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Air Quality Department

Maricopa County Air Monitoring Network: Technical Assessment 2005–2009

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Maricopa County Air Monitoring Network: Technical Assessment 2005-2009

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Abstract

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 is to determine whether:

1. The monitoring network meets its required objectives,
2. Whether sites should be added or changed, and
3. If sites are no longer needed and can be terminated.

This network assessment fulfills these requirements by using a variety of indicators to assess the worth of the existing network, and to identify areas where the inclusion of new monitoring sites would be most beneficial. This assessment covers the time period of 2005-2009 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 network. Section 3 performs a site-by-site comparison of the existing network; sites are ranked by a variety of indicators designed to give a comprehensive view of the network. Section 4 uses a series of raster-based indicator maps that quantify where new monitoring sites would be most beneficial; these maps are then weighted, spatially averaged, and combined to give an overall representation of the most beneficial areas in which to add new monitoring sites. Section 5 uses the data generated in the previous sections to provide recommendations for each criteria pollutant about where monitoring sites could be added, relocated, or terminated.

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 98th 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.
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 microns (2.5 µ) or smaller in diameter.
PM_{10}:	Particulate matter of 10 microns (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.
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_{10}.
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 ozone 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.

The purpose of the network assessment is (as detailed in 40 CFR 58.10(e)): "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 network 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 site-to-site comparison of the existing network using a series of assessments. These comparisons rank each site against each other to determine its comparative worth. 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 – Determines areas where the existing monitoring network does not adequately represent potential air pollution problems, and where additional sites are potentially needed. 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 should be deployed.

Section 5 – Provides recommendations based upon the evaluations described in the preceding sections. Recommendations of where 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 Network Assessment will address the criteria pollutants monitored by MCAQD during the period 2005-2009, i.e. carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (both particulate matter <10 microns [PM_{10}] and particulate matter <2.5 microns [$PM_{2.5}$]) and sulfur dioxide (SO_2). Lead (Pb), also a criteria pollutant, is not included in the assessment, as MCAQD did not operate any lead monitors during the period covered by this network assessment. (A lead monitoring site became operational in summer 2010 to meet new requirements for lead monitoring.)

1.3 Assessment Methodology

A number of different analyses are used in determining the effectiveness of the existing monitoring sites, and the potential need for additional 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 network 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 worth 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). Sites near the NAAQS are more important. Sites well above or below the NAAQS do not provide as much information in terms of NAAQS compliance.
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 freeway 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 ranked higher.
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 Part 1, 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 freeways 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 Part 1, 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 2005–2009. 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 has been 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 2000 U.S. Census. While Maricopa County is a fast-growing region and 2000 census data might not be entirely adequate for characterizing the 2005-2009 study period; at the time of writing complete 2010 census data for the region were not yet available.

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.

Traffic counts were obtained from the Maricopa Association of Governments (MAG), the metro Phoenix region's transportation planning organization. MAG in turn collects the traffic data from individual state, county and municipal transportation agencies. The latest available traffic count data available (from 2007) were used exclusively in this assessment.

All Geographic Information System (GIS) data came exclusively from the Maricopa County government. Geographic road data are from 2009 (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 network assessment takes into account all monitoring sites included in the AQS database and located within Maricopa County or surrounding 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					
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$
04-013-0016	WI	West Indian School	33rd Ave. & W. Indian School Rd.	Phoenix	Maricopa		X				
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
04-013-1004	NP	North Phoenix	7th Street & Dunlap Ave.	Phoenix	Maricopa	X	X			X	
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	
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	
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				
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	
04-013-9508	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

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					
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$
04-007-0008	PW	Payson Well Site	204 W Aero Dr	Payson	Gila					X	X
04-007-1001	HJ	Hayden Old Jail	Jail-Canyon Dr	Hayden	Gila				X	X	
04-012-8000	AL	Alamo Lake	Alamo Lake State Park	Wenden	La Paz	X		X			
04-013-8006	BE	Bethune Elementary School	1310 South 15th Avenue	Phoenix	Maricopa					X	
04-013-9997	JS	JLG Supersite	4530 North 17th Avenue	Phoenix	Maricopa	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		
04-019-0020	RI	Rillito	8840 W Robinson Street	Rillito	Pima					X	
04-019-8031	GF	Green Valley Fire Admin	1285 W Camino Encanto	Green Valley	Pima					X	X
04-021-2001	SM	San Manuel	Douglas & 1st	San Manuel	Pinal				X		
04-021-8001	QV	Queen Valley	10 S Queen Ann	Queen Valley	Pinal	X		X			
04-025-2002	PV	Prescott Valley	7501 E. Civic Circle	Prescott Valley	Yavapai					X	X
04-025-8033	PC	Prescott College AQD	330 Grove Avenue	Prescott	Yavapai	X					
04-027-0004	YC	Yuma Courthouse	2440 W. 28th St	Yuma	Yuma					X	X
04-027-0006	YG	Yuma Game & Fish	9140 E 28th St	Yuma	Yuma	X		X			
04-027-8011	YS	Yuma Supersite	2323 S Arizona Ave	Yuma	Yuma	X	X		X	X	X
04-007-0010	TM	Tonto NM	South of SR88	—	Gila	X		X	X		
04-025-0005	HS	Hillside	Repeater Station near Hillside	Hillside	Yavapai	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					
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$
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					
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$
04-013-7002	VQ	Vee Quiva Casino-	6443 Komatke Lane	Laveen	Maricopa						X
04-013-7003	GC	Gila Crossing North Elem School	4208 West Pecos	Laveen	Maricopa	X					
04-021-7004	PI	Pima*	35 Pima St	Sacaton	Pinal	X					
04-013-9997	BA	Bapchule*	Casa Blanca/Preschool Rd	Bapchule	Pinal					X	

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

***Table 1.7.** Monitoring Sites Operated by Industrial Sources.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored					
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$
04-007-8000	FM	FMMI-Miami Golf Course	SR 188 & US 60	Globe	Gila					X	
04-007-0009	MR	Miami Ridgeline	4030 Linden Street	Miami	Gila				X	X	

***Table 1.8.** Monitoring Sites Operated by the U.S. National Park Service.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored					
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$
04-019-0021	SG	Saguaro Park	3905 S. Old Spanish Trail	Not in a city	Pima	X			X		
04-019-9000	SW	Saguaro West*	Saguaro West	Not in a city	Pima				X		
04-007-8100	SA	Sierra Ancha*	Sierra Ancha	Young	Gila				X		
04-025-8104	IB	Ike's Backbone	Ike's Backbone (not in a city)	Not in a city	Yavapai				X		

***Table 1.9.** Monitoring Sites Operated by the Pima County Air Quality Department.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored					
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$
04-019-0002	DT	Downtown	190 W Pennington	Tucson	Pima	X			X		
04-019-0008	CD	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
04-019-1001	ST	South Tucson	1601 S 6th Ave	South Tucson	Pima					X	
04-019-1009	PR	Prince Road	1016 W. Prince Rd	Tucson	Pima					X	
04-019-1011	CY	22nd & Craycroft	1237 S Beverly	Tucson	Pima	X	X	X	X		

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	
04-019-1026	SC	Santa Clara	6910 S Santa Clara Ave	Tucson	Pima					X	
04-019-1030	GV	Green Valley	601 N La Canada Dr	Green Valley	Pima	X				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					X
04-019-1034	CA	Coachline	9597 N Coachline Blvd	Tucson	Pima	X					X
04-019-1113	GO	Geronimo	2498 N Geronimo	Tucson	Pima	X					X

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

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored					
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$
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	
04-021-3005	EO	Eloy (Old)	620 N Main St	Eloy	Pinal					X	
04-021-3006	MM	Mammoth	118 S Catalina	Mammoth	Pinal					X	
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	
04-021-3010	MC	Maricopa	44625 W Garvey Rd	Maricopa	Pinal	X				X	
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	
04-021-3013	CT	Cowtown	37580 W Maricopa-	Maricopa	Pinal					X	X
04-021-3014	EY	Eloy	801 N Main St	Eloy	Pinal					X	
04-021-0001	CD	Casa Grande Downtown	401 N Marshall St	Casa Grande	Pinal					X	X

Table 1.11. *Monitoring Sites Operated by the Salt River-Pima Maricopa Indian Community.*

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored					
						O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$
04-013-7020	OR	Osborn Road*	10844 East Osborn Road	Scottsdale	Maricopa	X				X	X
04-013-7021	BH	Beeline Highway*	15115 Beeline Highway	Scottsdale	Maricopa	X					
04-013-7022	SD	Stapley Drive*	3230 North Stapley Drive	Scottsdale	Maricopa	X				X	
04-013-7024	NC	North Country Club*	4827 North Country Club Drive	Scottsdale	Maricopa	X				X	

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

This section includes descriptions of each of the 24 sites within the MCAQD monitoring network. 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 buffer that represents the assigned monitoring scale. This buffer is assumed to represent a relatively homogeneous air parcel, and the entire area should be well represented by the monitoring site.

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.

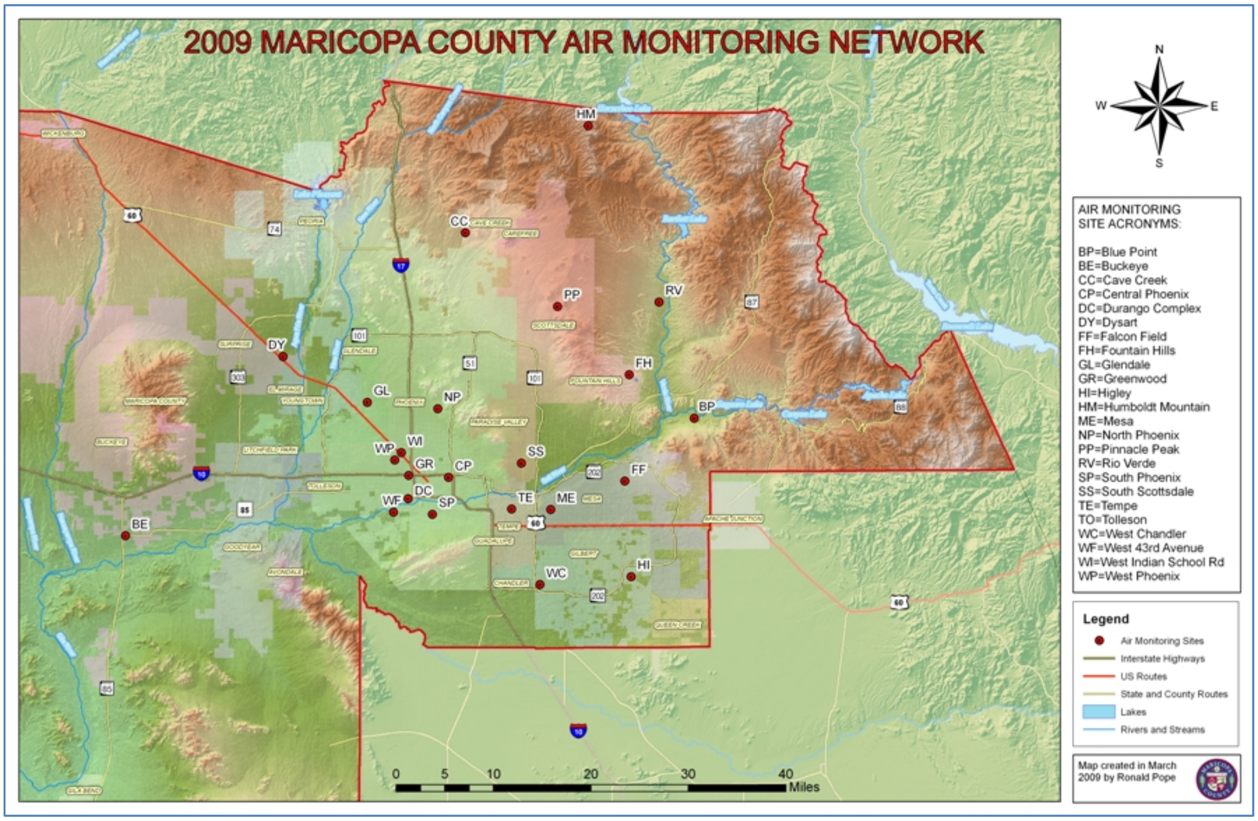

Figure 2.1. Map of the Maricopa County Air Monitoring Network as of 2009.

Blue Point (Code: BP, AQS Monitor no. 04-013-9702)

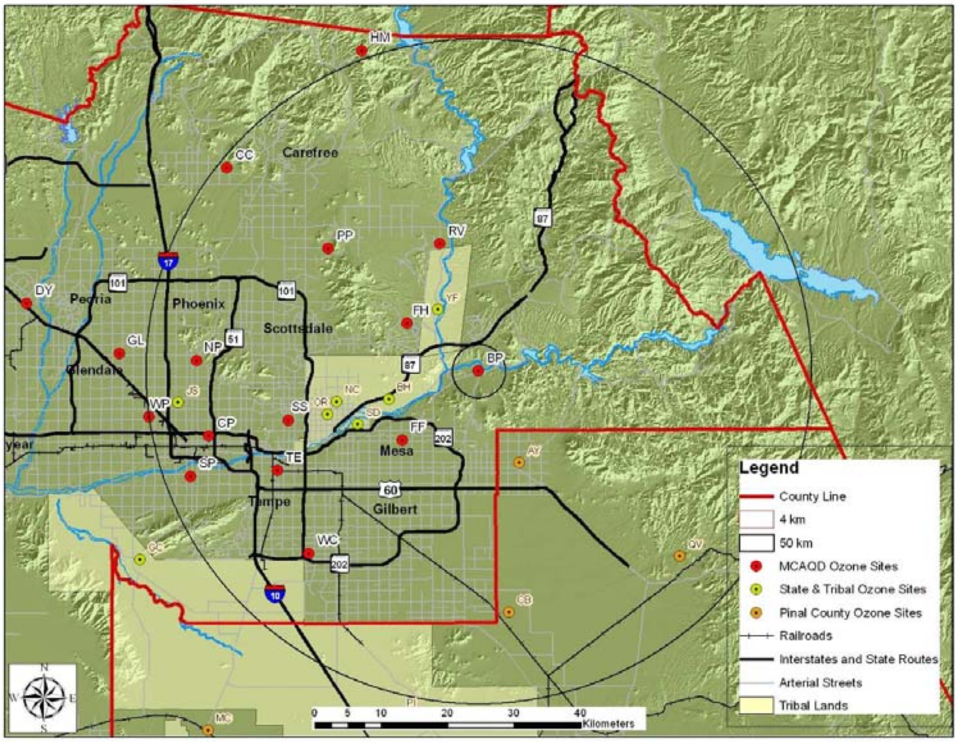

Figure 2.2. Map showing the location of the Blue Point monitoring site (center), including the 4 to 50 km radius of the urban monitoring scale. The map also indicates the location of O_3 monitors operated by other agencies, including ADEQ, tribes, and Pinal County Air Quality Control District (PCAQCD).

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 40 miles east of the Phoenix metropolitan area. O_3 concentrations, wind speed and wind direction are monitored at the site.

Buckeye (BE, 04-013-4011)

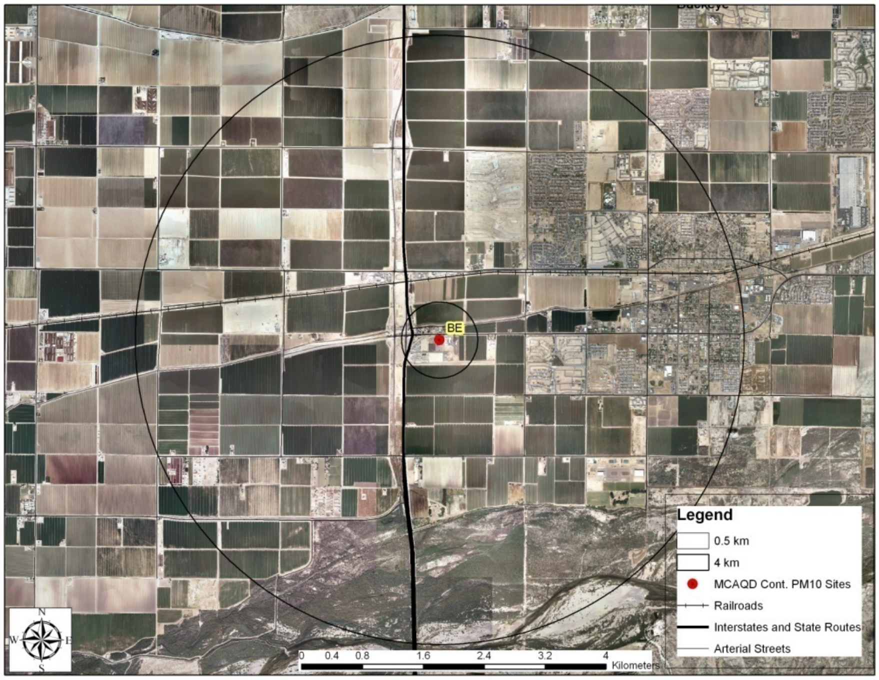

Figure 2.3. Map showing the location of the Buckeye monitoring site (center), with concentric circles representing the 0.5–4 km boundaries for the "neighborhood"-scale CO, O_3, and PM_{10} monitors.

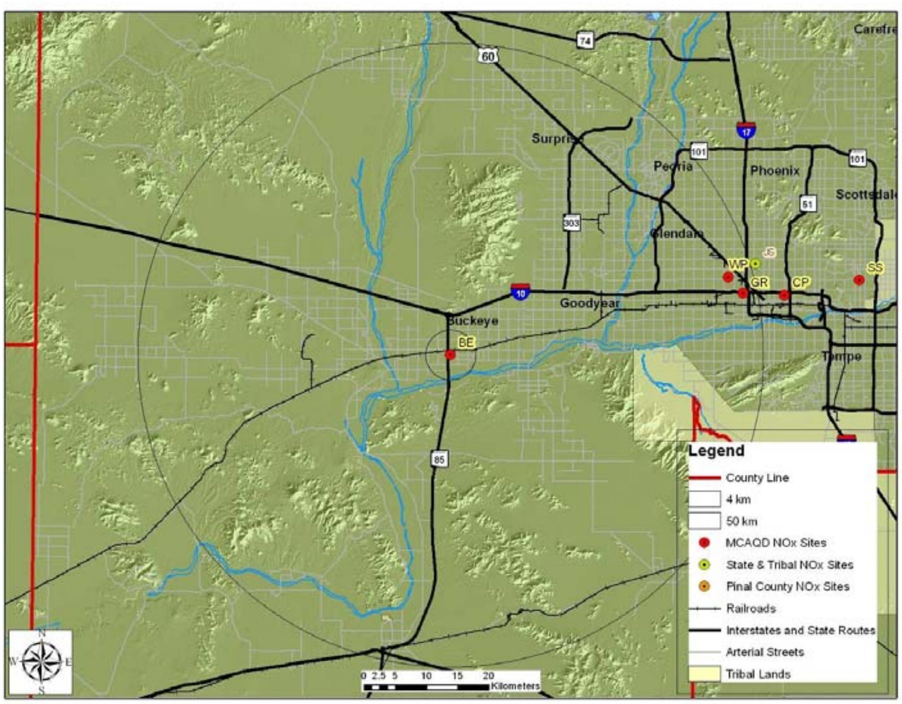

Figure 2.4. Map showing the location of the Buckeye monitoring site (center), with concentric circles representing the 4–50 km radius of the "urban" NO_2 monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	2004	Neighborhood (0.5–4 km)	Population exposure
NO_2	2004	Urban (4–50 km)	Source-oriented
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, O_3, PM_{10}, and NO_2 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 are classified as source-oriented monitors, addressing power plants located approximately 15 miles west of the site.

Cave Creek (CC, 04-013-4008)

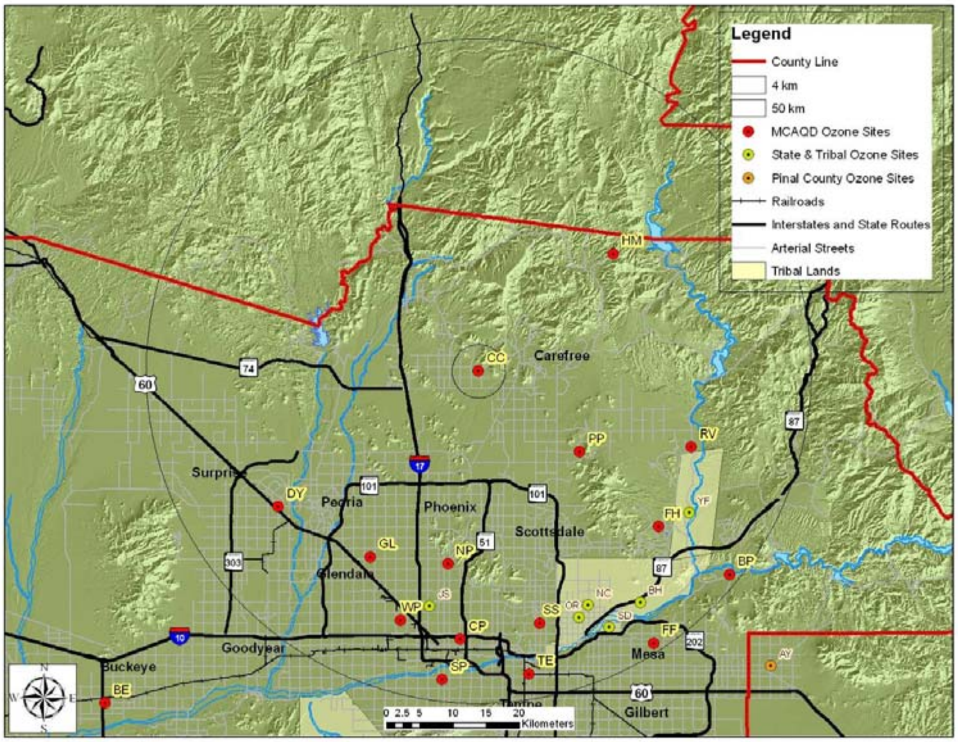

Figure 2.5. Map showing the location of the Cave Creek monitoring site (center), with concentric circles representing the 4–50 km radius of the "urban" monitoring scale. The map also indicates O_3 monitors operated by other agencies, including ADEQ, tribes, and PCAQCD.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O_3	2001	Urban (4–50 km)	Population exposure

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. O_3, wind speed and wind direction are monitored at this site.

Central Phoenix (CP, 04-013-3002)

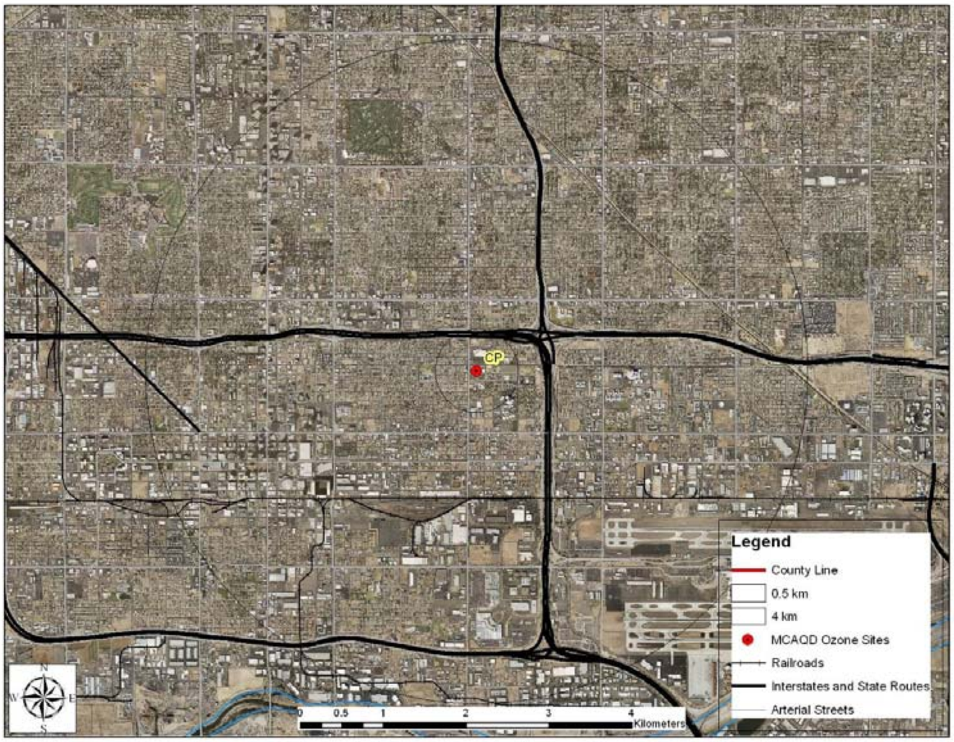

Figure 2.6. Map showing the location of the Central Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

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)	Highest concentration
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)	Highest concentration

Site Description: The Central Phoenix site has been in existence for over four decades and has provided a long-term historical database with a high rate of data recovery. The site is representative of high population exposure (greater than 5000 people per square mile) in the central Phoenix area and is located close to several high-volume freeways and interchanges.

Coyote Lakes (CL, 04-013-4014)

Figure 2.7. Map showing the location of the Coyote Lakes 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}	2007*	Middle (100–500 m)	Source-oriented

* Monitoring ended in 2009.

Site Description: The Coyote Lakes site became operational in April 2007. PM_{10} was the only pollutant measured at this Special-Purpose Monitoring (SPM) site. The monitoring objective of this site was to determine the impact of local sources in the area; the site was located within the Agua Fria river channel which has several sand & gravel mining operations, among other sources such as unpaved roads. SPM sites are only allowed to operate for two years before being required to convert to a permanent site. As this site was nearing the end of this two year period, it was shut down in February 2009 to make way for a more permanent site, Zuni Hills, which was opened in December 2009 approximately 1.7 miles away to the northeast. This site has a wider spatial scale and the monitoring objective has changed to population exposure; thus it can characterize the air quality for a larger area and population than Coyote Lakes did.

Durango Complex (DC, 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)
PM_{10}	1999	Middle (100–500 m)	Highest concentration
$PM_{2.5}$	2005	Middle (100–500 m)	Highest concentration

Site Description: This site is located in the Maricopa County Flood Control District storage yard which is one mile 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 USEPA determined that the site was not equivalent to the Salt River site; therefore the West 43rd Avenue site was started. Continuous particulate monitors are located at this site. There are also meteorological monitors (wind speed/direction and atmospheric pressure) located at the site.

Dysart (DY, 04-013-4010)

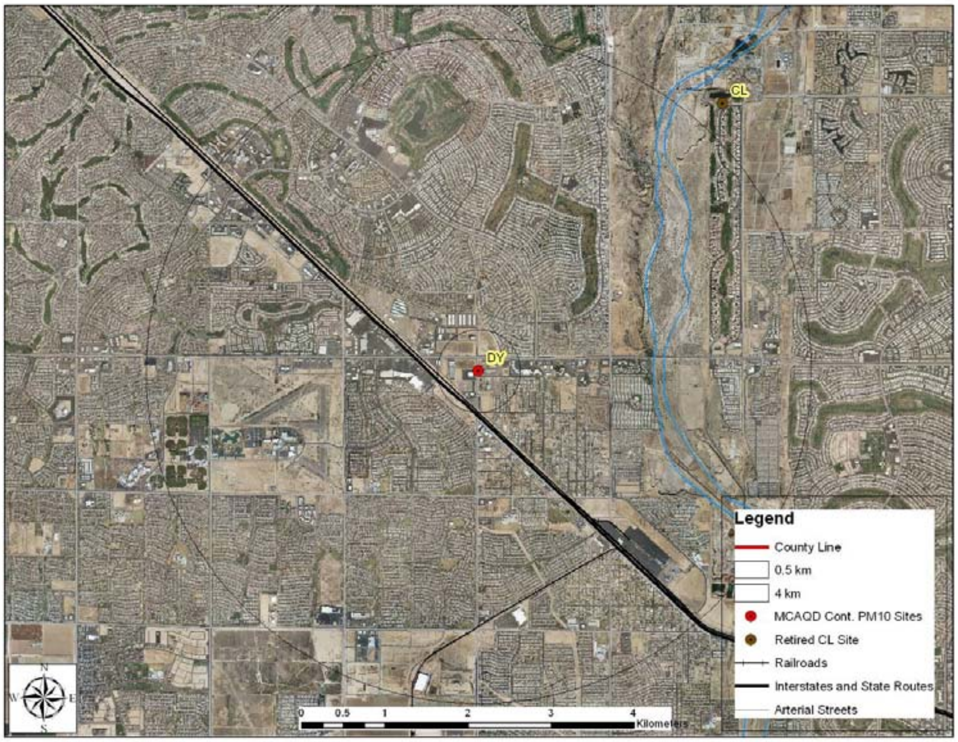

Figure 2.9. Map showing the location of the Dysart monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

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 one mile west of the Agua Fria riverbed. Seasonal CO, seasonal O_3, and PM_{10} are monitored at this station. In September 2009 the PM_{10} monitor was upgraded from a 1-in-6 day scheduled monitor to a continuous-monitoring TEOM. This upgrade took place in accordance with regulations due to a PM_{10} exceedance which occurred at the site in July 2009.

Falcon Field (FF, 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 seasonal O_3 began in 1989; since that time the surrounding area has transformed from mostly agricultural citrus fields to primarily residential development.

Fountain Hills (FH, 04-013-9704)

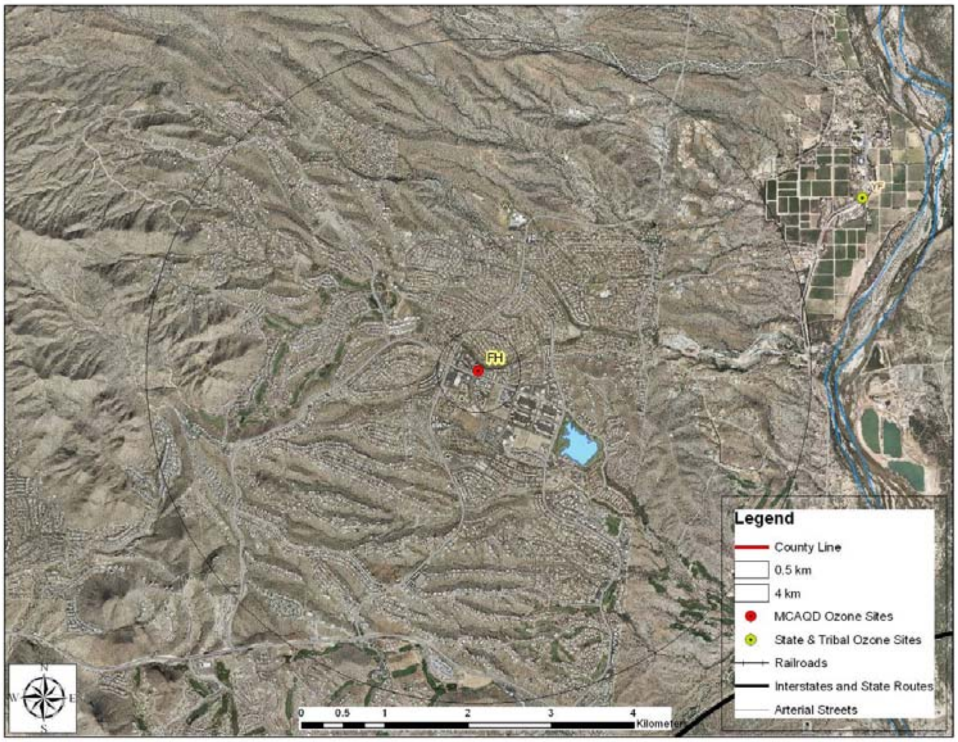

Figure 2.11. Map showing the location of the Fountain Hills monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

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, along with wind speed and wind direction. The site is located approximately 15 miles east of the Phoenix metropolitan area, and was chosen to represent the high downwind concentrations on the fringes of the central basin district along the predominant summer/fall daytime wind direction.

Glendale (GL, 04-013-2001)

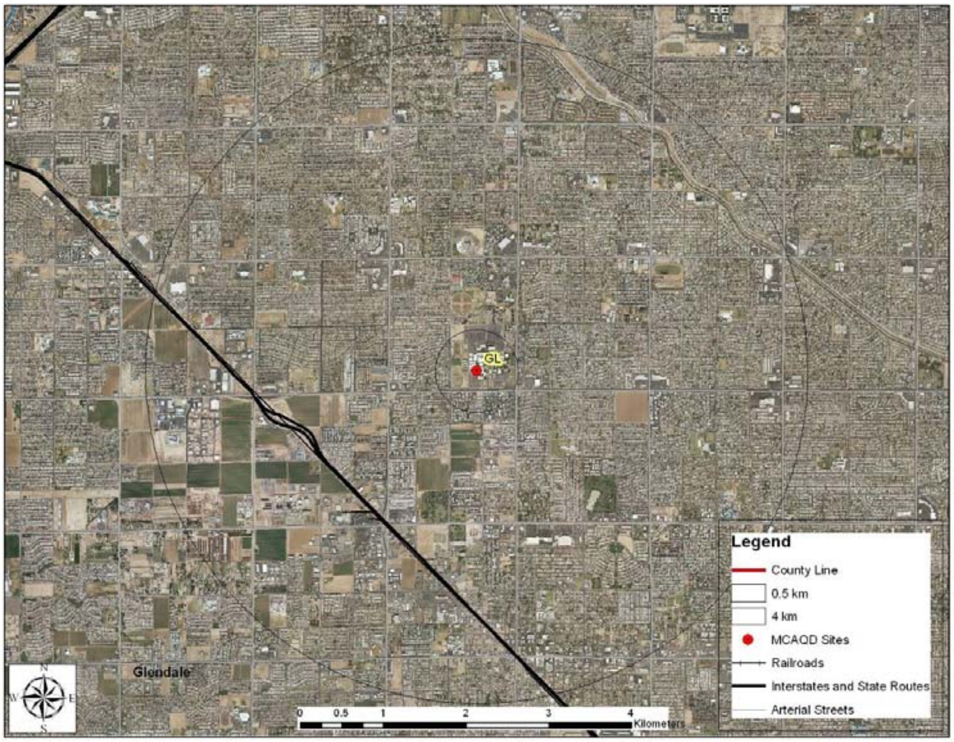

Figure 2.12. Map showing the location of the Glendale monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

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

Site Description: The Glendale site, established over three 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, seasonal O_3, and PM_{10} are monitored at this station. In September 2009 the site's PM_{10} monitor was upgraded from a 1-in-6 day filter-based monitor to a continuous-monitoring TEOM. This upgrade took place in accordance with regulations due to a PM_{10} exceedance which occurred at the site in July 2009.

Greenwood (GR, 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 one mile to the east of the site. CO, NO_2, and PM_{10} are the criteria pollutants monitored at this location. This site was converted to continuous PM_{10} monitoring in the beginning of 2006.

Higley (HI, 04-013-4006)

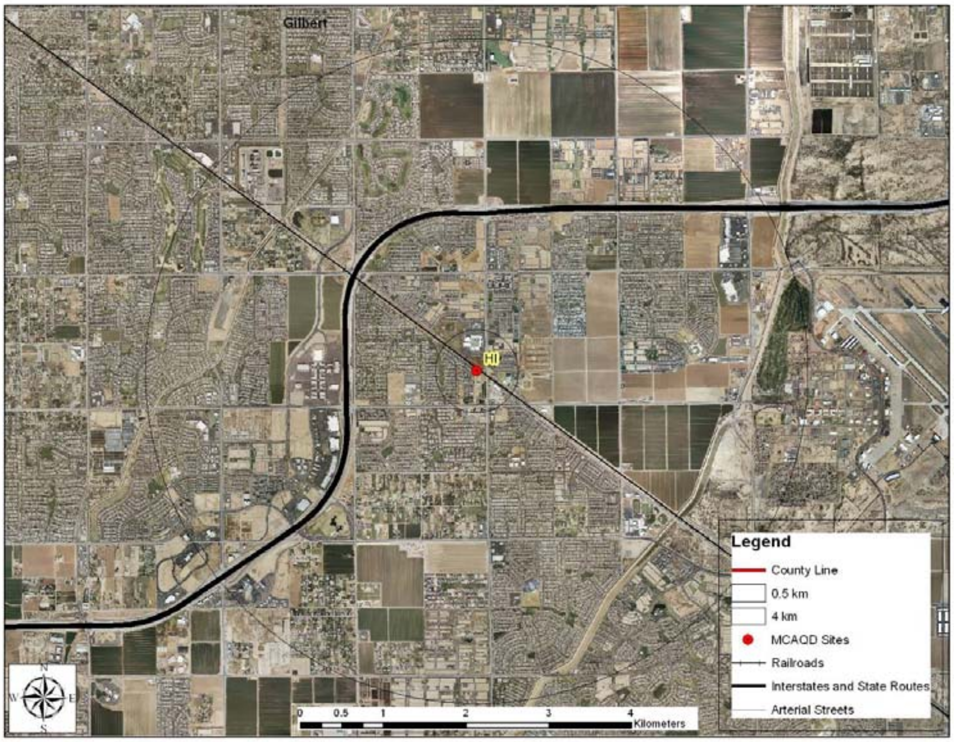

Figure 2.14. Map showing the location of the Higley monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

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 (1-in-6 day) PM_{10} in the second quarter of 2000. As of October 2004 the 1-in-6 day PM_{10} monitor was replaced with an hourly continuous PM_{10} monitor in accordance with 40 CFR 50, Appendix K. This continuous monitor samples on the neighborhood scale with a monitoring objective of high population exposure.

Humboldt Mountain (HM, 04-013-9508)

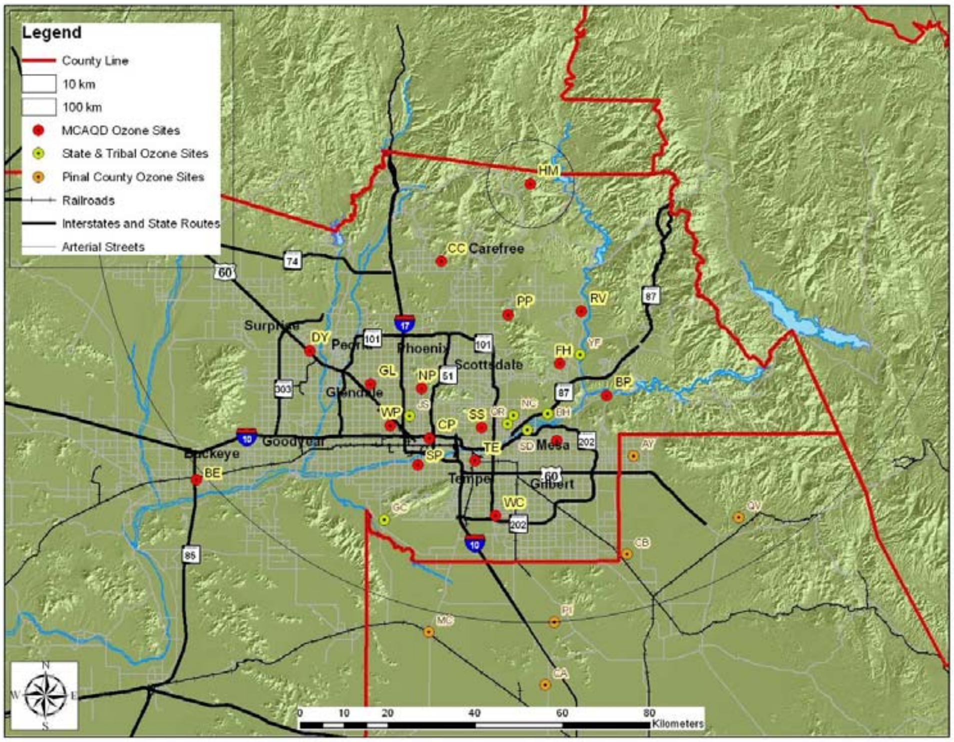

Figure 2.15. Map showing location of Humboldt Mountain monitoring site (center), including the assumed 10-100 km radius of the Regional monitoring scale. Map also includes O_3 monitors from other agencies, including ADEQ, Tribal, and PCAQCD.

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 40 miles north-northeast of the Phoenix metropolitan area at an elevation of 5190 feet. O_3 is the only criteria pollutant that is monitored at this seasonal site.

Mesa (ME, 04-013-1003)

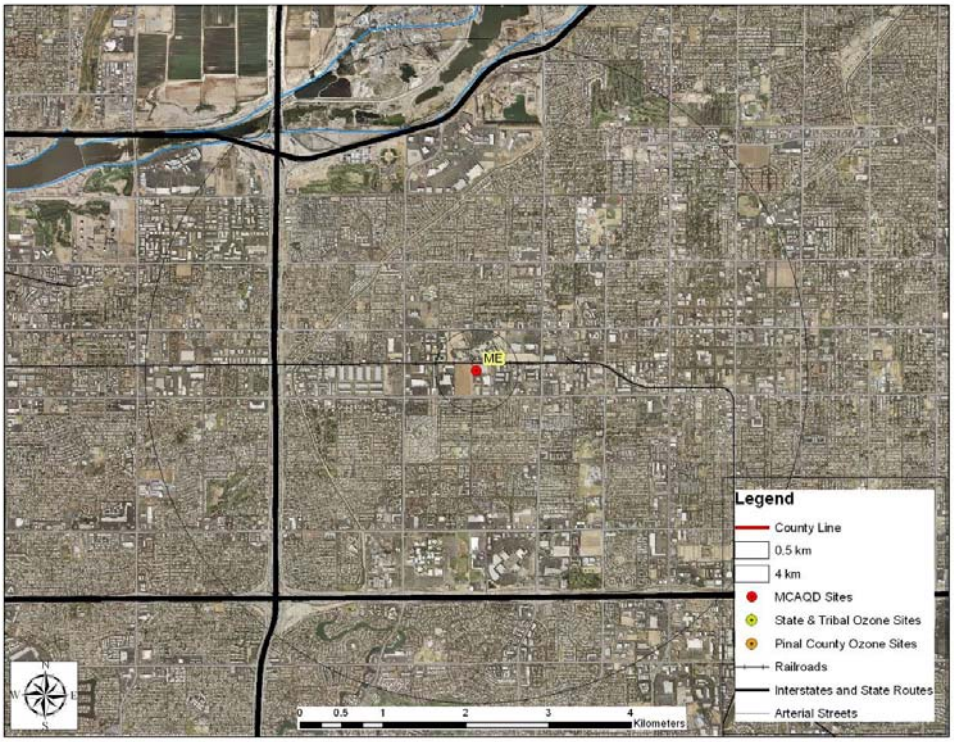

Figure 2.16. Map showing the location of the Mesa monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1978	Neighborhood (0.5–4 km)	Population exposure
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, industrial, and a small amount of agricultural activity. An open field borders the site on the west with commercial development to the north, and light industry east and south of the site. CO, $PM_{2.5}$, and PM_{10} are the criteria pollutants monitored at this site. The department started operation of the $PM_{2.5}$ Federal Reference Method monitor in May 2005.

North Phoenix (NP, 04-013-1004)

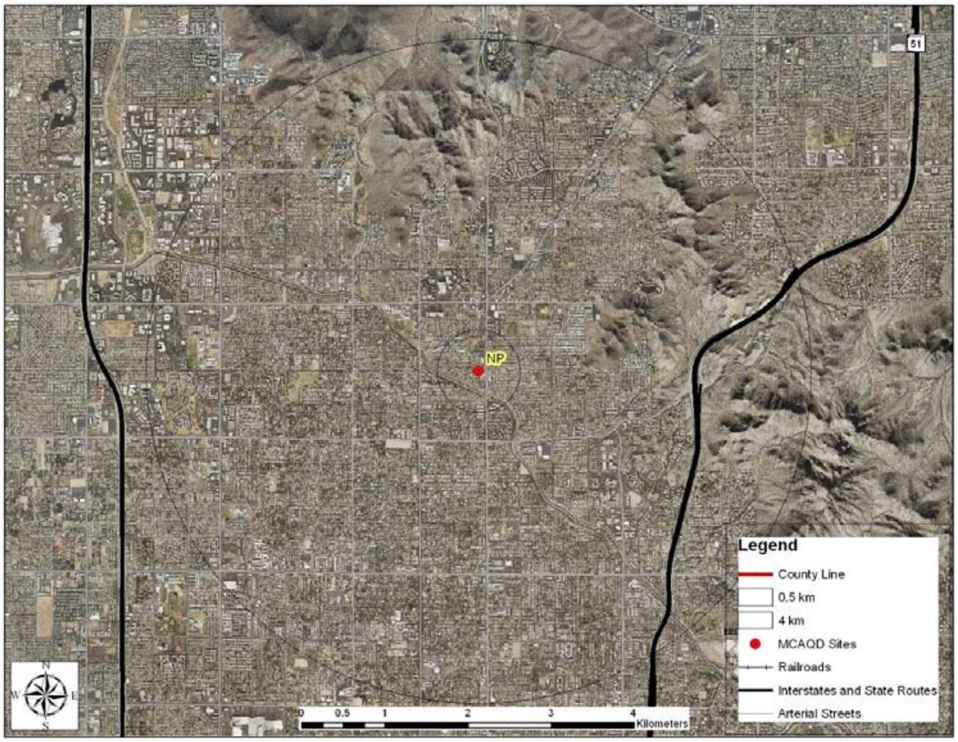

Figure 2.17. Map showing the location of the Mesa monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1975	Neighborhood (0.5–4 km)	Population exposure
O_3	1974	Neighborhood (0.5–4 km)	Population exposure
PM_{10}	1990	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 (change in temperature or temperature inversion).

Pinnacle Peak (PP, 04-013-2005)

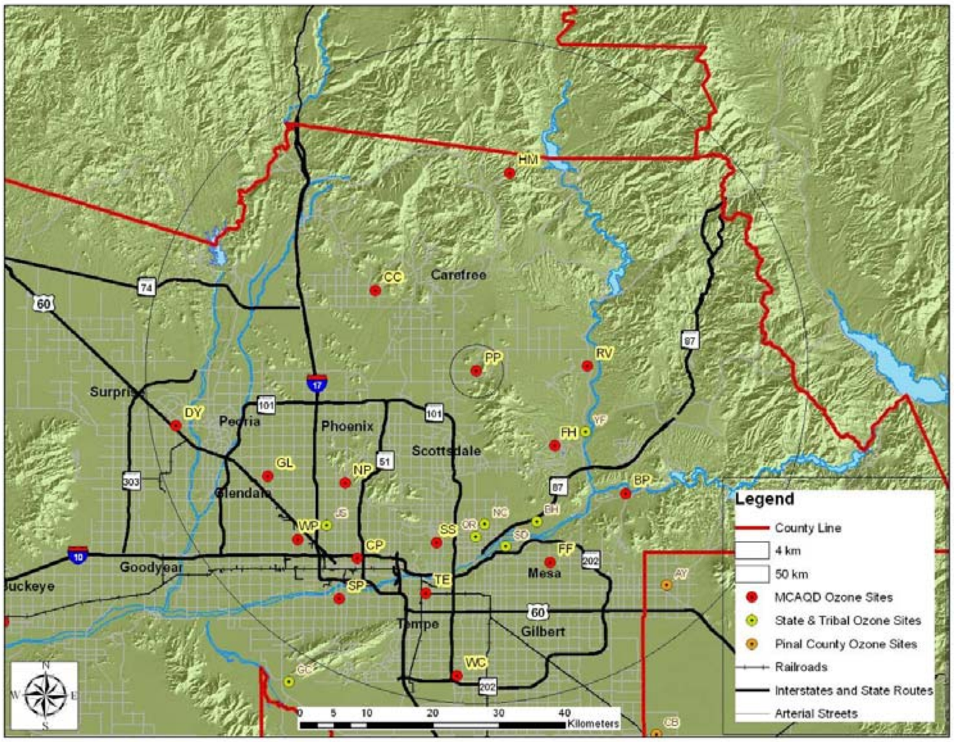

Figure 2.18. Map showing location of Pinnacle Peak monitoring site (center), including the assumed 4-50 km radius of the Urban monitoring scale. Map also includes O_3 monitors from other agencies, including ADEQ, Tribal, and PCAQCD.

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

Site Description: This O_3 site is located on the roof of a golf course country club and is surrounded by residential homes. It is located in a geographic area of low-density population (less than 2500 people per square mile). In previous years, O_3 exceedances have been recorded due to transport of O_3 and precursors from more urbanized areas of metropolitan Phoenix.

Rio Verde (RV, 04-013-9706)

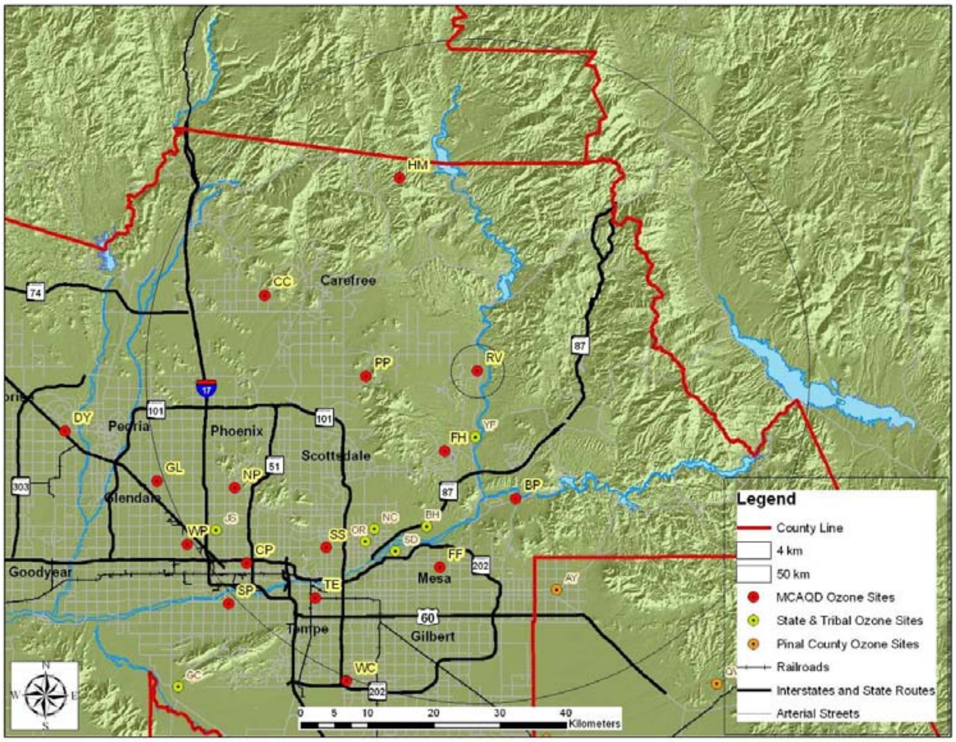

Figure 2.19. Map showing location of Rio Verde monitoring site (center), including the 4–50 km radius of the urban monitoring scale. The map also indicates O_3 monitors operated by other agencies, including ADEQ, tribes, and PCAQCD.

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

Site Description: This seasonal 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 eight miles north of the Fountain Hills station, on the edge of a Class I Wilderness Area.

South Phoenix (SP, 04-013-4003)

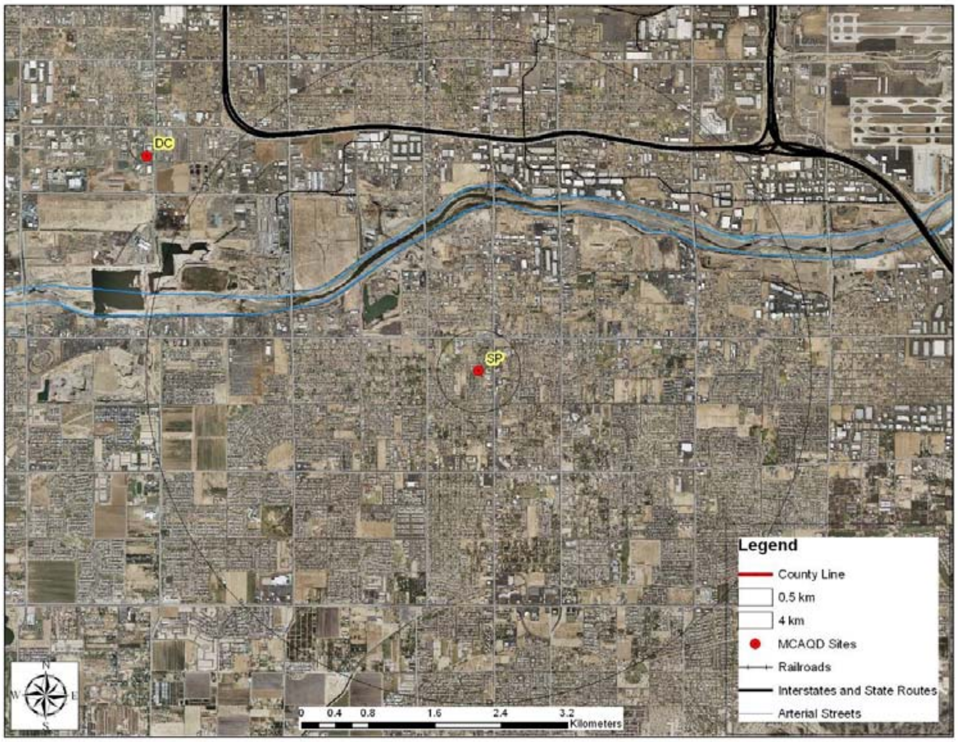

Figure 2.20. Map showing the location of the South Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

Pollutant(s) Monitored	Year Established		Scale	Objective(s)
	Original Site	Current Site		
CO	1974	1999	Neighborhood (0.5–4 km)	Population exposure
NO_2	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, but was moved a short distance to its current location in October 1999. 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 (>5000 people per square mile) north and west of the site. Seasonal CO, O_3, and PM_{10} are at this station. The department started operation of a $PM_{2.5}$ Federal Reference Monitor in May 2005.

South Scottsdale (SS, 04-013-3003)

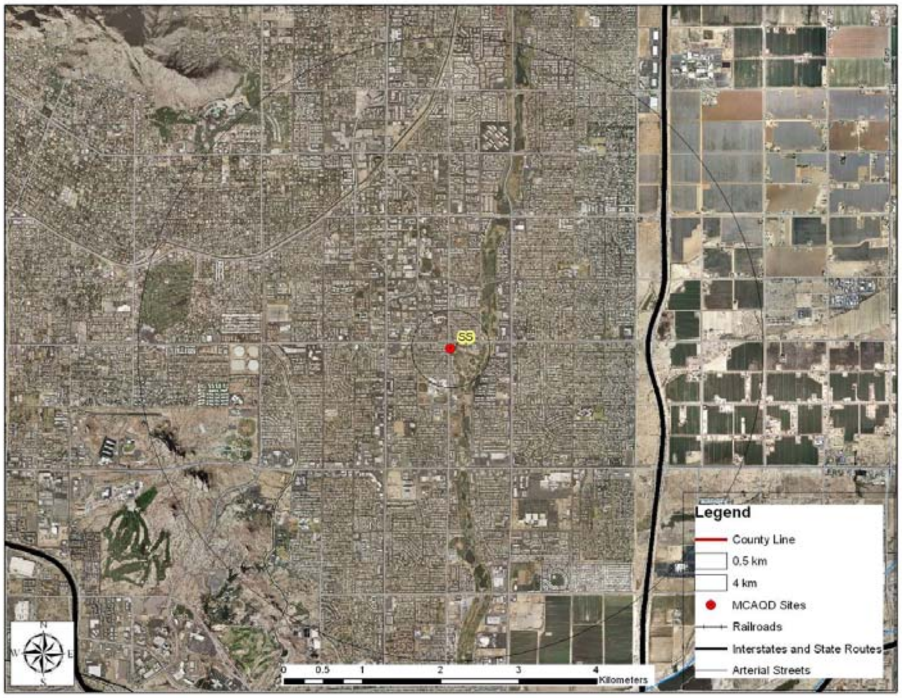

Figure 2.21. Map showing the location of the South Scottsdale monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood"- scale CO, O_3, PM_{10}, and SO_2 monitors.

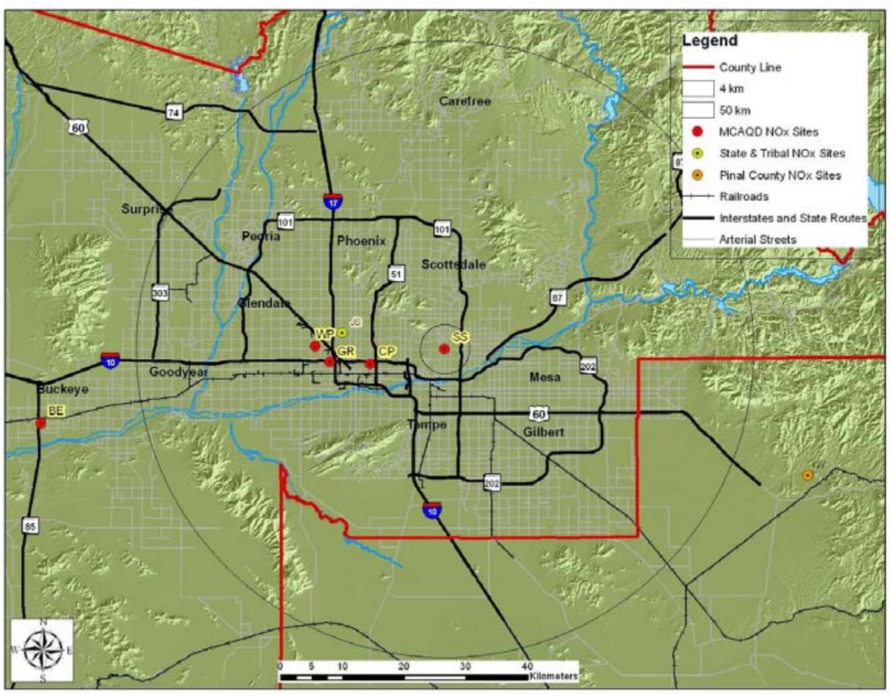

Figure 2.22. Map showing the location of the South Scottsdale monitoring site (center), with concentric circles representing the 4–50 km radius of the "urban"- scale NO_2 monitor. The map also depicts monitoring sites operated by other agencies, including ADEQ, tribes, and PCAQCD.

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	1975	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

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 2,500 to 5,000 persons per square mile. This site is located 12 miles east of metropolitan Central Phoenix. CO, O_3, NO_2, SO_2, and PM_{10} are the criteria pollutants monitored at this station. MCAQD was notified in 2010 that the host fire station might be closed or moved. If the station is moved, it is unknown if the new location could accommodate the department's monitoring equipment. If this event occurs, MCAQD will need to determine if each monitor should be moved to another location or removed from operation.

Tempe (TE, 04-013-4005)

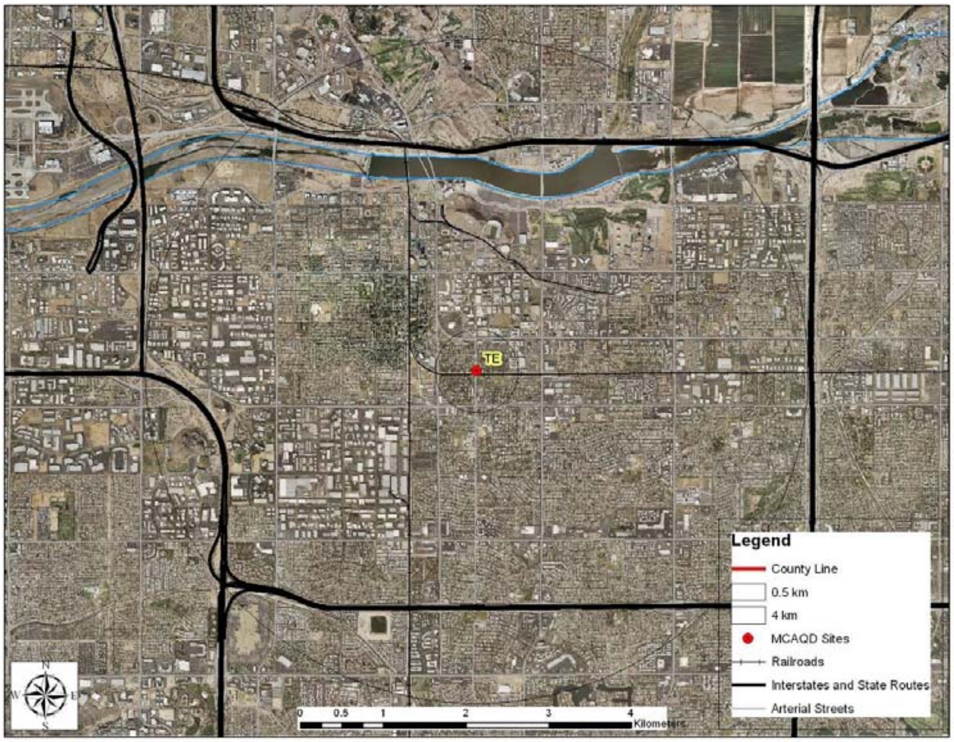

Figure 2.23. Map showing the location of the Tempe monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

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

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 CO are monitored at the site on a seasonal basis. Wind speed and direction and delta temperature (temperature inversion) meteorological parameters are also monitored at this site on a yearly basis. The station is located just south of the Arizona State University campus and is surrounded by residential and commercial properties.

West Chandler (WC, 04-013-4004)

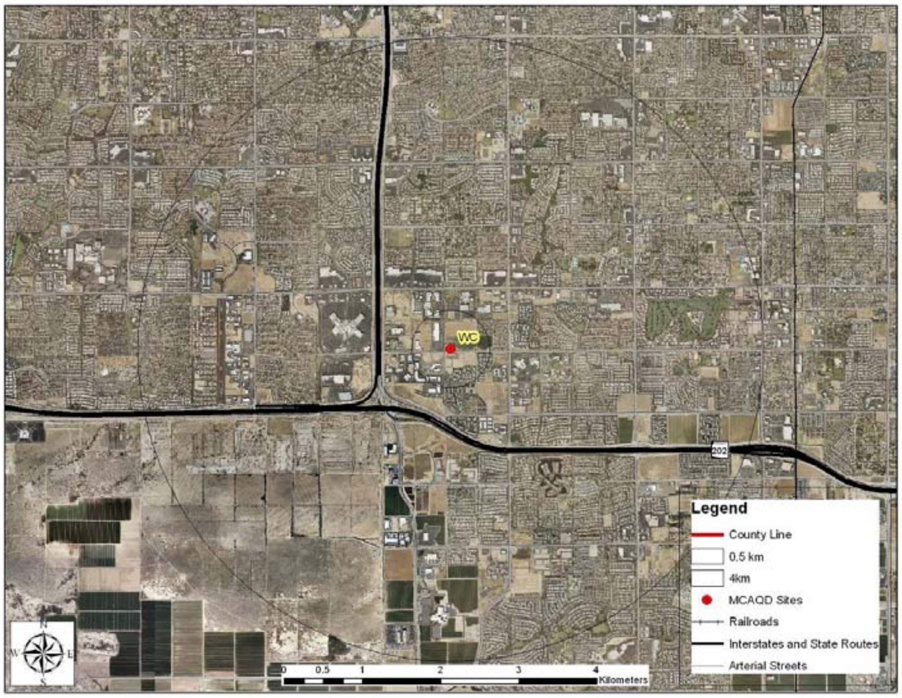

Figure 2.24. Map showing the location of the West Chandler monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood"-scale CO and O_3 monitors.

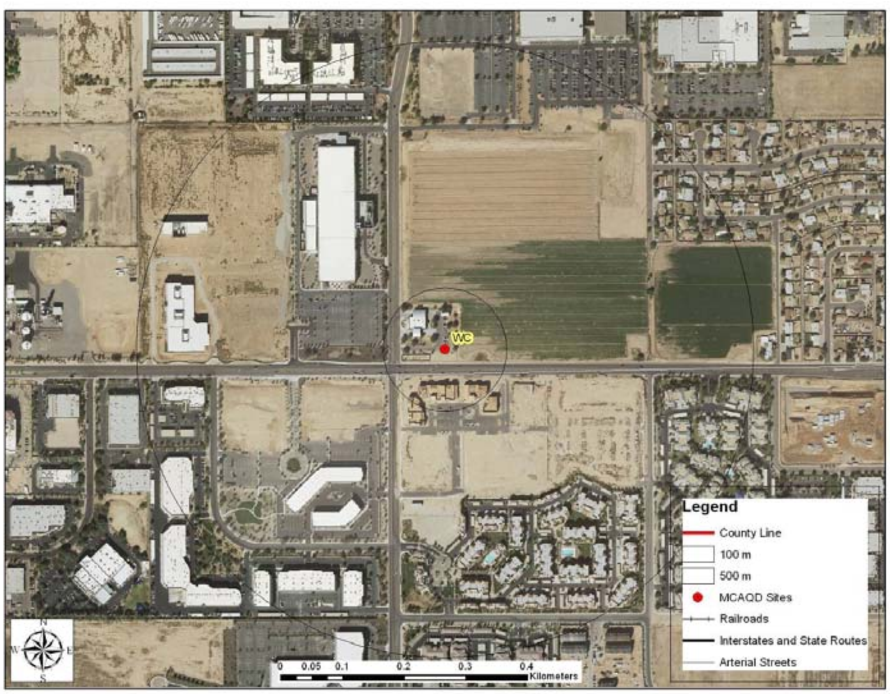

Figure 2.25. Map showing location of West Chandler monitoring site (center), with concentric circles representing the 100–500m radius for the "middle"-scale PM_{10} monitor.

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. The site was moved one half mile to the southeast in May 2000. A wide range of land uses surround the site including residential, agriculture, and heavy industry (semiconductor manufacturing plants and liquid air storage). Seasonal CO, seasonal O_3, and PM_{10} are the criteria pollutants monitored at this site. In accordance with regulations, the PM_{10} monitor was upgraded from a 1-in-6 day scheduled monitor to a continuous-monitoring TEOM following a PM_{10} exceedance at the site in September 2009.

West 43rd Avenue (WF, 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)	Maximum concentration

Site Description: This site started as a replacement for the Salt River site (04-013-3007), located approximately 2 miles 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.

West Indian School Rd (WI, 04-013-0016)

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 is 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 was 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 is no longer necessary as this area is adequately represented by the neighborhood scale site.

West Phoenix (WP, 04-013-0019)

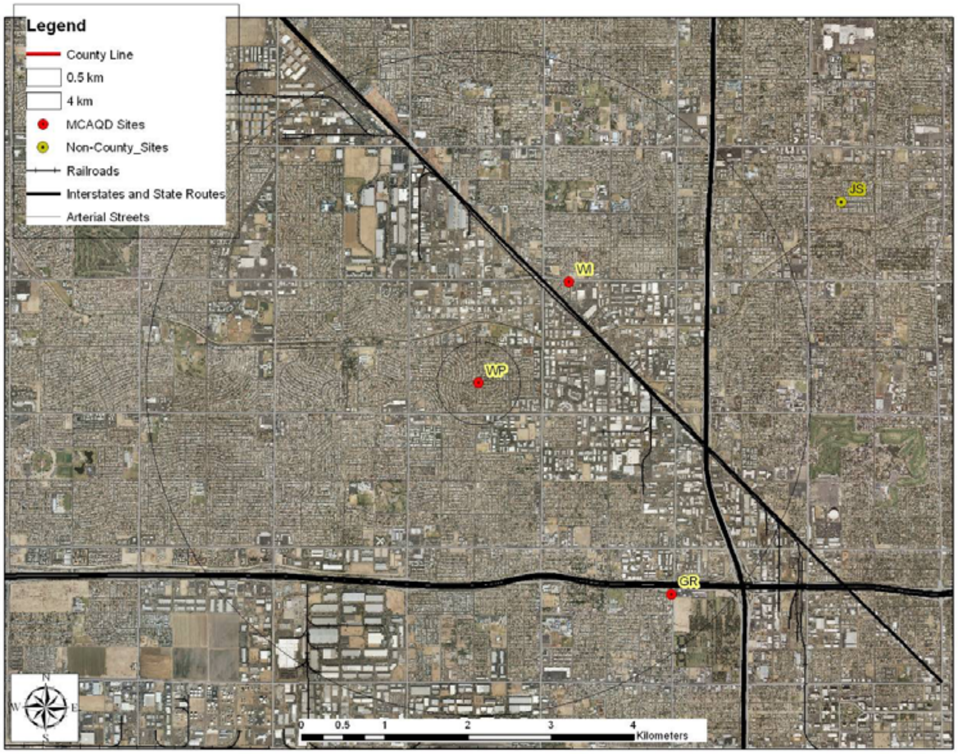

Figure 2.28. Map showing the location of the West Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale.

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
SO_2	2000	Neighborhood (0.5–4 km)	Maximum concentration

Site Description: This site became operational in 1984. The spatial scale for the West Phoenix site is neighborhood. It is located in an area of stable, high-density residential population. CO, PM_{10}, O_3, and NO_2 are monitored at this site. The department also operates collocated $PM_{2.5}$ FRM monitors and a continuous FEM $PM_{2.5}$ monitor at this site.

Zuni Hills (ZH, 04-013-4016)

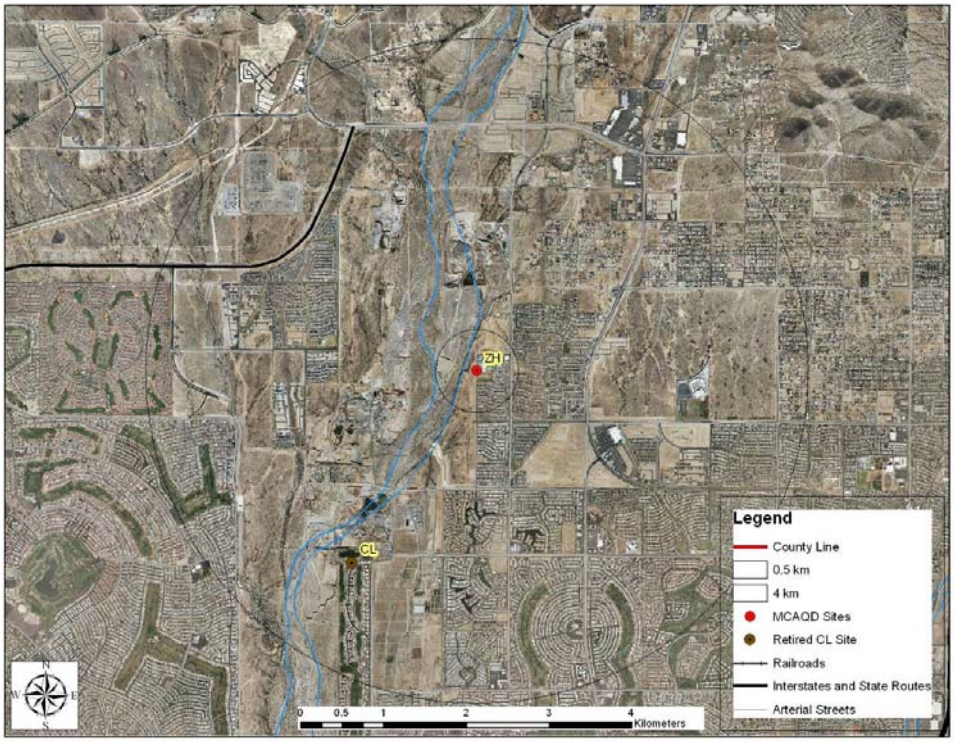

Figure 2.29. Map showing the location of the Zuni Hills monitoring site (center), with concentric circles representing the 0.5–4 km radius of the "neighborhood" monitoring scale. The map also indicates the location of the retired Coyote Lakes monitoring site which it replaced.

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 and is located on the campus of the Zuni Hills elementary school, which is approximately 1.7 miles to the northeast from the now-closed Coyote Lakes monitor. This site has an objective of measuring air quality in an area of high population density and at a scale of neighborhood dimensions.

Section 3: Site-to-Site Comparisons

In this section the existing MCAQD monitoring network is assessed, and site-to-site comparisons conducted using a series of indicators and analyses. These comparisons rank each site against each other to determine its comparative worth. 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 worth of a site to specific criteria, and identifying sites 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].

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
9	Emissions Inventory
9b	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, wind direction, and temperature difference parameters are also included because these data are very 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 which have not been included in this analysis.

This analysis' value 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 total number of parameters.*

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Rank
West Phoenix	04-013-0019	WP	8	1
Central Phoenix	04-013-3002	CP	7	2
South Scottsdale	04-013-3003	SS	7	2
Buckeye	04-013-4011	BE	6	3
North Phoenix	04-013-1004	NP	6	3
South Phoenix	04-013-4003	SP	6	3
Dysart	04-013-4010	DY	5	4
Glendale	04-013-2001	GL	5	4
Greenwood	04-013-3010	GR	5	4
Mesa	04-013-1003	ME	5	4
Tempe	04-013-4005	TE	5	4
West Chandler	04-013-4004	WC	5	4
West Indian School Rd	04-013-0016	WI	3	5

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	Rank
West Phoenix	04-013-0019	WP	8	1
Central Phoenix	04-013-3002	CP	7	2
South Scottsdale	04-013-3003	SS	7	2
Buckeye	04-013-4011	BE	6	3
Greenwood	04-013-3010	GR	5	4

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	Rank
West Phoenix	04-013-0019	WP	8	1
Central Phoenix	04-013-3002	CP	7	2
South Scottsdale	04-013-3003	SS	7	2
North Phoenix	04-013-1004	NP	6	3
South Phoenix	04-013-4003	SP	6	3
Buckeye	04-013-4011	BE	6	3
Glendale	04-013-2001	GL	5	4
West Chandler	04-013-4004	WC	5	4
Tempe	04-013-4005	TE	5	4
Dysart	04-013-4010	DY	5	4
Pinnacle Peak	04-013-2005	PP	3	5
Falcon Field	04-013-1010	FF	3	5
Blue Point	04-013-9702	BP	3	5
Fountain Hills	04-013-9704	FH	3	5
Cave Creek	04-013-4008	CC	3	5
Humboldt Mountain	04-013-9508	HM	1	6
Rio Verde	04-013-9706	RV	1	6

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	Rank
West Phoenix	04-013-0019	WP	8	1
Central Phoenix	04-013-3002	CP	7	2
South Scottsdale	04-013-3003	SS	7	2
Buckeye	04-013-4011	BE	6	3
North Phoenix	04-013-1004	NP	6	3
South Phoenix	04-013-4003	SP	6	3
Dysart	04-013-4010	DY	5	4
Glendale	04-013-2001	GL	5	4
Greenwood	04-013-3010	GR	5	4
Mesa	04-013-1003	ME	5	4
West Chandler	04-013-4004	WC	5	4
Higley	04-013-4006	HI	4	5
West 43rd Avenue	04-013-4009	WF	4	5
Durango Complex	04-013-9812	DC	3	6

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	Rank
West Phoenix	04-013-0019	WP	8	1
South Phoenix	04-013-4003	SP	6	2
Mesa	04-013-1003	ME	5	3
Durango Complex	04-013-9812	DC	3	4

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	Rank
Central Phoenix	04-013-3002	CP	7	1
South Scottsdale	04-013-3003	SS	7	1

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 the number of years that a monitor has been operating continuously. Note that if a monitor had alternating periods of operation (not including seasonal monitors), then only the most recent operating period is considered. Seasonal monitors (those CO and 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. 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, such as population density or emission source mix, in the area of the monitoring site.

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 2009)	Rank
Central Phoenix	CP	44	1
Glendale	GL	36	2
North Phoenix	NP	36	2
South Phoenix	SP	36*	2
South Scottsdale	SS	36	2
Mesa	ME	32	3
West Phoenix	WP	26	4
West Indian School Rd	WI	20	5
Greenwood	GR	17	6
West Chandler	WC	17**	6
Tempe	TE	10	7
Dysart	DY	7	8
Buckeye	BE	6	9

* includes former South Phoenix 04-013-0013 site
** includes former West Chandler 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 2009)	Rank
Central Phoenix	CP	43	1
South Scottsdale	SS	35	2
West Phoenix	WP	20	3
Greenwood	GR	17	4
Buckeye	BE	6	5

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 2009)	Rank
Central Phoenix	CP	43	1
Glendale	GL	36	2
South Scottsdale	SS	36	2
North Phoenix	NP	35	3
South Phoenix	SP	35*	3
West Phoenix	WP	26	4
Pinnacle Peak	PP	22	5
Falcon Field	FF	21	6
Blue Point	BP	17	7
Humboldt Mountain	HM	17	7
West Chandler	WC	17**	7
Fountain Hills	FH	14	8
Rio Verde	RV	13	9
Tempe	TE	10	10
Cave Creek	CC	9	11
Dysart	DY	7	12
Buckeye	BE	6	13

* 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 2009)	Rank
Central Phoenix	CP	25	1
South Phoenix	SP	25*	1
Glendale	GL	23	2
South Scottsdale	SS	23	2
West Phoenix	WP	22	3
Mesa	ME	20	4
North Phoenix	NP	20	4
Greenwood	GR	17	5

West Chandler	WC	17**	5
Durango Complex	DC	11	6
Higley	HI	10	7
West 43rd Avenue	WF	8	8
Dysart	DY	7	9
Buckeye	BE	6	10
Zuni Hills	ZH	1	11

* 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 2009)	Rank
West Phoenix	WP	10 (FRM)	1
Durango Complex	DC	5 (continuous non-FRM or FEM)*	2
Mesa	ME	5 (FRM)	2
South Phoenix	SP	5 (FRM)	2

*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 2009)	Rank
Central Phoenix	CP	45	1
South Scottsdale	SS	26	2

3.3 Analysis #3: Measured Concentrations

This analysis ranks monitors based upon the concentration of the pollutants that they measure. The measure uses the design value of each monitoring site; the design value is generally the highest annual concentration measured in that averaging interval. Monitors with higher design values are ranked higher than those with lower design values.

The assumption of this analysis is that sites that measure high concentrations are important for assessing NAAQS compliance and population exposure and for performing model evaluations. A drawback of this analysis is that it does not consider any kind of monitor-siting issues, as a monitor might not measure maximum concentrations if it has not been sited optimally. Also, 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)						Rank
	2005	2006	2007	2008	2009	Average	
West Indian School Rd.	6.8	7.8	6.2	3.9	5.6	6.06	1
West Phoenix	7.2	7.2	6.0	4.7	4.9	6.00	2
Central Phoenix	6.0	4.1	3.6	3.6	4.5	5.20	3
South Phoenix	5.5	5.2	4.9	3.7	4.1	4.68	4
Greenwood	5.9	6.3	4.6	3.0	3.5	4.66	5
North Phoenix	3.8	3.5	3.4	2.1	5.9	3.74	6
Tempe	3.2	3.7	3.2	2.4	4.0	3.30	7
South Scottsdale	3.2	5.5	2.7	2.0	2.9	3.26	8
Glendale	3.2	3.8	4.3	2.1	2.0	3.08	9
Mesa	3.4	4.1	3.9	1.7	2.0	3.02	10
West Chandler	3.5	2.7	2.7	1.8	2.1	2.56	11
Buckeye	1.1	1.2	3.9	0.7	1.2	1.62	12
Dysart	1.7	1.3	1.8	1.5	1.0	1.46	13

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

MCAQD Site Name	Design Value (Annual Average Concentration, in ppm)						Rank
	2005	2006	2007	2008	2009	Average	
Greenwood	0.0315	0.0306	0.029	0.026	0.0253	0.02848	1
Central Phoenix	0.0262	0.0251	0.0237	0.0215	0.0208	0.02346	2
West Phoenix	0.0235	0.0238	0.0209	0.0186	0.0171	0.02078	3
South Scottsdale	0.0196	0.0192	0.0163	0.0146	0.0139	0.01672	4
Buckeye	0.0119	0.0111	0.0102	0.0094	0.0088	0.01028	5

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

MCAQD Site Name	Design Value (3-Year Average of Fourth High, in ppm)						Rank
	2005	2006	2007	2008	2009	Average	
North Phoenix	0.083	0.083	0.082	0.081	0.077	0.0812	1
Rio Verde	0.081	0.081	0.083	0.080	0.075	0.0800	2
Fountain Hills	0.082	0.082	0.082	0.079	0.074	0.0798	3
Humboldt Mountain	0.084	0.081	0.081	0.078	0.074	0.0796	4
Cave Creek	0.080	0.079	0.080	0.078	0.075	0.0784	5
South Scottsdale	0.076	0.077	0.078	0.078	0.075	0.0768	6
PP	0.078	0.076	0.078	0.075	0.073	0.0760	7
Tempe	0.076	0.075	0.077	0.078	0.074	0.0760	8
Glendale	0.079	0.077	0.075	0.074	0.071	0.0752	9
West Chandler	0.074	0.075	0.076	0.077	0.073	0.0750	10
Falcon Field	0.075	0.075	0.076	0.076	0.071	0.0746	11
West Phoenix	0.072	0.074	0.075	0.078	0.073	0.0744	12
Central Phoenix	0.076	0.076	0.075	0.074	0.070	0.0742	13
South Phoenix	0.075	0.072	0.072	0.072	0.072	0.0726	14
Blue Point	0.081	0.073	0.067	0.065	0.067	0.0706	15
Dysart	0.068	0.068	0.068	0.068	0.067	0.0678	16
Buckeye	0.062	0.063	0.065	0.066	0.065	0.0642	17

Table 3.3.4. *MCAQD PM_{10} monitoring sites, ranked by highest design value.*

MCAQD Site Name	Design Value (Maximum 24-hour average, in µg/m^3)						Rank
	2005	2006	2007	2008	2009	Average	
West 43rd	233	313	227	278	317	273.6	1
Buckeye	169	272	195	223	439	259.6	2
Durango Complex	206	253	155	247	277	227.6	3
Higley	142	274	230	133	275	210.8	4
South Phoenix	147	132	171	230	250	186.0	5
Greenwood	173	212	124	133	229	174.2	6
Central Phoenix	116	190	267	133	153	171.8	7
West Phoenix	155	178	124	113	210	156.0	8
West Chandler	94	77	104	67	220	112.4	9
Dysart	76	67	111	75	227	111.2	10
Glendale	84	60	92	80	196	102.4	11
South Scottsdale	121	76	73	92	135	99.4	12
Mesa	86	75	110	71	87	85.8	13
North Phoenix	81	79	78	88	69	79.0	14
Zuni Hills					*		N/A

*Zuni Hills began operation in December 2009 and did not operate long enough to create a valid design value

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/m³)						Rank
	2005	2006	2007	2008	2009	Average	
Durango Complex	N/A	34.5	32.6	30.8	28.2	31.5	1
South Phoenix	36.4	32.6	31.5	26.9	28.8	31.2	2
West Phoenix	35.2	33.1	32.2	26.8	27.0	30.9	3
Mesa	17.5	18.8	18.6	17.6	16.7	17.8	4

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

MCAQD Site Name	Design Value (Maximum 24-hour average, in ppm)						Rank
	2005	2006	2007	2008	2009	Average	
Central Phoenix	0.008	0.007	0.005	0.004	0.005	0.0058	1
South Scottsdale	0.006	0.006	0.005	0.005	0.006	0.0056	2

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

This analysis, like the Measured Concentration analysis, also uses the design values from each monitoring site. Unlike the previous analysis, however, this technique uses the absolute value between the design value and the National Ambient Air Quality Standards (NAAQS). Monitoring sites 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 standard, thus being considered to be more important to determine NAAQS compliance. The disadvantage to this technique is that it is a narrow focus, so therefore does not consider the importance of having a monitor in a highly polluted area with concentrations high 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)								Rank
	2005	2006	2007	2008	2009	Avg.	NAAQS	Deviance	
West Indian School	6.8	7.8	6.2	3.9	5.6	6.06	35	-28.94	1
West Phoenix	7.2	7.2	6.0	4.7	4.9	6.00	35	-29	2
South Phoenix	5.5	5.2	4.9	3.7	4.1	4.68	35	-30.32	3
Greenwood	5.9	6.3	4.6	3.0	3.5	4.66	35	-30.34	4
Central Phoenix	5.2	6.0	4.1	3.6	3.6	4.50	35	-30.5	5
North Phoenix	3.8	3.5	3.4	2.1	5.9	3.74	35	-31.26	6
Tempe	3.2	3.7	3.2	2.4	4.0	3.30	35	-31.7	7
South Scottsdale	3.2	5.5	2.7	2.0	2.9	3.26	35	-31.74	8
Glendale	3.2	3.8	4.3	2.1	2.0	3.08	35	-31.92	9
Mesa	3.4	4.1	3.9	1.7	2.0	3.02	35	-31.98	10
West Chandler	3.5	2.7	2.7	1.8	2.1	2.56	35	-32.44	11
Buckeye	1.1	1.2	3.9	0.7	1.2	1.62	35	-33.38	12
Dysart	1.7	1.3	1.8	1.5	1.0	1.46	35	-33.54	13

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)								Rank
	2005	2006	2007	2008	2009	Avg.	NAAQS	Deviance	
Greenwood	0.032	0.031	0.029	0.026	0.025	0.029	0.053	-0.0245	1
Central Phoenix	0.026	0.025	0.024	0.022	0.021	0.024	0.053	-0.0295	2
West Phoenix	0.024	0.024	0.021	0.019	0.017	0.021	0.053	-0.0322	3
South Scottsdale	0.020	0.019	0.016	0.015	0.014	0.017	0.053	-0.0363	4
Buckeye	0.012	0.011	0.010	0.009	0.009	0.010	0.053	-0.0427	5

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

MCAQD Site Name	Design Value (Maximum 1-hour average, in ppm)								Rank
	2005	2006	2007	2008	2009	Avg.	NAAQS	Deviance	
West Chandler	0.074	0.075	0.076	0.077	0.073	0.0750	0.075	0	1
Glendale	0.079	0.077	0.075	0.074	0.071	0.0752	0.075	0.0002	2
Falcon Field	0.075	0.075	0.076	0.076	0.071	0.0746	0.075	-0.0004	3
West Phoenix	0.072	0.074	0.075	0.078	0.073	0.0744	0.075	-0.0006	4
Central Phoenix	0.076	0.076	0.075	0.074	0.070	0.0742	0.075	-0.0008	5
Pinnacle Peak	0.078	0.076	0.078	0.075	0.073	0.0760	0.075	0.0010	6
Tempe	0.076	0.075	0.077	0.078	0.074	0.0760	0.075	0.0010	6
South Scottsdale	0.076	0.077	0.078	0.078	0.075	0.0768	0.075	0.0018	7
South Phoenix	0.075	0.072	0.072	0.072	0.072	0.0726	0.075	-0.0024	8
Cave Creek	0.080	0.079	0.080	0.078	0.075	0.0784	0.075	0.0034	9
Blue Point	0.081	0.073	0.067	0.065	0.067	0.0706	0.075	-0.0044	10
Humboldt Mountain	0.084	0.081	0.081	0.078	0.074	0.0796	0.075	0.0046	11
Fountain Hills	0.082	0.082	0.082	0.079	0.074	0.0798	0.075	0.0048	12
Rio Verde	0.081	0.081	0.083	0.080	0.075	0.0800	0.075	0.0050	13
North Phoenix	0.083	0.083	0.082	0.081	0.077	0.0812	0.075	0.0062	14
Dysart	0.068	0.068	0.068	0.068	0.067	0.0678	0.075	-0.0072	15
Buckeye	0.062	0.063	0.065	0.066	0.065	0.0642	0.075	-0.0108	16

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 µg/m^3)								Rank
	2005	2006	2007	2008	2009	Avg.	NAAQS	Deviance	
West Phoenix	155	178	124	113	210	156.0	150	6.0	1
Central Phoenix	116	190	267	133	153	171.8	150	21.8	2
Greenwood	173	212	124	133	229	174.2	150	24.2	3
South Phoenix	147	132	171	230	250	186.0	150	36.0	4
West Chandler	94	77	104	67	220	112.4	150	-37.6	5
Dysart	76	67	111	75	227	111.2	150	-38.8	6
Glendale	84	60	92	80	196	102.4	150	-47.6	7
South Scottsdale	121	76	73	92	135	99.4	150	-50.6	8
Higley	142	274	230	133	275	210.8	150	60.8	9
Mesa	86	75	110	71	87	85.8	150	-64.2	10
North Phoenix	81	79	78	88	69	79.0	150	-71.0	11
Durango Complex	206	253	155	247	277	227.6	150	77.6	12
Buckeye	169	272	195	223	439	259.6	150	109.6	13
West 43rd	233	313	227	278	317	273.6	150	123.6	14

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)								Rank
	2005	2006	2007	2008	2009	Avg.	NAAQS	Deviance	
Durango Complex	N/A	34.5	32.6	30.8	28.2	31.5	35	-3.5	1

South Phoenix	36.4	32.6	31.5	26.9	28.8	31.2	35	-3.8	2
West Phoenix	32.1	33.1	32.2	26.8	27.0	30.2	35	-4.8	3
Mesa	17.5	18.8	18.6	17.6	16.7	17.8	35	-17.2	4

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

MCAQD Site Name	Design value (Maximum 24-hour average, in ppm)								Rank
	2005	2006	2007	2008	2009	Avg.	NAAQS	Deviance	
Central Phoenix	0.008	0.007	0.005	0.004	0.005	.0058	0.14	-0.1342	1
South Scottsdale	0.006	0.006	0.005	0.005	0.006	.0056	0.14	-0.1344	2

3.5 Analysis #5: Area Served

This analysis analyzes the spatial coverage of each monitor. The technique used to determine the spatial coverage is to apply Thiessen polygons to represent that monitor's coverage area. Thiessen polygons, a standard technique used in geography to assign a zone of influence around a point, 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 will be the closest monitor within its perspective Thiessen polygon, it is used to represent the entire area of the polygon. Larger Thiessen polygons (measured by km^2), and thus larger areas served, will score higher in this analysis.

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 are in a rural area will tend to serve larger areas and thus 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 even less representation since there is even 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 (e.g. prevailing wind currents push emission plumes away from the polygon's monitoring point), but this analysis will not give any weight to this situation. 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 also included in the creation of the Thiessen polygons. Monitoring sites of that particular pollution parameter were not always available in adjacent counties, so there are polygons that extend off the map analysis area. In the tables below, listings with an asterisk (*) indicate that the polygon for that site extends off the map and area is actually larger than value listed, i.e., the area of the polygon within Maricopa County.

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

3.5.1 CO Parameter Details

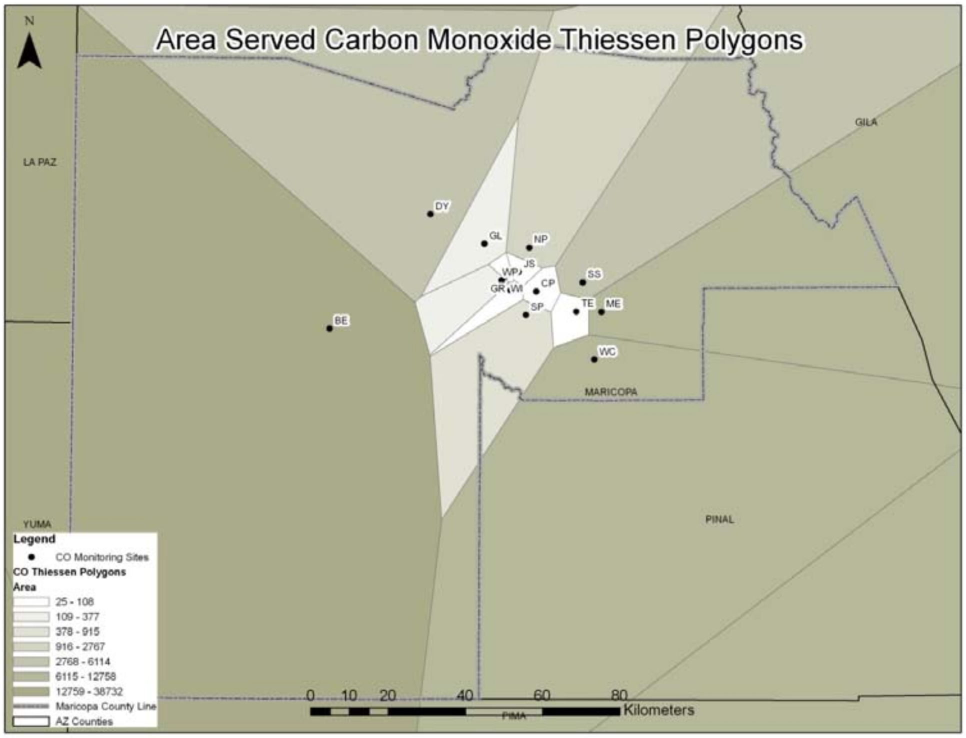

Figure 3.5.1. Thiessen polygons for CO monitoring sites.

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

Site	AQS Identifier	Acronym	Area Served (km^2)	Rank
Buckeye	04-013-4011	BE	12,861*	1
West Chandler	04-013-4004	WC	10,016	2
Dysart	04-013-4010	DY	3,081*	3
South Scottsdale	04-013-3003	SS	1,788*	4
Mesa	04-013-1003	ME	1,599*	5
North Phoenix	04-013-1004	NP	1,510*	6
South Phoenix	04-013-4003	SP	915	7
Glendale	04-013-2001	GL	377	8
West Phoenix	04-013-0019	WP	254	9
Tempe	04-013-4005	TE	108	10
Greenwood	04-013-3010	GR	92	11
Central Phoenix	04-013-3002	CP	78	12
West Indian School Rd	04-013-0016	WI	25	13

*The polygon extends off of the analysis map. Area listed is that within Maricopa County.

3.5.2 NO_2 Parameter Details

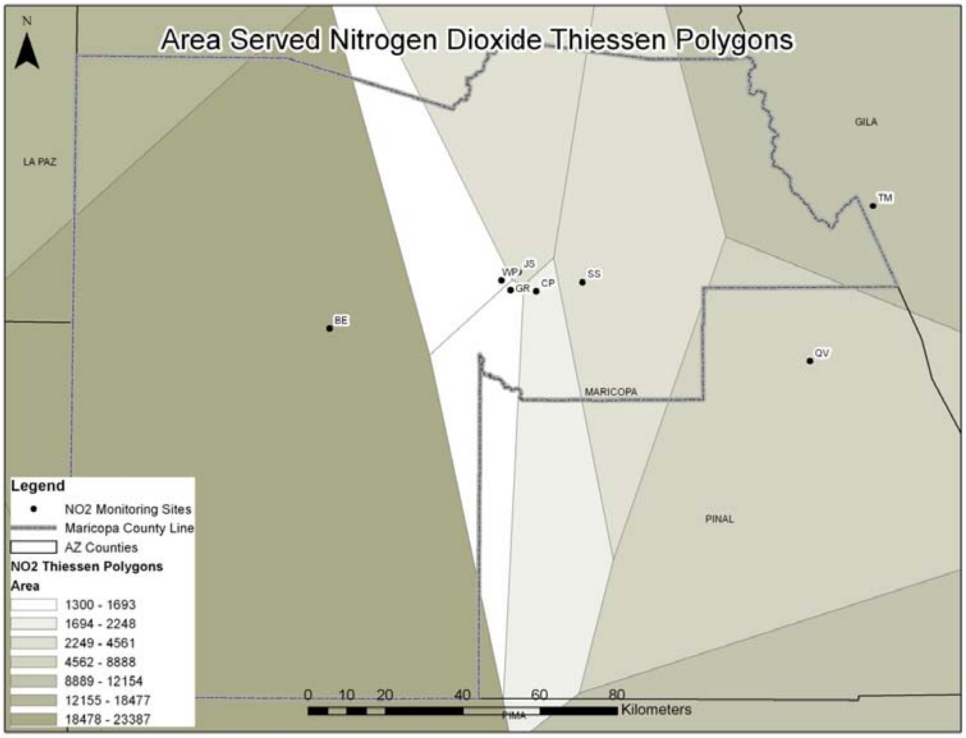

Figure 3.5.2. Thiessen polygons for NO_2 monitoring sites.

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)	Rank
Buckeye	04-013-4011	BE	21,265	1
South Scottsdale	04-013-3003	SS	4,144	2
Central Phoenix	04-013-3002	CP	2,248	3
West Phoenix	04-013-0019	WP	1,693	4
Greenwood	04-013-3010	GR	1,300	5

3.5.3 O_3 Parameter Details

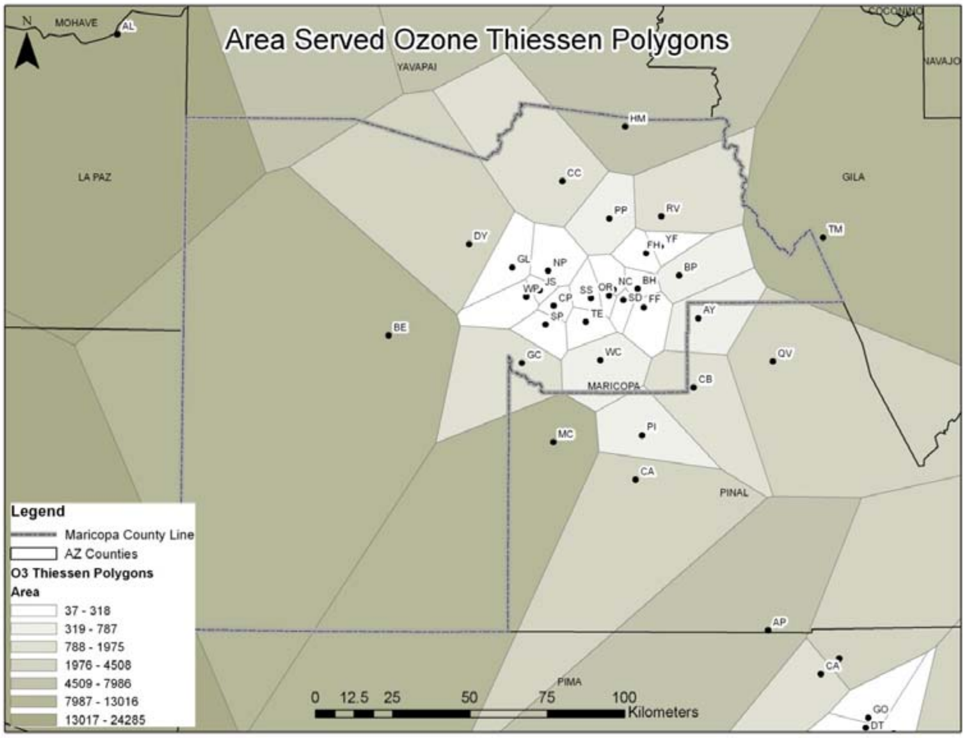

Figure 3.5.3. Thiessen polygons for O_3 monitoring sites.

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)	Rank
Buckeye	04-013-4011	BE	12,565	1
Humboldt Mountain	04-013-9508	HM	7,767*	2
Dysart	04-013-4010	DY	2,690	3
Cave Creek	04-013-4008	CC	1617	4
Rio Verde	04-013-9706	RV	940	5
West Chandler	04-013-4004	WC	511	6
Blue Point	04-013-9702	BP	441	7
Pinnacle Peak	04-013-2005	PP	414	8
Glendale	04-013-2001	GL	318	9
North Phoenix	04-013-1004	NP	273	10
Falcon Field	04-013-1010	FF	228	11
West Phoenix	04-013-0019	WP	190	12
Tempe	04-013-4005	TE	147	13
Fountain Hills	04-013-9704	FH	139	14
South Phoenix	04-013-4003	SP	123	15
South Scottsdale	04-013-3003	SS	118	16
Central Phoenix	04-013-3002	CP	80	17

*The area extends off of the analysis map. The area served listed for Humboldt Mountain includes areas within Gila, Yavapai, and Coconino counties as it extends to the northern-most O_3 monitor, the ADEQ's Prescott College in Yavapai County.

3.5.4 PM_{10} Parameter Details

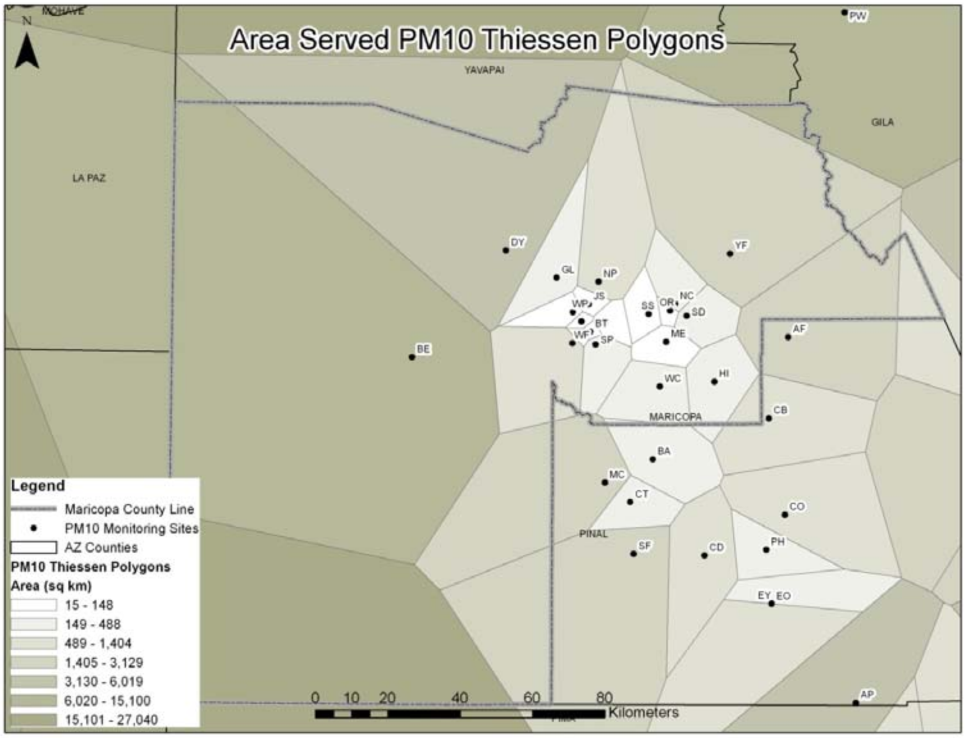

Figure 3.5.5. Thiessen polygons for PM_{10} sites.

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)	Rank
Buckeye	04-013-4011	BE	15,100	1
Dysart	04-013-4010	DY	4,845	2
North Phoenix	04-013-1004	NP	857	3
West 43rd Avenue	04-013-4009	WF	638	4
Glendale	04-013-2001	GL	379	5
Higley	04-013-4006	HI	376	6
West Chandler	04-013-4004	WC	344	7
South Phoenix	04-013-4003	SP	207	8
Mesa	04-013-1003	ME	148	9
South Scottsdale	04-013-3003	SS	136	10
West Phoenix	04-013-0019	WP	112	11
Central Phoenix	04-013-3002	CP	86	12
Greenwood	04-013-3010	GR	20	13
Durango Complex	04-013-9812	DC	15	14

3.5.5 $PM_{2.5}$ Parameter Details

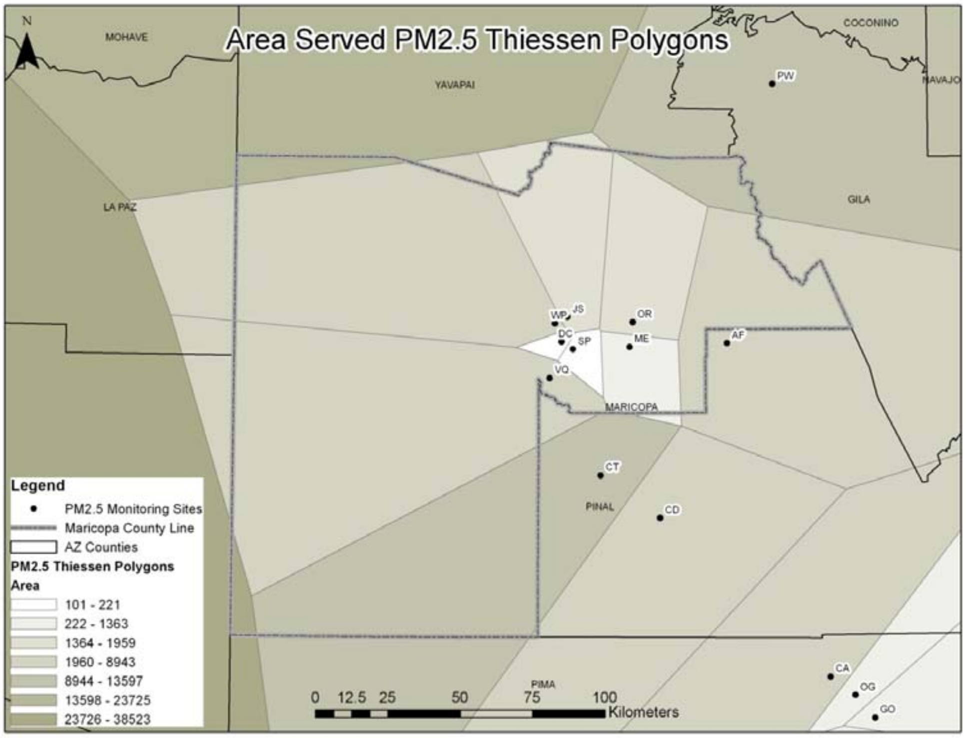

Figure 3.5.5. Thiessen polygons for $PM_{2.5}$ monitoring sites.

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)	Rank
West Phoenix	04-013-0019	WP	7,054	1
Mesa	04-013-1003	ME	750	2
South Phoenix	04-013-4003	SP	221	3
Durango Complex	04-013-9812	DC	101	4

3.5.6 SO_2 Parameter Details

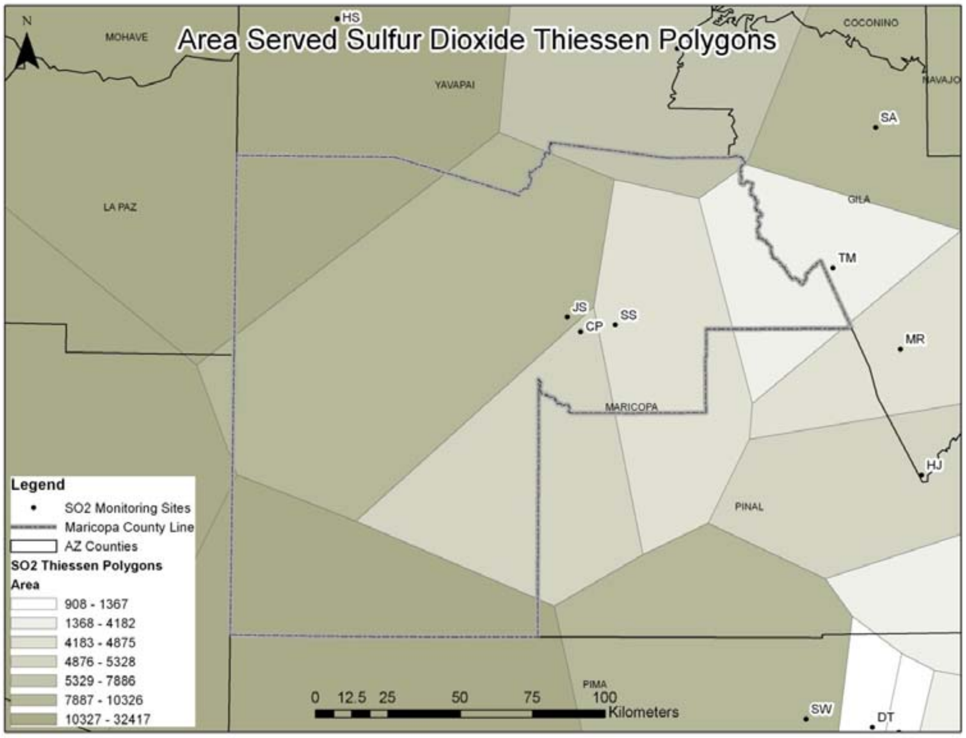

Figure 3.5.7. Thiessen polygons for SO_2 monitoring sites.

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)	Rank
Central Phoenix	04-013-3002	CP	5,214	1
South Scottsdale	04-013-3003	SS	4,811	2

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, organized by pollutant parameter. Data from the 2000 Census were then used within a Geographic Information System (GIS) to create a polygon coverage map of census block groups within Maricopa County. The census block group polygons were converted to centroid points which contained 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 population and a large area of representation. Note that in the case of large areas of representation, 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; that is this technique is purely spatial in its construction and does not consider meteorology, topology, location of sources, etc.

The 2000 Census block groups that were used in the analysis cover the Maricopa County metropolitan area, and include parts of Pinal, Gila, and Yavapai counties. Where applicable, the census block groups from these surrounding counties were used in calculating the population served.

Figure 3.6.1 depicts population densities of the central Maricopa County metropolitan area. The population density, or people per km^2, is based upon the 2000 Census block groups. Site Thiessen polygons for all monitoring parameters are also shown in this figure. Illustrations of Thiessen polygons for individual pollutant parameters are contained in Figures 3.5.1 through 3.5.7.

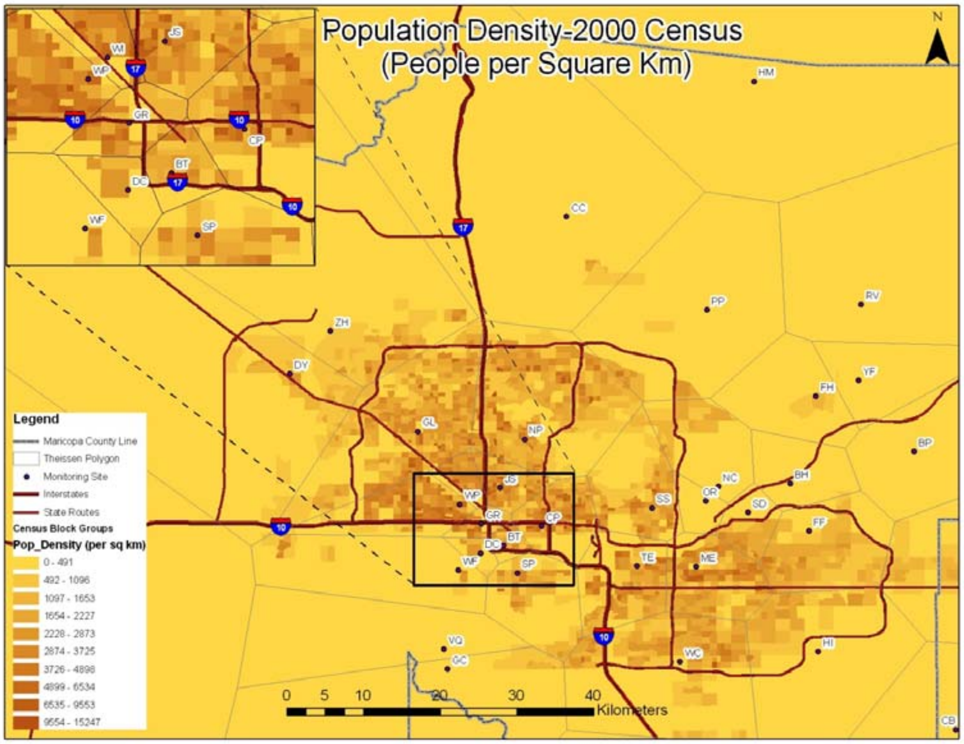

Figure 3.6.1. Maricopa County population density (2000, in people/sq km).

3.6.1 CO Parameter Details

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

Maricopa County AQD Site	Acronym	Population Served	Rank
Mesa	ME	575,310	1
North Phoenix	NP	470,081	2
Glendale	GL	462,389	3
West Chandler	WC	345,294	4
South Scottsdale	SS	256,159	5
West Phoenix	WP	204,379	6
Dysart	DY	179,961	7
Tempe	TE	158,620	8
Central Phoenix	CP	149,579	9
South Phoenix	SP	120,810	10
West Indian School Rd	WI	61,104	11
Greenwood	GR	58,593	12
Buckeye	BE	38,357	13

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	Rank
South Scottsdale	SS	1,229,168	1
West Phoenix	WP	640,461	2
Central Phoenix	CP	332,190	3
Greenwood	GR	93,412	4
Buckeye	BE	48,821	5

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	Rank
Glendale	GL	457,740	1
North Phoenix	NP	387,993	2
West Chandler	WC	321,428	3
Falcon Field	FF	248,082	4
West Phoenix	WP	246,076	5
Tempe	TE	236,002	6
Dysart	DY	174,019	7
Central Phoenix	CP	153,630	8
South Scottsdale	SS	130,327	9
South Phoenix	SP	90,333	10
Pinnacle Peak	PP	67,517	11
Cave Creek	CC	46,772	12
Fountain Hills	FH	34,926	13
Buckeye	BE	31,132	14
Humboldt Mountain	HM	14,197	15
Rio Verde	RV	2,414	16
Blue Point	BP	3	17

3.6.4 PM_{10} Parameter Details

Table 3.6.4. *PM_{10} monitoring sites, ranked by population served.*

Maricopa County AQD Site	Acronym	Population Served	Rank
Glendale	GL	467,204	1
North Phoenix	NP	452,859	2
Mesa	ME	293,977	3

West Chandler	WC	266,220	4
West Phoenix	WP	211,122	5
Dysart	DY	179,961	6
Higley	HI	166,608	7
South Scottsdale	SS	148,186	8
Central Phoenix	CP	144,345	9
South Phoenix	SP	126,432	10
West 43rd Avenue	WF	38,150	11
Buckeye	BE	35,459	12
Greenwood	GR	31,503	13
Durango Complex	DC	12,348	14

3.6.5 $PM_{2.5}$ Parameter Details

Table 3.6.5. *$PM_{2.5}$ monitoring sites, ranked by population served.*

Maricopa County AQD Site	Acronym	Population Served	Rank
Mesa	ME	759,393	1
West Phoenix	WP	674,274	2
South Phoenix	SP	200,030	3
Durango Complex	DC	54,836	4

3.6.6 SO_2 Parameter Details

Table 3.6.6. *SO_2 monitoring sites, ranked by population served.*

Maricopa County AQD Site	Acronym	Population Served	Rank
South Scottsdale	SS	1,308,615	1
Central Phoenix	CP	395,967	2

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. > 0.75) 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, 2009 data were collected from each criteria parameter monitored within Maricopa County, including State and tribal monitors. Data were also collected from surrounding counties (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 by using a matrix format. Within the matrix each monitoring pair were subjected to a linear regression test from which a Pearson correlation 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 vs. distance was created for each parameter.

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

- CO-Hourly concentration values from 2009 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 ADEQ (JLS Supersite).
- NO_2- Hourly concentration values from 2009 were used. All monitoring site locations were within Maricopa County and included data from MCAQD and ADEQ (JLS Supersite).
- O_3- Hourly concentration values from 2009 were used. Since some O_3 monitors in Maricopa County are seasonal, only data from April to October were used. Monitoring locations included sites within Maricopa Gila, and Pinal counties and included data reported by MCAQD, ADEQ, Pinal County AQD, Gila River Indian Community, Fort McDowell Yavapai Nation, and Salt River Pima-Maricopa Indian Community.
- PM_{10}- Hourly or 24-hour average concentrations from 2009 were used, but all data were subsequently converted to 24-hour daily block averages for correlation comparison. Data from 1-in-3 and 1-in-6 day monitors were also used; these values were accurately aligned with their calendar day to maintain temporal integrity in the linear regression. Monitoring locations included sites within Maricopa and Pinal counties and included data reported by MCAQD, ADEQ, Pinal County AQD, Gila River Indian Community, Fort McDowell Yavapai Nation, and Salt River Pima-Maricopa Indian Community.
- $PM_{2.5}$- Hourly or 24-hour average concentrations from 2009 were used, but all data were subsequently converted to 24-hour daily block averages for correlation comparison. Data from 1-in-3 and 1-in-6 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 2009 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

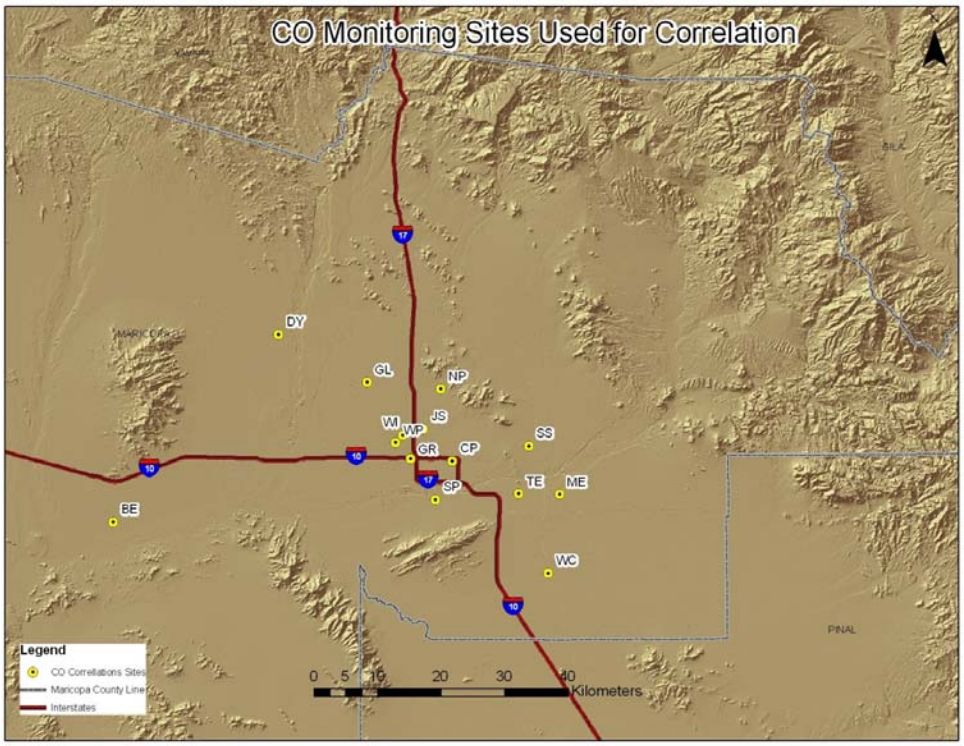

Figure 3.7.1. Map of CO monitoring sites used for analysis.

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

Maricopa County AQD Site	Acronym	Max. Correlation	Rank
Dysart	DY	0.16	1
Buckeye	BE	0.25	2
Mesa	ME	0.42	3
Tempe	TE	0.42	3
South Scottsdale	SS	0.49	4
North Phoenix	NP	0.50	5
Glendale	GL	0.52	6

West Chandler	WC	0.54	7
South Phoenix	SP	0.61	8
Central Phoenix	CP	0.64	9
Greenwood	GR	0.68	10
West Indian School Rd	WI	0.80	11
West Phoenix	WP	0.80	11

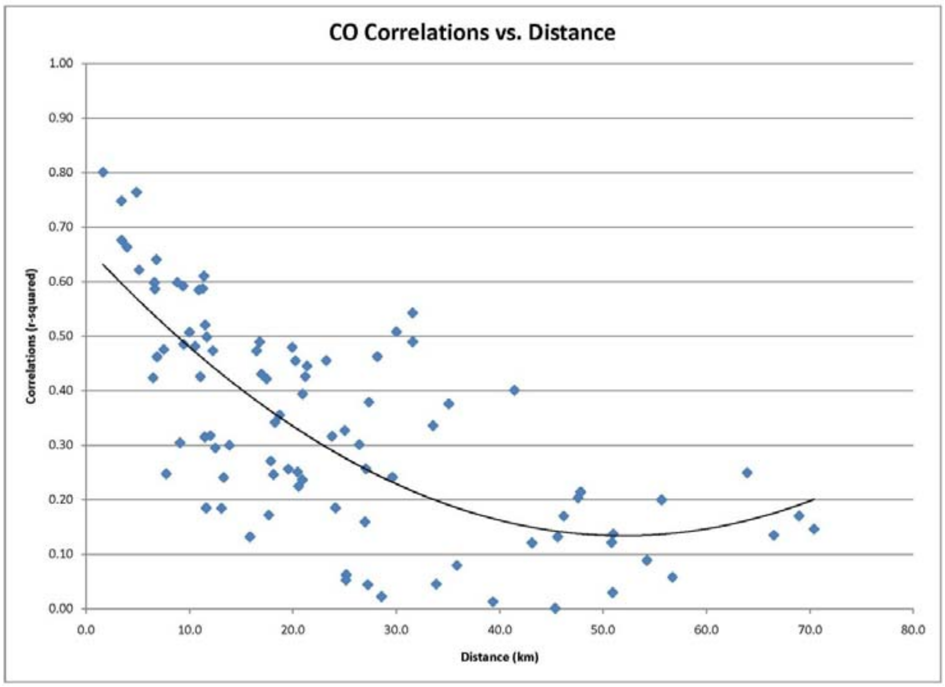

Figure 3.7.2. Correlogram of CO monitoring sites.

3.7.2 NO_2 Parameter Details

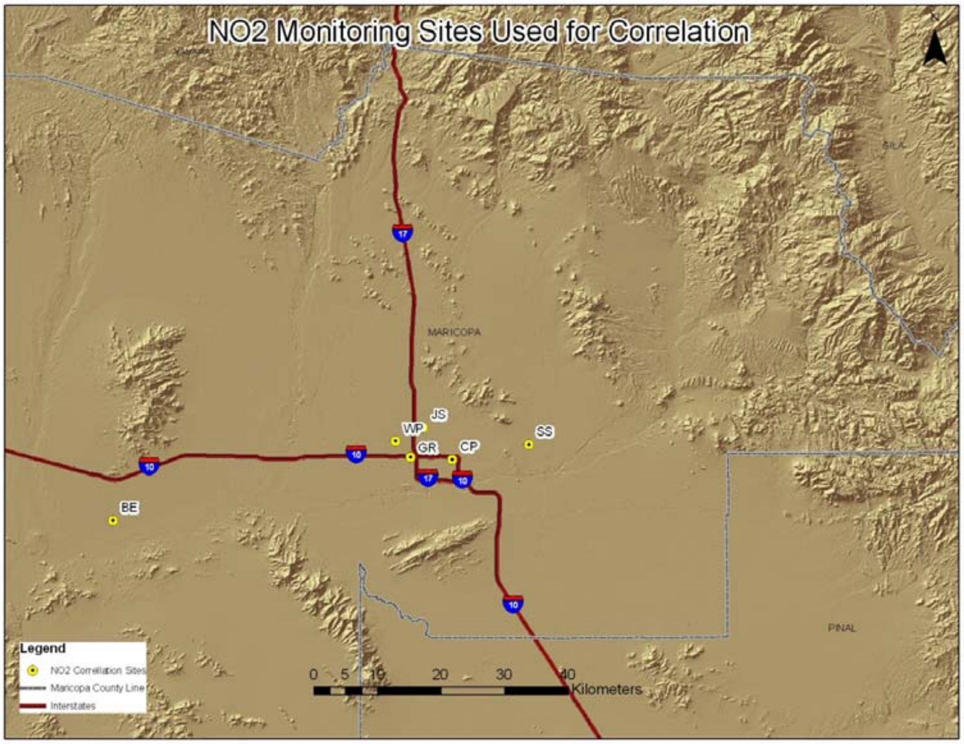

Figure 3.7.3. Map of NO_2 sites used for analysis.

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

Maricopa County AQD Site	Acronym	Max. Correlation	Rank
Buckeye	BE	0.60	1
South Scottsdale	SS	0.72	2
Central Phoenix	CP	0.79	3
Greenwood	GR	0.79	4
West Phoenix	WP	0.85	5

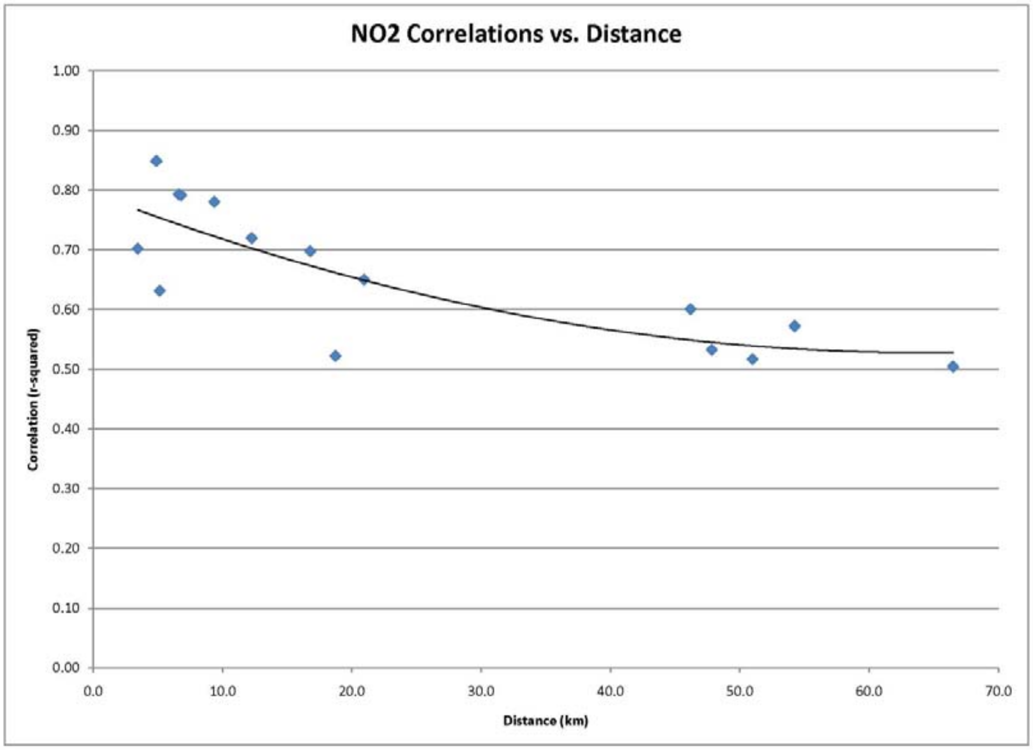

Figure 3.7.4. Correlogram of NO_2 monitoring sites.

3.7.3 O_3 Parameter Details

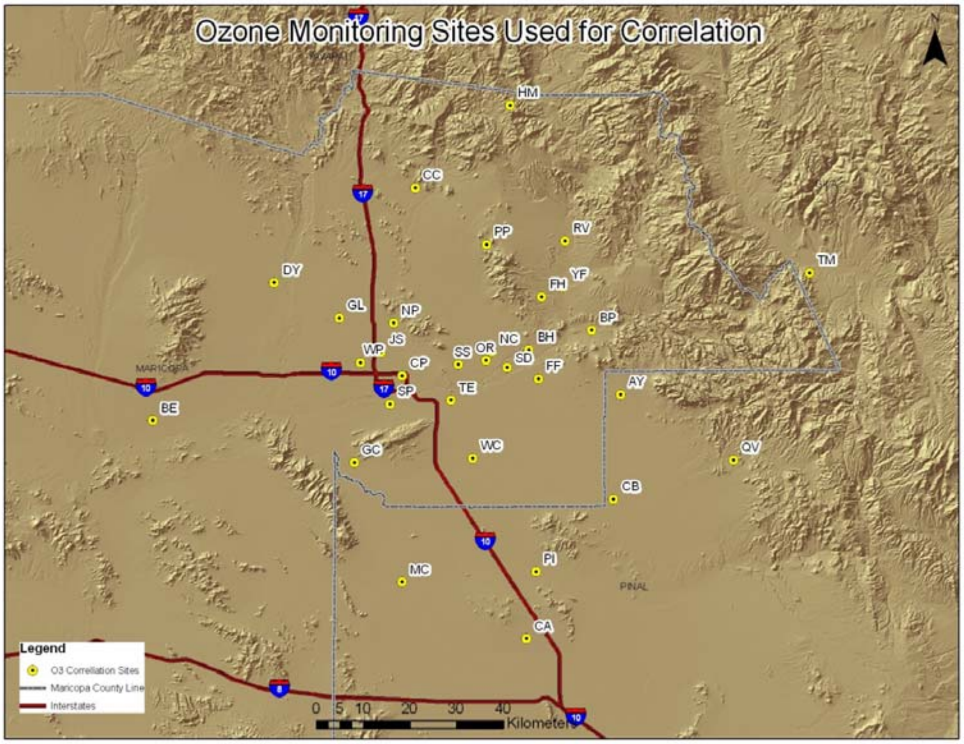

Figure 3.7.5. Map of O_3 sites used for analysis.

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

Maricopa County AQD Site	Acronym	Max. Correlation	Rank
Humboldt Mountain	HM	0.59	1
Pinnacle Peak	PP	0.64	2
Cave Creek	CC	0.69	3
Dysart	DY	0.76	4
Blue Point	BP	0.78	5
Buckeye	BE	0.79	6
Glendale	GL	0.81	7
Fountain Hills	FH	0.83	8
Rio Verde	RV	0.83	8
Falcon Field	FF	0.86	9
West Chandler	WC	0.86	9
North Phoenix	NP	0.89	10
South Scottsdale	SS	0.89	10
Tempe	TE	0.89	10
Central Phoenix	CP	0.90	11
South Phoenix	SP	0.90	11
West Phoenix	WP	0.94	12

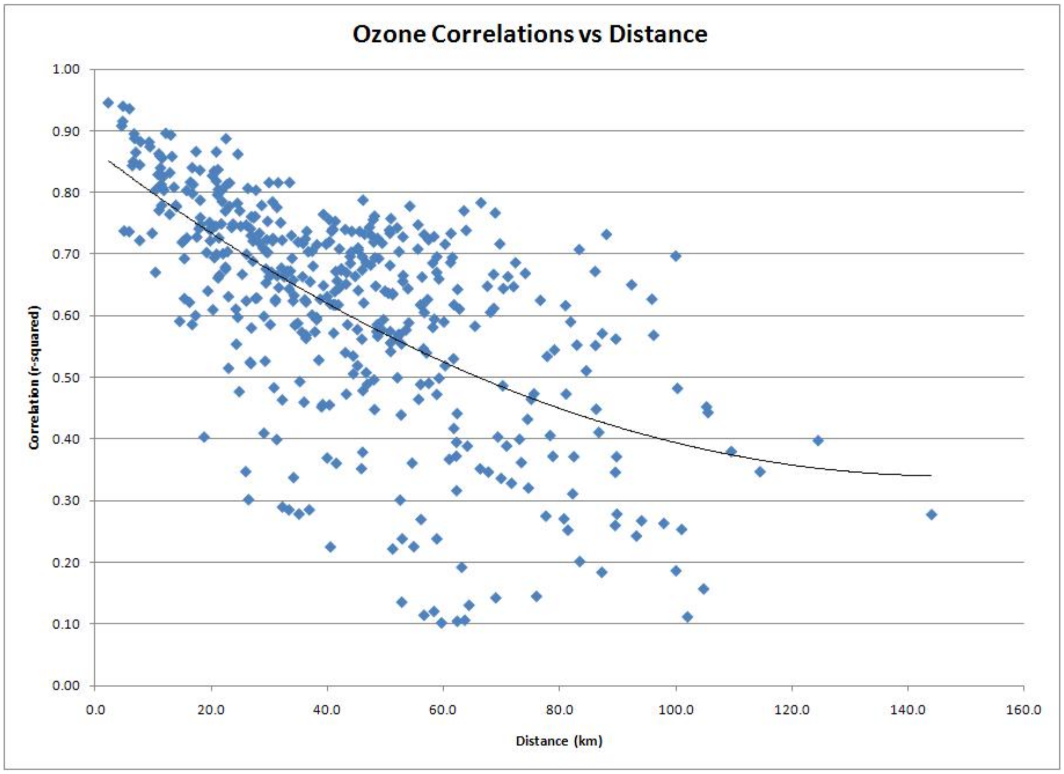

Figure 3.7.6. Correlogram of O_3 monitoring sites.

3.7.4 PM_{10} Parameter Details

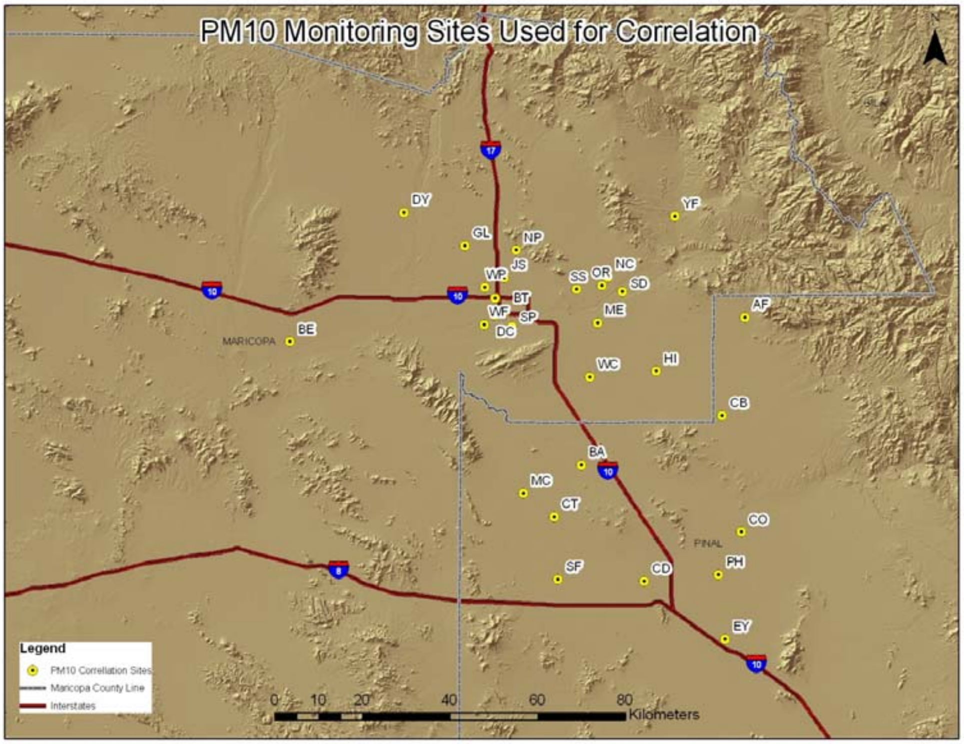

Figure 3.7.7. Map of PM_{10} sites used for analysis.

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

Maricopa County AQD Site	Acronym	Max. Correlation	Rank
Mesa	ME	0.72	1
Higley	HI	0.78	2
North Phoenix	NP	0.81	3
Buckeye	BE	0.82	4
West 43rd Avenue	WF	0.86	5
West Chandler	WC	0.87	6
Dysart	DY	0.89	7
Glendale	GL	0.89	7
South Phoenix	SP	0.89	7
South Scottsdale	SS	0.89	7
Central Phoenix	CP	0.90	8
Durango Complex	DC	0.91	9
Greenwood	GR	0.92	10
West Phoenix	WP	0.92	10

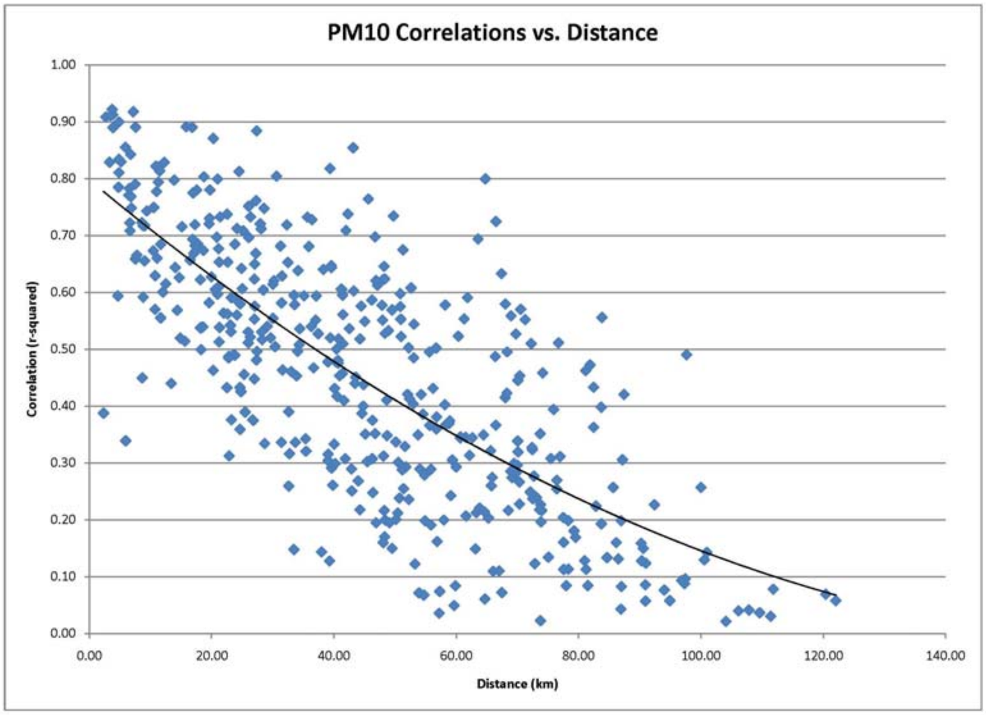

Figure 3.7.8. Correlogram from PM_{10} monitoring sites.

3.7.5 $PM_{2.5}$ Parameter Details

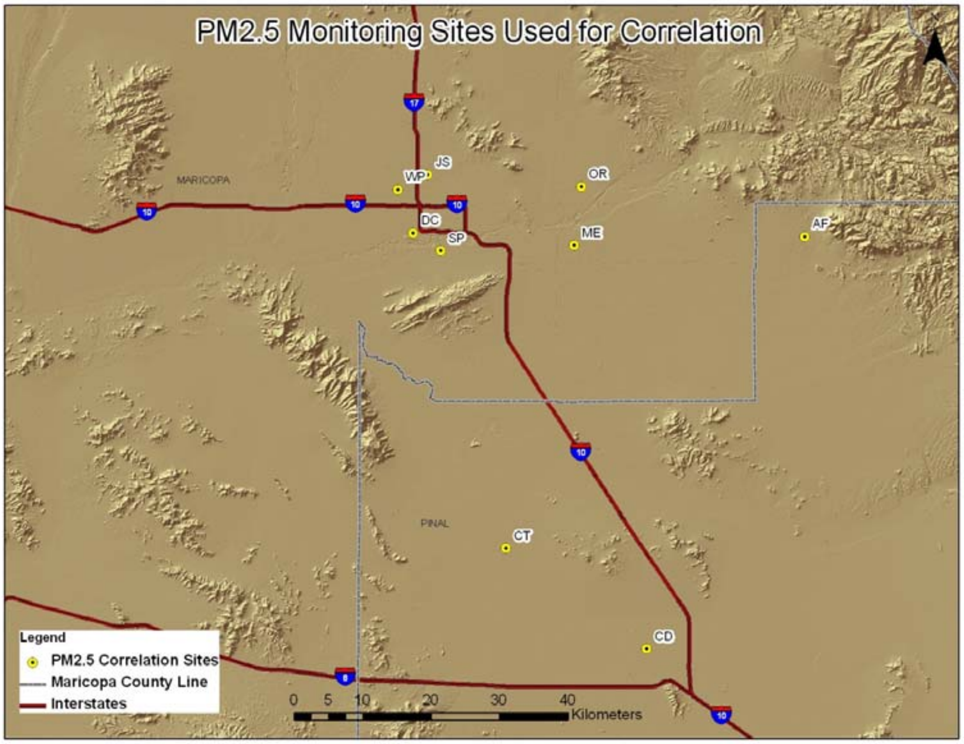

Figure 3.7.9. Map of $PM_{2.5}$ sites used for analysis.

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

Maricopa County AQD Site	Acronym	Max. Correlation	Rank
Mesa	ME	0.60	1
Durango Complex	DC	0.82	2
South Phoenix	SP	0.91	3
West Phoenix	WP	0.91	3

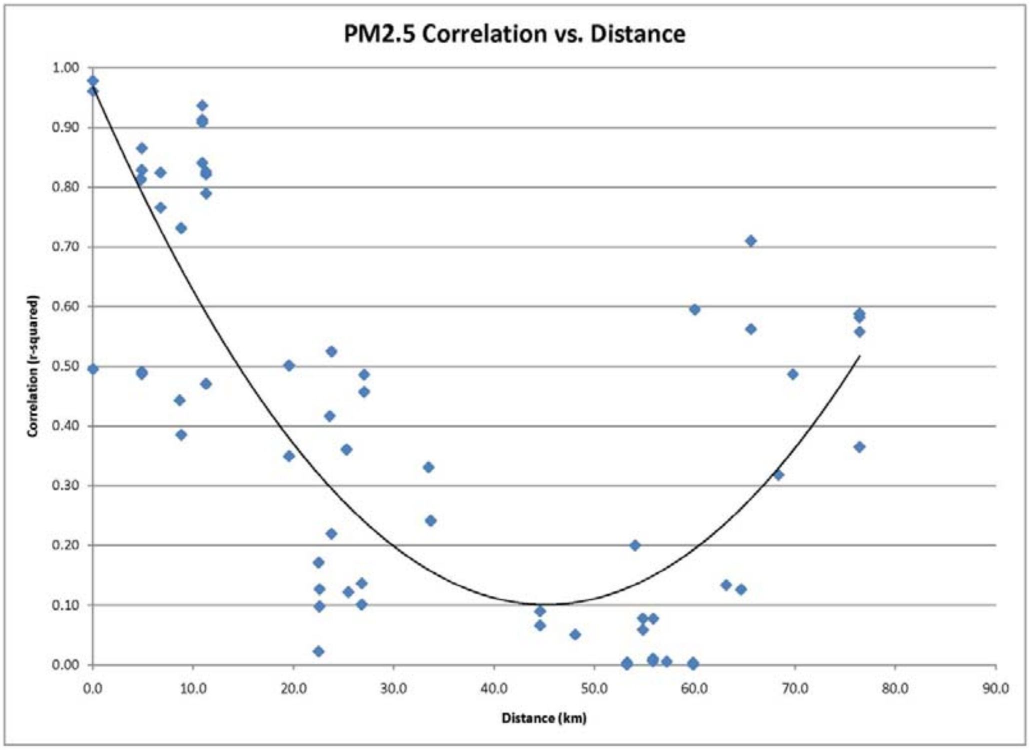

Figure 3.7.10. Correlogram of $PM_{2.5}$ monitoring sites.

3.7.6 SO_2 Parameter Details

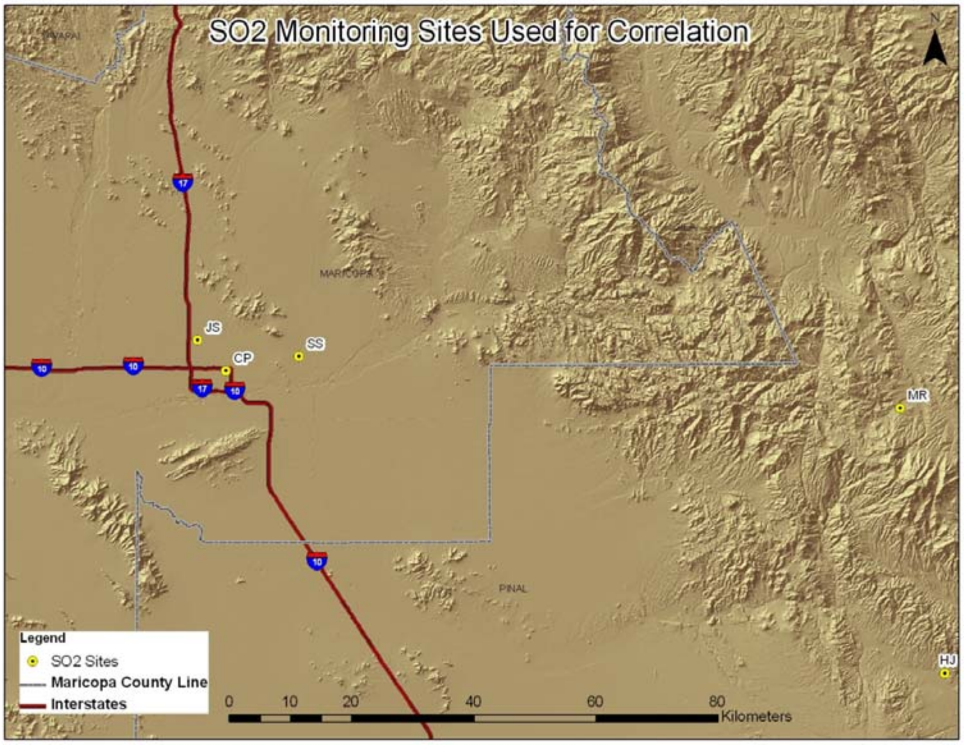

Figure 3.7.11. Map of SO_2 sites used for analysis.

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

Maricopa County AQD Site	Acronym	Max. Correlation	Rank
Central Phoenix	CP	0.13	1
South Scottsdale	SS	0.13	1

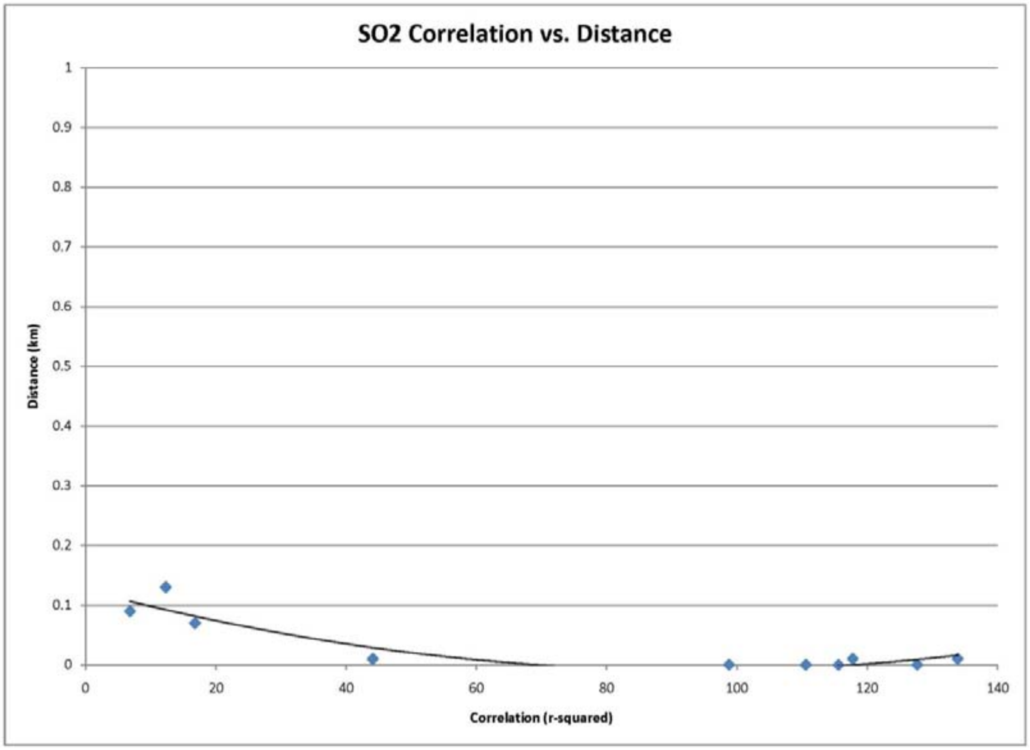

Figure 3.7.12. Correlogram of SO_2 monitoring sites.

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 which incorporates all monitoring sites. Each monitoring site is then systematically removed from the dataset and the interpolation map was recreated. The difference between the actual value from the monitoring site and the predicted value from the interpolation once the site was removed was recorded; this is the removal bias. Sites are then ranked using the absolute value of the 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 monitored pollution surface. The removal bias technique would likely be quite different if a different temporal scale was used; however, this network 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, thus their values add a unique perspective to the overall pollution surface. On the other hand, sites with a low removal bias difference could possibly be redundant with other sites, at least in the long-term temporal scale.

This analysis has disadvantages in that not every pollutant parameter has enough sites to create a kriging interpolation map, thus those parameters were not included in this analysis. Also, some parameters were not represented in counties adjacent to Maricopa County, e.g. carbon monoxide only has sites within the metropolitan area of Maricopa County. A limitation of the technology used in creating interpolation maps is that the map is bounded and by those outer-most monitoring sites, which do not contribute fully to the creation of the map (known as 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.

3.8.1 CO Parameter Details

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. Note: there were not enough sites to perform this analysis for NO_2 or SO_2 monitoring sites.

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

Maricopa County AQD Site	Average Concentration for 2005-2009	Removal Bias	Difference	Rank
Glendale	0.38	0.605	0.225	1
West Indian School Rd	1.02	0.818	-0.202	2
North Phoenix	0.44	0.555	0.115	3
West Phoenix	0.902	0.799	-0.103	4
Tempe	0.48	0.393	-0.087	5
South Phoenix	0.58	0.63	0.05	6
South Scottsdale	0.4	0.439	0.039	7
Greenwood	0.81	0.78	-0.03	8
Central Phoenix	0.614	0.635	0.021	9
Buckeye	0.16	N/A *	N/A	
Dysart	0.26	N/A *	N/A	
Mesa	0.32	N/A *	N/A	
West Chandler	0.38	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.

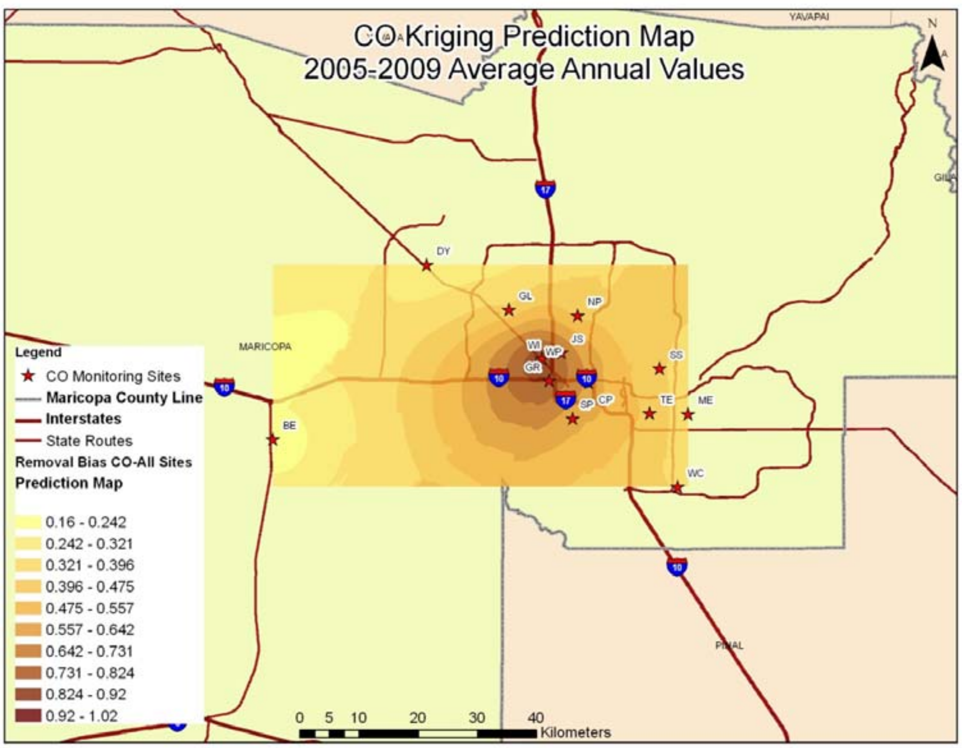

Figure 3.8.1. Kriging prediction map for CO.

3.8.2 O_3 Parameter Details

Table 3.8.2. *O_3 monitoring sites ordered and ranked by removal bias difference.*

Maricopa County AQD Site	Average Concentration for 2005-2009	Removal Bias	Difference	Rank
Buckeye	0.0295	0.0391	0.0096	1
Fountain Hills	0.0443	0.0367	-0.0076	2
Humboldt Mountain	0.0526	0.0464	-0.0062	3
North Phoenix	0.0367	0.0321	-0.0046	4
Pinnacle Peak	0.0472	0.0442	-0.0030	5
Falcon Field	0.0389	0.0362	-0.0027	6
Tempe	0.0317	0.0338	0.0021	7
West Phoenix	0.0317	0.0301	-0.0016	8
West Chandler	0.0353	0.0338	-0.0015	9
Dysart	0.0336	0.035	0.0014	10
Blue Point	0.0373	0.0386	0.0013	11
Cave Creek	0.0471	0.0459	-0.0012	12
Rio Verde	0.0437	0.0426	-0.0011	13
South Scottsdale	0.0344	0.0333	-0.0011	13
Glendale	0.034	0.0333	-0.0007	14
South Phoenix	0.0327	0.0321	-0.0006	15
Central Phoenix	0.0311	0.0312	0.0001	16

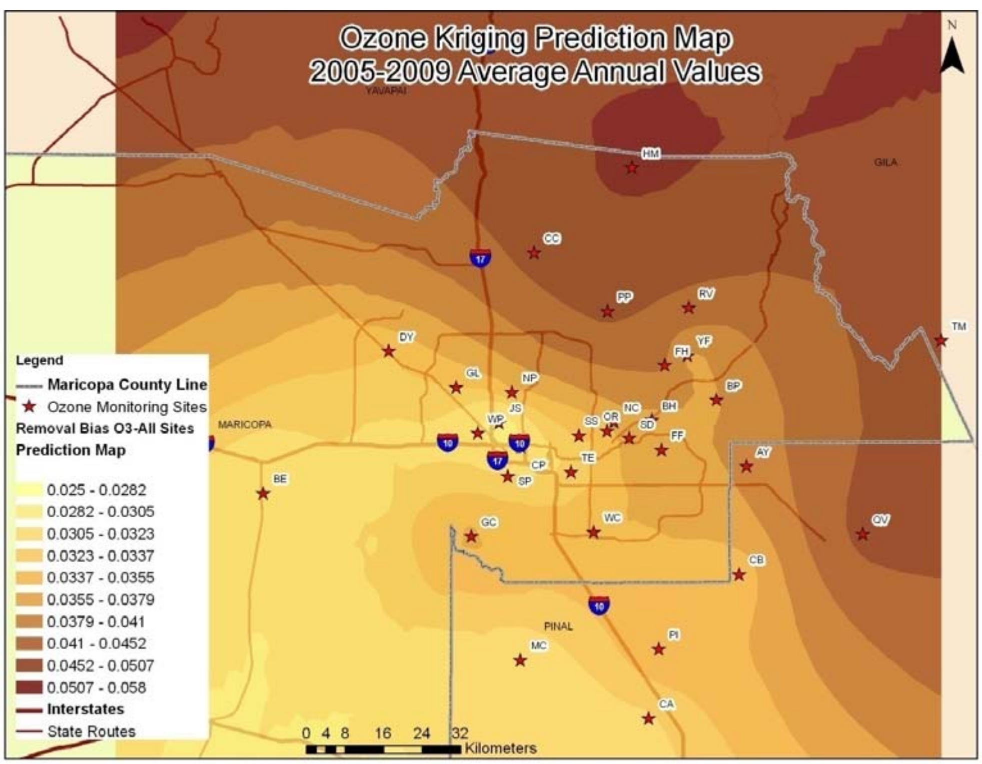

Figure 3.8.2. Kriging prediction map for O_3.

3.8.3 PM$_{10}$ Parameter Details

Table 3.8.3. *PM$_{10}$ monitoring sites ordered and ranked by removal bias difference.*

Maricopa County AQD Site	Average Concentration for 2005-2009	Removal Bias	Difference	Rank
West Chandler	31.0	47.8	16.8	1
West 43rd Avenue	66.6	52.1	–14.5	2
Higley	48.7	37.3	–11.4	3
Mesa	27.6	37.9	10.3	4
South Scottsdale	29.6	39.2	9.6	5
North Phoenix	29.1	34.8	5.7	6
Durango Complex	57.5	51.9	–5.6	7
Dysart	29.3	34.7	5.4	8
Glendale	31.0	34.9	3.9	9
Central Phoenix	38.3	41.0	2.7	10
Greenwood	47.6	46.3	–1.3	11
South Phoenix	50.9	49.7	–1.2	12
West Phoenix	42.9	43.4	0.5	13
Buckeye	48.1	N/A *	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.

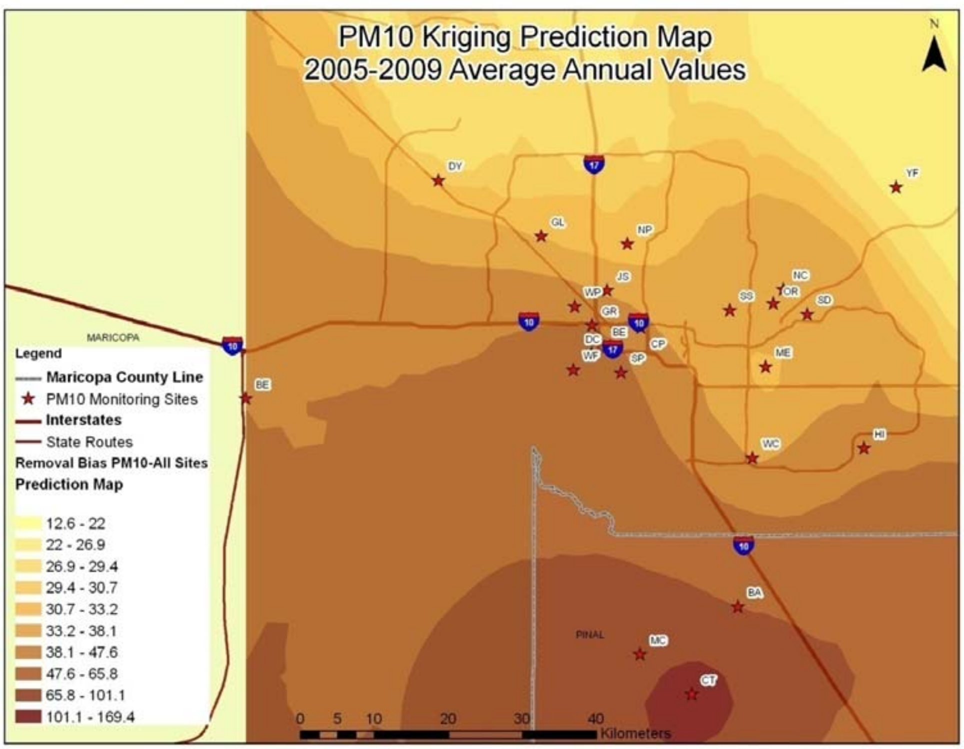

Figure 3.8.3. Kriging interpolation PM$_{10}$ prediction map.

3.8.4 PM2$_{2.5}$ Parameter Details

Table 3.8.4. *$PM_{2.5}$ monitoring sites ordered and ranked by removal bias difference.*

Maricopa County AQD Site	Average Concentration for 2005-2009	Removal Bias	Difference	Rank
Durango Complex	DC	13.58	11.33	–2.25
West Phoenix	WP	11.66	11.02	–0.64
South Phoenix	SP	11.95	11.63	–0.32
Mesa	ME	8.78	8.56	–0.22

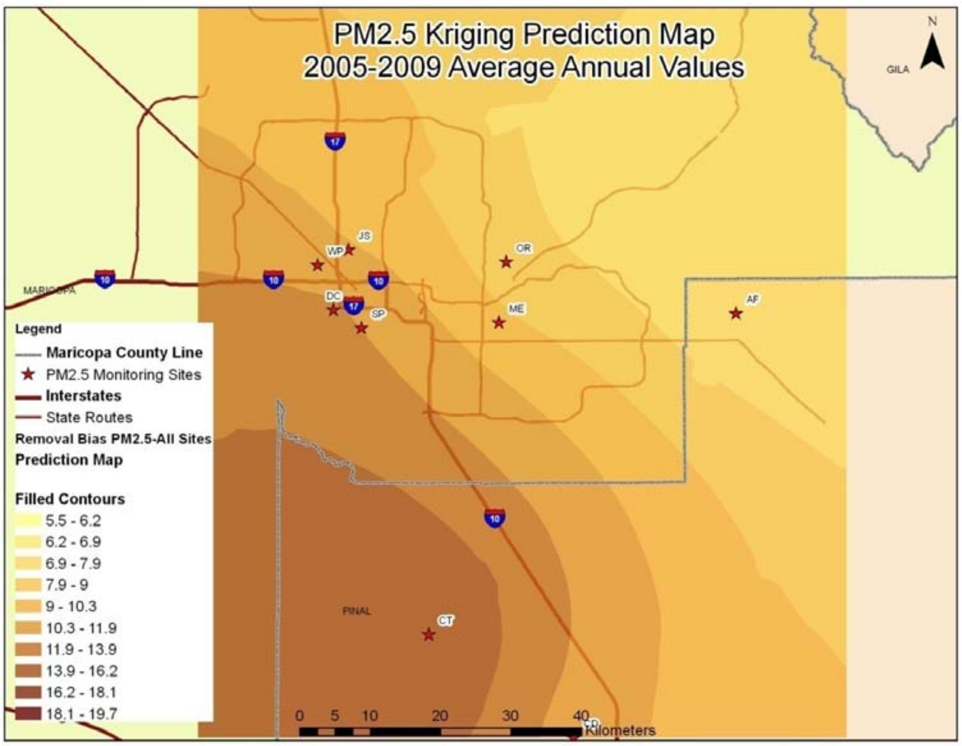

Figure 3.8.4. Kriging interpolation $PM_{2.5}$ prediction map.

3.9 Analysis #9: Emissions Inventory

This analysis ranks sites based on their proximity to point sources of pollution by giving weight to each monitor according to the 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's Emissions Inventory section provided the 2008 Emissions Inventory report, which lists reported emissions from approximately 1000 permitted sources within Maricopa County (the 2008 Emissions Inventory was the latest one available at the time of this network assessment). Point sources were spatially located within the inventory, and then with this spatial information emissions were aggregated using the township, range, and section grid system, with each section being 1-mile 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 2008 Emissions Inventory only includes point sources within the limits of Maricopa County, the Thiessen polygons were trimmed to only include area 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.

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

3.9.1 CO Parameter Details

There are fourteen CO monitoring sites within Maricopa County, though only the thirteen belonging to MCAQD were used in the analysis. Figure 3.9.1 shows point source emissions aggregated by township, range, and section (emission-sections), while Figure 3.9.2 shows the same emission-sections aggregated within each CO monitor's Thiessen polygon.

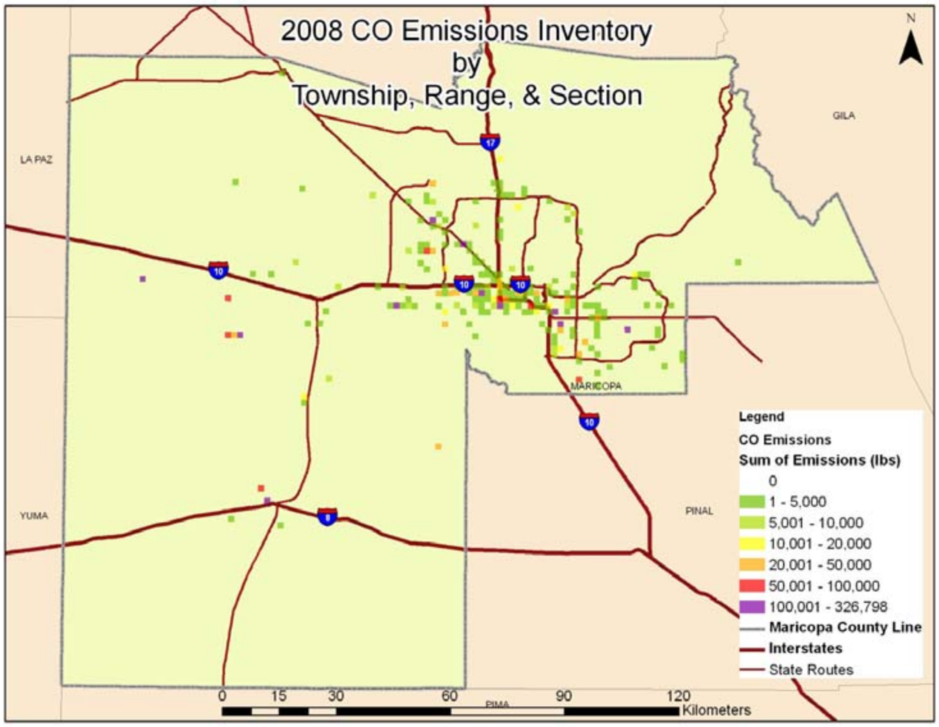

Figure 3.9.1. Annual (2008) point source CO emissions, aggregated by township, range, and section.

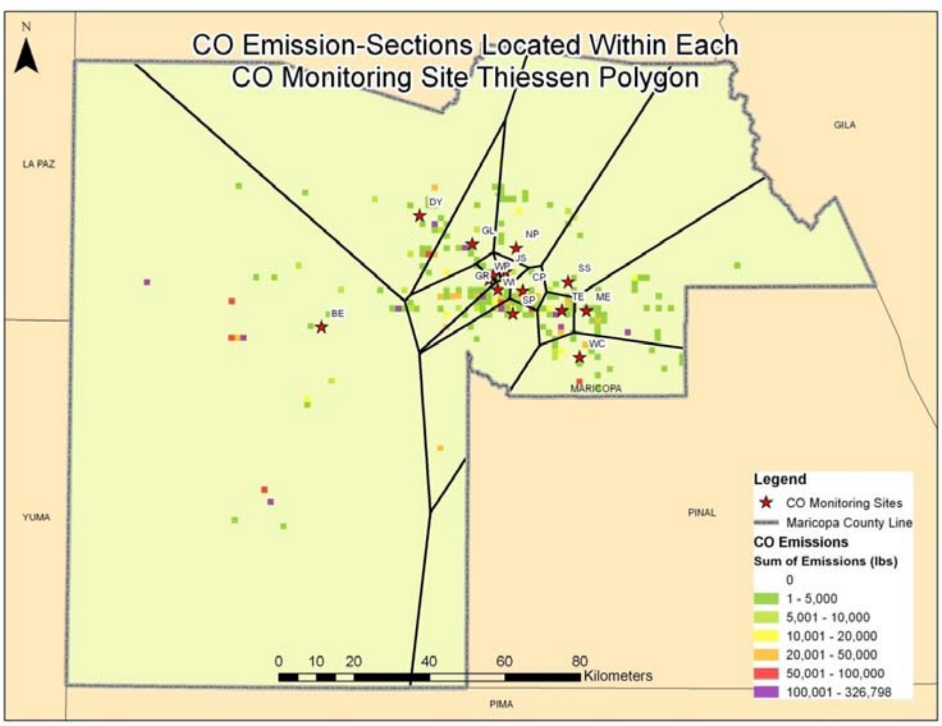

Figure 3.9.2. CO Emission-Sections aggregated by CO monitor's Thiessen polygons.

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 ranked 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)	Rank
Greenwood	389,627	21,64	201,396	92	4,235.1	1
Tempe	325,014	9,308	128,120	108	3,009.4	2
Central Phoenix	121,003	9,308	40,930	78	1,551.3	3
West Phoenix	181,575	8,646	35,645	254	714.9	4
Glendale	254,901	16,99	175,083	377	676.1	5
South Phoenix	353,886	23,59	179,537	784	451.4	6
West Indian School	6,844	2,281	3,772	25	273.8	7
Mesa	331,604	13,81	261,467	1,599	207.4	8
West Chandler	176,722	8,836	72,258	1,291	136.9	9
Buckeye	1,030,885	42,95	326,798	12,861	80.2	10
Dysart	230,336	11,51	100,176	3,081	74.8	11
North Phoenix	31,675	2,262	14,791	1,510	21.0	12
South Scottsdale	20,254	2,893	7,386	1,788	11.3	13

3.9.2 NO_2 Parameter Details

There are six NO_2 monitors within Maricopa County, though only the five that are operated by MCAQD were analyzed. Results are shown below.

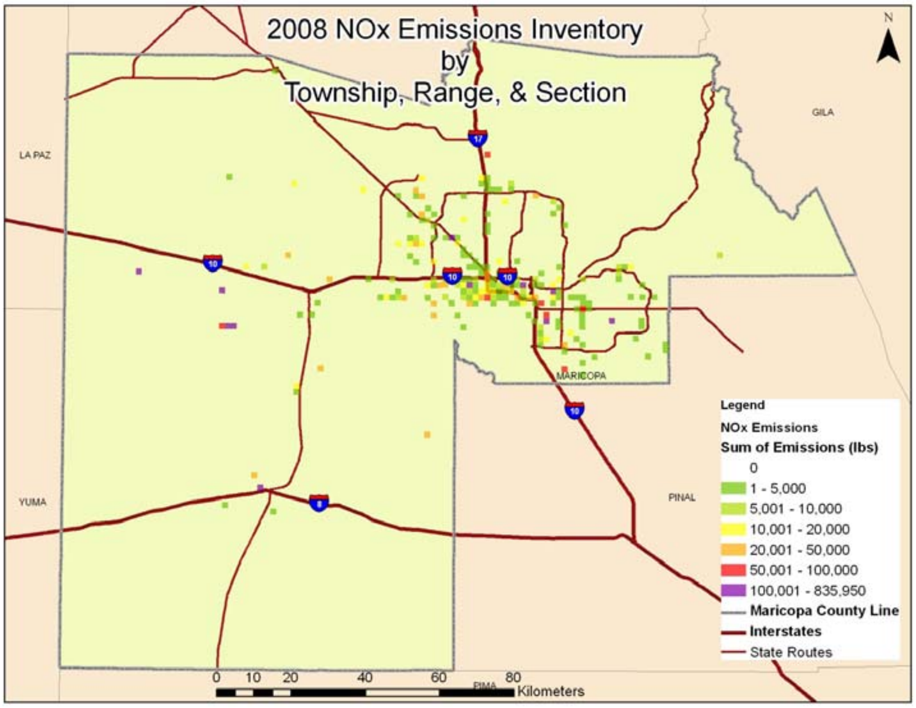

Figure 3.9.3. Annual (2008) point source NOx emissions, aggregated by township, range, and section.

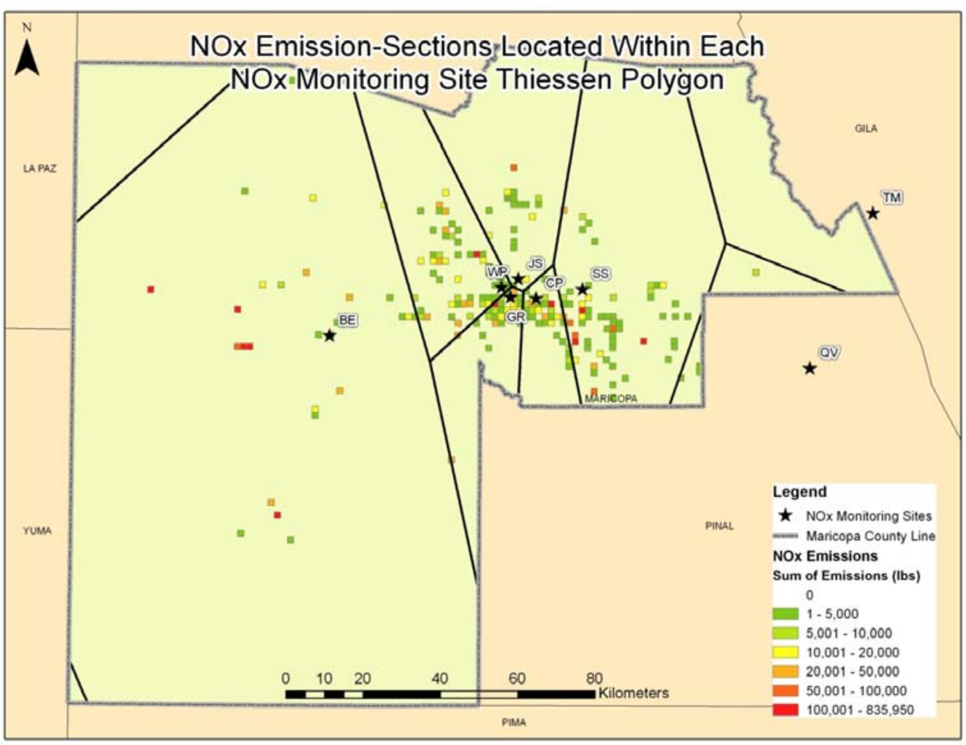

Figure 3.9.4. NO_x Emission-Sections aggregated by NO_x monitor Thiessen polygons.

Table 3.9.2 displays the sum of NO_x 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_x monitoring sites aggregated and normalized by Thiessen polygon area.*

Site	Sum of NO_x Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km^2)	Density: Sum/Area (lbs/km^2)	Rank
Greenwood	1,145,212	40,900	835,950	713	1,606	1
West Phoenix	1,310,444	25,201	801,002	1,312	999	2
Central Phoenix	344,346	11,874	116,046	413	834	3
South Scottsdale	1,396,307	24,497	627,669	3,013	463	4
Buckeye	2,229,083	82,559	686,014	14,242	157	5

3.9.3 PM_{10} Parameter Details

There are 20 PM_{10} monitors within Maricopa County; these are operated by MCAQD, ADEQ, and tribal agencies. This does not include the Zuni Hills PM_{10} site, which was started late in 2009 or the Coyote Lakes site which ran from 2007 to 2009; neither of which is included in any of the analyses. Only the 14 PM_{10} monitors operated by MCAQD were analyzed using this technique.

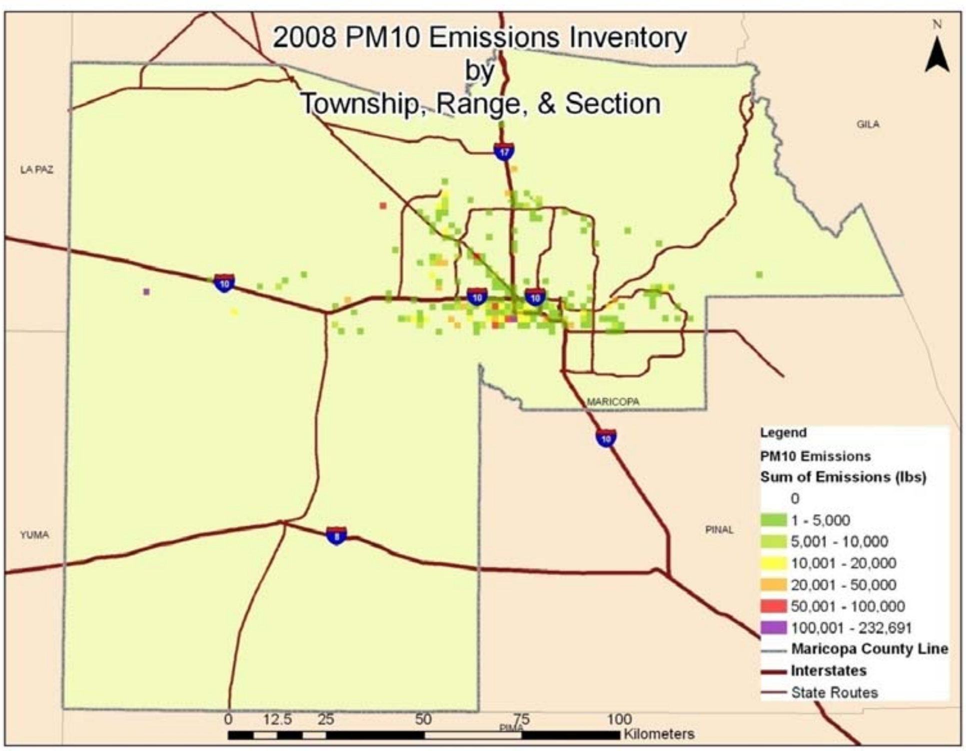

Figure 3.9.5. Annual (2008) point source PM_{10} emissions, aggregated by township, range, and section.

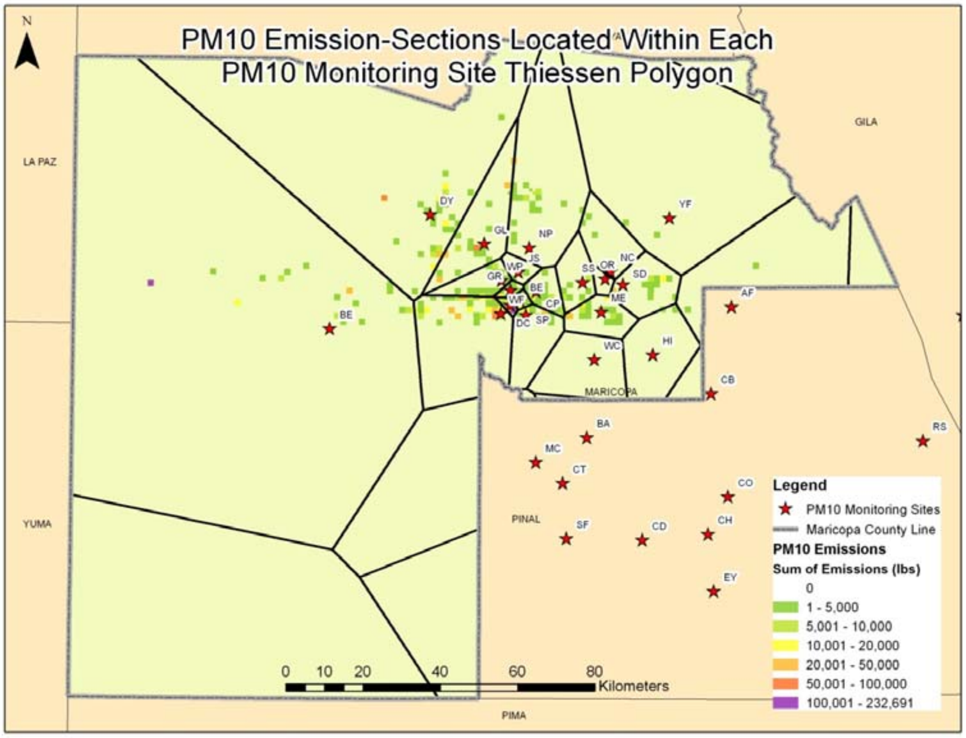

Figure 3.9.6. PM_{10} Emission-Sections aggregated by PM_{10} monitor Thiessen polygons.

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)	Rank
Durango Complex	291,007	58,201	195,492	15	19,400	1
Greenwood	95,471	11,934	71,659	20	4,774	2
Mesa	80,546	5,034	30,970	148	544	3
Glendale	201,152	11,175	56,032	379	531	4
West 43rd Ave.	295,379	10,185	57,469	607	487	5
Central Phoenix	39,517	2,325	11,188	86	460	6
South Phoenix	50,062	5,006	22,774	206	243	7
West Phoenix	18,427	1,417	7,620	112	165	8
South Scottsdale	14,984	2,141	7,793	136	110	9
Dysart	209,309	7,475	14,202	3,081	68	10
Buckeye	321,961	18,939	232,691	8,179	39	11
North Phoenix	32,177	1,788	5,994	837	38	12
Higley	138	69	87	349	0.4	13
West Chandler	0	0	0	342	0	14

3.9.4 $PM_{2.5}$ Parameter Details

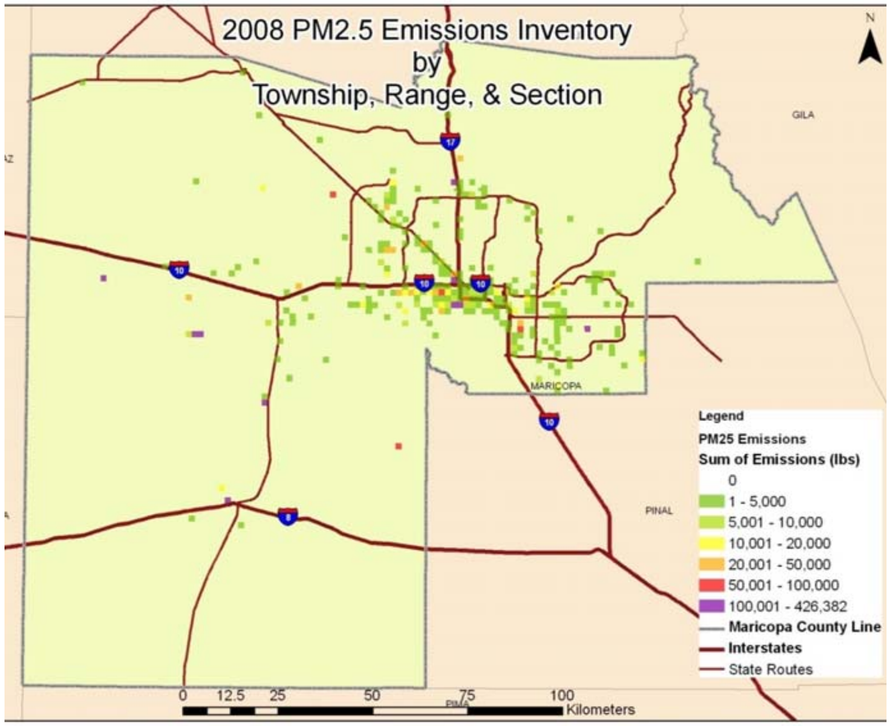

Figure 3.9.7. Annual (2008) point source PM2.5 emissions, aggregated by township, range, and section.

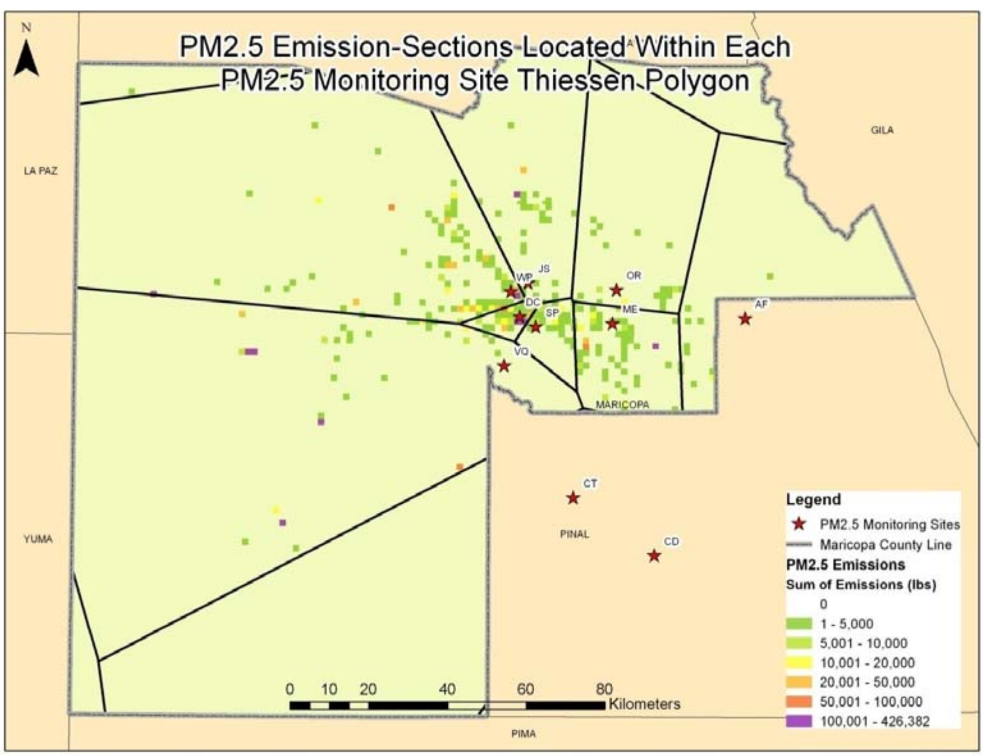

Figure 3.9.8. $PM_{2.5}$ Emission-Sections aggregated by $PM_{2.5}$ monitor Thiessen polygons.

Table 3.9.4 displays the sum of $PM_{2.5}$ emissions in each monitor's Thiessen polygon. After normalizing for density, the monitoring sites are ranked in order of greatest density.

Table 3.9.4. *$PM_{2.5}$ monitoring sites aggregated and normalized by Thiessen polygon area.*

Site	Sum of $PM_{2.5}$ Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km^2)	Density: Sum/Area (lbs/km^2)	Rank
Durango Complex	707,361	30,755	344,479	101	7,004	1
Mesa	316,477	5,754	100,650	705	449	2
South Phoenix	70,668	2,718	10,178	221	320	3
West Phoenix	1,208,639	14,561	426,382	5,623	215	4

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 South Scottsdale. The two MCAQD monitors were the only ones evaluated in this analysis.

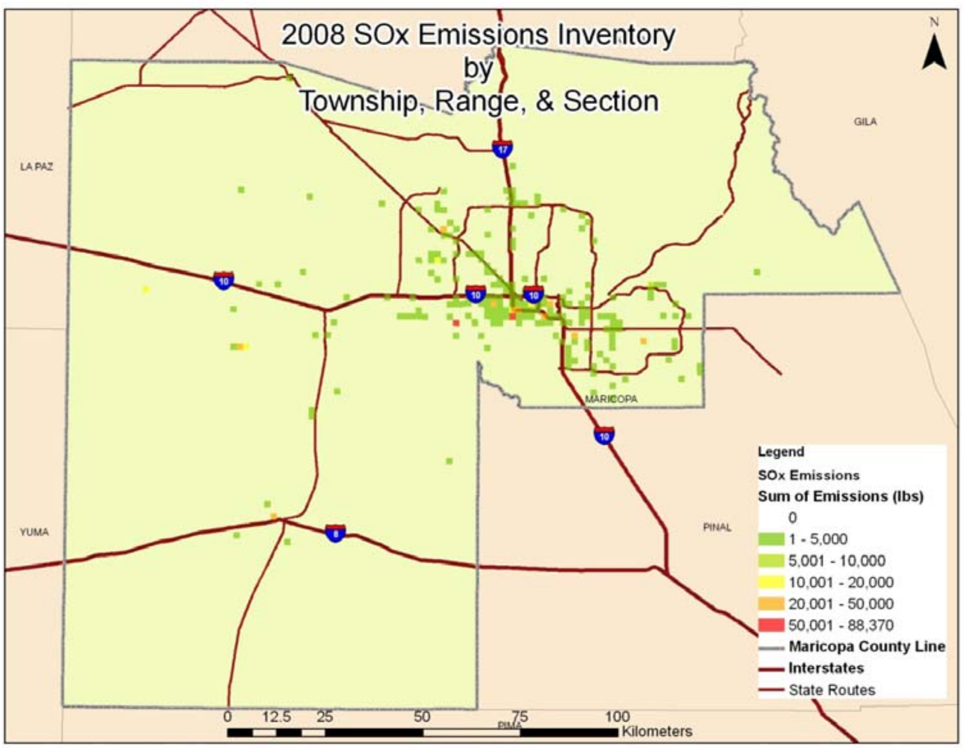

Figure 3.9.9. Annual (2008) point source SO2 emissions, aggregated by township, range, and section.

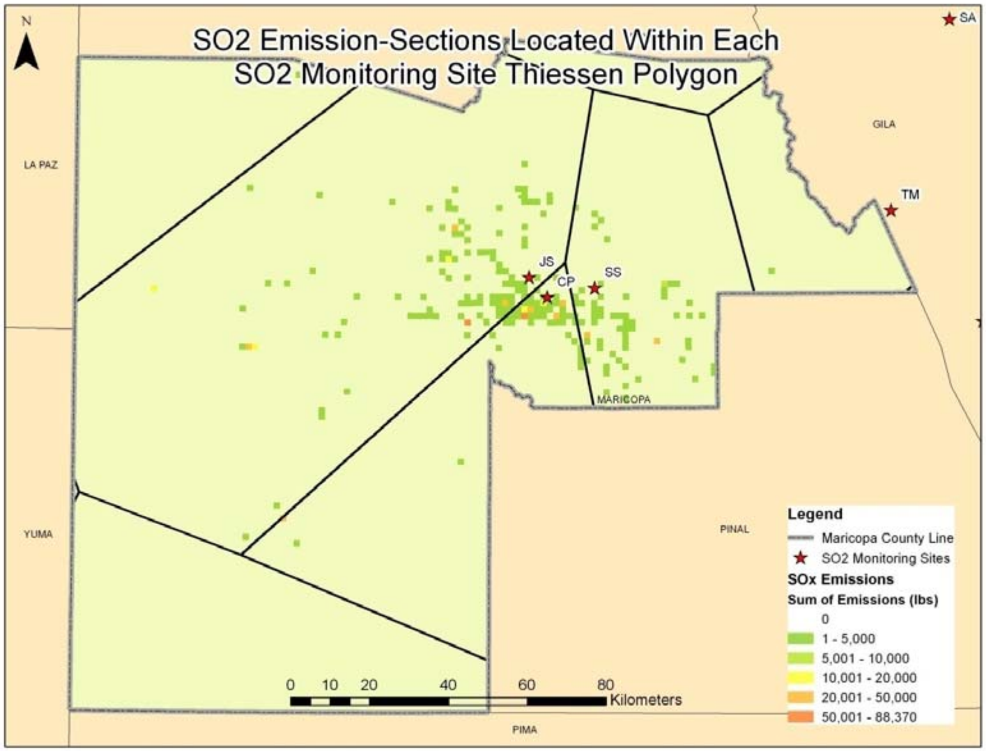

Figure 3.9.10. SO_2 Emission-Sections aggregated by SO_2 monitor Thiessen polygons.

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)	Rank
Central Phoenix	227,667	4,844	58,356	3,261	70	1
South Scottsdale	75,761	1,263	35,991	2,877	26	2

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 form near its pre-cursor sources and increase as the plume moves downwind and has more time to react with the sun. 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. 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 3.9.11 shows this relationship by displaying a prediction map of O_3 values generated by using the 2008 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 in the short-term O_3 levels are still high in the areas surrounding the precursor point-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 2008 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.

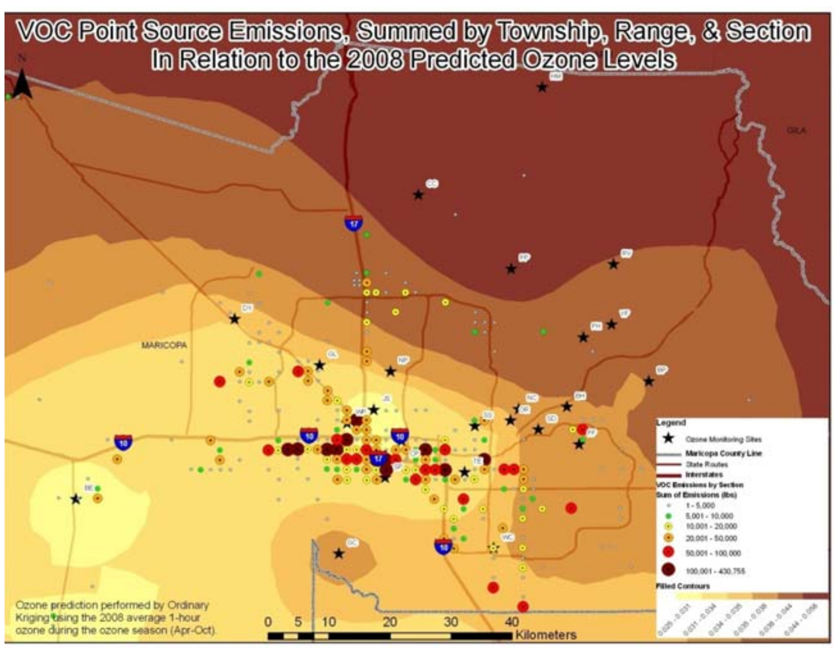

Figure 3.9.11. 2008 predicted O_3 levels in relation to VOC precursor point sources.

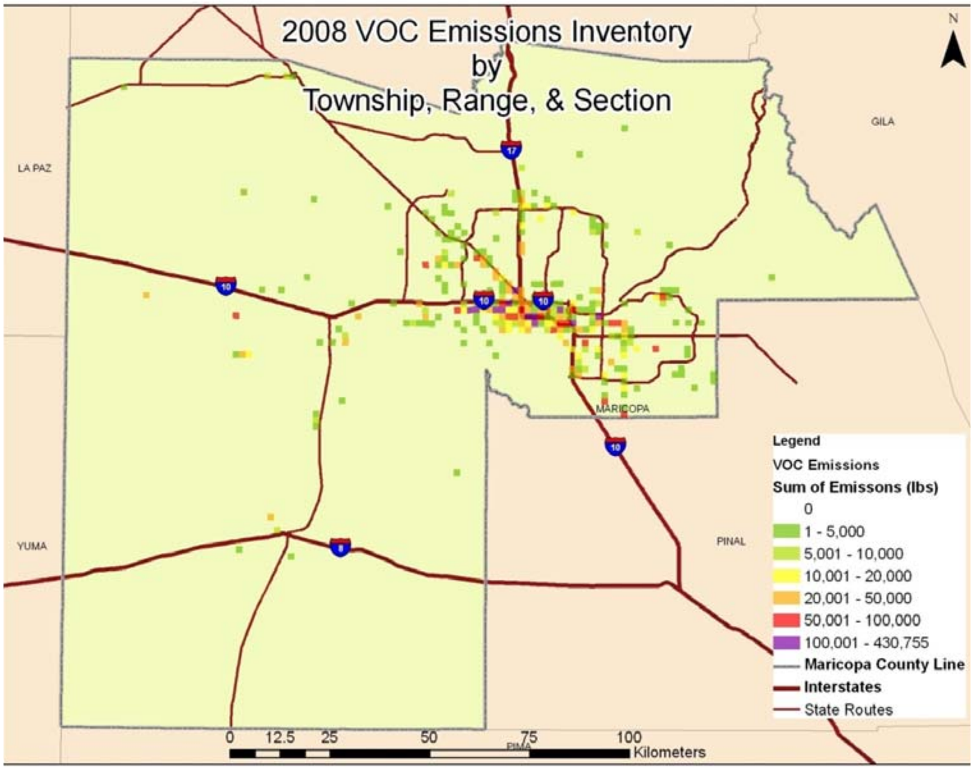

Figure 3.9.12. Map of VOC point sources summed by township, range, & section

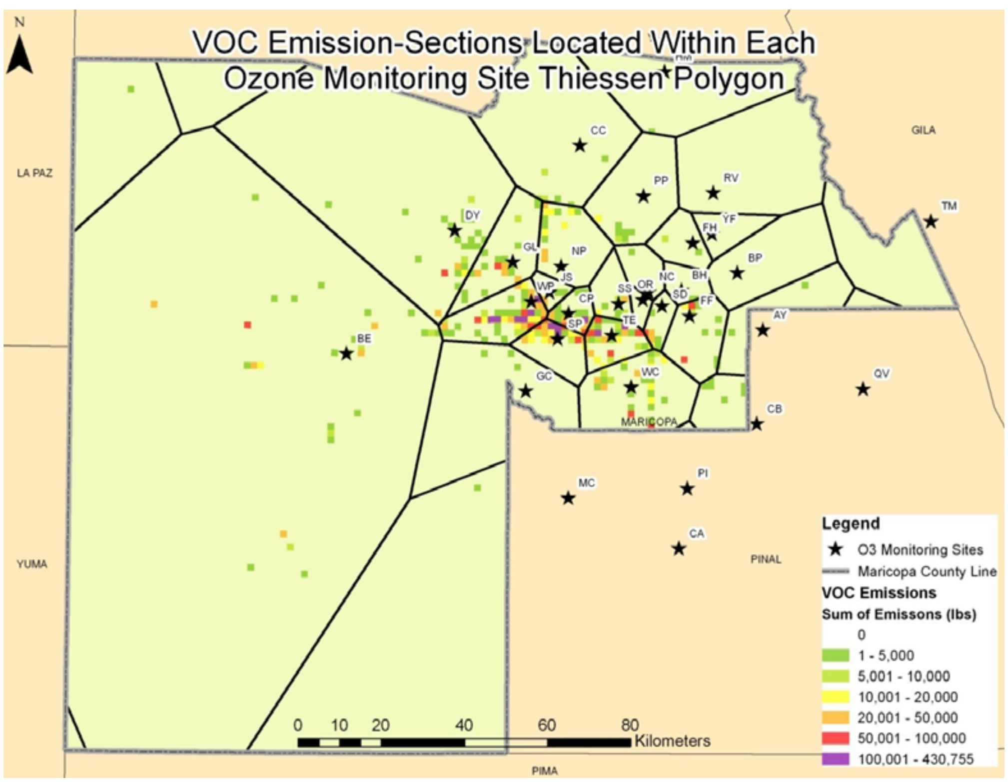

Figure 3.9.13. VOC Emission-Sections aggregated by O_3 monitor Thiessen polygons.

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 23 O_3 monitors within Maricopa County, though only the 17 monitors operated by MCAQD were used 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. *O_3 monitoring sites aggregated and normalized by Thiessen polygon area.*

Site	Sum of VOC Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km^2)	Density: Sum/Area (lbs/km^2)	Rank
West Phoenix	2,303,800	50,08	430,755	249	9,252	1
Central Phoenix	447,686	22,38	106,506	83	5,394	2
South Phoenix	832,811	43,83	202,998	168	4,957	3
Tempe	702,033	26,00	113,404	147	4,776	4
Falcon Field	200,057	16,67	94,343	228	877	5
West Chandler	356,114	13,18	73,189	442	806	6
Glendale	240,333	10,92	92,160	318	756	7
South Scottsdale	73,843	10,54	34,738	118	626	8
North Phoenix	162,441	12,49	32,645	273	595	9
Pinnacle Peak	28,811	4,116	13,729	414	70	10
Dysart	161,902	6,746	51,863	2,333	69	11
Fountain Hills	6,121	3,060	5,915	139	44	12
Buckeye	258,594	9,235	51,590	9,902	26	13
Cave Creek	16,699	3,340	7,815	985	17	14
Humboldt	18	18	18	668	0.03	15
Blue Point	0	0	0	441	0	16
Rio Verde	0	0	0	850	0	16

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 aggregated 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 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	0.0463	0.0520	0.0491	7,767	1
Rio Verde	0.0402	0.0498	0.0459	940	2
Cave Creek	0.0401	0.0496	0.0457	1,617	3
Pinnacle Peak	0.0398	0.0490	0.0453	414	4

Fountain Hills	0.0381	0.0438	0.0411	139	5
Blue Point	0.0376	0.0443	0.0404	441	6
Dysart	0.0314	0.0460	0.0392	2,690	7
North Phoenix	0.0318	0.0424	0.0376	273	8
Falcon Field	0.0355	0.0381	0.0370	228	9
Glendale	0.0320	0.0403	0.0348	318	10
West Chandler	0.0336	0.0361	0.0347	511	11
South Scottsdale	0.0323	0.0396	0.0346	118	12
Tempe	0.0320	0.0353	0.0333	147	13
South Phoenix	0.0310	0.0344	0.0331	168	14
Buckeye	0.0296	0.0433	0.0322	12,565	15
West Phoenix	0.0297	0.0333	0.0320	50	16
Central Phoenix	0.0299	0.0336	0.0316	83	17

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. Area sources are not analyzed in this Network 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 freeway generally emit less pollution per mile 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 network 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 2007 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 freeways 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 freeway 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 freeway 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.

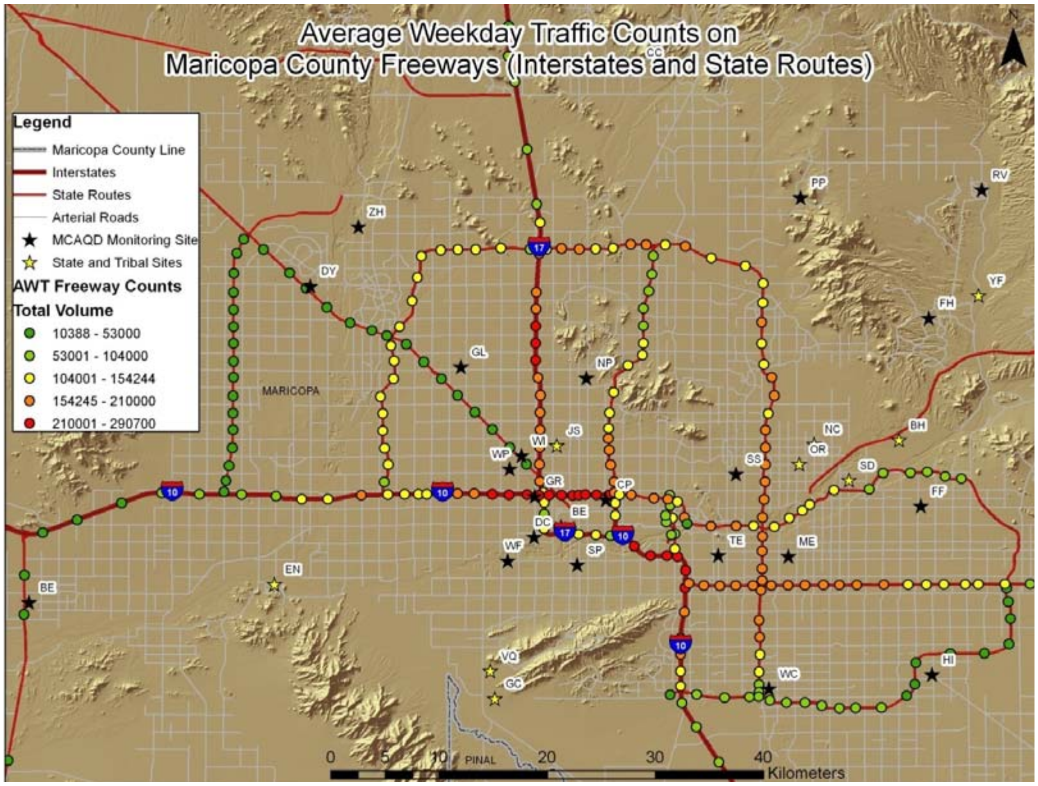

Figure 3.10.1. Average Weekday Traffic (AWT) Counts on Maricopa County Freeways.

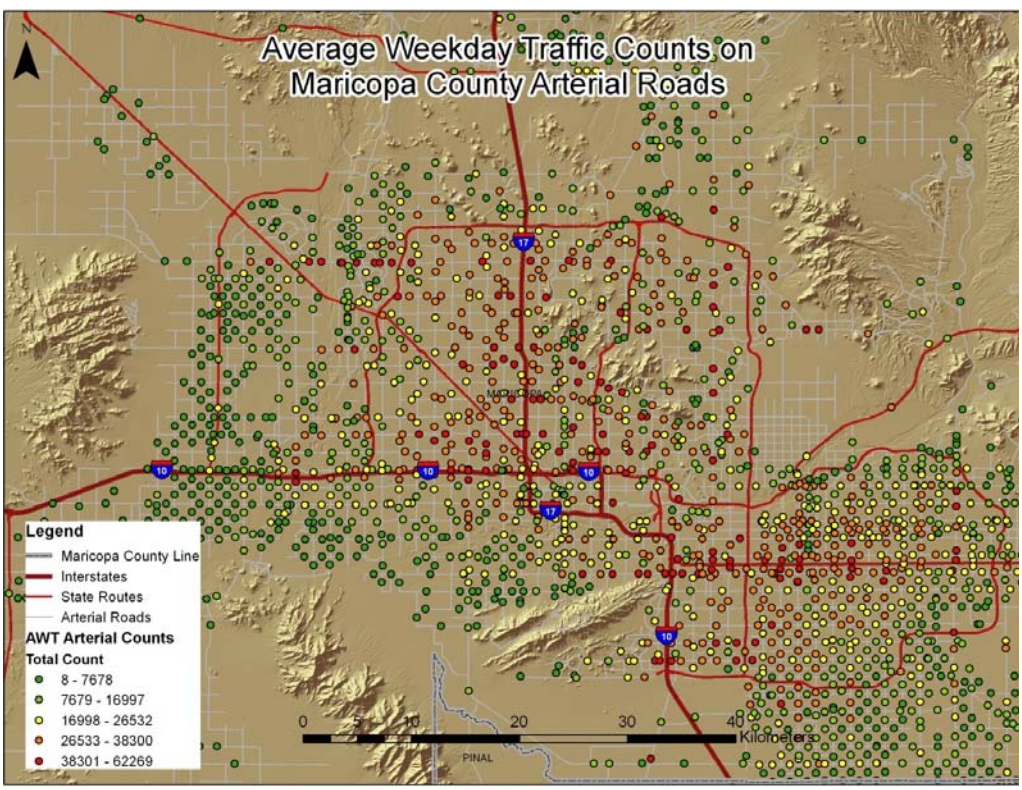

Figure 3.10.2. Average weekday traffic counts on Maricopa County Arterial roads.

3.10.1 CO Parameter Details

Table 3.10.1a. *CO monitoring sites, ranked by average weekday traffic (AWT) count.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Freeway	Arterial				
Central Phoenix	3,794,643	1,476,012	78	171,520	67,573	2,199
Tempe	3,639,569	1,893,627	108	228,053	51,233	2,112
West Chandler	2,603,656	5,763,640	639	779,138	13,094	1,219
Glendale	2,394,725	3,285,316	377	447,363	15,066	1,187
West Phoenix	1,899,420	2,695,153	255	296,753	18,018	1,164
Greenwood	1,893,021	1,024,860	92	100,600	31,716	1,093
W Indian School	294,475	519,827	25	24,519	32,572	981
North Phoenix	4,692,317	4,454,849	1,510	940,135	6,058	623
Mesa	4,396,957	8,311,384	1,599	878,241	7,948	549
Dysart	997,355	2,943,584	3,081	1,333,503	1,279	433
S. Scottsdale	2,166,855	1,398,760	1,788	769,353	1,994	430
South Phoenix	348,788	1,500,125	784	257,691	2,358	329
Buckeye	441,881	559,489	12,861	2,455,487	78	191

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

Site	Scores			Rank
	Traffic Density	Road Density	Average	
Central Phoenix	1	1	1.0	1
Tempe	2	2	2.0	2
West Chandler	8	3	5.5	3
Glendale	7	4	5.5	3
West Phoenix	6	5	5.5	3
Greenwood	5	6	5.5	3
W Indian School	4	8	6.0	4
North Phoenix	10	9	9.5	5
Mesa	9	10	9.5	5
Dysart	13	11	12.0	6
S. Scottsdale	12	12	12.0	6
South Phoenix	11	13	12.0	6
Buckeye	14	14	14.0	7

3.10.2 NO_2 Parameter Details

Table 3.10.2a. *NO_2 monitoring sites, ranked by average weekday traffic (AWT) count.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Freeway	Arterial				
Central Phoenix	7,080,422	3,695,175	413	511,948	26,087	1,239
West Phoenix	4,141,873	7,378,111	1,312	1,226,620	8,782	935
S. Scottsdale	10,213,583	16,981,718	3,013	2,506,002	9,026	832
Greenwood	2,011,021	1,641,304	713	265,187	5,124	372
Buckeye	642,640	799,233	14,242	2,871,283	101	202

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

Site	Scores			Rank
	Traffic Density	Road Density	Average	
Central Phoenix	1	1	1.0	1
West Phoenix	3	2	2.5	2
S. Scottsdale	2	3	2.5	2
Greenwood	5	5	5.0	3
Buckeye	6	6	6.0	4

3.10.3 O_3 Parameter Details

Table 3.10.3a. *O_3 monitoring sites, ranked by average weekday traffic (AWT) count.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Freeway	Arterial				
Tempe	5,259,616	2,951,145	147	357,331	55,821	2,429
Central Phoenix	4,075,333	1,531,085	83	181,510	67,809	2,195
West Phoenix	3,478,558	3,686,963	249	362,031	28,739	1,452
North Phoenix	4,085,750	3,201,204	272	376,181	26,706	1,379
S. Scottsdale	810,010	1,205,076	118	170,788	17,025	1,443
Glendale	2,206,427	3,312,061	317	426,544	17,381	1,343
West Chandler	2,548,856	5,278,548	441	547,268	17,723	1,239
Falcon Field	1,272,800	4,179,774	228	261,969	23,892	1,148
South Phoenix	467,456	1,527,054	168	137,799	11,840	818
Pinnacle Peak	1,030,877	925,787	413	250,215	4,730	605
Dysart	780,091	2,786,684	2,333	1,185,701	1,529	508

Fountain Hills	0	114,946	139	59,387	829	428
Cave Creek	405,562	653,505	985	416,285	1,075	423
Blue Point	0	23,718	441	98,003	54	222
Buckeye	441,881	559,413	9902	2,152,160	101	217
Rio Verde	0	8,349	850	144,614	10	170
Humboldt Mtn.	0	1,668	668	89,156	2	133

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

Site	Scores			Rank
	Traffic Density	Road Density	Average	
Tempe	2	1	1.5	1
Central Phoenix	1	2	1.5	1
West Phoenix	3	3	3.0	2
North Phoenix	4	5	4.5	3
S. Scottsdale	8	4	6.0	4
Glendale	7	6	6.5	5
West Chandler	6	7	6.5	5
Falcon Field	5	8	6.5	5
South Phoenix	9	9	9.0	6
Pinnacle Peak	10	10	10.0	7
Dysart	11	11	11.0	8
Fountain Hills	13	12	12.5	9
Cave Creek	12	13	12.5	9
Blue Point	15	14	14.5	10
Buckeye	14	15	14.5	10
Rio Verde	16	16	16.0	11
Humboldt Mtn.	17	17	17.0	12

3.10.4 PM_{10} Parameter Details

Table 3.10.4a. *PM_{10} monitoring sites, ranked by average weekday traffic (AWT) count.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Freeway	Arterial				
Central Phoenix	4,681,440	1,474,336	86	215,563	71,938	2,519
Greenwood	1,774,353	413,467	20	39,263	110,384	1,981
Mesa	4,145,383	3,723,345	148	320,602	53,024	2,160
West Phoenix	1,984,895	2,280,263	112	189,279	38,242	1,697
S. Scottsdale	1,202,720	1,443,388	136	222,159	19,421	1,631
West Chandler	2,672,268	3,621,075	342	423,711	18,376	1,237
Glendale	2,394,725	3,322,245	379	447,363	15,097	1,181

Durango Comp.	118,668	266,203	15	11,732	25,008	762
Higley	1,150,509	4,115,465	349	344,946	15,096	989
North Phoenix	4,541,914	4,239,517	838	685,792	10,485	819
South Phoenix	117,988	1,396,107	206	125,655	7,338	609
West 43rd Ave.	0	1,455,885	607	264,137	2,400	435
Dysart	997,355	2,937,941	3,081	1,333,503	1,277	433
Buckeye	441,881	541,860	8,179	2,242,300	120	274

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

Site	Scores			Rank
	Traffic Density	Road Density	Average	
Central Phoenix	2	1	1.5	1
Greenwood	1	3	2	2
Mesa	3	2	2.5	3
West Phoenix	4	4	4	4
S. Scottsdale	6	5	5.5	5
West Chandler	7	6	6.5	6
Glendale	8	7	7.5	7
Durango Comp.	5	10	7.5	7
Higley	9	8	8.5	8
North Phoenix	10	9	9.5	9
South Phoenix	11	11	11	10
West 43rd Ave.	12	12	12	11
Dysart	13	13	13	12
Buckeye	14	14	14	13

3.10.5 $PM_{2.5}$ Parameter Details

Table 3.10.5a. *$PM_{2.5}$ monitoring sites, ranked by average weekday traffic (AWT) count.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Freeway	Arterial				
South Phoenix	4,044,350	2,231,640	221	337,207	28,398	1,526
Mesa	7,214,520	11,801,23	705	1,087,107	26,973	1,542
Durango Comp.	698,716	1,246,781	101	109,578	19,262	1,085
West Phoenix	5,700,732	7,853,765	5,623	2,450,663	2,411	436

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

Site	Scores			Rank
	Traffic Density	Road Density	Average	
South Phoenix	1	2	1.5	1
Mesa	2	1	1.5	1

Durango Comp.	3	3	3	2
West Phoenix	4	4	4	3

3.10.6 SO_2 Parameter Details

Table 3.10.6a. *SO_2 monitoring sites, ranked by average weekday traffic (AWT) count.*

Site	Sum of AWT Counts		Area of Thiessen Polygon (km^2)	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/ Area)
	Freeway	Arterial				
S. Scottsdale	10,213,583	17,555,17	2,877	2,590,081	9,652	900
Central Phoenix	7,695,780	4,633,095	3,261	1,033,885	3,781	317

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

Site	Scores			Rank
	Traffic Density	Road Density	Average	
S. Scottsdale	1	1	1	1
Central Phoenix	2	2	2	2

3.11 Analysis #11: Environmental Justice-Minority Population Served

The EPA has the goal 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 Network 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 2000 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 2000 Census block groups that were used in the analysis cover the Maricopa County metropolitan area, and include parts of Pinal, Gila, and Yavapai counties. Where applicable, the census block groups from these surrounding counties were used in calculating the population served.

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 2000 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. (2010). Environmental Justice. http://www.epa.gov/environmentaljustice/

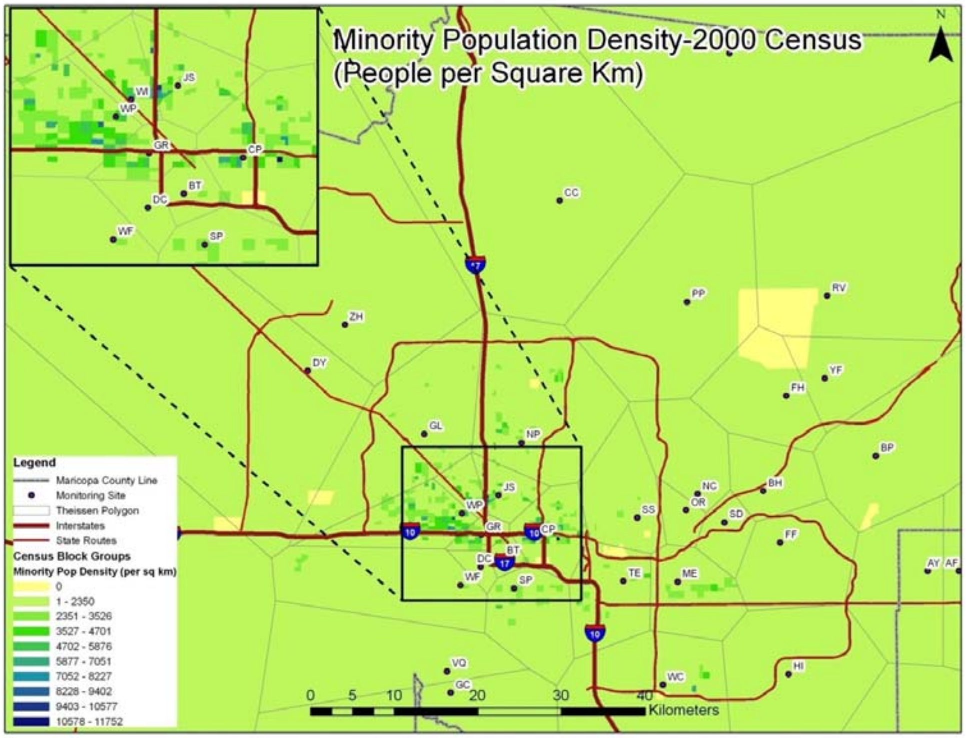

Figure 3.11.1. Map of minority population density per census block group from the 2000 U.S. Census.

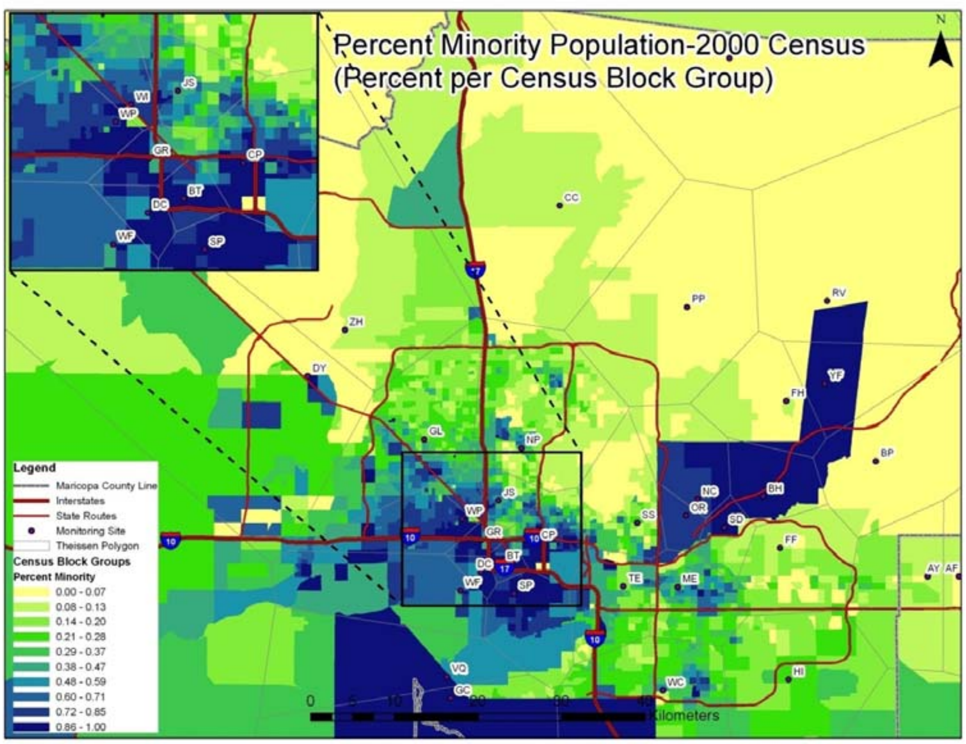

Figure 3.11.2. Percentage of minority population per census block group from the 2000 U.S Census.

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	Rank
Greenwood	58,593	46,665	80%	1
West Phoenix	204,379	149,029	73%	2
South Phoenix	120,810	82,779	69%	3
Central Phoenix	149,579	93,847	63%	4
West Indian School Rd	61,104	35,693	58%	5
Buckeye	36,237	14,529	40%	6
Tempe	158,620	58,593	37%	7
West Chandler	345,294	105,646	31%	8
Glendale	457,152	134,341	29%	9
Mesa	574,267	138,195	24%	10
North Phoenix	457,974	93,201	20%	11
Dysart	164,124	29,581	18%	12
South Scottsdale	248,735	39,891	16%	13

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	Rank
Greenwood	93,412	71,539	77%	1
Central Phoenix	332,190	189,970	57%	2
West Phoenix	640,461	284,865	44%	3
Buckeye	48,821	16,617	34%	4
South Scottsdale	1,229,168	283,280	23%	5

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	Rank
South Phoenix	90,333	84,455	93%	1
West Phoenix	246,076	196,670	80%	2
Central Phoenix	153,630	100,866	66%	3
Tempe	236,002	87,838	37%	4
Buckeye	31,132	11,231	36%	5
Glendale	457,740	134,973	29%	6

West Chandler	321,428	84,768	26%	7
North Phoenix	387,993	86,371	22%	8
South Scottsdale	130,327	24,482	19%	9
Dysart	174,019	28,312	16%	10
Falcon Field	248,082	39,184	16%	11
Cave Creek	46,772	4,856	10%	12
Pinnacle Peak	67,517	6,006	9%	13
Humboldt Mountain	14,197	1,115	8%	14
Fountain Hills	34,926	2,461	7%	15
Rio Verde	2,414	78	3%	16
Blue Point	3	0	0%	17

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	Rank
Greenwood	31,503	25,542	81%	1
Durango Complex	12,348	8,775	71%	2
West Phoenix	211,122	150,192	71%	3
Central Phoenix	144,345	90,392	63%	4
South Phoenix	126,432	80,046	63%	4
Mesa	293,977	109,276	37%	5
Buckeye	35,459	12,559	35%	6
Glendale	467,204	136,339	29%	7
West Chandler	266,220	74,082	28%	8
West 43rd Avenue	38,150	8,775	23%	9
South Scottsdale	148,186	30,938	21%	10
North Phoenix	452,859	91,983	20%	11
Higley	166,608	29,375	18%	12
Dysart	179,961	29,581	16%	13

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	Rank
Durango Complex	54,836	42,916	78%	1
South Phoenix	200,030	127,027	64%	2
West Phoenix	674,274	301,803	45%	3
Mesa	759,393	221,123	29%	4

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	Rank
Central Phoenix	395,967	235,570	59%	1
South Scottsdale	1,308,615	302,909	23%	2

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 object of having multiple analysis methods was to have a comprehensive perspective of evaluation; i.e., by using multiple analyses many variables, such as cost-effectiveness, suitability for modeling, proximity to population and sources, correlations and redundancies, and concentrations monitored could be determined. However, it is not assumed that all methods are of equal importance, for instance the concentrations of pollution monitored is 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 were then averaged to determine the final rank.

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 Percentage
1	Number of other parameters monitored	50%
2	Trends Impact	100%
3	Measured Concentrations	200%
4	Deviation from the NAAQS	100%
5	Area Served	100%
6	Population Served	150%
7	Monitor-to-Monitor Correlation	150%
8	Removal Bias	125%
9	Emissions Inventory	175%
9b (O_3 only)	Predicted Ozone	175%
10	Traffic Counts	150%
11	Environmental Justice	150%

3.12.2 Results for CO

The rankings from each CO analyses were first converted to scores. There were 13 possible points in the score, 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; these results are also shown graphically in Figure 3.12.1. Tables 3.12.3 and 3.12.4 show the breakdown of the data per analysis by raw scores and weighted scores, respectively.

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

Site	Rank
West Phoenix	1
Central Phoenix	2
Tempe	3
Glendale	4
South Phoenix	5
Greenwood	6
West Indian School Rd	7
North Phoenix	8
Mesa	9
West Chandler	10
South Scottsdale	11
Buckeye	12
Dysart	13

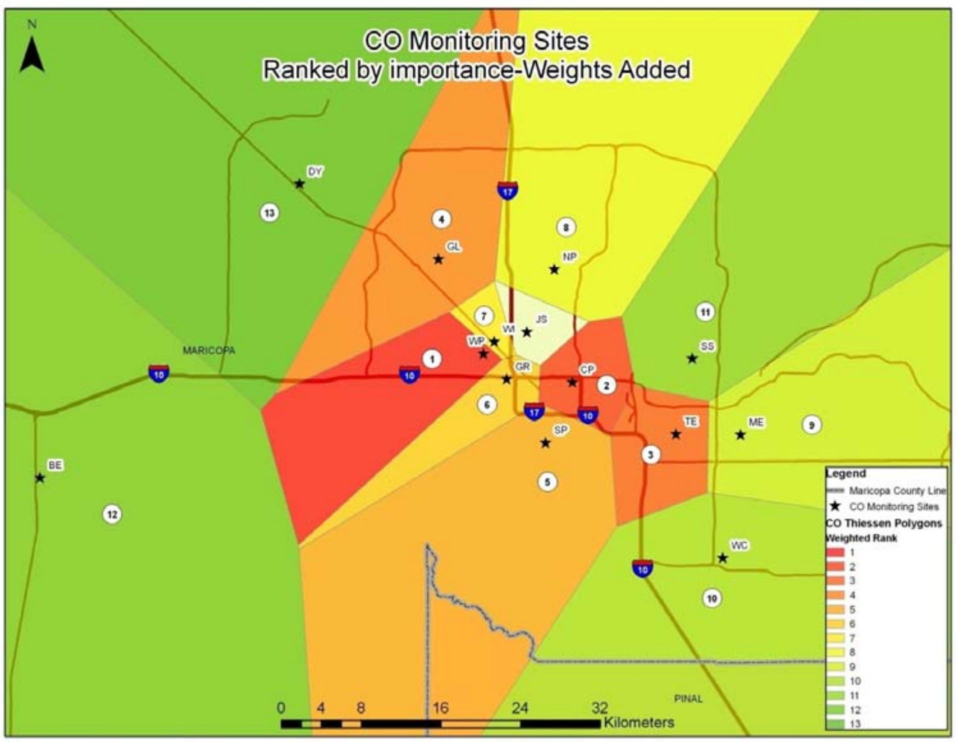

Figure 3.12.1. Ranking of CO monitoring sites. Illustration shows each CO site's Thiessen polygon. Polygons are color coded by final average rank, with 1 to 13 being depicted as red to green, respectively.

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	Average	Rank
Buckeye	11	5	2	2	13	1	12	-	4	6	8	6.40	12
Central Phoenix	12	13	11	9	2	5	5	5	11	13	10	8.73	2
Dysart	10	6	1	1	11	7	13	-	3	7	2	6.10	13
Glendale	10	12	5	5	6	11	8	13	9	10	5	8.55	4
Greenwood	10	8	9	10	3	2	4	6	13	10	13	8.00	7
Mesa	10	11	4	4	9	13	11	-	6	8	4	8.00	7
North Phoenix	11	12	8	8	8	12	9	11	2	8	3	8.36	5
South Phoenix	11	12	10	11	7	4	6	8	8	7	11	8.64	3
South Scottsdale	12	12	6	6	10	9	10	7	1	7	1	7.36	11
Tempe	10	7	7	7	4	6	11	9	12	12	7	8.36	5
West Chandler	10	8	3	3	12	10	7	-	5	10	6	7.40	10
West Indian School Rd	9	9	13	13	1	3	3	12	7	9	9	8.00	7
West Phoenix	13	10	12	12	5	8	3	10	10	10	12	9.55	1
WEIGHT	3.39%	6.78%	13.56%	6.78%	6.78%	10.17%	10.17%	8.47%	11.86%	11.86%	10.17%		

Table 3.12.4. *CO scores after applying weight*

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	Average	Rank
Buckeye	0.37	0.34	0.27	0.14	0.88	0.10	1.22	-	0.47	0.71	0.81	0.53	12
Central Phoenix	0.41	0.88	1.49	0.61	0.14	0.51	0.51	0.42	1.31	1.54	1.02	0.80	2
Dysart	0.34	0.41	0.14	0.07	0.75	0.71	1.32	-	0.36	0.83	0.20	0.51	13
Glendale	0.34	0.81	0.68	0.34	0.41	1.12	0.81	1.10	1.07	1.19	0.51	0.76	4
Greenwood	0.34	0.54	1.22	0.68	0.20	0.20	0.41	0.51	1.54	1.19	1.32	0.74	6
Mesa	0.34	0.75	0.54	0.27	0.61	1.32	1.12	-	0.71	0.95	0.41	0.70	9
North Phoenix	0.37	0.81	1.08	0.54	0.54	1.22	0.92	0.93	0.24	0.95	0.31	0.72	8
South Phoenix	0.37	0.81	1.36	0.75	0.47	0.41	0.61	0.68	0.95	0.83	1.12	0.76	5
South Scottsdale	0.41	0.81	0.81	0.41	0.68	0.92	1.02	0.59	0.12	0.83	0.10	0.61	11
Tempe	0.34	0.47	0.95	0.47	0.27	0.61	1.12	0.76	1.42	1.42	0.71	0.78	3
West Chandler	0.34	0.54	0.41	0.20	0.81	1.02	0.71	-	0.59	1.19	0.61	0.64	10
West Indian School Rd	0.31	0.61	1.76	0.88	0.07	0.31	0.31	1.02	0.83	1.07	0.92	0.73	7
West Phoenix	0.44	0.68	1.63	0.81	0.34	0.81	0.31	0.85	1.19	1.19	1.22	0.86	1

3.12.3 Results for NO_2

The rankings from each NO_2 analysis were first converted to a score. There were 5 possible points in the score, one for each of the 5 sites analyzed. Table 3.12.5 shows the final results of the NO_2 evaluation, which is also displayed graphically in Figure 3.12.2. Table 3.12.6 and Table 3.12.7 show the breakdown of the data per analysis by raw scores and weighted scores, respectively.

Table 3.12.5. *Final rankings for NO_2 sites*

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

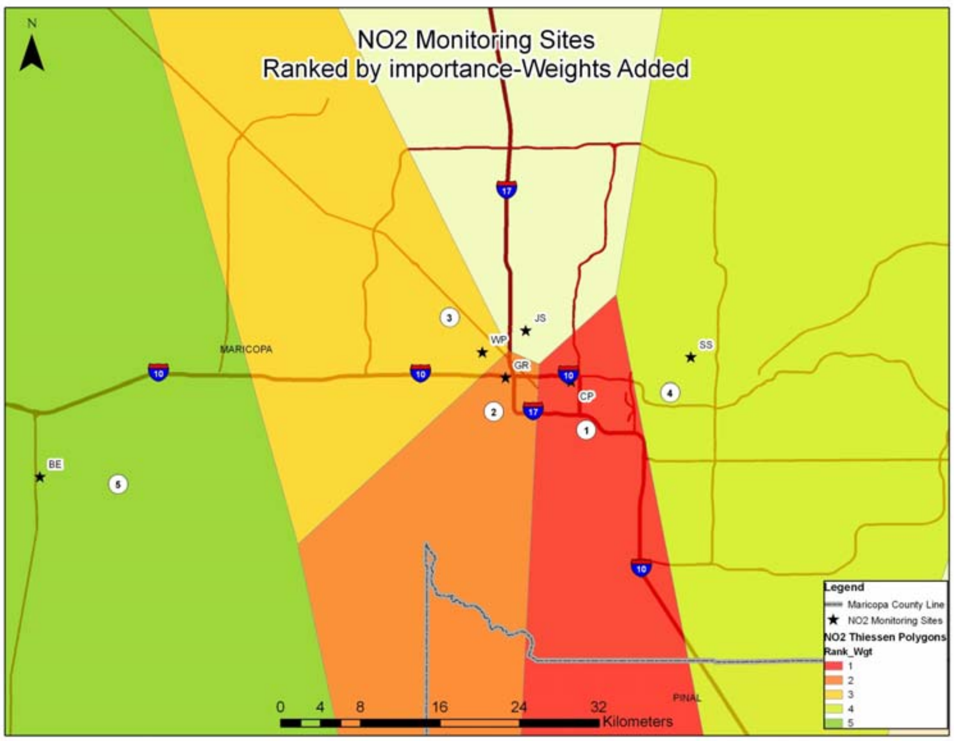

Figure 3.12.2. Ranking of NO_2 monitoring sites. Illustration shows each NO_2 site's Thiessen polygon. Polygons are color coded by final average rank, with 1 to 5 being depicted as red to green, respectively.

Table 3.12.6. *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	Average	Rank
Buckeye	3	1	1	1	5	1	5	–	1	2	2	2.20	5
Central Phoenix	4	5	4	4	3	3	3	–	3	5	4	3.80	1
Greenwood	2	2	5	5	1	2	2	–	5	3	5	3.20	2
South Scottsdale	4	4	2	2	4	5	4	–	2	4	1	3.20	2
West Phoenix	5	3	3	3	2	4	1	–	4	4	3	3.20	2
WEIGHT	3.70%	7.41%	14.81%	7.41%	7.41%	11.11%	11.11%	–	12.96%	12.96%	11.11%		

Table 3.12.7. *NO_2 scores after applying weight*

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	Average	Rank
Buckeye	0.111	0.074	0.148	0.074	0.370	0.111	0.556	–	0.130	0.259	0.222	0.206	5
Central Phoenix	0.148	0.370	0.593	0.296	0.222	0.333	0.333	–	0.389	0.648	0.444	0.378	1
Greenwood	0.074	0.148	0.741	0.370	0.074	0.222	0.222	–	0.648	0.389	0.556	0.344	2
South Scottsdale	0.148	0.296	0.296	0.148	0.296	0.556	0.444	–	0.259	0.519	0.111	0.307	4
West Phoenix	0.185	0.222	0.444	0.222	0.148	0.444	0.111	–	0.519	0.519	0.333	0.315	3

3.12.4 Results for O_3

The rankings from each O_3 analysis were first converted to a score. There were 17 possible points in the score, one for each of the 13 sites analyzed. Table 3.12.8 shows the final results of the O_3 evaluation, which is also shown graphically in Figure 3.12.3Figure . Table 3.12.9 and Table 3.12.10 show the breakdown of the data per analysis by raw scores and weighted scores, respectively.

Table 3.12.8. *Final rankings for O_3 sites*

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

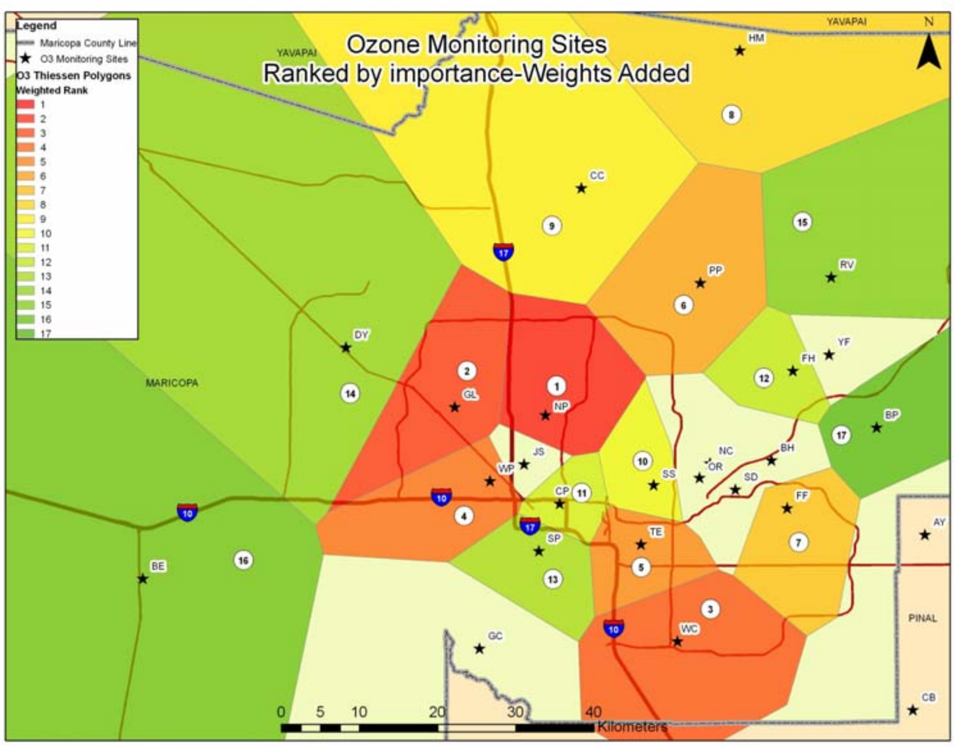

Figure 3.12.3. Final ranking for O_3 monitoring sites. Illustration shows each O_3 site's Thiessen polygon. Polygons are color coded by final average rank, with 1 to 17 being depicted as red to green, respectively.

Table 3.12.9. *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	Average	Rank
Blue Point	13	11	3	8	11	1	13	7	2	12	8	1	7.50	17
Buckeye	15	5	1	2	17	4	12	17	5	3	8	13	8.50	15
Cave Creek	13	7	13	9	14	6	15	6	4	15	9	6	9.75	11
Central Phoenix	16	17	5	13	1	10	7	2	16	1	17	15	10.00	9
Dysart	14	6	2	3	15	11	14	8	7	11	10	8	9.08	13
Falcon Field	13	12	7	15	7	14	9	12	13	9	13	7	10.92	6
Fountain Hills	13	10	14	6	4	5	10	16	6	13	9	3	9.08	13
Glendale	14	16	8	16	9	17	11	4	11	8	13	12	11.58	2
Humboldt Mountain	12	11	15	7	16	3	17	15	3	17	6	4	10.50	8
North Phoenix	15	15	17	4	8	16	8	14	9	10	15	10	11.75	1
Pinnacle Peak	13	13	10	12	10	7	16	13	8	14	11	5	11.00	5
Rio Verde	12	9	16	5	13	2	10	5	2	16	7	2	8.25	16
South Phoenix	15	15	4	10	3	8	7	3	15	4	12	17	9.42	12
South Scottsdale	16	16	12	11	2	9	8	5	10	6	14	9	9.83	10
Tempe	14	8	11	12	5	12	8	11	14	5	17	14	10.92	6
West Chandler	14	11	9	17	12	15	9	9	12	7	13	11	11.58	2
West Phoenix	17	14	6	14	6	13	6	10	17	2	16	16	11.42	4
WEIGHT	3.08%	6.15%	12.31%	6.15%	6.15%	9.23%	9.23%	7.69%	10.77%	10.77%	9.23%	9.23%		

Table 3.12.10. *O_3 scores after applying weight*

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	Average	Rank
Blue Point	0.40	0.68	0.37	0.49	0.68	0.09	1.20	0.54	0.22	1.29	0.74	0.09	0.57	17
Buckeye	0.46	0.31	0.12	0.12	1.05	0.37	1.11	1.31	0.54	0.32	0.74	1.20	0.64	16
Cave Creek	0.40	0.43	1.60	0.55	0.86	0.55	1.38	0.46	0.43	1.62	0.83	0.55	0.81	9
Central Phoenix	0.49	1.05	0.62	0.80	0.06	0.92	0.65	0.15	1.72	0.11	1.57	1.38	0.79	11
Dysart	0.43	0.37	0.25	0.18	0.92	1.02	1.29	0.62	0.75	1.18	0.92	0.74	0.72	14
Falcon Field	0.40	0.74	0.86	0.92	0.43	1.29	0.83	0.92	1.40	0.97	1.20	0.65	0.88	7
Fountain Hills	0.40	0.62	1.72	0.37	0.25	0.46	0.92	1.23	0.65	1.40	0.83	0.28	0.76	12
Glendale	0.43	0.98	0.98	0.98	0.55	1.57	1.02	0.31	1.18	0.86	1.20	1.11	0.93	2
Humboldt Mountain	0.37	0.68	1.85	0.43	0.98	0.28	1.57	1.15	0.32	1.83	0.55	0.37	0.87	8
North Phoenix	0.46	0.92	2.09	0.25	0.49	1.48	0.74	1.08	0.97	1.08	1.38	0.92	0.99	1
Pinnacle Peak	0.40	0.80	1.23	0.74	0.62	0.65	1.48	1.00	0.86	1.51	1.02	0.46	0.90	6
Rio Verde	0.37	0.55	1.97	0.31	0.80	0.18	0.92	0.38	0.22	1.72	0.65	0.18	0.69	15
South Phoenix	0.46	0.92	0.49	0.62	0.18	0.74	0.65	0.23	1.62	0.43	1.11	1.57	0.75	13
South Scottsdale	0.49	0.98	1.48	0.68	0.12	0.83	0.74	0.38	1.08	0.65	1.29	0.83	0.80	10
Tempe	0.43	0.49	1.35	0.74	0.31	1.11	0.74	0.85	1.51	0.54	1.57	1.29	0.91	4
West Chandler	0.43	0.68	1.11	1.05	0.74	1.38	0.83	0.69	1.29	0.75	1.20	1.02	0.93	3
West Phoenix	0.52	0.86	0.74	0.86	0.37	1.20	0.55	0.77	1.83	0.22	1.48	1.48	0.91	5

3.12.5 Results for PM_{10}

The rankings from each PM_{10} analysis were first converted to a score. There were 14 possible points in the score, one for each of the 14 sites analyzed. Table 3.12.11 shows the final results of the PM_{10} evaluation, which is also shown graphically in Figure 3.12.4. Table 3.12.12 and Table 3.12.13 show the breakdown of the data per analysis by raw scores and weighted scores, respectively.

Table 3.12.11. *Final average rankings for PM_{10} sites*

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

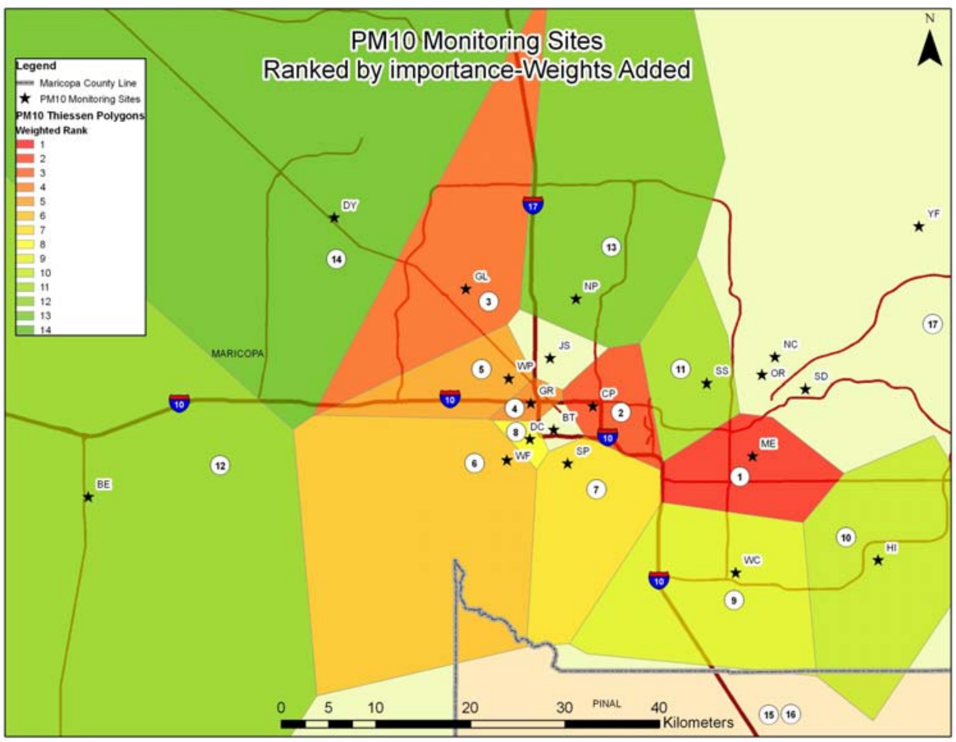

Figure 3.12.4. Ranking for PM_{10} monitoring sites. Illustration shows each PM_{10} site's Thiessen polygon. Polygons are color coded by final average rank, with 1 to 14 being depicted as red to green, respectively.

Table 3.12.12. *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	Average	Rank
Buckeye	12	5	13	2	14	3	11	-	4	2	9	7.50	13
Central Phoenix	13	14	8	13	3	6	7	5	9	14	11	9.36	2
Durango Complex	9	9	12	3	1	1	6	8	14	8	13	7.64	12
Dysart	11	6	5	9	13	9	8	7	5	3	2	7.09	14
Glendale	11	13	4	8	10	14	8	6	11	8	8	9.18	3
Greenwood	11	10	9	12	2	2	5	4	13	13	14	8.64	5
Higley	10	8	11	6	9	8	13	12	2	7	3	8.09	9
Mesa	11	11	2	5	6	12	14	11	12	12	10	9.64	1
North Phoenix	12	11	1	4	12	13	12	9	3	6	4	7.91	10
South Phoenix	12	14	10	11	7	5	8	3	8	5	11	8.55	7
South Scottsdale	13	13	3	7	5	7	8	10	6	10	5	7.91	10
West 43rd Avenue	10	7	14	1	11	4	10	13	10	4	7	8.27	8
West Chandler	11	10	6	10	8	11	9	14	1	9	6	8.64	5
West Phoenix	14	12	7	14	4	10	5	2	7	11	12	8.91	4
WEIGHT	3.39%	6.78%	13.56%	6.78%	6.78%	10.17%	10.17%	8.47%	11.86%	11.86%	10.17%		

Table 3.12.13. *PM_{10} scores after applying weight*

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	Average	Rank
Buckeye	0.41	0.34	1.76	0.14	0.95	0.31	1.12	-	0.47	0.24	0.92	0.664	12
Central Phoenix	0.44	0.95	1.08	0.88	0.20	0.61	0.71	0.42	1.07	1.66	1.12	0.832	2
Durango Complex	0.31	0.61	1.63	0.20	0.07	0.10	0.61	0.68	1.66	0.95	1.32	0.740	8
Dysart	0.37	0.41	0.68	0.61	0.88	0.92	0.81	0.59	0.59	0.36	0.20	0.584	14
Glendale	0.37	0.88	0.54	0.54	0.68	1.42	0.81	0.51	1.31	0.95	0.81	0.803	3
Greenwood	0.37	0.68	1.22	0.81	0.14	0.20	0.51	0.34	1.54	1.54	1.42	0.798	4
Higley	0.34	0.54	1.49	0.41	0.61	0.81	1.32	1.02	0.24	0.83	0.31	0.720	10
Mesa	0.37	0.75	0.27	0.34	0.41	1.22	1.42	0.93	1.42	1.42	1.02	0.871	1
North Phoenix	0.41	0.75	0.14	0.27	0.81	1.32	1.22	0.76	0.36	0.71	0.41	0.650	13
South Phoenix	0.41	0.95	1.36	0.75	0.47	0.51	0.81	0.25	0.95	0.59	1.12	0.743	7
South Scottsdale	0.44	0.88	0.41	0.47	0.34	0.71	0.81	0.85	0.71	1.19	0.51	0.666	11
West 43rd Avenue	0.34	0.47	1.90	0.07	0.75	0.41	1.02	1.10	1.19	0.47	0.71	0.766	6
West Chandler	0.37	0.68	0.81	0.68	0.54	1.12	0.92	1.19	0.12	1.07	0.61	0.737	9
West Phoenix	0.47	0.81	0.95	0.95	0.27	1.02	0.51	0.17	0.83	1.31	1.22	0.773	5

3.12.6 Results for $PM_{2.5}$

The rankings from each $PM_{2.5}$ analysis were first converted to a score. There were 4 possible points in the score, one for each of the 4 sites analyzed. Table 3.12.14 shows the final results of the $PM_{2.5}$ evaluation, which is also shown graphically in Figure 3.12.5. Table 3.12.15 and Table 3.12.16 show the breakdown of the data per analysis by raw scores and weighted scores, respectively.

Table 3.12.14. *Final rankings for $PM_{2.5}$ sites*

Site	Rank
Durango Complex	1
South Phoenix	2
Mesa	3
West Phoenix	4

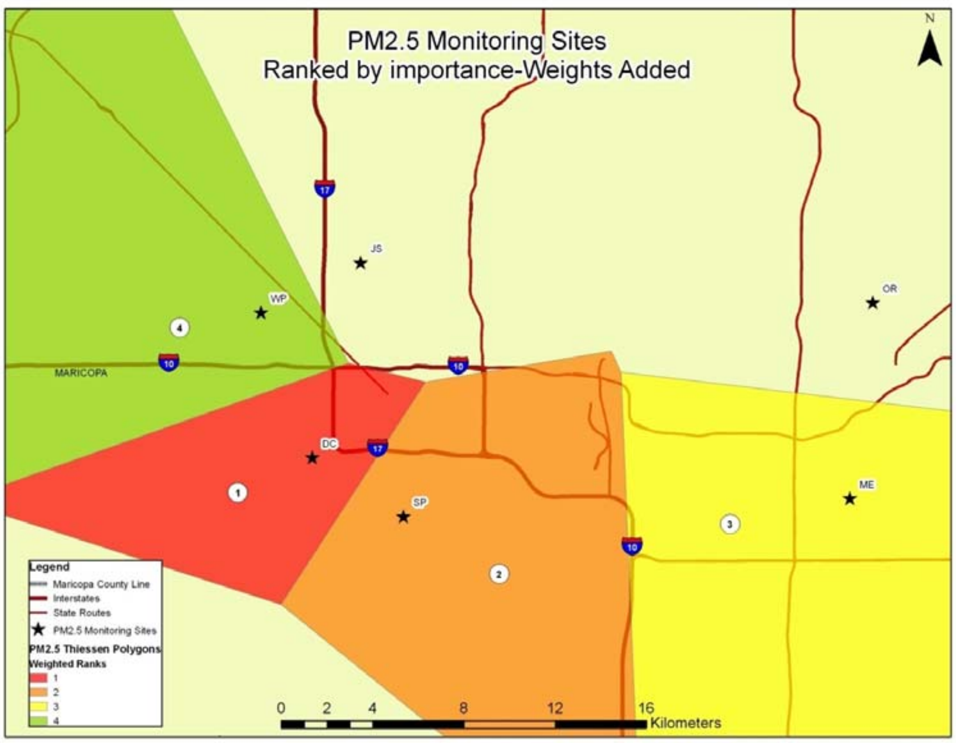

Figure 3.12.5. Ranking for $PM_{2.5}$ monitoring sites. Illustration shows each $PM_{2.5}$ site's Thiessen polygon. Polygons are color coded by final average rank, with 1 to 4 being depicted as red to green, respective

Table 3.12.15. *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	Average	Rank
Durango Complex	1	3	4	4	1	1	3	4	4	3	4	2.91	1
Mesa	2	3	1	1	3	4	4	1	3	4	1	2.45	4
South Phoenix	3	3	3	3	2	2	2	2	2	4	3	2.64	2
West Phoenix	4	4	2	2	4	3	2	3	1	2	2	2.64	2
WEIGHT	3.39%	6.78%	13.56%	6.78%	6.78%	10.17%	10.17%	8.47%	11.86%	11.86%	10.17%		

Table 3.12.16. *$PM_{2.5}$ scores after applying weight*

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	Average	Rank
Durango Complex	0.03	0.20	0.54	0.27	0.07	0.10	0.31	0.34	0.47	0.36	0.41	0.28	1
Mesa	0.07	0.20	0.14	0.07	0.20	0.41	0.41	0.08	0.36	0.47	0.10	0.23	3
South Phoenix	0.10	0.20	0.41	0.20	0.14	0.20	0.20	0.17	0.24	0.47	0.31	0.24	2
West Phoenix	0.14	0.27	0.27	0.14	0.27	0.31	0.20	0.25	0.12	0.24	0.20	0.22	4

3.12.7 Results for SO_2

The rankings from each SO_2 analysis were first converted to a score. There were 2 possible points in the score since there are only 2 SO_2 sites in the MCAQD network. Table 3.12.17 shows the final results of the SO_2 evaluation, which is also shown graphically in Figure 3.12.6. Table 3.12.18 and Table 3.12.19 show the breakdown of the data per analysis by raw scores and weighted scores, respectively.

Table 3.12.17. *Final rankings for SO_2 sites*

Site	Rank
Central Phoenix	1
South Scottsdale	2

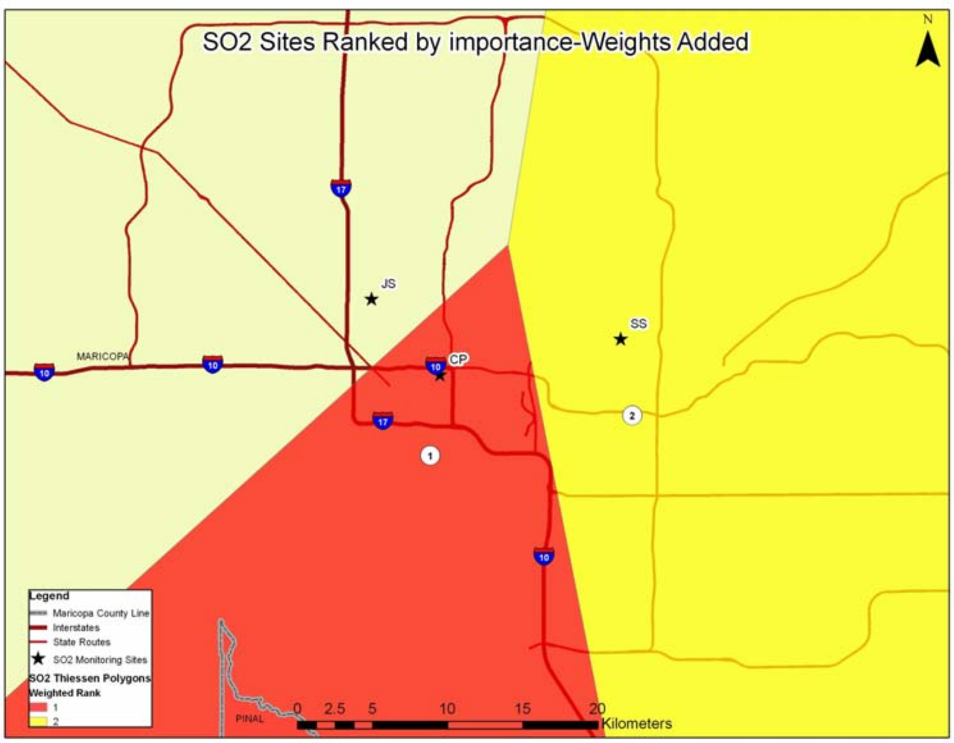

Figure 3.12.6. Ranking of SO_2 monitoring sites.

Table 3.12.18. *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	Average	Rank
Central Phoenix	2	2	2	2	2	1	2	-	2	1	2	1.80	1
South Scottsdale	2	1	1	1	1	2	2	-	1	2	1	1.40	2
WEIGHT	3.39%	6.78	13.56%	6.78%	6.78	10.17%	10.17%	8.47%	11.86%	11.8	10.17		

Table 3.12.19. *SO_2 scores after applying weight*

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	Average	Rank
Central Phoenix	0.07	0.14	0.27	0.14	0.14	0.10	0.20	-	0.24	0.12	0.20	0.16	1
South Scottsdale	0.07	0.07	0.14	0.07	0.07	0.20	0.20	-	0.12	0.24	0.10	0.13	2

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 the 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.

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 an equal partition of the data distribution within that variable. The reclassified rasters are then aggregated into a weighted spatial overlay which displays the weighted average in each spatial location.

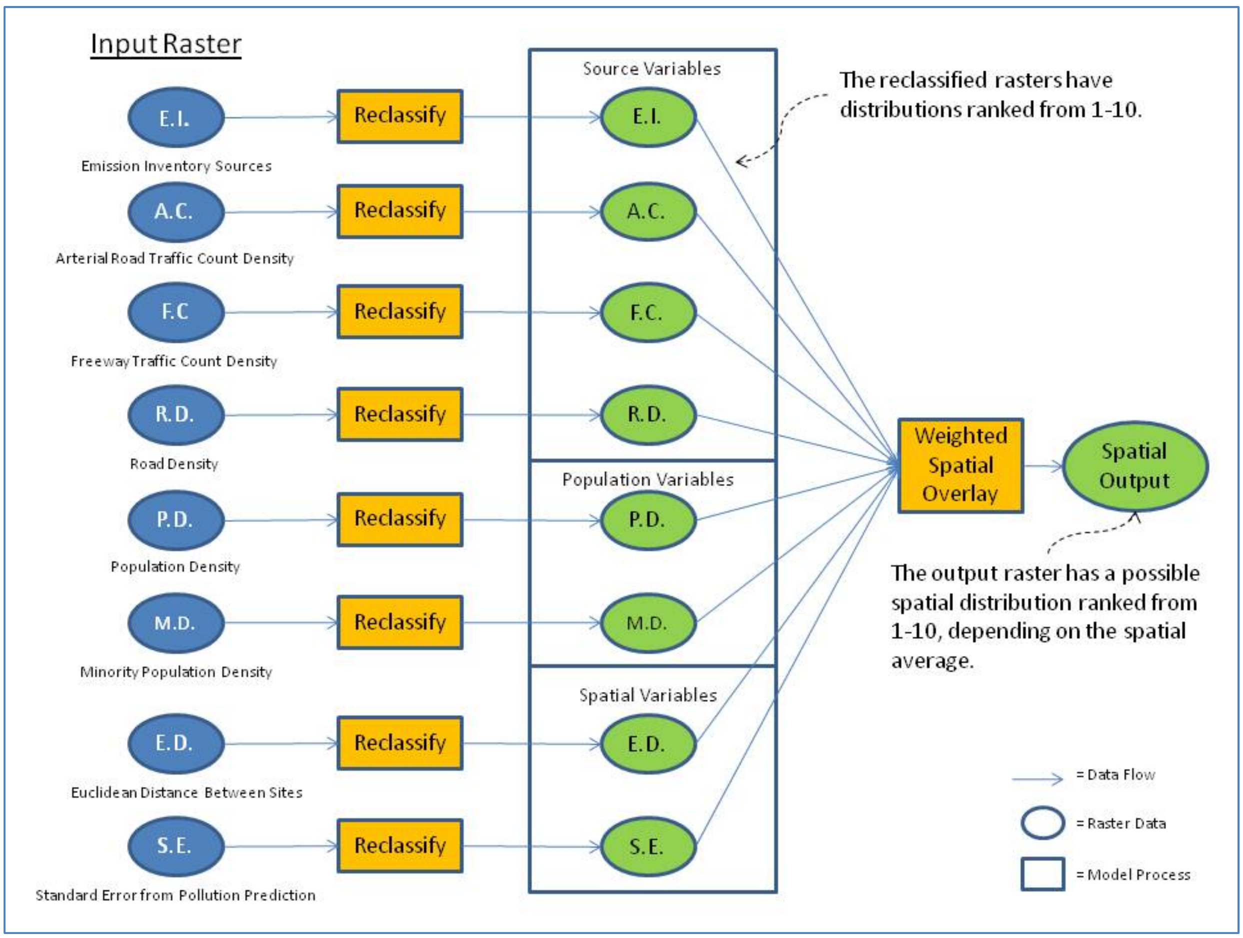

Figure 4.0.1. Model for assessing air monitoring adequacy.

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 network assessment the results scores never go over 5.

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, 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 (emission sections) is used as the raster value. When reclassifying the raster, the entire distribution of emission sections is divided into 10 equal 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: Freeway 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, both arterial and freeways, 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) with 1 km cells. Higher densities are assigned higher scores.

4.1.2 Population-Oriented Indicators

- Indicator #5: Population Density

  This indicator uses the 2000 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 space that the location is from existing monitoring sites.

- 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 is 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 Sections 1, 2, and 3 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		Notes
Source-Oriented Indicators		.35		
	Emissions Inventory Point Sources		.12	
	Arterial Road Traffic Count		.09	
	Freeway 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	Concentric rings set to 5 km
	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.

CO tends to be a highly urban pollutant found in areas of high population, especially in areas of high minority population. Therefore, more weight was assigned to minority population density, while Population-Oriented variable are given slightly higher weight.

Correlation between CO monitoring sites rapidly decreases in a linear fashion 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, topping out at 50 km where autocorrelation appears to cease. 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.

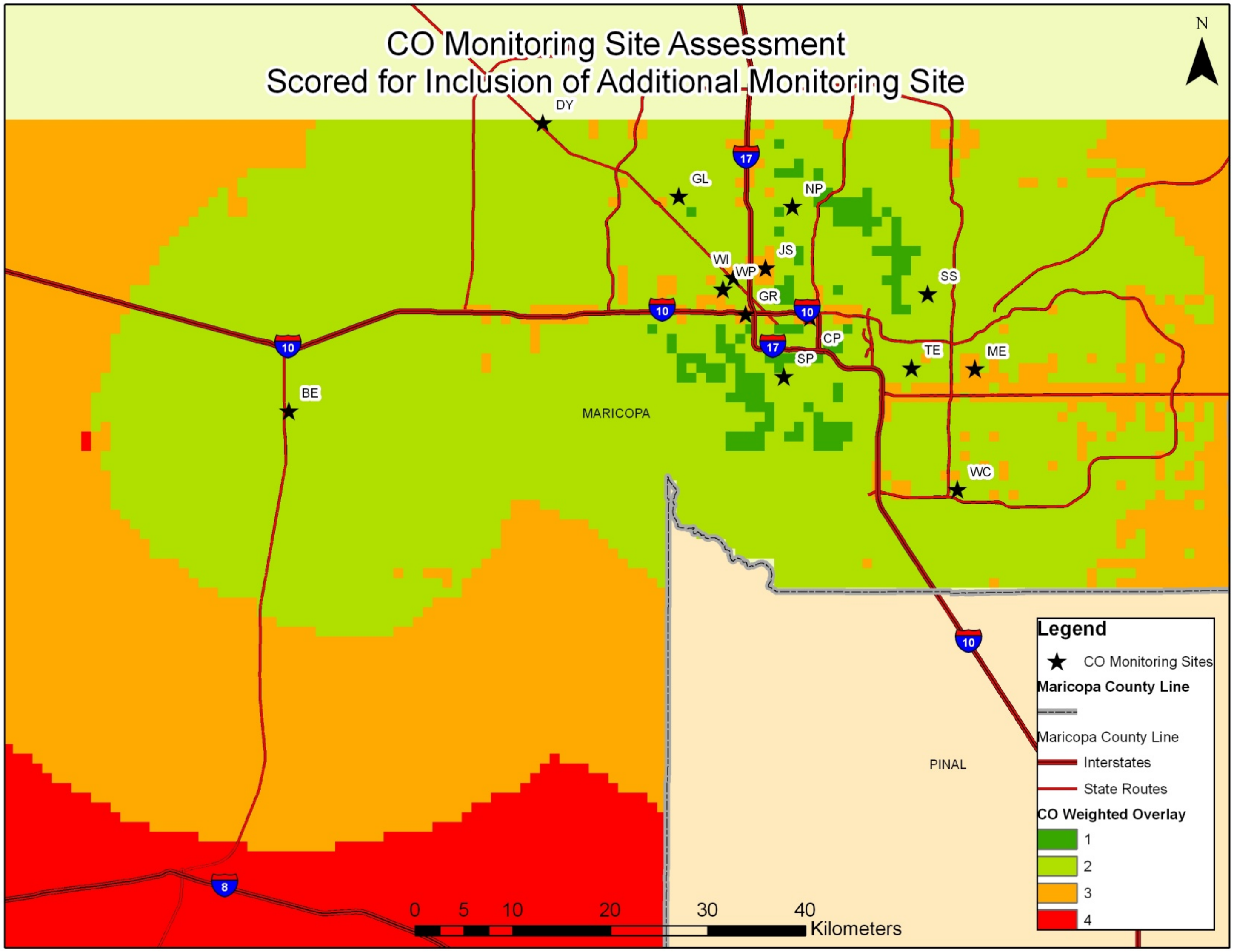

Figure 4.2.1. Map showing overlay of probable new CO sites.

4.3 NO_2 Parameter Results

4.3.1 Weights used

Table 4.3.1. *NO_2 Weights*

Area	Indicator	Weights		Notes
Source-Oriented Indicators		.38		
	Emissions Inventory Point Sources		.15	
	Arterial Road Traffic Count		.08	
	Freeway 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	Concentric rings set to 20 km
	Standard Error from Predicted Pollution		.13	
Totals		1.0	1.0	

4.3.2 Justification

NOx sources are a mix of mobile and point sources, though the EPA lists on-road vehicles as the highest source in Maricopa County[4], followed by non-road equipment. Therefore, source-oriented indicators are given a lot of weight and the traffic indicators have a more of that weight than point sources.

NOx 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 NOx monitoring sites remains very high, even with considerable distance between them (see Figure 3.7.4, Correlogram of NOx Monitoring Sites). Therefore NOx sites should not be located close together otherwise they chance becoming redundant. Because of this, concentric rings on the Euclidean Distance indicator are set at intervals of 20 km and this area is given the least amount of weight.

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

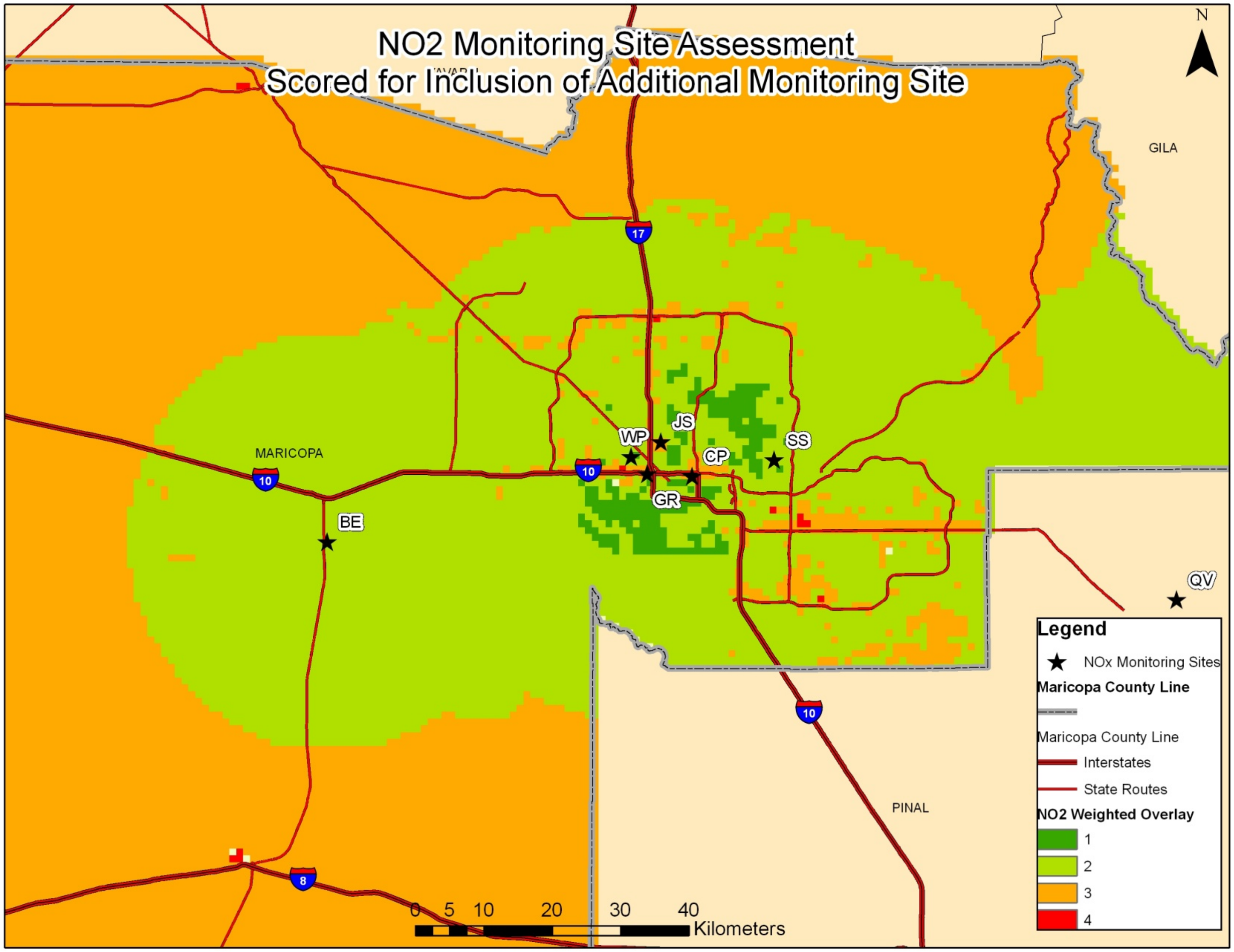

Figure 4.3.1. Map showing overlay of probable new NO_2 sites.

4.4 O_3 Parameter Results

4.4.1 Weights Used

Table 4.4.1. *O_3 Weights*

Area	Indicator	Weights		Notes
Source-Oriented Variables		.30		
	Emissions Inventory Point Sources		.16	
	Arterial Road Traffic Count		.05	
	Freeway Traffic Count		.04	
	Road Density		.05	
Population-Oriented Variables		.34		
	Population Density		.19	
	Minority Population Density		.15	
Spatially-Oriented Variables		.36		
	Euclidean Distance Between Monitors		.14	Concentric rings set to 10 km
	Standard Error from Predicted Pollution		.22	
Totals		1.0	1.0	

4.4.2 Justification

O_3 is a secondary pollutant, and therefore is related to the emissions sources indirectly. In the short term, O_3 will form near the precursor emission sources, but in the long term O_3 concentrations are found independent of sources. Because of this, the Source-oriented variables are given the lowest weight in this model. The EPA list solvent use as the largest source of precursor VOC emissions, followed closely by on-road vehicles[5]; therefore point source indicators were given a slightly higher weight than mobile source emissions.

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 amount of 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 farther distances, showing that having a network of O_3 monitoring sites close together is not necessary, so the Euclidean Distance indicator was set with concentric rings at 10 km and is 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 the highest weight.

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

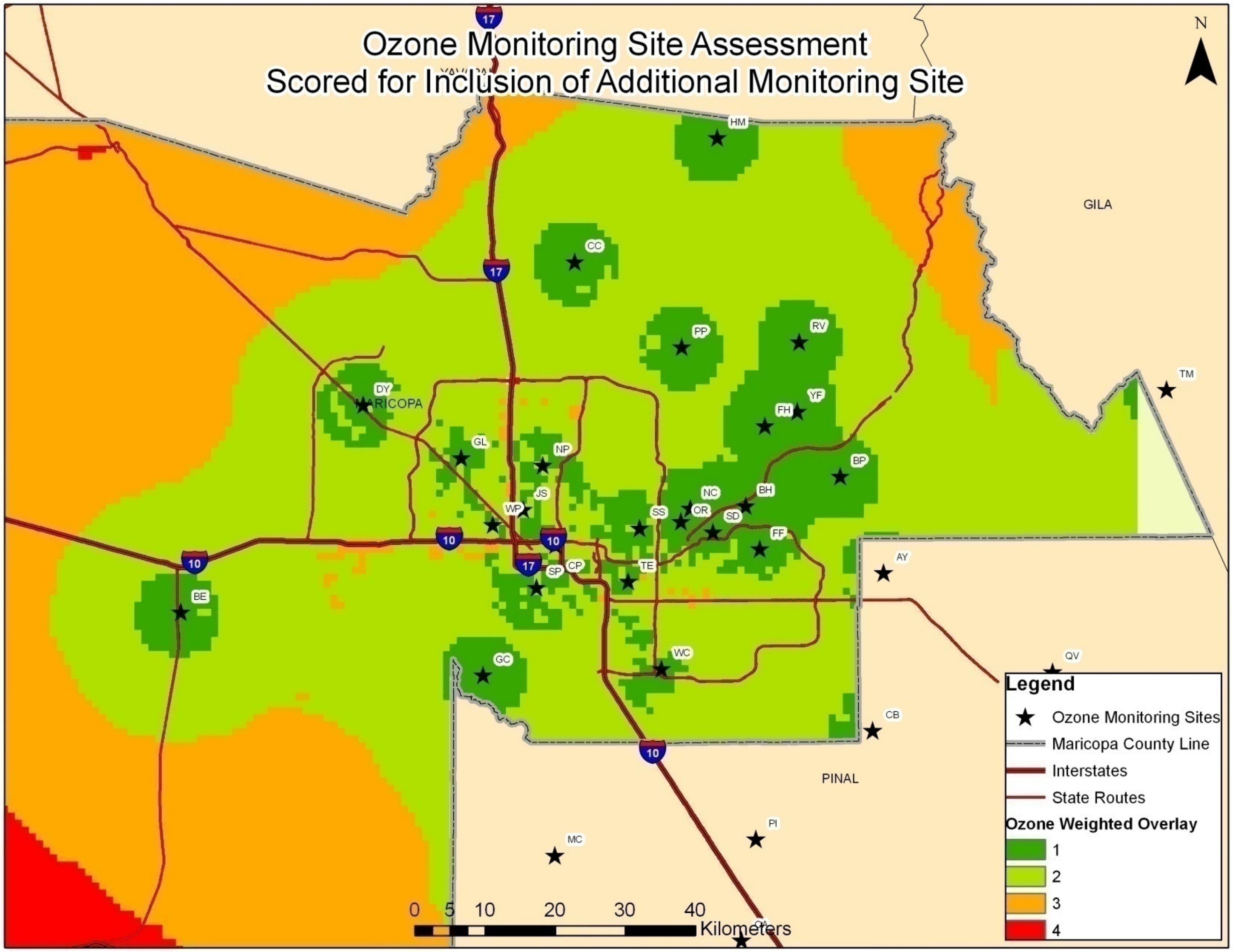

Figure 4.4.1. Map showing overlay of probable new O_3 sites.

4.5 PM_{10} Parameter Results

4.5.1 Weights Used

Table 4.5.1. *PM_{10} Weights*

Area	Indicator	Weights		Notes
Source-Oriented Variables		.40		
	Emissions Inventory Point Sources		.22	
	Arterial Road Traffic Count		.06	
	Freeway Traffic Count		.06	
	Road Density		.06	
Population-Oriented Variables		.36		
	Population Density		.16	
	Minority Population Density		.20	
Spatially-Oriented Variables		.24		
	Euclidean Distance Between Monitors		.10	Concentric rings set at 5 km
	Standard Error from Predicted Pollution		.14	
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 EPA does list road dust as the single largest source[6]. 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, especially areas with high minority population densities. Therefore the Population-Oriented variables were given weight just slightly less than the Source-Oriented variables. Minority Population Density was given the higher weight among the two indicators.

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 Euclidean Distance indicator is not given much weight. The Standard Error indicator is given a medium amount of weight, as the assumption is that PM_{10} is going to be much greater around sources and monitoring outside of sources is probably of little use.

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

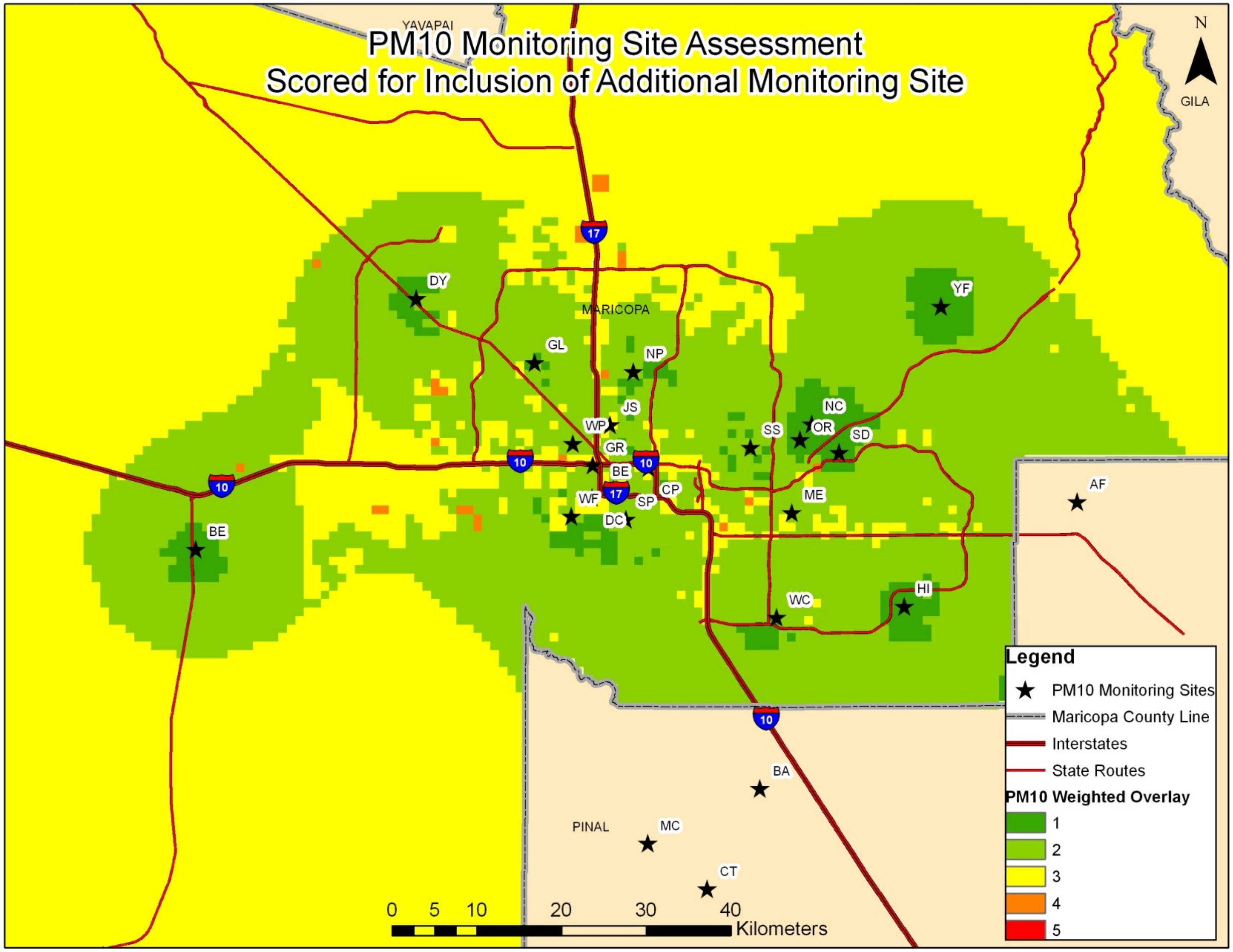

Figure 4.5.1. Map showing overlay of probable new PM_{10} sites.

4.6 $PM_{2.5}$ Parameter Results

4.6.1 Weights Used

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

Area	Indicator	Weights		Notes
Source-Oriented Variables		.38		
	Emissions Inventory Point Sources		.17	
	Arterial Road Traffic Count		.07	
	Freeway Traffic Count		.07	
	Road Density		.07	
Population-Oriented Variables		.38		
	Population Density		.18	
	Minority Population Density		.20	
Spatially-Oriented Variables		.24		
	Euclidean Distance Between Monitors		.10	Concentric rings set at 5 km
	Standard Error from Predicted Pollution		.14	
Totals		1.0	1.0	

4.6.2 Justification

The EPA lists the major sources of $PM_{2.5}$ in Maricopa County, in order, (based off of emissions inventory) as miscellaneous, non-road equipment, road dust, industrial processes, fires, and on-road vehicles[7]. In this model, point sources and mobile sources will have almost the same weight with an emphasis on mobile.

Since fires and residential wood combustion have such an impact on $PM_{2.5}$ emissions, the population-oriented variable are given the same weight as source-oriented variables. $PM_{2.5}$ also tends to be located in urban areas and is very local in its effects, so higher weight is given to the minority population density indicator.

$PM_{2.5}$ monitoring sites tend to very quickly lose correlation with distance; after 15km monitoring sites show only insignificant correlation (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, therefore the Euclidean Distance indicator is not given much weight. The Standard Error indicator is given a medium amount of weight, as the relatively few $PM_{2.5}$ monitoring sites already introduces a considerable amount of error in predicting $PM_{2.5}$.

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

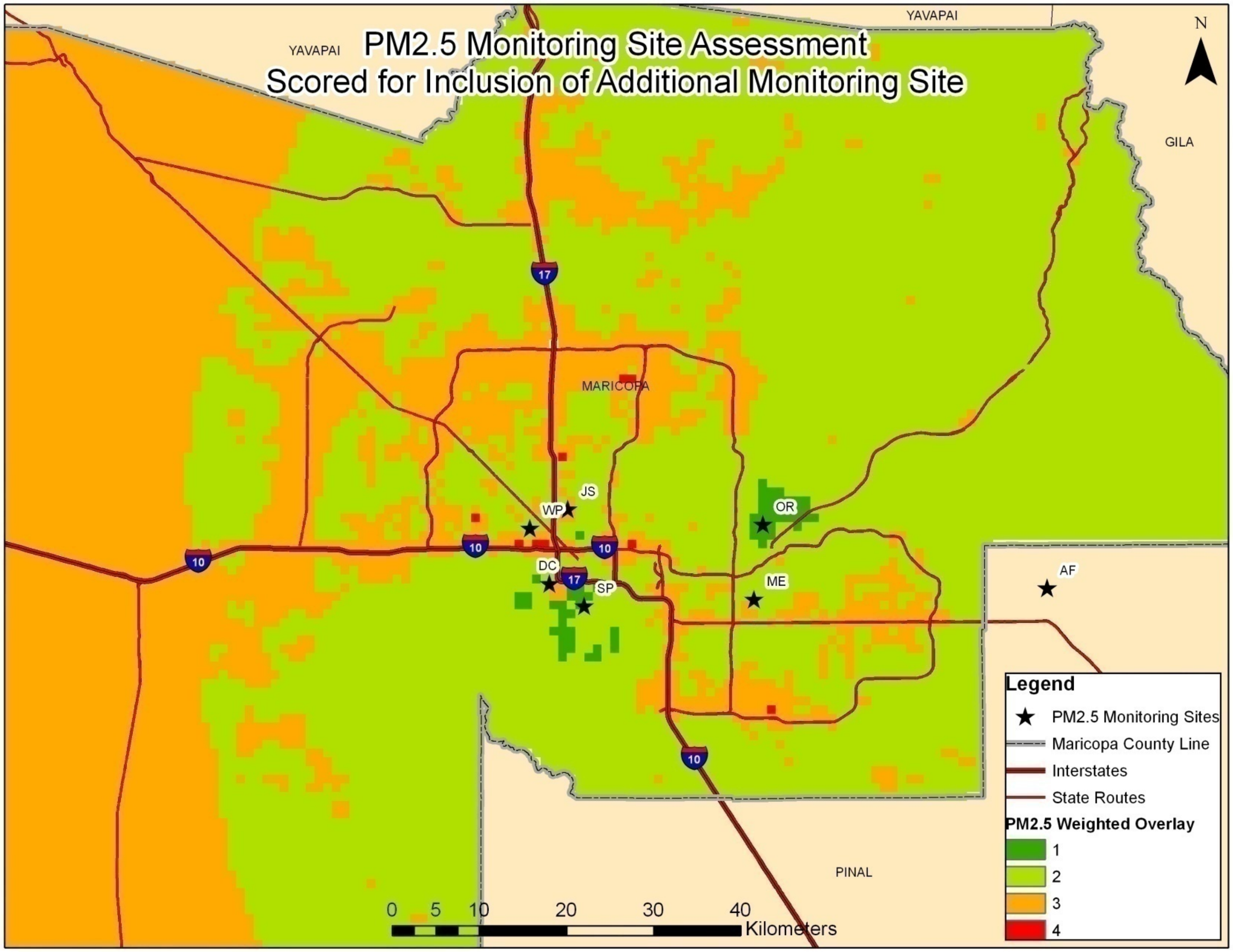

Figure 4.6.1. Map showing overlay of probable new $PM_{2.5}$ sites.

4.7 SO_2 Parameter Results

4.7.1 Weights Used

Table 4.7.1. *SO_2 Weights*

Area	Indicator	Weights		Notes
Source-Oriented Variables		.42		
	Emissions Inventory Point Sources		.18	
	Arterial Road Traffic Count		.08	
	Freeway Traffic Count		.08	
	Road Density		.08	
Population-Oriented Variables		.38		
	Population Density		.19	
	Minority Population Density		.19	
Spatially-Oriented Variables		.20		
	Euclidean Distance Between Monitors		.20	Concentric rings set at 10 km
	Standard Error from Predicted Pollution		N/A	
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[8]. 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 amount of weight in the model.

Minority and total population indictors are given an equal amount of weight.

SO_2 monitoring sites show almost no correlation; though this might be a statistical error since SO_2 levels are almost at non-detect levels and have very little variance (see Figure 3.7.12, Correlogram of SO_2 Monitoring Sites). Even though close monitoring sites show little redundancy, SO_2 levels are fairly uniform across existing sites. Because of this the Euclidean distance indicator was set with concentric rings at 10 km and given relatively low weight. There are not enough SO_2 sites to run a proper kriging interpolation, so the standard error indicator is not used.

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

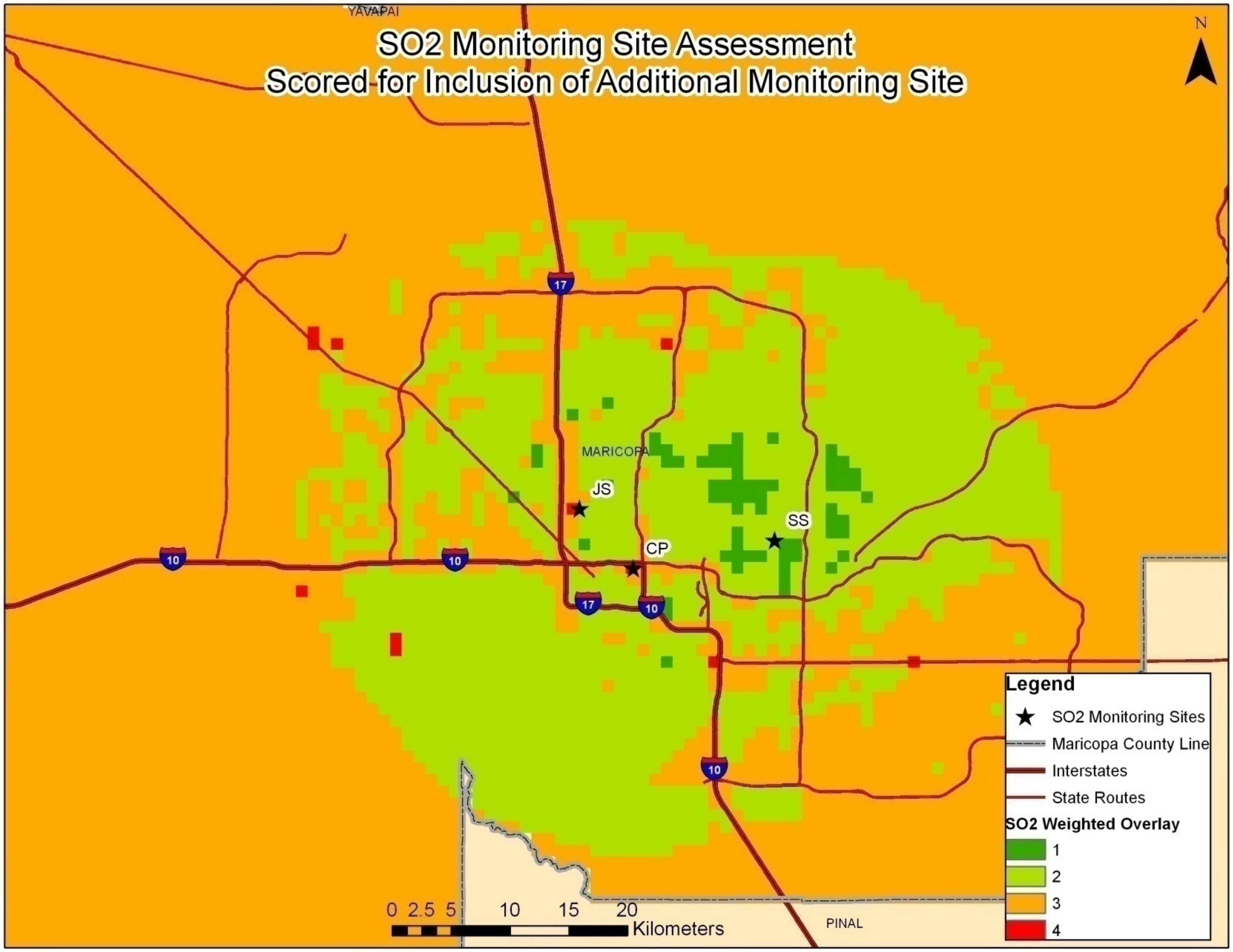

Figure 4.7.1. Map showing overlay of probable new SO_2 sites.

Section 5: Suggested Changes to the MCAQD Monitoring Network

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. These suggestions are organized per criteria pollutant category.

5.1 Suggested Changes to the CO Network

5.1.1 Summary

Number of existing sites: 13

Sites recommended for closure: West Indian School (closed summer 2010)

Sites recommended being moved or changed: None to be moved; change the West Phoenix objective from Population Exposure to Highest concentration.

Recommended new sites: None (though adding CO monitors to an existing Gila Bend site, micro-scale near road monitoring site, or existing Higley site would be beneficial)

Table 5.1.1. *CO monitoring site summary*

Site	Objective	Scale
Buckeye	Population Exposure	Neighborhood
Central Phoenix	Population Exposure	Neighborhood
Dysart	Population Exposure	Neighborhood
Glendale	Population Exposure	Neighborhood
Greenwood	Population Exposure	Middle
Mesa	Population Exposure	Neighborhood
North Phoenix	Population Exposure	Neighborhood
South Phoenix	Population Exposure	Neighborhood
South Scottsdale	Population Exposure	Neighborhood
Tempe	Population Exposure	Neighborhood
West Chandler	Population Exposure	Neighborhood
West Indian School	Highest Concentration	Micro
West Phoenix	Population Exposure	Neighborhood

5.1.2 Narrative

Closing Sites: In the summer of 2010 the West Indian school micro-scale site was closed down due to the closing of the City of Phoenix's operation at the building. This network assessment includes the West Indian School site since it was in operation during the evaluation period of 2005-2009. Though the site has already been closed and the closure approved by the EPA, this evaluation shows that the site would have been recommended for closure in any event. West Indian School did have the network's highest CO design value, and it was appropriately classified with a highest concentration objective; however, West Phoenix has a design value that is almost as high and the two sites were redundant. In the analyses contained in Section 3, the West Phoenix site ranks highest, while West Indian School only ranked 7th out of the 13 sites. Furthermore, West Indian School only had the CO and wind monitors, as compared to the seven monitors at West Phoenix, so it was the least cost effective CO site. It was suggested, and approved by the EPA, to close West Indian School and have the West Phoenix site assume representation for the area. It is recommended that West Phoenix be reclassified with the Highest Concentration objective.

Dysart and Buckeye rank lowest in the analyses contained in Section 3, which is not surprising since these two sites are farthest from the urban core. Though it would do the least harm to close these sites, it is not recommended because there are other parameters monitored at these sites and the inclusion of a CO monitor at the existing site has little additional cost.

Moving/Changing Sites: It is not recommended to move any existing CO sites. It is recommended to change the objective for West Phoenix from Population Exposure to Highest Concentration.

Adding New Sites: CO levels across Maricopa County are uniformly low as compared to the NAAQS. Because of this it is not necessary to add any new CO monitoring sites and it not recommended. Nevertheless, the analysis shows that Gila Bend could benefit from a CO monitor, though CO levels are likely to be extremely low and this would only be cost effective if other parameters were also going to be monitored at the site. In the Phoenix metropolitan area the same situation applies, although the analysis show that East Mesa could benefit from a CO monitor, possibly one located at the existing Higley site. Also, the closure of the West Indian School monitor takes the only micro-scale CO monitor from the network; if a new near-road NO_2 monitoring site is started in the future it would be beneficial to also include a micro-scale CO monitor at the site.

5.2 Suggested Changes to the NO_2 Network

5.2.1 Summary

Number of existing sites: 5

Sites recommended for closure: None

- Sites recommended being moved or changed:
- South Scottsdale moved to the existing Tempe site.
- If a new site was created in Gila Bend it is recommended to move Buckeye there.
- If Buckeye is not moved, it is recommended to change the objective from Source Oriented to Upwind Background.

Recommended new sites:

- A near-road monitor along a high traffic corridor is necessary.
- It is also possible to add a new site in Gila Bend with a new monitor instead of moving Buckeye.

Table 5.2.1. *NO_2 monitoring site summary*

Site	Objective	Scale
Buckeye	Source Oriented	Urban
Central Phoenix	Highest Concentration	Neighborhood
Greenwood	Population Exposure	Middle
South Scottsdale	Population Exposure	Urban
West Phoenix	Population Exposure	Neighborhood

5.2.2 Narrative

Closing Sites: It is not recommended to close any NO_2 sites. Section 3 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.

Moving/Changing Sites: Section 4 notes that Gila Bend has one of the highest NO_2 emission sources in the county and the weighted overlay gives it a high score for adding a new site. If a new site was created in Gila Bend, it would be a useful source-oriented, urban scale monitor. It might even be worth considering moving the Buckeye monitor to Gila Bend and allowing it to take over the background functions.

If Buckeye is not moved, it is suggested to change the objective from Source Oriented to Upwind Background. The Buckeye NO_2 monitor was 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 are having little effect on the monitor, but the monitor does play a useful role in measuring background levels of NO_2.

With NO_2 concentrations within attainment of the NAAQS, it is probably not necessary to add any additional monitoring sites (with the exception of the NO_2 near-road monitor, see below). However, Tempe and the Highway 101/U.S. 60 area rank high in the Section 4 analysis. It is recommended to move South Scottsdale, which ranked fourth in the Section 3 analyses, to the existing Tempe monitoring site.

<u>Adding Sites</u>: As just mentioned, it is probably not necessary to add more monitoring sites, other than a near-road NO_2 monitoring site. The near-road NO_2 monitoring site is a new requirement that MCAQD has begun planning to meet. The analyses (freeway/arterial traffic counts) show many possible locations to place this; the best possibilities include near I-10 between the I-17/Loop 51 interchanges followed by I-10/U.S. 60 interchange and the I-10 west of I-17 (Figure). However, because of the existing location of the Central Phoenix and Greenwood sites, it might be most beneficial to locate the new site near the I-10/U.S. 60 interchange.

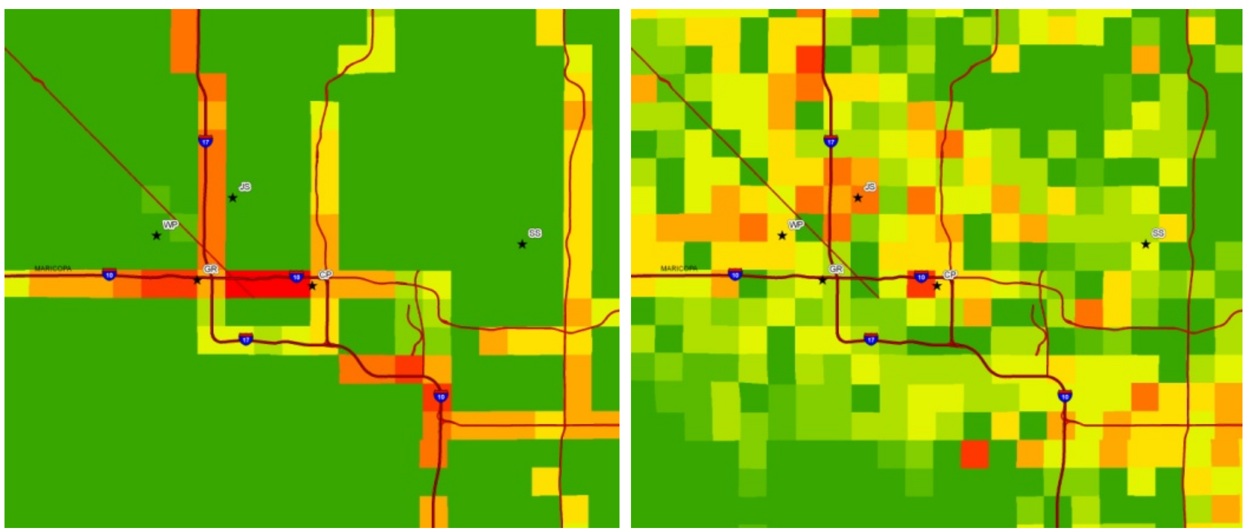

Figure 5.2.1. Freeway and arterial road counts, ranked from highest (red) to lowest (green).

5.3 Suggested Changes to the O_3 Network

5.3.1 Summary

Number of existing sites: 17

Sites recommended for closure: None

Sites recommended to be moved/changed:

- None, though the possibility of moving South Scottsdale north to the Deer Valley or Paradise Valley area should be considered.
- Blue Point is recommended to be changed from a Maximum Ozone Concentration to an Extreme Downwind objective.

Recommended new sites:

- Deer Valley area
- Avondale/Goodyear area
- Gila Bend Area
- Wickenburg area.

Table 5.3.1*. O_3 monitoring site summary*

Site	Objective	Scale
Blue Point	Maximum Ozone Concentration	Urban
Buckeye	Population Exposure	Neighborhood
Cave Creek	Population Exposure	Urban
Central Phoenix	Population Exposure	Neighborhood
Dysart	Population Exposure	Neighborhood
Falcon Field	Population Exposure	Neighborhood
Fountain Hills	Maximum Ozone Concentration	Neighborhood
Glendale	Population Exposure	Neighborhood
Humboldt Mountain	Maximum Ozone Concentration	Regional
North Phoenix	Population Exposure	Neighborhood
Pinnacle Peak	Maximum Ozone Concentration	Urban
Rio Verde	Maximum Ozone Concentration	Urban
South Phoenix	Population Exposure	Neighborhood
South Scottsdale	Population Exposure	Neighborhood
Tempe	Population Exposure	Neighborhood
West Chandler	Population Exposure	Neighborhood
West Phoenix	Population Exposure	Neighborhood

5.3.2 Narrative

Closing sites: O_3 is in non-attainment of the NAAQS within Maricopa County, so it is not recommended to close any existing site as they all are important to characterizing O_3 concentrations.

Moving/Changing Sites: Just as with closing monitoring sites, it is not recommended to move any monitors; though there is a heavy concentration of O_3 monitors east of the metropolitan area and it would be beneficial to consider moving South Scottsdale north to the north Scottsdale/Paradise Valley/Deer Valley area if a new monitoring site is not added at Deer Valley. South Scottsdale, located in a City of Scottsdale fire station, is a relatively important O_3 monitor with a medium to high design value and a long history of operation, but there has been mention from the city that the fire station might be closed and moved. If this occurs then moving the monitor north should definitely be considered. It is also recommended to change the objective of the Blue Point monitor from Max O_3 Concentration to Extreme Downwind as this monitor's design value is in the bottom three of all MCAQD O_3 monitors.

Adding Sites: The analyses show that the metropolitan area would benefit from O_3 monitors around the Deer Valley (I-17 and Loop 101 interchange) area. The Avondale/Tolleson region of the west valley also scores high in needing a new O_3 site (Figure 4.4.1). Outside of the metropolitan area, the Gila Bend and Wickenburg areas score high. A new site in Gila Bend would also benefit from having multiple parameters monitored and would provide a useful Upwind/Background O_3 objective.

5.4 Suggested Changes to the PM_{10} Network

5.4.1 Summary

Number of existing sites: 15 (as of 2010)

Sites recommended for closure: None

Sites recommended being moved or changed:

- West Chandler scale changed from Middle to Neighborhood.
- Buckeye objective changed from Population Exposure to Highest Concentration.
- Possibly moving South Scottsdale to Tempe should be considered.

Recommended new sites:

- Deer Valley area
- Avondale/Tolleson area
- Gila Bend area.

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

Site	Objective	Scale
Buckeye	Population Exposure	Neighborhood
Central Phoenix	Population Exposure	Neighborhood
Coyote Lakes*	Source Oriented	Middle
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
West 43rd Avenue	Highest Concentration	Middle
West Chandler	Population Exposure	Middle
West Phoenix	Population Exposure	Neighborhood
Zuni Hills*	Population Exposure	Neighborhood

*Coyote Lakes operated less than two years and was closed in early 2009. Zuni Hills began operation in late 2009. These two sites were not included in the analyses contained in Sections 3 and 4.

5.4.2 Narrative

Closing sites: Maricopa County is not in attainment of the NAAQS, so therefore it is not recommended to close any PM_{10} sites. Dysart and North Phoenix ranked lowest in the site-to-site analyses, but both of these sites provide valuable background monitoring, cover large areas of representation with much population, and have multiple parameters monitored. The new Zuni Hills site is very close to the Dysart site and the two sites are likely highly redundant; however there is presently not enough data collected to make that determination.

Moving/Changing Sites: The analyses show that there are no large point sources of PM_{10} close to the West Chandler site; and though the road density and traffic count is significant, these variables are fairly consistent in a 10-km radius around the site. It is therefore recommended to change West Chandler from a middle-scale monitor to neighborhood scale.

The Buckeye site currently has the second largest design value in the network; less than West 43rd Avenue, but greater than Durango Complex. Both West 43rd Ave and Durango Complex have Highest Concentration objectives, but Buckeye has a Population Exposure objective. It is therefore recommended to change Buckeye to a Highest Concentration objective.

It is also recommended to consider moving the South Scottsdale site south to the existing Tempe site. The analyses contained in Section 4 show that Tempe has a greater concentration of point and mobile sources and a comparable population density, though South Scottsdale has been in operation for many years and has a high trends impact score and also monitors multiple parameters. However, as previously mentioned the fire station where the South Scottsdale monitor is housed might be closed down or moved. If this occurs, it would then definitely be recommended to move the site to Tempe.

Adding Sites: The analyses show that the Deer Valley area would benefit the most from the inclusion of a new PM-10 monitoring site.   The Avondale/Tolleson/Southwest Phoenix area also scores high, as well as the well as the West Glendale area near the convergence of the Agua Fria and New Rivers.

Outside of the metropolitan area, the Tonopah area in western Maricopa County scores the highest, as this area has point sources (power plants) with the highest annual emissions, though population and mobile sources are very light in the area.   If a new site is opened in Gila Bend, than that area would also benefit from a PM-10 monitor.

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

5.5.1 Summary

Number of existing sites: 4

Sites recommended for closure: None

Sites recommended being moved or changed: None

Recommended new sites: See narrative for list of hotspots which would benefit from a new PM-2.5 site.

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

Site	Objective	Scale
Durango Complex	Highest Concentration	Middle
Mesa	Population Exposure	Neighborhood
South Phoenix	Population Exposure	Neighborhood
West Phoenix	Highest Concentration	Neighborhood

5.5.2 Narrative

Closing sites: It is not recommended to close any $PM_{2.5}$ Sites. Though Maricopa County is in attainment for $PM_{2.5}$, the existing network is sparse and could be expanded to better represent the pollutant.

Moving/Changing Sites: It is not recommended to move or change any $PM_{2.5}$ sites.

Adding Sites: Most major point-sources of $PM_{2.5}$ emissions within the metropolitan area are already fairly covered, with exceptions being in the east valley north of the Higley monitor and the Deer Valley area. When all factors were considered in the Section 4 analyses, the following hotspots within the metropolitan area were identified:

- North Phoenix in the Bell Rd/SR51 area.
- Phoenix in the Northern Ave/I-17 area.
- West Phoenix in the Indian School Rd/67th Ave area.
- Along the I-10 west of the I-17 interchange (near the existing Greenwood monitor).
- Phoenix in the McDowell Rd/32nd St area, just north of Sky Harbor airport.
- Chandler in the Pecos Rd/Arizona Ave area, 4 km east of the existing West Chandler site.

Outside of the metropolitan area, the following hotspots were identified:

- Wintersburg area (power plants near the Palo Verde nuclear generating station).
- West of Tonopah at 491st Ave/Courthouse Rd.
- There is also an emission point source in Gila Bend, though that area did not score as high as the others listed above.

5.6 Suggested Changes to the SO_2 Network

5.6.1 Summary

Number of existing sites: 2

Sites recommended for closure: None

Sites recommended being moved or changed: South Scottsdale

Recommended new sites: None

Table 5.6.1. *SO_2 monitoring site summary*

Site	Objective	Scale
Central Phoenix	Highest Concentration	Neighborhood
South Scottsdale	Population Exposure	Neighborhood

5.6.2 Narrative

Closing sites: It is not recommended to close any SO_2 Sites. Maricopa County is in attainment for SO_2 and levels of this pollutant are very low as compared to the NAAQS. However, the two existing monitors are at sites with other parameters monitored and there is little additional cost to include the SO_2 monitors.

Moving/Changing Sites: The South Scottsdale site is not near any major point sources and measured levels of SO_2 are often at or below the non-detect level. Even though this monitor has been in operation for a long time, it is recommended to move the monitor to an area with more emission sources or a higher score on the adequacy analysis contained in Section 4. The hotspots identified include the far west Phoenix/Avondale area near the Salt River, Surprise in the Bell Rd/Grand Ave area, central Mesa near U.S. 60/Gilbert Rd, and Tempe near the U.S. 60/I-10 interchange. However, the few SO_2 point sources in the metropolitan area are most conglomerated near the I-17 Durango curve and the highest source is in the west Phoenix area of 99th Ave/Southern. It is recommended to move South Scottsdale to the existing Durango Complex site, or if a monitoring site were to be added in the west Phoenix/Salt river area then moving the monitor there could also be considered.

Adding Sites: It is not recommended to add any new SO_2 sites.

5.7 Recommendation for New Technologies within the Monitoring Network

MCAQD is committed to keeping its monitoring network as technologically advanced as possible, budget permitting. MCAQD has been most active in upgrading filter-based Federal Reference Method (FRM) particulate monitors to continuously operating Federal Equivalency Method (FEM) monitors. FEM monitors provide a much 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 much more expensive than the filter-based monitors, and replacement is taking place at a steady pace as budgets permit. Currently, of the 15 PM_{10} monitoring sites that MCAQD operates, 12 are continuous FEM monitors and 3 are filter-based FRM monitors. Of the four $PM_{2.5}$ monitoring sites, one site (Durango Complex) is exclusively a continuous FEM monitor and one site (Mesa) is exclusively a filter-based FRM monitor. The other two sites (West Phoenix and South Phoenix) operate collocated FEM and FRM monitors.

To illustrate the rate that MCAQD is upgrading its network to keep it technologically advanced, the current ratio of FRM to FEM PM_{10} monitors is in contrast to the 2005 ratio when MCAQD also operated 15 PM_{10} sites of which nine were FRM, four were FEM and two contained collocated FRM/FEM monitors. In 2005, MCAQD operated three $PM_{2.5}$ sites, all of which were filter-based FRM monitors.

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.

Data acquisition and management software is also maintained and upgraded annually, with maintenance contracts automatically giving upgrades as they become available. MCAQD used the E-DAS Ambient software from Agilaire (formerly ESC) to manage its database from 2005-2009, but the department is currently in the process of upgrading to the newly released version of Agilaire's Air Vision data acquisition software. The monitoring network is also being upgraded so that data from all sites will be collected through high-speed network connections; when this is completed it will be possible to poll all sites on a five-minute basis to have a near real-time picture of air quality within the monitoring network.

It is not recommended to make any changes in MCAQD's policy of technological upgrades, as MCAQD current policy is as progressive as budgets will allow.