIC Population Density | 11.4% |
| ***Spatially-Oriented*** | ***41.0%*** |
| Distance from an Existing Monitor | 14.0% |
| Interpolated Concentration | 27.0% |

$PM_{10}$ concentrations typically have a strong relationship with point sources. Furthermore, dust from paved and unpaved roads is a particular problem in Colorado and the western U.S. in general. For this reason, the point and mobile source indicators were assigned relatively high weights, with the point source indicator being given a slightly larger weight than the mobile source indicators.

As with CO and $NO_2$, the monitor-to-monitor correlation study described in Section 2.5.5 suggests that $PM_{10}$ sites can be located relatively close together without producing redundant data. Therefore, the Distance from an Existing Monitor indicator was given a relatively low weight.

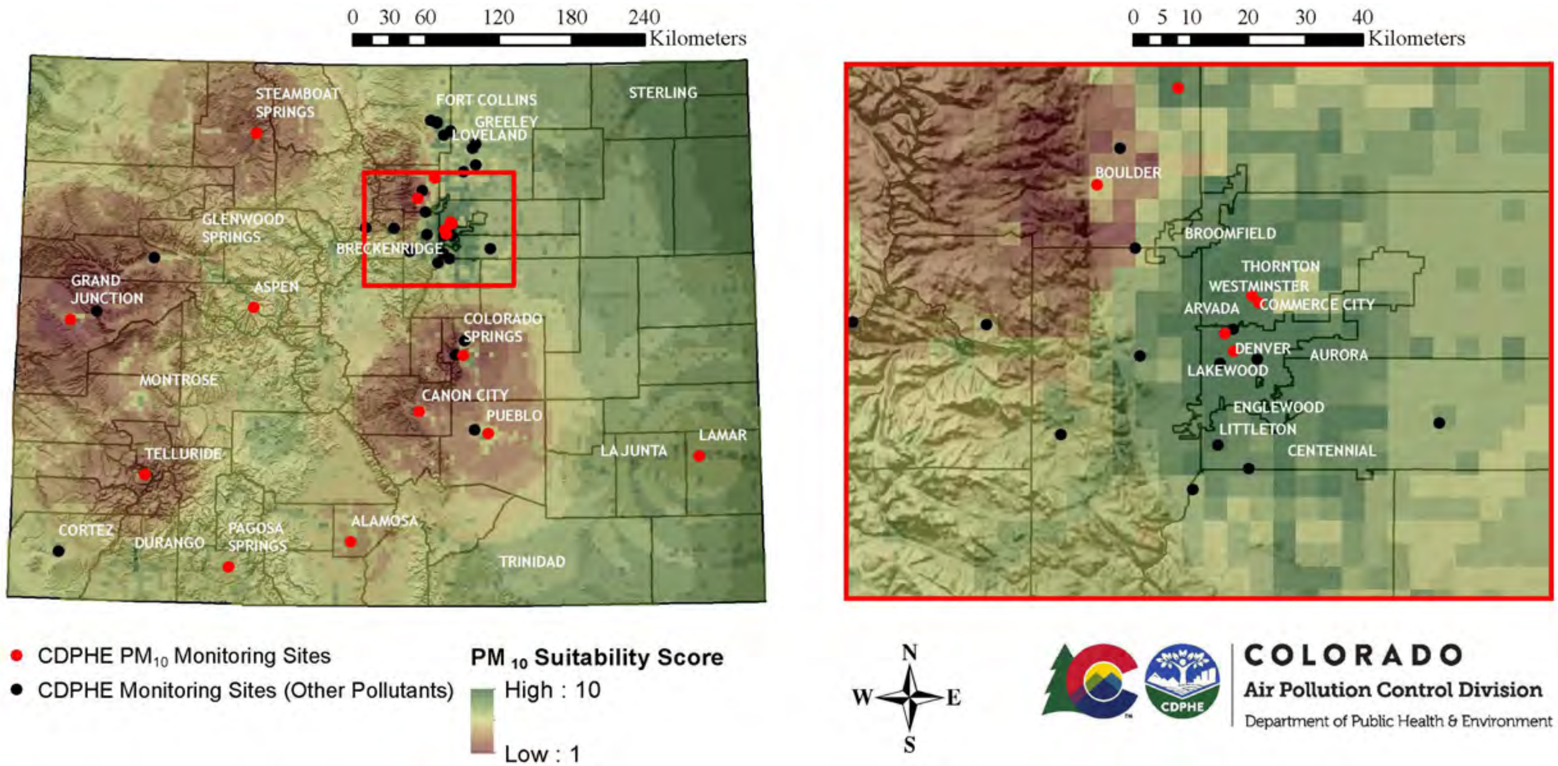


Figure 40. Results of the $PM_{10}$ suitability model showing the entire state of Colorado as well as the Denver metropolitan area. Criteria pollutant monitoring sites operated by the APCD and listed in Table 6 are symbolized with black circles. Detailed site information, including AQS identification numbers, site descriptions and histories, addresses and coordinates, monitoring start dates, site elevations, site orientation/scale designations, etc., can be found in Appendix A.

### 3.2.6 $PM_{2.5}$

Table 96. Weights applied in the $PM_{2.5}$ suitability model.

| Analysis | Weight Percentage |
|---|---|
| ***Source-Oriented*** | ***25.0%*** |
| Point Source Emissions | 10.0% |
| Traffic Counts | 9.0% |
| Road Density | 6.0% |
| ***Population-Oriented*** | ***21.2%*** |
| Population Density | 10.6% |
| DIC Population Density | 10.6% |
| ***Spatially-Oriented*** | ***53.8%*** |
| Distance from an Existing Monitor | 12.0% |
| Interpolated Concentration | 41.8% |

Like $O_3$, $PM_{2.5}$ is a secondary pollutant and its spatial variability is only indirectly related to precursor emissions sources. Therefore, the source-oriented indicators were assigned a relatively small weight in the $PM_{2.5}$ suitability model, with the mobile source indicators being given a slightly larger weight than the point source indicators.

As with $PM_{10}$, the monitor-to-monitor correlation study described in Section 2.5.6 suggests that $PM_{2.5}$ sites can be located relatively close together without producing redundant data. Therefore, the Distance from an Existing Monitor indicator was given a relatively low weight in the $PM_{2.5}$ suitability model. The Interpolated Concentration indicator was given a relatively large weight.

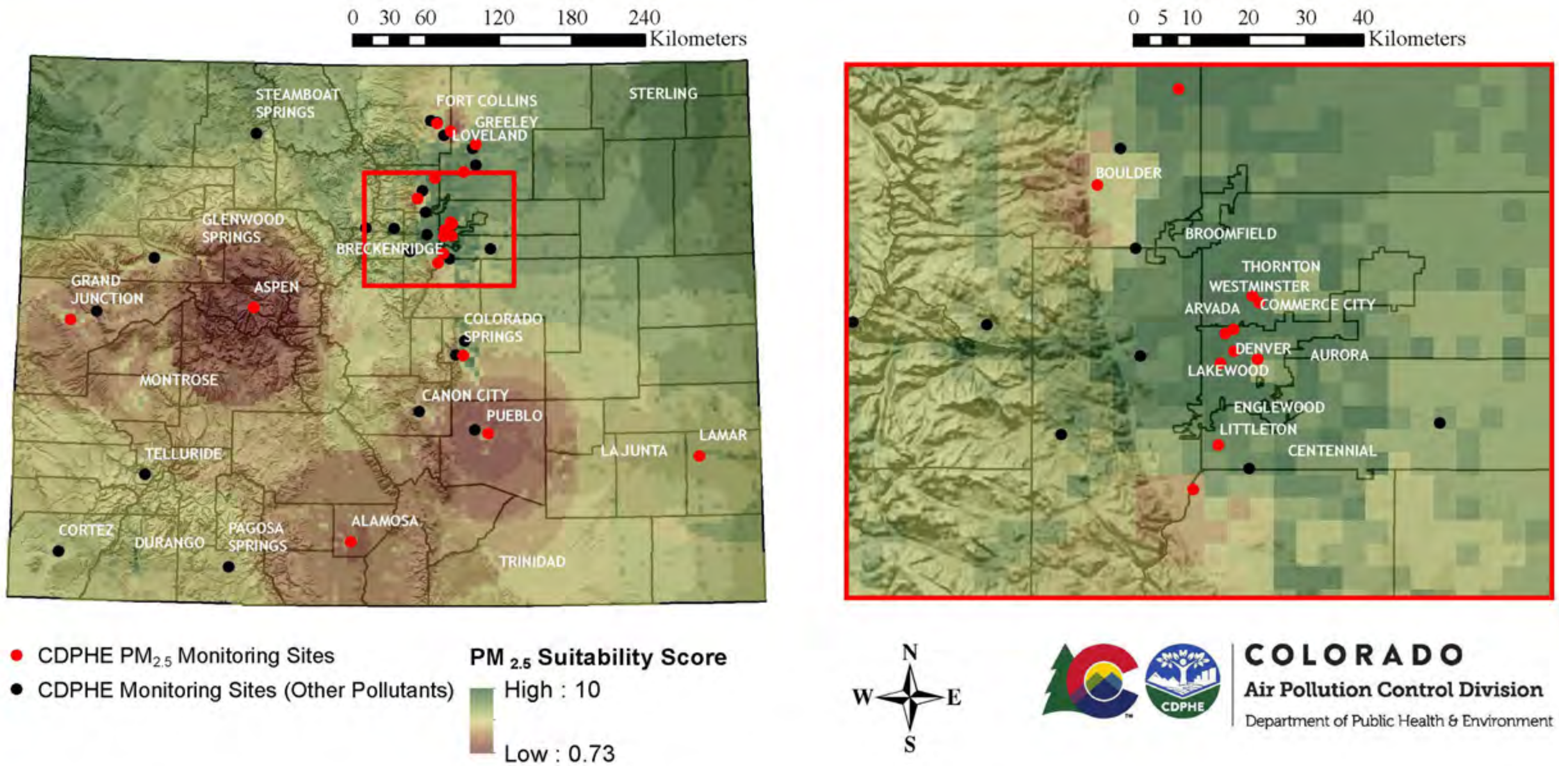


Figure 41. Results of the $PM_{2.5}$ suitability model showing the entire state of Colorado as well as the Denver metropolitan area. Criteria pollutant monitoring sites operated by the APCD and listed in Table 6 are symbolized with black circles. Detailed site information, including AQS identification numbers, site descriptions and histories, addresses and coordinates, monitoring start dates, site elevations, site orientation/scale designations, etc., can be found in Appendix A.

## 4. CONCLUSIONS AND RECOMMENDATIONS

Colorado's ambient air monitoring network has been and will continue to be in a constant state of flux. Change within the network is most notably driven by changes to the NAAQS, changes in population demographics, and changes in land use. For example, the EPA lowered the $PM_{2.5}$ NAAQS standard from 12 µg $m^{-3}$ to 9 µg $m^{-3}$ in 2024, which has may require the APCD to enhance its $PM_{2.5}$ monitoring, identify potential precursor sources, and to refine its scientific understanding of Colorado's $PM_{2.5}$ problems

The following section contains suggestions for modifications to the APCD monitoring network to be considered over the next five years. Results of the analyses presented in previous sections are used to suggest the addition, removal, or relocation of individual monitors or monitoring sites. These suggestions are ultimately based upon the EPA requirements for monitoring sites (e.g., site objective and number of required sites) and the objectives and priorities of the APCD as stated in Section 1.5.3.

### 4.1 Parameter-Specific Recommendations

#### 4.1.1 Carbon Monoxide (CO)

The current CO monitoring network configuration adequately supports APCD monitoring objectives and meets all federal requirements. CO concentrations are typically well below the NAAQS and no state-operated monitor has recorded a violation of the 8-hour standard since 1996. For this reason, it is the opinion of APCD program managers and technical experts that CO monitoring should be deemphasized and funds shifted to monitoring objectives of higher priority. Most Colorado CO monitoring sites are currently in place in support of SIP maintenance plans, which necessitate that monitoring activities continue until these plans expire. However, we recommend the removal of the lowest value sites (e.g., Greeley, Fort Collins, and Colorado College) once they have achieved their monitoring objectives. A SIP amendment arguing that the maintenance plan for CO has been fulfilled and CO monitoring should be discontinued has been approved by the Colorado Air Quality Control Commission and is awaiting EPA approval.

#### 4.1.2 Nitrogen Dioxide ($NO_2$)

The current $NO_2$ monitoring network meets all federal requirements and adequately supports most APCD monitoring objectives. $NO_2$ concentrations are typically well below the NAAQS. No state-operated monitor has recorded a violation of the annual standard since 1977 and the one-hour standard has not been violated since it was promulgated in 2010. However, despite the decreased relevance of $NO_2$ as an ambient air pollutant, the APCD feels that the monitoring network should be expanded due to the importance of $NO_2$ as an $O_3$ precursor. Furthermore, the collocation of $O_3$ and $NO_2$ monitors can be very helpful in understanding ozone dynamics at a particular site. Total oxidant, or "odd oxygen," estimates can be derived by simply adding $NO_2$ and $O_3$ concentrations. These estimates provide an important indicator of the $O_3$ production potential at a location, and help to differentiate low $O_3$ production potential from $NO_x$ scavenging.

Therefore, we recommend adding supplemental $NO_2$ monitoring at high-concentration ozone monitoring sites in the Front Range. $NO_2$ monitoring has been added at Bethke Elementary School and will be added to Mehaffey Park in Loveland, Fort Collins West, and Chatfield. Determination of a suitable additional $NO_x$ location to the east of Interstate 25 should be considered. Increases in population in Colorado Springs, and changes in land use, suggest the addition of $NO_2$ monitoring in the area. Either of these recommendations would require reallocation of limited resources.

### 4.1.3 Sulfur Dioxide ($SO_2$)

The current $SO_2$ monitoring network meets all federal requirements and adequately supports APCD monitoring objectives. All sites have 2024 one-hour design values less than 20% of the NAAQS standard.

### 4.1.4 Ozone ($O_3$)

The current $O_3$ monitoring network supports the APCD's monitoring objectives reasonably well. Areas of high concentrations, as well as background concentration areas have been monitored all along the Front Range, the Continental Divide, and in several areas on the Western Slope.

The North Front Range nonattainment area continues to exceed the NAAQS. Additional $O_3$ monitors have been installed at several sites in the North Front Range to add resolution to the monitoring program. Some of these monitors include $NO_2$ analyzers as discussed in Section 4.1.2. We recommend, in addition to the collocated $NO_2$ analyzers, that the $O_3$ network on the North Front Range not be reduced.

Cortez was ranked lowest in the $O_3$ site-to-site comparison analysis. We recommend that this site be closed.

The APCD recommends the installation of additional $O_3$ monitors in Durango in the Southwestern region, and in San Luis in the San Luis Valley region. These areas have limited previous air quality monitoring and emissions and modeling data suggest potential for elevated concentrations.

### 4.1.5 $PM_{10}$

The current $PM_{10}$ monitoring network meets all federal requirements and adequately supports APCD monitoring objectives. The APCD has decreased the size of its $PM_{10}$ monitoring network over the past 10-15 years and removed the monitors deemed to be of lowest value. This was done to make funding available for other monitoring networks of higher priority within the state of Colorado (e.g., $O_3$ and $PM_{2.5}$). Many of the lowest ranked sites in the site-to-site comparison analysis presented here are associated with SIP maintenance plans and cannot be removed or relocated. The APCD is working toward a SIP amendment that would determine the end of the SIP maintenance window for $PM_{10}$. Most of the $PM_{10}$ analyzers have been converted from filter-based to continuous analyzers. This conversion has made $PM_{10}$ (and $PM_{2.5}$) data available to the public in real-time.

The APCD is working toward installation of $PM_{10}$ and $PM_{2.5}$ analyzers in Edwards along the Eagle River valley, in Delta on the Western Slope, in Durango in the Southwestern region, and in San Luis in the San Luis Valley region. These areas have limited previous air quality monitoring and an increased potential for impact from blowing dust events.

### 4.1.6 $PM_{2.5}$

The current $PM_{2.5}$ monitoring network meets all federal requirements and adequately supports APCD monitoring objectives. The APCD is working toward installation of $PM_{10}$ and $PM_{2.5}$ analyzers in Edwards, Colorado, along the Eagle River valley, in Delta on the Western Slope, in Durango in the Southwestern region, and in San Luis in the San Luis Valley region. These areas have limited previous air quality monitoring and an increased potential for impact from wildland fire events.

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# APPENDIX A

## Monitoring site descriptions

| AQS # | Site Name | Address | Site Start | Elevation (m) | Latitude | Longitude |
|---|---|---|---|---|---|---|
| | Parameter | POC | Start | Orient/Scale | Monitor | Type |
| **Adams** | | | | | | |
| 080010010 | Birch Street | 7275 Birch St | Jul 2023 | 1569 | 39.8281 | -104.93647 |
| | $PM_{10}$ | 3 | Jul 2023 | P.O. Neigh | Met One - E-Seq | SLAMS |
| | $PM_{2.5}$ | 3 | Jul 2023 | P.O. Neigh | URG - 3000-N | SLAMS |
| | $PM_{10}$ | 3 | Sep 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 1 | Dec 2023 | P.O. Neigh | | SLAMS |
| | $PM_{2.5}$ | 2 | Dec 2023 | P.O. Neigh | | SLAMS |
| 080013001 | Welby | 3174 E. 78TH AVE. | Jan 1975 | 1554 | 39.838119 | -104.94984 |
| | Temperature | 1 | Jan 1975 | | Met One - 062MP | OTHER |
| | Wind Speed | 1 | Jan 1992 | | RM Young - 05305V | OTHER |
| | Wind Direction | 1 | Jan 1992 | | | OTHER |
| | $SO_2$ | 2 | Jan 2006 | P.O. Neigh | TAPI - T100 | SLAMS |
| | $O_3$ | 2 | Sep 2007 | P.O. Neigh | TAPI - T400 | SLAMS |
| | $NO_2$ | 1 | Nov 2019 | P.O. Urban | TAPI - T200 | SLAMS |
| | $PM_{10}$ | 3 | Jan 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 3 | Jan 2024 | Back Micro | TAPI - 640X | SLAMS |
| | $PM_{2.5}$ | 3 | Jan 2024 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 4 | May 2024 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 4 | May 2024 | P.O. Neigh | TAPI - 640X | SLAMS |
| | $PM_{2.5}$ | 4 | May 2024 | P.O. Neigh | | SLAMS |
| **Alamosa** | | | | | | |
| 080030001 | Alamosa - Adams State | 208 EDGEMONT BLVD. | Oct 2023 | 2302 | 37.469391 | -105.878691 |
| | $PM_{10}$ | 3 | Oct 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 3 | Oct 2023 | P.O. Neigh | | SLAMS |
| | $PM_{2.5}$ | 3 | Oct 2023 | P.O. Neigh | | SLAMS |
| **Arapahoe** | | | | | | |
| 080050002 | HIGHLAND RESERVOIR | 8100 S. UNIVERSITY BLVD | Jun 1978 | 1747 | 39.567887 | -104.957193 |
| | $O_3$ | 1 | Sep 2015 | H.C. Neigh | TAPI - T400 | SLAMS |
| | Wind Speed | 1 | Sep 2015 | | Met One - 010C | OTHER |
| | Wind Direction | 1 | Sep 2015 | | Met One - 020C | OTHER |
| | Temperature | 1 | Sep 2015 | | Met One - 062 | OTHER |
| 080050005 | Arapahoe Community College | 6190 S. SANTA FE DR. | Apr 2024 | 1636 | 39.604399 | -105.019526 |
| | $PM_{10}$ | 3 | Apr 2024 | P.O. Neigh | | SPM |
| | $PM_{2.5}$ | 3 | Apr 2024 | P.O. Neigh | Grimm - EDM 180 | SLAMS |
| 080050006 | Aurora East | 36001 E. Quincy Ave. | Jun 2009 | 1799 | 39.638522 | -104.569335 |
| | $O_3$ | 1 | Jun 2009 | P.O. Urban | TAPI - T400 | SLAMS |
| | Wind Speed | 1 | Jun 2009 | P.O. Urban | Met One - 010C | OTHER |
| | Wind Direction | 1 | Jun 2009 | P.O. Urban | Met One - 020C | OTHER |
| | Temperature | 1 | Jun 2009 | P.O. Urban | Met One - 060 | OTHER |
| **Archuleta** | | | | | | |
| 080070001 | PAGOSA SPRINGS SCHOOL | 309 LEWIS ST. | Nov 2023 | 2165 | 37.26842 | -107.009659 |
| | $PM_{10}$ | 4 | Nov 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 4 | Nov 2023 | P.O. Neigh | TAPI - 640X | SLAMS |
| | $PM_{2.5}$ | 4 | Jan 2025 | P.O. Neigh | | SLAMS |
| **Boulder** | | | | | | |
| 080130003 | LONGMONT - MUNICIPAL BLDG | 350 KIMBARK ST. | Jan 2024 | 1520 | 40.164576 | -105.100856 |
| | $PM_{10}$ | 4 | Jan 2024 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 4 | Jan 2024 | P.O. Neigh | TAPI - 640X | SPM |
| | $PM_{2.5}$ | 4 | Jan 2024 | P.O. Neigh | | SLAMS |
| 080130014 | Boulder Reservoir | 5545 Reservoir Road. | Sep 2016 | 1586 | 40.070016 | -105.220238 |
| | $O_3$ | 1 | Sep 2016 | P.O. Urban | TAPI - 400E | SLAMS |
| | Wind Speed | 1 | Sep 2016 | P.O. | RM Young - 05305V | OTHER |
| | Wind Direction | 1 | Sep 2016 | P.O. | | OTHER |
| | Temperature | 1 | Sep 2016 | P.O. | RM Young - 41372V | OTHER |
| | Relative Humidity | 1 | Sep 2016 | P.O. | | OTHER |
| 080131001 | BOULDER - CU-ATHENS | 2102 ATHENS ST. | Aug 2023 | 1622 | 40.012969 | -105.267212 |
| | $PM_{2.5}$ | 3 | Aug 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 3 | Aug 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 3 | Sep 2023 | P.O. Neigh | TAPI - 640X | SLAMS |

| AQS # | Site Name | Address | Site Start | Elevation (m) | Latitude | Longitude |
|---|---|---|---|---|---|---|
| | Parameter | POC | Start | Orient/Scale | Monitor | Type |
| **Clear Creek** | | | | | | |
| 080190006 | Mines Peak | Near summit of Berthoud Pass off US Highway 40 | Jul 2014 | 3806 | 39.794391 | -105.76398 |
| | $O_3$ | 1 | Jul 2014 | Back Region | TAPI - T400 | SPM |
| **Denver** | | | | | | |
| 080310002 | DENVER - CAMP | 2105 BROADWAY | Jan 1985 | 1593 | 39.751184 | -104.987625 |
| | Temperature | 1 | Jan 1985 | | | OTHER |
| | Wind Speed | 1 | Jan 1992 | | | OTHER |
| | Wind Direction | 1 | Jan 1992 | | | OTHER |
| | $SO_2$ | 1 | Nov 2005 | H.C. Neigh | TAPI - T100 | SLAMS |
| | $O_3$ | 6 | Jan 2012 | P.O. Neigh | TAPI - T400 | SLAMS |
| | $PM_{2.5}$ | 3 | Apr 2013 | H.C. Micro | Grimm - EDM 180 | SPM |
| | $NO_2$ | 1 | Jan 2014 | H.C. Neigh | TAPI - T200U | SLAMS |
| | $PM_{10}$ | 3 | Feb 2015 | H.C. Micro | | SPM |
| | $PM_{2.5}$ | 1 | Feb 2024 | P.O. Micro | R&P - Partisol 2025 | SLAMS |
| | $PM_{2.5}$ | 2 | Feb 2024 | P.O. Micro | | SLAMS |
| 080310013 | DENVER - NJH-E | 14TH AVE. & ALBION ST. | Mar 2018 | 1620 | 39.738578 | -104.939925 |
| | $PM_{10}$ | 3 | Jul 2023 | P.O. Middle | | SPM |
| | $PM_{2.5}$ | 3 | Jul 2023 | P.O. Neigh | TAPI - 640 | SLAMS |
| 080310026 | La Casa | 4545 Navajo St. | Jan 2013 | 1602 | 39.77949 | -105.00518 |
| | CO | 1 | Jan 2013 | P.O. Neigh | Thermo - 48i-TL | SLAMS |
| | NOy | 1 | Jan 2013 | P.O. Neigh | | SLAMS |
| | NOy - NO | 1 | Jan 2013 | P.O. Neigh | TAPI - T200U-NOY | SLAMS |
| | $O_3$ | 1 | Jan 2013 | P.O. Neigh | TAPI - T400 | SLAMS |
| | Wind Speed | 1 | Jan 2013 | P.O. Neigh | Met One - 010C | SLAMS |
| | Wind Direction | 1 | Jan 2013 | P.O. Neigh | Met One - 020C | SLAMS |
| | Temperature | 1 | Jan 2013 | P.O. Neigh | Met One - 010C | SLAMS |
| | Temperature | 2 | Jan 2013 | P.O. Neigh | Met One - 010C | SLAMS |
| | $SO_2$ | 1 | Apr 2013 | P.O. Neigh | TAPI - T100U | SLAMS |
| | $NO_2$ | 1 | Jul 2014 | P.O. Neigh | TAPI - T500U | SLAMS |
| | Relative Humidity | 1 | Nov 2014 | P.O. Neigh | Met One - 083E-1-35 | SLAMS |
| | Solar radiation | 1 | Apr 2018 | P.O. Neigh | KIPP&ZONEN - CMP11 | SLAMS |
| | $PM_{2.5}$ | 3 | Jul 2023 | P.O. Neigh | TAPI - 640 | SLAMS |
| | $PM_{10}$ | 3 | Sep 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 1 | Apr 2024 | P.O. Neigh | Met One - E-Seq | SLAMS |
| | $PM_{10}$ | 2 | Apr 2024 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 1 | Apr 2024 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 2 | Apr 2024 | P.O. Neigh | | SLAMS |
| | $PM_{2.5}$ | 1 | Apr 2024 | P.O. Neigh | Met One - E-Seq | SLAMS |
| 080310027 | I-25 | 971 Yuma Street | Jun 2013 | 1583 | 39.73217 | -105.0153 |
| | CO | 1 | Jun 2013 | P.O. Micro | Thermo - 48i-TL | SLAMS |
| | Wind Speed | 1 | Jun 2013 | P.O. | RM Young - 05305V | OTHER |
| | Wind Direction | 1 | Jun 2013 | P.O. | | OTHER |
| | Temperature | 1 | Jun 2013 | P.O. | RM Young - 41372V | OTHER |
| | $PM_{2.5}$ | 3 | Jan 2014 | P.O. Micro | Grimm - EDM 180 | SLAMS |
| | $PM_{10}$ | 3 | Feb 2015 | P.O. Micro | | SLAMS |
| | Relative Humidity | 1 | May 2020 | P.O. | RM Young - 41372V | OTHER |
| | $NO_2$ | 1 | May 2021 | P.O. Micro | TAPI - T200 | SLAMS |
| | $PM_{2.5}$ | 1 | Sep 2023 | P.O. Micro | R&P - Partisol 2025 | SLAMS |
| 080310028 | Globeville | 4903 Acoma St. | Oct 2015 | 1587 | 39.7861 | -104.9886 |
| | $NO_2$ | 1 | Oct 2015 | P.O. Micro | TAPI - T200 | SLAMS |
| | Temperature | 1 | Oct 2015 | P.O. | RM Young - 41372V | OTHER |
| | Relative Humidity | 1 | Oct 2015 | P.O. | | OTHER |
| | $PM_{10}$ | 3 | Oct 2015 | P.O. Micro | | SLAMS |
| | $PM_{2.5}$ | 3 | Oct 2015 | P.O. Micro | Grimm - EDM 180 | SLAMS |
| | Wind Speed | 1 | Mar 2020 | P.O. | RM Young - 05305V | OTHER |
| | Wind Direction | 1 | Mar 2020 | P.O. | | OTHER |
| **Douglas** | | | | | | |
| 080350004 | Chatfield State Park | 11500 N. Roxborough Park Rd. | Apr 2004 | 1676 | 39.534488 | -105.070358 |
| | Wind Speed | 1 | Apr 2004 | | Met One - 010C | OTHER |
| | Wind Direction | 1 | Apr 2004 | | Met One - 020C | OTHER |
| | Temperature | 1 | Apr 2004 | | | OTHER |
| | $PM_{10}$ | 3 | Jul 2023 | P.O. Neigh | | SPM |

| AQS # | Site Name | Address | Site Start | Elevation (m) | Latitude | Longitude |
|---|---|---|---|---|---|---|
| | **Parameter** | **POC** | **Start** | **Orient/Scale** | **Monitor** | **Type** |
| | $PM_{2.5}$ | 3 | Jul 2023 | P.O. Neigh | TAPI - 640 | SLAMS |
| | $O_3$ | 1 | Aug 2024 | H.C. Urban | TAPI - T265 | SLAMS |
| **El Paso** | | | | | | |
| 080410013 | U.S. AIR FORCE ACADEMY | ROAD 640, USAF ACADEMY | Jun 1996 | 1971 | 38.958341 | -104.817215 |
| | $O_3$ | 1 | Aug 2010 | H.C. Urban | TAPI - T400 | SLAMS |
| 080410016 | MANITOU SPRINGS | 101 BANKS PL. | Apr 2004 | 1955 | 38.853097 | -104.901289 |
| | $O_3$ | 1 | Oct 2007 | H.C. Neigh | TAPI - T400 | SLAMS |
| 080410017 | COLORADO SPRINGS - COLLEGE | 130 W. CACHE LA POUDRE | Jun 2016 | 1832 | 38.848014 | -104.828564 |
| | $PM_{10}$ | 3 | Jun 2016 | P.O. Neigh | | SLAMS |
| | $PM_{2.5}$ | 3 | Jun 2016 | P.O. Neigh | | SLAMS |
| | CO | 1 | Dec 2023 | P.O. Neigh | Thermo - 48i-TL | SLAMS |
| | $PM_{10}$ | 1 | Sep 2024 | P.O. Neigh | R&P - Partisol 2025 | SLAMS |
| | $PM_{10}$ | 1 | Sep 2024 | P.O. Neigh | | SLAMS |
| **Fremont** | | | | | | |
| 080430003 | CANON CITY - CITY HALL | 128 MAIN ST. | Oct 2023 | 1626 | 38.43829 | -105.24504 |
| | $PM_{10}$ | 3 | Oct 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 3 | Oct 2023 | P.O. Neigh | TAPI - 640X | SLAMS |
| | $PM_{2.5}$ | 3 | Jan 2025 | P.O. Neigh | | SLAMS |
| **Garfield** | | | | | | |
| 080450012 | Rifle-Health Dept | 195 W. 14th St. | Jun 2008 | 1640 | 39.54182 | -107.784125 |
| | $O_3$ | 1 | Jun 2008 | P.O. Neigh | | SLAMS |
| **Gilpin** | | | | | | |
| 080470003 | Black Hawk | 831 Miners Mesa Road, Black | Jul 2019 | 2633 | 39.792519 | -105.49127 |
| | $O_3$ | 1 | Jul 2019 | P.O. Urban | TAPI - 400E | SLAMS |
| **Jefferson** | | | | | | |
| 080590006 | ROCKY FLATS-N | 16600 W COLO #128 | Jun 1992 | 1802 | 39.912799 | -105.188587 |
| | Wind Speed | 1 | Jun 1992 | | RM Young - 05305V | OTHER |
| | Wind Direction | 1 | Jun 1992 | | | OTHER |
| | Temperature | 1 | Jun 1992 | | RM Young - 41372V | OTHER |
| | Temperature | 2 | May 2018 | | RM Young - 41372V | OTHER |
| | Relative Humidity | 1 | Jun 2018 | Back Neigh | RM Young - 41372V | OTHER |
| | Barometric pressure | 1 | Jun 2018 | Back Neigh | RM Young - 61302V | OTHER |
| | NOy | 1 | Feb 2019 | H.C. Urban | TAPI - 501Y | SLAMS |
| | $NO_2$ | 1 | Feb 2019 | Urban | TAPI - T500U | SLAMS |
| | NOy - NO | 1 | Feb 2019 | H.C. Urban | TAPI - T200U-NOY | SLAMS |
| | Solar radiation | 1 | Jun 2019 | Urban | KIPP&ZONEN - CMP11 | SLAMS |
| | $O_3$ | 1 | Jul 2024 | H.C. Urban | TAPI - T265 | SLAMS |
| 080590011 | NATIONAL RENEWABLE ENERGY | 2054 QUAKER ST. | Jun 1994 | 1832 | 39.743724 | -105.177989 |
| | $O_3$ | 1 | Jul 2024 | H.C. Urban | TAPI - T265 | SLAMS |
| 080590014 | Evergreen | 5124 South Hatch Drive | Oct 2020 | 2225 | 39.620408 | -105.33872 |
| | $O_3$ | 1 | Oct 2020 | P.O. Urban | TAPI - T400 | SLAMS |
| | Wind Speed | 1 | Oct 2020 | P.O. Urban | RM Young - 05305V | OTHER |
| | Wind Direction | 1 | Oct 2020 | P.O. Urban | | OTHER |
| | Temperature | 1 | Oct 2020 | P.O. Urban | RM Young - 41372V | OTHER |
| | Relative Humidity | 1 | Oct 2020 | P.O. Urban | | OTHER |
| **Larimer** | | | | | | |
| 080690009 | FORT COLLINS - CSU - Edison | 251 EDISON DR. | Jun 2009 | 1524 | 40.571288 | -105.079693 |
| | $PM_{10}$ | 3 | Jun 2015 | P.O. Neigh | | SPM |
| | $PM_{2.5}$ | 3 | Jun 2015 | P.O. Neigh | | SLAMS |
| 080690011 | FORT COLLINS - WEST | 3416 LA PORTE AVE. | Aug 2023 | 1571 | 40.592543 | -105.141122 |
| | Wind Speed | 1 | Aug 2023 | Urban | RM Young - 05305V | SPM |
| | Wind Direction | 1 | Aug 2023 | Urban | | SPM |
| | Temperature | 1 | Aug 2023 | Urban | RM Young - 41372V | SPM |
| | Temperature | 2 | Aug 2023 | Urban | RM Young - 41372V | SPM |
| | Relative Humidity | 1 | Aug 2023 | Urban | RM Young - 41372V | SPM |
| | Solar radiation | 1 | Aug 2023 | Urban | KIPP&ZONEN - CMP11 | SPM |
| | Barometric pressure | 1 | Aug 2023 | Urban | RM Young - 61402V | SPM |
| | $O_3$ | 1 | Jul 2024 | H.C. Urban | TAPI - T265 | SLAMS |

| AQS # | Site Name | Address | Site Start | Elevation (m) | Latitude | Longitude |
|---|---|---|---|---|---|---|
| | **Parameter** | **POC** | **Start** | **Orient/Scale** | **Monitor** | **Type** |
| 080690015 | Fossil Creek | 3340 CO 392 | Jan 2024 | 1489 | 40.48346 | -105.01618 |
| | $NO_2$ | 1 | Jan 2024 | H.C. Urban | | SLAMS |
| | $O_3$ | 1 | Jan 2024 | H.C. Urban | TAPI - T400 | SLAMS |
| | Wind Speed | 1 | Jan 2024 | Urban | RM Young - 05305V | SPM |
| | Wind Direction | 1 | Jan 2024 | Urban | | SPM |
| | Temperature | 1 | Jan 2024 | Urban | RM Young - 41372V | SPM |
| | Temperature | 2 | Jan 2024 | Urban | RM Young - 41372V | SPM |
| | Relative Humidity | 1 | Jan 2024 | Urban | RM Young - 41372V | SPM |
| | Solar radiation | 1 | Jan 2024 | Urban | | SPM |
| | Barometric pressure | 1 | Jan 2024 | Urban | RM Young - 61402V | SPM |
| 080690016 | Bethke | 5100 School House Dr | Jun 2024 | 1472 | 40.515109 | -104.949932 |
| | $NO_2$ | 1 | Jun 2024 | H.C. Urban | | SLAMS |
| | $O_3$ | 1 | Jun 2024 | H.C. Urban | TAPI - T400 | SLAMS |
| | $PM_{10}$ | 3 | Oct 2024 | P.O. Urban | | SLAMS |
| | $PM_{2.5}$ | 3 | Oct 2024 | P.O. Urban | | SLAMS |
| 080691004 | Fort Collins - CSU - S. Mason | 708 S. Mason St. | Jan 1981 | 1524 | 40.57747 | -105.07892 |
| | Temperature | 1 | Jan 1981 | | | OTHER |
| | Wind Speed | 1 | Jan 1992 | | | OTHER |
| | Wind Direction | 1 | Jan 1992 | | RM Young - 05305V | OTHER |
| | $O_3$ | 1 | May 2004 | P.O. Neigh | TAPI - T400 | SLAMS |
| | CO | 1 | May 2016 | P.O. Neigh | Thermo - 48i-TL | SLAMS |
| **Mesa** | | | | | | |
| 080770017 | GRAND JUNCTION - POWELL BLDG | 650 SOUTH AVE. | Jan 2014 | 1398 | 39.063798 | -108.561173 |
| | $PM_{2.5}$ | 3 | Jan 2014 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 3 | Feb 2015 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 1 | Jul 2024 | P.O. Neigh | R&P - Partisol 2025 | SLAMS |
| | $PM_{10}$ | 1 | Jul 2024 | P.O. Neigh | | SLAMS |
| 080770018 | GRAND JUNCTION - PITKIN | 645 1/4 PITKIN AVE. | Jan 2004 | 1398 | 39.064289 | -108.56155 |
| | Wind Speed | 1 | Jan 2004 | | | OTHER |
| | Wind Direction | 1 | Jan 2004 | | | OTHER |
| | Temperature | 1 | Jan 2004 | | | OTHER |
| | Relative Humidity | 1 | Nov 2014 | | | OTHER |
| | Barometric pressure | 1 | Sep 2020 | | | OTHER |
| 080770020 | Palisade-Water Treatment | 865 Rapid Creek Rd. | May 2008 | 1521 | 39.130575 | -108.313835 |
| | $O_3$ | 1 | May 2008 | P.O. Urban | TAPI - T400 | SLAMS |
| | Wind Speed | 1 | May 2008 | P.O. Urban | | SPM |
| | Wind Direction | 1 | May 2008 | P.O. Urban | RM Young - 05305V | SPM |
| | Temperature | 1 | May 2008 | P.O. Urban | | SPM |
| **Montezuma** | | | | | | |
| 080830006 | Cortez - Health Dept | 106 W. North Street | Jun 2008 | 1890 | 37.350054 | -108.592334 |
| | $O_3$ | 1 | Jun 2008 | P.O. Neigh | | SLAMS |
| **Pitkin** | | | | | | |
| 080970008 | Aspen Yellow Brick Building | 215 N. Garmisch | Jun 2024 | 2408 | 39.19296 | -106.82323 |
| | $PM_{10}$ | 3 | Jun 2024 | P.O. Neigh | TAPI - 640X | SLAMS |
| | $PM_{10}$ | 3 | Jun 2024 | P.O. Neigh | | SLAMS |
| | $PM_{2.5}$ | 3 | Jun 2024 | P.O. Neigh | | SLAMS |
| **Prowers** | | | | | | |
| 080990002 | Lamar Municipal Bldg | 104 E. PARMENTER ST. | Oct 2023 | 1107 | 38.084688 | -102.618641 |
| | $PM_{10}$ | 3 | Oct 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 3 | Oct 2023 | P.O. Neigh | TAPI - 640X | SLAMS |
| | $PM_{2.5}$ | 3 | Oct 2023 | P.O. Neigh | | SLAMS |
| **Pueblo** | | | | | | |
| 081010015 | Pueblo - Fountain School | 925 N. GLENDALE AVE. | Sep 2023 | 1433 | 38.276099 | -104.597613 |
| | $PM_{10}$ | 3 | Sep 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 3 | Sep 2023 | P.O. Neigh | TAPI - 640X | SLAMS |
| | $PM_{2.5}$ | 3 | Sep 2023 | P.O. Neigh | | SLAMS |
| | Pueblo West | 803 South Cellini Circle | Feb 2023 | 1564 | 38.30333 | -104.7225 |

| AQS # | Site Name | Address | Site Start | Elevation (m) | Latitude | Longitude |
|---|---|---|---|---|---|---|
| | **Parameter** | **POC** | **Start** | **Orient/Scale** | **Monitor** | **Type** |
| 081010016 | $O_3$ | 1 | Feb 2023 | H.C. Neigh | TAPI - T400 | SLAMS |
| | Wind Speed | 1 | Mar 2023 | H.C. Neigh | RM Young - 05305V | SLAMS |
| | Wind Direction | 1 | Mar 2023 | H.C. Neigh | | SLAMS |
| | Temperature | 1 | Mar 2023 | H.C. Neigh | RM Young - 41372V | SLAMS |
| **Routt** | | | | | | |
| 081070003 | Steamboat Springs | 136 6TH ST. | Sep 2023 | 2054 | 40.485201 | -106.831625 |
| | $PM_{10}$ | 4 | Sep 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 4 | Sep 2023 | P.O. Neigh | TAPI - 640X | SLAMS |
| | $PM_{2.5}$ | 4 | Jan 2025 | P.O. Neigh | | SLAMS |
| **San Miguel** | | | | | | |
| 081130004 | Telluride | 333 W. COLORADO AVE. | Nov 2023 | 2684 | 37.937872 | -107.813061 |
| | $PM_{10}$ | 3 | Nov 2023 | P.O. Neigh | | SLAMS |
| | $PM_{10}$ | 3 | Nov 2023 | P.O. Neigh | TAPI - 640X | SLAMS |
| | $PM_{2.5}$ | 3 | Jan 2025 | P.O. Neigh | | SLAMS |
| **Weld** | | | | | | |
| 081230006 | Greeley - Hospital | 1516 HOSPITAL RD. | Jun 2016 | 1441 | 40.414877 | -104.70693 |
| | $PM_{10}$ | 3 | Jun 2016 | P.O. | | SLAMS |
| | $PM_{2.5}$ | 3 | Jun 2016 | P.O. | Grimm - EDM 180 | SLAMS |
| 081230008 | Platteville - Middle School | 1004 MAIN ST. | Jun 2024 | 1469 | 40.209387 | -104.82405 |
| | $PM_{10}$ | 3 | Jun 2024 | P.O. Region | | SLAMS |
| | $PM_{2.5}$ | 3 | Jun 2024 | P.O. Region | TAPI - 640 | SLAMS |
| 081230009 | Greeley - Weld County Tower | 3101 35TH AVE. | Jun 2002 | 1484 | 40.386368 | -104.73744 |
| | $O_3$ | 1 | Jan 2004 | P.O. Neigh | TAPI - T400 | SLAMS |
| | Wind Speed | 1 | Feb 2012 | P.O. | Met One - 010C | OTHER |
| | Wind Direction | 1 | Feb 2012 | P.O. | Met One - 020C | OTHER |
| | Temperature | 1 | Feb 2012 | P.O. | Met One - 060A | OTHER |
| | CO | 1 | Apr 2016 | P.O. Neigh | Thermo - 48i-TL | SLAMS |
| 081230015 | La Salle Tower | 18490 County Road 38 | Feb 2024 | 1719 | 40.2614 | -104.70645 |
| | $NO_2$ | 1 | Feb 2024 | S.O. Region | TAPI - T200 | SLAMS |
| | $O_3$ | 1 | Feb 2024 | S.O. Region | TAPI - T400 | SLAMS |