Maricopa County
Air Quality Department

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January 29, 2016

Meredith Kurpius, Ph.D
Manager, Air Quality Analysis Office, EPA Region 9
75 Hawthorne Street
San Francisco, CA 94105

Re: Maricopa County 2015 Network Review and Assessment

Dear Dr. Kurpius,

In accordance with 40 CFR Part 58, attached please find copies of Maricopa County Air Quality Department's (MCAQD) 2015 Network Review and Network Assessment.

If you need additional information, please contact Ben Davis at (602) 258-5155 x221.

Sincerely,

Philip A. McNeely, R.G.
Director

Cc: Colleen McKaughan (USEPA)
Eric Massey (ADEQ)
Lindy Bauer (MAG)

Maricopa County
Air Quality Department

Maricopa County Air Monitoring Network Assessment 2010-2014

Philip McNeely: Director, Maricopa County Air Quality Department

Ben Davis: Manager, Maricopa County Air Monitoring Division

Table of Contents

List of Tables

List of Figures

Executive Summary

The U.S. EPA amended the air monitoring regulations in 40 CFR 58.10(e) in 2006 to include a requirement that all state and local air monitoring agencies prepare an assessment of their monitoring networks once every five years. The purpose of this Network Assessment (Assessment) is to evaluate whether:

1. The monitoring network meets the monitoring objectives defined in the U.S. EPA monitoring regulations,
2. Whether new sites are needed or should be changed, and
3. If sites are no longer needed and can be terminated.

Following the procedures described below, this Assessment fulfills these requirements by using a variety of indicators to evaluate the ability of the existing network to achieve, within available resources, the best possible scientific value and protection of public and environmental health and welfare. This Assessment covers the time period of 2010-2014 and uses data from state, local and tribal air monitoring agencies within Maricopa County and the surrounding area.

Section 2 of the Assessment provides details on each of the monitoring sites within Maricopa County Air Quality Department's (MCAQD) network; this includes a listing of their operation scale, objective, and a map/aerial photograph of the monitored area.

Section 3 performs a site-by-site comparison of the existing network; sites are ranked by a variety of analyses designed to give a comprehensive view of the network. These analyses are then weighted and combined to find the comparative rank of each site for each parameter. The analyses used are:

1. Number of Parameters Monitored
2. Trends Impact
3. Measured Concentrations
4. Deviation from the NAAQS
5. Area Served
6. Population Served
7. Monitor-to-Monitor Correlation
8. Removal Bias

9a. Emissions Inventory

9b. Predicted Ozone (for O_3 only)

10. Traffic Counts
11. Environmental Justice-Minority Population Served

Section 4 uses a series of raster-based maps that identify where new monitoring sites might be considered. These maps are then weighted, spatially averaged, and combined to give an overall representation of the areas for which new monitoring sites might be considered. The analyses used to create these maps are:

1. Emissions Inventory – Point-Source
2. Traffic Counts-Mobile Source
3. Population Density
4. Environmental Justice-Minority Population Density
5. Euclidean Distance
6. Standard Error Prediction Map

Section 5 uses the data generated in the previous sections to support a discussion of whether monitoring sites could be added, relocated, changed or terminated. Tables i through iv summarize this information for each of the criteria pollutants monitored by MCAQD.

This Assessment confirms that the current MCAQD network substantially meets all federally required monitoring objectives. However, as ambient air monitoring objectives have shifted over time (e.g. air quality has improved, new air quality objectives and standards have been strengthened), MCAQD may wish to consider the findings of this Assessment during future Air Monitoring Network Planning exercises to determine whether or how to reconfigure and optimize its monitoring network to enhance its value to stakeholders, scientists and the general public.

Specifically, as a result of this Assessment, MCAQD will be informed to evaluate whether:

- unnecessary or redundant monitors for some pollutants could be removed;
- the monitoring network may be reconfigured to deemphasize the collection of data for pollutants that are steadily becoming less problematic (e.g. carbon monoxide);
- the existing network could be reconfigured to refine the monitoring of pollutants that are new or are presenting persistent challenges (e.g. ground level ozone and precursors).

Table i. *Summary of assessment results for the CO and NO_2 parameters. Information about the results is given in italics.*

	CO	NO_2
Monitors Considered for Closing	Option 1: West Chandler, Dysart, South Scottsdale Option 2: Tempe, North Phoenix, West Chandler, Dysart, South Scottsdale Option 3: Dysart, Glendale, Mesa, North Phoenix, South Phoenix, South Scottsdale, Tempe, West Chandler *See narrative for information on closing options*	**None.**
Monitors Considered for Moving or Changing	1. Move Greenwood to near-road Thirty-Third site. *The near-road Thirty-Third site opened in late 2015.*	1. Move Greenwood to near-road Thirty-Third site. *The near-road Thirty-Third site opened in late 2015.*
	2. Change West Phoenix objective from 'Population Exposure' to 'Highest Concentration'. *West Phoenix has the highest concentration of CO in the network*	2. Change Buckeye objective from 'Population Exposure' to 'Upwind Background'. *Buckeye is currently situated as the best upwind background site in the MCAQD network, has a low population density surrounding it, and has the lowest concentrations in the network.*
	3. Change Buckeye objective from 'Population Exposure' to 'Upwind Background'. *Buckeye is currently situated as the best upwind background site in the MCAQD network, has a low population density surrounding it, and has the lowest concentrations in the network.*	3. Change Central Phoenix objective from 'Population Exposure' to 'Highest Concentration' *Central Phoenix has the highest NO_2 concentrations in the network and there currently isn't a site with the 'Highest Concentration' objective.*
Potential New Monitors	**None.**	**None.**

Table ii. *Summary of assessment results for the O_3 parameter. Information about the results is given in italics.*

	O_3	
Monitors Considered for Closing	1. Rio Verde *The area is already well represented by the Fountain Hills, Pinnacle Peak, and Yuma Frank monitors. Further, when current data are compared to historic data, Rio Verde current readings are lower than in the past, apparently coincidental with building construction at the site. MCAQD should review site configuration and options to improve site configuration if there is an actual impact to the representativeness of the data. The area is well represented by the Fountain Hills, Pinnacle Peak, and Yuma Frank monitors, so closing might also be a potential option.*	
Monitors Considered for Moving or Changing	1. Change North Phoenix objective from 'Population Exposure' to 'Max Ozone Concentration'. *North Phoenix consistently has the highest concentration in the network.*	5. Change Fountain Hills objective from 'Max Ozone Concentration' to 'Population Exposure'. *Concentration averages have decreased over the years in this area, though this site is in a populated area.*
	2. Change Cave Creek objective from 'Max Ozone Concentration' to 'Extreme Downwind'. *Concentration averages have decreased over the years in this area and 'Downwind' is a better objective for this site.*	6. Change Humboldt Mountain objective from 'Max Ozone Concentration' to 'Extreme Downwind'. *Concentration averages have decreased over the years in this area and 'Downwind' is a better objective for this site.*
	3. Change Pinnacle Peak objective from 'Max Ozone Concentration' to 'Extreme Downwind'. *Concentration averages have decreased over the years in this area and 'Downwind' is a better objective for this site.*	7. Change Rio Verde objective from 'Max Ozone Concentration' to 'Extreme Downwind' (if staying open). *Concentration averages have decreased over the years in this area and 'Downwind' is a better objective for this site.*
	4. Change Blue Point objective from 'Max Ozone Concentration' to 'Extreme Downwind'. *Concentration averages have decreased over the years in this area and 'Downwind' is a better objective for this site.*	8. Change Buckeye objective from 'Population Exposure' to 'Upwind Background' and scale changed to 'Urban'. *Buckeye is currently situated as the best upwind background site in the MCAQD network, has a low population density surrounding it. The scale can be increased to represent a large area upwind of the urban core.*
Potential New Monitors	None.	None.

Table iii. *Summary of assessment results for the PM_{10} parameter. Information about the results is given in italics.*

	PM_{10}
Monitors Considered for Closing	1. Greenwood. *Greenwood PM_{10} is highly redundant with West Phoenix and Durango Complex.*
Monitors Considered for Moving or Changing	1. West 43rd Avenue scale changed from 'Middle' to 'Neighborhood'. *Based upon correlation analysis, source changes in the area, and inspection of aerial photographs, West 43rd Avenue now represents a broader scale than it did in the past.*
	2. Change Durango Complex objective from 'Highest Concentration' to 'Population Exposure' and its scale changed to 'Neighborhood'. *Values at Durango Complex are much reduced since the last Network Assessment and the monitor is being impacted by sources at a broader scale.*
Potential New Monitors	**None.**

Table iv. *Summary of assessment results for the $PM_{2.5}$, SO_2, and Pb parameters. Information about the results is given in italics.*

	$PM_{2.5}$	SO_2	Pb
Monitors Considered for Closing	**None.**	1. Durango Complex. *SO_2 was moved from South Scottsdale to Durango Complex after the last Network Assessment as values were very low at that site. Values at Durango Complex have been a little higher than South Scottsdale, but still barely above the non-detect point. Central Phoenix alone is sufficient to represent urban SO_2 concentrations.*	**None.**
Monitors Considered for Moving or Changing	1. Change Durango Complex scale from 'Middle' to 'Neighborhood'. *The correlation analysis and studies by the Air Monitoring Division show that Durango Complex is impacted by sources at a broader scale.*	1. Change Central Phoenix scale from 'Neighborhood' to 'Urban' *SO_2 concentrations from Central Phoenix, Durango Complex and the JLG Supersite are very low and range together, showing that SO_2 concentrations are consistent with a larger scale such as 'Urban'.*	**None.**
Potential New Monitors	**None.**	**None.**	**None.**

Glossary of Terms

Term/ Acronym	Definition
ADEQ	Arizona Department of Environmental Quality.
AQS	Environmental Protection Agency's Air Quality System database.
Attainment:	Compliance with the NAAQS of the federal Clean Air Act. After several years with no violations of the NAAQS, an agency can request that the EPA reclassify the area as being "in attainment" for that pollutant.
AWT:	Average Weekday Traffic count (vehicles/day).
CFR:	Code of Federal Regulations.
Class I:	A Federally designated park or wilderness area with mandated visibility protection requirements.
CO:	Carbon monoxide.
Continuous monitoring:	A method of monitoring air pollutants that is continually measuring the quantity of the pollutant, either gaseous or particulate. Continuous monitors can be used to obtain real-time or short-term averages of pollutants.
Criteria Pollutants:	Six pollutants (CO, lead, NO_2, O_3, particulates, and SO_2) for which NAAQS have been established by the US EPA.
Design Value:	A statistic that describes the air quality status of a given area relative to the level of the NAAQS. For a concentration-based standard, the air quality design value is simply the standard-related test statistic. The design value of a pollutant monitoring network is the highest sample value in the network used to compare to the NAAQS; e.g., the 24-hour $PM_{2.5}$ design value for the network is the monitor with the highest 3-year average of the 98^{th} percentile.
Emissions inventory:	An accounting of the amount of pollutants discharged into the atmosphere. An emission inventory usually contains the total emissions for one or more specific air pollutants, originating from all source categories within a defined geographic area and for a specific time span (often a specific calendar year).
Environmental justice:	Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.
EPA:	U. S. Environmental Protection Agency.

Euclidean distance:	The straight-line distance between two points.
FEM:	Federal Equivalency Method. An official method, i.e. equipment and procedure, of monitoring air pollution that has been determined to produce results similar to the Federal Reference Method (FRM).
Filter-based monitor:	A method of monitoring particulate pollution that involves exposing a pre-weighed filter to a specific flow volume of air to capture the particulates in the air. The filters are then post-weighed to determine the weight of particulates per volume, e.g. $\mu g/m^3$. Filter-based monitors used by MCAQD are all FRM monitors.
FRM:	Federal Reference Method. An official method, i.e. equipment and procedure, of monitoring air pollution that has been tested and determined to produce results that accurately measure air pollution with acceptable precision. These methods are the baseline that all other methods, e.g. Federal Equivalency Methods (FEMs), refer to.
GIS:	Geographic Information System, e.g. ArcGIS.
Kriging:	Kriging is a group of geostatistical techniques to interpolate the value of a random field at an unobserved location, based upon observations of its value at nearby locations.
MAG:	Maricopa Association of Governments.
MCAQD:	Maricopa County Air Quality Department.
NAAQS:	National Ambient Air Quality Standards. A set of health- and welfare-based standards set by the US EPA to qualify allowable levels of criteria pollutants.
NO_2:	Nitrogen dioxide.
NO_X:	Nitrogen oxides. Sum of nitric oxide (NO), NO_2, and oxides of nitrogen.
O_3:	Ozone.
Pb:	Lead.
PLSS	Public Land Survey System, aka the Rectangular Survey System. The surveying method developed and used in the United States soon after the Revolutionary War to plat, or divide, real property for sale and settling. With the exception of the original colonies and their derivatives, which were surveyed using the British system of "metes and bounds", most if not all of the remaining U.S.

	lands were surveyed using the PLSS.
PM:	Particulate matter. Material suspended in the air in the form of minute solid particles or liquid droplets.
$PM_{2.5}$:	Particulate matter of 2.5 micrometers (2.5 µ) or smaller in diameter.
PM_{10}:	Particulate matter of 10 micrometers (10 µ) or smaller in diameter.
PPM:	Parts per million.
Raster:	In its simplest form, a raster consists of a matrix of cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information, such as temperature or pollution value.
Removal Bias	The difference between the actual pollutant value from the monitoring site and the predicted pollutant value from the interpolation map used as an absolute value.
SO_2:	Sulfur dioxide.
SPM:	Special purpose monitor. Special Purpose Monitors provide data for special studies needed by state and local agencies, including support of State Implementation Plans (SIPs) and other air program activities. SPMs are not permanently established and can be adjusted easily to accommodate changing needs and priorities.
TEOM:	Tapered Element Oscillating Microbalance. A continuous particulate measuring instrument used to measure PM.
Thiessen polygon:	Thiessen (also known as Voroni polygons). Polygons whose boundaries define the area that is closest to each point relative to all other points. They are mathematically defined by the perpendicular bisectors of the lines between all points, and define individual areas of influence around each of a set of points.
VOCs:	Volatile organic compounds. VOCs are chemical compounds that can easily vaporize and enter the atmosphere. There are many natural and artificial sources of VOCs; solvents and gasoline make up some of the largest artificial sources. VOCs will react with NO_x in the presence of sunlight to create ground-level O_3 pollution.

Section 1: Introduction

1.1 Overview of this report

The U.S. Environmental Protection Agency (EPA) amended the ambient air monitoring regulations on October 17, 2006 to include a requirement for state and local agencies to perform an assessment of their monitoring networks once every five years. This first network assessment was due on July 1, 2010, and subsequent assessments are due on July 1 every following five years.

The purpose of the network assessment (as detailed in 40 CFR 58.10(e)) is *"to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation in to the ambient air monitoring network."*

A network assessment includes:

(1) Re-evaluation of the objectives and budget for air monitoring,

(2) evaluation of a network's effectiveness and efficiency relative to its objectives and costs, and

(3) development of recommendations for network reconfigurations and improvements.

To achieve the above objectives, the analyses contained in the subsequent sections of this Assessment are presented as follows:

Section 2 – Provides details of each MCAQD monitoring site, including specific information on the pollutants measured, and lists key equipment located at each site.

Section 3 – Provides a monitor-to-monitor comparison of the existing network using a series of assessments. These comparisons rank each site against each other to determine its comparative-value. Finally, each assessment is assigned a weight, and each site within the MCAQD 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.

Section 4 –Evaluates whether the existing monitoring network adequately assesses potential air pollution problems, and if it does not, suggests where additional sites may be considered. This evaluation is done using a series of raster-based maps representing a variety of indicators. 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 computed. This spatial average is then used to determine the optimal locations at which new monitors may be considered.

Section 5 –Describes potential monitoring network changes based upon the evaluations described in the preceding sections. Considerations of whether to add additional sites, move, or discontinue existing sites reflect a variety of parameters considered in the preceding evaluations, such as population count, pollution sources, monitoring history, compliance with air quality standards, and environmental justice concerns.

1.2 Parameters Assessed

This Assessment will address the criteria pollutants monitored by MCAQD during the period 2010-2014, i.e. carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (both particulate matter <10 micrometers [PM_{10}] and particulate matter <2.5 micrometers [$PM_{2.5}$]) and sulfur dioxide (SO_2).

1.3 Assessment Methodology

A number of different analyses are used in assessing the effectiveness of the existing monitoring sites. These analyses were chosen to represent a number of variables; however each analysis is not necessarily of equal importance. To reflect this variability among factors addressed in this Assessment, MCAQD has assigned a weight of relative importance; each analysis will then be ranked using this weighted average. This process is repeated for each criteria pollutant addressed in this assessment.

Table 1.1 describes the analyses used in Section 3 of the assessment. The parameters outlined in this table have been used to evaluate the monitoring network and conduct the site-by-site comparison.

Table 1.1. Analyses used in Section 3 of this Network Assessment.

#	Analysis	Description of Analysis Technique
1	Number of Parameters Monitored	Multiple pollution parameters monitored at a site make that site more valuable, as the site is more cost-effective, and collocated pollutant measurements can be compared together. This analysis is the primary indicator of economic value of a site.
2	Trends Impact	This analysis ranks sites by the length of their continuous monitoring records. Monitors that have a long historical record are more valuable for tracking long-term trends.
3	Measured Concentrations	This analysis ranks sites by their design value. Sites with higher concentrations are more important from a regulatory perspective.
4	Deviation from the NAAQS	This analysis ranks sites by how close they are to the National Ambient Air Quality Standards (NAAQS). This analysis recognizes sites that are close to the NAAQS are important and could more easily influence compliance either way.
5	Area Served	Sites are ranked based on their area of coverage. Using the Thiessen polygon technique, spatial locations that are closest to an existing monitor are collected into one neighborhood polygon. The polygon with the largest area is most important.
6	Population Served	Using the Thiessen polygon technique, the number of people living within each polygon is calculated. Areas with higher population are ranked higher.
7	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 thus are ranked higher.
8	Removal Bias	Measured values for each individual pollutant were interpolated by the kriging method across the entire study area. Sites were systematically removed and then the interpolation was repeated. The difference between the measured concentration and the predicted concentration was then used to determine the removal bias. The greater a site's bias, the higher its ranking.
9	Emissions Inventory	Emissions inventory data were used to spatially locate point emission sources. Total emissions were then aggregated using the Thiessen polygon technique for each monitoring site. The emissions were then normalized by using a density measure. Sites with greater emissions were ranked higher.
10	Traffic Counts	Similar to the Emissions Inventory analysis, the Traffic Counts analysis uses current Average Weekday Traffic (AWT) data from both highway and arterial roads within the study area. With the assumption that higher traffic density results in more pollution, the Thiessen polygon technique was used to assign the traffic density to each monitoring site. A second indicator of road density was also calculated for each polygon, and a weighted average was created. Sites with higher traffic counts were
11	Environmental Justice-Minority Population served	This analysis uses the same technique as the population served analysis, only minority population was used instead of total population. The Thiessen polygon with the highest total minority population ranked higher in this test.

Section 4 includes analyses similar to those in Section 3 and uses much of the same data sources, but these analyses use raster-based maps spatially averaged together with the purpose of identifying areas that could benefit from additional monitors. Table 1.2 describes the indicators used in Section 4.

Table 1.2. *Analyses used in Section 4 of this Network Assessment.*

#	Analysis	Description of Analysis Technique
1	Emissions Inventory – Point-Source Emissions	Using the emissions inventory maps from Section 3, this technique finds the areas of the highest point source pollution that are least represented by pollution monitors.
2	Traffic Counts-Mobile Source Emissions	Using maps of traffic density (on both highways and arterial roads) and road density, the highest areas of mobile source emissions are estimated. This technique then finds the areas that are least represented by pollution monitors.
3	Population Density	Using the population density maps from the Population Served analysis in Section 3, this technique identifies areas of high population density that are least represented by pollution monitors.
4	Environmental Justice-Minority Population Density	Similar to the Population Density measure above, this technique identifies areas of the highest minority population density and finds those areas that are least represented by pollution monitors.
5	Euclidean Distance	This technique measures the Euclidean distance between existing monitoring sites. The greater the distance to the nearest site, the more valuable an additional monitoring site would be.
6	Standard Error Prediction Map	Each pollution parameter has a kriging interpolation map created using the entire monitoring network; only instead of the normal predicted surface output, a standard error surface is created. The standard error output shows areas of greatest uncertainty in the kriging interpolation. This map is then compared with the other techniques in a spatially weighted average to find areas that would benefit the most from additional air monitors.

1.4 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 2010-2014. Yearly and five-year averages were derived from the raw air pollution data. Other significant statistics were also calculated as needed, such as maximum values or the fourth-highest hourly O_3 concentration at a particular monitoring site. One advantage of averaging data at a single resolution is that this technique normalizes data that was collected at differing intervals; e.g. PM_{10} concentrations that had been collected at an hourly, 24-hour, 1-in-3 day, or 1-in-6 day schedule.

Census data were obtained from the 2010 U.S. Census and were converted to GIS data as necessary. Census data were obtained at the resolution of Census Block Group where applicable.

Emissions inventory data were obtained from the MCAQD Emissions Inventory Unit. These data were spatially located using the addresses of the inventory respondents. The individual emission reports were then aggregated by the township, range, and section system to create emissions by section. The latest available emissions inventory survey from 2013 was used, though survey results going back to 2004 were used to fill in blanks for currently operating businesses.

Traffic counts were obtained from the Maricopa Association of Governments (MAG), the Phoenix region's metropolitan transportation planning organization. MAG collects the traffic data from individual state, county and municipal transportation agencies. The latest available traffic count data available are from 2011 and were used exclusively in this assessment.

All Geographic Information System (GIS) data came exclusively from the Maricopa County government offices. The assessment used the most current geographic road data, which are from 2015 (the most current year available at the time of writing, an important factor as the road network continues to grow rapidly in Maricopa County.

1.5 Sites Used in This Network Assessment

This Assessment takes into account all monitoring sites reporting data to the AQS database that are located within Maricopa County or adjacent counties including those sites operated by the Arizona Department of Environmental Quality (ADEQ), other county air quality agencies, and tribal governments. 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 kriging interpolations, which were frequently used in this assessment. However, only results evaluating MCAQD sites are displayed in this report.

The following tables list all of the sites used in this assessment, organized by their operating agencies. Note that the location and information about each one of these sites comes from the AQS database; site acronyms and local site names were not always listed or up-to-date in AQS. In these cases, an assumed site acronym or local name was created and is consistently used throughout this assessment. These site acronyms or local names might be different from that used by the individual agency, but that is unimportant as the site can always be referenced by the official AQS number which is listed on these tables.

Table 1.3. *Monitoring Sites Operated by the Maricopa County Air Quality Department.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$	Pb	
04-013-0016	WI	West Indian School	33rd Ave. & W. Indian School Rd.	Phoenix	Maricopa		X						Site closed June 2010
04-013-0019	WP	West Phoenix	39th Ave. & Earll Dr.	Phoenix	Maricopa	X	X	X		X	X		
04-013-1003	ME	Mesa	Broadway Rd. & Alma School Rd.	Mesa	Maricopa	X	X			X	X		O_3 monitor opened November 2012
04-013-1004	NP	North Phoenix	7th Street & Dunlap Ave.	Phoenix	Maricopa	X	X			X	X		$PM_{2.5}$ monitor opened September 2011
04-013-1010	FF	Falcon Field	McKellips & Greenfield Rd.	Mesa	Maricopa	X							
04-013-2001	GL	Glendale	59th Ave & W. Olive	Glendale	Maricopa	X	X			X	X		$PM_{2.5}$ monitor opened June 2011
04-013-2005	PP	Pinnacle Peak	Pima Rd & Pinnacle Peak Rd.	Scottsdale	Maricopa	X							
04-013-3002	CP	Central Phoenix	16th St & Roosevelt St.	Phoenix	Maricopa	X	X	X	X	X			
04-013-3003	SS	South Scottsdale	Scottsdale Rd. & Thomas Rd.	Scottsdale	Maricopa	X	X	X	X	X			NO_2 monitor closed June 2011; SO_2 monitor closed December 2010
04-013-3010	GR	Greenwood	27th Ave. & Interstate 10	Phoenix	Maricopa		X	X		X			
04-013-4003	SP	South Phoenix	Central Ave. & Broadway Rd.	Phoenix	Maricopa	X	X			X	X		
04-013-4004	WC	West Chandler	Ellis St & Frye Rd.	Chandler	Maricopa	X	X			X			
04-013-4005	TE	Tempe	College Ave. & Apache Blvd.	Tempe	Maricopa	X	X			X	X		PM_{10} & $PM_{2.5}$ monitors opened March 2012
04-013-4006	HI	Higley	Higley Rd. & Chandler Blvd.	Gilbert	Maricopa					X			
04-013-4008	CC	Cave Creek	32nd St. & Carefree Highway	Phoenix	Maricopa	X							
04-013-4009	WF	West 43rd Ave	43rd Ave. and Broadway Rd.	Phoenix	Maricopa					X			

04-013-4010	DY	Dysart	Dysart Rd & Bell Rd.	Surprise	Maricopa	X	X			X			
04-013-4011	BE	Buckeye	Hwy 85 & MC 85	Buckeye	Maricopa	X	X	X		X			
04-013-4016	ZH	Zuni Hills	108th Ave. & Deer Valley Rd.	Sun City	Maricopa					X			
04-013-4018	DV	Deer Valley	10th Ave. & Deer Valley Rd.	Phoenix	Maricopa							X	Site opened July 2010
04-013-4019	DI	Diablo	1919 W Fairmont Dr.	Tempe	Maricopa		X	X			X		Near-road monitoring site; CO & NO_2 monitors opened February 2014; $PM_{2.5}$ monitor opened May 2014
04-013-4020	TT	Thirty-Third	Interstate 10 & Mooreland Rd.	Phoenix	Maricopa		X	X			X		Near-road monitoring site; opened in late 2015, data not used in Assessment.
04-013-9508	HM	Humboldt Mountain	N Seven Springs Rd. & Bartlett Lake Rd.	Not in a city	Maricopa	X							
04-013-9702	BP	Blue Point	Usery Pass Rd. & Bush Highway	Not in a city	Maricopa	X							
04-013-9704	FH	Fountain Hills	Palisades & Fountain Hills Blvd.	Fountain Hills	Maricopa	X							
04-013-9706	RV	Rio Verde	Forest Rd & Del Ray Ave.	Rio Verde	Maricopa	X							
04-013-9812	DC	Durango Complex	27th Ave. & Durango St.	Phoenix	Maricopa				X	X	X		SO_2 monitor opened January 2011

Table 1.4. Monitoring Sites Operated by the Arizona Department of Environmental Quality.

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$	Pb	
04-007-0008	PW	Payson Well Site	204 W Aero Dr.	Payson	Gila					X			PM_{10} monitor closed June 2014
04-007-0009	MR	Miami Ridgeline	4030 Linden Street	Miami	Gila				X	X			

04-007-0010	TM	Tonto NM	South of SR88	—	Gila	X							
04-007-0011	MJ	Miami Jones Ranch	Cherry Flats Rd.	-	Gila				X				Site opened February 2013
04-007-0012	MT	Miami Townsite	Sullivan St & Davis Canyon	Miami	Gila				X				Site opened February 2013
04-007-1001	HJ	Hayden Old Jail	Jail-Canyon Dr.	Hayden	Gila				X	X			
04-007-1002	GW	Globe Highway	SR 77	-	Gila							X	
04-007-8000	FM	FMMI-Miami Golf Course	SR 188 & US 60	Globe	Gila					X		X	
04-012-8000	AL	Alamo Lake	Alamo Lake State Park	Wenden	La Paz	X		X	X	X	X		O_3 monitor opened July 2014; SO2 monitor opened April 2014; PM10 & PM2.5 opened January 2014
04-013-8006	BT	Bethune Elementary School	1310 South 15th Avenue	Phoenix	Maricopa					X			Site closed June 2011
04-013-9997	JS	JLG (Supersite)	4530 North 17th Avenue	Phoenix	Maricopa	X	X	X	X	X	X	X	
04-019-0001	AO	Ajo	AZ HWY Dept Yard-Well Rd	Ajo	Pima					X			
04-019-0005	OP	Organ Pipe NM	Visitors center, Organ Pipe NM	—	Pima				X				SO_2 Monitor operated by NPS
04-019-0020	RI	Rillito	8840 W Robinson Street	Rillito	Pima					X			
04-021-8001	QV	Queen Valley	10 S Queen Ann	Queen Valley	Pinal	X		X					SO_2 Monitor operated by NPS
04-025-2002	PV	Prescott Valley	7501 E. Civic Circle	Prescott Valley	Yavapai					X	X		Site closed December 2013
04-025-8033	PC	Prescott College AQD	330 Grove Avenue	Prescott	Yavapai	X							
04-025-0005	HL	Hillside	Repeater Station near Hillside	Hillside	Yavapai	x			X				SO_2 monitor operated by NPS
04-027-8011	YS	Yuma Supersite	2323 S Arizona Ave	Yuma	Yuma	X				X	X		

Table 1.5. *Monitoring Sites Operated by the Fort McDowell Yavapai Nation.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$	Pb	
04-013-5100	YF	Fort McDowell/Yuma Frank	18791 Yuma Frank Road	Ft McDowell	Maricopa	X				X			

Table 1.6. *Monitoring Sites Operated by the Gila River Indian Community.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$	Pb	
04-013-7003	SJ	St. Johns	4208 West Pecos	Laveen	Maricopa	X				X			O_3 monitor opened January 2013
04-021-7001	SN	Sacaton	35 Pima St	Sacaton	Pinal	X				X			O_3 monitor opened January 2013
04-021-7004	BL	Casa Blanca	Casa Blanca/Preschool Rd	Bapchule	Pinal					X			

Table 1.7. *Monitoring Sites Operated by the U.S. National Park Service.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$	Pb	
04-007-8100	SA	Sierra Ancha*	Sierra Ancha	Young	Gila				X				
04-019-9000	SW	Saguaro West*	Saguaro West	Not in a city	Pima				X				
04-025-8104	IB	Ike's Backbone	Ike's Backbone (not in a city)	Not in a city	Yavapai				X				

*Assumed site name. Actual site name is not listed in AQS database.

Table 1.10. *Monitoring Sites Operated by the Pima County Air Quality Department.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$	Pb	
04-019-0008	CR	Corona De Tucson	22000 S Houghton Rd	Corona deTucson	Pima					X			
04-019-0011	OG	Orange Grove	3401 W Orange Grove Rd	Tucson	Pima					X	X		
04-019-0021	SG	Saguaro Park	3905 S. Old Spanish Trail	Not in a city	Pima	X							
04-019-1001	ST	South Tucson	1601 S 6th Ave	South Tucson	Pima					X			
04-019-1009	PR	Prince Road	1016 W. Prince Rd	Tucson	Pima					X			Site closed March 2014
04-019-1011	CY	22nd & Craycroft	1237 S Beverly	Tucson	Pima	X	X	X	X				SO_2 monitor closed December 2010
04-019-1014	AV	22nd & Alvernon	22nd & Alvernon	Tucson	Pima		X						
04-019-1018	TG	Tangerine	12101 N Camino De Oeste	Marana	Pima	X				X			
04-019-1020	FG	Fairgrounds	11330 S Houghton	Tucson	Pima	X							
04-019-1021	CG	Cherry & Glenn	2745 N Cherry	Tucson	Pima		X						
04-019-1023	BS	Broadway & Swan	4625 E Broadway at Swan	Tucson	Pima					X			Site closed November 2010
04-019-1026	SL	Santa Clara	6910 S Santa Clara Ave	Tucson	Pima					X			
04-019-1028	CI	Children's Park	400 W River Rd	Tucson	Pima	X	X	X	X		X	X	SO_2 monitor opened October 2010, Pb monitor opened February 2012
04-019-1030	GV	Green Valley	601 N La Canada Dr	Green Valley	Pima	X				X			
04-019-1031	GF	Golf Links	2601 S Kolb Rd	Tucson	Pima		X						
04-019-1032	RE	Rose Elementary	710 W Michigan	Tucson	Pima	X							
04-019-1034	CE	Coachline	9597 N Coachline Blvd	Tucson	Pima	X							
04-019-1113	GO	Geronimo	2498 N Geronimo	Tucson	Pima						X		

Table 1.11. *Monitoring Sites Operated by the Pinal County Air Quality Department.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$	Pb	
04-021-0001	CD	Casa Grande Downtown	401 N Marshall St	Casa Grande	Pinal					X	X		
04-021-3001	AY	AJ Maintenance Yard	305 E Superstition Blvd	Apache Junction	Pinal	X							
04-021-3002	AF	AJ Fire Station	3955 E Superstition Blvd	Apache Junction	Pinal					X	X		
04-021-3003	CA	Casa Grande Airport	660 W Aero Dr.	Casa Grande	Pinal	X							
04-021-3004	CO	Coolidge	212 E Broadway	Coolidge	Pinal					X			
04-021-3006	MM	Mammoth	118 S Catalina	Mammoth	Pinal					X			Site closed March 2011
04-021-3007	AP	Pinal Air Park	Water Well #2 Pinal Air Park Rd	Marana	Pinal	X				X			
04-021-3008	SF	Stanfield	36697 W Papago Dr	Stanfield	Pinal					X			
04-021-3009	CB	Combs	301 E Combs Rd	Queen Creek	Pinal	X				X			O_3 monitor closed May 2011
04-021-3010	MC	Maricopa	44625 W Garvey Rd	Maricopa	Pinal	X				X			O_3 monitor closed May 2011
04-021-3011	CH	Pinal County Housing	970 N Eleven Mile Corner Rd	Casa Grande	Pinal					X			
04-021-3012	RS	Riverside	54964 E Florence-Kelvin Hwy	Kearny	Pinal					X			Site closed March 2011
04-021-3013	CT	Cowtown	37580 W Maricopa-	Maricopa	Pinal					X	X		
04-021-3014	EY	Eloy	801 N Main St	Eloy	Pinal					X			

Table 1.12. *Monitoring Sites Operated by the Salt River-Pima Maricopa Indian Community.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$	Pb	
04-013-7020	SC	Senior Center	10844 East Osborn Road	Scottsdale	Maricopa	X				X	X		
04-013-7021	RM	Red Mountain	15115 Beeline Highway	Scottsdale	Maricopa	X							
04-013-7022	LE	Lehi	3230 North Stapley Drive	Scottsdale	Maricopa	X				X			
04-013-7024	HS	High School	4827 North Country Club Drive	Scottsdale	Maricopa	X				X			PM_{10} closed Jun 2012

Section 2: Background, Scale, and Objectives of the MCAQD Monitoring Network

This section includes descriptions of each of the 26 sites within the MCAQD monitoring network during 2010-2014 including sites and monitors that are now closed, but were operating during the study period. The criteria pollutant parameters monitored at each site are listed, as well as the date the monitor began operation. Each site listing includes an aerial photograph or map, shown with a circular boundary that represents the assigned monitoring scale. This boundary is assumed to represent a relatively homogeneous air parcel, and the entire area is expected to be well represented by the monitoring site (though variable between the minimum and maximum boundaries).

Monitoring sites are each classified by their (1) monitoring scale and (2) objective. As previously mentioned, the monitoring scale is an assumed area of a relatively homogeneous air parcel. A monitoring objective is a specific purpose that the monitoring site was installed to fulfill. The following table demonstrates the scale and objective choices available:

Table 2.1. *Monitoring site scales and objectives*

Scale	Defined parameter (radius)	Objective Examples
Micro Scale	0 to 100 meters	Determine highest concentrations expected to occur in the area covered by the network.
Middle Scale	100 to 500 meters	Determine representative concentrations in areas of high population density.
Neighborhood Scale	0.5 to 4 kilometers	Determine the impact on ambient pollution levels of significant sources or source categories.
Urban Scale	4 to 50 kilometers	Determine general background concentration levels.
Regional Scale	10 to 100s of kilometers	Determine the extent of regional pollutant transport from populated areas, with regards to the secondary standards (such as visibility impairment and effects on vegetation).
		Determine the welfare-related impacts in more rural and remote areas.

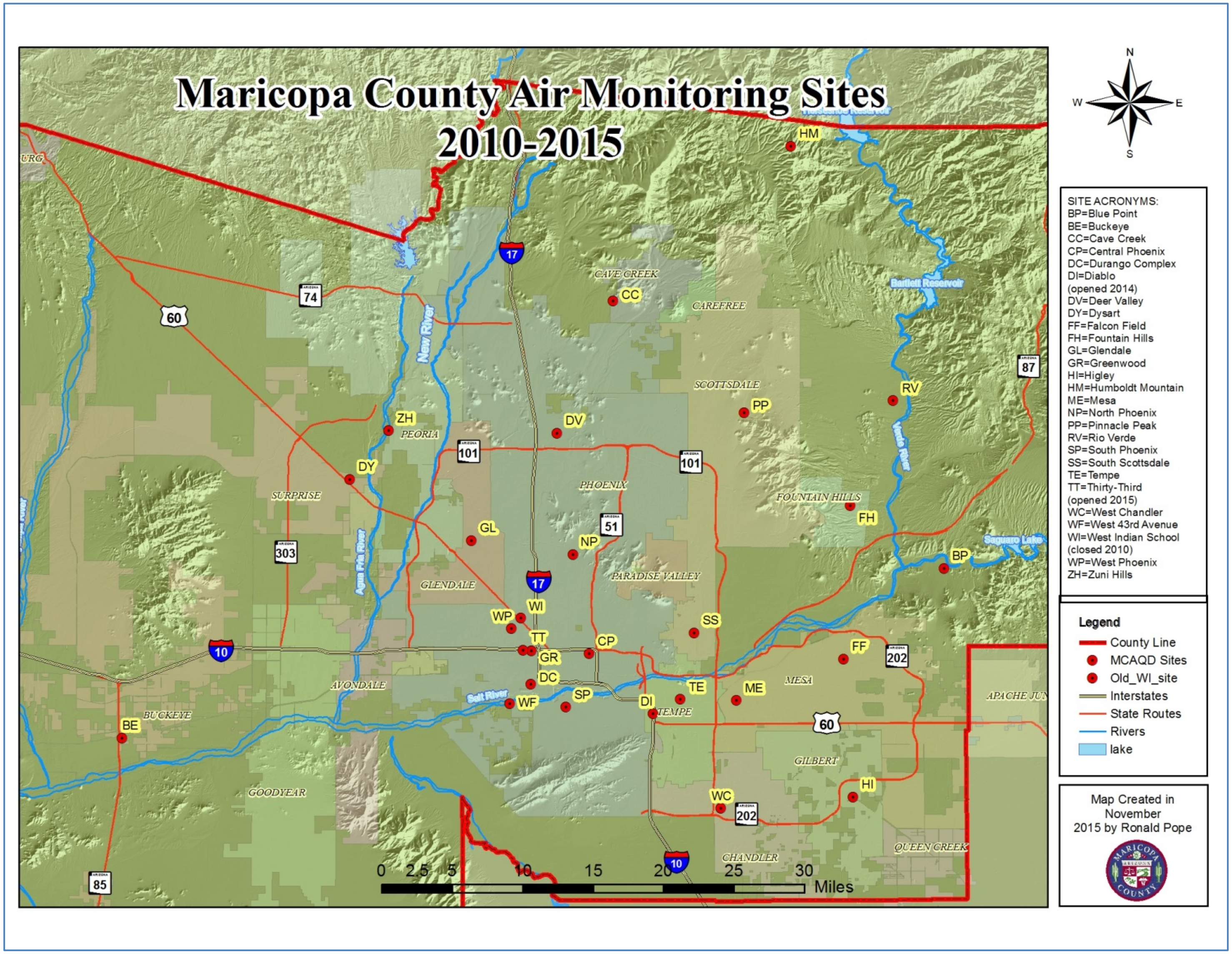

Figure 2.1. Map of the Maricopa County Air Monitoring Network as of 2015.

2.1 Summary of MCAQD Network's Scale and Objectives

The following tables detail the scale and objective status of MCAQD monitors as of December 2014.

Table 2.2. *CO monitoring sites*

Site	AQS#	Scale	Objective
Buckeye	04-013-4011	Neighborhood	Population exposure
Central Phoenix	04-013-3002	Neighborhood	Population exposure
Diablo	04-013-4019	Micro scale	Source oriented
Dysart	04-013-4010	Neighborhood	Population exposure
Glendale	04-013-2001	Neighborhood	Population exposure
Greenwood	04-013-3010	Middle	Population exposure
Mesa	04-013-1003	Neighborhood	Population exposure
North Phoenix	04-013-1004	Neighborhood	Population exposure
South Phoenix	04-013-4003	Neighborhood	Population exposure
South Scottsdale	04-013-3003	Neighborhood	Population exposure
Tempe	04-013-4005	Neighborhood	Population exposure
West Chandler	04-013-4004	Neighborhood	Population exposure
West Indian School Rd	04-013-0016	*Closed June 2010*	*Closed June 2010*
West Phoenix	04-013-0019	Neighborhood	Population exposure

Table 2.3. *NO_2 monitoring sites*

Site	AQS#	Scale	Objective
Buckeye	04-013-4011	Urban	Population exposure
Central Phoenix	04-013-3002	Neighborhood	Population exposure
Diablo	04-013-4019	Micro scale	Source oriented
Greenwood	04-013-3010	Middle	Population exposure
South Scottsdale	04-013-3003	*Closed June 2011*	*Closed June 2011*
West Phoenix	04-013-0019	Neighborhood	Population exposure

Table 2.4. *O_3 monitoring sites*

Site	AQS#	Scale	Objective
Blue Point	04-013-9702	Urban	Maximum Ozone Concentration
Buckeye	04-013-4011	Neighborhood	Population exposure
Cave Creek	04-013-4008	Urban	Maximum Ozone Concentration
Central Phoenix	04-013-3002	Neighborhood	Population exposure
Dysart	04-013-4010	Neighborhood	Population exposure
Falcon Field	04-013-1010	Neighborhood	Population exposure
Fountain Hills	04-013-9704	Neighborhood	Maximum Ozone Concentration
Glendale	04-013-2001	Neighborhood	Population exposure
Humboldt Mountain	04-013-9508	Regional	Maximum Ozone Concentration
Mesa	04-013-1003	Neighborhood	Population exposure
North Phoenix	04-013-1004	Neighborhood	Population exposure
Pinnacle Peak	04-013-2005	Urban	Maximum Ozone Concentration
Rio Verde	04-013-9706	Urban	Maximum Ozone Concentration
South Phoenix	04-013-4003	Neighborhood	Population exposure
South Scottsdale	04-013-3003	Neighborhood	Population exposure

Tempe	04-013-4005	Neighborhood	Population exposure
West Chandler	04-013-4004	Neighborhood	Population exposure
West Phoenix	04-013-0019	Neighborhood	Population exposure

Table 2.5. *SO_2 monitoring sites*

Site	AQS#	Scale	Objective
Central Phoenix	04-013-3002	Neighborhood	Population exposure
Durango Complex	04-013-9812	Middle	Population exposure
South Scottsdale	04-013-3003	*Closed Dec 2010*	*Closed Dec 2010*

Table 2.6. *Pb monitoring sites*

Site	AQS#	Scale	Objective
Deer Valley	04-013-4018	Middle	Source oriented

Table 2.7. *PM_{10} monitoring sites*

Site	AQS#	Scale	Objective
Buckeye	04-013-4011	Neighborhood	Population exposure
Central Phoenix	04-013-3002	Neighborhood	Population exposure
Durango Complex	04-013-9812	Middle	Highest concentration
Dysart	04-013-4010	Neighborhood	Population exposure
Glendale	04-013-2001	Neighborhood	Population exposure
Greenwood	04-013-3010	Middle	Population exposure
Higley	04-013-4006	Neighborhood	Population exposure
Mesa	04-013-1003	Neighborhood	Population exposure
North Phoenix	04-013-1004	Neighborhood	Population exposure
South Phoenix	04-013-4003	Neighborhood	Population exposure
South Scottsdale	04-013-3003	Neighborhood	Population exposure
Tempe	04-013-4005	Neighborhood	Population exposure
West Chandler	04-013-4004	Middle	Population exposure
West 43rd Avenue	04-013-4009	Middle	Highest concentration
West Phoenix	04-013-0019	Neighborhood	Population exposure
Zuni Hills	04-013-4016	Neighborhood	Population exposure

Table 2.8. *$PM_{2.5}$ monitoring sites*

Site	AQS#	Scale	Objective
Diablo	04-013-4019	Micro scale	Source oriented
Durango Complex	04-013-9812	Middle	Highest Concentrations
Glendale	04-013-2001	Neighborhood	Population exposure
Mesa	04-013-1003	Neighborhood	Population exposure
North Phoenix	04-013-1004	Neighborhood	Population exposure
South Phoenix	04-013-4003	Neighborhood	Population exposure
Tempe	04-013-4005	Neighborhood	Population exposure
West Phoenix	04-013-0019	Neighborhood	Highest concentration

2.2 Summary of Sites in the MCAQD Network

The following section details each of the sites operating in the MCAQD network between 2010 and 2014. Site history, parameters monitored, and monitoring scale and objectives are detailed. A map and/or aerial photograph showing the area of the monitoring scale is also depicted.

Blue Point (Code: BP, AQS# 04-013-9702)

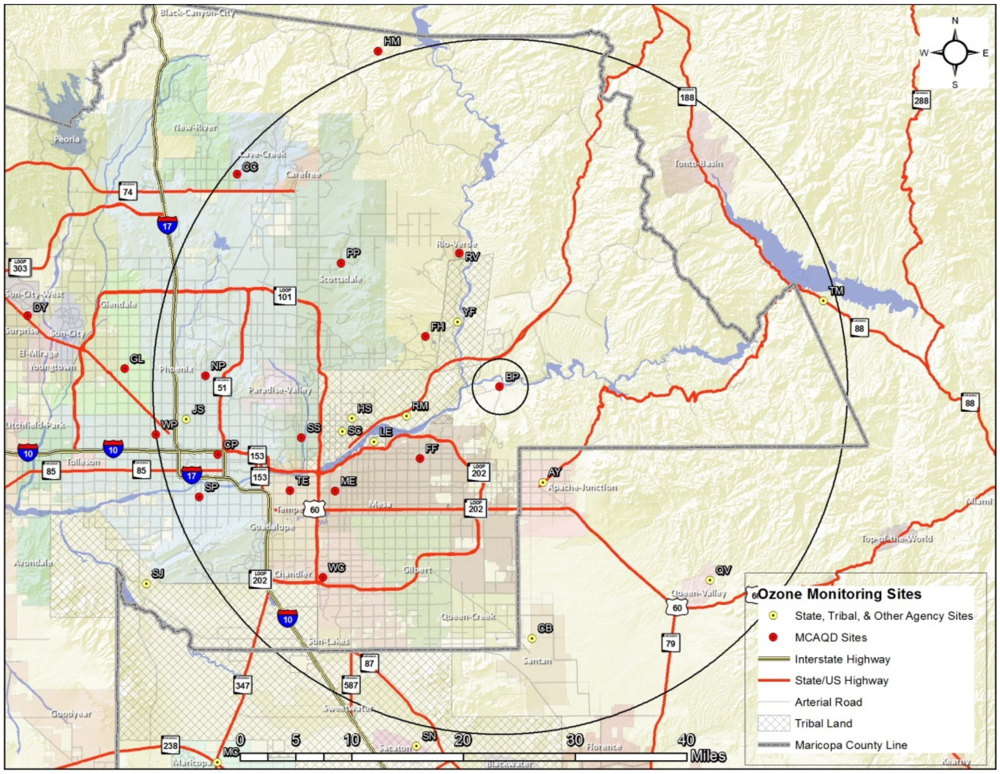

Figure 2.2. Map showing the location of the Blue Point monitoring site (center), including the 4 to 50 km radius of the urban monitoring scale. The map also indicates the location of O_3 monitors operated by other agencies, including ADEQ, Tribal, and Pinal County Air Quality Control District (PCAQCD).

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O_3	1993	Urban (4–50 km)	Maximum ozone concentration

Site Description: The Blue Point site became operational in July 1995 and is located in a Maricopa County Sheriff's substation in the Tonto National Forest. This site was placed to represent the maximum O_3 concentration and urban-scale downwind transport conditions. The site is located approximately 64 km east of the Phoenix metropolitan area. The site monitors O_3, wind speed and wind direction.

Buckeye (BE, AQS# 04-013-4011)

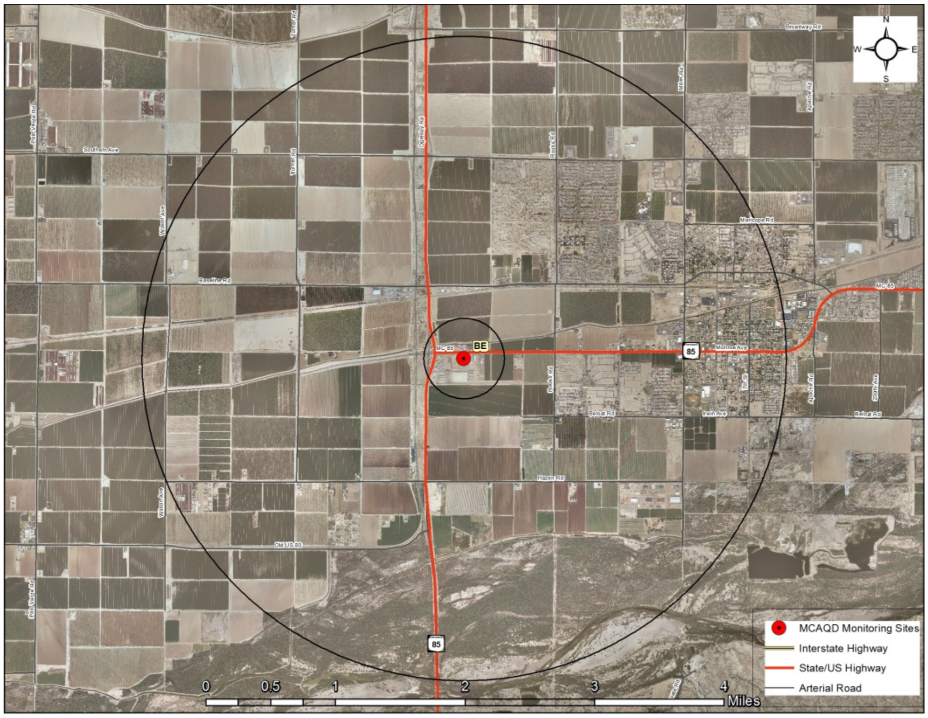

Figure 2.3. Map showing the location of the Buckeye monitoring site (center), with concentric circles representing the 0.5–4 km boundaries for the "neighborhood-scale" CO, O_3, and PM_{10} monitors.

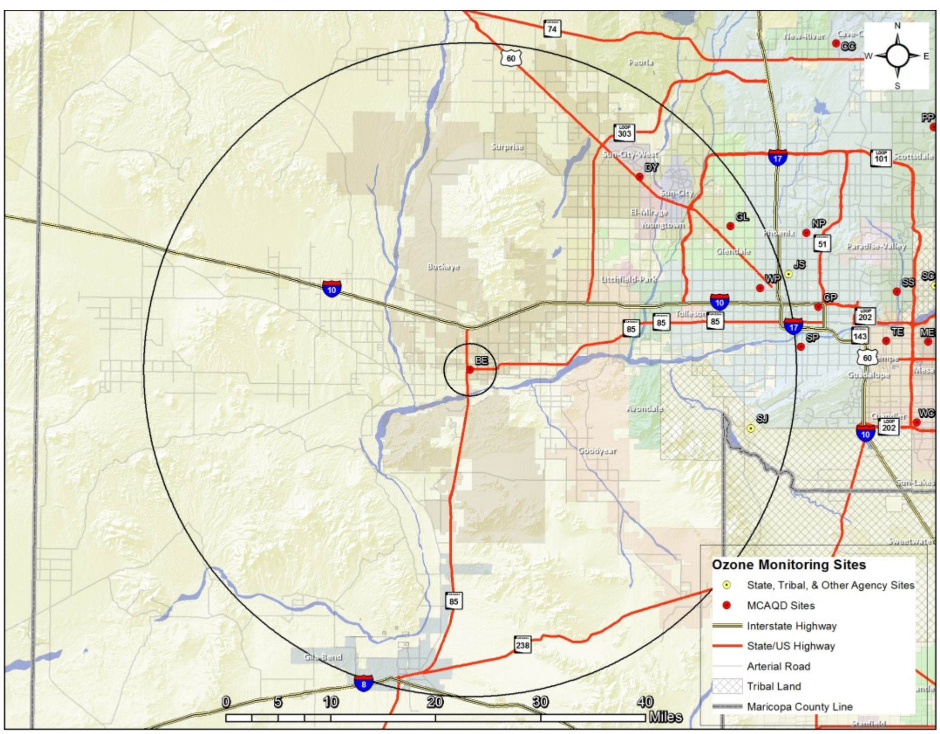

Figure 2.4. Map showing the location of the Buckeye monitoring site (center), with concentric circles representing the 4–50 km radius of the "urban" NO_2 monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	2004	Neighborhood (0.5–4 km)	Population exposure
NO_2	2004	Urban (4–50 km)	Population exposure
O_3	2004	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	2004	Neighborhood (0.5–4 km)	Population exposure

Site Description: The Buckeye site began operation on August 1, 2004 and monitors CO, NO_2, O_3, and PM_{10} concentrations. The site is located in the Maricopa County Department of Transportation's Southwest Facility and is surrounded by agriculture and encroaching residential development. The NO_2 monitors at this site were originally sited with a source-oriented objective to address power plants located approximately 24 km west of the site, but this was changed to a population exposure objective to better meet monitoring conditions noted at the site. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

Cave Creek (CC, AQS# 04-013-4008)

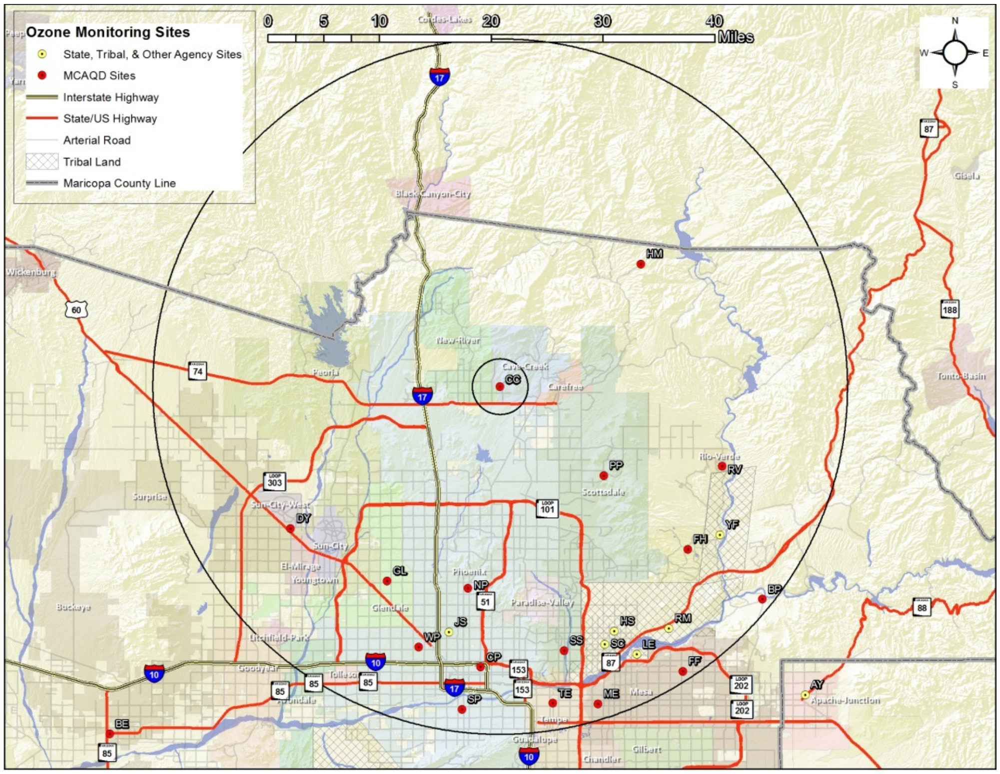

Figure 2.5. Map showing the location of the Cave Creek monitoring site (center), with concentric circles representing the 4–50 km radius of the "urban" monitoring scale. The map also indicates O_3 monitors operated by other agencies, including ADEQ, tribes, and PCAQCD.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O_3	2001	Urban (4–50 km)	Maximum Ozone Concentration

Site Description: The Cave Creek site became operational in August 2001 and is located in the Maricopa County Cave Creek Recreation Area Park Office. This site was chosen through discussions on modifying the O_3 network for the new 8-hour O_3 standard. The sites monitors O_3, wind speed and wind direction.

Central Phoenix (CP, AQS# 04-013-3002)

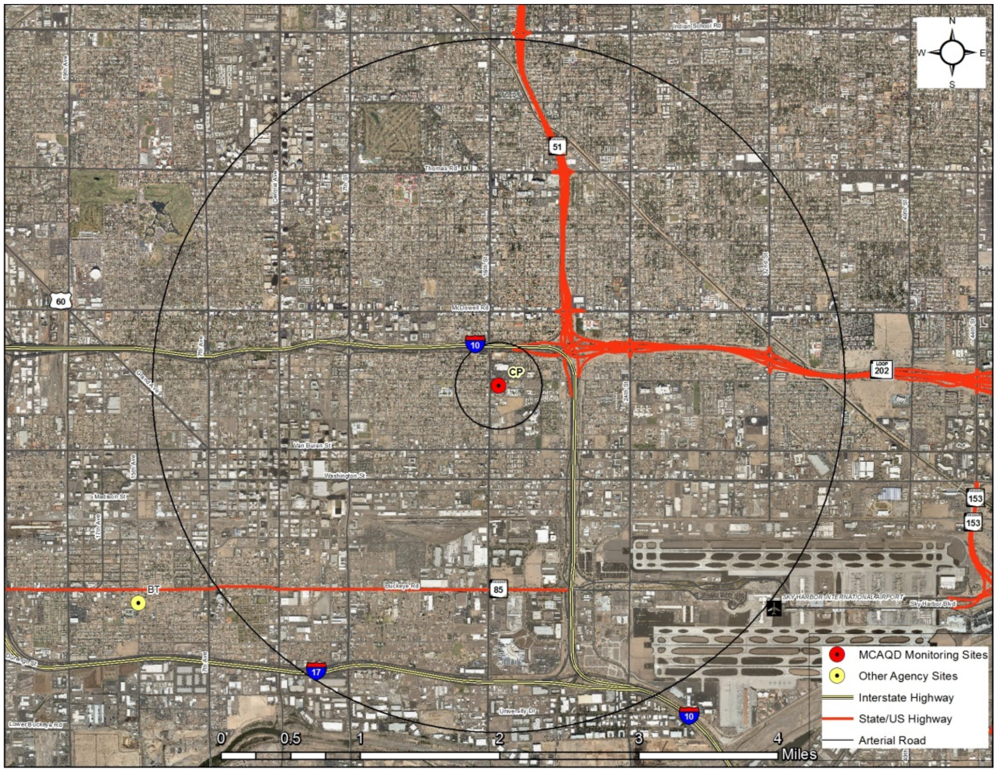

Figure 2.6. Map showing the location of the Central Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1966	Neighborhood (0.5–4 km)	Population exposure
NO_2	1967	Neighborhood (0.5–4 km)	Population exposure
O_3	1967	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	1985	Neighborhood (0.5–4 km)	Population exposure
SO_2	1965	Neighborhood (0.5–4 km)	Population exposure

Site Description: The Central Phoenix site has been in existence for over four decades and has provided a long-term historical data with a high rate of data recovery. The site is representative of high population exposure, i.e., greater than 2000 people per square kilometer, in the central Phoenix area, and it is located close to several high-volume highways and interchanges. This site monitors for CO, NO_2, O_3, PM_{10} and SO_2 as well as the meteorological parameters of barometric pressure, ambient temperature, and wind speed and direction.

Deer Valley (DV, AQS# 04-013-4018)

Figure 2.7. Map showing the location of the Deer Valley monitoring site (center), with concentric circles representing the 100–500 m radius of the "middle" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
Lead (Pb)	2010	Middle (100–500 m)	Source-oriented

Site Description: The Deer Valley site is located on the grounds of the Deer Valley Airport in north Phoenix. This site was started in July 2010, because changes in the Pb NAAQS necessitated that MCAQD begin Pb monitoring again. All ambient Pb monitoring had been discontinued in 1997, because Pb concentrations were consistently much lower than the standard at that time. The source of Pb emissions is the general aviation fuels used in propeller-driven aircraft. Deer Valley Airport is one of the busiest general aviation airports in Maricopa County. In addition to Pb, this site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

Diablo (DI, AQS# 04-013-4019)

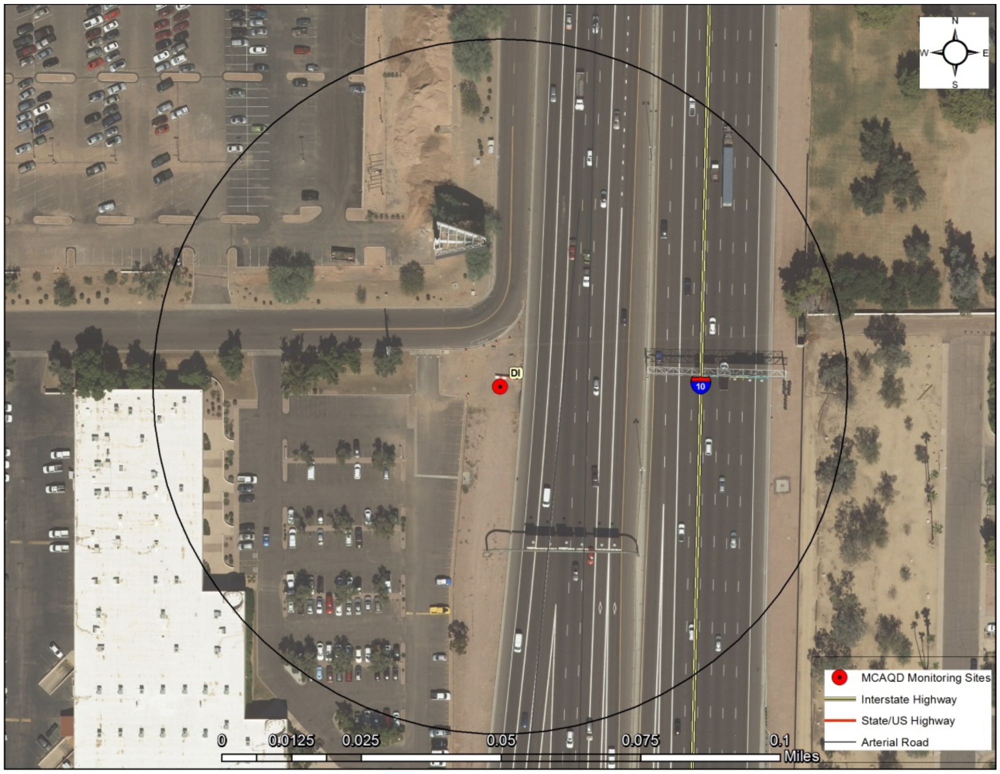

Figure 2.8. Map showing the location of the Diablo monitoring site (center), with concentric circles representing the 100m radius of the "micro" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	2014	Micro scale (0-100 M)	Source-Oriented
NO_2	2014	Micro scale (0-100 M)	Source-Oriented
$PM_{2.5}$	2014	Micro scale (0-100 M)	Source-Oriented

Site Description: The Diablo site began operation in February 2014 as the first near-road NO_2 site in MCAQD's network. This site, located near the onramp for the convergence of Interstate-10 and the US-60 highways, was chosen because it possessed many favorable elements for a near-road site. This section of highway is, on average, one of the most congested in the metropolitan area and has the highest vehicle traffic counts for light and heavy-duty vehicles. In addition, local terrain, topography, meteorology, and nearby source contribution were favorable to locating a near-road site in this area.

In addition to CO, NO_2, and $PM_{2.5}$, this site also monitors the meteorological parameters of relative humidity, ambient temperature, and wind speed and direction.

Durango Complex (DC, AQS# 04-013-9812)

Figure 2.8. Map showing the location of the Durango Complex monitoring site (center), with concentric circles representing the 100–500 m radius of the "middle" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
SO_2	2011	Middle (100–500 m)	Population-Oriented
PM_{10}	1999	Middle (100–500 m)	Highest Concentration
$PM_{2.5}$	2010	Middle (100–500 m)	Highest concentration

Site Description: This site is located in the Maricopa County Flood Control District storage yard, which is 1.6 km northwest from the former Salt River site. Sampling began on January 6, 1999 with the intent to replace the Salt River site. However, in 2000 the U.S. EPA determined that the Durango Complex site was not equivalent to the Salt River site; therefore, the West 43rd Avenue site was started and became the replacement. Continuous particulate monitors are located at this site and a SO_2 monitor was placed here in 2011 in response the recommendations from the 2005-2009 Network Assessment.

This site also monitors the meteorological parameters of wind speed and direction, barometric pressure, ambient temperature, and relative humidity.

Dysart (DY, AQS# 04-013-4010)

Figure 2.9. Map showing the location of the Dysart monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	2003	Neighborhood (0.5–4 km)	Population exposure
O_3	2003	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	2003	Neighborhood (0.5–4 km)	Population exposure

Site Description: The Dysart site was established in July 2003. It is located at the Maricopa County Facility Maintenance Yard at the corner of Bell Rd. and Dysart Rd. The site is in a growing population area in the northwest valley. The land use around the site consists of subdivisions of single-family homes, commercial, and industrial properties. The site is approximately 1.6 km west of the Agua Fria riverbed. Seasonal CO, O_3, and PM_{10} are monitored at this station. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

Falcon Field (FF, AQS# 04-013-1010)

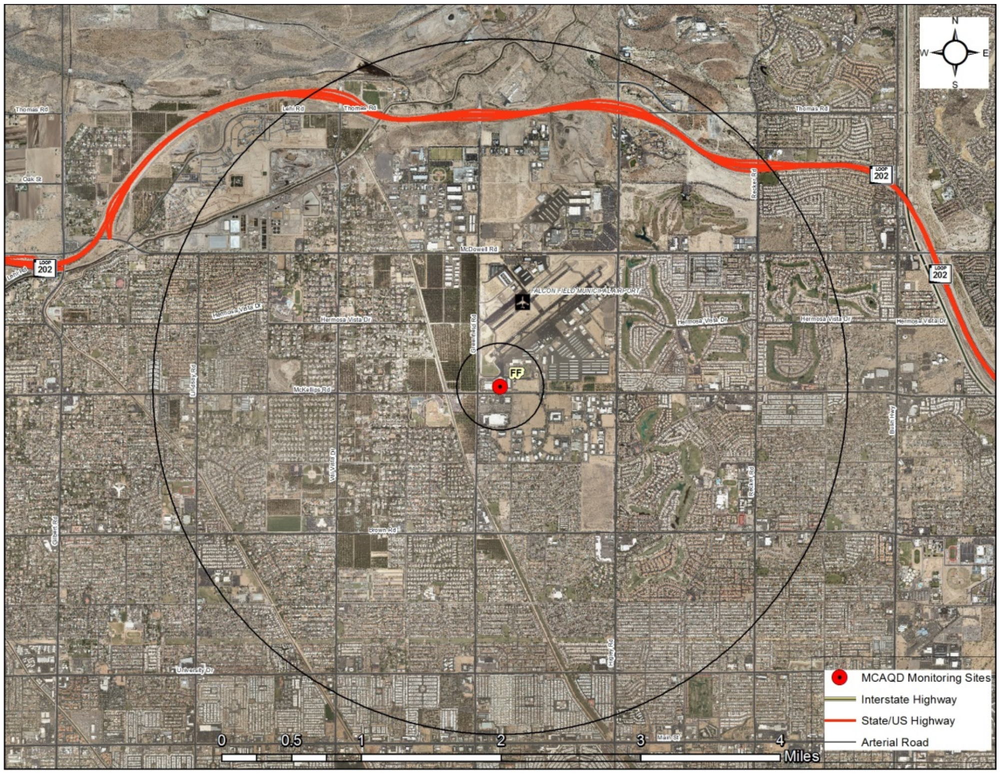

Figure 2.10. Map showing the location of the Falcon Field monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O_3	1989	Neighborhood (0.5–4 km)	Population exposure

Site Description: The Falcon Field site is located within a City of Mesa fire station adjacent to the Falcon Field airport. Monitoring for O_3 began in 1989; since that time the surrounding area has transformed from mostly agricultural citrus fields to primarily residential development. This site also monitors the meteorological parameters of relative humidity, ambient temperature, and wind speed and direction.

Fountain Hills (FH, AQS# 04-013-9704)

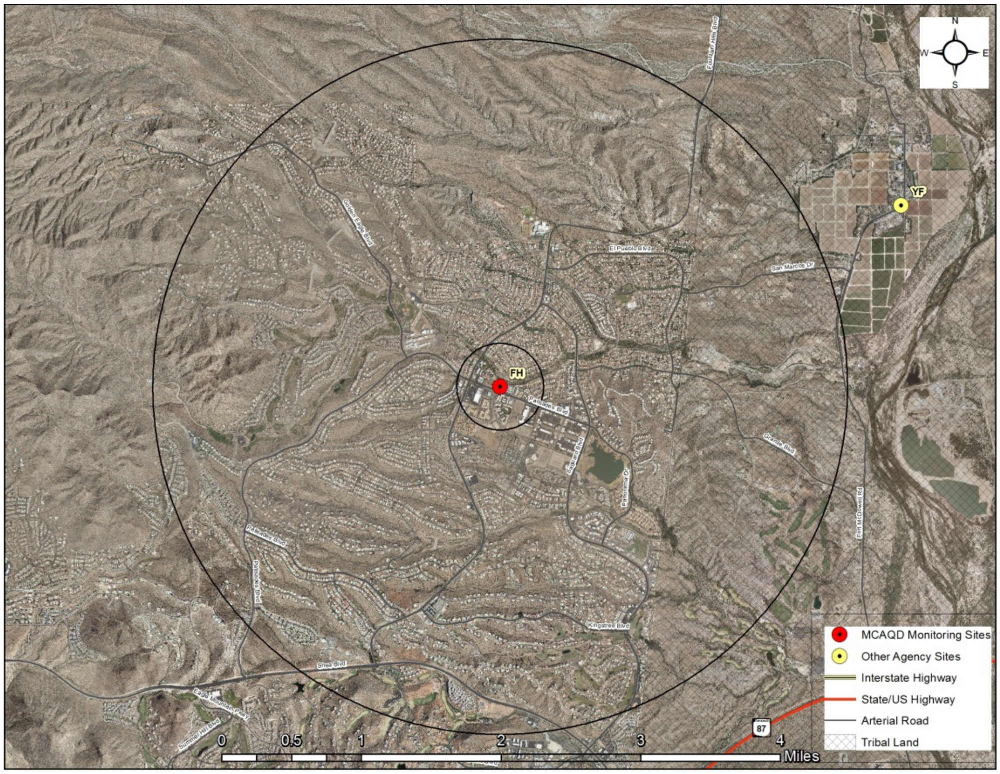

Figure 2.11. Map showing the location of the Fountain Hills monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O_3	1996	Neighborhood (0.5–4 km)	Maximum Ozone Concentration

Site Description: The site, located at a Fountain Hills fire station, became operational in April 1996 and measures O_3 concentrations. The site is located approximately 24 km east of the Phoenix metropolitan area, and it was chosen to represent the high downwind concentrations on the fringes of the central basin district along the predominant summer/fall daytime wind direction. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

Glendale (GL, AQS# 04-013-2001)

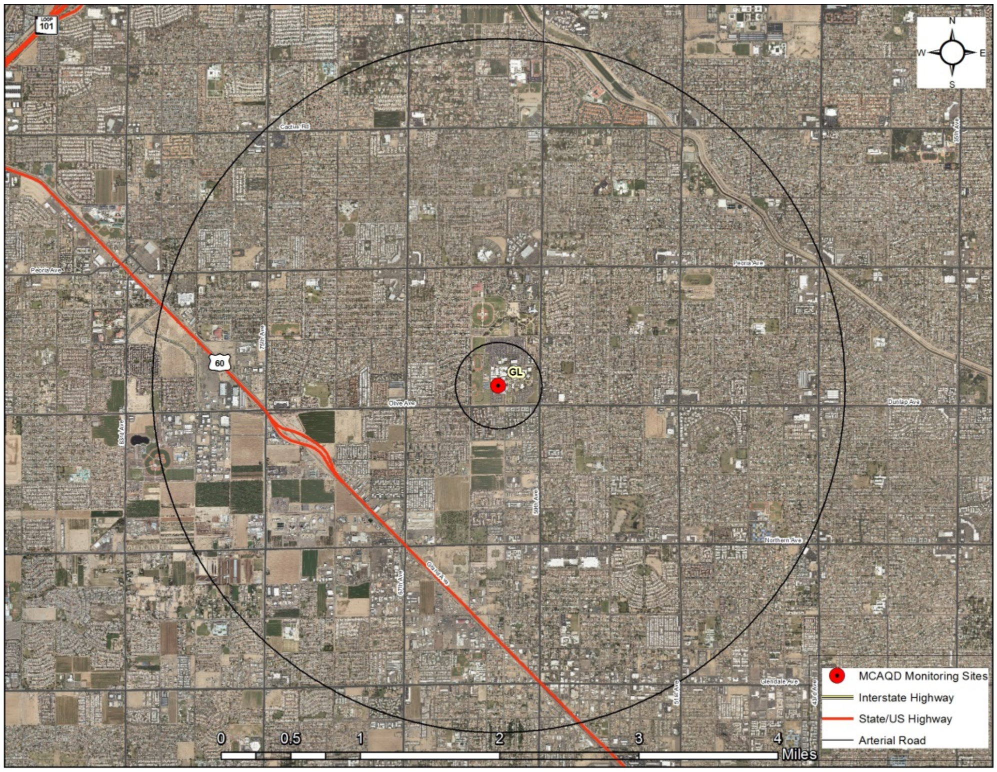

Figure 2.12. Map showing the location of the Glendale monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1974	Neighborhood (0.5–4 km)	Population exposure
O_3	1974	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	1987	Neighborhood (0.5–4 km)	Population exposure
$PM_{2.5}$	2011	Neighborhood (0.5–4 km)	Population exposure

Site Description: The Glendale site, established over four decades ago, is located on the grounds of Glendale Community College in a populous residential area. Single-family homes, strip malls, food establishments, and parks surround the site. Seasonal CO, O_3, and PM_{10} are monitored at this station. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

Greenwood (GR, AQS# 04-013-3010)

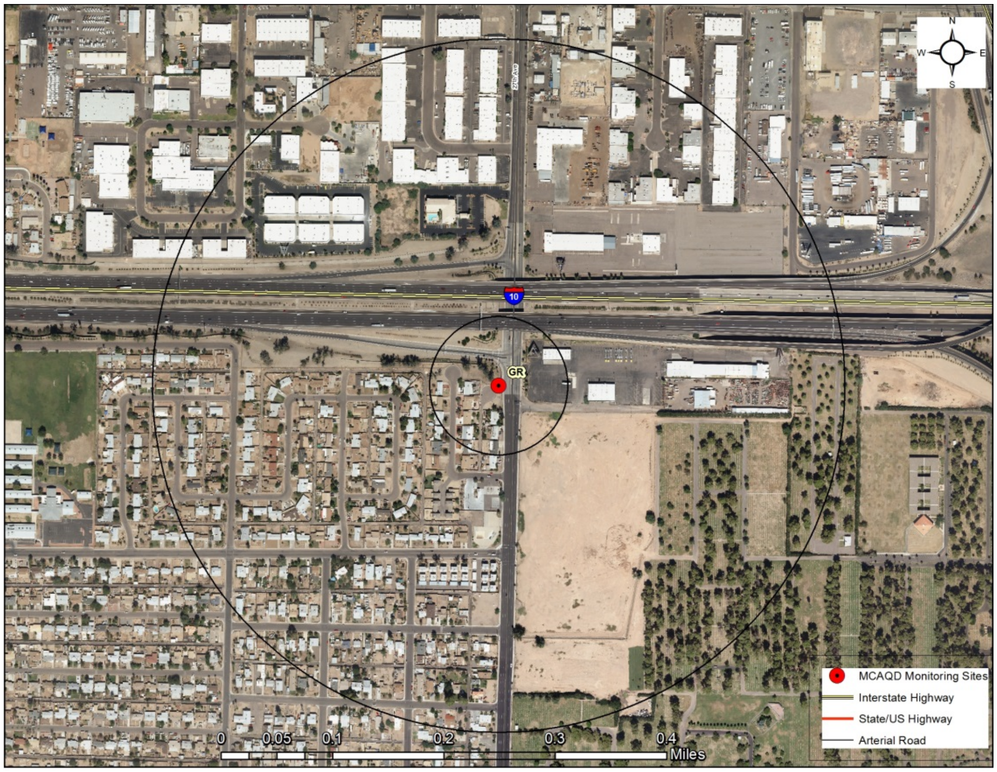

Figure 2.13. Map showing location of the Greenwood monitoring site (center), including the assumed 100-500 m radius of the Middle monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1993	Middle (100–500 m)	Population exposure
NO_2	1993	Middle (100–500 m)	Population exposure
PM_{10}	1993	Middle (100–500 m)	Population exposure

Site Description: Monitoring began at this site in December 1993. The station is bordered on the north by Interstate 10, on the west and south by neighborhood homes, and to the east by Greenwood Cemetery. Interstate 17 is approximately 1.6 km to the east of the site. CO, NO_2, and PM_{10} are the criteria pollutants monitored at this location. This site also monitors the meteorological parameters of barometric pressure, ambient temperature, and wind speed and direction.

Higley (HI, AQS# 04-013-4006)

Figure 2.14. Map showing the location of the Higley monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
PM_{10}	2000	Neighborhood (0.5–4 km)	Population exposure

Site Description: Originally, in 1994, ADEQ set up this site to monitor for background particulate concentrations near the urban limits of Maricopa County. Since then, urban expansion has enveloped the site, so it no longer serves its original intended purpose. MCAQD installed a PM_{10} monitor in the second quarter of 2000. This monitor samples on the neighborhood scale with a monitoring objective of high population exposure. This site also monitors the meteorological parameters of barometric pressure, ambient temperature, temperature difference, and wind speed and direction.

The Roosevelt Water Conservation District, the property owner where the site is located, informed us to remove the monitor by the end of 2014. MCAQD shut the site down in October 2014 and is currently constructing a new site a short distance away with a plan to open in 2016.

Humboldt Mountain (HM, AQS# 04-013-9508)

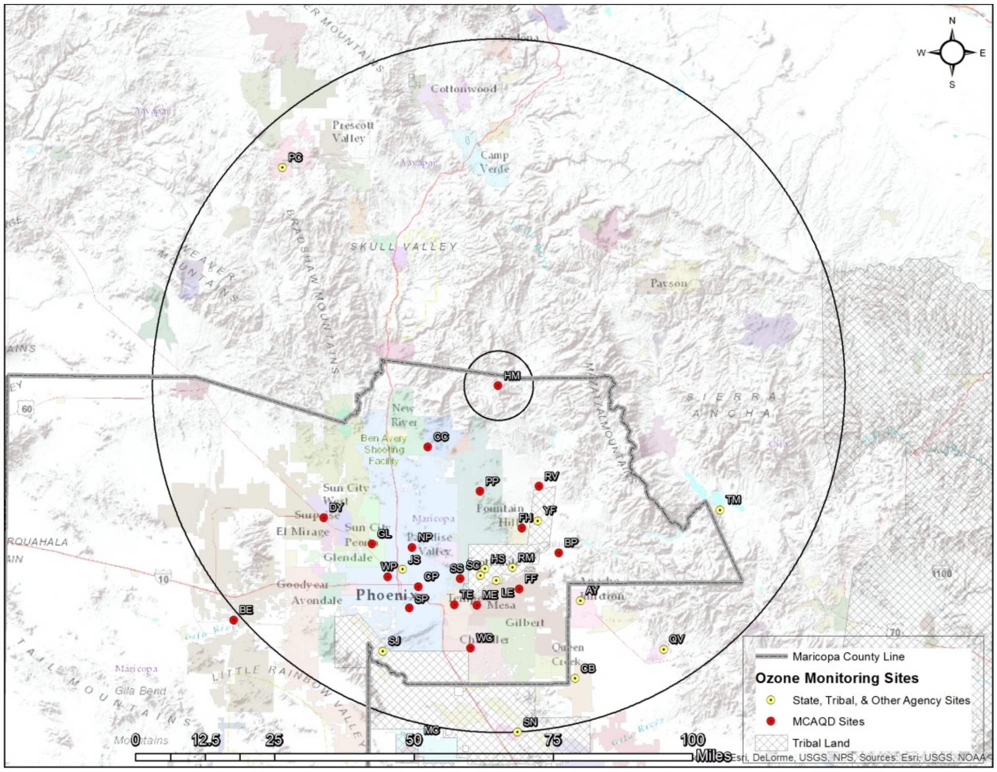

Figure 2.15. Map showing location of Humboldt Mountain monitoring site (center), including the assumed 10-100 km radius of the Regional monitoring scale. Map also includes O_3 monitors from other agencies, including ADEQ, Tribal, and PCAQCD.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O_3	1993	Regional (10–100+ km)	Maximum Ozone Concentration

Site Description: This site became operational in August 1995. The Humboldt Mountain site is located on property owned by the Federal Aviation Administration, in a National Forest Service building in the Tonto National Forest. This site is located approximately 64 km north-northeast of the Phoenix metropolitan area at an elevation of 1582 m. O_3 is the only criteria pollutant that is monitored at this site. This site currently monitors the meteorological parameters of relative humidity, ambient temperature, and wind speed and direction.

Mesa (ME, AQS# 04-013-1003)

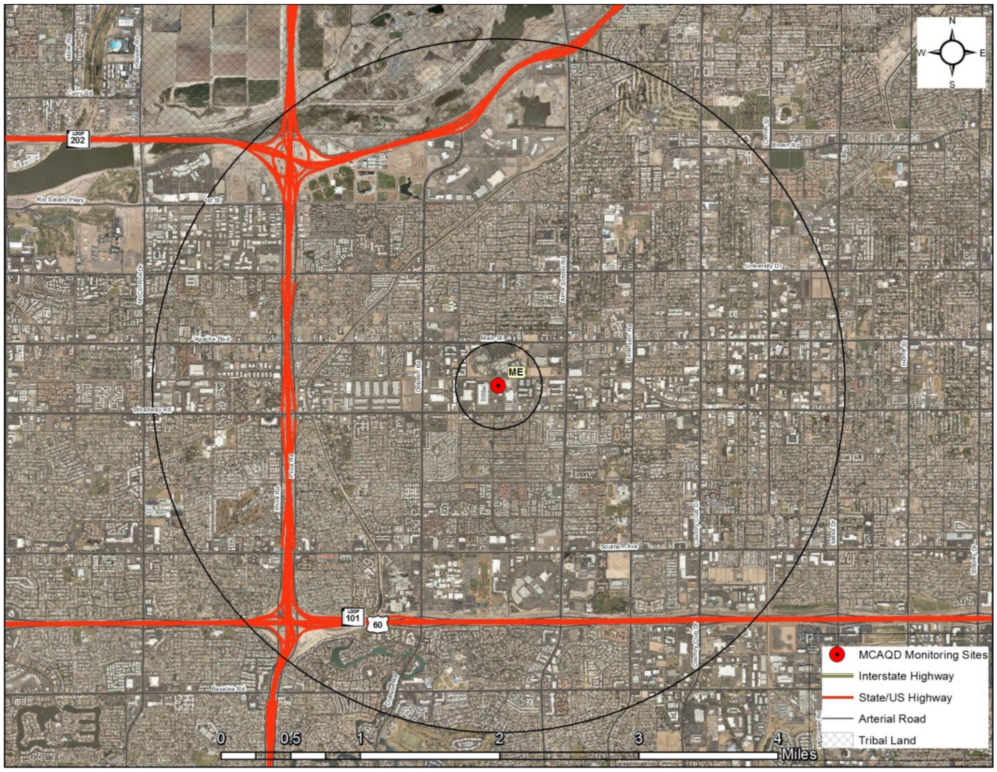

Figure 2.16. Map showing the location of the Mesa monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1978	Neighborhood (0.5–4 km)	Population exposure
O_3	2012	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	1990	Neighborhood (0.5–4 km)	Population exposure
$PM_{2.5}$	2005	Neighborhood (0.5–4 km)	Population exposure

Site Description: This site is located at Brooks Reservoir at the western edge of the city near the Tempe border. It is centered in an area that contains residential, commercial, and industrial activity. CO, PM_{10}, and $PM_{2.5}$ are the criteria pollutants monitored at this site. The department resumed operation of the O_3 monitor in 2012 after a 10-year hiatus. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

North Phoenix (NP, AQS# 04-013-1004)

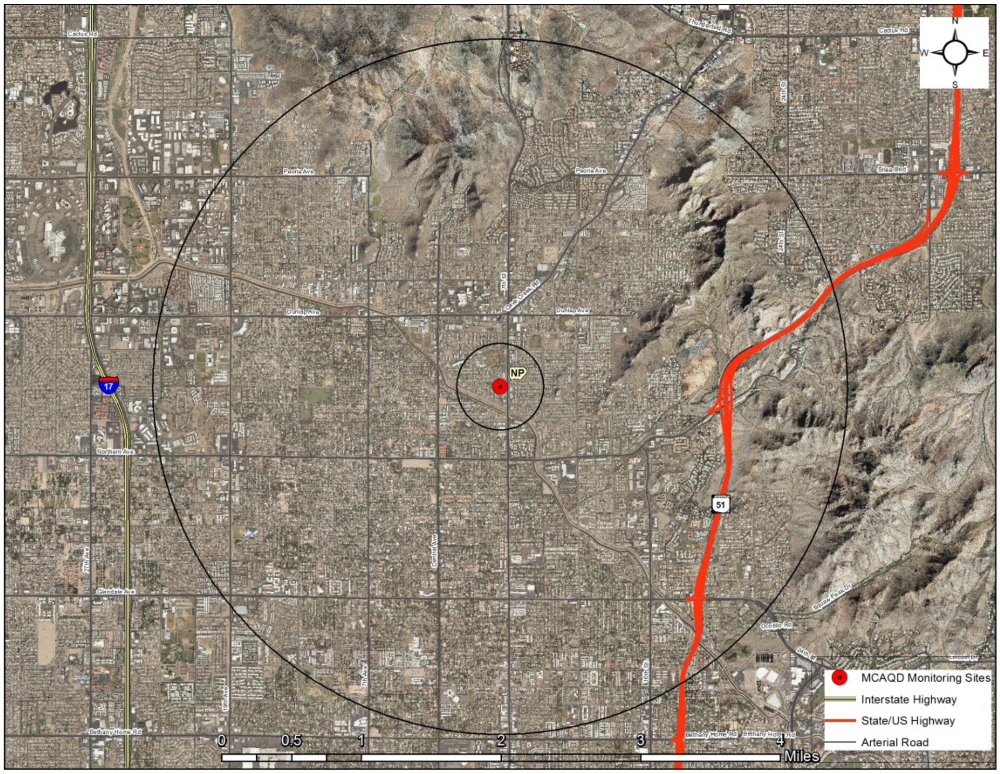

Figure 2.17. Map showing the location of the North Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1974	Neighborhood (0.5–4 km)	Population exposure
O_3	1975	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	1990	Neighborhood (0.5–4 km)	Population exposure
$PM_{2.5}$	2011	Neighborhood (0.5–4 km)	Population exposure

Site Description: This site is located in the Sunnyslope area of North Phoenix. Sunnyslope is an old established neighborhood, primarily residential. High-density population surrounds the site. Seasonal CO, O_3, and PM_{10} are monitored at this site, along with delta temperature (temperature inversion). This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

Pinnacle Peak (PP, AQS# 04-013-2005)

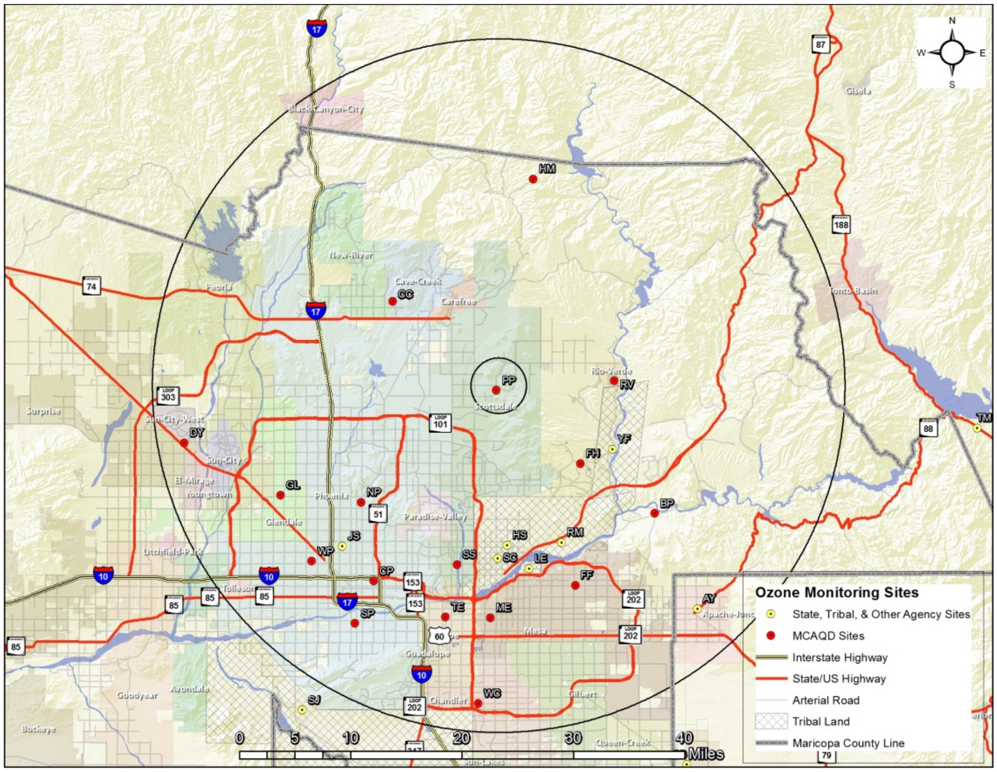

Figure 2.18. Map showing location of Pinnacle Peak monitoring site (center), including the assumed 4-50 km radius of the Urban monitoring scale. This map also includes O_3 monitors from other agencies, including ADEQ, Tribal agencies, and PCAQCD.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O_3	1988	Urban (4–50 km)	Maximum ozone concentration

Site Description: The site, originally located in 1988 on the roof of the Troon Golf Course Country Club in North Scottsdale, was moved a kilometer south in 2012 to their maintenance yard. This was at the request by the property owner. It is located in a geographic area of low-density population (less than 1000 people per square kilometer). In the current and previous years, O_3 exceedances have been recorded due to transport of O_3 and precursors from more urbanized areas of metropolitan Phoenix. In addition to O_3, this site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

Rio Verde (RV, AQS# 04-013-9706)

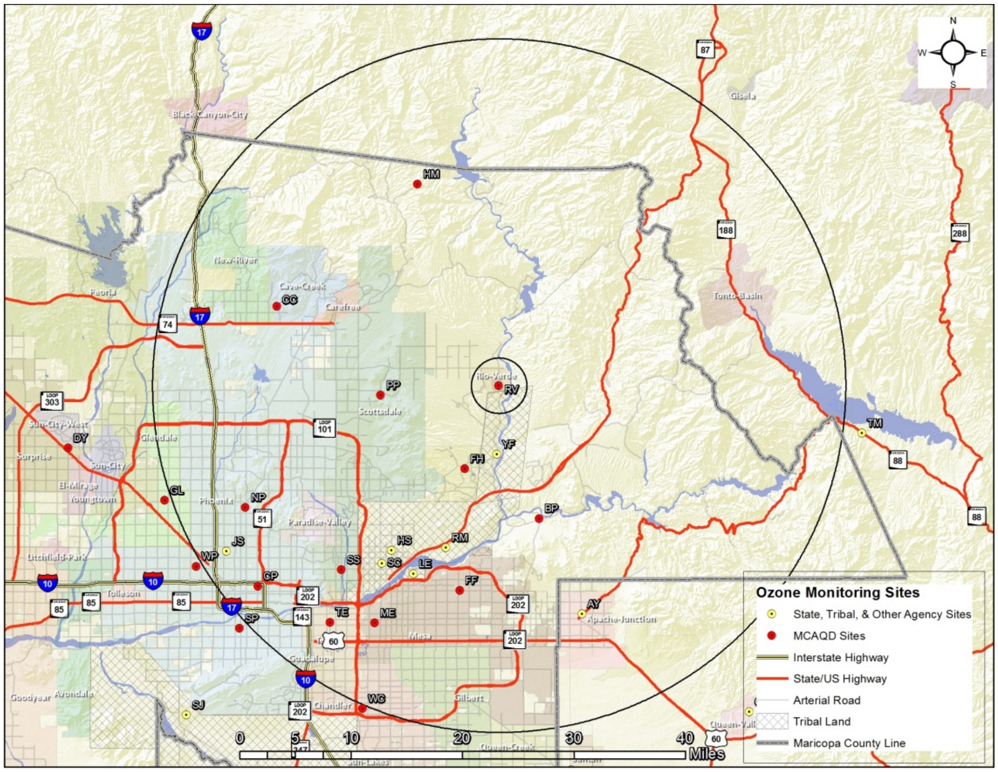

Figure 2.19. Map showing location of Rio Verde monitoring site (center), including the 4–50 km radius of the urban monitoring scale. The map also indicates O_3 monitors operated by other agencies, including ADEQ, Tribal agencies, and PCAQCD.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O_3	1997	Urban (4–50 kilometers)	Maximum Ozone Concentration

Site Description: This O_3 site became operational in spring 1997. The monitor is located at the fire station and County Sheriff's office sub-station located in a residential area surrounded by the desert of Tonto National Forest. The site is 13 km north of the Fountain Hills station, on the edge of a Class I Wilderness Area. O_3 is the only parameter monitored at this site.

South Phoenix (SP, AQS# 04-013-4003)

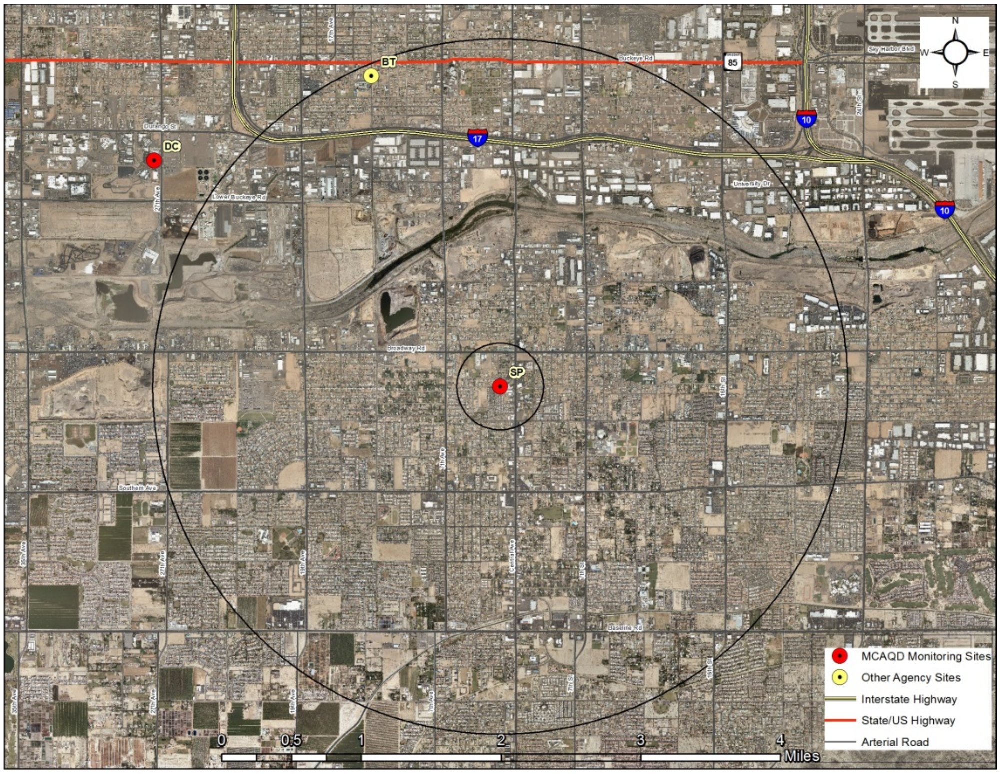

Figure 2.20. Map showing the location of the South Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established		Scale	Objective(s)
	Original Site	Current Site		
CO	1974	1999	Neighborhood (0.5–4 km)	Population exposure
O_3	1975	1999	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	1985	1999	Neighborhood (0.5–4 km)	Population exposure
$PM_{2.5}$	—	2005	Neighborhood (0.5–4 km)	Population exposure

Site Description: The site was originally opened in 1974 under AQS# 04-013-0013, but was moved a short distance to its current location in October 1999 and changed to AQS# 04-013-4003. The site borders on a mixture of residential and commercial (retail stores, food establishments, and office parks) land use. The site is situated near two densely populated areas (>2000 people per square kilometer) north and west of the site. Seasonal CO, O_3, PM_{10}, and $PM_{2.5}$ are monitored at this station. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

South Scottsdale (SS, AQS# 04-013-3003)

Figure 2.21. Map showing the location of the South Scottsdale monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "Neighborhood"- scale CO, O_3, PM_{10}, and SO_2 monitors. The now closed NO_2 monitor operated on an 'Urban' scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1974	Neighborhood (0.5–4 km)	Population exposure
NO_2*	1974	Urban (4–50 km)	Population exposure
O_3	1974	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	1987	Neighborhood (0.5–4 km)	Population exposure
SO_2*	1984	Neighborhood (0.5–4 km)	Population exposure

*Monitor closed

Site Description: This long-term site is located at a City of Scottsdale Fire Station. The area surrounding the site is residential with a density of 1,000 to 2,000 persons per square kilometer. This site is located 19 km east of metropolitan Central Phoenix. CO, NO_2, O_3, PM_{10}, and SO_2 were all previously monitored at this station; however, the 2010 Network Assessment found that the SO_2 and NO_2 monitors were ineffective and recommended moving them. In December 2010, the SO_2 monitor at South Scottsdale was moved west to the Durango Complex site. The NO_2 monitor was then closed in June 2011.

This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

Tempe (TE, AQS# 04-013-4005)

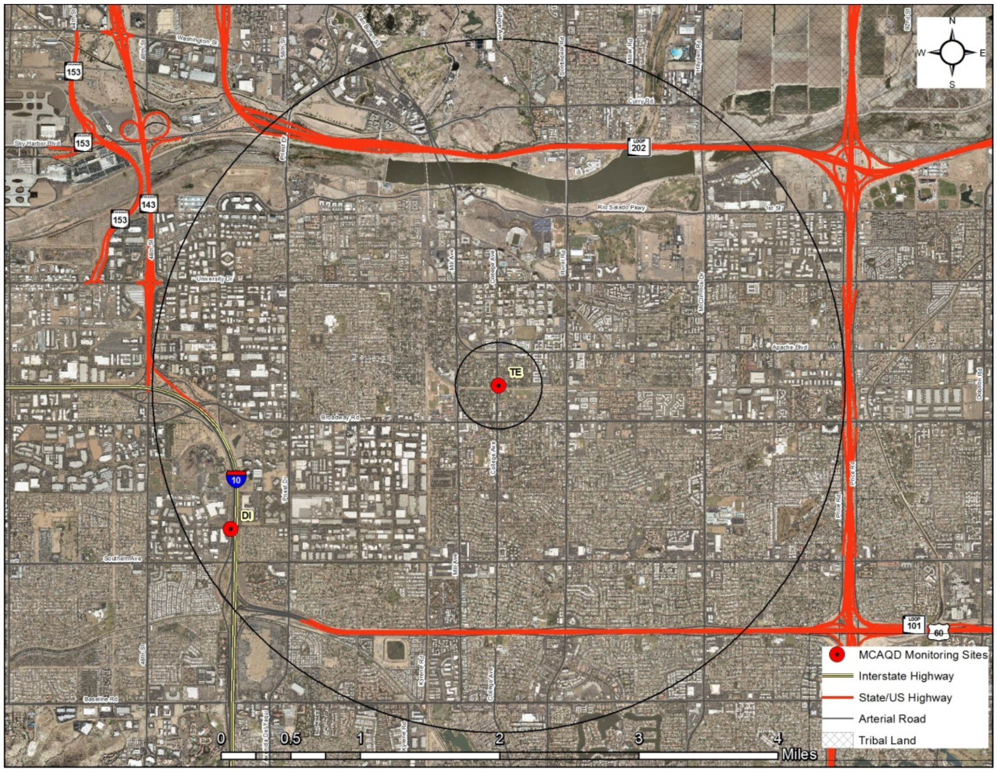

Figure 2.23. Map showing the location of the Tempe monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	2000	Neighborhood (0.5–4 km)	Population exposure
O_3	2000	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	2012	Neighborhood (0.5–4 km)	Population exposure
$PM_{2.5}$	2012	Neighborhood (0.5–4 km)	Population exposure

Site Description: The site was established in 2000 to fill in a spatial gap between the metropolitan Phoenix area and the city of Mesa. O_3 and seasonal CO have been monitored at this site since it opened, and PM_{10} and $PM_{2.5}$ monitors were added in 2012 in response to recommendation from the 2010 Network Assessment. Wind speed and direction, rainfall, ambient temperature, and delta temperature (temperature inversion) meteorological parameters are also monitored at this site. The station is located just south of the Arizona State University campus and is surrounded by residential and commercial properties.

West Chandler (WC, AQS# 04-013-4004)

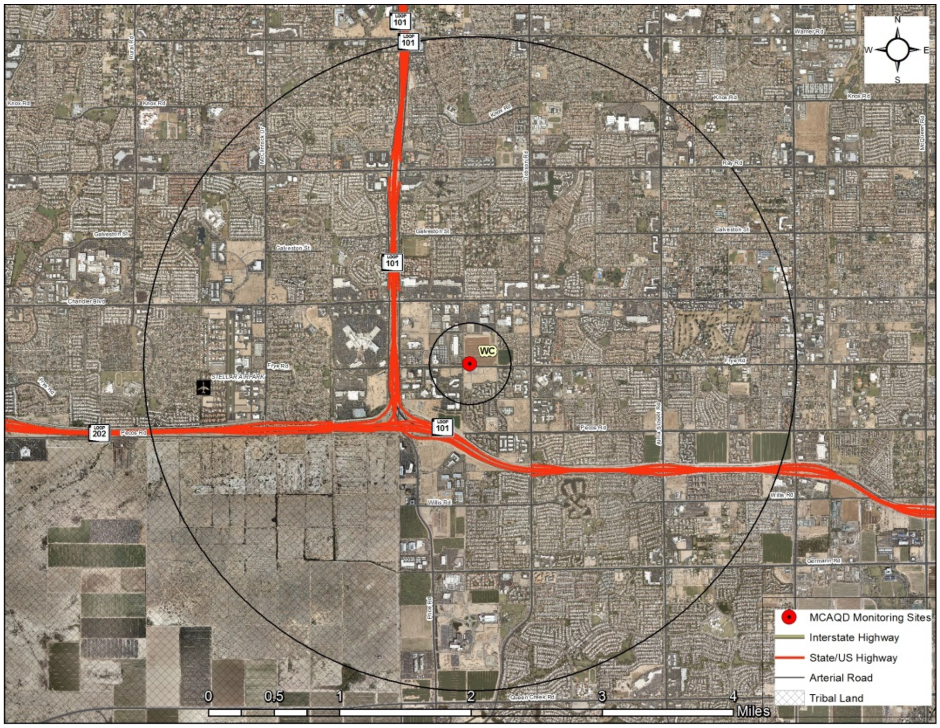

Figure 2.24. Map showing the location of the West Chandler monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood"-scale CO and O_3 monitors.

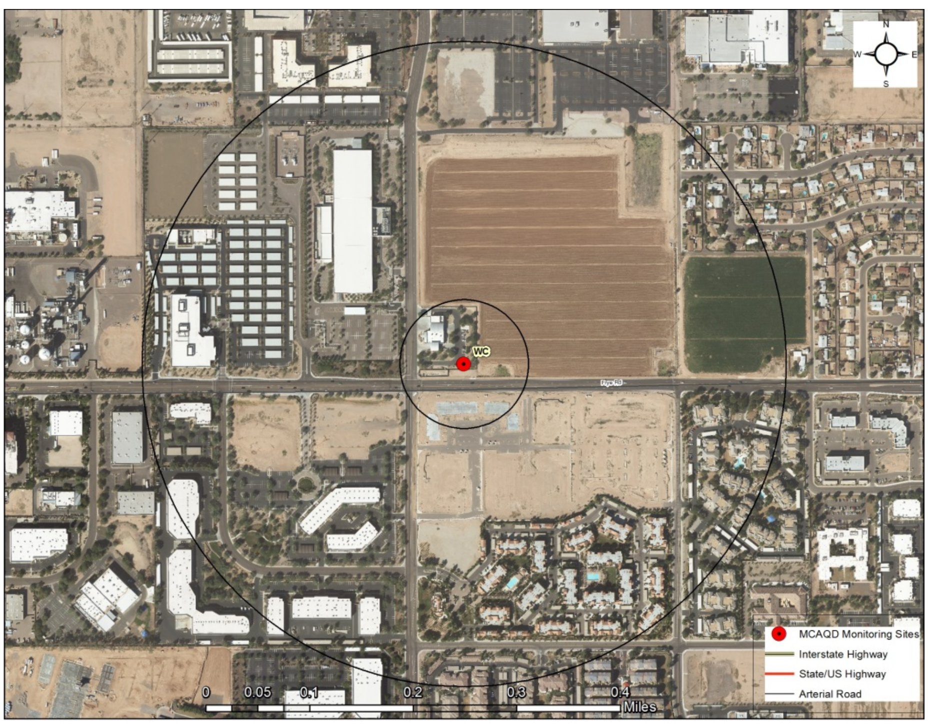

Figure 2.25. Map showing location of West Chandler monitoring site (center), with concentric circles representing the 100–500m radius for the "middle"-scale PM_{10} monitor.

Pollutant(s) Monitored	Year Established		Scale	Objective(s)
	Original Site	Current Site		
CO	1993	2000	Neighborhood (0.5–4 km)	Population exposure
O_3	1993	2000	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	1993	2000	Middle (100–500 m)	Population exposure

Site Description: This site was first established in January 1993 under AQS #04-013-3009. The site was moved one kilometer to the southeast in May 2000 and changed to AQS #04-013-4004. A wide range of land uses surround the site including: residential, agriculture, and heavy industry such as semiconductor manufacturing plants and liquid air storage. Seasonal CO, O_3, and PM_{10} are the criteria pollutants monitored at this site. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

West 43rd Avenue (WF, AQS# 04-013-4009)

Figure 2.26. Map showing the location of the West 43rd Ave. monitoring site (center), with concentric circles representing the 100–500 m radius of the "middle" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
PM_{10}	2002	Middle (100–500 m)	Highest concentration

Site Description: This site started as a replacement for the Salt River site (AQS #04-013-3007), located approximately 3 km to the northeast and closed in 2000, after it was determined that the Durango Complex site was not an adequate replacement. Monitoring began at the site in the second quarter of 2002. This site is located at a Maricopa County Department of Transportation storage lot and is surrounded by a combination of heavy industry and residential homes. The main purposes of the site are to measure maximum concentration PM_{10} and to determine the impact on ambient pollution levels of significant sources or source categories. The sources around the site include sand and gravel operations, auto- and metal-recycling facilities, landfills, paved and unpaved haul roads, and cement casting operations. This site also monitors the meteorological parameters of barometric pressure, ambient temperature, temperature difference (temperature inversion), and wind speed and direction.

West Indian School Rd (WI, AQS# 04-013-0016) <u>Site Closed June 2010</u>

Figure 2.27. Map showing the location of the West Indian School Rd. monitoring site (center), with circle representing the 100 m radius of the "microscale" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1980	Micro (< 100 m)	Maximum concentration

Site Description: This site was located at the City of Phoenix Firefighter Training Center. This site was opened in December 1980 and was used to monitor micro-scale maximum concentrations based on high vehicular traffic. The Average Weekday Traffic (AWT) volume past this location on Indian School Road was estimated to be approximately 55,000 vehicles/day. The site is also in close proximity to Grand Ave. and 35th Ave., which have AWT volumes of about 35,000 vehicles/day. This site was closed in June 2010 after the City of Phoenix sold the building. The data collected at this site were very similar to that collected at the nearby West Phoenix site, a neighborhood-scale site less than two kilometers away. This implies that this micro-scale site was no longer necessary as this area is adequately represented by the neighborhood scale site.

West Phoenix (WP, AQS# 04-013-0019)

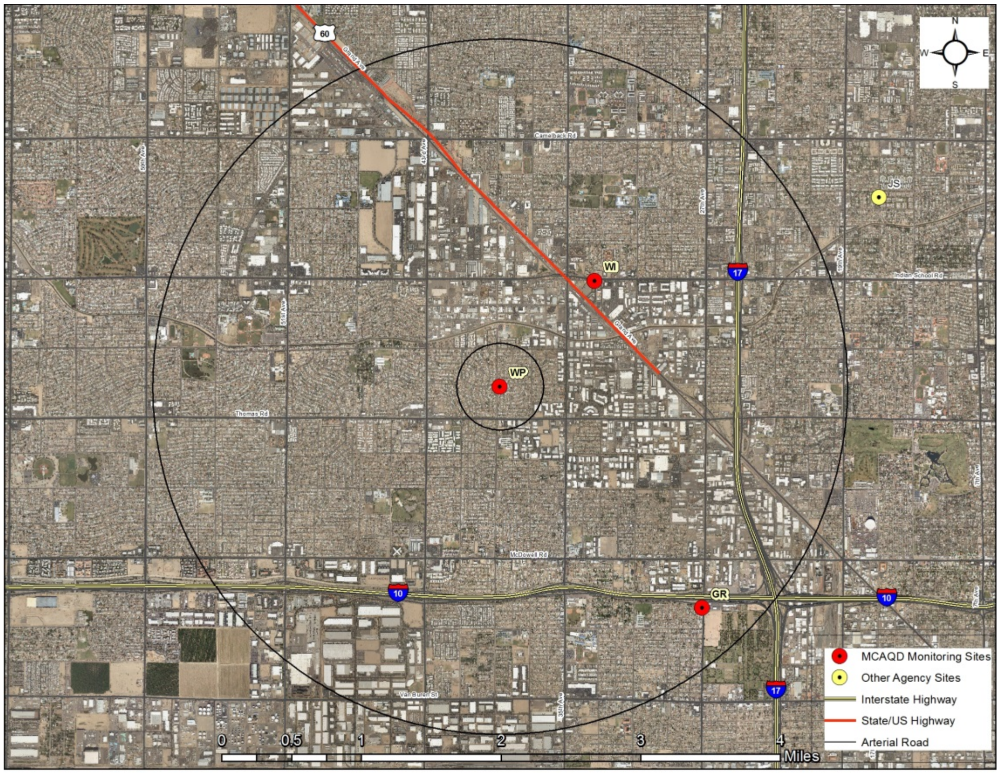

Figure 2.28. Map showing the location of the West Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1984	Neighborhood (0.5–4 km)	Population exposure
NO_2	1990	Neighborhood (0.5–4 km)	Population exposure
O_3	1984	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	1988	Neighborhood (0.5–4 km)	Population exposure
$PM_{2.5}$	2000	Neighborhood (0.5–4 km)	Highest concentration

Site Description: This site, which is located in a City of Phoenix groundwater well enclosure, became operational in 1984. It is located in an area of stable, high-density residential population. CO, , NO_2, O_3, PM_{10}, and $PM_{2.5}$ are monitored at this site. This site also monitors the meteorological parameters of barometric pressure, ambient temperature, temperature difference (temperature inversion), and wind speed and direction.

Zuni Hills (ZH, AQS# 04-013-4016)

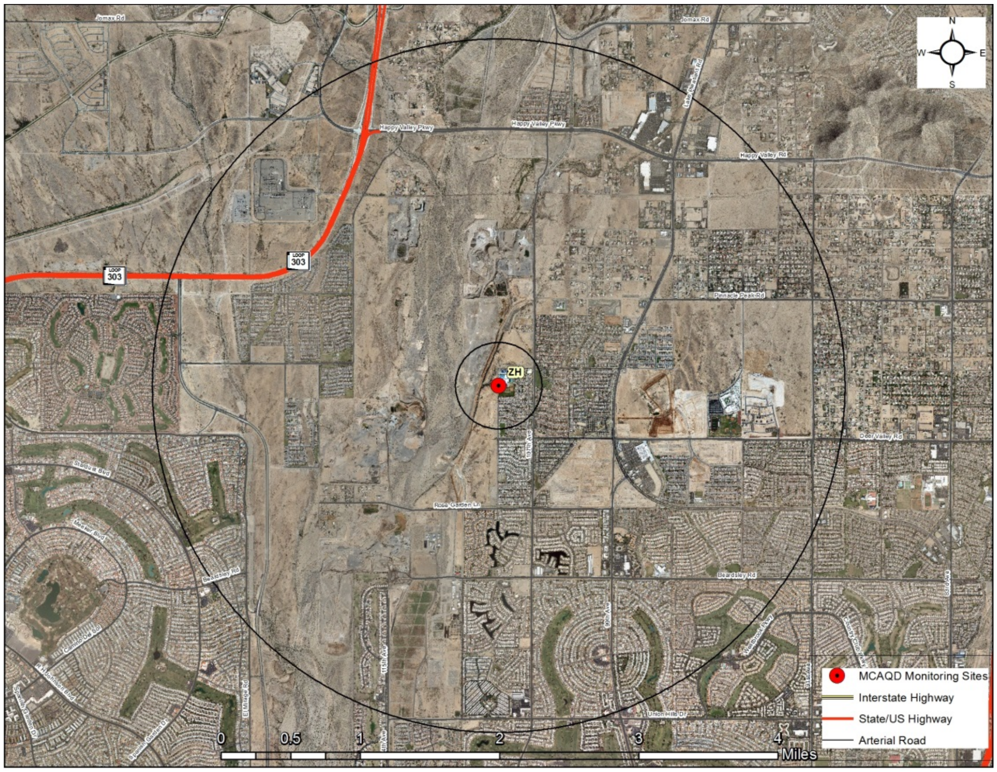

Figure 2.29. Map showing the location of the Zuni Hills monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
PM_{10}	2009	Neighborhood (0.5–4 km)	Population exposure

Site Description: This site was opened in December 2009 as a replacement for the now-closed Coyote Lakes site (AQS #04-013-4014) and is located on the campus of the Zuni Hills elementary school, which is approximately 2.7 km to the northeast from the old Coyote Lakes monitor. The Coyote Lakes monitor was a special purpose middle-scale PM_{10} monitor with a source-oriented objective; the sources being sand & gravel mining operations in the area of the Agua Fria riverbed. The Zuni Hills site, in contrast, has an objective of measuring air quality in an area of higher population density and at a scale of neighborhood dimensions. In addition to PM_{10}, this site also monitors the meteorological parameters of ambient temperature and wind speed and direction.

Section 3: Monitor-to-Monitor Comparisons

In this section the existing MCAQD monitoring network is assessed, and monitor-to-monitor comparisons are conducted using a series of indicators and analyses. These comparisons rank each air quality monitor against each other to determine its comparative value. Finally, each indicator is assigned a weight and the monitoring network is ranked by the weighted averages. These rankings are then used for subsequent analyses, including comparing the value of a monitor to specific criteria, evaluating a monitor's objective, and identifying monitors of lesser utility that can potentially be terminated. Indicators are chosen to represent pertinent topics, e.g. economic cost-effectiveness, correlation and redundancies, proximity to population and sources, suitability for pollution modeling, and actual pollutant concentrations monitored. The objective of having these different, often competing, indicators is to provide a comprehensive evaluation technique; weighting factors are used to emphasize particularly important indicators. Table 3.0.1 below lists the indicators used; this list includes several indicators that were adapted from an EPA guidance document[1] as well as those developed independently by the author (the Predicted Ozone, Traffic Counts, and Environmental Justice—Minority Population Served Indicators).

Table 3.0.1. *List of indicators used in Section 3 of this assessment.*

#	Indicator
1	Number of Parameters Monitored
2	Trends Impact
3	Measured Concentrations
4	Deviation from the NAAQS
5	Area Served
6	Population Served
7	Monitor-to-Monitor Correlation
8	Removal Bias
9a	Emissions Inventory
9b (for O_3 only)	Predicted Ozone
10	Traffic Counts
11	Environmental Justice-Minority Population Served

1 Raffuse, S. M., Sullivan, D. C., McCarthy, M. C., Penfold, B. M. & Hafner, H. R. (2007) Ambient Air Monitoring Network Assessment Guidance: Analytical Techniques for Technical Assessments of Ambient Air Monitoring Networks. U.S. Environmental Protection Agency, Research Triangle Park, NC.

3.1 Analysis #1: Number of Parameters Monitored

The first analysis to be performed is a simple measure of the number of parameters that are monitored at each site. This analysis counts parameters that MCAQD enters into AQS, i.e. criteria pollutant concentrations, wind speed, wind direction and temperature difference. It does not include ancillary parameters, e.g. pressure, temperature, or PM volatiles on the $PM_{2.5}$ monitors, since these are dependent on the parent parameter. Sites with the most parameters monitored are ranked highest; sites with the same number of parameters monitored are ranked equally.

While criteria pollutants are the primary focus of this analysis, wind speed and direction, and temperature difference parameters are also included because these data are valuable in modeling exercises, and thus are entered into the AQS database. Note that many of these sites also record other meteorological parameters such as temperature, barometric pressure, and relative humidity, but these have not been included in this analysis.

The value from this analysis derives from the benefits of having multiple parameters measured at the same site. First, collocated measurements of several pollutants can be used in model evaluation, source apportionment, and emission inventory reconciliation. Second, a single site with multiple pollutants measured is more cost-effective than having multiple single pollutant sites.

This single analysis naturally applies to all pollutant parameters, i.e., CO, O_3, NO_2, particulates (both PM_{10} and $PM_{2.5}$), and SO_2, and will be weighed against all of them in the final evaluation. A disadvantage of this analysis is that it does not differentiate between different pollutant types and the relative importance of each; e.g. it gives the same weight to PM_{10} as SO_2, although PM_{10} is of much more concern within Maricopa County.

Note that this analysis is the primary method of judging a site's economic value.

3.1.1 Results for All Parameters

Table 3.1.1. *All MCAQD CO monitoring sites, ranked by number of parameters monitored.*

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
West Phoenix	04-013-0019	WP	7	4
Central Phoenix	04-013-3002	CP	6	3
Tempe	04-013-4005	TE	6	3
South Scottsdale	04-013-3003	SS	5	2
Buckeye	04-013-4011	BE	5	2
North Phoenix	04-013-1004	NP	5	2
South Phoenix	04-013-4003	SP	5	2
Glendale	04-013-2001	GL	5	2
Mesa	04-013-1003	ME	5	2
Dysart	04-013-4010	DY	4	1
Greenwood	04-013-3010	GR	4	1
West Chandler	04-013-4004	WC	4	1
Diablo	04-013-4019	DI	4	1
West Indian School Rd	04-013-0016	WI	Site closed June 2010	

Table 3.1.2. *All MCAQD NO_2 monitoring sites, ranked by number of parameters monitored.*

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
West Phoenix	04-013-0019	WP	7	4
Central Phoenix	04-013-3002	CP	6	3
Buckeye	04-013-4011	BE	5	2
Greenwood	04-013-3010	GR	4	1
Diablo	04-013-4019	DI	4	1
South Scottsdale	04-013-3003	SS	NO_2 closed June 2011	

Table 3.1.3. *All MCAQD O_3 monitoring sites, ranked by number of parameters monitored.*

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
West Phoenix	04-013-0019	WP	7	6
Central Phoenix	04-013-3002	CP	6	5
North Phoenix	04-013-1004	NP	6	5
Tempe	04-013-4005	TE	6	5
South Scottsdale	04-013-3003	SS	5	4
South Phoenix	04-013-4003	SP	5	4
Buckeye	04-013-4011	BE	5	4
Glendale	04-013-2001	GL	5	4
Mesa	04-013-1003	ME	5	4
West Chandler	04-013-4004	WC	4	3
Dysart	04-013-4010	DY	4	3
Pinnacle Peak	04-013-2005	PP	2	2
Falcon Field	04-013-1010	FF	2	2
Blue Point	04-013-9702	BP	2	2
Fountain Hills	04-013-9704	FH	2	2
Cave Creek	04-013-4008	CC	2	2
Humboldt Mountain	04-013-9508	HM	1	1
Rio Verde	04-013-9706	RV	1	1

Table 3.1.4. *All MCAQD PM_{10} monitoring sites, ranked by number of parameters monitored.*

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
West Phoenix	04-013-0019	WP	7	6
Central Phoenix	04-013-3002	CP	6	5
North Phoenix	04-013-1004	NP	6	5
Tempe	04-013-4005	TE	6	5
South Scottsdale	04-013-3003	SS	5	4
Buckeye	04-013-4011	BE	5	4
Glendale	04-013-2001	GL	5	4
South Phoenix	04-013-4003	SP	5	4
Mesa	04-013-1003	ME	5	4
Dysart	04-013-4010	DY	4	3
Greenwood	04-013-3010	GR	4	3
West Chandler	04-013-4004	WC	4	3
Durango Complex	04-013-9812	DC	4	3
Higley	04-013-4006	HI	3	2
West 43rd Avenue	04-013-4009	WF	3	2
Zuni Hills	04-013-4016	ZH	2	1

Table 3.1.5. *All MCAQD $PM_{2.5}$ monitoring sites, ranked by number of parameters monitored.*

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
West Phoenix	04-013-0019	WP	7	4
North Phoenix	04-03-1004	NP	6	3
Tempe	04-013-4005	TE	6	3
South Phoenix	04-013-4003	SP	5	2
Mesa	04-013-1003	ME	5	2
Glendale	04-013-2001	GL	5	2
Durango Complex	04-013-9812	DC	4	1
Diablo	04-03-4019	DI	4	1

Table 3.1.6. *All MCAQD SO_2 monitoring sites, ranked by number of parameters monitored.*

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
Central Phoenix	04-013-3002	CP	6	2
Durango Complex	04-013-9812	DC	4	1
South Scottsdale	04-013-3003	SS	SO_2 closed Dec 2010	

3.2 Analysis #2: Trends Impact

Analysis #2 is based on the historical monitoring record of the site, i.e., the length of time for which the site or monitor has been in operation. Monitors that have a long historical record are valuable for tracking trends; continuation of that long unbroken monitoring record is desirable in the network. Therefore, those monitors with the longest unbroken historical monitoring record score the highest.

This analysis simply considers how many years a monitor has been operating continuously. Note that if a monitor had alternating periods of operation other than seasonal, then only the most recent operating period is considered. Seasonal monitors, i.e., those CO and previously O_3 monitors designated to operate only during their respective seasons, are counted as if they were in continual operation.

Note that two sites, South Phoenix and West Chandler, have been relocated at some point in their history, and their AQS numbers changed due to the distance from the original site. These relocations were required by changes in the original host locations, and the new locations were chosen to represent the original location as closely as possible.

A drawback to this analysis is that it does not take into account any changes in other variables that may affect the area of the monitoring site, such as population density or emission source mix.

3.2.1 Results for All Parameters

Table 3.2.1. *All MCAQD CO monitoring sites, ranked by length of monitoring record.*

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2014)	Score
Central Phoenix	CP	48	9
Glendale	GL	40	8
North Phoenix	NP	40	8
South Phoenix	SP	40*	8
South Scottsdale	SS	40	8
Mesa	ME	36	7
West Phoenix	WP	30	6
Greenwood	GR	21	5
West Chandler	WC	21**	5
Tempe	TE	14	4
Dysart	DY	11	3
Buckeye	BE	10	2
Diablo	DI	1	1
West Indian School Rd	WI	Site Closed June 2010	-

* includes former South Phoenix AQS# 04-013-0013 site

** includes former West Chandler AQS# 04-013-3009 site

Table 3.2.2. *All MCAQD NO_2 monitoring sites, ranked by length of monitoring record.*

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2014)	Score
Central Phoenix	CP	47	5
West Phoenix	WP	24	4
Greenwood	GR	21	3
Buckeye	BE	10	2
Diablo	DI	1	1
South Scottsdale	SS	NO_2 closed Jun 2011	-

Table 3.2.3. *All MCAQD O_3 monitoring sites, ranked by length of monitoring record.*

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2014)	Score
Central Phoenix	CP	47	14
Glendale	GL	40	13
South Scottsdale	SS	40	13
North Phoenix	NP	39	12
South Phoenix	SP	39*	12
West Phoenix	WP	30	11
Pinnacle Peak	PP	26	10
Falcon Field	FF	25	9
Blue Point	BP	22	8
Humboldt Mountain	HM	22	8
West Chandler	WC	22**	8
Fountain Hills	FH	18	7
Rio Verde	RV	17	6
Tempe	TE	14	5
Cave Creek	CC	13	4
Dysart	DY	11	3
Buckeye	BE	10	2
Mesa	ME	2	1

* includes former South Phoenix 04-013-0013 site

** includes former West Chandler 04-013-3009 site

Table 3.2.4. *All MCAQD PM_{10} monitoring sites, ranked by length of monitoring record.*

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2014)	Score
Central Phoenix	CP	29	12
South Phoenix	SP	29*	12
Glendale	GL	27	11
South Scottsdale	SS	27	11
West Phoenix	WP	26	10
Mesa	ME	24	9
North Phoenix	NP	24	9
Greenwood	GR	21	8
West Chandler	WC	21**	8
Durango Complex	DC	15	7
Higley	HI	14	6
West 43rd Avenue	WF	12	5
Dysart	DY	11	4
Buckeye	BE	10	3
Zuni Hills	ZH	5	2
Tempe	TE	2	1

* includes former South Phoenix 04-013-0013 site

** includes former West Chandler 04-013-3009 site

Table 3.2.5. *All MCAQD $PM_{2.5}$ monitoring sites, ranked by length of monitoring record.*

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2014)	Score
West Phoenix	WP	14	6
Mesa	ME	9	5
South Phoenix	SP	9	5
Durango Complex	DC	4	4
Glendale	GL	3	3
North Phoenix	NP	3	3
Tempe	TE	2	2
Diablo	DI	1	1

*FRM: Federal Reference Method; FEM Federal Equivalence Method

Table 3.2.6. *All MCAQD SO_2 monitoring sites, ranked by length of monitoring record.*

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2014)	Score
Central Phoenix	CP	45	2
Durango Complex	DC	3	1
South Scottsdale	SS	SO_2 closed Dec 2010	-

3.3 Analysis #3: Measured Concentrations

This analysis ranks pollutant monitors based upon the concentrations recorded. The analysis uses the "design value" of each pollutant monitor operating at a site. The design value is generally the highest annual concentration recorded. Monitors with higher design values are ranked higher than those with lower design values.

The assumption of this analysis is that sites with the highest concentrations are more important for assessing NAAQS compliance, population exposure, and performing model evaluations. A drawback of this analysis is that it does not consider any kind of monitor siting issues; a monitor might not measure maximum concentrations if it has not been sited optimally. Additionally, since this analysis focuses only on those monitors with high concentrations (often urban monitors 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.

3.3.1 Results for All Parameters

Table 3.3.1. *MCAQD CO monitoring sites, ranked by highest design value.*

MCAQD Site Name	Design Value (Max 1-hour concentration, in ppm)						Score
	2010	2011	2012	2013	2014	Average	
West Phoenix	4.3	4.4	4.8	4.6	5	4.62	12
South Phoenix	4.4	3	3.5	3.5	3.7	3.62	11
Greenwood	4.3	3	4.3	3.3	2.9	3.56	10
Central Phoenix	3.2	3.8	3.3	2.8	3.6	3.34	9
Glendale	9	1.9	1.9	1.9	1.9	3.32	8
Tempe	3.4	3.6	2.1	2.2	1.9	2.64	7
North Phoenix	2.9	2.9	1.9	2.3	1.7	2.34	6
Mesa	2	1.9	2.1	1.8	1.9	1.94	5
West Chandler	2	1.8	1.9	2.1	1.9	1.94	4
South Scottsdale	2.1	1.8	2.1	1.8	1.7	1.90	3
Dysart	2	1	1.4	1.2	1.2	1.36	2
Buckeye	1.9	1.8	0.9	0.9	1	1.30	1
Diablo*	-	-	-	-	1.5	1.50	-
West Indian School Rd.*	3.7	-	-	-	-	3.70	-

*Not included in analysis due to limited operating time

Table 3.3.2. *MCAQD NO_2 monitoring sites, ranked by highest design value.*

MCAQD Site Name	Design Value (Annual 98th Percentile, in ppb)						Score
	2010	2011	2012	2013	2014	Average	
Greenwood	70.0	68.0	66.0	64.0	64.0	66.40	4
Central Phoenix	64.0	62.0	61.0	61.0	61.0	61.80	3
West Phoenix	57.0	55.0	56.0	56.0	57.0	56.20	2
Buckeye	38.0	36.0	37.0	37.0	36.0	36.80	1
Diablo*	-	-	-	-	59.0	59.00	-
South Scottsdale*	54.0	53.0	-	-	-	53.50	-

*Not included in analysis due to limited operating time

Table 3.3.3. *MCAQD O_3 monitoring sites, ranked by highest design value.*

MCAQD Site Name	Design Value (3-Year Average of Fourth High, in ppb)						Score
	2010	2011	2012	2013	2014	Average	
North Phoenix	77	77	81	81	80	79.20	15
West Phoenix	73	73	78	79	78	76.20	14
Pinnacle Peak	73	74	77	77	78	75.80	13
Cave Creek	74	75	78	77	74	75.60	12
South Scottsdale	74	74	77	76	75	75.20	11
South Phoenix	72	72	76	76	75	74.20	10
Glendale	72	72	76	76	74	74.00	9
Blue Point	70	72	75	77	75	73.80	8
Humboldt Mountain	71	71	75	76	75	73.60	8
Fountain Hills	74	73	76	74	71	73.60	7
Rio Verde	72	73	74	75	72	73.20	6
Central Phoenix	71	71	74	75	74	73.00	5
West Chandler	72	72	74	72	71	72.20	4
Falcon Field	70	68	69	72	74	70.60	4
Dysart	68	70	71	72	72	70.60	3
Tempe	71	68	70	71	71	70.20	2
Buckeye	64	64	66	65	62	64.20	1
Mesa	-	-	-	*	*	*	-

*Insufficient data to calculate

Table 3.3.4. *MCAQD PM_{10} monitoring sites, ranked by highest design value after exceptional events were excluded from these values. Note that the actual design value is the annual number of expected exceedances, but as these design values are often zero and are not easily analyzed, this was substituted with the cardinal maximum daily value.*

MCAQD Site Name	Design Value (Maximum 24-hour average, in µg/m^3)						Score
	2010	2011	2012	2013	2014	Average	
West Chandler	76	126	402	144	146	178.8	16
Buckeye	113	151	205	112	175	151.2	15
Greenwood	158	148	145	119	125	139.0	14
West 43rd	112	150	174	121	121	135.6	13
Higley	83	152	136	143	137	130.2	12
South Phoenix	120	168	134	118	109	129.8	11
West Phoenix	86	139	148	114	148	127.0	10
Central Phoenix	106	144	117	114	135	123.2	9
Durango Complex	111	151	124	110	107	120.6	8
Dysart	81	136	127	147	90	116.2	7
North Phoenix	44	132	140	153	107	115.2	6
Tempe			107	146	88	113.7	5
Glendale	92	141	136	90	86	109.0	4
Zuni Hills	70	147	147	80	86	106.0	3
Mesa	86	127	64	151	101	105.8	2
South Scottsdale	37	119	102	142	98	99.6	1

Table 3.3.5. *MCAQD $PM_{2.5}$ monitoring sites, ranked by highest design value.*

MCAQD Site Name	Design value (3-Yr Avg 98th Percentile, in µg/m^3)						Score
	2010	2011	2012	2013	2014	Average	
West Phoenix	25	27	26	28	28	26.8	7
Durango Complex	24	28	27	28	25	26.4	6
South Phoenix	27	29	24	25	24	25.8	5
Glendale	-	28	23	21	18	22.5	4
North Phoenix	-	23	22	20	20	21.3	3
Tempe	-	-	20	19	18	19.0	2
Mesa	15	16	16	16	16	15.8	1
Diablo*	-	-	-	-	21	21.0	-

*Not included in analysis due to limited operating time

Table 3.3.6. *MCAQD SO_2 monitoring sites, ranked by highest design value.*

MCAQD Site Name	Design Value (3-Yr Avg 1-hour 99th Percentile, in ppb)						Score
	2010	2011	2012	2013	2014	Average	
Durango Complex	-	8.0	9.0	9.0	9.0	8.75	2
Central Phoenix	9.0	9.0	9.0	8.0	8.0	8.60	1
South Scottsdale*	7.0	-	-	-	-	7.00	-

*Not included in analysis due to limited operating time

3.4 Analysis #4: Deviation from the National Ambient Air Quality Standards

This analysis, like the Measured Concentration analysis, also uses the design value from each monitor. Unlike the previous analysis, however, this technique uses the absolute value between the design value and the NAAQS. Monitors whose design values are closest to the standard, either below or above, are given the highest rank.

The objective of this technique is to give weight to sites that are closest to the NAAQS, thus considering them to be more important for determining NAAQS compliance. Sites close to the standard are important because they could more easily influence compliance either way. The disadvantage to this technique is that it uses a narrow focus that does not consider the importance of having a monitor in a highly polluted area with concentrations well above the NAAQS, or having a monitor measuring background concentrations well below the NAAQS.

3.4.1 Results for All Parameters

Table 3.4.1. *List of MCAQD CO monitoring sites, ranked by deviation from the NAAQS.*

MCAQD Site Name	Design Value (Maximum 1-hour average, in ppm)								Score
	2010	2011	2012	2013	2014	Average	NAAQS	Deviance	
West Phoenix	4.3	4.4	4.8	4.6	5	4.62	35	-30.38	11
South Phoenix	4.4	3	3.5	3.5	3.7	3.62	35	-31.38	10
Greenwood	4.3	3	4.3	3.3	2.9	3.56	35	-31.44	9
Central Phoenix	3.2	3.8	3.3	2.8	3.6	3.34	35	-31.66	8
Glendale	9	1.9	1.9	1.9	1.9	3.32	35	-31.68	7
Tempe	3.4	3.6	2.1	2.2	1.9	2.64	35	-32.36	6
North Phoenix	2.9	2.9	1.9	2.3	1.7	2.34	35	-32.66	5
Mesa	2	1.9	2.1	1.8	1.9	1.94	35	-33.06	4
West Chandler	2	1.8	1.9	2.1	1.9	1.94	35	-33.06	4
South Scottsdale	2.1	1.8	2.1	1.8	1.7	1.90	35	-33.10	3
Dysart	2	1	1.4	1.2	1.2	1.36	35	-33.64	2
Buckeye	1.9	1.8	0.9	0.9	1	1.30	35	-33.70	1
Diablo*					1.5	1.50	35	-33.50	-
West Indian School Rd*	3.7					3.70	35	-31.30	-

*Not included in analysis due to limited operating time

Table 3.4.2. *List of MCAQD NO_2 monitoring sites, ranked by deviation from the NAAQS.*

MCAQD Site Name	Design Value (Annual average concentration, in ppm)								Score
	2010	2011	2012	2013	2014	Average	NAAQS	Deviance	
Greenwood	24.5	25.4	26.0	24.6	24.6	25.00	53	-28.00	4
Central Phoenix	18.8	19.8	21.2	19.7	19.4	19.79	53	-33.21	3
West Phoenix	17.7	18.0	19.4	18.0	18.0	18.20	53	-34.80	2
Buckeye	7.7	8.8	9.4	8.4	8.7	8.58	53	-44.42	1
Diablo*					20.9	20.85	53	-32.15	-
South Scottsdale*	13.9	15.5				14.72	53	-38.28	-

*Not included in analysis due to limited operating time

Table 3.4.3. *List of MCAQD O_3 monitoring sites, ranked by deviation from the NAAQS.*

MCAQD Site Name	Design Value (3-Year Average of Fourth High, in ppm)								Score
	2010	2011	2012	2013	2014	Average	NAAQS	Deviance	
South Scottsdale	74	74	77	76	75	75.2	75	0.20	13
Cave Creek	74	75	78	77	74	75.6	75	0.60	12
South Phoenix	72	72	76	76	75	74.2	75	-0.80	11
Pinnacle Peak	73	74	77	77	78	75.8	75	0.80	11
Glendale	72	72	76	76	74	74.0	75	-1.00	10
Blue Point	70	72	75	77	75	73.8	75	-1.20	9
West Phoenix	73	73	78	79	78	76.2	75	1.20	9
Humboldt	71	71	75	76	75	73.6	75	-1.40	8
Fountain Hills	74	73	76	74	71	73.6	75	-1.40	8
Rio Verde	72	73	74	75	72	73.2	75	-1.80	7
Central Phoenix	71	71	74	75	74	73.0	75	-2.00	6
West Chandler	72	72	74	72	71	72.2	75	-2.80	5
North Phoenix	77	77	81	81	80	79.2	75	4.20	4
Falcon Field	70	68	69	72	74	70.6	75	-4.40	3
Dysart	68	70	71	72	72	70.6	75	-4.40	3
Tempe	71	68	70	71	71	70.2	75	-4.80	2
Buckeye	64	64	66	65	62	64.2	75	-10.80	1
Mesa			*	*	*	*	75		

*Insufficient data to calculate

Table 3.4.4. *List of MCAQD PM_{10} monitoring sites, ranked by deviation from the NAAQS.*

MCAQD Site Name	Design Value (Maximum 24-hour average, in $\mu g/m^3$)								Score
	2010	2011	2012	2013	2014	Average	NAAQS	Deviance	
Buckeye	113	151	205	112	175	151.2	150	1.20	16
Greenwood	158	148	145	119	125	139.0	150	-11.00	15
West 43rd	112	150	174	121	121	135.6	150	-14.40	14
Higley	83	152	136	143	137	130.2	150	-19.80	13
South Phoenix	120	168	134	118	109	129.8	150	-20.20	12
West Phoenix	86	139	148	114	148	127.0	150	-23.00	11
Central Phoenix	106	144	117	114	135	123.2	150	-26.80	10
West Chandler	76	126	402	144	146	178.8	150	28.80	9
Durango Complex	111	151	124	110	107	120.6	150	-29.40	8
Dysart	81	136	127	147	90	116.2	150	-33.80	7
North Phoenix	44	132	140	153	107	115.2	150	-34.80	6
Tempe			107	146	88	113.7	150	-36.33	5
Glendale	92	141	136	90	86	109.0	150	-41.00	4
Zuni Hills	70	147	147	80	86	106.0	150	-44.00	3
Mesa	86	127	64	151	101	105.8	150	-44.20	2
South Scottsdale	37	119	102	142	98	99.6	150	-50.40	1

Table 3.4.5. *List of MCAQD $PM_{2.5}$ monitoring sites, ranked by deviation from the NAAQS.*

MCAQD Site Name	Design value (3-year average, 98th percentile, in µg/m^3)								Score
	2010	2011	2012	2013	2014	Average	NAAQS	Deviance	
West Phoenix	25	27	26	28	28	26.8	35.0	-8.20	7
Durango Complex	24	28	27	28	25	26.4	35.0	-8.60	6
South Phoenix	27	29	24	25	24	25.8	35.0	-9.20	5
Glendale		28	23	21	18	22.5	35.0	-12.50	4
North Phoenix		23	22	20	20	21.3	35.0	-13.75	3
Tempe			20	19	18	19.0	35.0	-16.00	2
Mesa	15	16	16	16	16	15.8	35.0	-19.20	1
Diablo*					21	21.0	35.0	-14.00	

*Not included in analysis due to limited operating time

Table 3.4.6. *List of MCAQD SO_2 monitoring sites, ranked by deviation from the NAAQS.*

MCAQD Site Name	Design Value (3-Yr Avg 1-hour 99th Percentile, in ppb)								Score
	2010	2011	2012	2013	2014	Average	NAAQS	Deviance	
Durango Complex		8.0	9.0	9.0	9.0	8.75	75	-66.25	2
Central Phoenix	9.0	9.0	9.0	8.0	8.0	8.60	75	-66.40	1
South Scottsdale*	7.0					7.00	75	-68.00	

*Not included in analysis due to limited operating time

3.5 Analysis #5: Area Served

This test analyzes the spatial coverage of each monitor by using the technique of applying Thiessen proximity polygons that represent a monitor's geographic coverage area. This is a standard technique used in geography to assign a zone of influence around a point. Thiessen polygons are created by delineating those areas around the monitoring point that are closer than any other monitoring point[2]. Since the individual monitoring site under consideration houses the closest monitor(s) within its perspective Thiessen polygon, the monitor(s) is used to represent the entire area of the polygon. Larger Thiessen polygons (measured by km^2) will score higher because they serve larger areas and have been weighted accordingly.

The advantage of this technique is that it utilizes a simple method to give weight to a monitor's boundaries of influence. Monitors that are on the boundary of the urban area or in a rural area will tend to serve larger areas; and thus they will have a higher rank. These sites are valuable for interpolation purposes, determining background concentrations, and adding spatial coverage to a large metropolitan area. Also, removing these monitors from the network would give those areas less representation since there is more distance to the next nearest monitor.

Note that this technique is purely spatial in nature, and its major disadvantage is that it does not take into account meteorology, landscape topography, or proximity to pollution sources. Thus, an area within one polygon might, in reality, be better represented by another monitor. For instance, prevailing wind currents could push emission plumes away from the polygon's monitoring point. Another disadvantage is that the polygon might be so large that its monitoring point cannot adequately represent the outer edges of the area; however, that monitoring site *most closely* represents the area spatially.

To create an accurate analysis, monitoring sites from Gila, Pinal, Pima, Yavapai, and Yuma counties, as well as monitors from all the tribal agencies within these counties, were included in the creation of the Thiessen polygons. If possible, polygons and areas served are extended into these adjacent counties. If this is not possible, such as in the case of a lack of surrounding monitors in other counties, then the area reported has an outside boundary approximately 50% greater than the network boundary; this was the technique used to determine the area of the CO and NO_2 parameters. This analysis does not include sites that closed before 2014, though sites that began operating by 2014 are included.

[2] O'Sullivan, D. & Unwin, D. J. (2003) *Geographic Information Analysis.* John Wiley & Sons, Inc, Hoboken, New Jersey.

3.5.1 CO Parameter Details

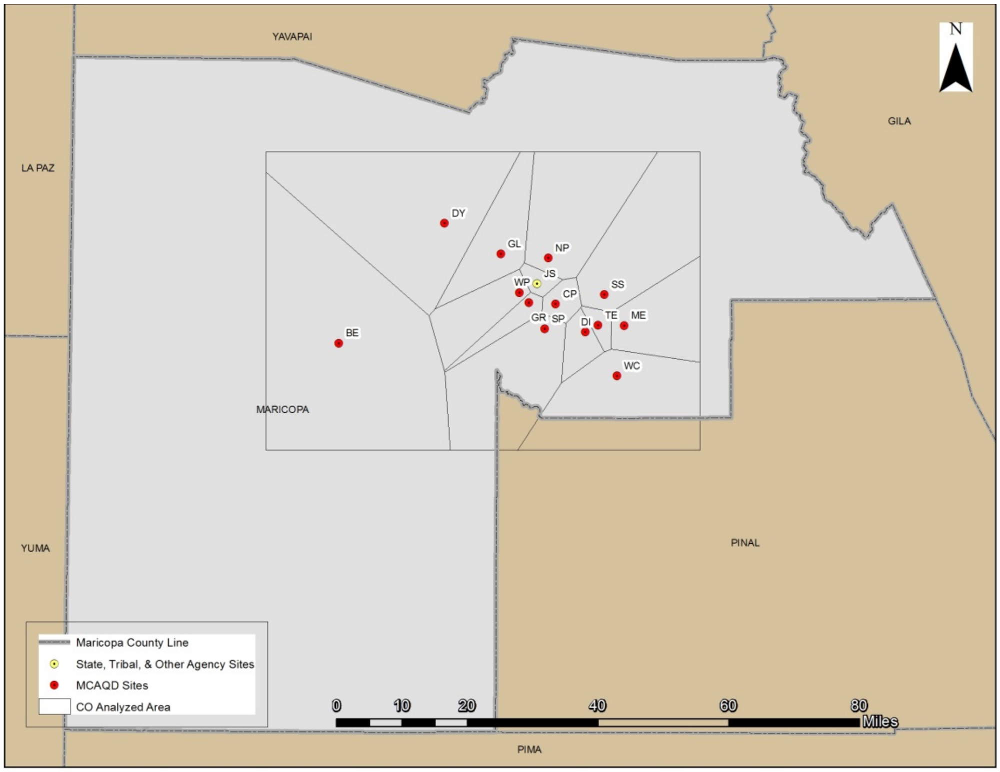

Figure 3.5.1. Thiessen polygons for CO monitoring sites. Note that outside of was calculated as an area approximately 50% greater than network boundary; i.e., the rectangular boundary of BE, DY, ME, and WC.

Table 3.5.1. *CO Monitoring Sites, Ranked by Area Served within Maricopa County.*

Site	AQS Identifier	Acronym	Area Served (km^2)	Score
Buckeye	04-013-4011	BE	2,152	13
Dysart	04-013-4010	DY	1,374	12
West Chandler	04-013-3003	WC	858	11
South Scottsdale	04-013-1003	SS	733	10
South Phoenix	04-013-1004	SP	698	9
North Phoenix	04-013-4004	NP	655	8
Mesa	04-013-4003	ME	386	7
Glendale	04-013-2001	GL	365	6
West Phoenix	04-013-0019	WP	270	5
Diablo	04-013-4019	DI	104	4
Greenwood	04-013-3010	GR	93	3
Central Phoenix	04-013-3002	CP	74	2
Tempe	04-013-4005	TE	48	1

3.5.2 NO_2 Parameter Details

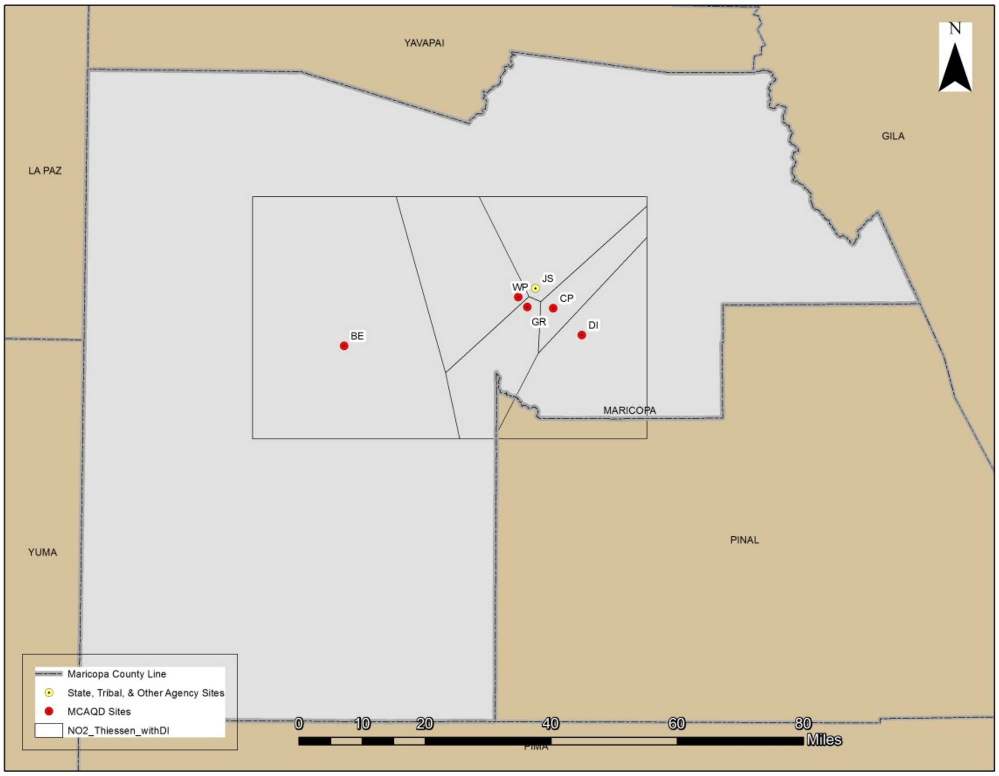

Figure 3.5.2. Thiessen polygons for NO2 monitoring sites. Note that outside of was calculated as an area approximately 50% greater than network boundary; i.e., the rectangular boundary of BE, JS, and DI.

Table 3.5.2. *NO_2 Monitoring Sites, Ranked by Area Served within Maricopa County.*

Maricopa County AQD Site	AQS Identifier	Acronym	Area Served (km^2)	Score
Buckeye	04-013-4011	BE	2,794	5
Diablo	04-13-4019	DI	1,139	4
West Phoenix	04-013-0019	WP	870	3
Greenwood	04-013-3010	GR	500	2
Central Phoenix	04-013-3002	CP	280	1

3.5.3 O_3 Parameter Details

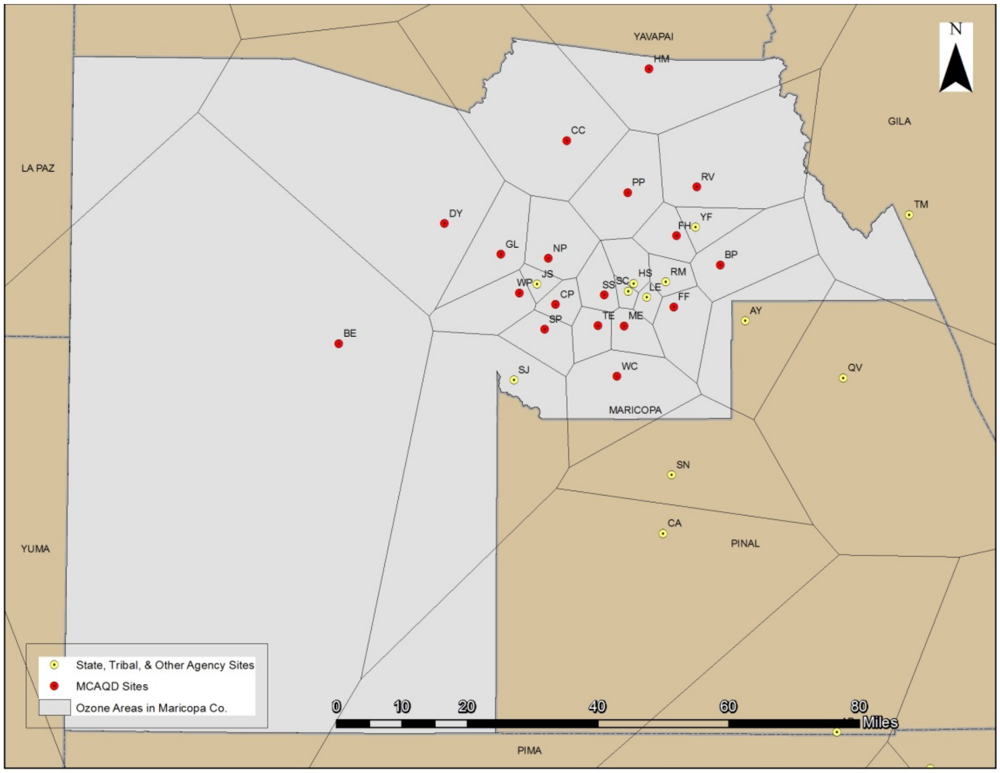

Figure 3.5.3. Thiessen polygons for O_3 monitoring sites.

Table 3.5.3. *O_3 Monitoring Sites, Ranked by Area Served within Maricopa County.*

Maricopa County AQD Site	AQS Identifier	Acronym	Area Served (km^2)	Score
Buckeye	04-013-4011	BE	15,705	18
Humboldt Mountain	04-013-9508	HM	7,770	17
Dysart	04-013-4010	DY	3,007	16
Cave Creek	04-013-4008	CC	1,620	15
Rio Verde	04-013-9706	RV	946	14
West Chandler	04-013-4004	WC	575	13
Blue Point	04-013-9702	BP	441	12
Pinnacle Peak	04-013-2005	PP	411	11
Glendale	04-013-2001	GL	318	10
North Phoenix	04-013-1004	NP	269	9
West Phoenix	04-013-0019	WP	250	8
Falcon Field	04-013-1010	FF	224	7
South Phoenix	04-013-4003	SP	168	6
Fountain Hills	04-013-9704	FH	136	5
South Scottsdale	04-013-3003	SS	117	4
Mesa	04-013-1003	ME	111	3
Tempe	04-013-4005	TE	108	2
Central Phoenix	04-013-3002	CP	83	1

3.5.4 PM_{10} Parameter Details

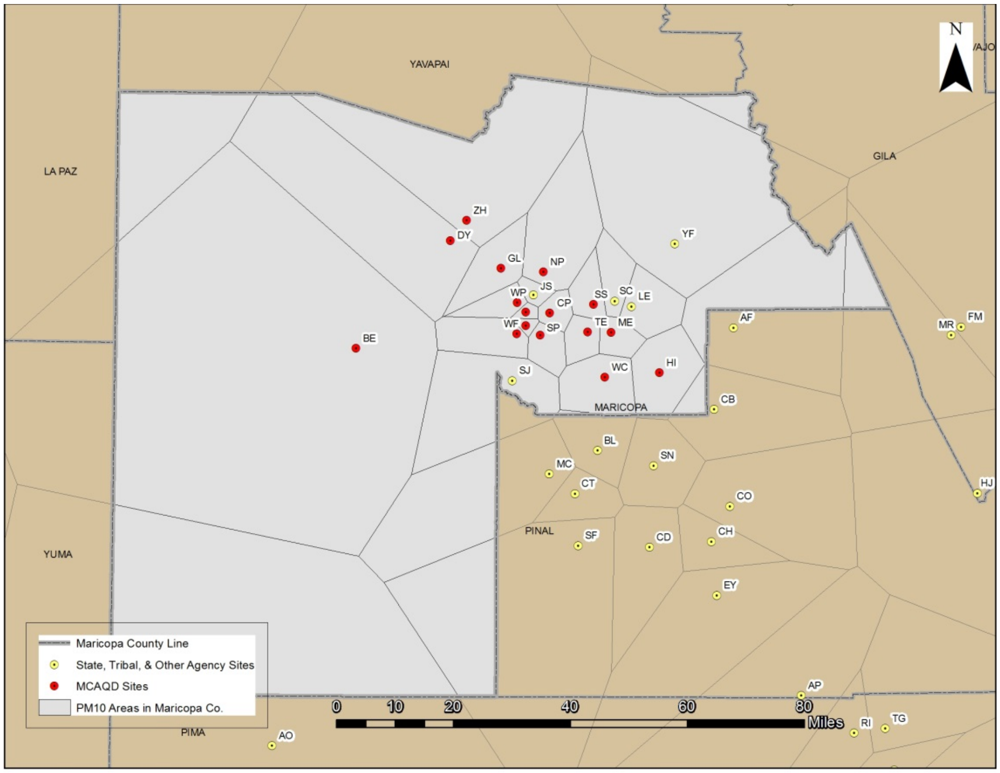

Figure 3.5.5. Thiessen polygons for PM_{10} sites.

Table 3.5.4. *PM_{10} Monitoring Sites, Ranked by Area Served within Maricopa County.*

Maricopa County AQD Site	AQS Identifier	Acronym	Area Served (km^2)	Score
Buckeye	04-013-4011	BE	9,091	16
Zuni Hills	04-013-4016	ZH	5,429	15
Dysart	04-013-4010	DY	1,659	14
North Phoenix	04-013-1004	NP	592	13
Higley	04-013-4006	HI	358	12
West Chandler	04-013-4004	WC	305	11
Glendale	04-013-2001	GL	270	10
West 43rd Ave	04-013-4009	WF	242	9
South Scottsdale	04-013-3003	SS	127	8
South Phoenix	04-013-4003	SP	116	7
West Phoenix	04-013-0019	WP	112	6
Tempe	04-013-4005	TE	108	5
Mesa	04-013-1003	ME	106	4
Central Phoenix	04-013-3002	CP	78	3
Greenwood	04-013-3010	GR	23	2
Durango Complex	04-013-9812	DC	21	1

3.5.5 $PM_{2.5}$ Parameter Details

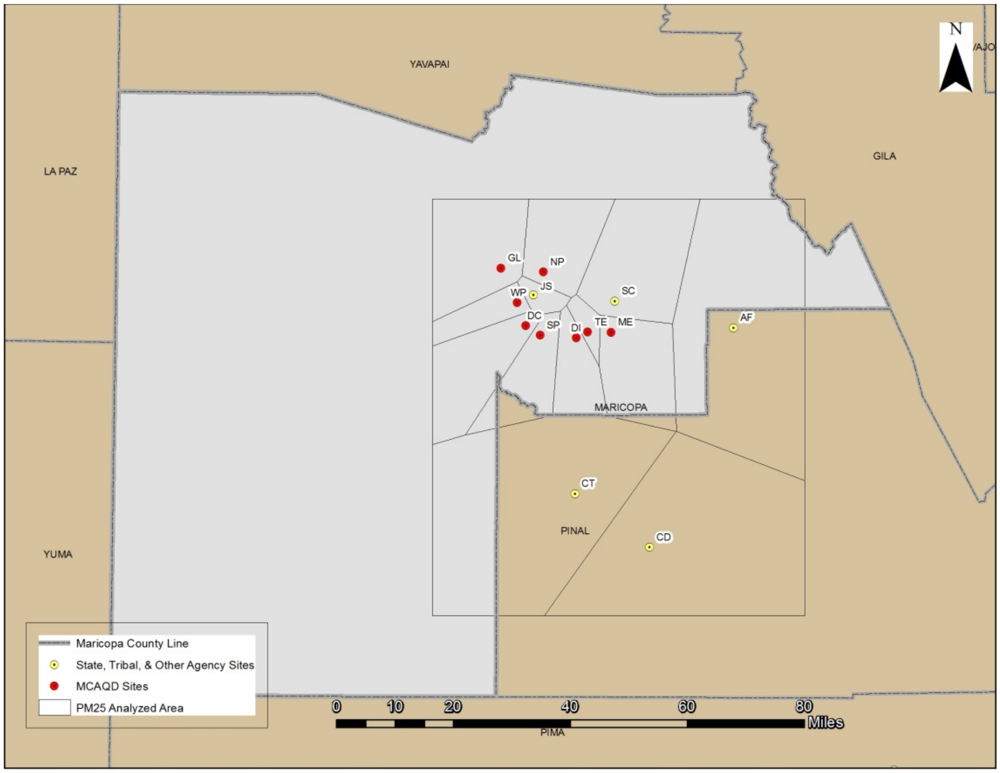

Figure 3.5.5. Thiessen polygons for $PM_{2.5}$ monitoring sites.

Table 3.5.5. *$PM_{2.5}$ Monitoring Sites, Ranked by Area Served within Maricopa County.*

Maricopa County AQD Site	AQS Identifier	Acronym	Area Served (km^2)	Score
Glendale	04-013-2001	GL	705	8
Mesa	04-013-1003	ME	572	7
Durango Complex	04-013-9812	DC	562	6
North Phoenix	04-013-1004	NP	484	5
South Phoenix	04-013-4003	SP	407	4
Diablo	04-013-4019	DI	293	3
West Phoenix	04-013-0019	WP	205	2
Tempe	04-013-4005	TE	84	1

3.5.6 SO_2 Parameter Details

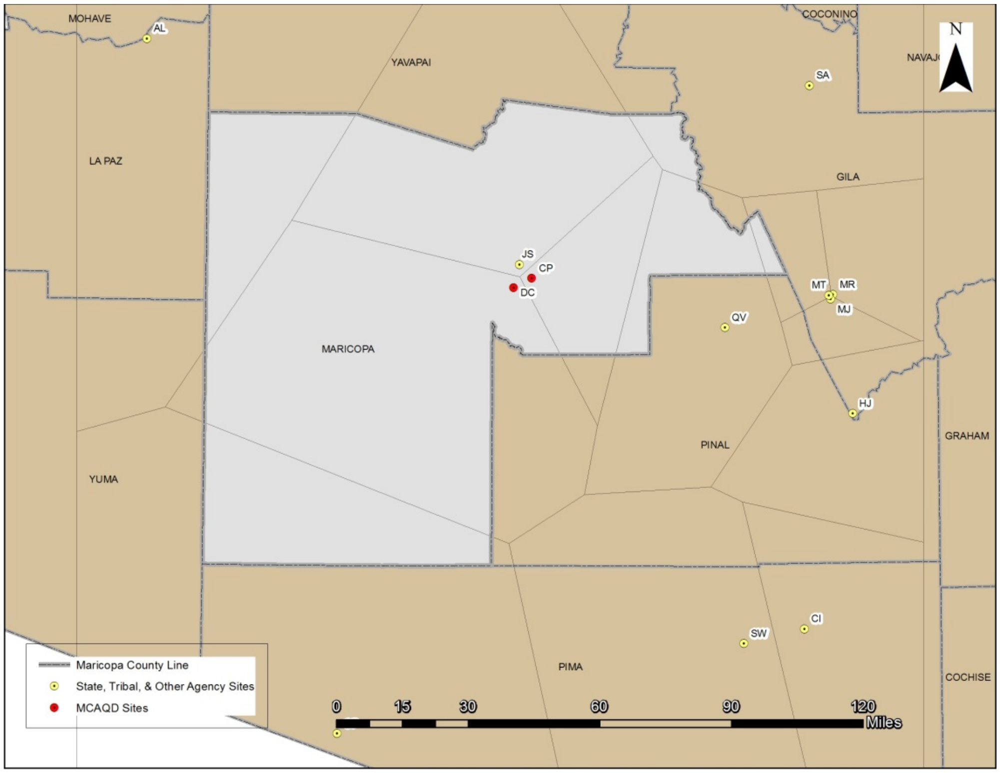

Figure 3.5.7. Thiessen polygons for SO_2 monitoring sites.

Table 3.5.6. *SO_2 Monitoring Sites, ranked by area served within Maricopa County.*

Maricopa County AQD Site	AQS Identifier	Acronym	Area Served (km^2)	Score
Durango Complex	04-013-9812	DC	11,423	2
Central Phoenix	04-013-3002	CP	21,82	1

3.6 Analysis #6: Population Served

This analysis attempts to gauge the impact of population on each monitoring site. Since areas of high population will generally have higher emissions, monitors representing more population will be of greater importance. Also, representing the air quality for the greatest number of people is critical; so monitors with the highest population counts are given the greatest rank.

This method also relies on the Thiessen polygon technique to determine each monitor's area of representation (see Analysis #5: Area Served for more details on Thiessen polygons). Thiessen polygons were created for each monitoring site and organized by pollutant parameter. Data from the 2010 Census were then used within a Geographic Information System (GIS) to create a polygon coverage map of census blocks within Maricopa County. The census block polygons were converted to centroid points which contain the population count information. The population within each monitor's Thiessen polygon was determined by summing those census block group centroids that were spatially located within the polygon.

The advantage of this analysis is that by using Thiessen polygons it provides a simple technique to quantify the population represented by a particular monitor. This technique will provide more weight to sites that have a high surrounding population and a large geographic area of representation. Note that in the case of large areas of representation, a population far away from the monitoring site might not necessarily be adequately represented by that monitoring site. However, they are closest to their perspective monitoring site, so this technique assumes that monitoring site is most important for representing them.

The disadvantage of this technique is the same as in the Area Served analysis; i.e. this technique is purely spatial in its construction and does not consider meteorology, topography, location of sources, etc.

The 2010 Census blocks that were used in the analysis cover the Maricopa County metropolitan area, and include parts of adjacent counties. Where applicable, the census block groups from these surrounding counties were used in calculating the population served. Note that the CO, NO_2, and $PM_{2.5}$ analysis area is limited by the network size. In these cases the analysis was limited to an area 50% greater than the network boundaries. See Section 3.5, Area Served Analysis, for more details.

Figure 3.6.1 depicts population densities of the central Maricopa County metropolitan area, with a close-up of the Phoenix metropolitan area in Figure 3.6.2. The population density, or people per km^2, is based upon the 2010 Census block groups. Illustrations of Thiessen polygons for individual pollutant parameters are contained in Figures 3.5.1 through 3.5.7.

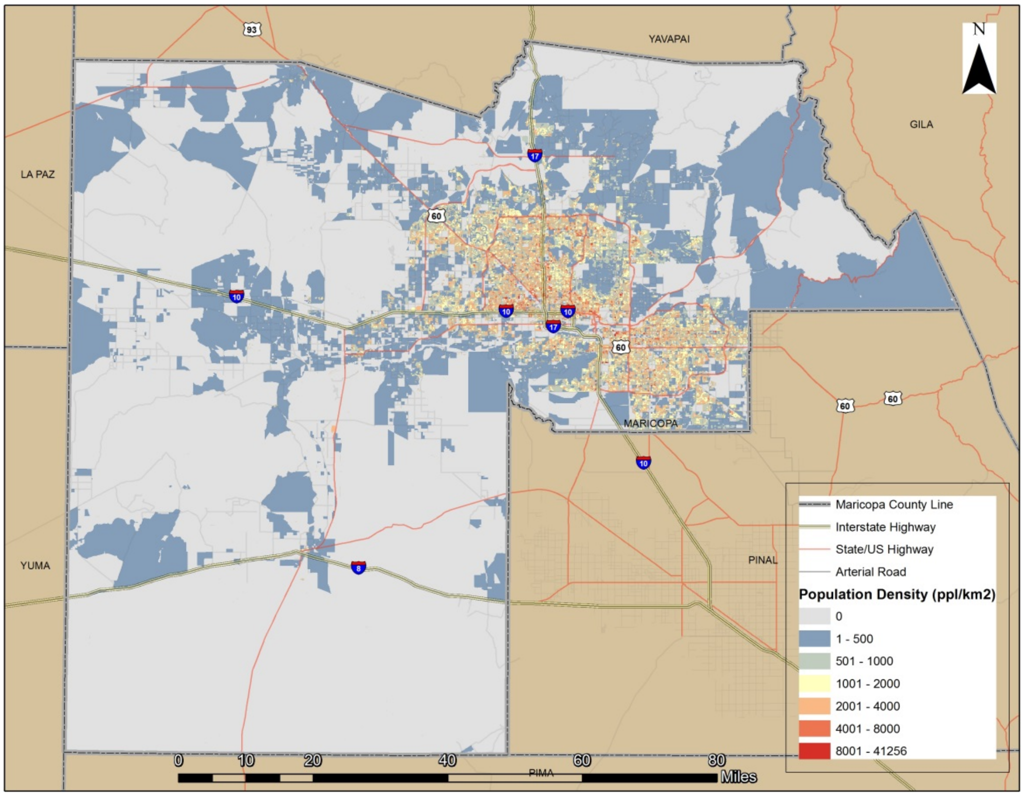

Figure 3.6.1. Maricopa County population density (2010 U.S. Census, #people/km^2).

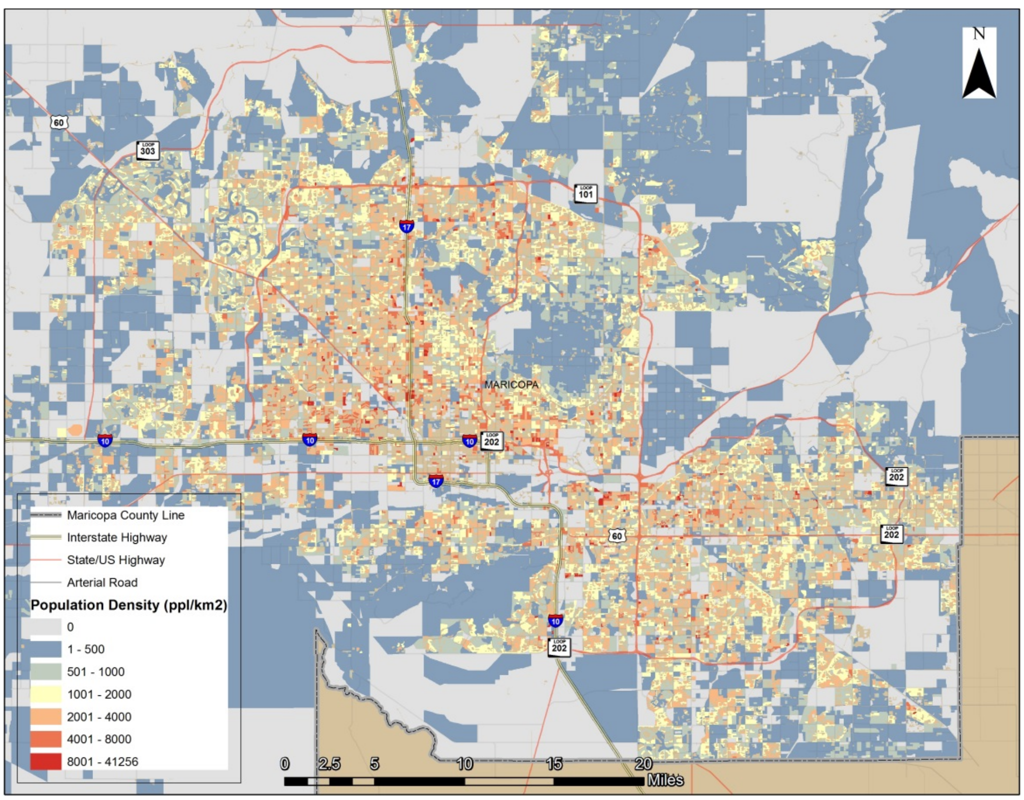

Figure 3.6.2. Maricopa County population density in the Phoenix metropolitan area urban core (2010 U.S. Census, #people/km^2).

3.6.1 CO Parameter Details

Table 3.6.1. *CO monitoring sites, ranked by population served.*

Maricopa County AQD Site	Acronym	Population Served	Score
Glendale	GL	510,613	13
North Phoenix	NP	480,147	12
Mesa	ME	467,941	11
West Chandler	WC	427,232	10
Dysart	DY	381,228	9
West Phoenix	WP	317,105	8
South Scottsdale	SS	251,796	7
South Phoenix	SP	154,784	6
Central Phoenix	CP	133,680	5
Diablo	DI	113,570	4
Buckeye	BE	98,527	3
Tempe	TE	85,264	2
Greenwood	GR	65,667	1

*Note: There were 215,350 people in Maricopa County who lived outside of the CO analysis area (see section 3.5.1 for analysis area).

3.6.2 NO_2 Parameter Details

Table 3.6.2. *NO_2 monitoring sites, ranked by population served.*

Maricopa County AQD Site	Acronym	Population Served	Score
West Phoenix	WP	911,729	5
Diablo	DI	833,650	4
Central Phoenix	CP	303,360	3
Greenwood	GR	132,796	2
Buckeye	BE	127,050	1

*Note: There were 739,851 people in Maricopa County who lived outside of the NO_2 analysis area (see section 3.5.2 for analysis area).

3.6.3 O_3 Parameter Details

Table 3.6.3. *O_3 monitoring sites, ranked by population served.*

Maricopa County AQD Site	Acronym	Population Served	Score
Glendale	GL	497,692	18
West Chandler	WC	411,382	17
Dysart	DY	391,317	16
North Phoenix	NP	369,874	15
West Phoenix	WP	348,785	14
Falcon Field	FF	259,988	13
Mesa	ME	207,579	12
Tempe	TE	159,324	11
South Phoenix	SP	154,025	10
Central Phoenix	CP	141,152	9
South Scottsdale	SS	126,692	8
Cave Creek	CC	117,340	7
Buckeye	BE	109,664	6
Pinnacle Peak	PP	109,218	5
Fountain Hills	FH	32,051	4
Humboldt Mountain	HM	29,049	3
Rio Verde	RV	4,084	2
Blue Point	BP	1,334	1

3.6.4 PM_{10} Parameter Details

Table 3.6.4. *PM10 monitoring sites, ranked by population served.*

Maricopa County AQD Site	Acronym	Population Served	Score
North Phoenix	NP	463,405	16
Glendale	GL	445,353	15
Higley	HI	317,300	14
West Chandler	WC	281,292	13
Dysart	DY	280,132	12
Zuni Hills	ZH	245,060	11
West Phoenix	WP	236,755	10
Mesa	ME	202,009	9
Tempe	TE	159,324	8
South Scottsdale	SS	136,670	7
West 43rd Ave	WF	135,058	6
Central Phoenix	CP	133,576	5
Buckeye	BE	105,743	4
South Phoenix	SP	104,768	3
Greenwood	GR	33,797	2
Durango Complex	DC	21,066	1

3.6.5 $PM_{2.5}$ Parameter Details

Table 3.6.5. *PM2.5 monitoring sites, ranked by population served.*

Maricopa County AQD Site	Acronym	Population Served	Score
Glendale	GL	783,269	8
Mesa	ME	732,010	7
North Phoenix	NP	457,198	6
West Phoenix	WP	310,150	5
Diablo	DI	191,020	4
Tempe	TE	137,757	3
South Phoenix	SP	134,126	2
Durango Complex	DC	114,866	1

*Note: There were 323,474 people in Maricopa County who lived outside of the $PM_{2.5}$ analysis area (see section 3.5.5 for analysis area).

3.6.6 SO_2 Parameter Details

Table 3.6.6. *SO2 monitoring sites, ranked by population served.*

Maricopa County AQD Site	Acronym	Population Served	Score
Central Phoenix	CP	1,459,233	2
Durango Complex	DC	645,642	1

3.7 Analysis #7: Monitor-to-Monitor Correlation

This analysis ranks monitoring sites based upon their "uniqueness". Sites that have more unique attributes are weighted more heavily in this analysis, as they are more valuable for interpolation and determining the spatial concentration of pollutants. This analysis is also useful for identifying redundant monitors. Monitor pairs that have a high correlation (e.g. > 75%) may be redundant, and this analysis can be used as a tool for indicating which monitors may be suitable for closure.

To conduct this analysis, 2014 data were collected from each criteria parameter monitored within Maricopa County, including state and tribal monitors. Data were also collected from the surrounding counties of Gila, Pinal, and Yavapai, as appropriate, to ensure a robust sample. The concentration of each monitoring site was then compared to every other monitoring site using a matrix format. Within the matrix each monitoring pair were subjected to a Pearson correlation test where the coefficient (r^2) was generated. The maximum correlation was then recorded for each site. Sites were scored based on their maximum correlation; higher values, showing more redundancy, received a lower score. A distance matrix between sites was also developed, and a correlogram plot of correlation versus distance was created for each parameter. The correlogram displays the relationship between correlation and distance; a regression trend line is added to determine the average correlation between sites at the specified distance. Correlograms are useful in determining the average distance of redundancy in the monitoring network.

Specific information regarding the method of collecting and correlating data for each parameter is as follows:

- CO: Hourly concentration values from 2014 were used. Since some CO monitors in Maricopa County are seasonal, only data from January to March and September to December were used. All monitoring site locations were within Maricopa County and included data from MCAQD and the ADEQ JLG (Supersite).
- NO_2: Hourly concentration values from 2014 were used. All monitoring site locations were within Maricopa County and included data from MCAQD and the ADEQ JLG (Supersite).
- O_3: Hourly concentration values from 2014 were used. Monitoring locations included sites within Maricopa and its surrounding counties: Gila, La Paz, Pinal, Pima, and Yavapai, and included data reported by MCAQD, ADEQ, Pinal County AQD, Pima County AQD, Gila River Indian Community, Fort McDowell Yavapai Nation, and Salt River Pima-Maricopa Indian Community.
- PM_{10}: Hourly average concentrations from 2014 were used, but only data from continuous monitors were used as the majority of the PM_{10} monitors running in 2014 were continuous (all MCAQD monitors were continuous). Monitoring locations included sites within Maricopa and Pinal counties and included data reported by MCAQD, ADEQ, Pinal County AQD, Gila River Indian Community, and Salt River Pima-Maricopa Indian Community.
- $PM_{2.5}$: Hourly or 24-hour average concentrations from 2014 were used, but all data were subsequently converted to 24-hour daily block averages for correlation comparison. Data from 1-in-3 day monitors were also used; these values were accurately aligned with their calendar day to maintain temporal integrity in the correlation coefficient. Monitoring locations included

sites within Maricopa and Pinal counties and included data reported by MCAQD, ADEQ, Pinal County AQD, Gila River Indian Community, and Salt River Pima-Maricopa Indian Community.

- SO_2: Hourly concentration values from 2014 were used. Monitoring site locations were within Maricopa County and Gila County and included data from MCAQD and ADEQ.

3.7.1 CO Parameter Details

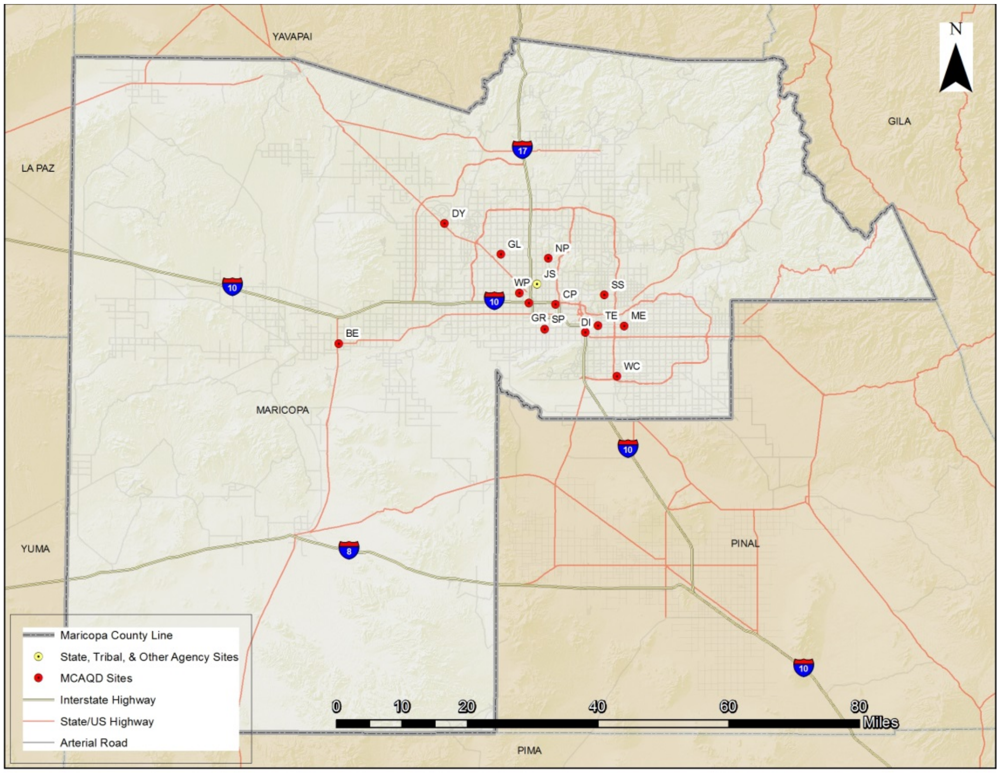

Figure 3.7.1. Map of CO monitoring sites used for analysis.

Table 3.7.1. *CO monitoring sites ordered and ranked by correlation.*

Maricopa County AQD Site	Acronym	Max. Correlation	Score
Dysart	DY	0.375	11
Diablo	DI	0.485	10
North Phoenix	NP	0.540	9
Glendale	GL	0.558	8
South Scottsdale	SS	0.570	7
West Chandler	WC	0.583	6
Mesa	ME	0.589	5
Tempe	TE	0.589	5
South Phoenix	SP	0.616	4
Buckeye	BE	0.617	3
Central Phoenix	CP	0.653	2
Greenwood	GR	0.783	1
West Phoenix	WP	0.783	1

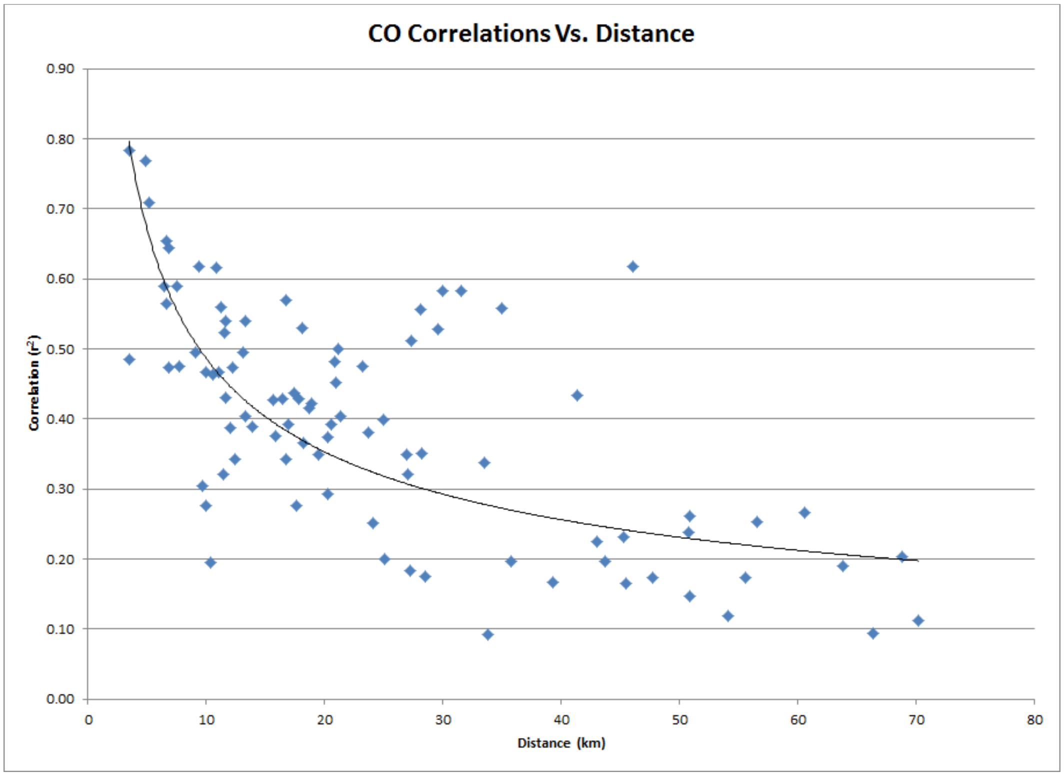

Figure 3.7.2. Correlogram of CO monitoring sites.

3.7.2 NO_2 Parameter Details

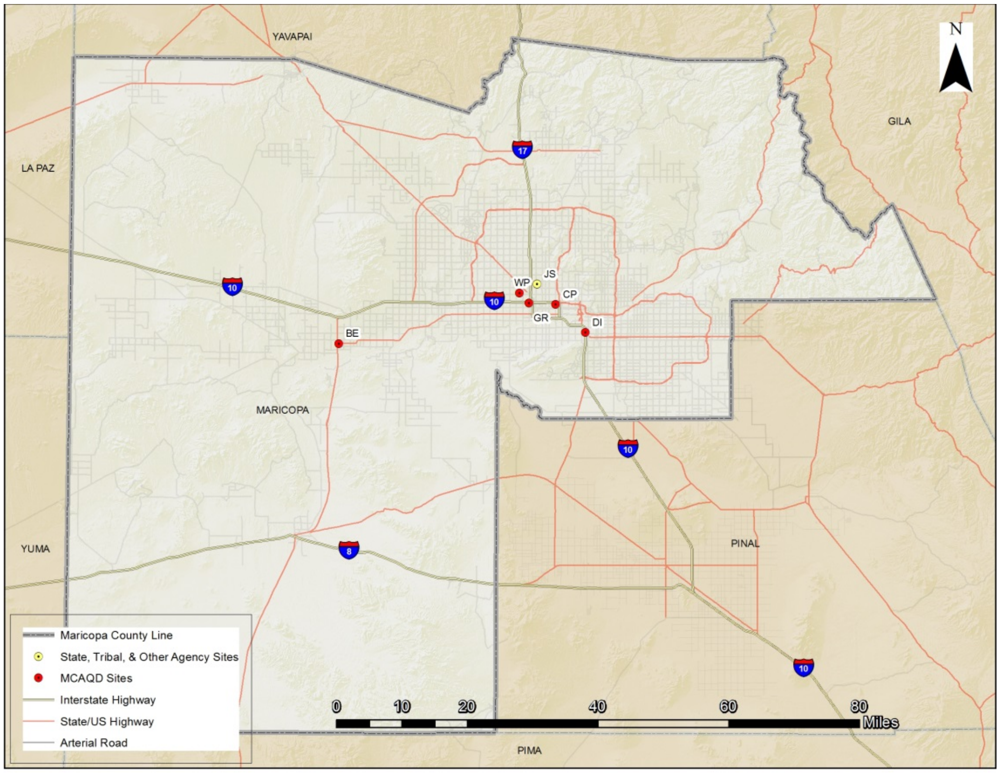

Figure 3.7.3. Map of NO_2 sites used for correlation analysis.

Table 3.7.2. *NO_2 monitoring sites ordered and ranked by correlation.*

Maricopa County AQD Site	Acronym	Max. Correlation	Score
Buckeye	BE	0.48	5
Diablo	DI	0.52	4
Greenwood	GR	0.76	3
Central Phoenix	CP	0.81	2
West Phoenix	WP	0.87	1

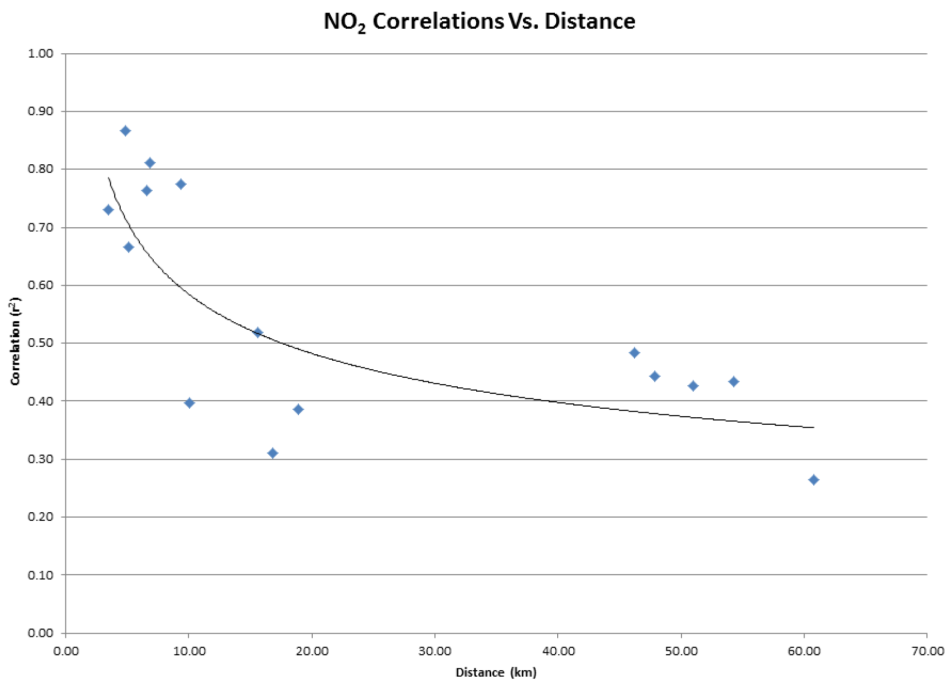

Figure 3.7.4. Correlogram of NO_2 monitoring sites.

3.7.3 O_3 Parameter Details

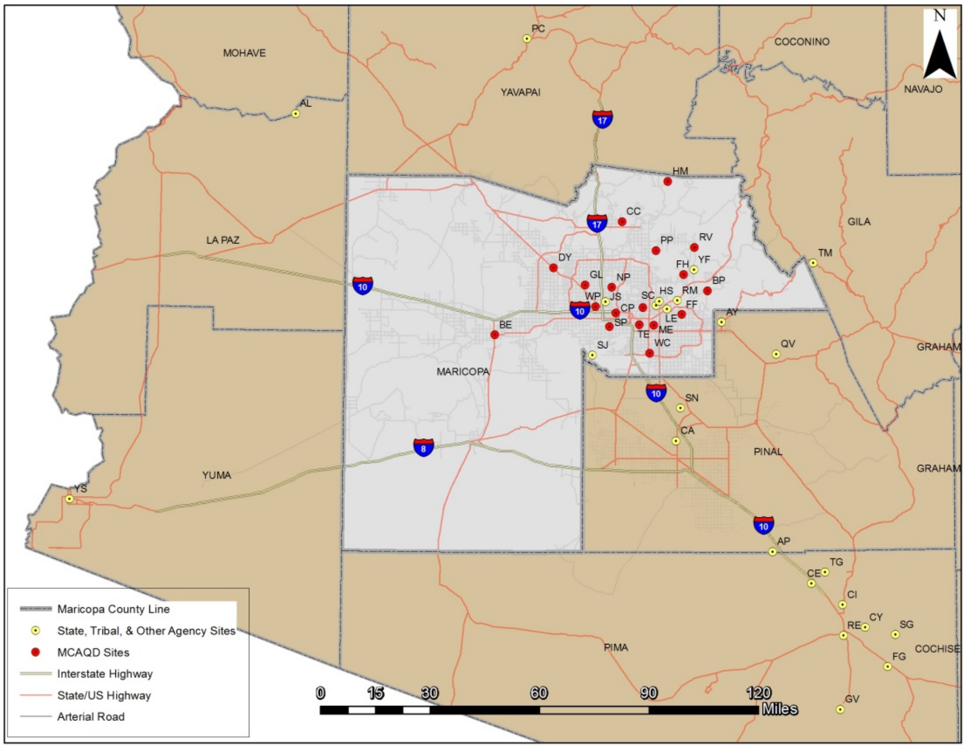

Figure 3.7.5. Map of O_3 sites used for analysis.

Table 3.7.3. *O_3 monitoring sites ordered and ranked by correlation.*

Maricopa County AQD Site	Acronym	Max. Correlation	Score
Humboldt Mountain	HM	0.573	17
Rio Verde	RV	0.791	16
Cave Creek	CC	0.796	15
Pinnacle Peak	PP	0.803	14
Fountain Hills	FH	0.814	13
Buckeye	BE	0.832	12
Dysart	DY	0.857	11
West Chandler	WC	0.871	10
Blue Point	BP	0.883	9
Falcon Field	FF	0.8916	8
South Scottsdale	SS	0.8917	7
Glendale	GL	0.894	6
North Phoenix	NP	0.898	5
Mesa	ME	0.900	4
Tempe	TE	0.900	4
South Phoenix	SP	0.910	3
Central Phoenix	CP	0.920	2
West Phoenix	WP	0.951	1

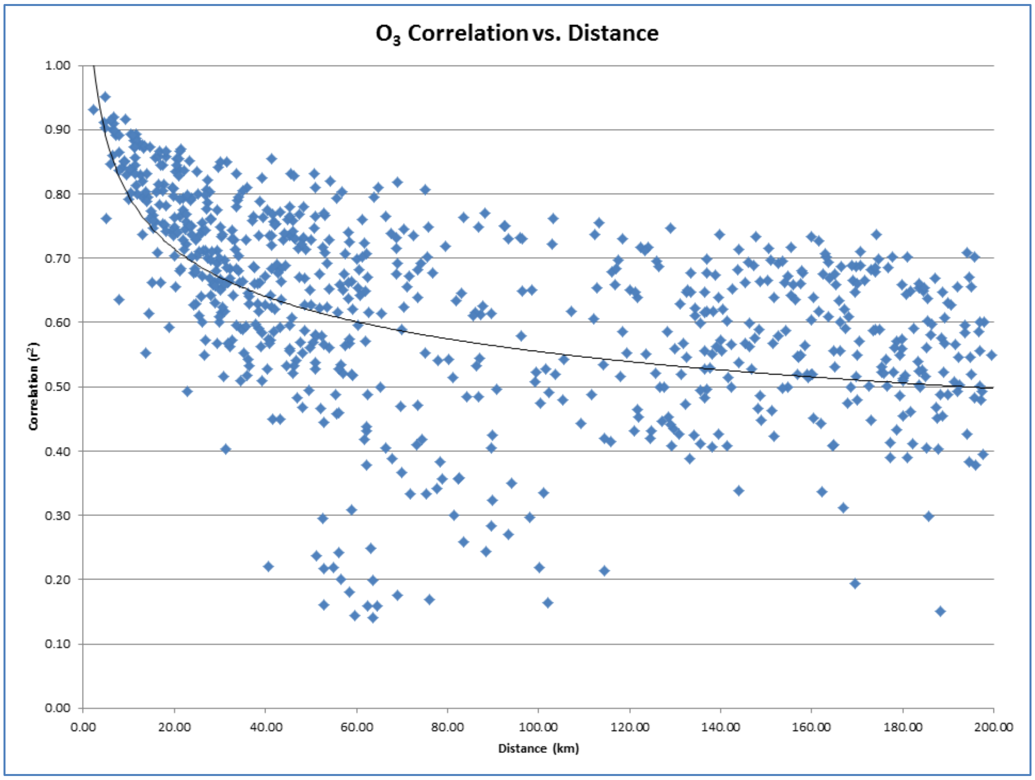

Figure 3.7.6. Correlogram of O_3 monitoring sites.

3.7.4 PM_{10} Parameter Details

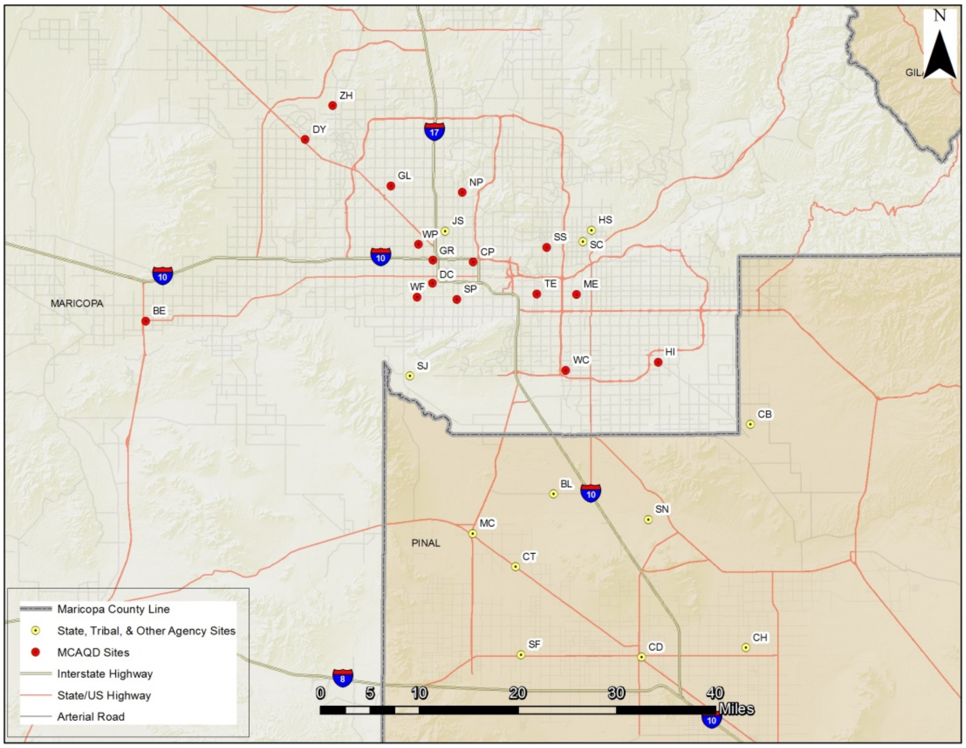

Figure 3.7.7. Map of PM_{10} sites used for analysis.

Table 3.7.4. *PM_{10} monitoring sites ordered and ranked by maximum correlation.*

Maricopa County AQD Site	Acronym	Max. Correlation	Score
Buckeye	BE	0.192	12
West Chandler	WC	0.555	11
Higley	HI	0.557	10
South Phoenix	SP	0.616	9
South Scottsdale	SS	0.643	8
Dysart	DY	0.668	7
Zuni Hills	ZH	0.668	7
Mesa	ME	0.712	6
Tempe	TE	0.712	6
West 43rd Avenue	WF	0.717	5
Glendale	GL	0.731	4
North Phoenix	NP	0.731	4
Durango Complex	DC	0.768	3
Central Phoenix	CP	0.786	2
Greenwood	GR	0.852	1
West Phoenix	WP	0.852	1

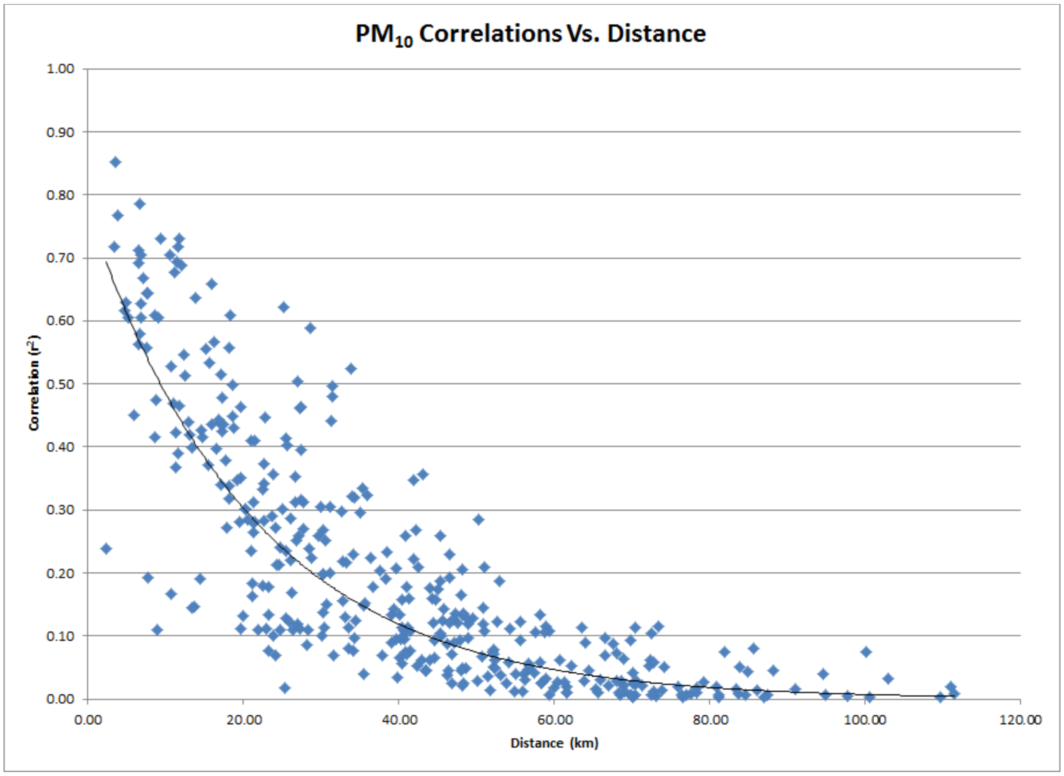

Figure 3.7.8. Correlogram from PM_{10} monitoring sites.

3.7.5 PM$_{2.5}$ Parameter Details

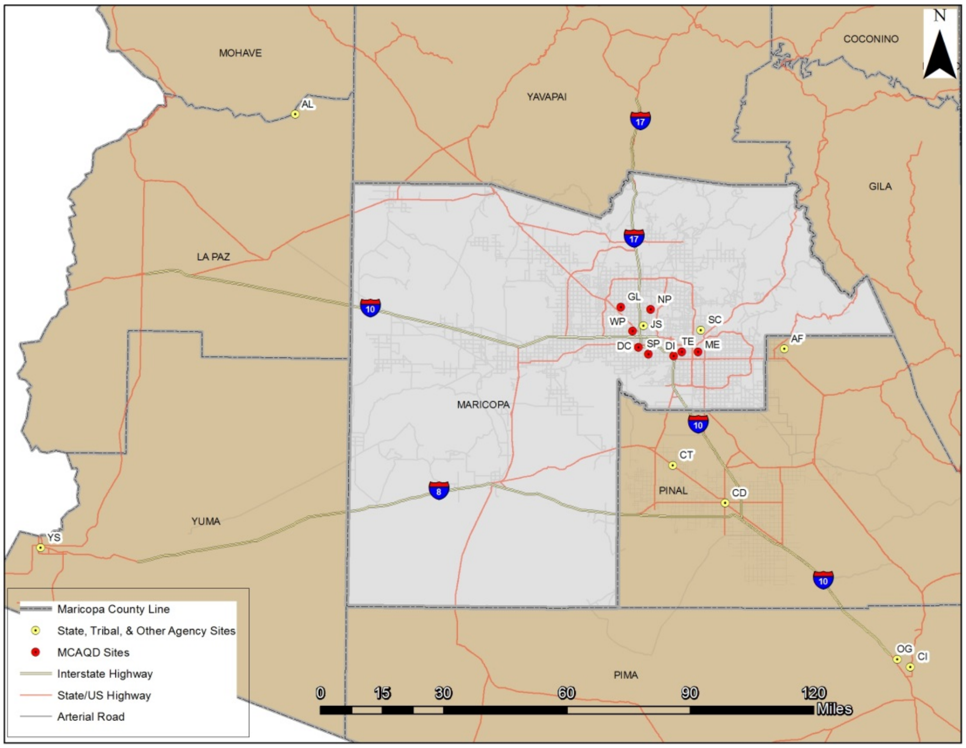

Figure 3.7.9. Map of PM$_{2.5}$ sites used for analysis.

Table 3.7.5. *PM$_{2.5}$ monitoring sites ordered and ranked by correlation.*

Maricopa County AQD Site	Acronym	Max. Correlation	Score
Durango Complex	DC	0.783	5
South Phoenix	SP	0.844	4
West Phoenix	WP	0.844	4
Diablo	DI	0.866	3
Mesa	ME	0.870	2
Tempe	TE	0.870	2
North Phoenix	NP	0.877	1
Glendale	GL	0.877	1

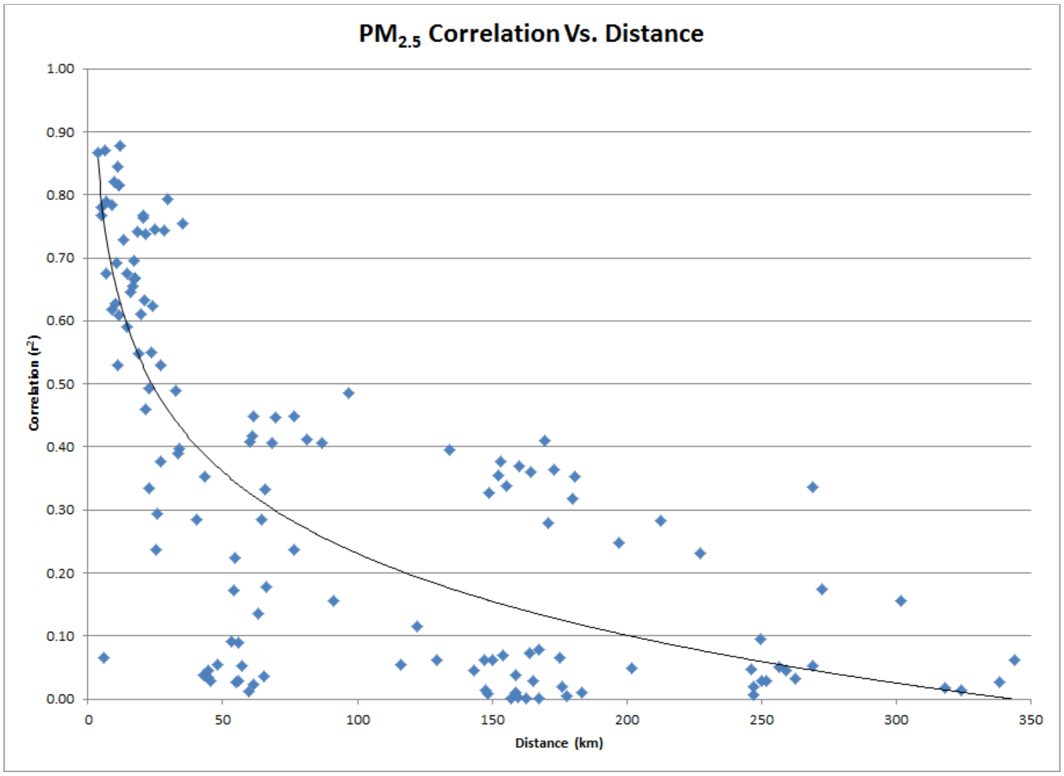

Figure 3.7.10. Correlogram of $PM_{2.5}$ monitoring sites.

3.7.6 SO_2 Parameter Details

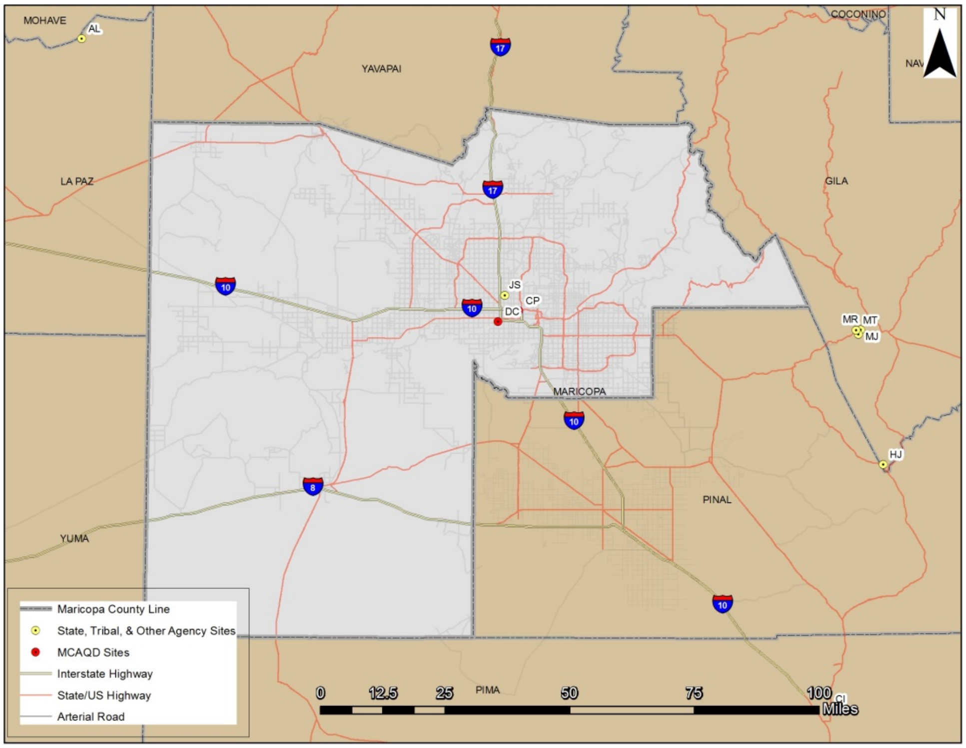

Figure 3.7.11. Map of SO_2 sites used for analysis.

Table 3.7.6. *SO_2 monitoring sites ordered and ranked by correlation.*

Maricopa County AQD Site	Acronym	Max. Correlation	Score
Durango Complex	DC	0.17	2
Central Phoenix	CP	0.30	1

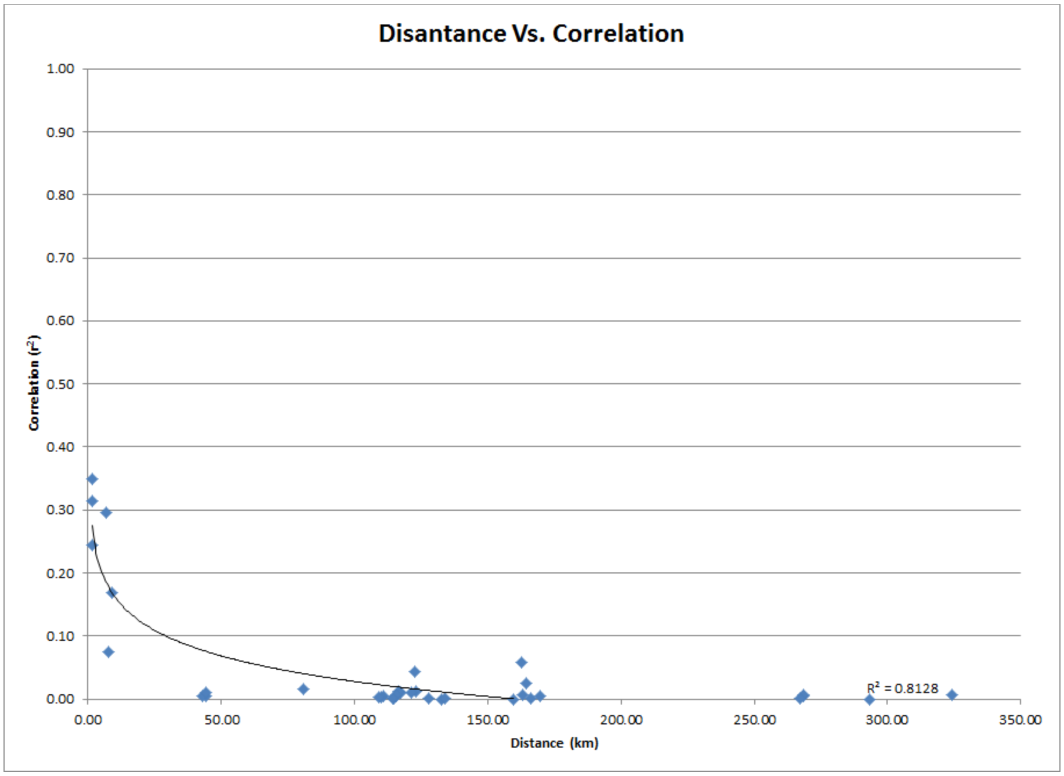

Figure 3.7.12. Correlogram of SO_2 monitoring sites.

3.8 Analysis #8: Removal Bias

This analysis evaluates the contribution of each monitoring site to the creation of an interpolation map. For each pollutant parameter, a kriging interpolation map was created that incorporates all monitoring sites. Each monitoring site is then systematically removed from the dataset and the interpolation map is recreated. After removing a site, the difference between the actual value from the monitoring site and the predicted value from the interpolation map is recorded; this value is the “removal bias”. Sites are then ranked using the absolute value of the removal bias difference; a higher value equates a higher rank.

A five-year average was used for each pollutant parameter; thus, this analysis focuses on the long-term contributions that each site makes in determining the modeled pollution surface. The removal bias result would likely be different if a different temporal scale was used; however, this Assessment has other analysis techniques that focus on short-term time periods and episodic events.

Removal bias is a useful technique for noting redundancies in the monitoring network. Sites with a high removal bias difference are important for creating the interpolation map and 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.

This analysis has disadvantages in that some parameters were not represented in counties adjacent to Maricopa County, i.e., carbon monoxide only has sites within the metropolitan areas of Maricopa and Pima Counties. A limitation of the technology used in creating interpolation maps is that the map is bounded by those outer-most monitoring sites, which do not contribute fully to the creation of the map; this is known as the “edge effect”. Removing those sites will thus shrink the boundaries of the interpolation map and a removal bias cannot be obtained. Monitoring sites that are on the edge of the map were not assessed for their removal bias, though they were still used in the creation of the interpolation map for the other sites within that pollutant parameter’s network.

In each of the parameters below, a kriging interpolation map of the predicted pollution surface created from utilizing all monitoring site is shown. The accompanying tables show the results of the removal bias difference; though additional interpolation maps are not displayed, there was a unique map created for every monitoring site within the parameter.

3.8.1 CO Parameter Details

Table 3.8.1. *CO monitoring sites ordered and ranked by removal bias difference.*

Maricopa County AQD Site	Average Concentration for 2010-2014	Removal Bias	Difference	Score
West Phoenix	0.576	0.476	-0.100	10
Greenwood	0.562	0.484	-0.078	9
Central Phoenix	0.448	0.511	0.063	8
Mesa	0.384	0.436	0.052	7
Tempe	0.474	0.434	-0.040	6
Glendale	0.418	0.456	0.038	5
North Phoenix	0.484	0.447	-0.037	4
South Phoenix	0.524	0.502	-0.022	3
West Chandler	0.438	0.43	-0.008	2
South Scottsdale	0.426	0.433	0.007	1
Buckeye*	0.304	N/A (on edge)	N/A	
Dysart*	0.31	N/A (on edge)	N/A	
Diablo#	N/A	N/A	N/A	

* These sites were on the edge of the edge of the kriging map and thus could not be used for an accurate removal bias. They were included in the kriging factoring of the other sites, however.

#This site did not have enough data completeness to be included in the analysis.

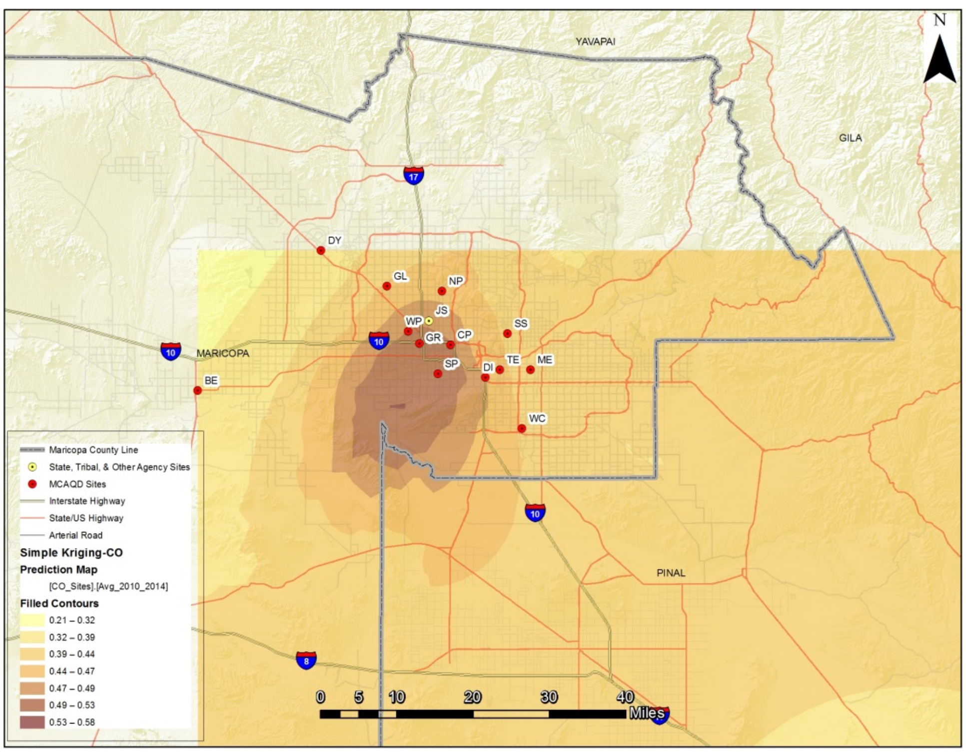

Figure 3.8.1. Kriging prediction map for CO.

3.8.2 NO_2 Parameter Details

Table 3.8.2. *NO_2 monitoring sites ordered and ranked by removal bias difference.*

Maricopa County AQD Site	Average Concentration for 2010-2014	Removal Bias	Difference	Score
Greenwood	25.00	18.45	-6.55	4
West Phoenix	18.2	20.9	2.7	3
Central Phoenix	19.79	19.71	-0.08	2
Buckeye*	8.582	N/A (on edge)	N/A	1
Diablo#	n/a	-	-	-

* This site was on the edge of the edge of the kriging map and thus could not be used for an accurate removal bias. They were included in the kriging factoring of the other sites, however.

#This site did not have enough data completeness to be included in the analysis.

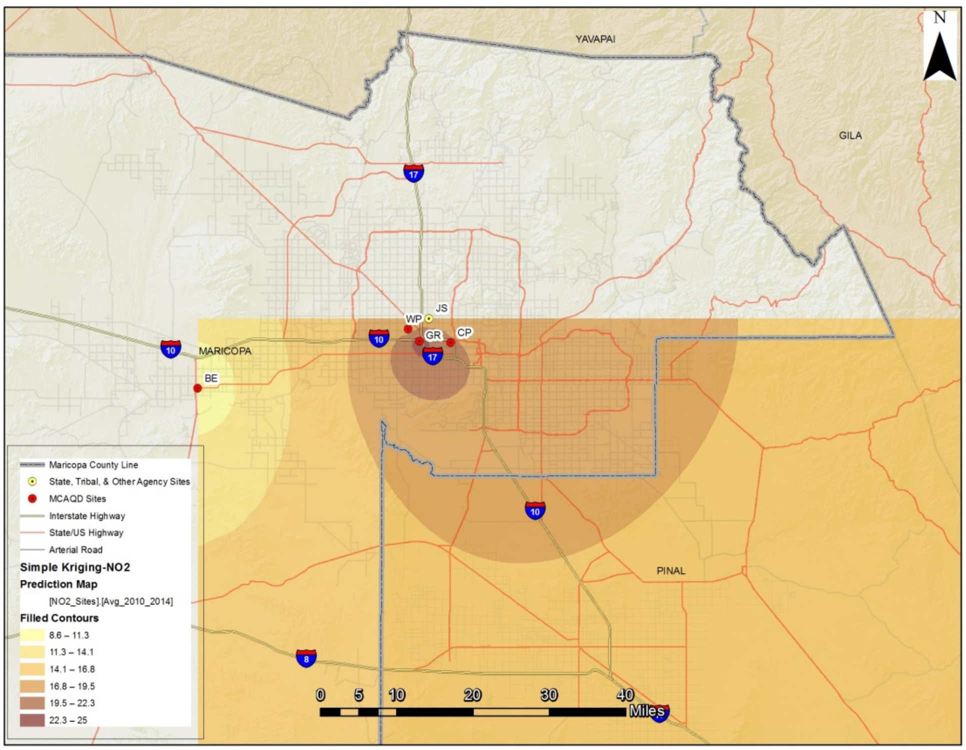

Figure 3.8.2. Kriging prediction map for NO_2.

3.8.3 O_3 Parameter Details

Table 3.8.3. *O_3 monitoring sites ordered and ranked by removal bias difference.*

Maricopa County AQD Site	Average Concentration for 2010-2014	Removal Bias	Difference	Score
Humboldt Mountain	0.0573	0.0498	-0.00753	17
Cave Creek	0.0569	0.0512	-0.00571	16
Glendale	0.0538	0.0488	-0.00499	15
Buckeye	0.0461	0.0504	0.00427	14
Rio Verde	0.0537	0.0497	-0.00404	13
Central Phoenix	0.0455	0.0493	0.00384	12
Falcon Field	0.0533	0.0498	-0.00350	11
South Scottsdale	0.0466	0.0499	0.00337	10
West Chandler	0.0535	0.0502	-0.00333	9
South Phoenix	0.0470	0.0492	0.00218	8
Fountain Hills	0.0491	0.0512	0.00216	7
West Phoenix	0.0471	0.0491	0.00201	6
Blue Point	0.0502	0.0491	-0.00107	5
Tempe	0.0506	0.0497	-0.00091	4
Pinnacle Peak	0.0519	0.0526	0.00071	3
Dysart	0.0511	0.0505	-0.00058	2
North Phoenix	0.0498	0.0494	-0.00034	1
Mesa#	n/a	-	-	-

#This site did not have enough data completeness to be included in the analysis.

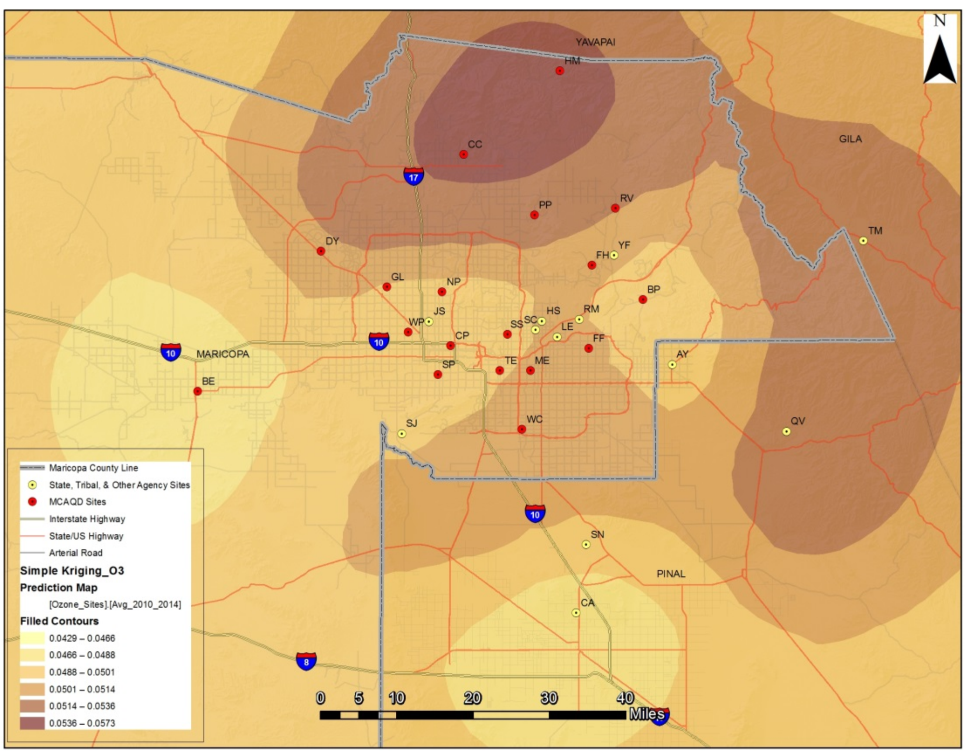

Figure 3.8.3. Kriging interpolation O_3 prediction map.

3.8.4 PM_{10} Parameter Details

***Table 3.8.4.** PM_{10} monitoring sites ordered and ranked by removal bias difference.*

Maricopa County AQD Site	Average Concentration for 2010-2014	Removal Bias	Difference	Score
Buckeye	41.02	32.48	-8.54	16
South Scottsdale	26.40	31.99	5.59	15
Mesa	25.22	30.16	4.94	14
North Phoenix	26.02	29.42	3.40	13
West 43rd Avenue	44.18	40.81	-3.37	12
South Phoenix	40.68	37.49	-3.19	11
Zuni Hills	24.62	27.57	2.95	10
West Phoenix	39.20	36.30	-2.90	9
Tempe	30.43	28.33	-2.097	8
Greenwood	40.66	38.56	-2.095	7
Higley	34.34	32.26	-2.08	6
Glendale	28.24	30.23	1.99	5
Central Phoenix	32.68	34.40	1.72	4
Dysart	25.94	27.49	1.55	3
West Chandler	29.72	29.20	-0.52	2
Durango Complex	41.92	42.08	0.16	1

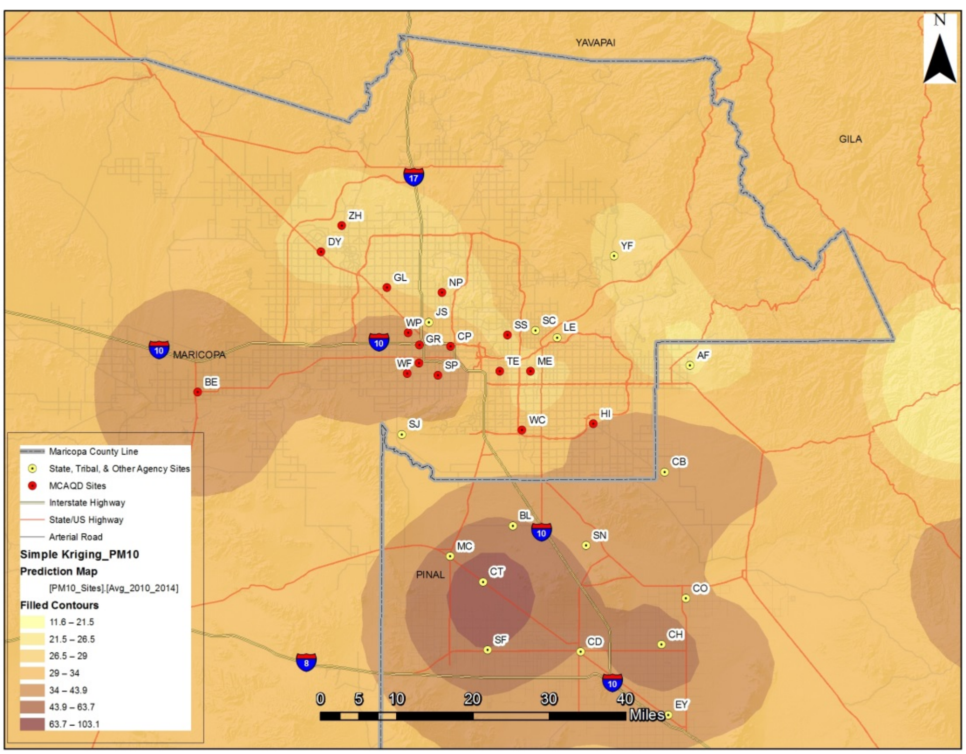

Figure 3.8.4. Kriging interpolation PM_{10} prediction map.

3.8.5 $PM_{2.5}$ Parameter Details

Table 3.8.5. *$PM_{2.5}$ monitoring sites ordered and ranked by removal bias difference.*

Maricopa County AQD Site	Average Concentration for 2010-2014	Removal Bias	Difference	Score
Durango Complex	10.95	9.56	-1.39	7
Tempe	8.86	7.62	-1.25	6
West Phoenix	10.26	9.09	-1.17	5
South Phoenix	9.28	10.38	1.10	4
North Phoenix	8.64	7.76	-0.88	3
Glendale	8.28	9.15	0.87	2
Mesa	7.00	7.69	0.69	1
Diablo#	n/a	-	-	-

#This site did not have enough data completeness to be included in the analysis.

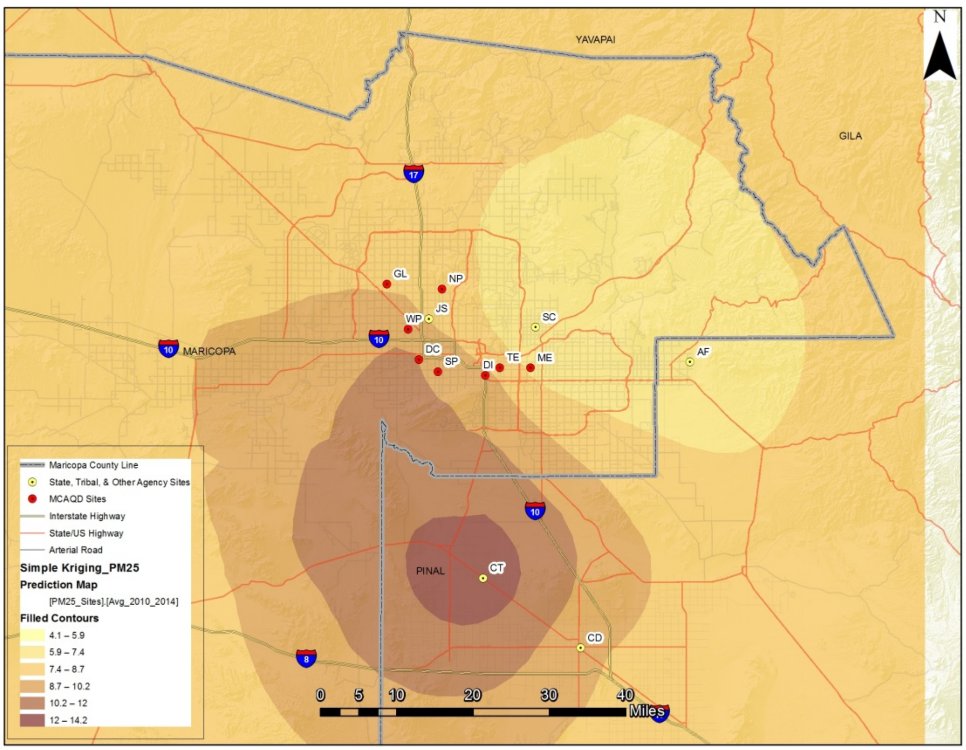

Figure 3.8.5. Kriging interpolation $PM_{2.5}$ prediction map.

3.8.6 SO_2 Parameter Details

Table 3.8.6. *SO_2 monitoring sites ordered and ranked by removal bias difference.*

Maricopa County AQD Site	Average Concentration for 2010-2014	Removal Bias	Difference	Score
Durango Complex	1.16	1.57	0.40	2
Central Phoenix	1.33	1.44	0.11	1

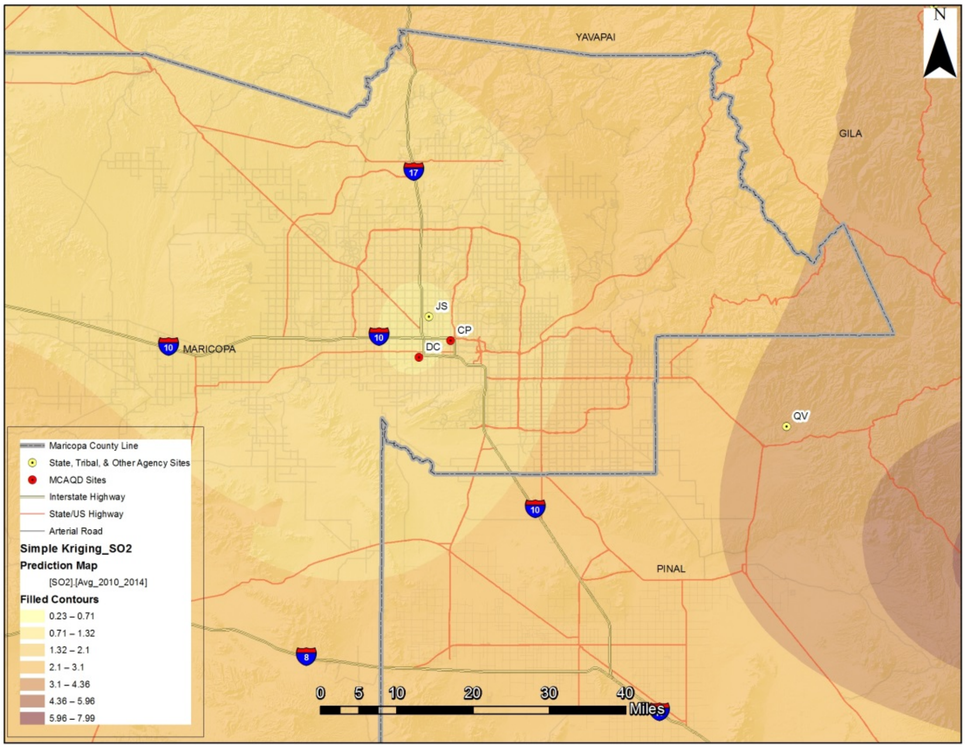

Figure 3.8.6. Kriging prediction map for SO_2.

3.9 Analysis #9: Emissions Inventory

This analysis ranks sites based on their proximity to permitted point-sources of pollution by giving weight to each monitor according to the density of the emissions in the surrounding area. The method used to determine the area of representation for each monitoring site was once again the use of Thiessen polygons (see Analysis #5: Area Served and Analysis #6: Population Served for more information about Thiessen polygons).

The MCAQD Planning and Analysis Division's Emissions Inventory section provided the 2004-2013 Annual Emissions Inventory reports, which list reported emissions from approximately 1400 permitted sources within Maricopa County. The 2013 Annual Emissions Inventory was the latest one available at the time of this Assessment. Only permitted sources that were operating in the 2010-2013 time period were analyzed, but their latest available emissions data from 2004 to 2013 were used. The goal of this method was to include the latest emissions data from all active permitted sources, even those that were last surveyed as far back as 2004. Major sources of emissions are surveyed annually, so data coming from older surveys tend to focus on smaller sources and it was assumed that their emissions stayed within the same order of magnitude even if significant time has passed since the last survey.

Point-sources were spatially located within the inventory, and their emissions were then aggregated using the Public Land Survey System (PLSS), i.e., township, range, and section grid system, with each section being 1-mile (1.6 km) square in size (labeled emission-sections). Emissions were summed within each monitor's Thiessen polygon by selecting the section centroids within that polygon. These results were normalized for emission density by dividing the emission sums by the Thiessen polygon area. Since the Annual Emissions Inventories only includes sources within the limits of Maricopa County, the Thiessen polygons were trimmed to only include areas within the county; monitors and areas outside of the county were not used in analyzing emission densities. Polygons with higher emission densities were ranked higher.

This analysis has the advantage of being able to spatially locate emission sources in relation to existing monitors. The emission density normalization technique aids the technique by taking weight away from the rural and urban fringe monitors that have large Thiessen polygons and thus emission sources that are farther away and have little effect on the monitor. There is a disadvantage in that this method, like the Area Served and Population Served methods, only accounts for spatial location and does not consider meteorology or landscape topography. However, the emission density normalization process does equalize the effect of spatial size and location and gives a fair representation of the point-source emission density that would affect each individual monitor. Another disadvantage of this analysis is that it does not consider area sources from the emissions inventories; area sources are an important component of emissions, particularly PM_{10}, but they lack the spatial data necessary to include them in this analysis. Mobile sources are also important component of emissions inventories, but these sources are addressed in the traffic counts analysis (q.v.).

The data from this method will also be used in Section 4 of this Assessment, as spatially-explicit point-source pollution data are very useful in determining monitoring weaknesses and locating new monitors.

3.9.1 CO Parameter Details

There are fourteen CO monitoring sites within Maricopa County, though results shown are restricted to the thirteen sites belonging to MCAQD. Figure 3.9.1 shows point-source emissions aggregated by township, range, and section (emission-sections), and the same emission-sections aggregated within each CO monitor's Thiessen polygon.

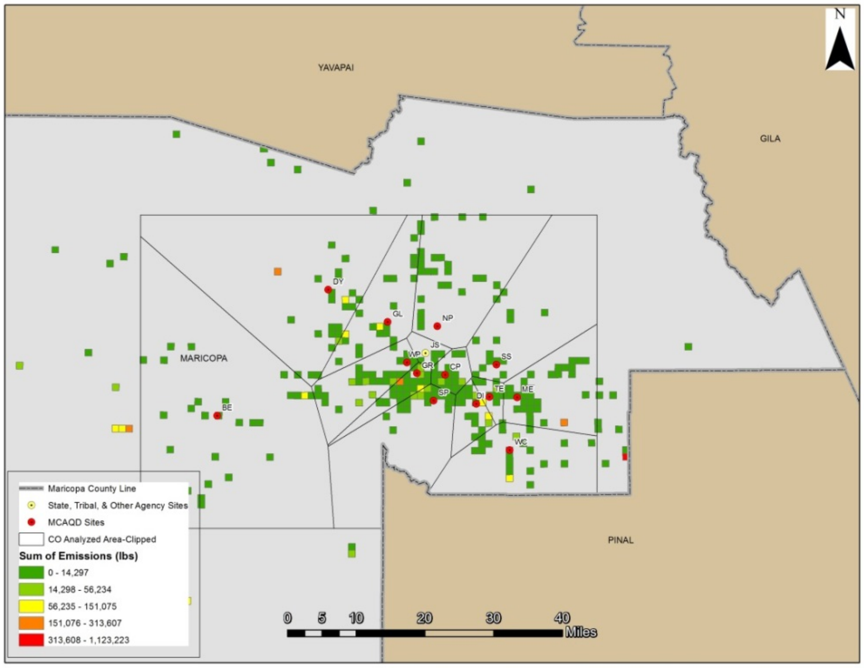

Figure 3.9.1. Permitted source CO emissions, aggregated by township, range, and section. CO network Thiessen polygons are also displayed; note that due to a lack of surrounding CO sites, the analysis area was restricted to an area 50% greater than the outside border of the network.

Table 3.9.1 displays the sum of CO emissions within each monitor's Thiessen polygon. Other statistics, including the average emission value and the maximum emission-section are also displayed. The sum is then divided by the polygon area to create the emission density. Polygons with the highest density are scored the highest.

Table 3.9.1. *CO monitoring sites aggregated and normalized by Thiessen polygon area.*

Site	Sum of CO Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km^2)	Density: Sum/Area (lbs/km^2)	Score
Greenwood	377,742	17,988	208,591	92.6	4,079.28	13
Diablo	293,856	18,366	103,915	104.4	2,814.71	12
Central Phoenix	104,062	6,504	29,741	74.2	1,402.46	11
Tempe	41,932	5,242	26,012	47.7	879.08	10
West Phoenix	202,461	7,787	53,326	269.9	750.13	9
Glendale	264,859	11,036	151,075	365.1	725.44	8
Mesa	249,165	8,305	201,079	386	645.00	7
West Chandler	162,145	7,370	75,022	524	309.67	6
Dysart	344,839	14,368	192,762	1,374	250.94	5
South Phoenix	91,242	5,367	33,286	585.5	155.84	4
Buckeye	175,171	6,737	119,758	2,152	81.40	3
North Phoenix	42,097	1,754	12,011	655	64.25	2
South Scottsdale	39,124	2,795	7,491	733	53.39	1

3.9.2 NO_2 Parameter Details

There are six NO_2 monitors within Maricopa County, though results shown are restricted to the five sites belonging to MCAQD. Results are shown below.

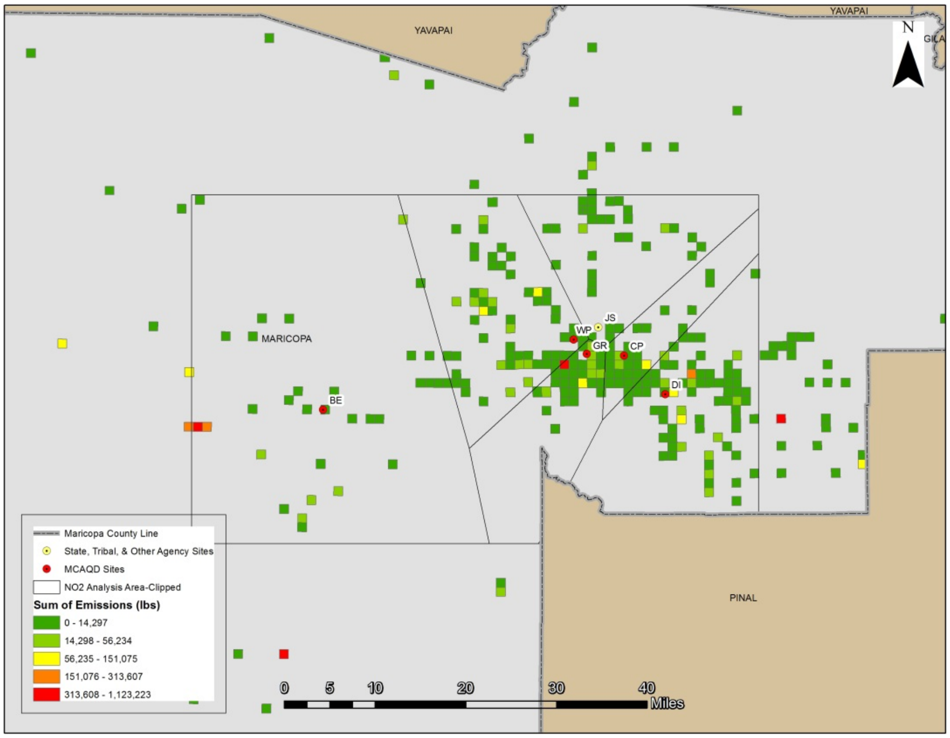

Figure 3.9.2. Permitted source NO_2 emissions, aggregated by township, range, and section. NO_2 network Thiessen polygons are also displayed; note that due to a lack of surrounding NO_2 sites, the analysis area was restricted to an area 50% greater than the outside border of the network.

Table 3.9.2 displays the sum of NO_2 emissions in each monitor's Thiessen polygon. After normalizing for density, the monitoring sites are ranked in order of greatest density.

Table 3.9.2. *NO_2 monitoring sites aggregated and normalized by Thiessen polygon area.*

Site	Sum of NO_2 Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km^2)	Density: Sum/Area (lbs/km^2)	Score
Greenwood	1,195,949	38,579	902,043	471	2,540.79	5
Diablo	782,499	11,021	152,739	917	853.42	4
Central Phoenix	239,019	8,853	90,639	280	852.42	3
West Phoenix	606,174	10,451	105,106	870	696.91	2
Buckeye	885,388	26,830	381,078	2,795	316.83	1

3.9.3 PM_{10} Parameter Details

There are 21 PM_{10} monitors within Maricopa County; these are operated by MCAQD, ADEQ, and tribal agencies. Of these, 16 are operated by MCAQD and only analysis results from these monitors are displayed in this section

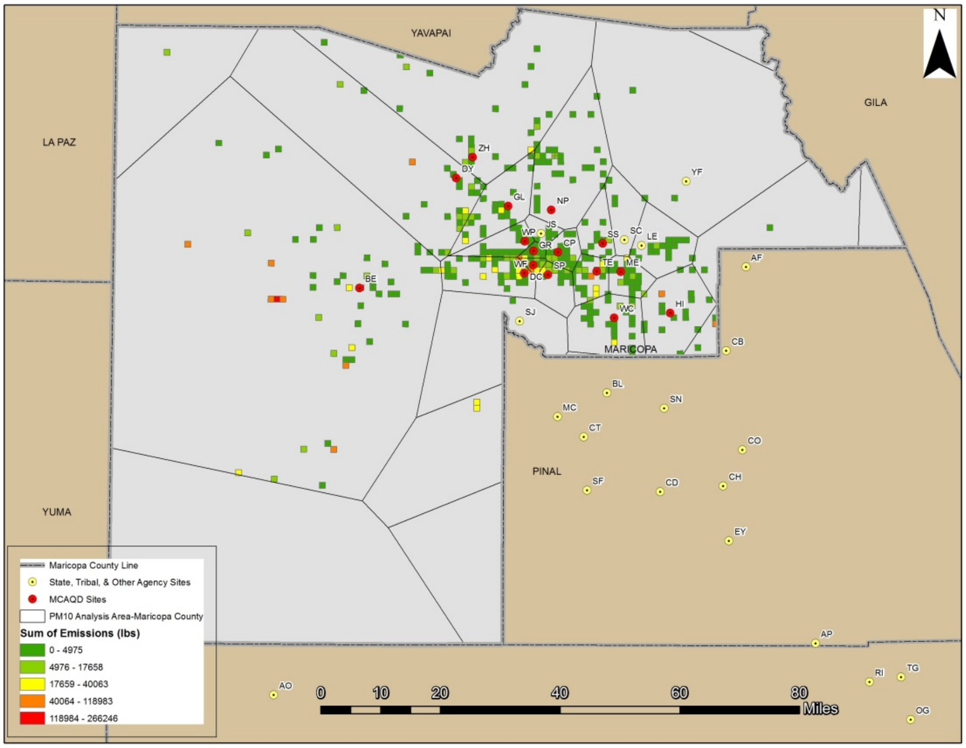

Figure 3.9.3. Permitted source PM10 emissions, aggregated by township, range, and section. Note that the polygons were clipped to only include areas within Maricopa County.

Table 3.9.3 displays the sum of PM_{10} emissions in each monitor's Thiessen polygon. After normalizing for density, the monitoring sites are ranked in order of greatest density.

Table 3.9.3. *PM_{10} monitoring sites aggregated and normalized by Thiessen polygon area.*

Site	Sum of PM_{10} Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km^2)	Density: Sum/Area (lbs/km^2)	Score
Durango Complex	248,941	35,564	109,415	21	11,854.33	16
South Phoenix	636,141	5,740	29,588	116	5,483.97	15
Greenwood	40,434	4,043	22,596	23	1,758.00	14
Tempe	175,078	8,754	55,778	108	1,621.09	13
West 43rd Ave.	240,825	7,083	33,311	242	995.14	12
Mesa	65,875	3,467	26,012	106	621.46	11
Central Phoenix	27,996	1,474	8,330	78	358.92	10
Higley	104,957	6,560	89,779	349	300.74	9
Glendale	76,639	3,332	32,855	270	283.85	8
West Phoenix	22,724	1,515	7,530	112	202.89	7
West Chandler	61,399	2,558	25,448	303	202.64	6
Buckeye	941,161	19,207	266,246	7328	128.43	5
North Phoenix	64,394	2,147	12,489	592	108.77	4
Dysart	169,325	6,513	62,962	1641	103.18	3
South Scottsdale	8,915	891	6,539	127	70.20	2
Zuni Hills	107,184	4,466	33,434	1674	64.03	1

3.9.4 $PM_{2.5}$ Parameter Details

$PM_{2.5}$ monitoring sites were not analyzed by this method as actual (not modeled) emissions inventory data for $PM_{2.5}$ does not exist.

3.9.5 SO_2 Parameter Details

There are only three SO_2 monitors within Maricopa, one at the ADEQ's Supersite and two operated by MCAQD at Central Phoenix and Durango Complex. The two MCAQD monitors were the only ones evaluated in this analysis.

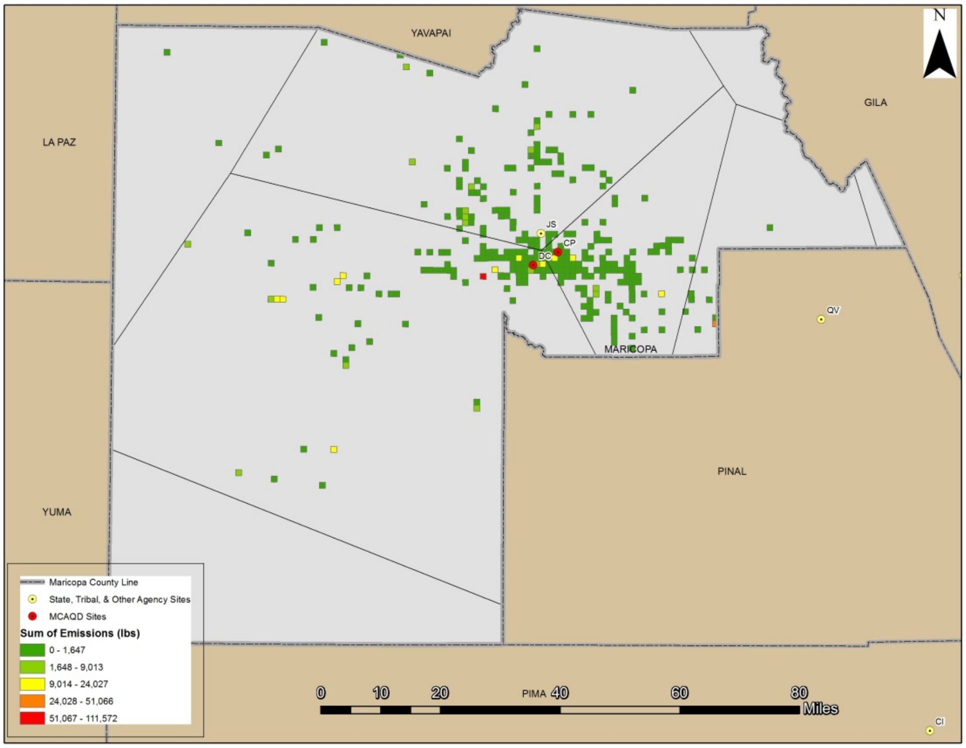

Figure 3.9.4. Permitted source SO2 emissions, aggregated by township, range, and section.

Table 3.9.5 displays the sum of SO_2 emissions in each monitor's Thiessen polygon. After normalizing for density, the monitoring sites are ranked in order of greatest density.

Table 3.9.5. *SO_2 monitoring sites aggregated and normalized by Thiessen polygon area.*

Site	Sum of SO_2 Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km^2)	Density: Sum/Area (lbs/km^2)	Score
Central Phoenix	76,883	680	17,173	1,922	40.00	2
Durango	305,894	3,289	111,572	9,077	33.70	1

3.9.6 Volatile Organic Compounds and Ozone Details

Tropospheric O_3 is a secondary pollutant, meaning that it is not directly emitted, but rather results from a chemical reaction between the sun and precursor compounds such as volatile organic compounds (VOCs) and nitrogen oxides (NO_x). Furthermore, although O_3 needs NO_x in its formation reaction, it is also scavenged, or destroyed, by NO_x in the atmosphere. Because of these chemical dynamics, O_3 concentrations follow much different patterns than other primary pollutants. In the short-term, several hours or less, O_3 will begin forming near its pre-cursor sources and increase in concentrations as the plume moves downwind during the afternoon and has more time to react. At night, with the photochemical reaction stopped, 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 low, O_3 will persist in the environment and can last for weeks before dissipating or deposition. 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. Figure 3.9.5 shows this relationship by displaying a prediction map of O_3 values in relation to its VOC precursor sources generated by using the 2014 annual average of O_3.

Because of these dynamics, the methodology of ranking O_3 monitors in order of the emission densities of VOC point-sources is not totally valid. It is still practical to use the method established with the other primary pollutants, as the short-term O_3 levels are still high in the areas surrounding the precursor sources, but another method of rank involving the long-term averages also needs to be adopted.

Table 3.9.6 shows this additional ranking system, a kriging interpolation map created with the 2010-2014 predicted O_3 levels. The map was converted into a raster surface and then statistics were generated for each O_3 monitor's Thiessen polygon. Ranks were based on the polygon's mean long-term O_3 concentration, with the highest concentration ranking higher. Both ranking systems will be combined and weighed together when evaluating O_3 monitoring sites.

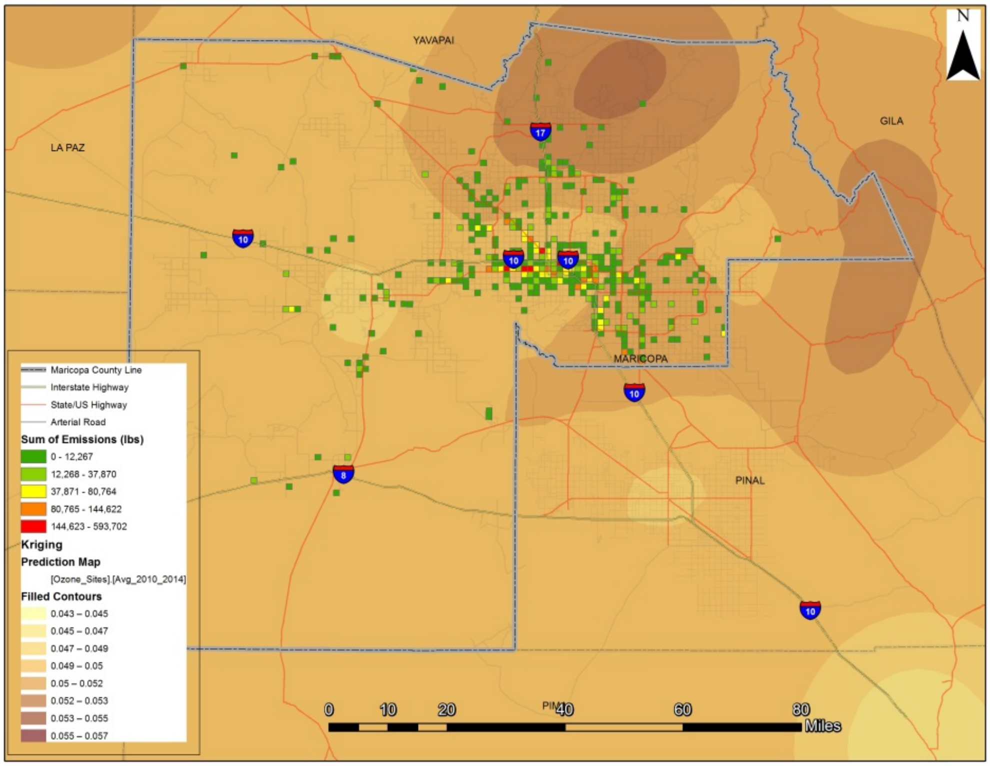

Figure 3.9.5. 2010-2014 predicted O_3 levels in relation to VOC precursor point-sources.

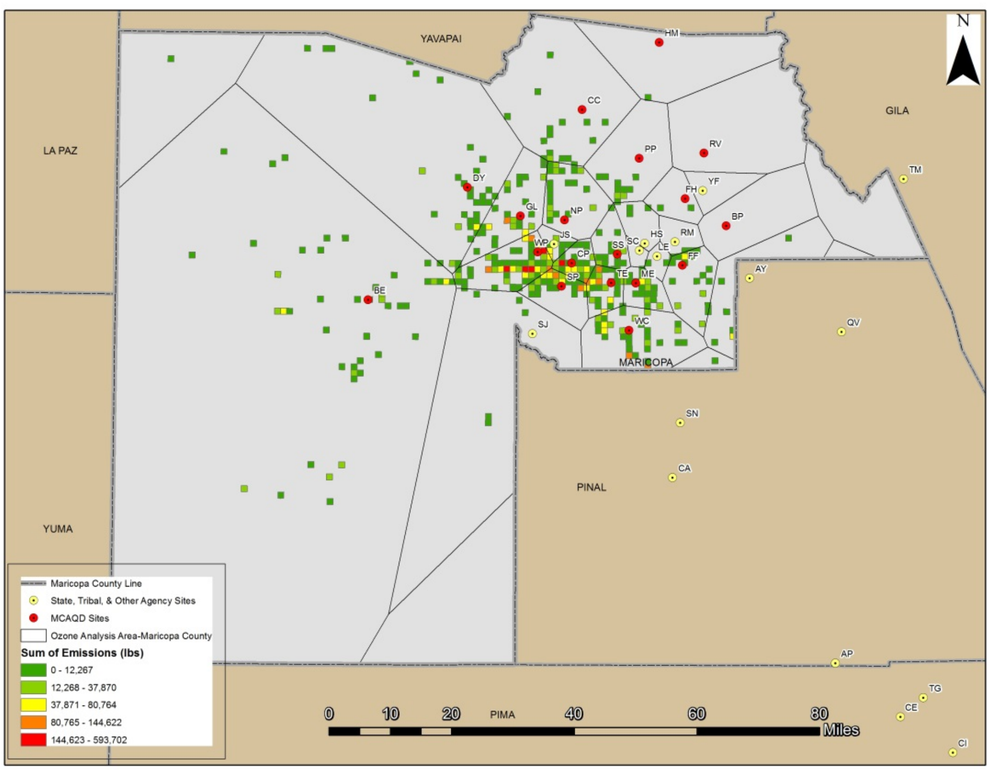

Figure 3.9.6. Map of VOC point-sources summed by township, range, & section.

Table 3.9.6 displays the VOC emission total based on the location of emission-sections located within the Thiessen polygon sector of the map. There are a total of 25 O_3 monitors within Maricopa County, though only results from the 18 monitors operated by MCAQD are displayed in this analysis. The other O_3 monitors in Maricopa County are operated by the ADEQ, Fort McDowell Yavapai Nation, Gila River Indian Community, and the Salt River Pima-Maricopa Indian Community.

Table 3.9.6. *VOC emissions aggregated and normalized by O_3 monitoring site Thiessen polygon area.*

Site	Sum of VOC Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km^2)	Density: Sum/Area (lbs/km^2)	Score
West Phoenix	2,680,573	51,54	593,702	250	10,722.29	16
Central Phoenix	775,240	31,01	295,050	83	9,340.24	15
Tempe	644,541	26,85	120,434	108	5,967.97	14
South Phoenix	486,482	22,11	111,475	168	2,895.73	13
Mesa	213,304	11,22	71,579	111	1,921.66	12
West Chandler	552,855	17,27	121,350	443	1,247.98	11
Glendale	375,394	13,40	144,622	318	1,180.48	10
Falcon Field	166,513	9,251	78,719	224	743.36	9
North Phoenix	193,652	9,683	29,784	269	719.90	8
South Scottsdale	75,587	5,039	22,481	117	646.04	7
Pinnacle Peak	82,790	8,279	37,733	411	201.44	7
Dysart	174,069	4,973	38,840	2,507	69.43	6
Fountain Hills	8,415	4,207	8,209	136	61.88	5
Cave Creek	41,195	2,746	17,974	988	41.70	4
Buckeye	356,365	7,919	65,202	10,732	33.21	3
Humboldt	18	18	18	699	0.03	2
Blue Point	0	0	0	441	0.00	1
Rio Verde	0	0	0	856	0.00	1

Table 3.9.7 displays the predicted O_3 levels computed from a kriging interpolation from the O_3 monitoring locations. The kriging interpolation was based off of a 5-year average O_3 concentration measured from the O_3 network. The predicted O_3 is calculated within each monitor's Thiessen polygon sector and the mean concentration is used to rank the sites. The ranking from mean predicted O_3 will also be used when weighing O_3 3 monitors with the emissions inventory analysis.

Table 3.9.7. *O_3 monitoring sites ranked by mean predicted O_3 concentrations.*

Site	Predicted O_3 concentration (ppm)			Area of Polygon (km^2)	Rank
	Minimum	Maximum	Mean		
Humboldt Mountain	0.0510	0.0539	0.0529	699	1
Cave Creek	0.0513	0.0539	0.0527	988	2
Pinnacle Peak	0.0504	0.0534	0.0520	411	3
West Chandler	0.0506	0.0519	0.0514	443	4
Rio Verde	0.0501	0.0530	0.05134	856	5
Mesa	0.0506	0.0519	0.05130	111	6
Falcon Field	0.0498	0.0516	0.0509	224	7
Fountain Hills	0.0500	0.0513	0.0507	136	8
Glendale	0.0492	0.0521	0.050384	318	9
North Phoenix	0.0492	0.0519	0.050380	269	10
Tempe	0.0493	0.0510	0.0503	108	11
Dysart	0.0492	0.0520	0.0501	2,507	12
Blue Point	0.0495	0.0509	0.0500	441	13
South Scottsdale	0.0494	0.0505	0.0499	117	14
Buckeye	0.0483	0.0497	0.0495	10,732	15
South Phoenix	0.0487	0.0505	0.0494	168	16
West Phoenix	0.0487	0.0494	0.049091	250	17
Central Phoenix	0.0487	0.0495	0.049088	83	18

3.10 Analysis #10: Traffic Counts

Point-source emissions only account for a portion of the pollution emission sources within an area, with other major sources being transportation and area sources. Due to a lack of spatial data, area sources are not analyzed in this Assessment, but this Traffic Count analysis does consider 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 prior Emissions Inventory method, are used to derive the total effect of emissions within each site's Thiessen polygon.

Emissions from mobile sources can vary greatly; factors which can affect the amount of pollution released include road type (fast-moving vehicles on a highway generally emit less pollution per kilometer 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 model which would give high spatial detail to mobile sources of pollution. Unfortunately, such traffic modeling is outside of the scope of this Assessment. Instead, traffic count and road density will be used as a proxy to approximate the spatial variability of mobile source pollution.

The average weekday traffic (AWT) counts for Maricopa County in 2011 were obtained from the Maricopa Association of Governments, which in turn collected them from various state, county and municipal agencies. The dataset includes counts for highways and arterial roads with comprehensive sample location coverage; however, it is difficult to ascertain if AWT sample locations include all arterial roads with the same density and it is likely that additional new roads were not sampled. To normalize these data for evaluation, both the AWT and the length of roads within each monitor's Thiessen polygon were selected. These were then divided by the area of the polygon to determine the traffic and road density. The densities are then scored and averaged together to obtain the rank for each polygon.

Figures 3.10.1 and 3.10.2 illustrate the traffic count sample locations for highways and arterial roads, respectively. The map is color coded to note the areas of highest traffic count.

The following sub-sections display traffic count information for the various parameters. The information displayed for each site is based upon that site's Thiessen polygon (See section 3.5., Analysis #5, for information and maps of the Thiessen polygons). The total sampled AWT and the total length of all arterial and highway roads was calculated inside of each polygon. These variables were then divided by the area of the polygon to find the density of the variable. Densities were scored against each other and then the average score was used to rank each site in order of impact from traffic emissions.

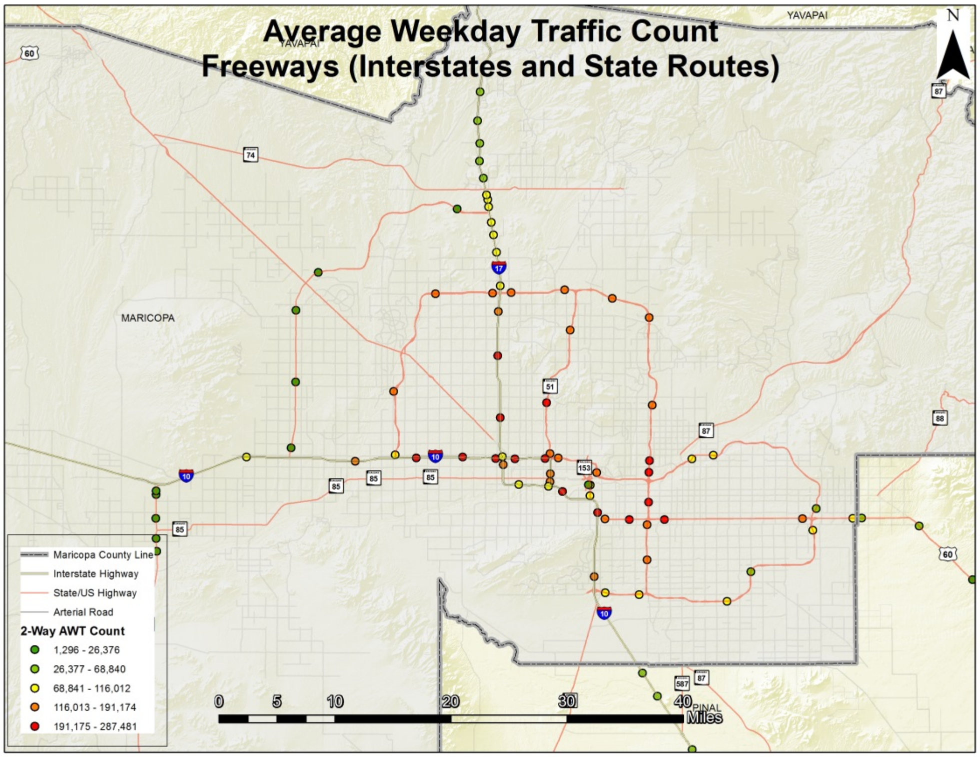

Figure 3.10.1. Average Weekday Traffic (AWT) counts on Maricopa County highways.

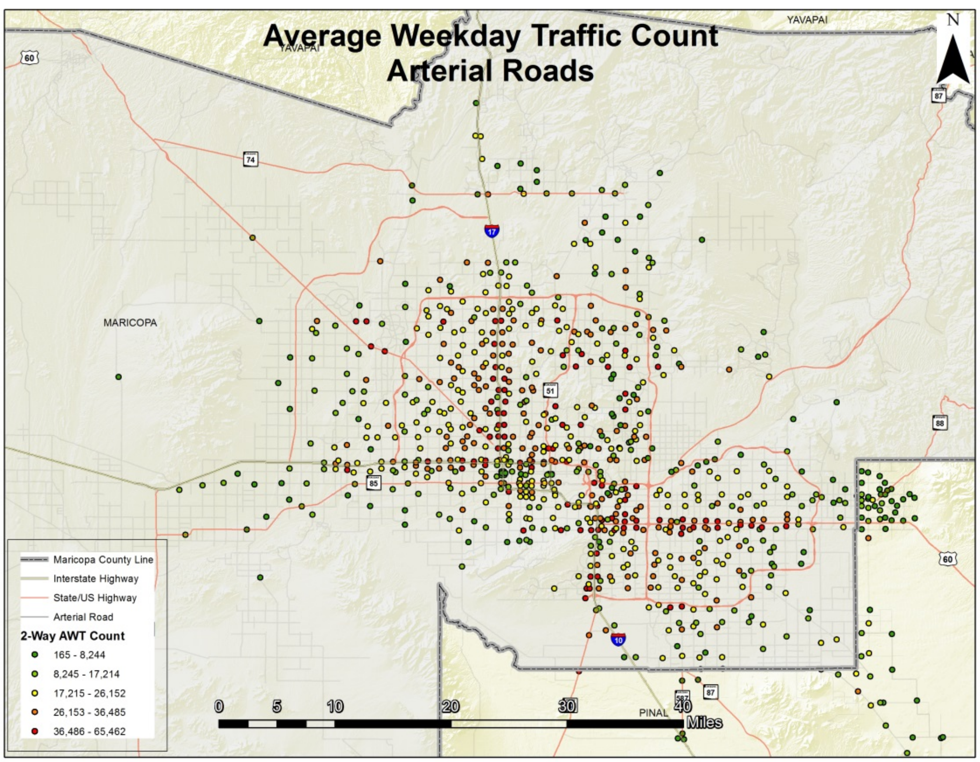

Figure 3.10.2. Average weekday traffic counts on Maricopa County Arterial roads.

3.10.1 CO Parameter Details

Table 3.10.1a. *CO monitoring sites average weekday traffic (AWT) statistics.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Highway	Arterial				
Buckeye	151,053	121,537	2,152	905,984	126.7	421.0
Central Phoenix	1,369,300	1,238,591	74	232,148	35,241.8	3,137.1
Diablo	645,659	1,175,099	104	222,241	17,507.3	2,136.9
Dysart	73,215	624,148	1,374	1,107,459	507.5	806.0
Glendale	924,114	1,828,200	365	544,475	7,540.6	1,491.7
Greenwood	715,903	761,041	93	147,248	15,881.1	1,583.3
Mesa	1,035,015	2,016,466	386	686,887	7,905.4	1,779.5
North Phoenix	1,200,568	2,582,404	655	756,353	5,775.5	1,154.7
South Phoenix	116,012	664,938	698	281,950	1,118.8	403.9
South Scottsdale	546,693	1,312,097	733	641,898	2,535.9	875.7
Tempe	382,917	909,233	48	131,423	26,919.8	2,738.0
West Chandler	751,391	1,824,535	858	817,674	3,002.2	953.0
West Phoenix	664,902	1,475,116	270	364,891	7,926.0	1,351.4

Table 3.10.1b. *Scores from Table 3.10.1a.*

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Central Phoenix	13	13	13	13
Tempe	12	12	12	12
Diablo	11	11	11	11
Greenwood	10	9	9.5	10
Mesa	8	10	9	9
West Phoenix	9	7	8	8
Glendale	7	8	7.5	7
North Phoenix	6	6	6	6
West Chandler	5	5	5	5
South Scottsdale	4	4	4	4
Dysart	2	3	2.5	3
South Phoenix	3	1	2	2
Buckeye	1	2	1.5	1

3.10.2 NO_2 Parameter Details

Table 3.10.2a. *NO_2 monitoring sites average weekday traffic (AWT) statistics.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/Area)
	Highway	Arterial				
Buckeye	164,464	130,857	2,794	1,257,542	105.7	450
Central Phoenix	1,369,300	2,339,712	280	522,206	13,246.5	1,865
Diablo	3,047,314	4,941,866	1,139	1,487,376	7,014.2	1,306
Greenwood	831,915	947,738	500	295,796	3,559.3	592
West Phoenix	834,195	2,969,788	870	1,307,365	4,372.4	1,503

Table 3.10.2b. *Scores from Table 3.10.2a.*

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Central Phoenix	5	5	5	4
Diablo	4	3	3.5	3
West Phoenix	3	4	3.5	3
Greenwood	2	2	2	2
Buckeye	1	1	1	1

3.10.3 O_3 Parameter Details

Table 3.10.3a. *O_3 monitoring sites average weekday traffic (AWT) statistics.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Highway	Arterial				
Blue Point	0	2,801	441	92,466	6.4	209.7
Buckeye	209,658	122,633	15,705	2,200,668	21.2	140.1
Cave Creek	832,964	388,474	1,620	569,080	754.0	351.3
Central Phoenix	1,623,648	1,329,880	83	259,889	35,584.7	3,131.2
Dysart	66,843	630,075	3,007	1,400,944	231.8	465.9
Falcon Field	123,256	986,461	224	399,256	4,954.1	1,782.4
Fountain Hills	0	81,926	136	70,219	602.4	516.3
Glendale	393,409	1,793,328	318	487,571	6,876.5	1,533.2
Humboldt Mtn.	0	9,487	7,770	166,445	1.2	21.4
Mesa	860,421	990,718	111	264,395	16,676.9	2,381.9
North Phoenix	1,043,260	2,039,109	269	445,200	11,458.6	1,655.0
Pinnacle Peak	304,024	569,575	411	332,303	2,125.5	808.5
Rio Verde	0	0	946	175,045	0.0	185.0
South Phoenix	116,012	879,717	168	199,133	5,927.0	1,185.3
South Scottsdale	208,803	776,867	117	193,811	8,424.5	1,656.5
Tempe	1,028,576	1,874,892	108	292,392	26,884.0	2,707.3
West Chandler	751,391	1,856,448	575	701,262	4,535.4	1,219.6
West Phoenix	1,126,457	1,888,746	250	430,380	12,060.8	1,721.5

Table 3.10.3b. *Scores from Table 3.10.3a.*

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Central Phoenix	18	18	18	17
Tempe	17	17	17	16
Mesa	16	16	16	15
West Phoenix	15	14	14.5	14
North Phoenix	14	12	13	13
South Scottsdale	13	13	13	13
Falcon Field	10	15	12.5	12
Glendale	12	11	11.5	11
South Phoenix	11	9	10	10
West Chandler	9	10	9.5	9
Pinnacle Peak	8	8	8	8
Fountain Hills	6	7	6.5	7
Cave Creek	7	5	6	6
Dysart	5	6	5.5	5
Blue Point	3	4	3.5	4
Buckeye	4	2	3	3
Rio Verde	1	3	2	2
Humboldt Mtn.	2	1	1.5	1

3.10.4 PM_{10} Parameter Details

Table 3.10.4a. *PM_{10} monitoring sites average weekday traffic (AWT) statistics.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Highway	Arterial				
Buckeye	201,523	121,537	9,091	1,949,952	36	214
Central Phoenix	1,369,300	1,216,319	78	241,173	33,149	3,092
Durango Complex	0	204,062	21	37,504	9,717	1,786
Dysart	66,843	546,059	1,659	957,210	369	577
Glendale	260,167	1,601,414	270	411,651	6,895	1,525
Greenwood	715,903	546,281	23	79,820	54,878	3,470
Higley	428,286	1,089,791	358	585,544	4,240	1,636
Mesa	860,421	938,337	106	259,409	16,969	2,447
North Phoenix	1,200,568	2,567,846	592	730,988	6,366	1,235
South Phoenix	116,012	614,597	116	125,644	6,298	1,083
South Scottsdale	208,803	927,482	127	209,346	8,947	1,648
Tempe	1,028,576	1,874,892	108	292,392	26,884	2,707
West 43rd Ave	0	292,466	242	240,453	1,209	994
West Chandler	488,800	1,495,242	305	453,299	6,505	1,486
West Phoenix	664,902	1,343,627	112	237,557	17,933	2,121
Zuni Hills	966,206	456,011	5,429	965,631	262	178

Table 3.10.4b. *Scores from Table 3.10.4a.*

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Greenwood	16	16	16.0	14
Central Phoenix	15	15	15.0	13
Tempe	14	14	14.0	12
Mesa	12	13	12.5	11
West Phoenix	13	12	12.5	11
Durango Complex	11	11	11.0	10
South Scottsdale	10	10	10.0	9
Glendale	9	8	8.5	8
West Chandler	8	7	7.5	7
Higley	5	9	7.0	6
North Phoenix	7	6	6.5	5
South Phoenix	6	5	5.5	4
West 43rd Ave	4	4	4.0	3
Dysart	3	3	3.0	2
Buckeye	1	2	1.5	1
Zuni Hills	2	1	1.5	1

3.10.5 $PM_{2.5}$ Parameter Details

Table 3.10.5a. *$PM_{2.5}$ monitoring sites average weekday traffic (AWT) statistics.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Highway	Arterial				
Diablo	1,248,099	1,802,801	293	181,955	10,413	621
Durango Complex	385,718	710,341	562	35,236	1,950	63
Glendale	508,698	2,413,990	705	195,280	4,146	277
Mesa	1,184,746	2,955,468	572	270,820	7,238	473
North Phoenix	1,200,568	2,744,976	484	190,620	8,152	394
South Phoenix	585,962	834,177	407	36,603	3,489	90
Tempe	382,917	1,189,060	84	58,951	18,714	702
West Phoenix	995,087	1,637,194	205	122,475	12,840	597

Table 3.10.5b. *Scores from Table 3.10.5a.*

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Tempe	8	8	8.0	6
West Phoenix	7	6	6.5	5
Diablo	6	7	6.5	5
Mesa	4	5	4.5	4
North Phoenix	5	4	4.5	4
Glendale	3	3	3.0	3
South Phoenix	2	2	2.0	2
Durango Complex	1	1	1.0	1

3.10.6 SO_2 Parameter Details

Table 3.10.6a. *SO_2 monitoring sites average weekday traffic (AWT) statistics.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Highway	Arterial				
Central Phoenix	4,888,023	8,503,339	2,182	2,719,428	6,137	1,246
Durango Complex	1,459,083	2,626,392	11,423	4,325,653	358	379

Table 3.10.6b. *Scores from Table 3.10.6a.*

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Central Phoenix	2	2	2.0	2
Durango Complex	1	1	1.0	1

3.11 Analysis #11: Environmental Justice-Minority Population Served

The EPA has the mandate of providing an environment where all people enjoy the same degree of protection from environmental and health hazards and equal access to the decision-making process to maintain a healthy environment in which to live, learn, and work[3]. This environmental justice mandate extends to all areas the EPA works with, including air monitoring networks. Thus this Assessment includes this method as a basic test of how the MCAQD monitoring networks relates to environmental equity issues, in this case minority populations within Maricopa County.

This analysis follows a methodology identical to the population served analysis described earlier; though instead of using total population as a data source, the total population minus the non-Hispanic white population was used to determine the total minority population in each census block group.

The actual methodology was to create Thiessen polygons around each monitoring site to determine the area of representation for each monitor. The total minority population in each census block group from the 2010 U.S. Census was calculated and then the census block groups were converted to a centroid point containing the population count information. The population within each monitor's Thiessen polygon was determined by summing those census block group centroids that were spatially located within the polygon.

The 2010 Census block groups that were used in the analysis cover the Maricopa County metropolitan area, and include parts of adjacent counties. Where applicable, the census block groups from these surrounding counties were used in calculating the population served. Note that for the CO, NO_2, and $PM_{2.5}$ analyses the analysis area is limited by the network size. In these cases the analysis was limited to an area 20% greater than the network boundaries. See Section 3.5, Area Served Analysis, for more details.

Results from each parameter are displayed by using the total population and total minority population to determine the percent minority population within each Thiessen polygon. Sites are then ranked by percent minority population with the highest percentages having the most importance in this analysis.

Figure 3.11.1 shows a density map of minority population within the central Maricopa County metropolitan area, based on the density of population within each census block group of the 2010 U.S. Census. Figure 3.11.2, by contrast, shows the percentage of minority population within each census block group. This map highlights areas, such as the tribal reservations, that have a high percentage of minority population, but might not appear on the density map because of the relatively few people per square km living in that census block group.

[3] U.S. Environmental Protection Agency. (2015). Environmental Justice. http://www.epa.gov/environmentaljustice/

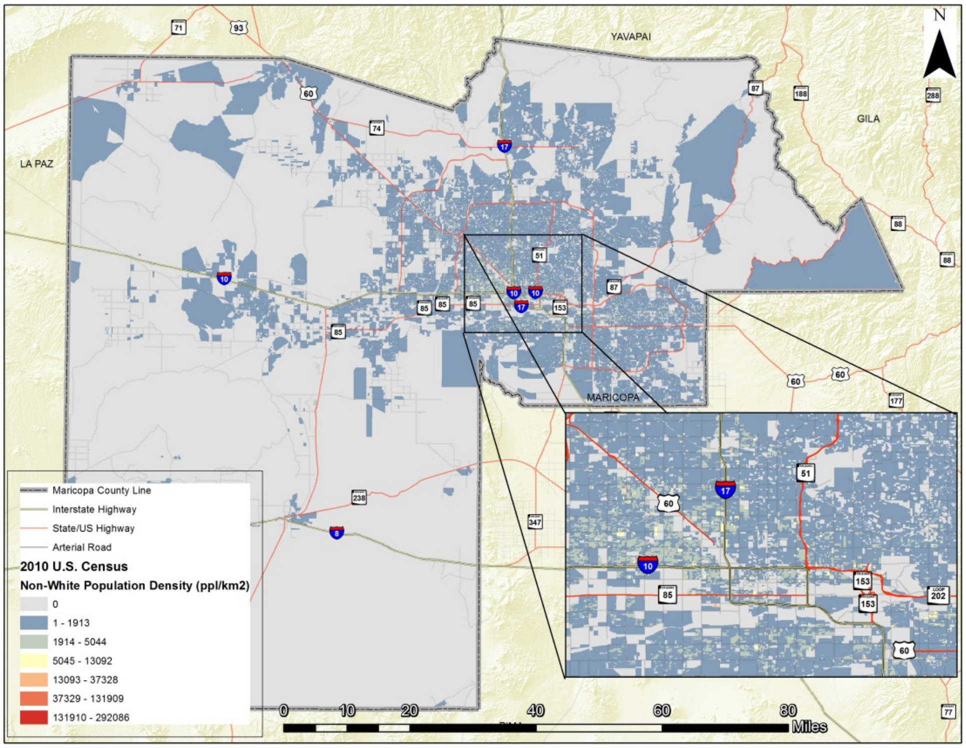

Figure 3.11.1. Map of minority population density per census block group from the 2010 U.S. Census.

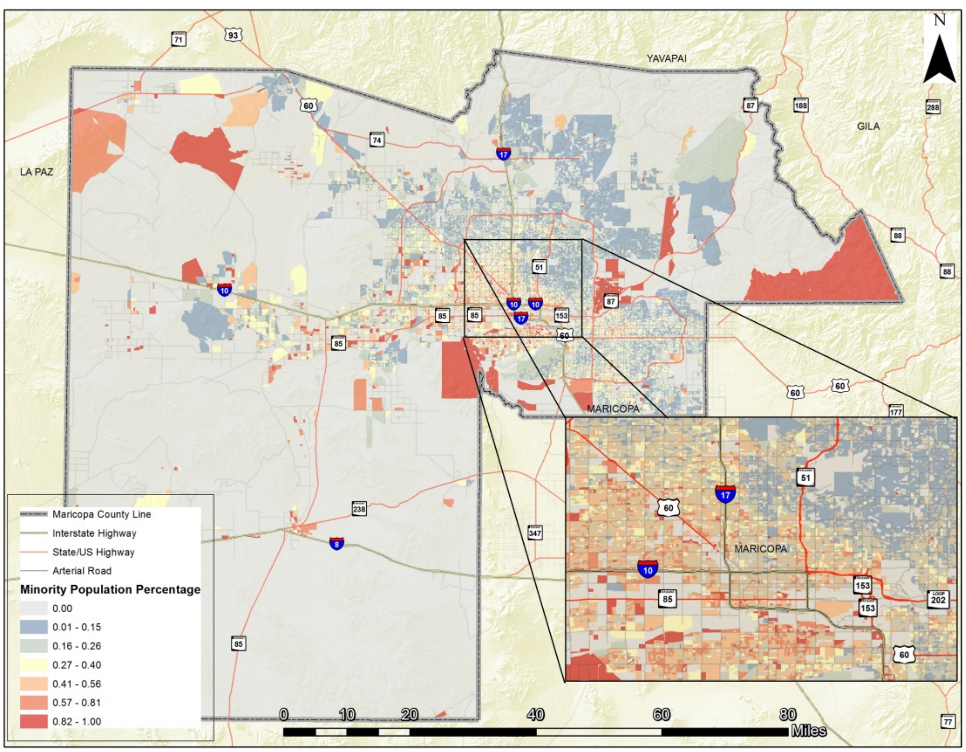

Figure 3.11.2. Percentage of minority population per census block group from the 2010 U.S. Census.

3.11.1 CO Parameter Details

***Table 3.11.1**. CO monitoring sites, ranked by percentage minority population served.*

Site	Total Population Served	Minority Population	% Minority Population	Score
South Phoenix	154,784	79,418	51.3%	13
Greenwood	65,667	33,449	51.0%	12
West Phoenix	317,105	157,696	50%	11
Central Phoenix	133,680	52,428	39%	10
Diablo	113,570	40,439	36%	9
Buckeye	98,527	30,617	31%	8
Tempe	85,264	23,558	28%	7
Glendale	510,613	140,063	27%	6
Mesa	467,941	108,196	23.1%	5
West Chandler	427,232	97,838	22.9%	4
North Phoenix	480,147	87,566	18.2%	3
Dysart	381,228	69,074	18.1%	2
South Scottsdale	251,796	35,780	14%	1

3.11.2 NO_2 Parameter Details

***Table 3.11.2.** NO_2 monitoring sites, ranked by percentage minority population served.*

Site	Total Population Served	Minority Population	% Minority Population	Score
Greenwood	132,796	70,786	53.3%	5
West Phoenix	911,729	310,416	34.0%	4
Central Phoenix	303,360	91,591	30.2%	3
Diablo	833,650	240,507	28.8%	2
Buckeye	127,050	36,894	29.0%	1

3.11.3 O_3 Parameter Details

Table 3.11.3. *O_3 monitoring sites, ranked by percentage minority population served.*

Site	Total Population Served	Minority Population	% Minority Population	Score
South Phoenix	154,025	81,183	53%	18
West Phoenix	348,785	175,714	50%	17
Central Phoenix	141,152	55,423	39%	16
Tempe	159,324	53,119	33%	15
Buckeye	109,664	34,410	31.4%	14
Mesa	207,579	64,927	31.3%	13
Glendale	497,692	138,088	28%	12
West Chandler	411,382	95,625	23%	11
North Phoenix	369,874	77,087	21%	10
Dysart	391,317	70,127	18%	9
South Scottsdale	126,692	20,563	16%	8
Falcon Field	259,988	39,346	15%	7
Cave Creek	117,340	11,844	10.1%	6
Pinnacle Peak	109,218	10,846	9.9%	5
Blue Point	1,334	119	9%	4
Humboldt Mountain	29,049	2,308	8%	3
Fountain Hills	32,051	2,352	7%	2
Rio Verde	4,084	158	4%	1

3.11.4 PM_{10} Parameter Details

Table 3.11.4. *PM_{10} monitoring sites, ranked by percentage minority population served.*

Site	Total Population Served	Minority Population	% Minority Population	Score
Durango Complex	21,066	11,771	56%	16
South Phoenix	104,768	54,025	52%	15
West Phoenix	236,755	119,608	51%	14
West 43rd Ave	135,058	67,484	50%	13
Greenwood	33,797	16,583	49%	12
Central Phoenix	133,576	52,373	39%	11
Tempe	159,324	53,119	33%	10
Mesa	202,009	64,765	32.1%	9
Buckeye	105,743	33,370	31.6%	8
Glendale	445,353	130,773	29%	7
West Chandler	281,292	70,205	25%	6
Dysart	280,132	58,322	21%	5
North Phoenix	463,405	85,748	19%	4
Higley	317,300	55,086	17%	3
South Scottsdale	136,670	21,316	16%	2
Zuni Hills	245,060	28,238	12%	1

3.11.5 $PM_{2.5}$ Parameter Details

Table 3.11.5. *$PM_{2.5}$ monitoring sites, ranked by percentage minority population served.*

Site	Total Population Served	Minority Population	% Minority Population	Score
Durango Complex	114,866	60,151	52%	8
West Phoenix	310,150	155,441	50.1%	7
South Phoenix	134,126	66,747	49.8%	6
Diablo	191,020	61,315	32%	5
Tempe	137,757	36,920	27%	4
Glendale	783,269	190,547	24.3%	3
Mesa	732,010	175,174	23.9%	2
North Phoenix	457,198	86,211	19%	1

3.11.6 SO_2 Parameter Details

Table 3.11.6. *SO_2 monitoring sites, ranked by percentage minority population served.*

Site	Total Population Served	Minority Population	% Minority Population	Score
Durango Complex	645,642	274,626	43%	2
Central Phoenix	1,459,233	366,224	25%	1

3.12 Results

The results from each analysis method have been displayed in order of rank; the variable of interest was sorted so as to show the most important site at rank 1 and so on. In order to evaluate the entire network, the ranks from each analysis are compared to each other and an average is computed. By ranking the averages, the order of importance of the sites for each parameter was determined.

The objective of having multiple analysis methods is to produce a comprehensive perspective of evaluation by using multiple analyses with many variables, such as: cost-effectiveness, suitability for modeling, proximity to population and sources, correlations and redundancies, and concentrations monitored. However, it is not assumed that all methods are of equal importance. For instance, pollutant concentrations are often looked upon as very important. To reflect this relative importance, weights were chosen for each method and applied to the score. These final weighted scores are then averaged to determine the final rank. For this assessment, weights were derived by surveying a panel of air quality experts, policymakers, and academics to get their opinion on the relative importance of these analyses[4]. Survey answers were averaged together and used for the weighting scheme (Table 3.12.1).

3.12.1 Weights

The following weighting guidelines were used for each analysis:

Table 3.12.1. *Weights applied to each analysis result.*

Analysis #	Analysis	Weight (Ozone Only)	Weight (All Others)
1	Number of other parameters	5%	5%
2	Trends Impact	10%	10%
3	Measured Concentrations	13%	14%
4	Deviation from the NAAQS	9%	9%
5	Area Served	8%	8%
6	Population Served	8%	10%
7	Monitor-to-Monitor Correlation	7%	6%
8	Removal Bias	8%	8%
9a	Emissions Inventory	8%	12%
9b (O_3 only)	Predicted Ozone	9%	*NA*
10	Traffic Counts	8%	9%
11	Environmental Justice	7%	9%

[4] Pope, R. L. & J. Wu. (2014) A Multi-Objective Assessment of an Air Quality Monitoring Network Using Environmental, Economic, and Social Indicators and GIS-Based Models. Journal of the Air & Waste Management Association 64(6):721-37.

3.12.2 Results for CO

There were 13 possible points in the score for each CO analysis, one for each of the 13 sites analyzed. Site ranking #1 in the analysis earned 13 points, those ranking #2 earned 12 points, etc.

Table 3.12.2 shows the final results of the CO evaluation where the scores have been converted to rank and Table 3.12.3 shows the breakdown of the data per analysis by raw scores with the final weighted average.

Table 3.12.2. *Final average rankings for CO sites.*

Site	Rank
West Phoenix	1
Central Phoenix	2
Glendale	3
Greenwood	4
South Phoenix	5

Site	Rank
Diablo	6
Mesa	7
Tempe	8
North Phoenix	9
West Chandler	10

Site	Rank
Dysart	11
South Scottsdale	12
Buckeye	13

Table 3.12.3. *Raw scores for CO analyses.*

Site	Number of other Para-meters monitored	Trends Impact	Measured Concentra tions	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Traffic Counts	Environ-mental Justice	Weighted Average	Rank
Buckeye	2	2	1	1	13	3	3	-	3	1	8	3.5	13
Central Phoenix	3	9	9	8	2	5	2	8	11	13	10	7.8	2
Diablo	1	1	-	-	4	4	10	-	12	11	9	6.8	6
Dysart	1	3	2	2	12	9	11	-	5	3	2	4.8	11
Glendale	2	8	8	7	6	13	8	5	8	7	6	7.4	3
Greenwood	1	5	10	9	3	1	1	9	13	10	12	7.4	4
Mesa	2	7	5	4	7	11	5	7	7	9	5	6.5	7
North Phoenix	2	8	6	5	8	12	9	4	2	6	3	5.9	9
South Phoenix	2	8	11	10	9	6	4	3	4	2	13	7.0	5
South Scottsdale	2	8	3	3	10	7	7	1	1	4	1	4.2	12
Tempe	3	4	7	6	1	2	5	6	10	12	7	6.0	8
West Chandler	1	5	4	4	11	10	6	2	6	5	4	5.4	10
West Phoenix	4	6	12	11	5	8	1	10	9	8	11	8.3	1
WEIGHT	5%	10%	14%	9%	8%	10%	6%	8%	12%	9%	9%		

3.12.3 Results for NO_2

There were 5 possible points in the score for each NO_2 analysis, one for each of the 5 sites analyzed. Table 3.12.4 shows the final results of the NO_2 evaluation. Table 3.12.5 shows the breakdown of the data per analysis by raw scores and weighted average.

Table 3.12.4. *Final rankings for NO_2 sites*

Site	Rank
Greenwood	1
Central Phoenix	2
West Phoenix	3
Diablo	4
Buckeye	5

Table 3.12.5. *Raw scores for NO_2 analyses*

Site	Number of other Para-meters monitored	Trends Impact	Measured Concentra tions	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Traffic Counts	Environ -mental Justice	Weighted Average	Rank
Buckeye	2	2	1	1	5	1	5	1	1	1	1	1.86	5
Central Phoenix	3	5	3	3	1	3	2	2	3	4	3	2.99	2
Diablo	1	1	-	-	4	4	4	-	4	3	2	2.96	4
Greenwood	1	3	4	4	2	2	3	4	5	2	5	3.36	1
West Phoenix	4	4	2	2	3	5	1	3	2	3	4	2.97	3
WEIGHT	5%	10%	14%	9%	8%	10%	6%	8%	12%	9%	9%		

3.12.4 Results for O_3

There were 18 possible points in the score for each O_3 analysis, one for each of the 18 sites analyzed. Table 3.12.6 shows the final results of the O_3 evaluation. Table 3.12.7 shows the breakdown of the data per analysis by raw scores and weighted average.

Table 3.12.6. *Final rankings for O_3 sites*

Site	Rank	Site	Rank	Site	Rank
West Phoenix	1	Cave Creek	7	Humboldt Mountain	13
Glendale	2	West Chandler	8	Tempe	14
South Phoenix	3	Pinnacle Peak	9	Dysart	15
Central Phoenix	4	Mesa	10	Blue Point	16
South Scottsdale	5	Falcon Field	11	Fountain Hills	17
North Phoenix	6	Buckeye	12	Rio Verde	18

Table 3.12.7. *Raw scores for O_3 analyses*

Site	Number of other Para-meters monitored	Trends Impact	Measured Concentrations	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Predicted Ozone	Traffic Counts	Environ-mental Justice	Weighted Average	Rank
Blue Point	2	8	8	9	12	1	9	5	1	13	4	4	6.7	16
Buckeye	4	2	1	1	18	6	12	14	3	15	3	14	7.3	12
Cave Creek	2	4	12	12	15	7	15	16	4	2	6	6	8.6	7
Central Phoenix	5	14	5	6	1	9	2	12	15	18	17	16	10.0	4
Dysart	3	3	3	3	16	16	11	2	6	12	5	9	7.2	15
Falcon Field	2	9	4	3	7	13	8	11	9	7	12	7	7.6	11
Fountain Hills	2	7	7	8	5	4	13	7	5	8	7	2	6.4	17
Glendale	4	13	9	10	10	18	6	15	10	9	11	12	10.8	2
Humboldt Mountain	1	8	8	8	17	3	17	17	2	1	1	3	7.3	13
Mesa	4	1	-	-	3	12	4	-	12	6	15	13	7.7	10
North Phoenix	5	12	15	4	9	15	5	1	8	10	13	10	9.4	6
Pinnacle Peak	2	10	13	11	11	5	14	3	7	3	8	5	8.1	9
Rio Verde	1	6	6	7	14	2	16	13	1	5	2	1	6.3	18
South Phoenix	4	12	10	11	6	10	3	8	13	16	10	18	10.4	3
South Scottsdale	4	13	11	13	4	8	7	10	7	14	13	8	9.8	5
Tempe	5	5	2	2	2	11	4	4	14	11	16	15	7.3	14
West Chandler	3	8	4	5	13	17	10	9	11	4	9	11	8.5	8
West Phoenix	6	11	14	9	8	14	1	6	16	17	14	17	11.5	1
WEIGHT	5%	10%	13%	9%	8%	8%	7%	8%	8%	9%	8%	7%		

3.12.5 Results for PM_{10}

There were 16 possible points in the score for each PM_{10} analysis, one for each of the 16 sites analyzed. Table 3.12.8 shows the final results of the PM_{10} evaluation. Table 3.12.9 shows the breakdown of the data per analysis by raw scores and weighted average.

Table 3.12.8. *Final average rankings for PM_{10} sites*

Site	Rank	Site	Rank
South Phoenix	1	North Phoenix	9
Greenwood	2	Glendale	10
West 43rd Avenue	3	Durango Complex	11
Buckeye	4	Mesa	12
West Phoenix	5	Tempe	13
West Chandler	6	Dysart	14
Higley	7	South Scottsdale	15
Central Phoenix	8	Zuni Hills	16

Table 3.12.9. *Raw scores for PM_{10} analyses*

Site	Number of other Para-meters monitored	Trends Impact	Measured Concentra tions	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Traffic Counts	Environ -mental Justice	Weighted Average	Rank
Buckeye	4	3	15	16	16	4	12	16	5	1	8	9.13	4
Central Phoenix	5	12	9	10	3	5	2	4	10	13	11	8.15	8
Durango Complex	3	7	8	8	1	1	3	1	16	10	16	7.39	11
Dysart	3	4	7	7	14	12	7	3	3	2	5	6.13	14
Glendale	4	11	4	4	10	15	4	5	8	8	7	7.47	10
Greenwood	3	8	14	15	2	2	1	7	14	14	12	9.26	2
Higley	2	6	12	13	12	14	10	6	9	6	3	8.88	7
Mesa	4	9	2	2	4	9	6	14	11	11	9	7.38	12
North Phoenix	5	9	6	6	13	16	4	13	4	5	4	7.74	9
South Phoenix	4	12	11	12	7	3	9	11	15	4	15	9.81	1
South Scottsdale	4	11	1	1	8	7	8	15	2	9	2	5.78	15
Tempe	5	1	5	5	5	8	6	8	13	12	10	7.24	13
West 43rd Avenue	2	5	13	14	9	6	5	12	12	3	13	9.14	3
West Chandler	3	8	16	9	11	13	11	2	6	7	6	8.89	6
West Phoenix	6	10	10	11	6	10	1	9	7	11	14	9.04	5
Zuni Hills	1	2	3	3	15	11	7	10	1	1	1	4.76	16
WEIGHT	5%	10%	14%	9%	8%	10%	6%	8%	12%	9%	9%		

3.12.6 Results for $PM_{2.5}$

There were 8 possible points in the score for each $PM_{2.5}$ analysis, one for each of the 8 sites analyzed. Table 3.12.10 shows the final results of the $PM_{2.5}$ evaluation. Table 3.12.11 shows the breakdown of the data per analysis by raw scores and weighted averages.

Table 3.12.10. *Final rankings for $PM_{2.5}$ sites*

Site	Rank
West Phoenix	1
Durango Complex	2
South Phoenix	3
Glendale	4
North Phoenix	5
Diablo	6
Mesa	7
Tempe	8

Table 3.12.11. *Raw scores for $PM_{2.5}$ analyses*

Site	Number of other Para-meters monitored	Trends Impact	Measured Concentra tions	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Traffic Counts	Environ -mental Justice	Weighted Average	Rank
Diablo	1	1	-	-	3	4	3	-	-	5	5	3.28	6
Durango Complex	1	4	6	6	6	1	5	7	-	1	8	4.64	2
Glendale	2	3	4	4	8	8	1	2	-	3	3	4.00	4
Mesa	2	5	1	1	7	7	2	1	-	4	2	3.22	7
North Phoenix	3	3	3	3	5	6	1	3	-	4	1	3.28	5
South Phoenix	2	5	5	5	4	2	4	4	-	2	6	4.03	3
Tempe	3	2	2	2	1	3	2	6	-	6	4	3.06	8
West Phoenix	4	6	7	7	2	5	4	5	-	5	7	5.44	1
WEIGHT	5%	10%	14%	9%	8%	10%	6%	8%	12%	9%	9%		

3.12.7 Results for SO_2

There were two possible points in the score since there are only two SO_2 sites in the MCAQD network. Table 3.12.12 shows the final results of the SO_2 evaluation. Table 3.12.13 shows the breakdown of the data per analysis by raw scores and weighted averages.

Table 3.12.12. *Final rankings for SO_2 sites*

Site	Rank
Central Phoenix	1
Durango Complex	2

Table 3.12.13. *Raw scores for SO_2 analyses*

Site	Number of other Para-meters monitored	Trends Impact	Measured Concentra tions	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Traffic Counts	Environ-mental Justice	Weighte d Average	Rank
Central Phoenix	2	2	2	1	1	2	1	1	2	2	1	1.6	1
Durango Complex	1	1	1	2	2	1	2	2	1	1	2	1.4	2
WEIGHT	5%	10%	14%	9%	8%	10%	6%	8%	12%	9%	9%		

Section 4: Adequacy of the Current Air Monitoring Network

This section attempts to determine if the existing ambient monitoring network adequately represents Maricopa County in the areas of population coverage, source coverage, and spatial coverage. The analysis takes eight different indicators in three different variable areas and reclassifies them into GIS rasters with a common ranking system. The rasters are then combined in a spatially-averaged overlay which provides a location score showing areas that could benefit from the addition of a monitoring site. The overlay is weighted toward certain variables, depending on the pollution parameter. Weights are assigned *ad hoc,* based on expert opinion of air pollution scientists[5].

As depicted in Figure 4.0.1, input spatial data are first converted to raster format within the GIS. Each raster is then reclassified to a congruous scale of 1-10, based on a partition of the data distribution, using Jenks natural breaks[6], within that variable. The reclassified rasters are then aggregated into a weighted spatial overlay which displays the weighted average in each spatial location.

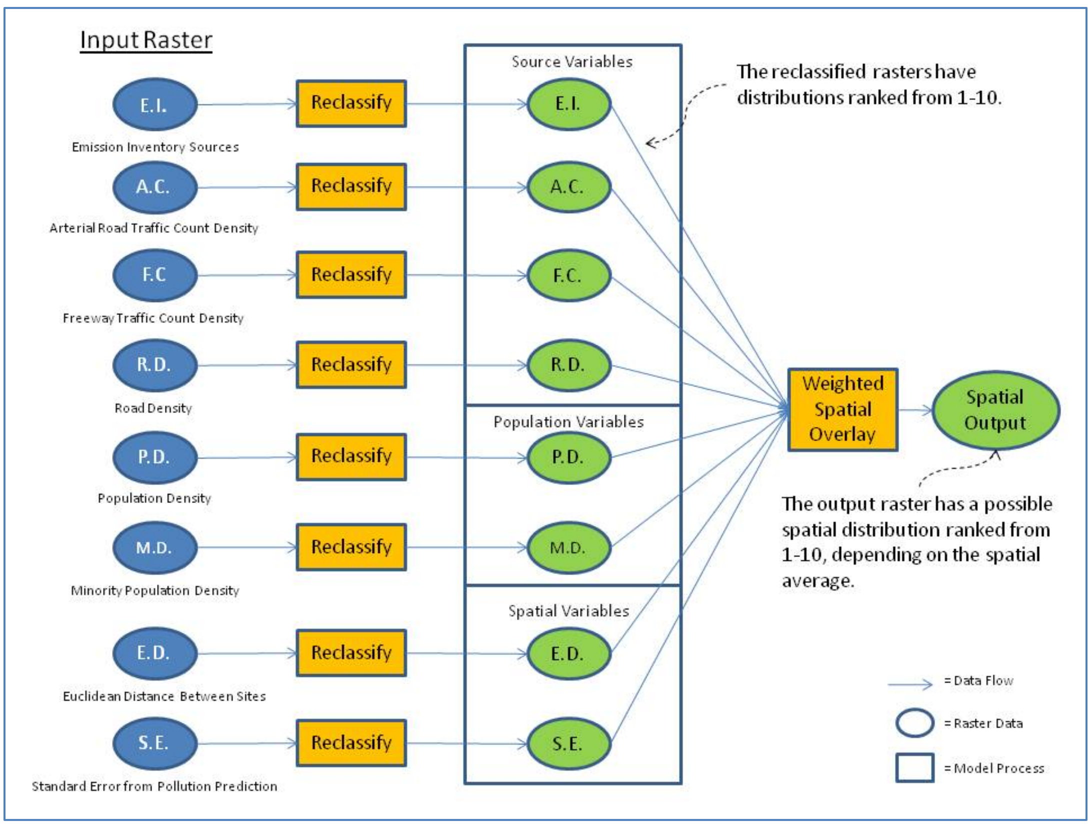

Figure 4.0.1. Model for assessing air monitoring adequacy.

[5] Pope, R. L. & J. Wu. (2014) A Multi-Objective Assessment of an Air Quality Monitoring Network Using Environmental, Economic, and Social Indicators and GIS-Based Models. Journal of the Air & Waste Management Association 64(6):721-37.

[6] A method of statistical data classification that partitions data into classes using an algorithm that calculates groupings of data values based on the data distribution. Jenks' optimization seeks to reduce variance within groups and maximize variance between groups.

This spatial output raster depicts a spatially-explicit scored map. The score represents the suitability of the location to add an additional monitoring site. Possible scores are 1-10, though this score does represent an average of all the input analysis variables, so in this Assessment the results scores vary.

4.1 Description of Analysis Indicators

Indicators are grouped into three separate categories: Source, Population, and Spatially Oriented. These categories are organized so as to simplify assigning weights and make the weighting process transparent. Weights are assigned differently to each pollution parameter, because they are based on the characteristics of that parameter.

4.1.1 Source-Oriented Indicators

- Indicator #1: Emissions Inventory Point-Sources

  This indicator creates a raster map of point emission sources taken from the MCAQD Emissions Inventory Report. The emission sources are aggregated into each township, range, and section; the sum of emissions in each sector, aka emission sections, is used as the raster value. When reclassifying the raster, the entire distribution of emission sections is divided into 10 parts and assigned a score of 1-10 with 10 being the highest partition.

- Indicator #2: Arterial Road Traffic Count

  First of the mobile source indicators, this uses the average weekday traffic (AWT) count from arterial roads in Maricopa County. AWT counts are averaged in each township, range, and section, with the average result being used as the raster value. Higher AWT counts are assigned higher scores.

- Indicator #3: Highway Traffic Count

  Second of the mobile source indicators and similar to the Arterial Road Traffic Count, this indicator uses the AWT from interstate and state highways in Maricopa County. AWT counts are also averaged in each township, range, and section. Higher AWT counts are assigned higher scores.

- Indicator #4: Road Density

  Third of the mobile source indicators, this assesses the density of roads, including highways, arterial, and collectors, in a given area and returns the result as the raster value. This indicator is designed to give support to the traffic counts in determining emissions from mobile sources. Since traffic counts are based upon discrete sampling locations and it is difficult to ascertain if these locations are evenly sampled, the road density will serve as another proxy in determining mobile source emissions. The indicator works by calculating the density of roads (lines) within the current and adjacent cells. Higher densities are assigned higher scores.

4.1.2 Population-Oriented Indicators

- Indicator #5: Population Density

  This indicator uses the 2010 Census block groups to account for total population. The population density of each block group (population/block group area) is calculated and this value is used for the raster. Higher population densities are assigned higher scores since it is desirable to have a monitor representing the greatest number of people.

- Indicator #6: Minority Population Density

  This indicator is identical in design to the Population Density variable above, except that instead of total population in each census block group, the minority (non-white) population is used. This indicator provides a method of accounting for environmental equity issues. Areas with higher minority population densities are assigned higher scores.

4.1.3 Spatially Oriented Indicators

- Indicator #7: Euclidean Distance between Monitors

  This indicator calculates and assigns scores based on the straight-line distance away from an existing monitoring site. The implied assumption is that it is more desirable to have a new monitoring site farther away from an existing site. In practice this method creates concentric rings around each monitoring site at pre-defined distances. The score increases the farther away in distance that the location is from existing monitoring sites. Scores were based upon the Section 3 correlation analysis by determining the distance where monitors were 75% correlated

- Indicator #8: Standard Error from Predicted Pollution

  This indicator accounts for the actual modeled pollution surface. This is accomplished by creating a kriging interpolation map for each pollution parameter using annual average data from each existing monitoring site. However, instead of a standard pollution surface output, a standard error map is generated. This map shows areas of highest uncertainty in the kriging model. After converting the map to a raster, the areas of highest uncertainty are reclassified with the highest score.

The spatial output results for each pollution parameter are displayed as a scored map. An explanation and justification for the weights used are also given. Recommendations for adding additional monitoring sites are not made in this section; rather those recommendations are made in Section 5 where results and information from the previous sections are brought together to provide comprehensive reasons to add, modify, or remove monitoring sites from the MCAQD network.

4.2 CO Parameter Results

4.2.1 Weights used

Table 4.2.1. *CO Weights*

Area	Indicator	Weights	
Source-Oriented Indicators		.35	
	Emissions Inventory Point-Sources		.12
	Arterial Road Traffic Count		.09
	Highway Traffic Count		.07
	Road Density		.07
Population-Oriented Indicators		.35	
	Population Density		.15
	Minority Population Density		.20
Spatially-Oriented Indicators		.30	
	Euclidean Distance Between Monitors		.16
	Standard Error from Predicted Pollution		.14
Totals		1.0	1.0

4.2.2 Justification

CO emission sources tend to be highest among mobile sources, especially among arterial roads where vehicles spend more time idling; therefore, mobile source indicators are given almost twice the weight of point-sources. The source-oriented variables themselves are given slightly higher weight.

In recent years, CO has become a pollutant that is highly associated with urban environments. It mostly occurs in areas of high population, especially in areas of high minority population. Therefore, more weight was assigned to minority population density, while the population-oriented variable was given slightly lower weight.

Correlation between CO monitoring sites decreases while moving away from existing sites (see Figure 3.7.2, Correlogram of CO Monitoring Sites); therefore, CO sites can be located relatively close together and still be useful. Because of this, concentric rings on the Euclidean Distance indicator were set at intervals of 5 km. Spatially-oriented variables were given a slightly lower weight than the other variables to deemphasize the effects of distance in respect to sources and population.

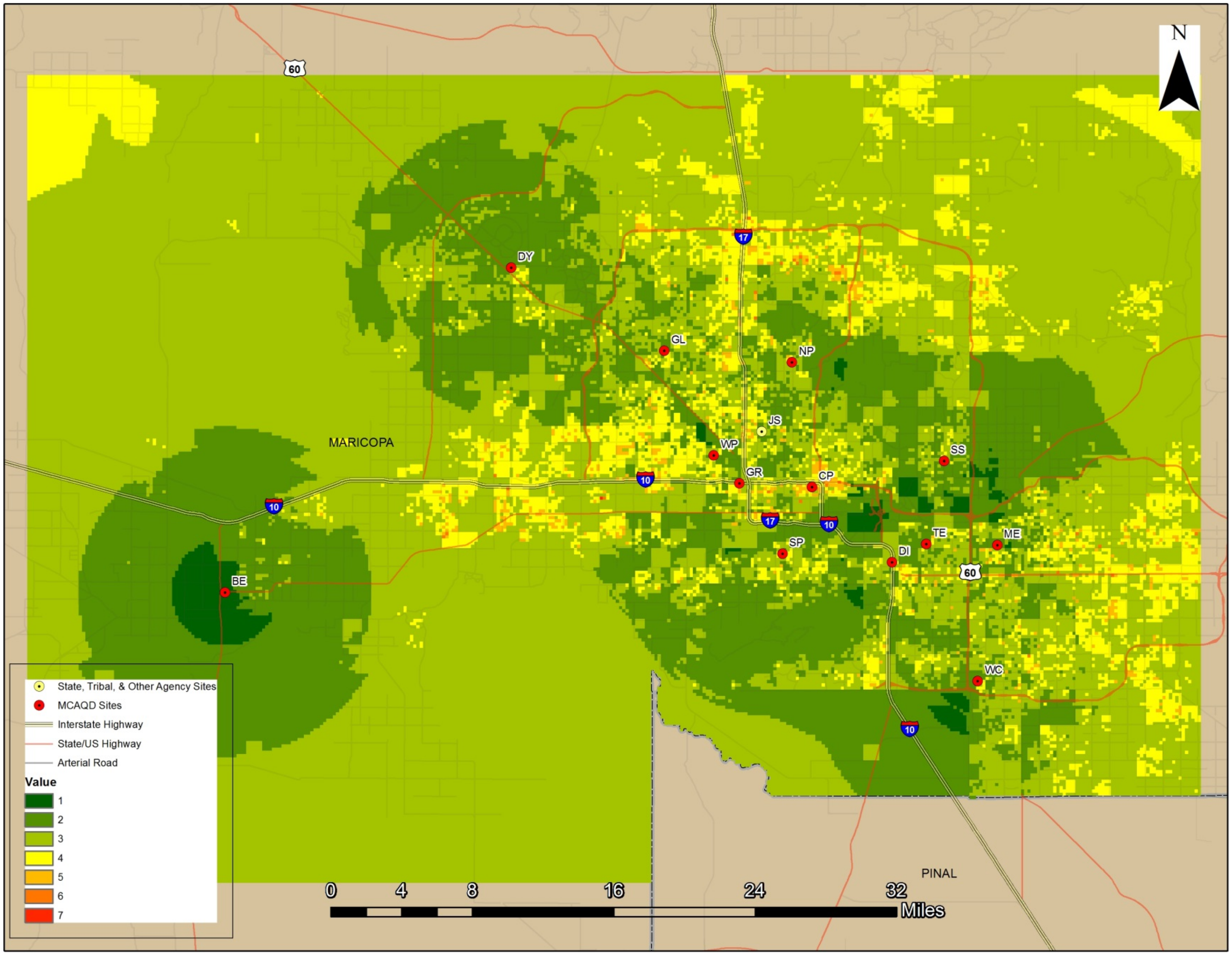

Figure 4.2.1. Map showing overlay of potentially-warranted CO site area rankings.

4.3 NO_2 Parameter Results

4.3.1 Weights Used

Table 4.3.1. *NO_2 Weights*

Area	Indicator	Weights	
Source-Oriented Indicators		.38	
	Emissions Inventory Point-Sources		.15
	Arterial Road Traffic Count		.08
	Highway Traffic Count		.08
	Road Density		.07
Population-Oriented Indicators		.37	
	Population Density		.17
	Minority Population Density		.20
Spatially-Oriented Indicators		.25	
	Euclidean Distance Between Monitors		.12
	Standard Error from Predicted Pollution		.13
Totals		1.0	1.0

4.3.2 Justification

NO_2 sources are a mix of mobile and point-sources, though the EPA lists on-road vehicles as the highest source in Maricopa County[7], followed by non-road equipment. Therefore, source-oriented indicators are given the highest weight and the traffic indicators have more of that weight than point-sources.

NO_2 tends to be a highly urban pollutant found in areas of high population, especially in areas of high minority population. Therefore, more weight is assigned to minority population density; while the population-oriented variables are given weight just slightly lower than source-oriented.

Correlation between NO_2 sites was relatively high, with 75% correlation at 5 km (see Figure 3.7.4, Correlogram of NO_2 Monitoring Sites). The correlogram also shows that this spatial correlation persists for a longer range, so NO_2 sites should be located farther apart to reduce the chance of redundancy.

[7] U.S. Environmental Protection Agency (2010) Air Emission Sources, http://www.epa.gov/air/emissions/.

Figure 4.3.1. Map showing overlay of potentially-warranted NO_2 site area rankings.

4.4 O_3 Parameter Results

4.4.1 Weights Used

Table 4.4.1. *O_3 Weights*

Area	Indicator	Weights	
Source-Oriented Variables		.40	
	Emissions Inventory Point-Sources		.13
	Arterial Road Traffic Count		.09
	Highway Traffic Count		.08
	Road Density		.10
Population-Oriented Variables		.32	
	Population Density		.18
	Minority Population Density		.14
Spatially-Oriented Variables		.28	
	Euclidean Distance Between Monitors		.13
	Standard Error from Predicted Pollution		.15
Totals		1.0	1.0

4.4.2 Justification

O_3 is a secondary pollutant that is indirectly related to the emissions from sources. However, the panel of experts that decided on weights for the O_3 analysis felt that the locations of precursor sources, especially mobile sources, were important to the siting of O_3 monitoring sites. This category of source-oriented variables includes stationary facilities, e.g. solvent-using facilities, combustion sources, and mobile traffic sources of VOCs.

O_3 is a pollutant with considerable immediate health concerns; therefore, it is important to have O_3 monitors near high populations. The highest long term O_3 concentrations tend to occur in rural areas away from high population densities, including minority populations. Because of these dynamics, the population-oriented variables are only given a medium weight with the population density indicator have more weight than the minority population density Indicator.

O_3 monitoring sites tend to be highly correlated up to 20 km apart (see Figure 3.7.6, Correlogram of O_3 Monitoring Sites). Correlations tend to stay high, even at greater distances, which show that having a network of O_3 monitoring sites close together is not necessary. Therefore, the Euclidean Distance indicator was given relatively low weight. The Standard Error indicator, on the other hand, is the only way to factor secondary-forming pollution into this model, so it is given slightly higher weight.

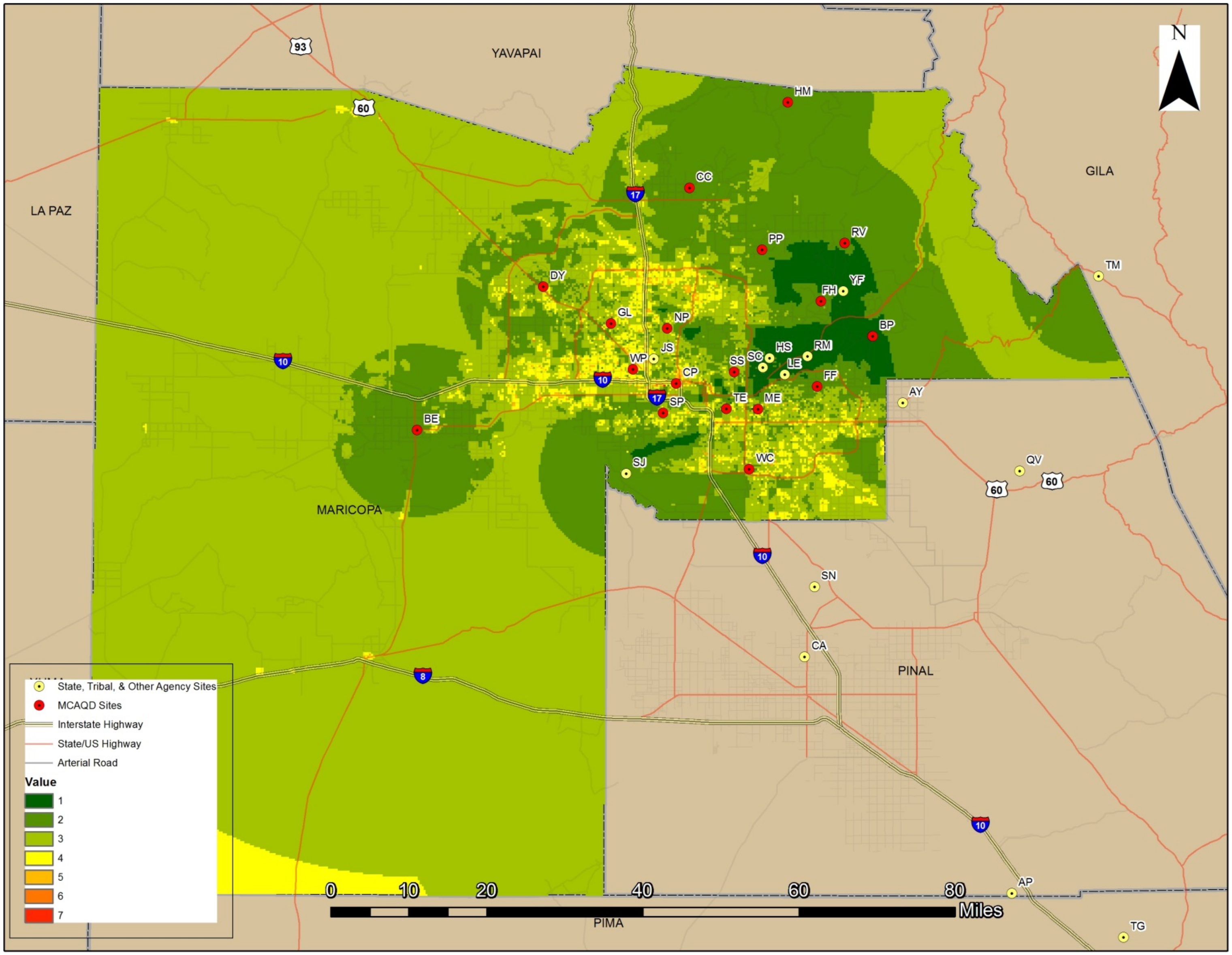

Figure 4.4.1. Map showing overlay of potentially-warranted O_3 site area rankings, zoomed out to county scale.

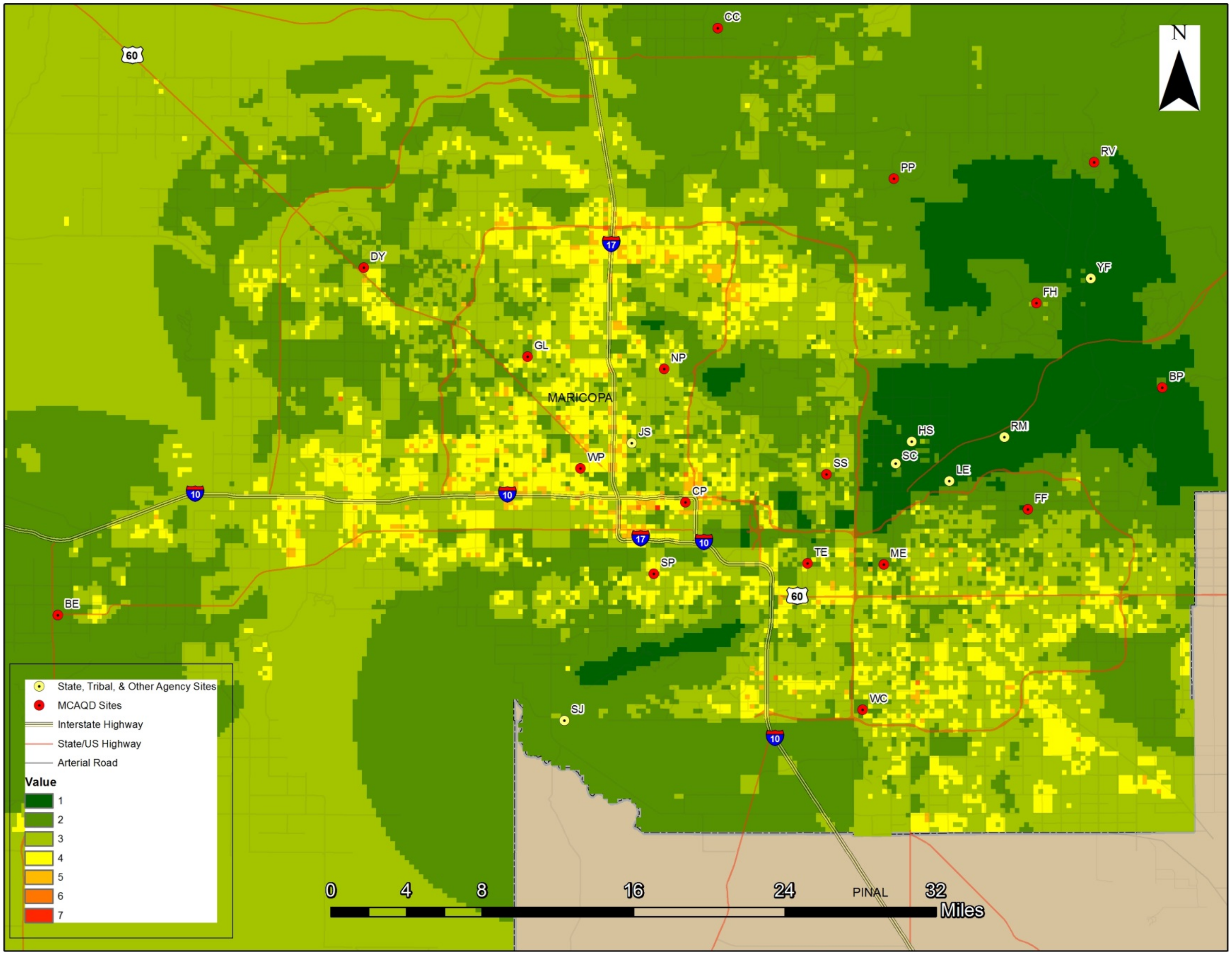

Figure 4.4.2. Map showing overlay of potentially-warranted O_3 site area rankings, zoomed into the Phoenix metropolitan area.

4.5 PM_{10} Parameter Results

4.5.1 Weights Used

Table 4.5.1. *PM_{10} Weights*

Area	Indicator	Weights	
Source-Oriented Variables		.47	
	Emissions Inventory Point-Sources		.20
	Arterial Road Traffic Count		.09
	Highway Traffic Count		.08
	Road Density		.10
Population-Oriented Variables		.29	
	Population Density		.16
	Minority Population Density		.13
Spatially-Oriented Variables		.24	
	Euclidean Distance Between Monitors		.12
	Standard Error from Predicted Pollution		.12
Totals		1.0	1.0

4.5.2 Justification

Based on evaluation of the re-classed emissions inventory map created for this section and the highest concentration analysis from Section 3, it has been shown that known PM_{10} concentrations have a strong relationship with point-sources; though the top sites with the highest concentrations (West Chandler and Buckeye) seemed to be impacted more from agricultural sources than PM_{10} sources listed in the inventory. Because of this, the Source-Oriented variable is given the highest weight in this model, and the Emissions Inventory Point-sources indicator is given the highest weight inside the variable.

Known PM_{10} concentrations tend to be highest in urban areas. Therefore the Population-Oriented variables were given a fair amount of weight, though less than the Source-Oriented variables.

PM_{10} monitoring sites tend to quickly lose correlation with distance, almost in a linear fashion (see Figure 3.7.8, Correlogram of PM_{10} Monitoring Sites). This shows that PM_{10} sites can be located relatively close together and not be redundant;, therefore the spatially-oriented variables were given a medium weight.

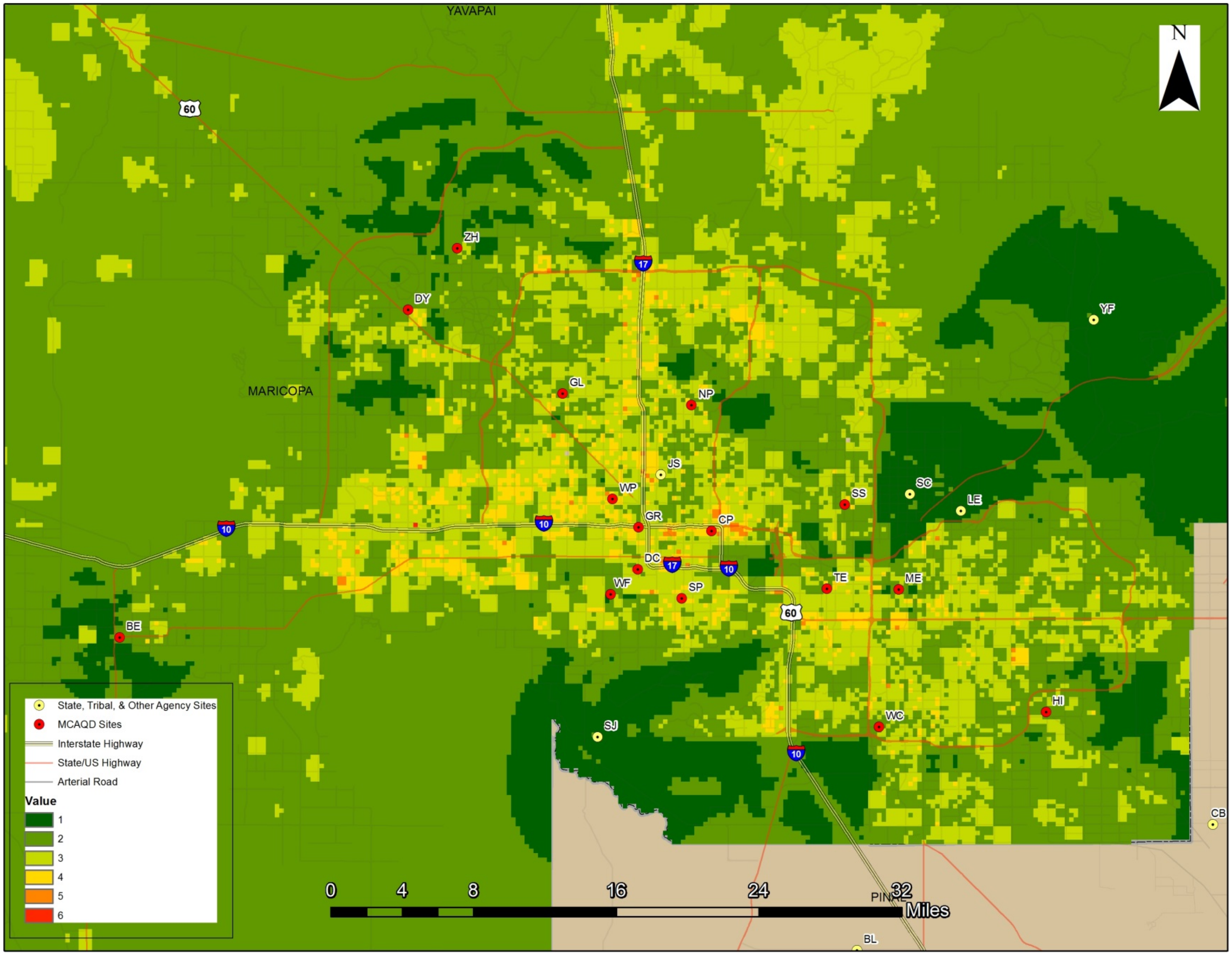

Figure 4.5.1. Map showing overlay of potentially-warranted PM_{10} site area rankings.

4.6 $PM_{2.5}$ Parameter Results

4.6.1 Weights Used

Table 4.6.1. *$PM_{2.5}$ Weights*

Area	Indicator	Weights	
Source-Oriented Variables		.36	
	Emissions Inventory Point-Sources		N/A
	Arterial Road Traffic Count		.12
	Highway Traffic Count		.12
	Road Density		.12
Population-Oriented Variables		.40	
	Population Density		.19
	Minority Population Density		.21
Spatially-Oriented Variables		.24	
	Euclidean Distance Between Monitors		.10
	Standard Error from Predicted Pollution		.14
Totals		1.0	1.0

4.6.2 Justification

Based on the emissions inventory report, the EPA lists the major sources of $PM_{2.5}$ in Maricopa County as: miscellaneous, non-road equipment, road dust, industrial processes, fires, and on-road vehicles[8]. In this model, a relatively high weight was applied to mobile sources, because no data were available for the point-sources.

Since fires and residential wood combustion have such a high impact on $PM_{2.5}$ emissions, the population-oriented variables were given higher weights than source-oriented variables. $PM_{2.5}$ also tends to be located in urban areas with high densities of minority demographics. Because $PM_{2.5}$ health effects occur locally, higher weight was given to the minority population density indicator.

$PM_{2.5}$ monitoring sites tend to quickly lose correlation with distance (see Figure 3.7.10, Correlogram of $PM_{2.5}$ Monitoring Sites). This shows that $PM_{2.5}$ sites can be located relatively close together and not be redundant, though the Euclidean Distance indicator was not given as much weight as the source and population variables. The Standard Error indicator was given a medium weight, because the relatively low number of $PM_{2.5}$ monitoring sites introduces a considerable amount of error when predicting $PM_{2.5}$.

[8] U.S. Environmental Protection Agency (2010) Air Emission Sources, http://www.epa.gov/air/emissions/

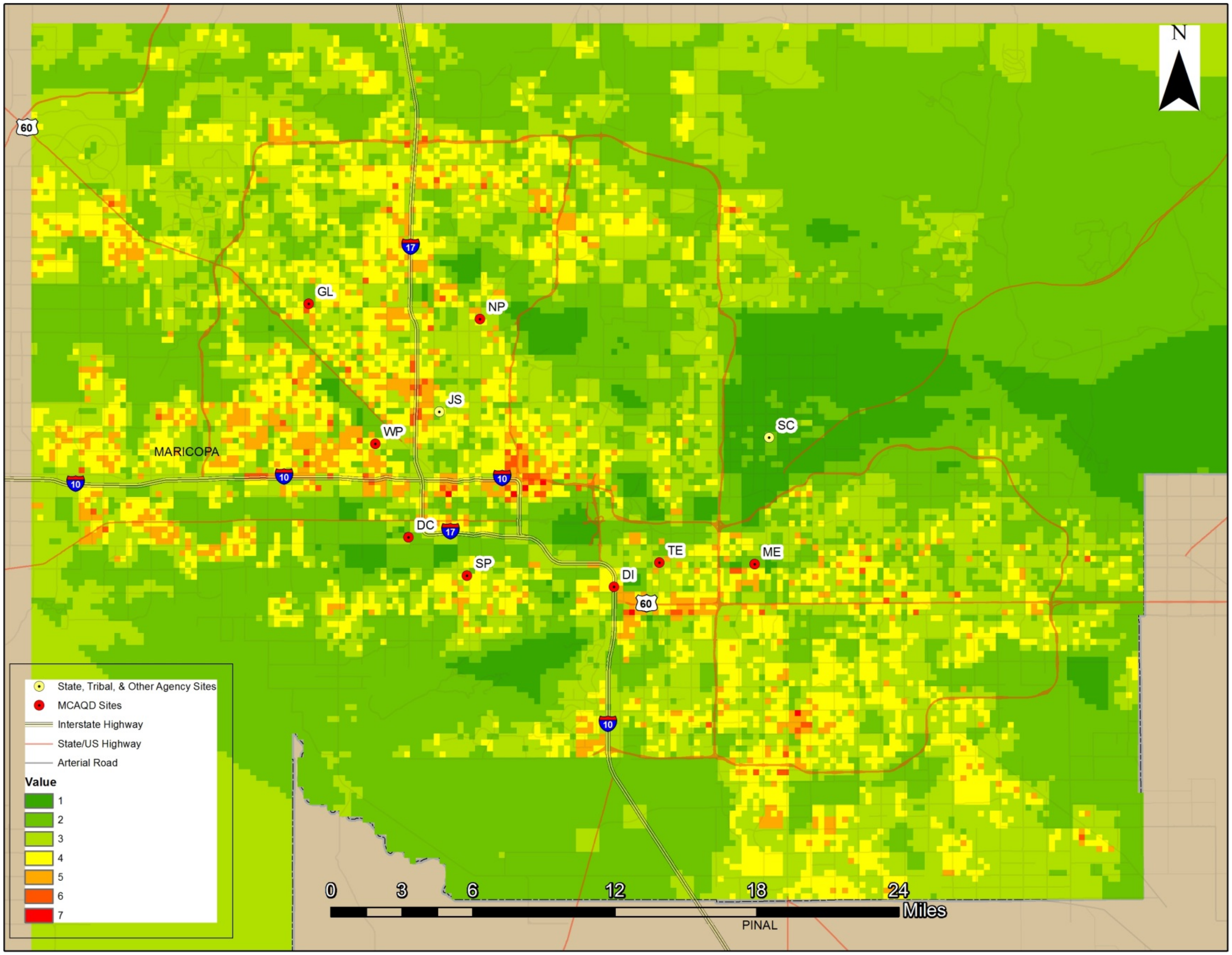

Figure 4.6.1. Map showing overlay of potentially-warranted $PM_{2.5}$ site area rankings.

4.7 SO_2 Parameter Results

4.7.1 Weights Used

Table 4.7.1. *SO_2 Weights*

Area	Indicator	Weights	
Source-Oriented Variables		.38	
	Emissions Inventory Point-Sources		.18
	Arterial Road Traffic Count		.06
	Highway Traffic Count		.08
	Road Density		.06
Population-Oriented Variables		.30	
	Population Density		.15
	Minority Population Density		.15
Spatially-Oriented Variables		.32	
	Euclidean Distance Between Monitors		.16
	Standard Error from Predicted Pollution		.16
Totals		1.0	1.0

4.7.2 Justification

The EPA lists the major source of SO_2 in Maricopa County as non-road equipment, i.e. diesel powered construction equipment[9]. On-road vehicles come in second with fossil fuel combustion ranking a distant third. Other processes, including industrial processes and electricity generation are insignificant. There are few sources of SO_2 in Maricopa County; most of Arizona's SO_2 sources are located in the mining and smelting areas in counties east of Maricopa, which are generally downwind. This model does not have an indicator to emphasis construction sources of SO_2, but mobile sources will be given more weight than point-sources. Emission source variables are still given a slightly higher weight in the model.

Minority and total population indictors are given an equal weight.

The SO_2 monitoring sites show low correlation and little redundancy; however, this may be due to statistical error since SO_2 concentrations are almost at non-detect levels and the sample size is low due to only having only two monitoring sites (see Figure 3.7.12, Correlogram of SO_2 Monitoring Sites). Although the sites are close by and SO_2 concentrations show little variance, a high amount of spatial error exists (see Table 3.3.6 for details). Because of these dynamics, the spatially-oriented variables were given a medium weight.

[9] U.S. Environmental Protection Agency (2010) Air Emission Sources, http://www.epa.gov/air/emissions/

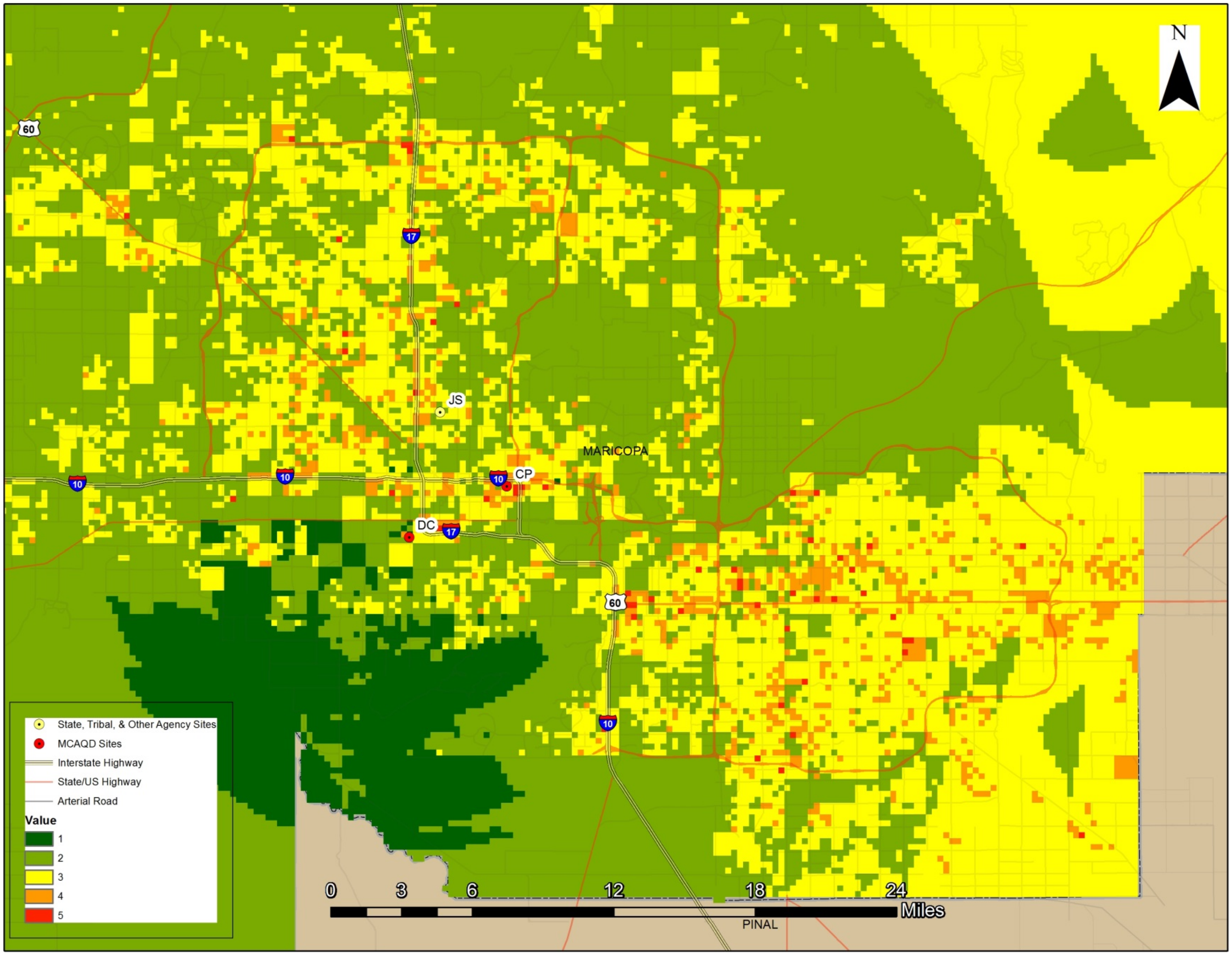

Figure 4.7.1. Map showing overlay of potentially-warranted SO_2 site area rankings.

Section 5: Findings/ Potential Changes to the MCAQD Monitoring Network

This Assessment confirms that the current MCAQD network substantially meets all federally required monitoring objectives. However, as ambient air monitoring objectives have shifted over time (e.g. air quality has improved, new air quality objectives and standards have been strengthened), MCAQD may wish to consider the findings of this Assessment during future Air Monitoring Network Planning exercises to determine whether or how to reconfigure and optimize its monitoring network to enhance its value to stakeholders, scientists and the general public.

Specifically, as a result of this Assessment, MCAQD will be informed to evaluate whether:

- unnecessary or redundant monitors for some pollutants could be removed;
- the monitoring network may be reconfigured to deemphasize the collection of data for pollutants that are steadily becoming less problematic (e.g. carbon monoxide);
- the existing network could be reconfigured to refine the monitoring of pollutants that are new or are presenting persistent challenges (e.g. ground level ozone and precursors).

This section contains suggestions for any changes to the monitoring network. Data and information from the analyses in the previous sections are used to suggest the addition, subtraction, or movement of monitors or sites. These suggestions are based upon the EPA requirements for monitoring sites, e.g. site objective and number of required sites as listed in 40 CFR Part 58. These suggestions are organized per criteria pollutant category.

5.1 Potential Changes to the CO Network

5.1.1 Summary

Number of existing monitors in 2014: 13

Network changes since 2010 Network Assessment:

1. West Indian School site closed July 2010. Maricopa County lost access to this site, though the 2010 Network Assessment noted that the area was well represented by the West Phoenix monitor and the site was recommended to be closed and not replaced. The EPA concurred with this decision.
2. Diablo site was opened in February 2014. Diablo is the first of two required near-road NO_2 monitors, though it also contains CO and $PM_{2.5}$. Its location was based upon an analysis of Maricopa County highways to find an area of high traffic emissions and favorable site characteristics.

Monitors that may be considered for closure: See Narrative. Monitors that should be considered to be moved or changed:

1. Move the Greenwood CO monitor from its current location to the new 'Thirty-Third' near-road monitoring site (opening in late 2015).
2. Change the West Phoenix site's monitoring objective from Population Exposure to Highest Concentration.
3. Change the Buckeye site objective from 'Population Exposure' to 'Upwind Background'.

Potential new monitors: None

Table 5.1.1. *CO monitoring site summary*

Site	AQS #	Objective	Scale
Buckeye	04-013-4011	Population Exposure	Neighborhood
Central Phoenix	04-013-3002	Population Exposure	Neighborhood
Diablo	04-013-4019	Source Oriented (Near-Road)	Microscale
Dysart	04-013-4010	Population Exposure	Neighborhood
Glendale	04-013-2001	Population Exposure	Neighborhood
Greenwood	04-013-3010	Population Exposure	Middle
Mesa	04-013-1003	Population Exposure	Neighborhood
North Phoenix	04-013-1004	Population Exposure	Neighborhood
South Phoenix	04-013-4003	Population Exposure	Neighborhood
South Scottsdale	04-013-3003	Population Exposure	Neighborhood
Tempe	04-013-4005	Population Exposure	Neighborhood
West Chandler	04-013-4004	Population Exposure	Neighborhood
West Phoenix	04-013-0019	Population Exposure	Neighborhood

5.1.2 Narrative

Closing monitors: Maricopa County is currently in attainment of the CO NAAQS and concentrations are usually quite low (the last violation of the eight-hour standard was in 1996 and the last violation of the one-hour standard was in 1984). However, Maricopa County was previously classified as serious nonattainment for CO, until it was reclassified as a maintenance area in 2005. Hence, MCAQD will be operating the CO network under a maintenance plan until 2025, see *Federal Register 70 FR 11553 (2005) and 80 FR 63185 (2015)*. The CO maintenance plan, see *70 FR 11553*, requires that the monitoring network adequately characterize the area. Because of the previous nonattainment and current maintenance status, there is a relatively large network of CO monitors across the metropolitan area.

Many of the CO monitors have design values close to zero and thereby experience little impact from CO; and they also have a low concentration correlation. Even though the correlation is low and the cost of operating these sites is normalized by monitoring multiple parameters, reducing the size of this network by closing select monitors would not significantly compromise CO characterization.

However, the policy and legal implications of changing Maricopa County's CO monitoring network need to be explored before closing any CO monitors.

The Maricopa County 2005 CO maintenance plan details a network of 12 CO monitoring sites, including the ADEQ's JLG (Supersite) location. As of October 2015, there are 15 CO sites operating including the new near-road monitoring sites Diablo and Thirty-Third, so this report suggests that closing three (3) CO monitors may be acceptable. The monitors that ranked the lowest in the Section 3 analysis (refer back to Table 3.12.2), not including Buckeye that serves an upwind background objective, and would have the least amount of impact if closed are:

Scenario A:

Monitors to be Shut Down Under Scenario A	
1.	West Chandler
2.	Dysart
3.	South Scottsdale

If it is possible to close additional CO monitors, there are multiple scenarios that could be employed:

Scenario B: Closing down the lowest ranking monitors (except Buckeye, which retains its background objective). This would result in 5 sites closed and leave 9 running, including the ADEQ's JLG (Supersite) and presuming that the Greenwood monitor is moved to the new Thirty-Third site:

Monitors to be Shut Down Under Scenario B	
1.	Tempe
2.	North Phoenix
3.	West Chandler
4.	Dysart
5.	South Scottsdale

Scenario C: Closing down current seasonal monitors (except Buckeye, which retains its background objective). This would result in 8 monitors closed and leave 6 running, including the ADEQ's JLG (Supersite) and presuming that the Greenwood monitor is moved to the new Thirty-Third site:

Monitors to be Shut Down Under Scenario C	
1.	Dysart
2.	Glendale
3.	Mesa
4.	North Phoenix

5. South Phoenix
6. South Scottsdale
7. Tempe
8. West Chandler

Moving/changing monitors: In late 2015, the Thirty-Third-near-road monitoring site was officially opened approximately 1.2 km to the west of the existing Greenwood site. Greenwood already has the highest CO correlation in the network with the West Phoenix site, located 3.2 km away, and is expected to have a very high correlation with this new site. In addition, Thirty-Third will cover the same sources (highway traffic) as Greenwood, though being located closer to the highway should cause measured concentrations to be higher and will call for a reduction of scale to 'Microscale' and a change of objective to 'Source-Oriented'. Therefore the Greenwood CO site could be closed and replaced with the Thirty-Third site.

In accordance with Appendix D of 40 CFR part 58, it is also appropriate to change the objective of the West Phoenix CO monitor to 'Highest Concentrations' as that monitor consistently has the highest measured concentrations in the network. Likewise, changing the Buckeye CO monitor objective to 'Upwind Background' would be appropriate since it has the lowest measured concentrations and is located in a general upwind position to the metropolitan area.

Potential new monitors: CO levels across Maricopa County are uniformly low as compared to the NAAQS. Because of this adding new CO monitoring sites is not warranted. However, the opening of the Thirty-Third near-road monitoring site will add a CO monitor to the network, though this could be a replacement for the Greenwood monitor.

5.2 Suggested Changes to the NO_2 Network

5.2.1 Summary

Number of existing sites in 2014: 5

Network changes since 2010 Network Assessment:

1. South Scottsdale monitor closed in June 2011. In the 2010 assessment this monitor was noted to be mostly ineffectual and it was recommended the monitor be moved. Ultimately, the monitor was closed down permanently to provide equipment for the new NO_2 near-road monitoring site, Diablo.
2. Diablo site opened in February 2014. Diablo is a near-road NO_2 site located near the junction of Interstate-10 and US 60. The site was chosen as the best combination of high-volume traffic sources, nearby population, and environmental conditions, i.e. terrain, elevation/grade, meteorological orientation, etc.

Monitors recommended for closure: None

Monitors recommended being moved or changed:

1. Greenwood monitor moved to the new Thirty-Third near-road NO_2 monitoring site.
2. Buckeye monitor objective changed to 'Upwind Background' or 'General/Background'.
3. Central Phoenix monitor objective changed to 'Maximum Concentrations'.

Potential new monitors:

1. A second near-road NO_2 monitoring site is required. The 'Thirty-Third' site has already been established in west Phoenix and started operation at the end of 2015.

Table 5.2.1. *NO_2 monitoring site summary*

Site	AQS #	Objective	Scale
Buckeye	04-013-4011	Population Exposure	Urban
Central Phoenix	04-013-3002	Population Exposure	Neighborhood
Diablo	04-013-4019	Source-Oriented	Microscale
Greenwood	04-013-3010	Population Exposure	Middle
West Phoenix	04-013-0019	Population Exposure	Neighborhood

5.2.2 Narrative

<u>Closing monitors</u>: It is not recommended that the closure of any NO_2 sites be considered. The Section 3 analyses ranked Buckeye with the lowest score; however, as there are other parameters monitored there, it incurs little additional cost to have the additional NO_2 monitor at the site and it provides a useful urban scale background function.

<u>Moving/changing monitors</u>: With the new near-road NO_2 site, 'Thirty-Third', operational, moving the NO_2 monitor from Greenwood to this new site may be considered (i.e. closing down the Greenwood NO_2 monitor). Thirty-Third is located approximately 1.2 km to the west of Greenwood and will serve the same purpose of monitoring emissions from the I-10 highway. However, as Thirty-Third will be a microscale monitor located closer to the highway, it is expected that its measured concentrations will be higher. Also, the Monitor-to-Monitor Correlation analysis of Section 3 shows that, on average, NO_2 monitors become redundant when located within 6 km of each other (see Figure 3.7.4), so it is expected that Greenwood and Thirty-Thirty would be highly correlated and redundant.

It is also suggested to change the objective of the Buckeye monitor from 'Population Exposure' to 'Upwind Background' in accordance with appendix D of 40 CFR part 58. The Buckeye NO_2 monitor was originally put into place with the objective of measuring NO_2 emissions from power plants to the west. However, the low design value of this monitor shows that the power plant emissions have little effect on the monitor and the objective was changed to Population Exposure. Conversely, population density in the vicinity of the monitor is relatively sparse and the NO_2 design value is consistently the lowest in the network, therefore a more appropriate objective would be measuring background levels of NO_2. The current 'Urban' monitoring scale is also appropriate to a background objective.

The NO_2 monitoring network currently lacks a monitor with the designated 'Maximum Concentrations' objective. The Section 3 Measured Concentrations analysis (Table 3.3.2) identifies Greenwood as having the highest design value; however, as that monitor is being recommended to be moved to the new Thirty-Third site, it is recommended to change the Central Phoenix monitor to the maximum concentration objective. Central Phoenix currently has the second highest concentrations in the network. It is possible that the new Thirty-Third monitor will have a higher design value than Central Phoenix, but Thirty-Third will have a source-oriented objective.

Potential new monitors: With NO_2 concentrations within attainment of the NAAQS, there are no requirements to add any additional monitoring sites (with the exception of the NO_2 near-road monitor as previously mentioned).

5.3 Suggested Changes to the O_3 Network

5.3.1 Summary

Number of existing sites in 2014: 18

Network changes since 2010 Network Assessment:

1. Pinnacle Peak site was moved one kilometer to the south by request of the site owner.
2. Rio Verde site construction in 2012 added more structures to the area, including an additional story to the building where the monitor is housed. Coincidental with these structural changes, O_3 concentrations at the monitor have decreased.

Monitors recommended for closure: Rio Verde (possible, after further analysis). Monitors recommended being moved or changed:

1. North Phoenix monitor objective changed to 'Maximum Ozone Concentration'.
2. Cave Creek monitor objective changed to 'Extreme Downwind'.
3. Pinnacle Peak monitor objective changed to 'Extreme Downwind'.
4. Blue Point monitor objective changed to 'Extreme Downwind'.
5. Fountain Hills monitor objective changed to 'Population Exposure'.
6. Humboldt Mountain monitor objective changed to 'Extreme Downwind'.
7. Rio Verde monitor objective changed to 'Extreme Downwind'.
8. Buckeye monitor objective changed to 'Upwind background' and monitoring scale changed to 'Urban'.

Potential new monitors: None.

***Table 5.3.1**. O_3 monitoring site summary*

Site	AQS#	Objective	Scale
Blue Point	04-013-9702	Maximum Ozone Concentration	Urban
Buckeye	04-013-4011	Population Exposure	Neighborhood
Cave Creek	04-013-4008	Maximum Ozone Concentration	Urban
Central Phoenix	04-013-3002	Population Exposure	Neighborhood
Dysart	04-013-4010	Population Exposure	Neighborhood
Falcon Field	04-013-1010	Population Exposure	Neighborhood
Fountain Hills	04-013-9704	Maximum Ozone Concentration	Neighborhood
Glendale	04-013-2001	Population Exposure	Neighborhood
Humboldt Mountain	04-013-9508	Maximum Ozone Concentration	Regional
Mesa	04-013-1003	Population Exposure	Neighborhood
North Phoenix	04-013-1004	Population Exposure	Neighborhood
Pinnacle Peak	04-013-2005	Maximum Ozone Concentration	Urban
Rio Verde	04-013-9706	Maximum Ozone Concentration	Urban
South Phoenix	04-013-4003	Population Exposure	Neighborhood
South Scottsdale	04-013-3003	Population Exposure	Neighborhood
Tempe	04-013-4005	Population Exposure	Neighborhood
West Chandler	04-013-4004	Population Exposure	Neighborhood
West Phoenix	04-013-0019	Population Exposure	Neighborhood

5.3.2 Narrative

Closing monitors: O_3 is in non-attainment of the NAAQS within Maricopa County, so it is generally not suggested to close any existing sites as they all are important to characterizing O_3 concentrations. However, there is concern that following construction at the site in 2012 the Rio Verde monitor is no longer collecting representative data. It is believed that the structures added have changed air patterns around the monitor's sample port, plus the additional story added to the building (the monitor is housed within a fire station) has increased the sample lines to their maximum allowable length to remain in compliance with residence time requirements. MCAQD was unable to relocate the monitor following construction because of code restrictions in the town of Rio Verde, and there are few options left to try for correcting the issues at the site. A follow-up analysis will need to be conducted to quantify the effects of this construction, but this assessment did find that Rio Verde scored lowest amongst all of the Section 3 analyses. There are three other O_3 monitors in close proximity to Rio Verde, Fountain Hills is 12.8 km away to the southwest, Pinnacle Peak is 16.9 km away to the west, and Yuma Frank is 9.7 km away to the south, so it likely that closing the Rio Verde site would not have an impact on network representation.

Moving/changing monitors: There are many monitors in the O_3 network where changing environmental conditions will require new monitoring objectives to be assigned. This includes many monitors in rural northeastern Maricopa County which previously had the highest design values in the network. Conditions now show the highest O_3 design values in the urban area, so it is suggested to change the rural monitors' objective types to either downwind or population exposure (for

Fountain Hills), and the North Phoenix urban monitor to 'Maximum Ozone Concentration'. It is also suggested to change the Buckeye monitor to a background objective, since it consistently has the lowest design values and is in a typical upwind location.

It is not suggested that any monitors be moved at this time

Adding new monitors: The various analyses show that the existing network represents the Phoenix metropolitan area in an adequate manner, so it is not recommended to add new O_3 monitoring sites.

5.4 Suggested Changes to the PM_{10} Network

5.4.1 Summary

Number of existing sites in 2014: 16

Network changes since 2010 Network Assessment:

1. Tempe PM_{10} monitor opened in March 2012 as a result of recommendations made in the 2010 Network Assessment.
2. Higley site temporarily shut down in October 2014 at the request of the site owner. The site is being relocated .5 km away and is scheduled to reopen in late 2015 or early 2016.

Monitors recommended for closure: Greenwood

Monitors recommended being moved or changed:

1. West 43rd Avenue scale changed from Middle to Neighborhood.
2. Durango Complex objective changed from Highest Concentration to Population Exposure and its scale changed from Middle to Neighborhood.

Potential new monitors: None.

Table 5.4.1. *PM_{10} monitoring site summary*

Site	Objective	Scale
Buckeye	Population Exposure	Neighborhood
Central Phoenix	Population Exposure	Neighborhood
Durango Complex	Highest Concentration	Middle
Dysart	Population Exposure	Neighborhood
Glendale	Population Exposure	Neighborhood
Greenwood	Population Exposure	Middle
Higley	Population Exposure	Neighborhood
Mesa	Population Exposure	Neighborhood
North Phoenix	Population Exposure	Neighborhood
South Phoenix	Population Exposure	Neighborhood
South Scottsdale	Population Exposure	Neighborhood
Tempe	Population Exposure	Neighborhood
West 43rd Avenue	Highest Concentration	Middle
West Chandler	Population Exposure	Middle
West Phoenix	Population Exposure	Neighborhood
Zuni Hills	Population Exposure	Neighborhood

5.4.2 Narrative

Closing monitors: Maricopa County has a long history of working to comply with the PM_{10} NAAQS, so normally it would not be suggested that any existing monitors be closed. However, the new near-road Thirty-Third site is located close to Greenwood, and the suggestion was made (q.v.) to shut down the CO and NO_2 monitors located there and consider them moved to Thirty-Third. As a result, it is suggested the Greenwood PM_{10} monitor be considered for closure instead of trying to relocate it or continuing to run the site with just one pollution monitor. Greenwood is a site with a long operational history and scores high in the Section 3 analyses (Table 3.12.8), having particularly high scores with Deviation from the NAAQS, nearby sources (stationary and mobile), and measured concentrations (Table 3.12.9). Greenwood is, however, located in a cluster of redundant PM_{10} sites including West Phoenix, Durango Complex, Central Phoenix, and West 43rd Avenue. Because of the close proximity to these other sites, it scores low in the correlation analysis, removal bias, area served, and population served analyses (Table 3.12.9). Greenwood is the most highly correlated site in the network, with correlation scores of 85% with West Phoenix, 79% with Central Phoenix, and 77% with Durango Complex; it is thus believed that these other sites would be able to adequately represent PM_{10} in the area.

Moving/changing monitors:

The Durango Complex monitor has decreased its PM_{10} design value since the 2010 Network Assessment. Because it now ranks lower in the Measured Concentration analysis (Table 3.3.4), it is suggested to change its objective from 'Highest Concentration' to 'Population Exposure'. It is also suggested to change the monitoring scale of Durango Complex and West 43rd Avenue from 'Middle' to 'Neighborhood' as the sites are not as impacted by close sources as they were in the past.

Adding new monitors: It is not suggested to add any new PM_{10} sites.

5.5 Suggested Changes to the $PM_{2.5}$ Network

5.5.1 Summary

Number of existing sites in 2014: 8

Network changes since 2010 Network Assessment:

1. New $PM_{2.5}$ monitoring sites: Diablo, Glendale, North Phoenix, Thirty-Third (in 2015) and Tempe.
2. All filter-based $PM_{2.5}$ monitors replaced with continuous monitors (West Phoenix still operates a co-located $PM_{2.5}$ filter monitor for QA purposes).

Monitors recommended for closure: None

Monitors recommended being moved or changed:

1. Change the monitoring scale for Durango Complex from 'Middle' to 'Neighborhood'.

Potential new monitors: None.

Table 5.5.1. *$PM_{2.5}$ monitoring site summary*

Site	Objective	Scale
Durango Complex	Highest Concentration	Middle
Diablo	Source Oriented	Microscale
Glendale	Population Exposure	Neighborhood
Mesa	Population Exposure	Neighborhood
North Phoenix	Population Exposure	Neighborhood
South Phoenix	Population Exposure	Neighborhood
Tempe	Population Exposure	Neighborhood
West Phoenix	Highest Concentration	Neighborhood

5.5.2 Narrative

Closing monitors: It is not recommended any $PM_{2.5}$ sites be closed.

Moving/changing monitors: Research performed by the MCAQD Mobile Monitoring section suggests that the sources impacting the Durango Complex $PM_{2.5}$ monitor are located farther than 1 km away; therefore, the ‘Middle’ monitoring scale is no longer appropriate and it is suggested to change it to ‘Neighborhood’ scale.

Adding new monitors: It is not suggested to add any new $PM_{2.5}$ sites.

5.6 Suggested Changes to the SO_2 Network

5.6.1 Summary

Number of existing sites in 2014: 2

Network changes since 2010 Network Assessment:

1. South Scottsdale SO_2 monitor was moved to Durango Complex in December 2010.

Monitors recommended for closure: Durango Complex

Monitors recommended being moved or changed:

1. The Central Phoenix monitor’s scale changed to ‘Urban’.

Recommended new monitors: None

Table 5.6.1. *SO_2 monitoring site summary*

Site	Objective	Scale
Central Phoenix	Highest Concentration	Neighborhood
Durango Complex	Highest Concentration	Middle

5.6.2 Narrative

Closing monitors: In the 2010 Network Assessment, it was recommended to move the SO_2 monitor from South Scottsdale to Durango Complex. This was because concentrations at South Scottsdale were low, often at the non-detect level, and it was shown that there were a greater volume of stationary and mobile sources in the vicinity of the Durango Complex area. After moving the monitor and collecting data for over five years, it has been shown that concentrations of SO_2 in the west valley are also low, and while the design value of Durango Complex is higher than South Scottsdale was, it is still close to the non-detection level. It is believed that the Central Phoenix monitor (which also has a low design value, see Table 3.3.6) would be sufficient to represent the region were the Durango Complex SO_2 monitor to be closed.

Moving/changing monitors: SO_2 concentrations at the three urban monitoring sites, Central Phoenix, Durango Complex, and the ADEQ’s JLG (Supersite), are consistently low and near the non-detection limit. The Section 3 correlation analysis found little correlation between the sites, but this is more likely a statistical anomaly resulting from the limited range in the concentration values versus a wide variation in the distribution. Therefore, it is suggested to change the scale of the Central Phoenix monitor to 'Urban' as it is believed SO_2 values from this location are representative of the entire urban region.

Adding new monitors: It is not suggested to add any new SO_2 sites.

5.7 Suggested Changes to the Lead Network

5.7.1 Summary

Number of existing sites in 2014: 1

Network changes since 2010 Network Assessment: The Deer Valley monitoring site was opened in July 2010.

Monitors recommended for closure: None

Monitors recommended being moved or changed: None

Recommended new monitors: None

Table 5.7.1. *Pb monitoring site summary*

Site	Objective	Scale
Deer Valley	Source Oriented	Middle Scale

5.6.2 Narrative

The Deer Valley Pb monitor was opened in July 2010 near the Deer Valley general aviation airport in north Phoenix, which is believed to be the largest source of Pb emissions (from leaded general aviation fuel) in the metropolitan area. Pb monitoring by Maricopa County was discontinued in 1997 because concentrations were well below the 1978 standard of 1.5 $\mu g/m^3$ per quarter. A new Pb standard of 0.15 $\mu g/m^3$ per quarter went into effect in 2008, and the Deer Valley monitor was started to ensure compliance with the new standard. Pb concentrations monitored at the Deer Valley monitor have also been consistently below the new standard, e.g. the 2014 Deer Valley quarterly design value was .05 $\mu g/m^3$.

As the Deer Valley airport is considered one of the largest sources of Pb emissions in Maricopa County, and since ambient Pb concentrations monitored there are consistently below the 2008 standard, it is not suggested that any new monitors be added or that changes be made to the network.

5.7 Options for New Technologies within the Monitoring Network

MCAQD is committed to keeping its monitoring network as technologically advanced as possible, budget permitting. Since the 2010 Network Assessment was completed, MCAQD has upgraded all of its filter-based Federal Reference Method (FRM) particulate monitors to continuously operating Federal Equivalency Method (FEM) monitors. FEM monitors provide a more temporally detailed view of particulate pollution than FRM filter-based monitors, which typically operate on a 1-in-6 or 1-in-3 day schedule. However, continuous FEM monitors are more expensive than the filter-based monitors, and replacements were made as budgets permitted. Currently, of the 16 PM_{10} monitoring sites that MCAQD operates, all are continuous FEM monitors and no filter-based FRM monitors remain. Of the eight $PM_{2.5}$ monitoring sites, all also operate continuous FEM monitors, though one site (West Phoenix) still operates a co-located FRM filter monitor for quality assurance purposes.

Gaseous monitors are replaced and upgraded on a continuous basis. The current schedule calls for existing monitoring equipment to be replaced on a five to seven-year cycle, as budgets permit. Currently all MCAQD's gaseous monitoring equipment are classified as FRMs and are state-of-the-art equipment.

Data acquisition and management software is also maintained and upgraded at least annually, with maintenance contracts automatically giving upgrades as they become available. MCAQD uses the AirVision software from Agilaire to manage its database. Monitoring network communication hardware has also been upgraded so that data from all sites are collected through high-speed network connections with repeat polling occurring on a five-minute basis. This system makes it possible to display real-time air pollution data on a web map that is accessible to the public. Also unique to this data management configuration is an alarm system that checks the 5-minute polled data for spikes in pollution concentrations. If an alarm is sounded, the data are checked for validity and an inspector can be dispatched to the area to attempt to mitigate any pollution-generating activities before they result in an unhealthful situation.

It is not suggested that any changes in MCAQD's current practice of technological upgrades as described above be made.