OFR-15-04

ADEQ 2015 5-Year Network Assessment

This document is the ADEQ 2015 5-year Network Assessment. Included is an executive summary which reports the findings of this assessment, a Ranking Analysis of current ADEQ monitors, and a Spatial Raster Analysis which shows areas of Arizona which potentially could be monitored to protect human health and the environment.

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5-Year Network Assessment

A. Purpose and Objective

The purpose and objectives of this assessment is to determine if the Arizona Department of Environmental Quality's (ADEQ) ambient air monitoring network meets its monitoring goals and objectives set forth by ADEQ to protect and enhance public health and the environment in Arizona. In supporting these goals, an analysis of ADEQ's air monitoring network is provided for ADEQ's air quality professionals for the purpose of determining the adequacy of the network. 40 CFR Part 58.10(d) states the specific requirements for this assessment:

> The state, or where applicable local, agency shall perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years 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 into the ambient air monitoring network. The network assessment must consider the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma), and, for any sites that are being proposed for discontinuance, the effect on data users other than the agency itself, such as nearby states and tribes or health effects studies. The state, or where applicable local, agency must submit a copy of this 5-year assessment, along with a revised annual network plan, to the Regional Administrator.

In order to achieve the above objectives, the analysis consists of the following:

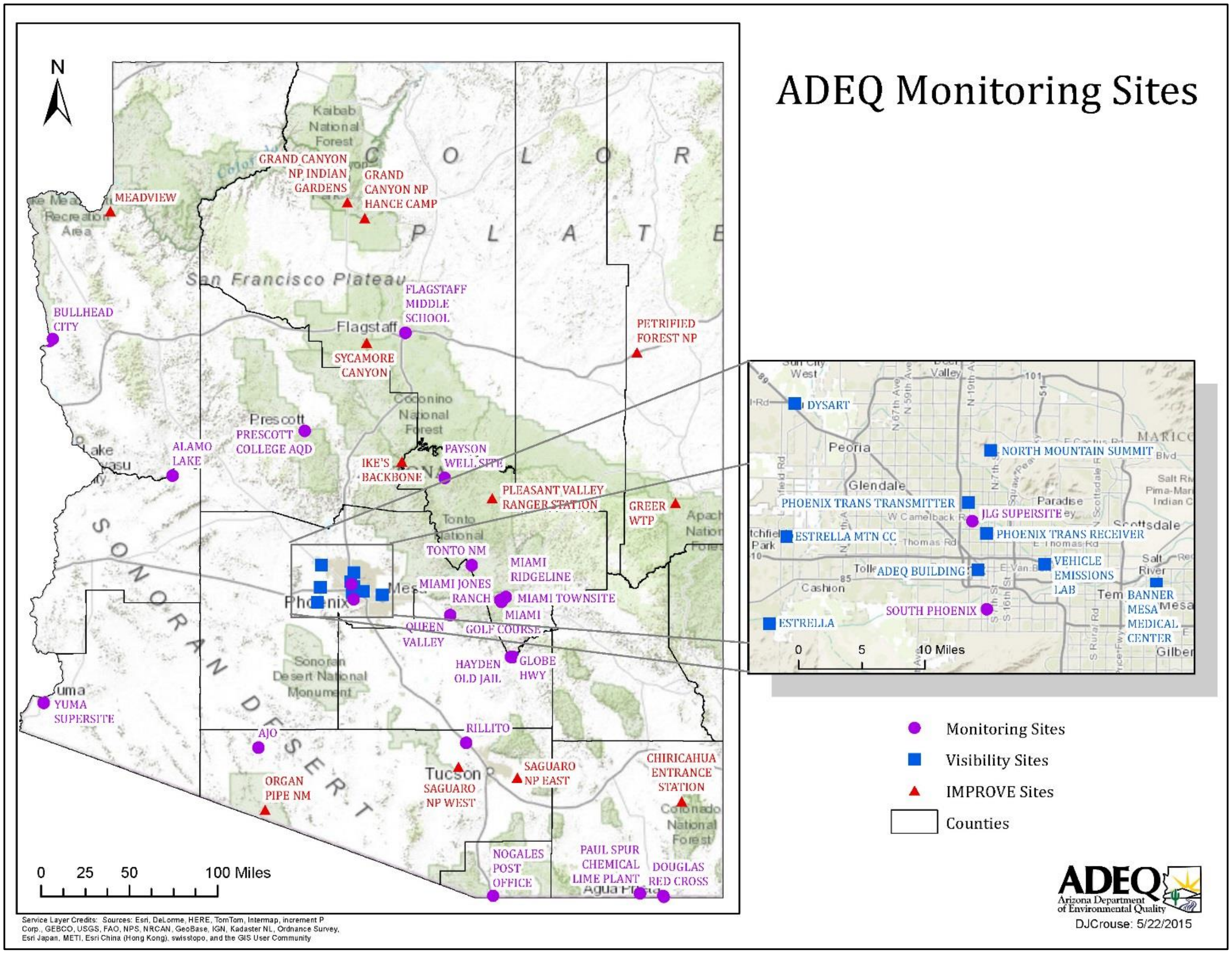
- Executive Summary – A summary of the recommendations and conclusions made by the Air Quality Division.
- Section I – An instrument-to-instrument Ranking Analysis which determines the comparative importance of each instrument using a variety of indicators. These indictors cover demographic, geographic, economic and regulatory perspectives that are important to air monitoring. The individual instruments in the monitoring network are separated by pollutant and ranked. The ranking is then used for the determination of final recommendations. The purpose of the Ranking Analysis is to determine the adequacy of ADEQ's current monitoring network and any recommended network modifications.
- Section II – A Spatial Analysis using a series of raster-based maps representing a variety of indicators. These indicators cover demographic, geographic, and source pollution perspectives that are important to air monitoring. Raster maps are a GIS tool that quantifies areas in Arizona for their importance to air monitoring. The spatial analysis is separated by pollutant and then used for the determination of final recommendations. The purpose of the Spatial Analysis is to determine potential locations or areas where new monitors could be deployed and to identify any areas of over representation.
- Section III – Recommendations and final conclusions using both the Ranking and Spatial analyses to determine: if the current network meets monitoring objectives, whether new sites are needed, whether existing sites are no longer needed, where areas with relatively high populations of sensitive individuals are located, and whether new technologies are appropriate for incorporating into the existing network.

The assessment addresses only the criteria pollutants monitored by ADEQ. The criteria pollutants include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), particulate matter (both PM_{10} and $PM_{2.5}$), and lead (Pb). The assessment uses instrument and site data from the years 2009-2013, as these data are the most current certified five-years of data at the time of the creation of this assessment. All data used are publically available and were taken from EPA's Air Quality System (AQS), the United States Census Bureau, ADEQ's permitted emission sources, Arizona Department of Transportation, and the Arizona Department of Health Services.

The recommendations stated in this assessment are used to plan for changes in the air monitoring network for the subsequent five years and to be included in the 2016 Annual Network Plan. The recommendations, conclusions, and rankings in this assessment include only sites and areas operated by ADEQ. The final conclusions and recommendations were determined by ADEQ's Air Quality management. Information included in this report may be helpful to other agencies and organizations in evaluating their monitoring activities.

Figure 1: ADEQ's 2013 Monitoring Sites

This Map shows all of ADEQ's monitoring sites in Arizona. This can be used for reference when referring to sites in subsequent sections.



B. Executive Summary

The purpose of this executive summary is to provide a summary of this analysis and the final recommendations and conclusions. The purpose of this analysis to determine the adequacy of ADEQ's air monitoring network. This is done using two types of analysis: a Ranking Analysis determines which instruments are of greatest and least impact to protecting and enhancing public health and the environment in Arizona; a Spatial Analysis determines which areas of Arizona are being under or over represented by air monitoring. Recommendations for the removal/addition of instruments are determined using both analyses and the full recommendations and conclusions are found in Section II (A) of this document. The conclusions and recommendations were made by ADEQ's Air Quality management. All results and findings are listed below.

1. Ranking Analysis Results:

The ranking scale starts at one, being the highest ranking instrument and therefore the most important to monitoring.

SO_2 Network Results

Site Name	Ranking
Miami Ridgeline	4
Miami Jones Ranch	5
Miami Townsite	6
Hayden Old Jail	1
Alamo Lake	3
JLG Supersite	2

O_3 Network Results

Site Name	Ranking
Flagstaff Middle School	6
Tonto National Mon.	5
Alamo Lake	4
JLG Supersite	2
Queen Valley	3
Prescott College AQD	7
Yuma Supersite	1

PM_{10} Network Results

Site Name	Ranking
Paul Spur Chemical Lime Plant	11
Douglas	5
Payson	10
Hayden Old Jail	6
Miami Golf Course	12
Alamo Lake	2
JLG Supersite	3
Bullhead City	9
Ajo	4
Rillito	8
Nogales Post Office (Continuous)	7
Nogales Post Office (Filter)	13
Yuma Supersite	1

$PM_{2.5}$ Network Results

Site Name	Ranking
Douglas	7
Alamo Lake	1
JLG Supersite (Continuous)	4
JLG Supersite (Filter)	2
Nogales Post Office (Continuous)	6
Nogales Post Office (Primary Filter)	3
Nogales Post Office (Secondary Filter)	8
Yuma Supersite	5

2. Ranking Analysis Recommendations:

- Removal of the PM_{10} (POC 1 Filter) and PM2.5 (POC 2 Secondary Filter) instruments at Nogales Post Office.
  - These instruments are not required and are lowest ranked. A request for their removal should be made in the 2015 Annual Network Plan. These instrument were required before 2013 because they were either the primary or the

required collocated instruments. When the continuous PM instruments were placed, these instruments became redundant but were not removed at the time.

3. Ranking Analysis Conclusions

- Consolidation of the Miami SO_2 Network
  - The three instruments in the Miami SO_2 Network are highly correlated and are the three lowest ranked monitors. This indicates that consolidation can be done to better effectively represent the Miami SO_2 non-attainment area without the loss of quality. Special consideration must be taken to follow all requirements under the State Implementation Plan (SIP). Consolation of the Miami SO_2 network is subject to requirements in the SO_2 non-attainment SIP and any removal or relocation should be made according network modification requirements in 40 CFR Part 58.14. Due to the placement of the Miami Jones Ranch and Miami Townsite locations in 2013, at least three years of data are required in order to be considered for relocation. Thus any modifications to the can be done at earliest in 2016.
- The JLG Supersite and Yuma Supersite special consideration
  - These monitoring sites are identified as of particular important to the ADEQ's air monitoring network. Both of these sites are consistently ranked high compared to the other sites. Yuma Supersite is important as a border transport site and representative of a large MSA. JLG supersite is important due to it long trend and research objectives for the Phoenix area. Any modernization of instrumentation or techniques should be made at these sites first.

4. Spatial Analysis Results

See Section II (H) page 72 for the final map results.

5. Spatial Analysis Recommendations

- Exploratory PM_{10} monitoring in the Quartzite, Kingman, and Benson/Willcox areas
  - This monitoring should be conducted to determine if permanent monitoring should be done for these areas and populations. Low cost sensors and alternative monitoring techniques are recommended to quickly and easily determine ambient concentrations.
- Exploratory $PM_{2.5}$ monitoring in the Bullhead City and Benson/Willcox areas
  - This monitoring should be conducted to determine if permanent monitoring should be done for these areas and populations. Low cost sensors and alternative monitoring techniques are recommended to quickly and easily determine ambient concentrations.
- Exploratory O_3 monitoring in the Kingman, Payson, and Bullhead City areas
  - This monitoring should be conducted to determine if permanent monitoring should be done for these areas and populations. Low cost sensors and alternative monitoring techniques are recommended to quickly and easily determine ambient concentrations.

6. Spatial Analysis Conclusions

- It was determined that ADEQ's monitoring network is generally satisfactory for Arizona. The minimum monitoring requirements set forth in 40 CFR Part 58 appendix D are being met by ADEQ and monitoring represents all major pollutant and population centers.
- It was determined that no areas in Arizona were being over represented by ADEQ's monitoring networks. No removals or relocations of instrument are recommended based on this analysis.

Section I: Ranking Analysis

A Ranking Analysis provides an instrument-to-instrument comparison for ADEQ's criteria networks. The purpose of the Ranking Analysis is to determine which instruments are most crucial to air monitoring and which can be removed or relocated. The analysis uses indicators to rank instruments for their importance to air monitoring. The indicators serve as a way to quantify different aspects important to monitoring and public health. This is done by assigning a value, known as the Indicator Value, to the individual instruments. The Indicator Values are on a scale from 0-10, with 0 the lowest valued and 10 the highest. The indicators cover regulatory, demographic, geographic, and economic topics. Focusing on one indicator does not give the full picture or status of ADEQ's monitoring network. Therefore, the Ranking Analysis combines all of the indicators in the Section J: Final Rankings page 35 to give a comprehensive and robust ranking of ADEQ's monitoring network.

Chosen indicators represent a variety of pertinent areas to look at the worth of instruments; e.g. cost-effectiveness, measured concentrations, spatial effectiveness, correlation, and population served. Nine indicators are used in the Ranking Analysis:

Table 1: Ranking Analysis Indicators

Indicator	Description	Indicator Type
Measured Concentration	Assigns an indicator value to instruments based on their measured concentrations, with the highest ranking having the highest concentrations. This indicator uses average design values from the years 2009-2013. It is considered more important to have instruments that measure the highest concentrations.	Measured Value
Deviation from the NAAQS	Assigns an indicator value to instruments using the absolute deviance from the NAAQS. Places importance on monitors that are closest to the standard. Instruments that are close to the standard can more easily change attainment status and are thus considered of more important for NAAQS compliance. This indicator uses average design values from the years 2009-2013.	Measured Value
Area Served	Assigns an indicator value based on an instrument's area of influence. The area of influence is calculated using Theissen polygons. Theissen polygons are polygons surrounding instruments which shown the relative area of representation based on the straight line distance to other instruments. It is considered more important to have instruments that represent large areas. A large area of influence results in a high indicator value.	Spatial
Population Served	Assigns an indicator valued based on the number of people that an instrument serves. Using the stated spatial scale of each monitor to determine each monitor's area of representation, population data are laid over the area to determine the represented population. It is considered more important to have instruments that represent the highest population. High population served results in a high indicator value.	Population
Monitor to Monitor Correlation	Using the monthly averages from 2009-2013, each instrument is correlated using Pearson's R^2 correlation coefficient. The maximum correlation to another instrument is used to assign an indicator value. It is considered more important to have instruments that are unique in their measurements. Low correlation with another instrument results in a high indicator value.	Measured Value
Length of Record	The indicator value is based on how long the instrument has been operating. A longer history is considered of greater importance to tracking trends and thus is more meaningful for air monitoring. Instruments with the longest record receive a higher indicator value.	Historic
Required Monitor	This is a simple yes or no indicator. If an instrument is required, it receives the highest indicator value.	Regulatory
Distance from Phoenix	Using the travel distance from Phoenix, instruments are assigned an indicator value from closest to furthest. It is considered more economical to operate instruments that are closest to ADEQ's center of operation. The closest monitoring receives the highest indicator value.	Cost Analysis
Parameters Monitored	Using the number of individual instruments at a given site, an indicator value is assigned. It is considered more economical to operate instruments at the same site as other instruments. Instrument located at sites with the most number of instruments results in high indicator value.	Cost Analysis

Each indicator uses publically available data and produces an indicator value that is unique to the different instruments. As shown, the indicators represent a wide range of air monitoring considerations, but it is not assumed that each indicator is as important a consideration as another. For this reason, the indicators values are weighed according to their importance. In order to establish weights for the indicators, a survey was conducted and given to air quality professionals at ADEQ. The survey asked the participants to place a value of the indicators. By doing this, some indicators are more heavily weighed than others. The results of the survey were placed on the Indicator Values and a new Weighted Indicator Value was produced. Using the Weighted Indicator Values, the monitoring networks are ranked by averaging the all the values and the highest average value being the most important instrument in the network. The results for the Ranking Analysis are found in Section I (J) page 35. The Final Conclusions and Recommendations (Section III page 80) then uses these rankings to determine the adequacy of ADEQ's current monitoring network in Arizona.

NOTE: Due to the small number of monitors in ADEQ's Pb, CO, and NO_2 networks, they are not analyzed in the Ranking Analysis. ADEQ only operates three Pb sites, one CO site, and two NO_2 sites. These networks will be analyzed in Section II page 40. The remaining pollutant networks (SO_2, O_3, PM_{10}, and $PM_{2.5}$) are included in the Ranking Analysis.

A. Measured Concentrations

This indicator assesses monitors based on the concentrations that are measured. The highest valued instrument has the highest average design value over the past five years. Instruments are given an indicator value on a 0-10 scale, with the monitor that has the lowest average design value receiving a value of 0, and the highest receiving a value of 10. Design values were taken from EPA's AQS database for the years 2009-2013 and were averaged.

It is assumed that instruments that measure higher concentrations are more important for the NAAQS, permitted sources, and regulatory compliance because these instruments already have or have the potential to exceed the standard. This indicator does not take into account monitors being used for reasons other than NAAQS compliance. Background, informational, and research oriented monitors provide valuable data to be used for trends and new source permit analysis and may not have high design values.

NOTE: PM_{10} values used in this indicator are the not the design values. The design value for PM_{10} is the number of exceedances over a three-year period. This results in a design value that does not represent actual ambient concentrations. Therefore, the highest annual PM_{10} value for each year is used in place of the design value for this and subsequent indicators.

1. Results

Results for the Measured Concentrations indicator are given by pollutant. The highest 2009-2013 average is assigned an indicator value of 10 and the lowest a 0. All instruments are assigned a value relative to these highest and lowest values.

Table 2: SO_2 Instruments by Highest Design Value

AQS ID Site Name		Design Value (99th Percentile of 1-hour Maximum Concentration, Averaged over 3 years in ppb)						Indicator Value
		2009	2010	2011	2012	2013	Average 2009-2013	
04-007-0009	Miami Ridgeline	113	123	96	102	117	110.2	**3.84**
04-007-0011	Miami Jones Ranch	N/A	N/A	N/A	N/A	148	148	**5.24**
04-007-0012	Miami Townsite	N/A	N/A	N/A	N/A	117	117	**4.09**
04-007-1001	Hayden Old Jail	274	314	189	353	256	277.2	**10.00**
04-012-8000	Alamo Lake	N/A	N/A	N/A	N/A	N/A	N/A	**N/A***
04-013-9997	JLG Supersite	7	6	5	6.1	5.5	5.92	**0.00**

*Alamo Lake began operation in 2014 and has not operated long enough to have a valid DV

Table 3: O_3 Instruments by Highest Design Value

AQS ID Site Name		Design Value (Annual 4th-highest daily Maximum 8-hour Concentration, Averaged over 3 years in ppb)						Indicator Value
		2009	2010	2011	2012	2013	Average 2009-2013	
04-005-1008	Flagstaff Middle School	66	68	68	72	69	68.6	**1.52**
04-007-0010	Tonto National Monument	72	70	76	78	72	73.6	**6.96**
04-012-8000	Alamo Lake	69	71	72	75	71	71.6	**4.78**
04-013-9997	JLG Supersite	73	76	78	76	79	76.4	**10.00**
04-021-8001	Queen Valley	70	72	78	78	76	74.2	**7.61**
04-025-8033	Prescott College AQD	62	67	70	72	65	67.2	**0.00**
04-027-8011	Yuma Supersite	68	76	76	80	73	74.6	8.04

Table 4: PM$_{10}$ Instruments by Highest Design Value

AQS ID Site Name		Design Value (Highest Annual Value in µg/m^3) 2009	2010	2011	2012	2013	Average 2009-2013	Indicator Value
04-003-0011	Paul Spur Chemical Lime Plant	49	46	85	194	165	107.8	**2.35**
04-003-1005	Douglas Red Cross	97	83	138	71	251	128.0	**3.10**
04-007-0008	Payson	40	42	39	44	58	44.6	**0.00**
04-007-1001	Hayden Old Jail	225	135	210	250	407	245.4	**7.46**
04-007-8000	Miami Golf Course	N/A	N/A	N/A	52	129	90.5	**1.71**
04-012-8000	Alamo Lake	N/A	N/A	N/A	N/A	N/A	N/A	**N/A***
04-013-9997	JLG Supersite	146	74	150	120	262	149.8	**3.91**
04-015-1003	Bullhead City	98	33	132	185	208	131.2	**3.22**
04-019-0001	Ajo	153	77	213	138	299	176.0	**4.88**
04-019-0020	Rillito	106	235	242	239	421	248.6	**7.58**
04-023-0004	Nogales Post Office (Continuous)	238	191	161	169	272	206.2	**6.00**
04-023-0004	Nogales Post Office (Filter)	123	96	126	102	89	107.2	**2.33**
04-027-8011	Yuma Supersite	306	124	225	274	640	313.8	**10.00**

*Alamo Lake began operation in 2013 and has not operated long enough to have a valid DV

Table 5: PM$_{2.5}$ Instruments by Highest Design Value

AQS ID Site Name		Design Value (98th Percentile of Annual Values, Averaged over 3 years in µg/m^3) 2009	2010	2011	2012	2013	Average 2009-2013	Indicator Value
04-003-1005	Douglas Red Cross	13.5	13.5	13.0	12.1	12.2	12.86	**0.00**
04-012-8000	Alamo Lake	N/A	N/A	N/A	N/A	N/A	N/A	**N/A***
04-013-9997	JLG Supersite (Continuous)	24.0	15.9	26.4	19.0	21.6	21.38	**5.51**
04-013-9997	JLG Supersite (Filter)	24.0	15.9	23.0	27.0	23.5	22.68	**6.35**
04-023-0004	Nogales Post Office (Continuous)	29.7	31.6	27.2	25.9	27.2	28.32	**10.00**
04-023-0004	Nogales Post Office (Primary Filter)	29.7	31.6	27.2	25.9	25.5	27.98	**9.78**
04-023-0004	Nogales Post Office (Secondary Filter)	29.2	32.5	26.2	15.7	18.2	24.36	**7.44**
04-027-8011	Yuma Supersite	15.4	13.5	15.6	15.8	17	15.46	**1.68**

*Alamo Lake began operation in 2013 and has not operated long enough to have a valid DV

B. Deviation from the NAAQS

This indicator assesses monitors based on the absolute deviation of measured concentrations from the NAAQS. The most important instrument in each network has the lowest deviation from the NAAQS using the average design value over the past five years. Each pollutant network is assessed on a 0-10 scale, with the instrument that is furthest from the standard receiving a value of 0, and the closest receiving a value of 10. Design values were taken from EPA's AQS database for the years 2009-2013 and averaged to obtain the final value.

It is assumed that monitors with measured concentrations that are closest to the NAAQS are most important to determine NAAQS compliance and have greater regulatory significance. The reasoning for this indicator is to identify monitors that could most easily be pushed into either attainment or nonattainment status. As with the measured concentration indicator, this indicator does not take into account monitors being used for reasons other than NAAQS compliance. Background, informational, and research oriented monitors provide valuable data to be used for trends and new source permit analysis and may not have high design values.

1. Results

Results for the Deviation from the NAAQS indicator are given by pollutant. The minimum deviation from the NAAQS using the 2009-2013 average is assigned an indicator value of 10 and the maximum a 0. All instruments are assigned a value relative to these highest and lowest values.

Table 6: SO_2 Instruments by Absolute Deviation from the NAAQS

AQS ID	Site Name	Design Value (99th Percentile of 1-hour Max Concentration, Averaged over 3 years in ppb)							Indicator Value
		2009	2010	2011	2012	2013	Average 2009-2013	Abs. Dev. from 75 ppb	
04-007-0009	Miami Ridgeline	113	123	96	102	117	110.2	35.2	**10.00**
04-007-0011	Miami Jones Ranch	N/A	N/A	N/A	N/A	148	148.0	73.0	**7.74**
04-007-0012	Miami Townsite	N/A	N/A	N/A	N/A	117	117.0	42.0	**9.59**
04-007-1001	Hayden Old Jail	274	314	189	353	256	277.2	202.2	**0.00**
04-012-8000	Alamo Lake	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A***
04-013-9997	JLG Supersite	7	6	5	6.1	5.5	5.92	69.08	**7.97**

*Alamo Lake began operation in 2014 and has not operated long enough to have a valid DV

Table 7: O_3 Instruments by Absolute Deviation from the NAAQS

AQS ID	Site Name	Design Value (Annual 4th-highest daily maximum 8-hour concentration, Averaged over 3 years in ppb)							Indicator Value
		2009	2010	2011	2012	2013	Average 2009-2013	Abs. Dev. from 75 ppb	
04-005-1008	Flagstaff Middle School	66	68	68	72	69	68.6	6.4	**1.89**
04-007-0010	Tonto National Monument	72	70	76	78	72	73.6	1.4	**8.65**
04-012-8000	Alamo Lake	69	71	72	75	71	71.6	3.4	**5.95**
04-013-9997	JLG Supersite	73	76	78	76	79	76.4	1.4	**8.65**
04-021-8001	Queen Valley	70	72	78	78	76	74.2	0.8	**9.46**
04-025-8033	Prescott College AQD	62	67	70	72	65	67.2	7.8	**0.00**
04-027-8011	Yuma Supersite	68	76	76	80	73	74.6	0.4	**10.00**

Table 8: PM_{10} Instruments by Absolute Deviation from the NAAQS

AQS ID	Site Name	Highest Annual Value in μg/m³ 2009	2010	2011	2012	2013	Average 2009-2013	Abs. Dev. from 150 μg/m³	Indicator Value
04-003-0011	Paul Spur Chemical Lime Plant	49	46	85	194	165	107.8	42.2	**7.43**
04-003-1005	Douglas Red Cross	97	83	138	71	251	128.0	22	**8.67**
04-007-0008	Payson	40	42	39	44	58	44.6	105.4	**3.57**
04-007-1001	Hayden Old Jail	225	135	210	250	407	245.4	95.4	**4.18**
04-007-8000	Miami Golf Course	N/A	N/A	N/A	52	129	90.5	59.5	**6.38**
04-012-8000	Alamo Lake	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A***
04-013-9997	JLG Supersite	146	74	150	120	262	149.8	0.2	**10.00**
04-015-1003	Bullhead City	98	33	132	185	208	131.2	18.8	**8.86**
04-019-0001	Ajo	153	77	213	138	299	176.0	26	**8.42**
04-019-0020	Rillito	106	235	242	239	421	248.6	98.6	**3.99**
04-023-0004	Nogales Post Office (Continuous)	238	191	161	169	272	206.2	56.2	**6.58**
04-023-0004	Nogales Post Office (Filter)	123	96	126	102	89	107.2	42.8	**7.40**
04-027-8011	Yuma Supersite	306	124	225	274	640	313.8	163.8	**0.00**

*Alamo Lake began operation in 2013 and has not operated long enough to have a valid DV

Table 9: $PM_{2.5}$ Instruments by Absolute Deviation from the NAAQS

AQS ID	Site Name	Design Value (98th Percentile of Annual Values, Averaged over 3 years in μg/m³) 2009	2010	2011	2012	2013	Average 2009-2013	Abs. Dev. from 35 μg/m³	Indicator Value
04-003-1005	Douglas Red Cross	13.5	13.5	13.0	12.1	12.2	12.86	22.14	**0.00**
04-012-8000	Alamo Lake	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A***
04-013-9997	JLG Supersite (Continuous)	24.0	15.9	26.4	19.0	21.6	21.38	13.62	**5.51**
04-013-9997	JLG Supersite (Filter)	24.0	15.9	23.0	27.0	23.5	22.68	6.68	**6.35**
04-023-0004	Nogales Post Office (Continuous)	29.7	31.6	27.2	25.9	27.2	28.32	19.54	**10.00**
04-023-0004	Nogales Post Office (Primary Filter)	29.7	31.6	27.2	25.9	25.5	27.98	7.02	**9.78**
04-023-0004	Nogales Post Office (Secondary Filter)	29.2	32.5	26.2	15.7	18.2	24.36	10.64	**7.44**
04-027-8011	Yuma Supersite	15.4	13.5	15.6	15.8	17	15.46	12.32	**1.68**

*Alamo Lake began operation in 2013 and has not operated long enough to have a valid DV

C. Area Served

This indicator assesses monitors based on the area of influence. All instruments in Arizona, including all state, local, and tribal monitors are used to show the instrument's area of representation. Theissen polygons are polygons that surround an instrument used to show its area of representation. These are drawn by locating the midway point between monitors and creating multisided polygons surrounding each monitor. The area in square-miles of each polygon is used to assess instruments on a 0-10 scale, with the monitor that has the largest area receiving a value of 10 and the smallest receiving a value of 0. Monitor location data were taken from EPA's AQS database.

It is assumed that monitors that cover the largest areas are of higher significance to air monitoring in Arizona because it represents the largest unique geographic area and are sampling a unique parcel of air. Instruments that are close together generally measure the same concentration, therefore it would be advantageous to operate an instrument that covers the largest area. Instruments on the edge of urban areas or background type monitors typically have a larger area of influence.

This indicator has disadvantages in that each pollutant cannot be represented over a very large area because of meteorology or topographic changes. Some polygons are so large that it shows a monitor having a representation of half the state. The monitors in these very large areas would not actually be representative of ambient concentrations in the entire area; therefore, this indicator is purely spatial in nature.

1. Results

Results for the Area Served indicator are given by pollutant. The maximum area served is assigned an indicator value of 10 and the minimum a 0. All instruments are assigned a value relative to these highest and lowest values.

Table 10: SO_2 Instruments by Area Served

AQS ID	Site Name	Area Served (sq-mi)	Indicator Value
04-007-0009	Miami Ridgeline	30484	**5.85**
04-007-0011	Miami Jones Ranch	323	**0.00**
04-007-0012	Miami Townsite	4321	**0.78**
04-007-1001	Hayden Old Jail	8770	**1.64**
04-012-8000	Alamo Lake	52064	**10.00**
04-013-9997	JLG Supersite	10483	**1.97**

Figure 2: SO_2 Thiessen Polygons

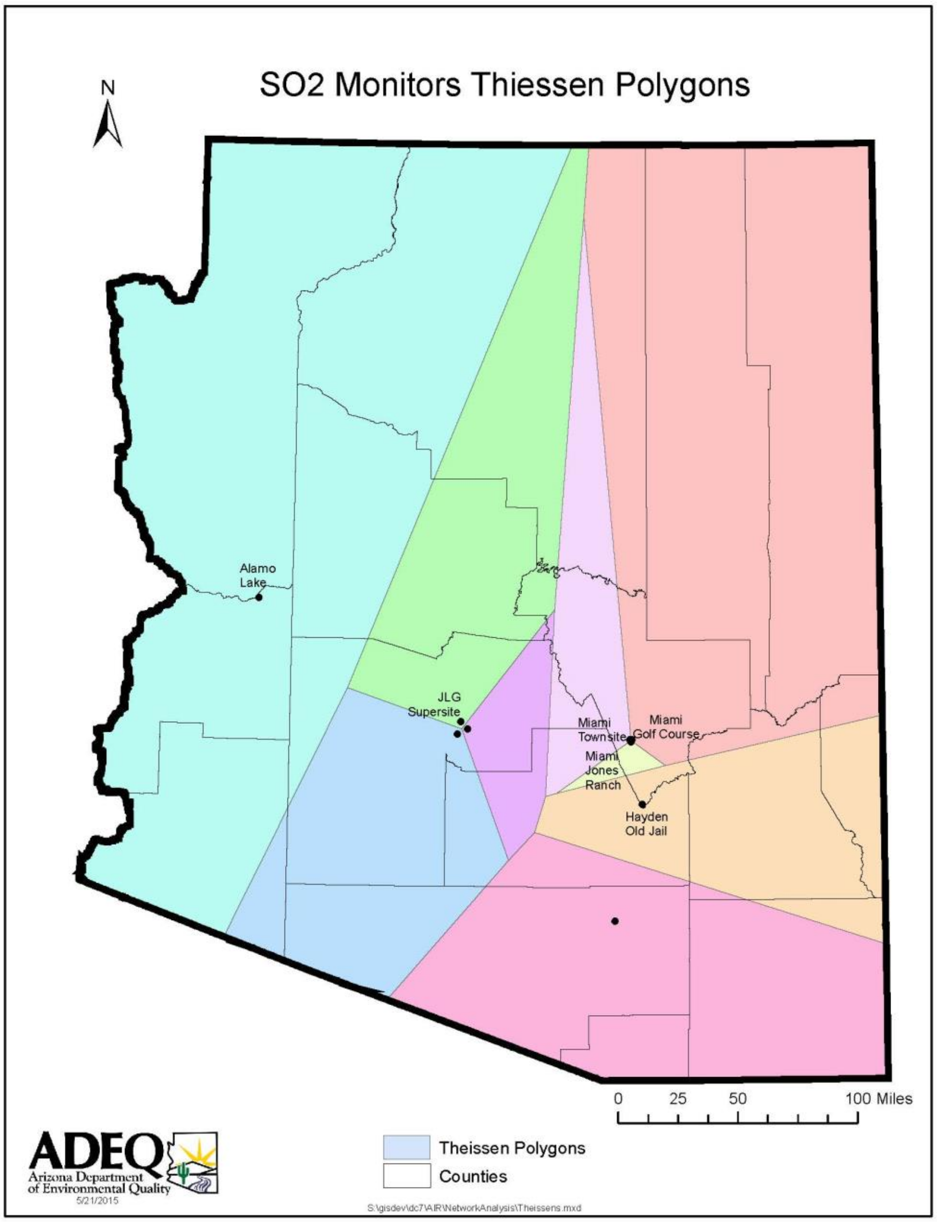


Table 11: O_3 Instruments by Area Served

AQS ID	Site Name	Area Served (sq-mi)	Indicator Value
04-005-1008	Flagstaff Middle School	8046	**4.32**
04-007-0010	Tonto National Monument	5578	**2.99**
04-012-8000	Alamo Lake	18609	**10.00**
04-013-9997	JLG Supersite	19	**0.00**
04-021-8001	Queen Valley	1583	**0.84**
04-025-8033	Prescott College AQD	5224	**2.80**
04-027-8011	Yuma Supersite	15384	**8.27**

Figure 3: O_3 Thiessen Polygons

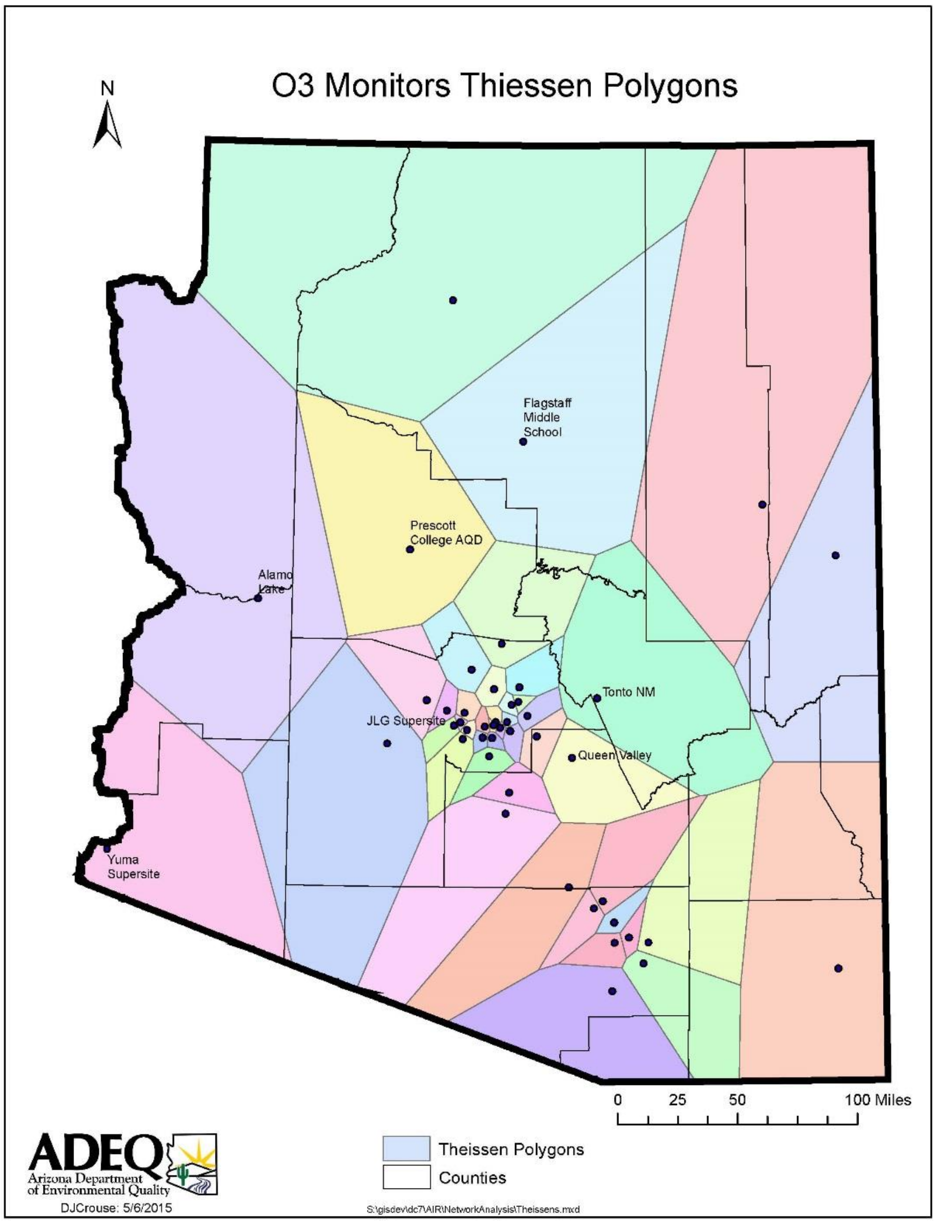


Table 12: PM_{10} Instruments by Area Served

AQS ID Site Name		Area Served (sq-mi)	Indicator Value
04-003-0011	Paul Spur Chemical Lime Plant	2468	**2.07**
04-003-1005	Douglas Red Cross	3748	**3.15**
04-007-0008	Payson	4419	**3.72**
04-007-1001	Hayden Old Jail	885	**0.73**
04-007-8000	Miami Golf Course	1650	**1.38**
04-012-8000	Alamo Lake	7886	**6.64**
04-013-9997	JLG Supersite	17	**0.00**
04-015-1003	Bullhead City	8963	**7.55**
04-019-0001	Ajo	10819	**9.12**
04-019-0020	Rillito	290	**0.23**
04-023-0004	Nogales Post Office (Continuous)	2126	**1.78**
04-023-0004	Nogales Post Office (Filter)	2126	**1.78**
04-027-8011	Yuma Supersite	11860	**10.00**

Figure 4: PM_{10} Thiessen Polygons

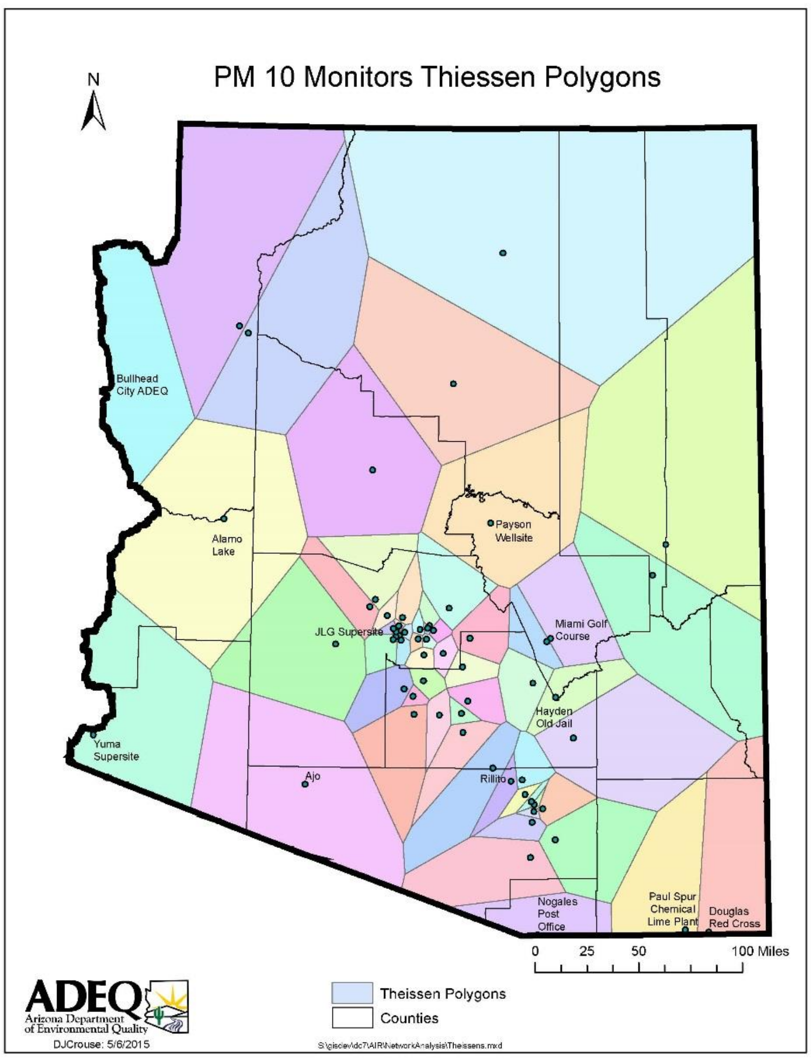
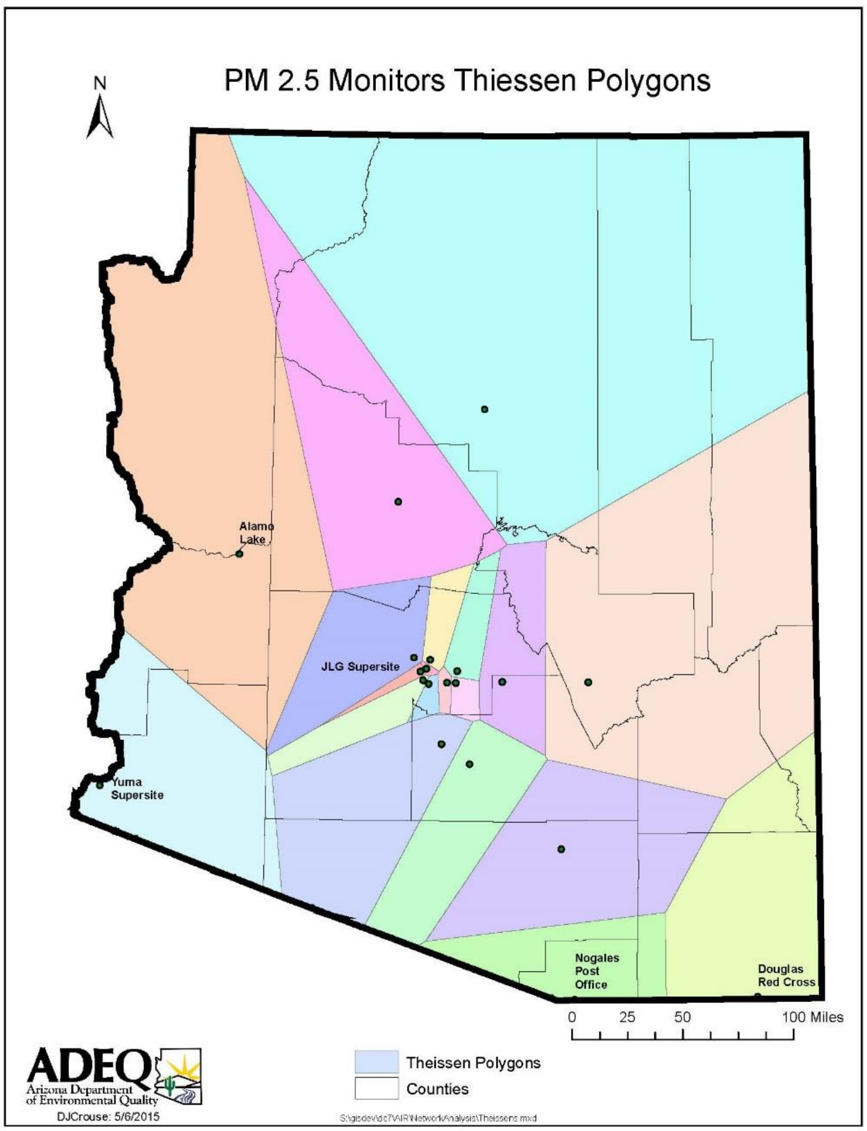


Table 13: $PM_{2.5}$ Instruments by Area Served

AQS ID	Site Name	Area Served (sq-mi)	Indicator Value
04-003-1005	Douglas Red Cross	7538	**3.01**
04-012-8000	Alamo Lake	24968	**10.00**
04-013-9997	JLG Supersite (Continuous)	30	**0.00**
04-013-9997	JLG Supersite (Filter)	30	**0.00**
04-023-0004	Nogales Post Office (Continuous)	4713	**1.88**
04-023-0004	Nogales Post Office (Primary Filter)	4713	**1.88**
04-023-0004	Nogales Post Office (Secondary Filter)	4713	**1.88**
04-027-8011	Yuma Supersite	16176	**6.47**

Figure 5: $PM_{2.5}$ Thiessen Polygons



D. Population Served

This indicator assesses instruments by the number of people that it represents. Instruments have a stated spatial scale related to their monitoring objectives and purposes, ranging from a few meters to global. EPA's spatial scales and distances are found in Table 14. The spatial scales of monitors are determined by ADEQ before installation and recorded in AQS and in the Network Plan. The EPA confirms the spatial scale. The spatial scale distances are effectively a radius of a circle in which the concentration readings are relatively uniform.

Using the spatial scale of each monitor, population data are laid over the spatial scale areas and the number of individuals in that area are counted to determine the population served. Population data are broken up into census blocks (small areas of population data). To calculate the population in the spatial scale area, total population data were superimposed with the spatial scale circle and then calculated in ArcGIS.

The population in each spatial scale circle is used to assess monitors on a 0-10 scale, with the monitor that has the greatest population receiving a value of 10 and the smallest receiving a value of 0. Population data are taken from the 2010 US Census.

It is assumed that a monitor that represents the largest population is of greatest significance. There are many advantages of using the spatial scale of each monitor to calculate the population served. Monitors are specifically sited to represent the area and population directly surrounding the site. The siting takes into account pollutant sources, roadways, topography, and meteorological considerations to represent the stated spatial scale. This indicator has disadvantages in that it does not take into account the specific purpose of each monitor (background, regional, source specific). Some instruments are not population oriented thus may not represent a large number of people. This is dealt with by only ranking the neighborhood scale type of monitors in each pollutant network as the neighborhood scale is population oriented.

NOTE: Since this indicator is population oriented, instruments whose purposes are not for population exposure bias the population results. ADEQ mainly monitors for population exposure using the neighborhood spatial scale. Since this scale is the predominate type for pollutant networks, the ranking values are based on these monitors. Regional scale monitors receive a ranking value of 10. Micro scale and middle scale monitors receive a ranking value of 0. Also, since JLG Supersite is located in a geographic, demographic, and urban anomaly compared to the rest of ADEQ's monitors, it also receives a ranking value of 10. All other monitors are ranked on a 0-10 scale.

Table 14: EPA Monitoring Spatial Scales

Type	Distance	Description
Micro	<100 meters	Defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters.
Middle	0.1-0.5 kilometers	Defines the concentration typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer.
Neighborhood	0.5-4.0 kilometers	Defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range. The neighborhood and urban scales listed below have the potential to overlap in applications that concern secondarily formed or homogeneously distributed air pollutants.
Urban	4.0-50.0 kilometers	Defines concentrations within an area of city-like dimensions, on the order of 4 to 50 kilometers. Within a city, the geographic placement of sources may result in there being no single site that can be said to represent air quality on an urban scale.
Regional	Tens to hundreds of kilometers*	Defines usually a rural area of reasonably homogeneous geography without large sources, and extends from tens to hundreds of kilometers.
National and Global	A whole nation or the entire globe	These measurement scales represent concentrations characterizing the nation and the globe as a whole.

*For purposes of this report, regional scale monitors use a radius of 100km

1. Results

Results for the Population Served indicator are given by pollutant. The maximum population served is assigned an indicator value of 10 and the minimum a 0. All instruments are assigned a value relative to these highest and lowest values. Removing the regional scale, middle scale, and JLG Supersite from the Indicator Value scale results in Yuma Supersite having the largest population served of 54,096 individuals.

Table 15: SO_2 Instruments by Population Served

AQS ID	Site Name	Spatial Scale	Population Served	Indicator Value
04-007-0009	Miami Ridgeline	Neighborhood	5,495	**0.84**
04-007-0011	Miami Jones Ranch	Neighborhood	3,797	**0.52**
04-007-0012	Miami Townsite	Neighborhood	3,791	**0.51**
04-007-1001	Hayden Old Jail	Neighborhood	1,060	**0.00**
04-012-8000	Alamo Lake	Regional	141,708	**10.00**
04-013-9997	JLG Supersite	Neighborhood	127,039	**10.00**

Table 16: O_3 Instruments by Population Served

AQS ID	Site Name	Spatial Scale	Population Served	Indicator Value
04-005-1008	Flagstaff Middle School	Neighborhood	41,273	**7.58**
04-007-0010	Tonto National Monument	Regional	4,450,878	**10.00**
04-012-8000	Alamo Lake	Regional	141,708	**10.00**
04-013-9997	JLG Supersite	Neighborhood	127,039	**10.00**
04-021-8001	Queen Valley	Regional	5,533,563	**10.00**
04-025-8033	Prescott College AQD	Neighborhood	29,765	**5.41**
04-027-8011	Yuma Supersite	Neighborhood	54,096	**10.00**

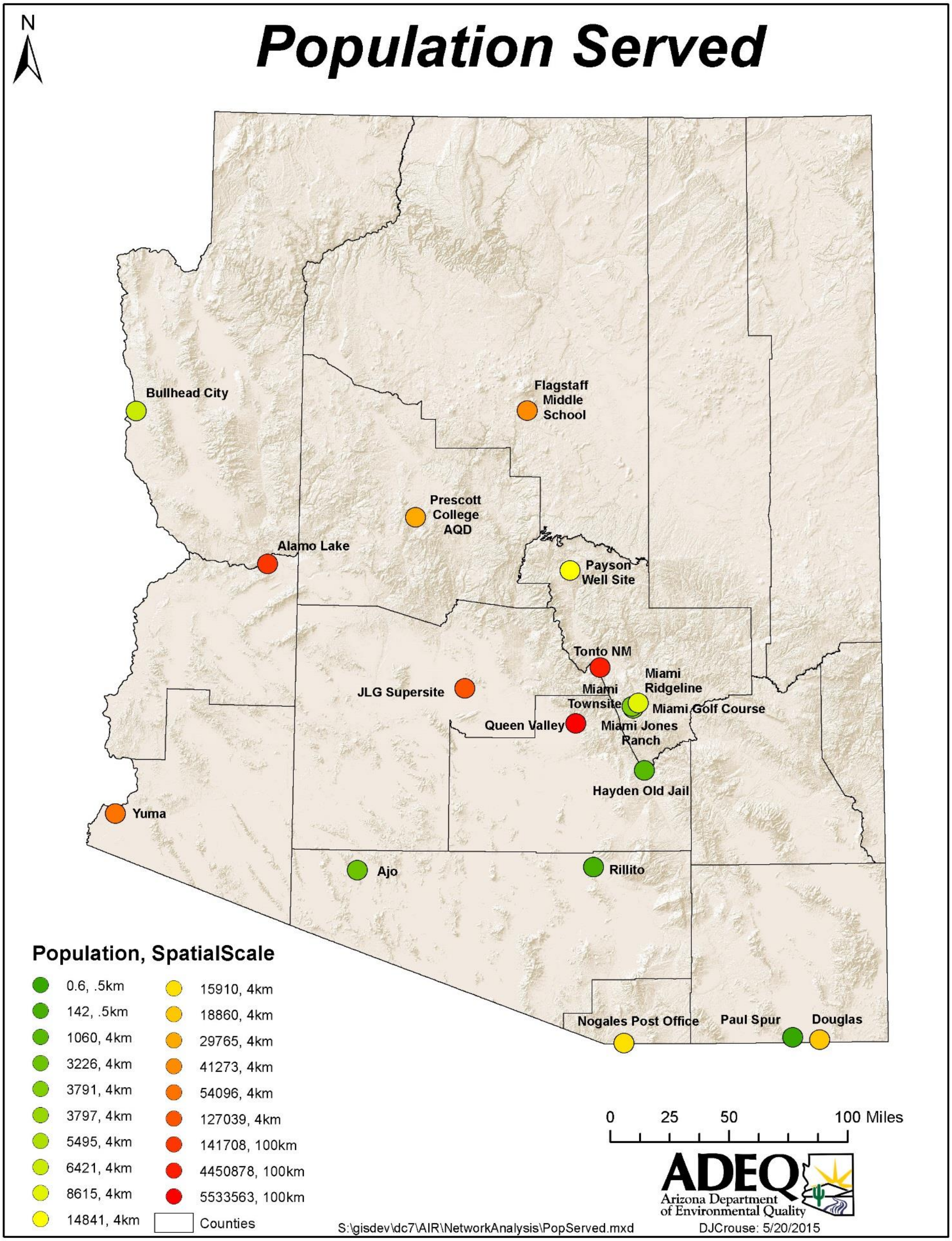
Table 17: PM_{10} Instruments by Population Served

AQS ID	Site Name	Spatial Scale	Population Served	Indicator Value
04-003-0011	Paul Spur Chemical Lime Plant	Middle	0.6	**0.00**
04-003-1005	Douglas Red Cross	Neighborhood	18,860	**3.36**
04-007-0008	Payson	Neighborhood	14,841	**2.60**
04-007-1001	Hayden Old Jail	Neighborhood	1,060	**0.00**
04-007-8000	Miami Golf Course	Neighborhood	8,615	**1.42**
04-012-8000	Alamo Lake	Regional	141,708	**10.00**
04-013-9997	JLG Supersite	Neighborhood	127,039	**10.00**
04-015-1003	Bullhead City	Neighborhood	6,421	**1.01**
04-019-0001	Ajo	Neighborhood	3,226	**0.41**
04-019-0020	Rillito	Middle	142	**0.00**
04-023-0004	Nogales Post Office (Continuous)	Neighborhood	15,910	**2.80**
04-023-0004	Nogales Post Office (Filter)	Neighborhood	15,910	**2.80**
04-027-8011	Yuma Supersite	Neighborhood	54,096	**10.00**

Table 18: $PM_{2.5}$ Instruments by Population Served

AQS ID Site Name		Spatial Scale	Population Served	Indicator Value
04-003-1005	Douglas Red Cross	Neighborhood	18,860	**3.36**
04-012-8000	Alamo Lake	Regional	141,708	**10.00**
04-013-9997	JLG Supersite (Continuous)	Neighborhood	127,039	**10.00**
04-013-9997	JLG Supersite (Filter)	Neighborhood	127,039	**10.00**
04-023-0004	Nogales Post Office (Continuous)	Neighborhood	15,910	**2.80**
04-023-0004	Nogales Post Office (Primary Filter)	Neighborhood	15,910	**2.80**
04-023-0004	Nogales Post Office (Secondary Filter)	Neighborhood	15,910	**2.80**
04-027-8011	Yuma Supersite	Neighborhood	54,096	**10.00**

Figure 6: Population Served by Site



E. Correlation Between Monitors

This indicator assesses instruments based on how well each monitor correlates with other monitors. The correlation used is Pearson's R^2 or coefficient of determination and it is a measure of linear correlation between two data sets, giving a value between 0.0 and 1.0. The maximum correlation for every instrument is used by this indicator to assess an instrument's statistical uniqueness. The highest assessed instrument in each network has the lowest correlation from other instruments over the past five years (2009-2013). Each pollutant network is assessed on a 0-10 scale, with the monitor that correlates best receiving a value of 0, and the most unique instrument receiving a value of 10.

Daily average concentration data were taken from EPA's AQS database for the years 2009-2013 and averaged into monthly means. Monthly means were chosen to determine if sites on a large scale are similar to one other. All monitors in the pollutant networks in Arizona were used to determine correlation for each of ADEQ's monitors. Data were used from Maricopa County Air Quality Department (MCAQD), Pinal County Air Quality Control District (PCAQD), Pima County Department of Environmental County (PDEQ), tribal monitors, and the National Park Service and taken from EPA's AQS database.

It is assumed that monitors that are most different from other monitors are most important because they may have a unique data set that is not represented elsewhere. If monitors correlate well with each other, then they may be monitoring the same pollutant sources and in the same area. This would be beneficial to determine which monitors are suitable for removal/relocation.

This indicator has disadvantages in that it does not take into account the requirements for collocation of monitors. The purpose of a collocated monitor is to ensure that there is good correlation; therefore, in these circumstances it would be advantageous to have monitors that correlate well.

1. Results

Results for the Correlation Between Monitors indicator are given by pollutant. The least correlated instrument is assigned an indicator value of 10 and the most a 0. All instruments are assigned a value relative to these highest and lowest values.

Table 19: SO_2 Instruments by Correlation Between Monitors

AQS ID	Site Name	Maximum Correlation	Highest Correlated Instrument	Indicator Value
04-007-0009	Miami Ridgeline	0.771	Miami Townsite	**0.00**
04-007-0011	Miami Jones Ranch	0.670	Miami Ridgeline	**1.62**
04-007-0012	Miami Townsite	0.771	Miami Ridgeline	**0.00**
04-007-1001	Hayden Old Jail	0.152	Children's Park NCore	**10.00**
04-012-8000	Alamo Lake	N/A	N/A	**N/A***
04-013-9997	JLG Supersite	0.590	Miami Jones Ranch	**2.91**

*Alamo Lake began operation in 2014 and has not operated long for the correlation

Table 20: O_3 Instruments by Correlation Between Monitors

AQS ID	Site Name	Maximum Correlation	Highest Correlated Instrument	Indicator Value
04-005-1008	Flagstaff Middle School	0.925	Prescott College AQD	**6.17**
04-007-0010	Tonto National Monument	0.938	Queen Valley	**4.81**
04-012-8000	Alamo Lake	0.932	Prescott College	**5.49**
04-013-9997	JLG Supersite	0.987	West Phoenix	**0.00**
04-021-8001	Queen Valley	0.940	Saguaro Park	**4.69**
04-025-8033	Prescott College AQD	0.932	Alamo Lake	**5.49**
04-027-8011	Yuma Supersite	0.886	Alamo Lake	**10.00**

Note: All of the O_3 monitors correlate very well with each other, all having a minimum correlation coefficient of 0.886. This indicates that O_3 is a regional issue and not a microscale problem.

Table 21: PM_{10} Instruments by Correlation Between Monitors

AQS ID	Site Name	Maximum Correlation	Highest Correlated Instrument	Indicator Value
04-003-0011	Paul Spur Chemical Lime Plant	0.424	Douglas Red Cross	**7.55**
04-003-1005	Douglas Red Cross	0.424	Paul Spur Chem Lime Plant	**7.56**
04-007-0008	Payson	0.277	Prince Road	**10.00**
04-007-1001	Hayden Old Jail	0.551	Green Valley	**5.45**
04-007-8000	Miami Golf Course	0.488	Hayden Old Jail	**6.50**
04-012-8000	Alamo Lake	N/A	N/A	**N/A***
04-013-9997	JLG Supersite	0.880	Central Phoenix	**0.00**
04-015-1003	Bullhead City	0.468	Durango Complex	**6.83**
04-019-0001	Ajo	0.516	Central Phoenix	**6.02**
04-019-0020	Rillito	0.519	Green Valley	**5.99**
04-023-0004	Nogales Post Office (Continuous)	0.697	Nogales Post Office (Filter)	**3.03**
04-023-0004	Nogales Post Office (Filter)	0.697	Nogales Post Office (Continuous)	**3.03**
04-027-8011	Yuma Supersite	0.423	Bullhead City	**7.57**

*Alamo Lake began operation in 2013 and has not operated long for the correlation

Table 22: $PM_{2.5}$ Instruments by Correlation Between Monitors

AQS ID	Site Name	Maximum Correlation	Highest Correlated Instrument	Indicator Value
04-003-1005	Douglas Red Cross	0.208	Yuma Supersite	**10**
04-012-8000	Alamo Lake	N/A	N/A	**N/A***
04-013-9997	JLG Supersite (Continuous)	0.840	Nogales Post Office (Continuous)	**1.63**
04-013-9997	JLG Supersite (Filter)	0.839	West Phoenix	**1.65**
04-023-0004	Nogales Post Office (Continuous)	0.945	Nogales Post Office (Primary Filter)	**0.25**
04-023-0004	Nogales Post Office (Primary Filter)	0.964	Nogales Post Office (Secondary Filter)	**0.00**
04-023-0004	Nogales Post Office (Secondary Filter)	0.964	Nogales Post Office (Primary Filter)	**0.00**
04-027-8011	Yuma Supersite	0.303	Cowtown	**8.74**

*Alamo Lake began operation in 2013 and has not operated long for the correlation

F. Length of Record

The length of record indicator values instruments based on their length of record. Greater length of record provides valuable trends data that new monitors do not have. It is assumed that monitors with the longest record are most valuable, and are ranked the highest in each network. The number of monitoring years for this ranking are taken from the number of continuous years of operation for every instrument. If there is a collocated monitor at a site, then the separate monitors have different time periods in order to more accurately rank them against each other. Pollutant networks are assessed on a 0-10 scale, with the monitor that has the shortest record receiving a value of 0, and the longest receiving a value of 10.

It is assumed that a monitor has greater regulatory and research significance if it has been operating in the same location for a longer period of time and therefore long term trends can be produced with greater confidence. Having a long trend record helps support achievement of the standard in nonattainment areas and also aids in air quality related research by providing a larger and more accurate dataset.

This indicator has disadvantages in that it tracks the trends of individual monitors when sites are collocated rather than the primary instrument. For example in Nogales, the primary $PM_{2.5}$ instrument has recently been upgraded, but the secondary instrument has been in operation for many more years. This indicator values the instrument that has been in operation for longer. Also, due to constant advances in technology, it is more advantageous to have a newer instrument rather than older ones. Newer monitors can also give continuous data on an hourly or even minute basis as opposed to a daily basis. These newer monitors have a shorter time period and thus are ranked lower.

1. Results

Results for the Length of Record indicator are given by pollutant. The longest record instrument is assigned an indicator value of 10 and the shortest a 0. All instruments are assigned a value relative to these highest and lowest values.

Table 23: SO_2 Instruments by Length of Record

AQS ID Site Name		Length of Record (Years)	Indicator Value
04-007-0009	Miami Ridgeline	20	**5.00**
04-007-0011	Miami Jones Ranch	2	**0.50**
04-007-0012	Miami Townsite	2	**0.50**
04-007-1001	Hayden Old Jail	40	**10**
04-012-8000	Alamo Lake	1	**0.25**
04-013-9997	JLG Supersite	10	**2.50**

Table 24: O_3 Instruments by Length of Record

AQS ID Site Name		Length of Record (Years)	Indicator Value
04-005-1008	Flagstaff Middle School	7	**3.18**
04-007-0010	Tonto National Monument	13	**5.91**
04-012-8000	Alamo Lake	10	**4.55**
04-013-9997	JLG Supersite	22	**10**
04-021-8001	Queen Valley	17	**7.73**
04-025-8033	Prescott College AQD	7	**3.18**
04-027-8011	Yuma Supersite	7	**3.18**

Table 25: PM_{10} Instruments by Length of Record

AQS ID	Site Name	Length of Record (Years)	Indicator Value
04-003-0011	Paul Spur Chemical Lime Plant	24	**7.06**
04-003-1005	Douglas Red Cross	17	**5.00**
04-007-0008	Payson	24	**7.06**
04-007-1001	Hayden Old Jail	34	**10.00**
04-007-8000	Miami Golf Course	3	**0.88**
04-012-8000	Alamo Lake	2	**0.59**
04-013-9997	JLG Supersite	22	**6.47**
04-015-1003	Bullhead City	18	**5.29**
04-019-0001	Ajo	24	**7.06**
04-019-0020	Rillito	30	**8.82**
04-023-0004	Nogales Post Office (Continuous)	12	**3.53**
04-023-0004	Nogales Post Office (Filter)	28	**8.24**
04-027-8011	Yuma Supersite	6	**1.76**

Table 26: $PM_{2.5}$ Instruments by Length of Record

AQS ID	Site Name	Length of Record (Years)	Indicator Value
04-003-1005	Douglas Red Cross	15	**9.38**
04-012-8000	Alamo Lake	2	**1.25**
04-013-9997	JLG Supersite (Continuous)	4	**2.50**
04-013-9997	JLG Supersite (Filter)	16	**10.00**
04-023-0004	Nogales Post Office (Continuous)	2	**1.25**
04-023-0004	Nogales Post Office (Primary Filter)	16	**10.00**
04-023-0004	Nogales Post Office (Secondary Filter)	16	**10.00**
04-027-8011	Yuma Supersite	5	**3.13**

G. Required Monitor

The required monitor indicator is a regulatory type indicator and is a simple yes or no. Regulations in 40 CFR Part 58 Appendix D contain minimum monitoring requirements per Metropolitan Statistical Area (MSA). Some pollutant networks require minimum monitoring based on populations, pollutant concentrations, or source emissions. Any additionally required instrument are subject to the EPA regional administrator and therefore the number of required instruments in an area may be more or less than what is stated in the CFR. If a monitor is required under minimum monitoring requirements in the CFR or by the regional administrator, it receives the highest value of 10; if it is not required, it receives a value of 0.

It is assumed that it is more important to have a monitor that is required by EPA. The minimum requirements for monitoring were created to set the standard needed for monitoring for any given situation. This indicator has disadvantages in that it does not take into account the full breadth of monitoring needed to fully characterize a unique area's ambient air quality.

1. Results

Results for the Required Monitor indicator are given by pollutant. The required monitors are assigned an indicator value of 10 and the non-required a 0.

Table 27: SO_2 Instruments by Required Monitor

AQS ID Site Name		Required Monitor?	Indicator Value
04-007-0009	Miami Ridgeline	Yes	**10**
04-007-0011	Miami Jones Ranch	Yes	**10**
04-007-0012	Miami Townsite	Yes	**10**
04-007-1001	Hayden Old Jail	Yes	**10**
04-012-8000	Alamo Lake	No	**0**
04-013-9997	JLG Supersite	Yes	**10**

Table 28: O_3 Instruments by Required Monitor

AQS ID Site Name		Required Monitor?	Indicator Value
04-005-1008	Flagstaff Middle School	Yes	**10**
04-007-0010	Tonto National Monument	Yes	**10**
04-012-8000	Alamo Lake	Yes	**10**
04-013-9997	JLG Supersite	Yes	**10**
04-021-8001	Queen Valley	Yes	**10**
04-025-8033	Prescott College AQD	Yes	**10**
04-027-8011	Yuma Supersite	Yes	**10**

Table 29: PM_{10} Instruments by Required Monitor

AQS ID Site Name		Required Monitor?	Indicator Value
04-003-0011	Paul Spur Chemical Lime Plant	Yes	**10**
04-003-1005	Douglas Red Cross	Yes	**10**
04-007-0008	Payson	Yes	**10**
04-007-1001	Hayden Old Jail	Yes	**10**
04-007-8000	Miami Golf Course	Yes	**10**
04-012-8000	Alamo Lake	Yes	**10**
04-013-9997	JLG Supersite	Yes	**10**
04-015-1003	Bullhead City	Yes	**10**
04-019-0001	Ajo	Yes	**10**
04-019-0020	Rillito	Yes	**10**
04-023-0004	Nogales Post Office (Continuous)	Yes	**10**
04-023-0004	Nogales Post Office (Filter)	No	**0**
04-027-8011	Yuma Supersite	Yes	**10**

Table 30: $PM_{2.5}$ Instruments by Required Monitor

AQS ID Site Name		Required Monitor?	Indicator Value
04-003-1005	Douglas Red Cross	Yes	**10**
04-012-8000	Alamo Lake	Yes	**10**
04-013-9997	JLG Supersite (Continuous)	Yes	**10**
04-013-9997	JLG Supersite (Filter)	Yes	**10**
04-023-0004	Nogales Post Office (Continuous)	Yes	**10**
04-023-0004	Nogales Post Office (Primary Filter)	Yes	**10**
04-023-0004	Nogales Post Office (Secondary Filter)	No	**0**
04-027-8011	Yuma Supersite	Yes	**10**

H. Distance from Phoenix

The distance from Phoenix indicator is a cost based indicator which uses the road distance between the ADEQ's Phoenix main office and each site location. All instruments in ADEQ's pollutant networks are assessed against each other on a scale of 0-10, with the monitor furthest away from Phoenix receiving a value of 0, and the closest a value of 10.

It is assumed that it is more economically viable to operate sites that are closer to the Phoenix main office because air monitoring operations are based in Phoenix. As part of the data quality management, required quality control checks on instruments are made frequently on monitors. Travel to the sites is a required component of operations, and all travel costs (vehicle mileage, fuel, staff time) are the consideration for this indicator.

This indicator has disadvantages in that it does not take into account the need and desire of ADEQ to enhance the public health in all of Arizona. It can be interpreted as favoring those that live in the greater Phoenix metropolitan area, but this indicator is purely economic in nature and ADEQ does not support favoring any population over another. This indicator also does not take into account the possibility of combining trips when maintaining and performing quality control checks at each site.

1. Results

Results for the Distance from Phoenix indicator are given by pollutant. The minimum distance from ADEQ is assigned an indicator value of 10 and the maximum a 0. All instruments are assigned a value relative to these highest and lowest values.

Table 31: SO_2 Instruments by Distance from Phoenix

AQS ID	Site Name	Distance in Miles	Indicator Value
04-007-0009	Miami Ridgeline	82	**6.73**
04-007-0011	Miami Jones Ranch	82	**6.73**
04-007-0012	Miami Townsite	82	**6.73**
04-007-1001	Hayden Old Jail	95	**6.22**
04-012-8000	Alamo Lake	134	**4.66**
04-013-9997	JLG Supersite	5	**9.80**

Table 32: O_3 Instruments by Distance from Phoenix

AQS ID	Site Name	Distance in Miles	Indicator Value
04-005-1008	Flagstaff Middle School	152	**3.94**
04-007-0010	Tonto National Monument	109	**5.66**
04-012-8000	Alamo Lake	134	**4.66**
04-013-9997	JLG Supersite	5	**9.80**
04-021-8001	Queen Valley	56	**7.77**
04-025-8033	Prescott College AQD	99	**6.06**
04-027-8011	Yuma Supersite	184	**2.67**

Table 33: PM_{10} Instruments by Distance from Phoenix

AQS ID	Site Name	Distance in Miles	Indicator Value
04-003-0011	Paul Spur Chemical Lime Plant	234	**0.68**
04-003-1005	Douglas Red Cross	234	**0.68**
04-007-0008	Payson	89	**6.45**
04-007-1001	Hayden Old Jail	95	**6.22**
04-007-8000	Miami Golf Course	82	**6.73**
04-012-8000	Alamo Lake	134	**4.66**
04-013-9997	JLG Supersite	5	**9.80**
04-015-1003	Bullhead City	251	**0.00**
04-019-0001	Ajo	111	**5.58**
04-019-0020	Rillito	97	**6.14**
04-023-0004	Nogales Post Office (Continuous)	179	**2.87**
04-023-0004	Nogales Post Office (Filter)	179	**2.87**
04-027-8011	Yuma Supersite	184	**2.67**

Table 34: $PM_{2.5}$ Instruments by Distance from Phoenix

AQS ID	Site Name	Distance in Miles	Indicator Value
04-003-1005	Douglas Red Cross	234	**0.68**
04-012-8000	Alamo Lake	134	**4.66**
04-013-9997	JLG Supersite (Continuous)	5	**9.80**
04-013-9997	JLG Supersite (Filter)	5	**9.80**
04-023-0004	Nogales Post Office (Continuous)	179	**2.87**
04-023-0004	Nogales Post Office (Primary Filter)	179	**2.87**
04-023-0004	Nogales Post Office (Secondary Filter)	179	**2.87**
04-027-8011	Yuma Supersite	184	**2.67**

I. Parameters Monitored

The number of parameters monitored indicator is a cost based indicator that uses data from the Air Monitoring Network Plan, which contains the number of parameters at each site. A parameter is defined as a physical piece of equipment which gives a unique set of measured data. This is different than counting the number criteria pollutant instruments as a site has other non-criteria parameters such as shelter temperature or wind speed. The site having the most parameters monitored receives a value of 10, and the least a value of 0.

It is assumed that it is more economically viable to operate sites with more monitored parameters. It is more economical to operate because utilizing existing infrastructure, consolidating site trips, and combining utilities are all ways to have a more cost-effective monitoring network. This indicator has disadvantages in that it does not take into account the need for optimizing a network based on unique sources and populations. If a new monitor were placed at a site solely because that site has many parameters, it may not be in the correct location to accurately represent the purpose of the monitor. If the purpose of an instrument is to monitor a specific source or population, then it would better to place the monitor on its own.

NOTE: Since JLG supersite has more than twice the number of parameters as any other site and would unfairly bias the rankings, only the seven criteria pollutants are counted at that site. By counting only the criteria parameters, it still is the highest valued site with 8 parameters.

1. Results

Results for the Parameters Monitored indicator are given by pollutant. The maximum number of instruments at a site is assigned an indicator value of 10 and the minimum a 0. All instruments are assigned a value relative to these highest and lowest values.

Table 35: SO_2 Instruments by Parameters Monitored

AQS ID Site Name		Total Parameters Monitored	Indicator Value
04-007-0009	Miami Ridgeline	1	**1.25**
04-007-0011	Miami Jones Ranch	1	**1.25**
04-007-0012	Miami Townsite	1	**1.25**
04-007-1001	Hayden Old Jail	4	**5.00**
04-012-8000	Alamo Lake	7	**8.75**
04-013-9997	JLG Supersite	8	**10.00**

Table 36: O_3 Instruments by Parameters Monitored

AQS ID Site Name		Total Parameters Monitored	Indicator Value
04-005-1008	Flagstaff Middle School	2	**2.50**
04-007-0010	Tonto National Monument	2	**2.50**
04-012-8000	Alamo Lake	7	**8.75**
04-013-9997	JLG Supersite	8	**10.00**
04-021-8001	Queen Valley	6	**7.50**
04-025-8033	Prescott College AQD	2	**2.50**
04-027-8011	Yuma Supersite	5	**6.25**

Table 37: PM_{10} Instruments by Parameters Monitored

AQS ID	Site Name	Total Parameters Monitored	Indicator Value
04-003-0011	Paul Spur Chemical Lime Plant	3	**3.75**
04-003-1005	Douglas Red Cross	5	**6.25**
04-007-0008	Payson	4	**5.00**
04-007-1001	Hayden Old Jail	4	**5.00**
04-007-8000	Miami Golf Course	4	**5.00**
04-012-8000	Alamo Lake	7	**8.75**
04-013-9997	JLG Supersite	8	**10.00**
04-015-1003	Bullhead City	1	**1.25**
04-019-0001	Ajo	3	**3.75**
04-019-0020	Rillito	3	**3.75**
04-023-0004	Nogales Post Office (Continuous)	7	**8.75**
04-023-0004	Nogales Post Office (Filter)	7	**8.75**
04-027-8011	Yuma Supersite	5	**6.25**

Table 38: $PM_{2.5}$ Instruments by Parameters Monitored

AQS ID	Site Name	Total Parameters Monitored	Indicator Value
04-003-1005	Douglas Red Cross	5	**6.25**
04-012-8000	Alamo Lake	7	**8.75**
04-013-9997	JLG Supersite (Continuous)	8	**10.00**
04-013-9997	JLG Supersite (Filter)	8	**10.00**
04-023-0004	Nogales Post Office (Continuous)	7	**8.75**
04-023-0004	Nogales Post Office (Primary Filter)	7	**8.75**
04-023-0004	Nogales Post Office (Secondary Filter)	7	**8.75**
04-027-8011	Yuma Supersite	5	**6.25**

J. Final Rankings

The final rankings combines all the indicators in the Ranking Analysis and ranks the instruments by averaging the indicator values. The highest indicator value average is the highest ranked instrument in the network and is therefore the most meaningful and important. The lowest ranked instrument could be considered for relocation or removal if possible. Recommendations for possible relocation, removal, or addition of monitors are in Section III page 80 of this assessment.

Indicator values from each of the previous indicator sections are then individually weighted and averaged to get a final ranking. Results are shown both weighted and un-weighted. Weighing the indicators is necessary because it is not assumed that all the indicators have the same importance to the public welfare, regulatory actions, and to ambient air monitoring in Arizona. For example, the measured concentration indicator is considered to be of higher importance and has more meaning than the Distance from Phoenix indicator. Both indicators are considerations when running an air monitoring network, but operating an instrument that has higher concentrations is of higher significance than how far that instrument is from Phoenix.

Weights were derived from a survey given to ADEQ's Air Quality Division staff and others in Arizona's air monitoring community. The survey was conducted by asking each individual to rate the significance of each indicator listed in Section I page 10. A total of 35 surveys were collected from ADEQ staff, project leaders, and management. Surveys were then averaged to determine a final weight for each indicator. The survey asked participants to rate the indicators on a scale from 0-200%. If an indicator had regular importance, it was given a 100% rating. Indicators with lower importance were rated lower than 100% and higher importance were rated higher than 100%. The survey results were averaged and the resultant percentage was multiplied to the indicator values. The results from the survey are found in Table 39. The weighted indicator values were then averaged by instrument for the Final Rankings.

Table 39: Ranking Analysis Pollutant Results from the Survey

Indicator	O_3	SO_2	PM_{10}	$PM_{2.5}$
Measured Concentration	190%	170%	190%	180%
Deviation from the NAAQS	150%	120%	140%	140%
Area Served	140%	90%	120%	110%
Population Served	170%	130%	170%	160%
Monitor to Monitor Correlation	130%	120%	140%	130%
Length of Record	110%	100%	120%	110%
Required Monitor	150%	140%	150%	150%
Distance from Phoenix	60%	50%	60%	60%
Parameters Monitored	100%	100%	110%	110%

1. Results

The ranking results for the four pollutant networks are shown hereafter. The unweighted and weighted ranking results are shown to compare the difference before the weighting and after the weighting. The highest indicator average is the highest ranked monitor and is the most important and meaningful to air monitoring.

a. SO_2 Results

Table 40: Weighted SO_2 Instrument Results. Unweighted Results in Parentheses

AQS ID	Site Name	Measured Concentration	Deviation from the NAAQS	Area Served	Population Served	Correlation Between Monitors	Length of Record	Required Monitor	Distance from Phoenix	Parameters Monitored	Average	Rank
04-007-0009	Miami Ridgeline	6.53 (3.84)	12 (10)	5.27 (5.85)	1.09 (0.84)	0 (0)	5 (5)	14 (10)	3.37 (6.73)	1.25 (1.25)	**5.39**	**4**
04-007-0011	Miami Jones Ranch	8.91 (5.24)	9.29 (7.74)	0 (0)	0.68 (0.52)	1.94 (1.62)	0.5 (0.5)	14 (10)	3.37 (6.73)	1.25 (1.25)	**4.44**	**5**
04-007-0012	Miami Townsite	6.95 (4.09)	11.51 (9.59)	0.7 (0.78)	0.68 (0.52)	0 (0)	0.5 (0.5)	14 (10)	3.37 (6.73)	1.25 (1.25)	**4.33**	**6**
04-007-1001	Hayden Old Jail	17 (10)	0 (0)	1.48 (1.64)	0 (0)	12 (10)	10 (10)	14 (10)	3.11 (6.22)	5 (5)	**6.95**	**1**
04-012-8000	Alamo Lake	N/A*	N/A*	9 (10)	13 (10)	N/A*	0.25 (0.25)	0 (0)	2.33 (4.66)	8.75 (8.75)	**5.56**	**3**
04-013-9997	JLG Supersite	0 (0)	9.56 (7.97)	1.77 (1.97)	13 (10)	3.5 (2.91)	2.5 (2.5)	14 (10)	4.9 (9.8)	10 (10)	**6.58**	**2**

*Alamo Lake began operation in 2014 and has not operated long for the Ranking Values

b. O_3 Results

Table 41: Weighted O_3 Instrument Results. Unweighted Results in Parentheses

AQS ID Site Name		Measured Concentration	Deviation from the NAAQS	Area Served	Population Served	Correlation Between Monitors	Length of Record	Required Monitor	Distance from Phoenix	Parameters Monitored	Average	Rank
04-005-1008	Flagstaff Middle School	2.89 (1.52)	2.84 (1.89)	6.05 (4.32)	12.89 (7.58)	8.02 (6.17)	3.5 (3.18)	15 (10)	2.36 (3.94)	2.5 (2.5)	**6.23**	**6**
04-007-0010	Tonto National Mon.	13.22 (6.96)	12.97 (8.65)	4.19 (2.99)	17 (10)	6.25 (4.81)	6.5 (5.91)	15 (10)	3.4 (5.66)	2.5 (2.5)	**9.00**	**5**
04-012-8000	Alamo Lake	9.08 (4.78)	8.92 (5.95)	14 (10)	17 (10)	7.14 (5.49)	5.01 (4.55)	15 (10)	2.8 (4.66)	8.75 (8.75)	**9.74**	**4**
04-013-9997	JLG Supersite	19 (10)	12.97 (8.65)	0 (0)	17 (10)	0 (0)	11 (10)	15 (10)	5.88 (9.8)	10 (10)	**10.09**	**2**
04-021-8001	Queen Valley	14.46 (7.61)	14.19 (9.46)	1.18 (0.84)	17 (10)	6.1 (4.69)	8.5 (7.73)	15 (10)	4.66 (7.77)	7.5 (7.5)	**9.84**	**3**
04-025-8033	Prescott College AQD	0 (0)	0 (0)	3.92 (2.8)	9.2 (5.41)	7.14 (5.49)	3.5 (3.18)	15 (10)	3.64 (6.06)	2.5 (2.5)	**4.99**	**7**
04-027-8011	Yuma Supersite	15.28 (8.04)	15 (10)	11.58 (8.27)	17 (10)	13 (10)	3.5 (3.18)	15 (10)	1.6 (2.67)	6.25 (6.25)	**10.91**	**1**

c. PM_{10} Results

Table 42: Weighted PM_{10} Instrument Results. Unweighted Results in Parentheses

AQS ID	Site Name	Measured Concentration	Deviation from the NAAQS	Area Served	Population Served	Correlation Between Monitors	Length of Record	Required Monitor	Distance from Phoenix	Parameters Monitored	Average	Rank
04-003-0011	Paul Spur Chem Lime	4.47 (2.35)	10.4 (7.43)	2.48 (2.07)	0 (0)	10.57 (7.55)	8.47 (7.06)	15 (10)	0.41 (0.68)	4.13 (3.75)	**6.21**	**11**
04-003-1005	Douglas	5.89 (3.1)	12.14 (8.67)	3.78 (3.15)	5.71 (3.36)	10.58 (7.56)	6 (5)	15 (10)	0.41 (0.68)	6.88 (6.25)	**7.38**	**5**
04-007-0008	Payson	0 (0)	5 (3.57)	4.46 (3.72)	4.42 (2.6)	14 (10)	8.47 (7.06)	15 (10)	3.87 (6.45)	5.5 (5)	**6.75**	**10**
04-007-1001	Hayden Old Jail	14.17 (7.46)	5.85 (4.18)	0.88 (0.73)	0 (0)	7.63 (5.45)	12 (10)	15 (10)	3.73 (6.22)	5.5 (5)	**7.20**	**6**
04-007-8000	Miami Golf Course	3.25 (1.71)	8.93 (6.38)	1.65 (1.38)	2.41 (1.42)	9.09 (6.5)	1.06 (0.88)	15 (10)	4.04 (6.73)	5.5 (5)	**5.66**	**12**
04-012-8000	Alamo Lake	N/A*	N/A*	7.97 (6.64)	17 (10)	N/A*	0.71 (0.59)	15 (10)	2.8 (4.66)	9.63 (8.75)	**8.85**	**2**
04-013-9997	JLG Supersite	7.43 (3.91)	14 (10)	0 (0)	17 (10)	0 (0)	7.76 (6.47)	15 (10)	5.88 (9.8)	11 (10)	**8.67**	**3**
04-015-100	Bullhead City	6.12 (3.22)	12.4 (8.86)	9.06 (7.55)	1.72 (1.01)	6.32 (4.52)	6.35 (5.29)	15 (10)	0 (0)	1.38 (1.25)	**6.84**	**9**
04-019-0001	Ajo	9.27 (4.88)	11.79 (8.42)	10.95 (9.12)	0.7 (0.41)	8.43 (6.02)	8.47 (7.06)	15 (10)	3.35 (5.58)	4.13 (3.75)	**8.01**	**4**
04-019-0020	Rillito	14.4 (7.58)	5.59 (3.99)	0.28 (0.23)	0 (0)	8.38 (5.99)	10.58 (8.82)	15 (10)	3.68 (6.14)	4.13 (3.75)	**6.89**	**8**
04-023-0004	Nogales Post Office (Continuous)	11.4 (6)	9.21 (6.58)	2.14 (1.78)	4.76 (2.8)	4.25 (3.03)	4.24 (3.53)	15 (10)	1.72 (2.87)	9.63 (8.75)	**6.93**	**7**
04-023-0004	Nogales Post Office (Filter)	4.43 (2.33)	10.36 (7.4)	2.14 (1.78)	4.76 (2.8)	4.25 (3.03)	9.89 (8.24)	0 (0)	1.72 (2.87)	9.63 (8.75)	**5.24**	**13**
04-027-8011	Yuma Supersite	19 (10)	0 (0)	12 (10)	17 (10)	10.6 (7.57)	2.11 (1.76)	15 (10)	1.6 (2.67)	6.88 (6.25)	**9.35**	**1**

*Alamo Lake began operation in 2014 and has not operated long for the Ranking Values

d. $PM_{2.5}$ Results

Table 43: Weighted $PM_{2.5}$ Instrument Results. Unweighted Results in Parentheses

AQS ID	Site Name	Measured Concentration	Deviation from the NAAQS	Area Served	Population Served	Correlation Between Monitors	Length of Record	Required Monitor	Distance from Phoenix	Parameters Monitored	Average	Rank
04-003-1005	Douglas	0 (0)	0 (0)	3.31 (3.01)	5.38 (3.36)	13 (10)	10.32 (9.38)	15 (10)	0.41 (0.68)	6.88 (6.25)	**6.03**	**7**
04-012-8000	Alamo Lake	N/A*	N/A*	11 (10)	16 (10)	N/A*	1.38 (1.25)	15 (10)	2.8 (4.66)	9.63 (8.75)	**9.30**	**1**
04-013-9997	JLG Supersite (Continuous)	9.92 (5.51)	7.71 (5.51)	0 (0)	16 (10)	2.12 (1.63)	2.75 (2.5)	15 (10)	5.88 (9.8)	11 (10)	**7.82**	**4**
04-013-9997	JLG Supersite (Filter)	11.43 (6.35)	8.89 (6.35)	0 (0)	16 (10)	2.15 (1.65)	11 (10)	15 (10)	5.88 (9.8)	11 (10)	**9.04**	**2**
04-023-0004	Nogales Post Office (Continuous)	18 (10)	14 (10)	2.07 (1.88)	4.48 (2.8)	0.32 (0.25)	1.38 (1.25)	15 (10)	1.72 (2.87)	9.63 (8.75)	**7.40**	**6**
04-023-0004	Nogales Post Office (Primary Filter)	17.6 (9.78)	13.69 (9.78)	2.07 (1.88)	4.48 (2.8)	0 (0)	11 (10)	15 (10)	1.72 (2.87)	9.63 (8.75)	**8.35**	**3**
04-023-0004	Nogales Post Office (Secondary Filter)	13.39 (7.44)	10.42 (7.44)	2.07 (1.88)	4.48 (2.8)	0 (0)	11 (10)	0 (0)	1.72 (2.87)	9.63 (8.75)	**5.86**	**8**
04-027-8011	Yuma Supersite	3.02 (1.68)	2.35 (1.68)	7.12 (6.47)	16 (10)	11.36 (8.74)	3.44 (3.13)	15 (10)	1.6 (2.67)	6.88 (6.25)	**7.42**	**5**

*Alamo Lake began operation in 2014 and has not operated long for the Ranking Values

Section II: Spatial Raster Analysis

In order to determine if ADEQ's existing ambient monitoring network adequately represents Arizona's unique air quality, a spatial analysis is conducted using a variety of indicators shown in Table 49. The indicators are mapped to visually show places in Arizona where monitoring could be beneficial for the welfare of Arizona's population and to show the adequacy of ADEQ's ambient monitoring network.

The seven indicators have three general classifications: demographic, source (point and mobile), and spatially oriented variables. A map is produced showing areas of higher interest based on the indicator's data and is then partitioned into 10 equal parts on a scale of 0-10. The indicator maps are converted into a GIS raster image. A raster image is a type of GIS map used to combine multiple maps together and assigns numerical values of every part of Arizona. By placing a numerical value to the maps, areas can be quantifiably valued. The seven raster images per pollutant are then weighed because it is not assumed that each indicator is as important to ambient air monitoring. The weighted raster images are layered and combined to show the final weighted spatial overlay map for all of Arizona which shows areas in Arizona that are important to the development of a monitoring network.

Chosen indicators represent a variety of aspects that are important to developing a robust air monitoring network. The following seven indicators are used in the raster analysis:

Table 44: Raster Analysis Indicators

Indicator	Description	Indicator Type
Hospitalization Density	Using the primary care areas in Arizona, this indicator ranks the areas based on the percent morbidity of air pollution related health effects per area population. The highest valued areas have the highest percentage of hospitalizations.	Demographic
Sensitive Age Density	Using the 2010 Census blocks, this indicator ranks the areas based on the percentage of sensitive individuals based on their age. Age sensitive individuals are children and the elderly, therefore the highest valued areas have the highest percentage of children 0-14 and the elderly >65.	Demographic
Total Population	Using the 2010 Census blocks, this indicator ranks the areas based on the number of individuals per square mile. The highest valued areas have the highest number of individuals per square mile.	Demographic
Point Sources	This indicator ranks areas that contain permitted and recorded sources. The highest valued areas contain the greatest amount of emissions.	Source
Traffic Count	This indicator ranks sections of roadway which have the highest daily traffic count. The highest valued areas have the highest traffic count.	Source
Distance between Monitors	This indicator ranks the straight line distance between monitors. The areas that have the furthest distance from other monitors are valued highest.	Spatial
Predicted Values	Using a Kriging interpolation map using 2009-2013 average design values, this indicator ranks areas that are based on the predicted values. A Kriging interpolation map is a simple prediction model that projects air concentrations based on actual measurement. The areas that have the highest predicted values are valued highest.	Spatial

A. Hospitalization Density

This indicator values areas based on morbidity (chronic or acute poor health) hospitalization records for Adult Asthma, Chronic Obstructive Pulmonary Disease (COPD), and Congestive Heart Failure (CHF). The average of number of Adult Asthma, COPD and CHF hospitalizations per 100,000 people per primary care area are used to show areas that have a greater percentage of individuals potentially affected by air pollution (see Figure 6). This indicator provides a method of accounting for environmental justice issues by identifying those that are particularly sensitive to air quality issues.

It is assumed that areas with higher hospitalizations are of greater importance, therefore are assigned higher scores. This indicator does not assume that the hospitalizations are a direct result of poor air quality in the area, only that individuals with the previously mentioned conditions can be sensitive to poor air quality. This indicator has disadvantages in that hospitalizations records do not show where the individuals work or live, only where they went to the hospital.

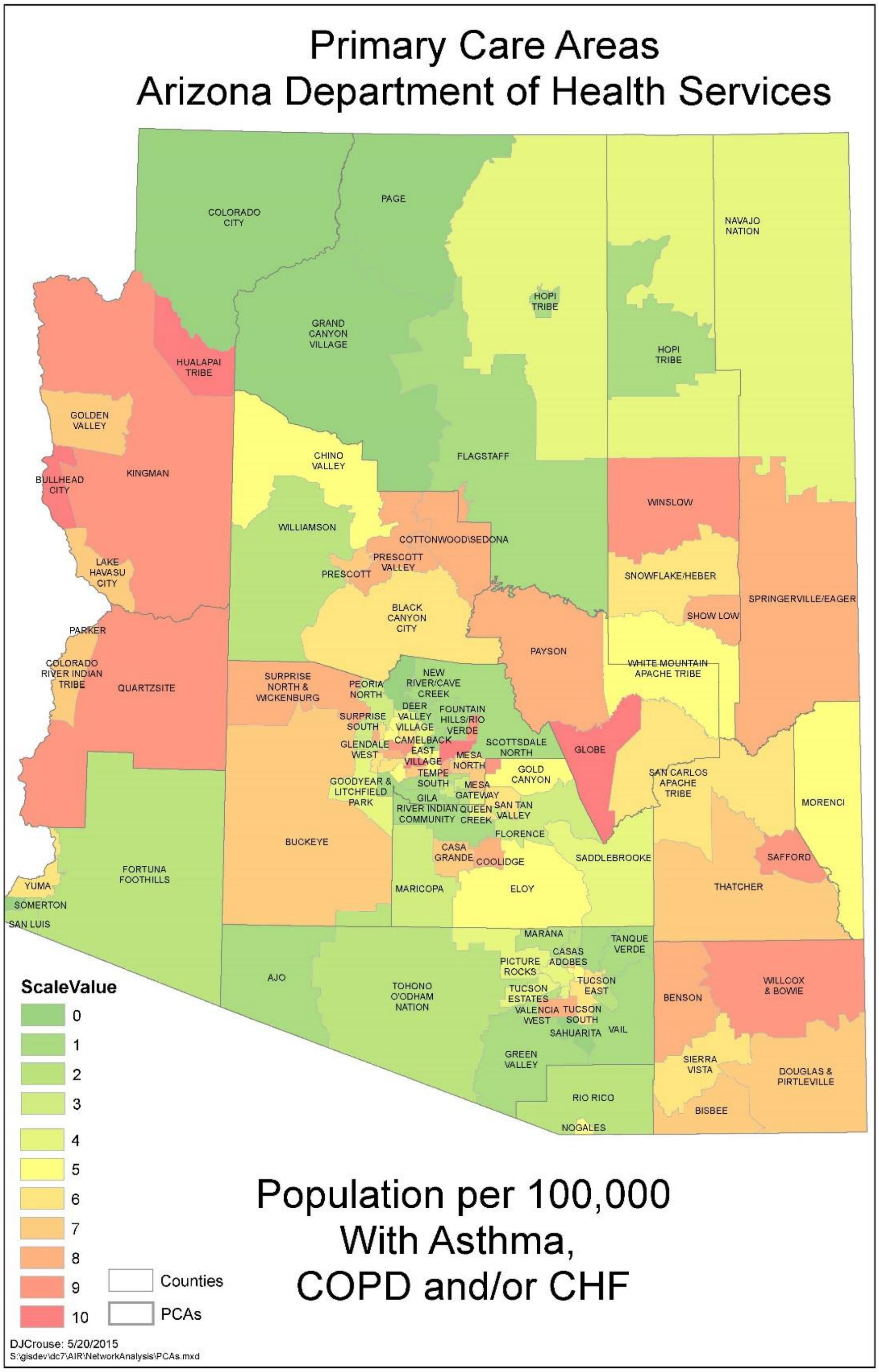
The entire distribution of hospitalizations is divided into ten parts and assigned a score of 0-10, with 10 being the highest partition.

Hospitalization data is from the Arizona Department of Health Services (AZDHS) where it is listed by primary care area, and is publically available on the AZDHS website: http://www.azdhs.gov/phs/phstats/profiles/.

1. Results

Figure 7: Hospitalization Density Map

The highest percentage of hospitalizations per 100,000 people is shown in red areas.



B. Sensitive Age Density

This indicator uses the 2010 Census data to account for another population of sensitive individuals. This indicator values areas on the percentage of individuals in the age categories of 0-14 and >65. The sensitive age density of each census block group (sensitive individuals per area) is calculated. Census blocks groups are geographical areas that have between 600-3,000 individuals. Higher density areas receive higher scores. This indicator provides a method of accounting for environmental justice issues.

It is assumed that areas with the highest percentage of children and the elderly are most affected by air quality issues. This indicator does not assume that all individuals in the 0-14 and >65 age groups are sensitive to poor air quality, only that these age groups are considered to be sensitive for the assessment. This indicator has disadvantages in that it does not take into account where people go to school or work, only where they live.

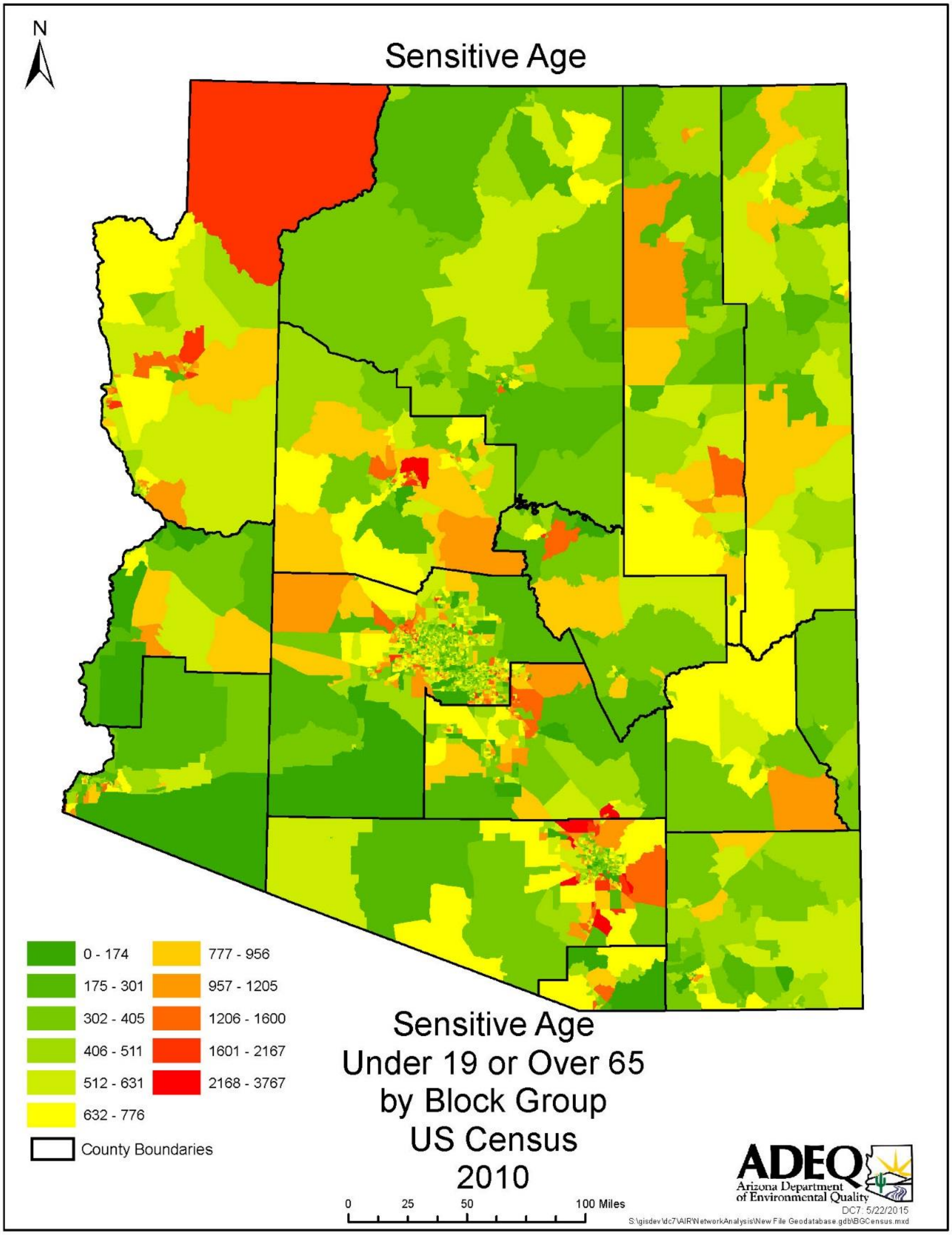
The entire distribution of sensitive individuals is divided into ten parts and assigned a score of 0-10, with 10 being the highest partition.

Population details by census block group are publically available data from the US 2010 Census.

1. Results

Figure 8: Sensitive Age Density Map

The highest Sensitive Age Density is shown in red areas.



C. Total Population

This indicator values areas by the number of people per census block. Census blocks are the smallest geographical areas used by the U.S. Census Bureau and have anywhere from zero to several hundred individuals. A spatial output map is created showing the total populations in Arizona.

The entire distribution is divided into ten parts and assigned a score of 0-10, with 10 being the highest partition.

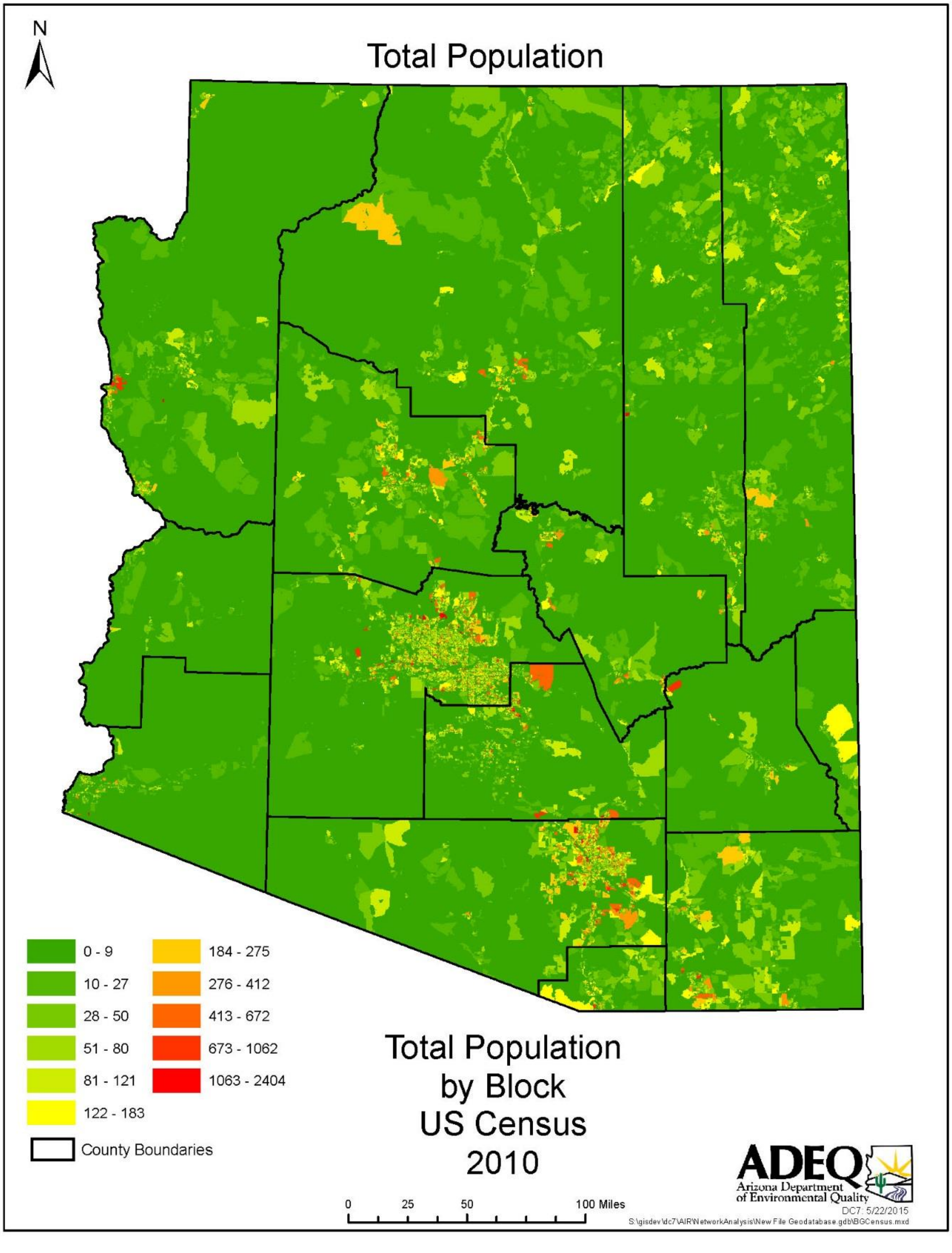
Higher populations per block group are assigned higher scores since it is assumed that it is more desirable to have a monitor representing the greatest number of people. This indicator has disadvantages in that census blocks generally have the same number of individuals, therefore each one may not differ drastically from another. This would then not correctly show areas of high concentrations of individuals. Population density (population divided by area) was also considered to be used for this indicator, as it gives a better representation of the urban areas but produces inaccuracies and over represented densities in the rural areas. Total population was chosen over population density because it gives a better representation of the rural areas and an acceptable representation of the urban areas of Arizona. Another disadvantage is that census block groups can include both an urban population and surrounding non-populated areas. This results in a block that seems to show a large number of people over a big area, where the actual population is concentrated in one spot. The resultant total population map (Figure 9) shows an accurate representation of populations in all of Arizona.

Population details by census block are publically available data from the US 2010 Census.

1. Results

Figure 9: Total Population Map

The highest total population is shown in red areas.



D. Point Sources

This indicator values areas on the actual tons of emissions from permitted sources per year. A map is created of major point emission sources by pollutant. "Major sources" is defined as a source that emits a minimum tonnage threshold and collectively they represent over the 90% of total source emissions. Minimum tonnage thresholds are listed in Table 50. A three mile radius buffer is then placed on each emission source and the actual emissions in tons are assigned to that buffer. Overlapping buffers are summed together to show the total emissions for an area.

It is assumed that the areas directly surrounding stationary sources represented by the buffer are of greater significance to air monitoring than other areas that do not have source emissions. A buffer radius of three miles is chosen to represent all of the sources spatially.

This indicator has disadvantages in that it does not take into account the different spatial impact of smaller or larger sources. Larger sources tend to impact a greater area than smaller sources and would therefore require a different size buffer. Also, this indicator does not take into account the different spatial impact of different pollutants. Some pollutants affect larger areas than others due to their reactivity in the atmosphere. Meteorology and topography also play a large factor in the spatial and concentration gradient impact of point sources. Due to these factors and others, it becomes very difficult to accurately show the exact spatial impact of every separate source. Therefore, a general impact buffer of a three mile radius is used for all pollutant sources and represents the average spatial impact for all pollutants.

When reclassifying the raster, the entire distribution of emissions is divided into ten equal parts and assigned a score of 0-10, with 10 being the highest partition.

Source emissions data are taken from ADEQ's Air Quality permitted sources emission inventories and the National Emissions Inventory maintained by the EPA. Emissions data by source were averaged for the years 2009-2013. This eliminates anomalies in any particular year. Since O_3 is not directly emitted, volatile organic compounds (VOC) were used to represent the source emissions as an O_3 precursor.

Table 45: Point Source Minimum Tonnage Threshold

Pollutant	Minimum Tonnage Threshold
SO_2	1.0 tons
VOC	10.0 tons
PM_{10}	10.0 tons
$PM_{2.5}$	5.0 tons
CO	100.0 tons
NO_2	10.0 tons
Pb	0.1 tons

1. Results

The highest sources emissions are shown as red dots.

Figure 10: SO_2 Point Sources Map

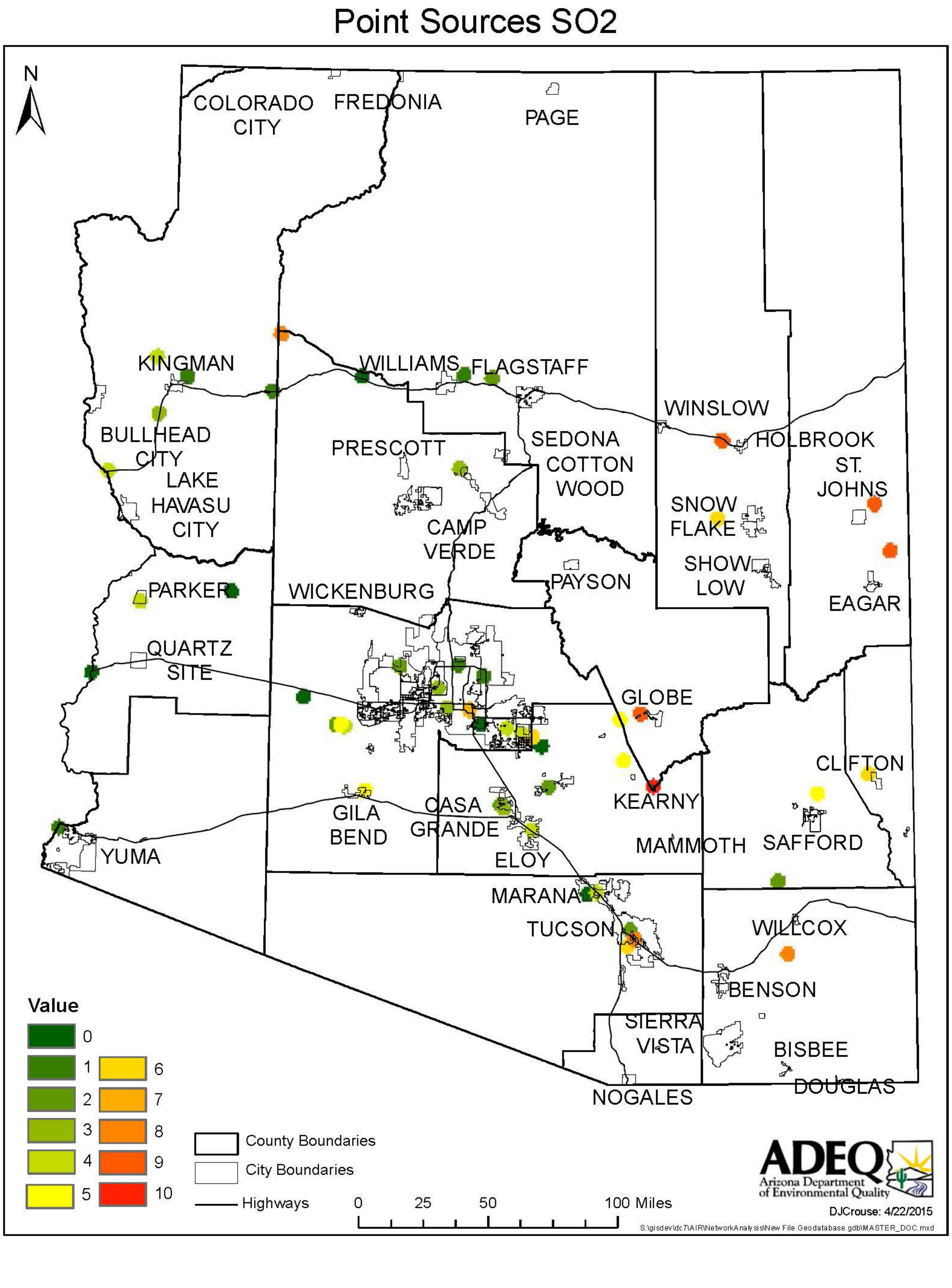


Figure 11: O_3 Point Sources Map

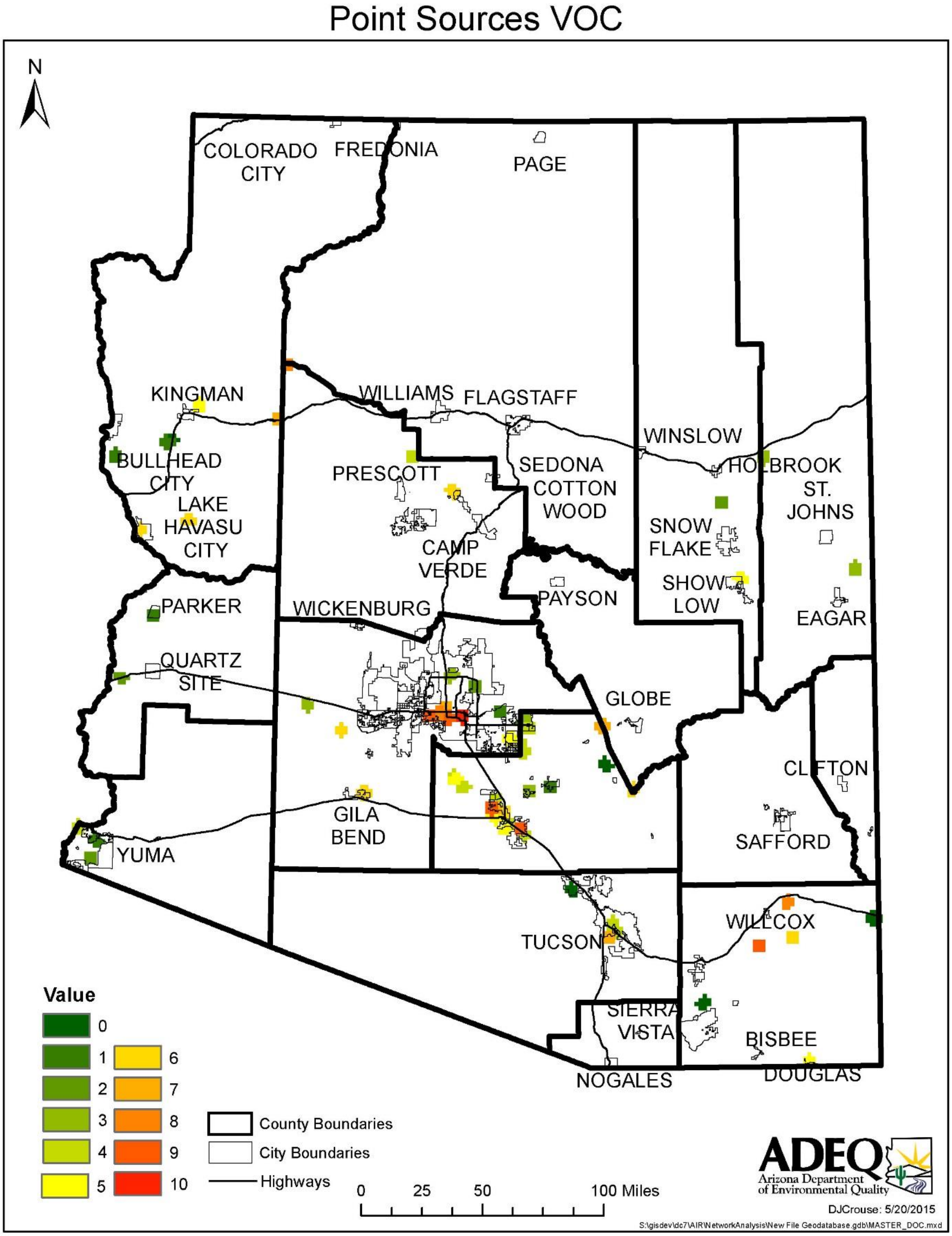


Figure 12: PM$_{10}$ Point Sources Map

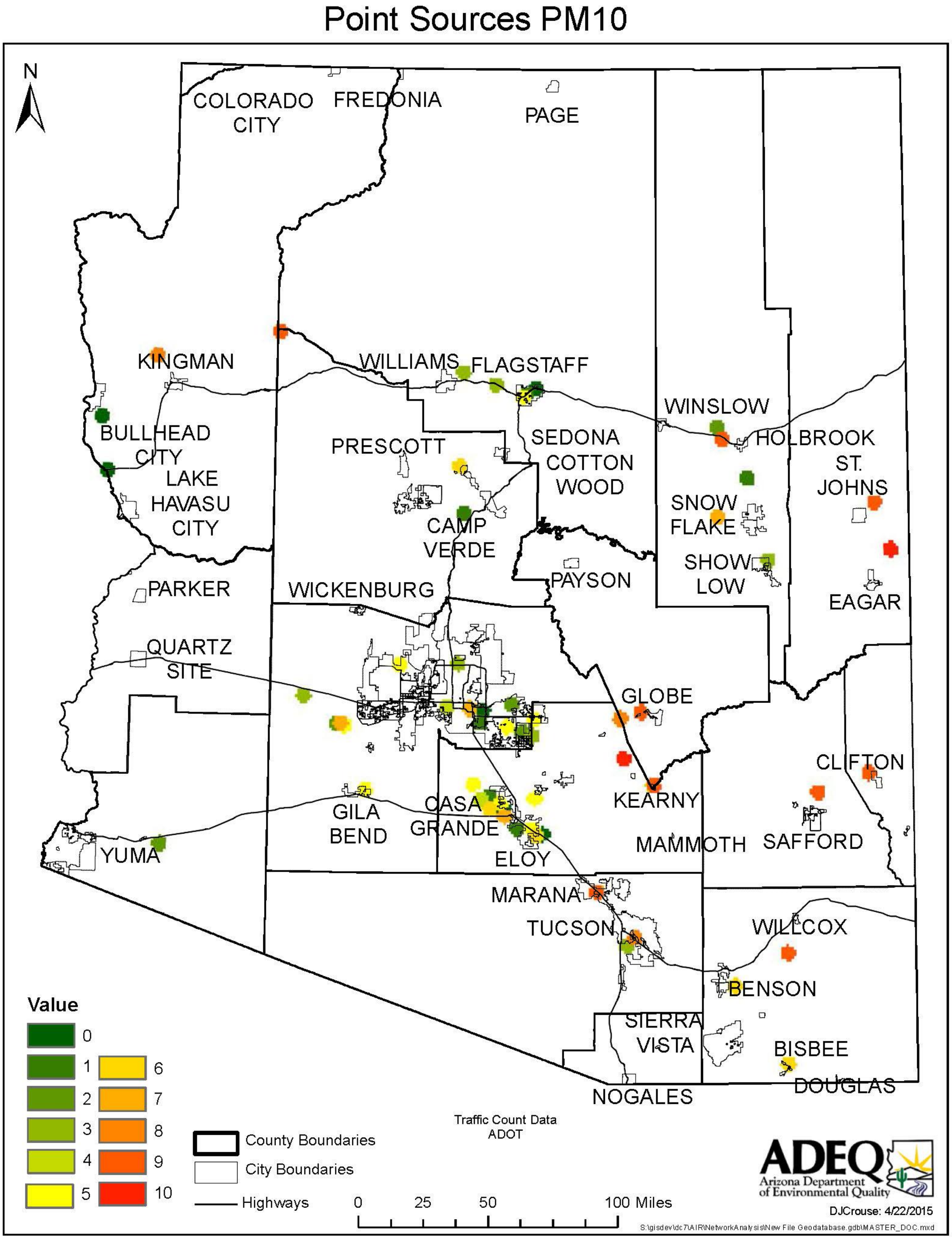


Figure 13: $PM_{2.5}$ Point Sources Map

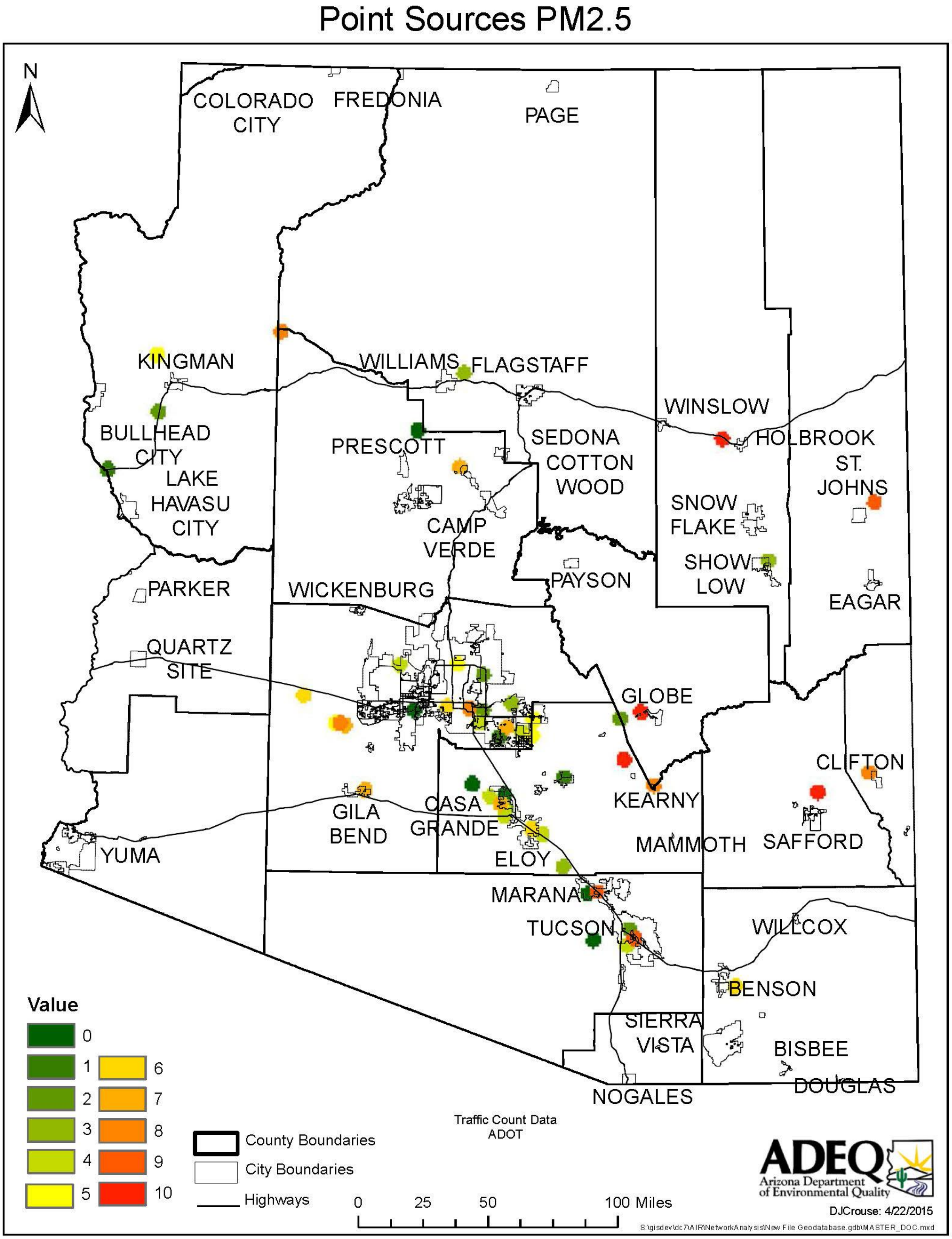


Figure 14: CO Point Sources Map

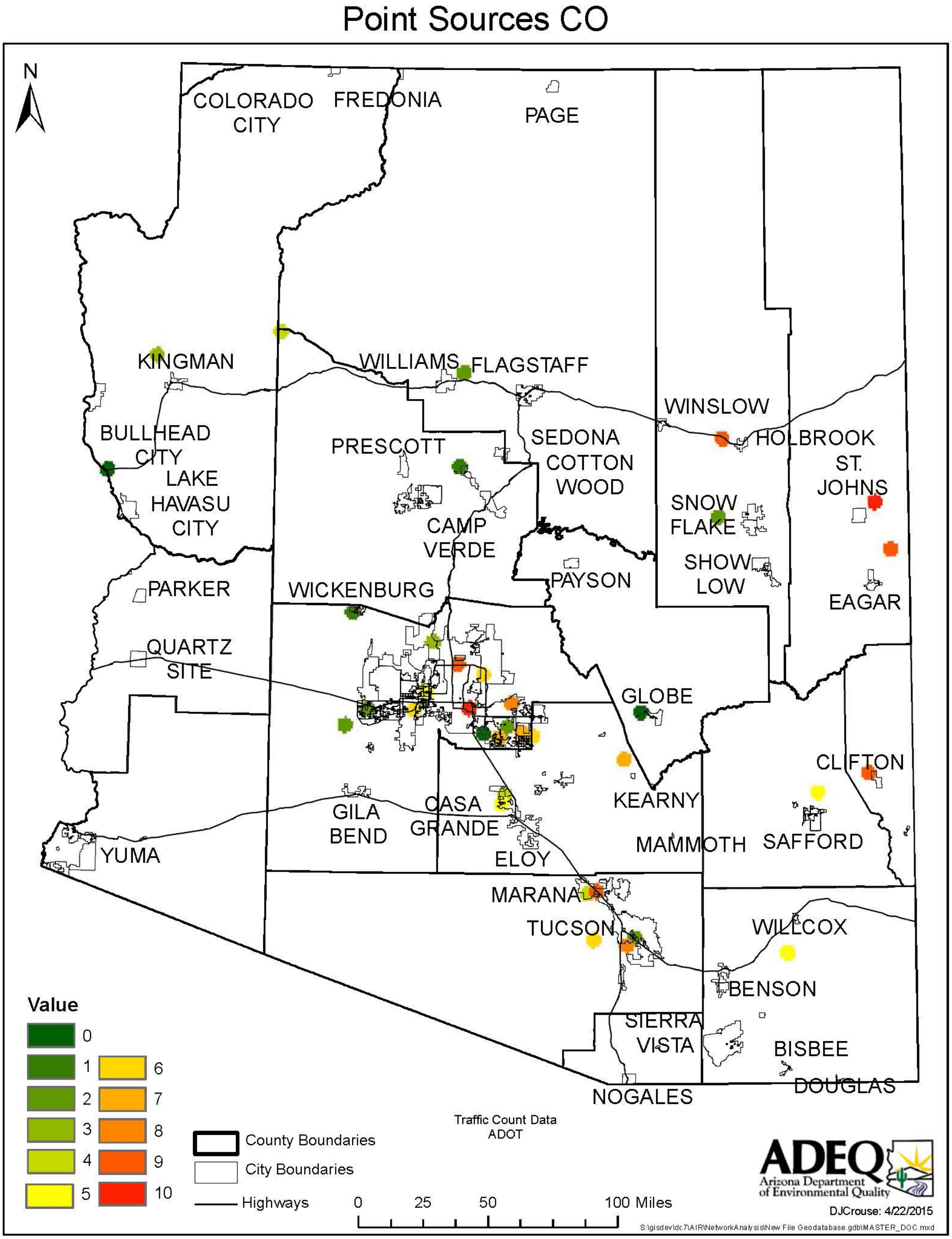


Figure 15: NO$_2$ Point Sources Map

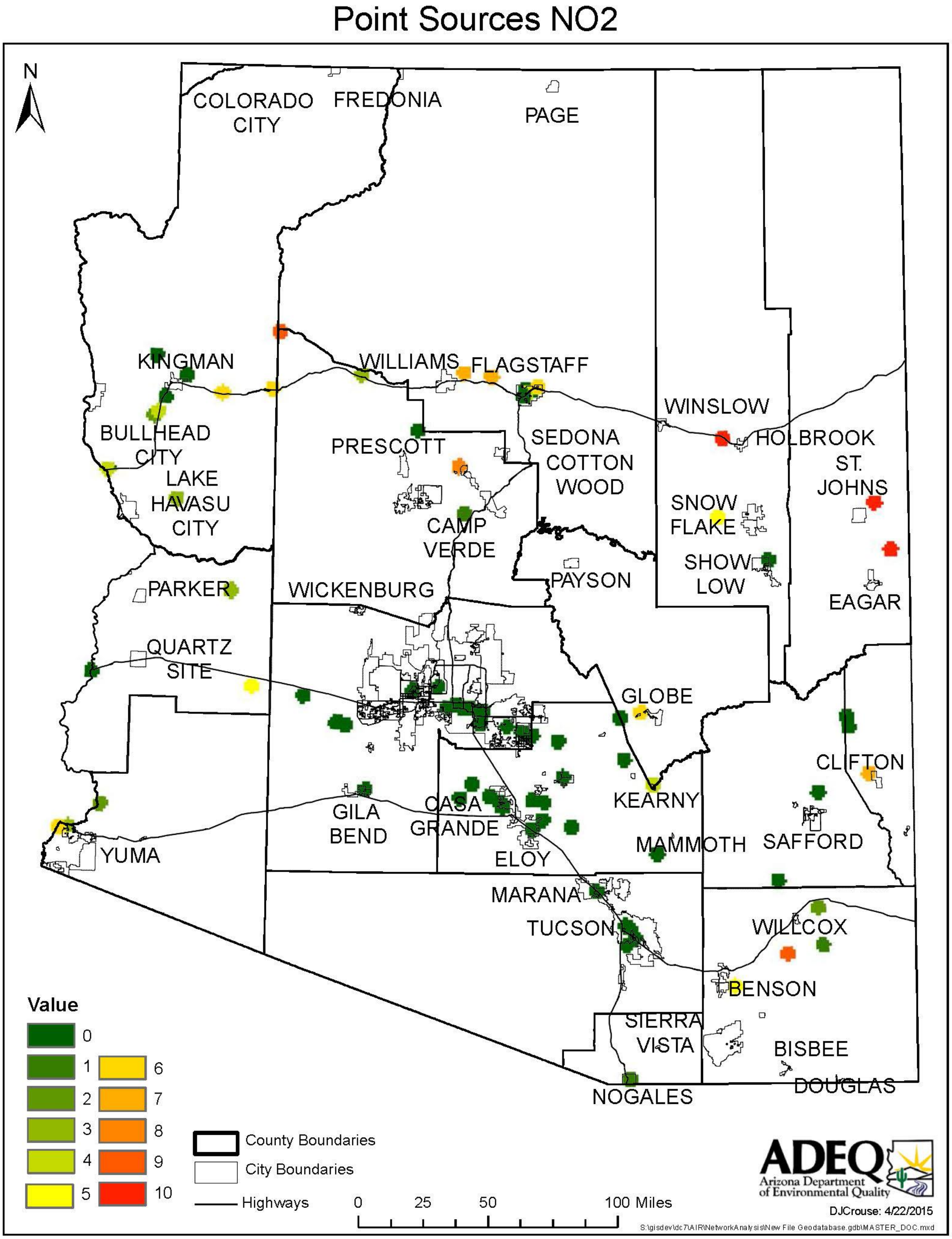
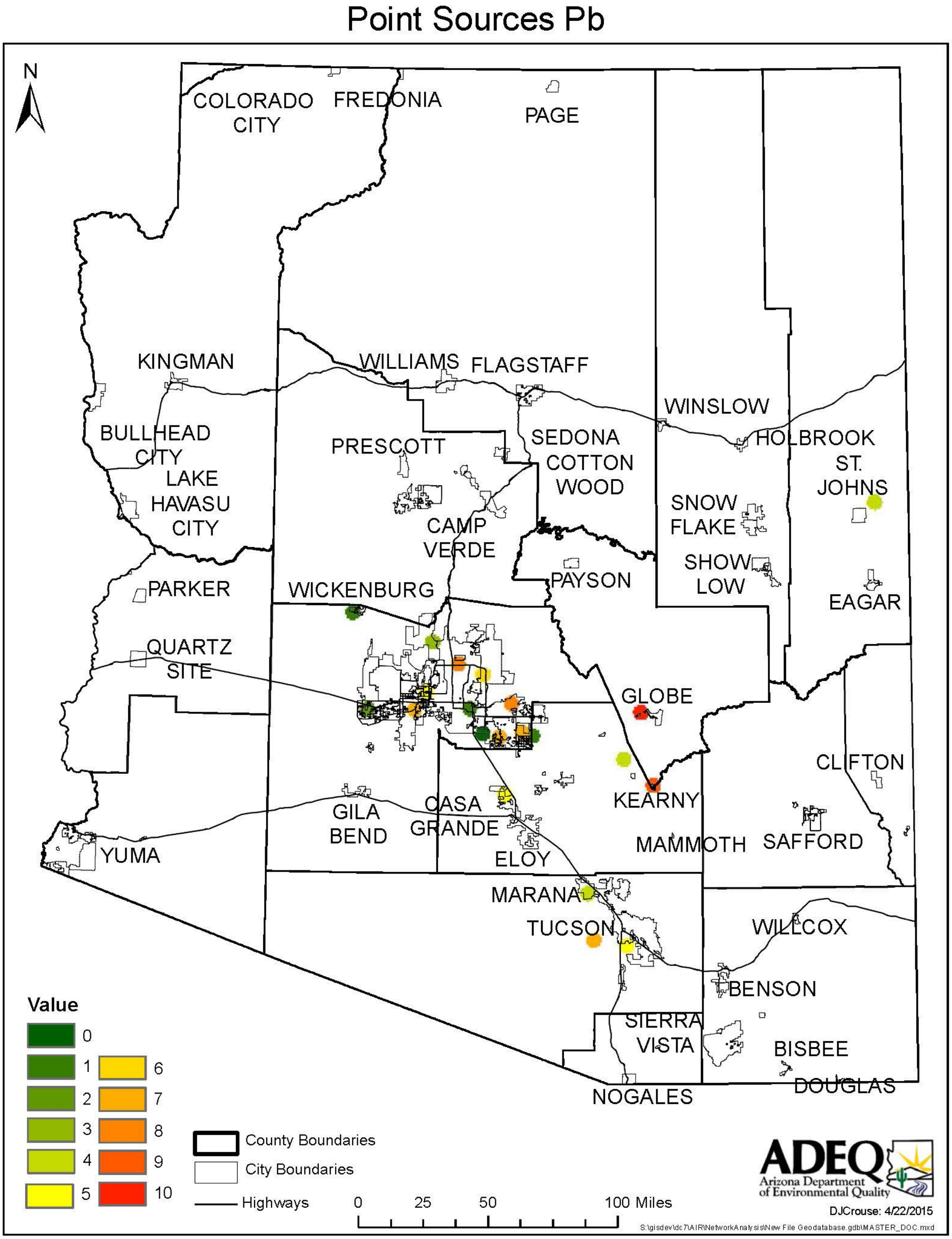


Figure 16: Pb Point Sources Map



E. Traffic Count

This indictor values road sections by daily traffic count. Road sections have a buffer with an associated traffic count. The buffer size is dependent on the actual traffic count, with higher traffic counts receiving a larger size buffer and being ranked the highest. Buffer sizes are taken from air monitoring siting criteria in 40 CFR Part 58 Appendix E Table E-1 which states the minimum distance sites must be away from the roadway centerline in order to be outside the area of influence of roadways and shown in Table 51. Differences to the buffer size were made due to limitations in GIS software to be able to visually show an area of representation.

It is assumed that the areas directly surrounding roadways are of higher significance to air monitoring than areas not close to roadways. Mobile source emissions play a major part in ambient air quality. This indicator has disadvantages in that it does not show every roadway in Arizona, only those counted by the Arizona Department of Transportation's (ADOT). It also does not show off -highway vehicle emissions including construction sites, rail traffic, and recreational vehicles.

The entire distribution of traffic counts is divided into ten parts and assigned a score of 0-10, with 10 being the highest partition.

Data and locations were taken from ADOT 2013 daily traffic counts and used to create a raster map of roadway sections.

Table 46: Traffic Count Buffer Sizes

Traffic Count in Thousands	Miles from Roadway Centerline
<15	0.025*
15-20	0.025**
20-40	0.025
40-70	0.040
70-110	0.075
>110	0.175

*Changed from 0.009 miles in order to be able to visually show an area of representation on a Raster Map
**Changed from 0.016 miles in order to be able to visually show an area of representation on a Raster Map

1. Results

The highest traffic counts are shown as red section lines.

Figure 17: Traffic Count Map

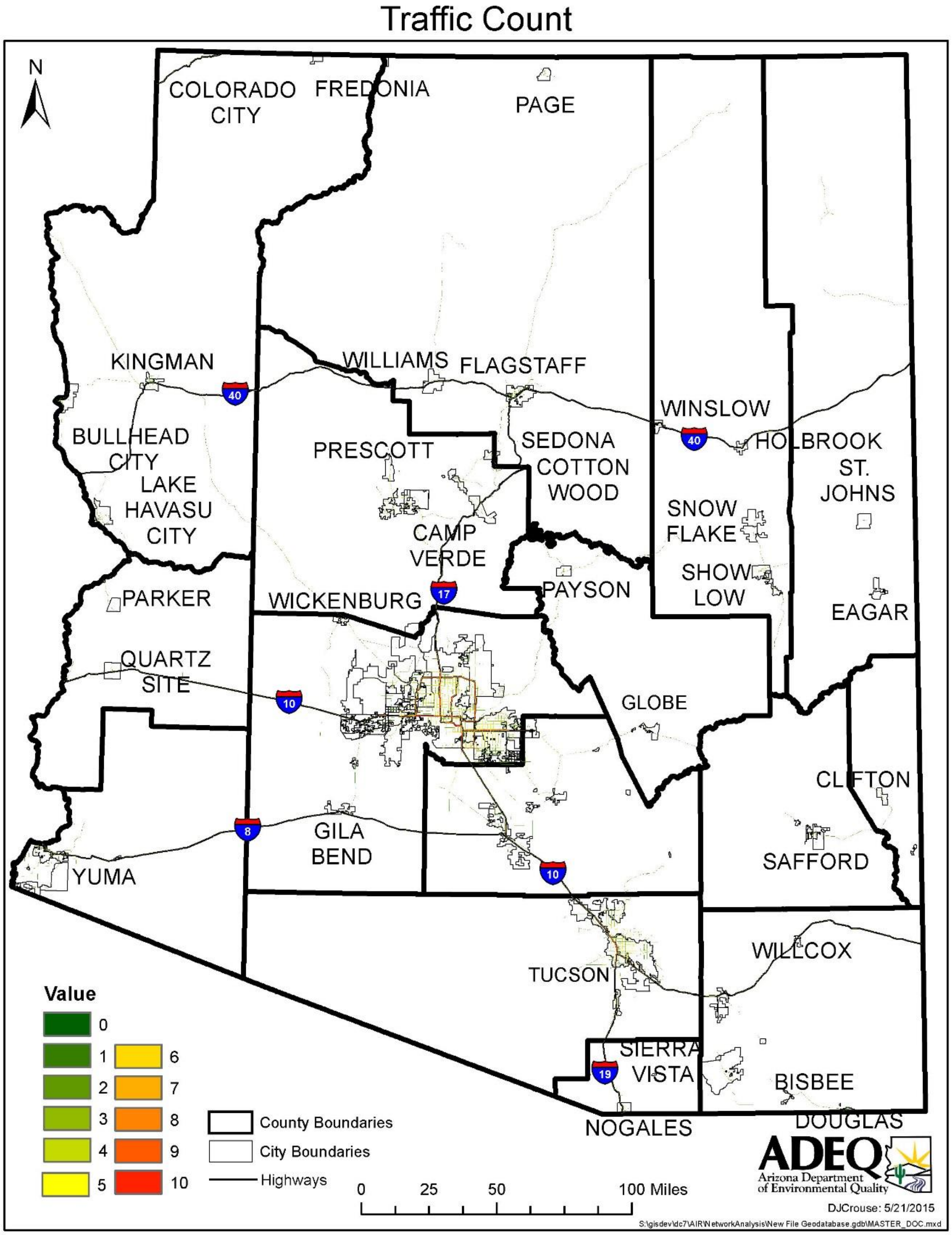


Figure 18: Phoenix Traffic Count Map

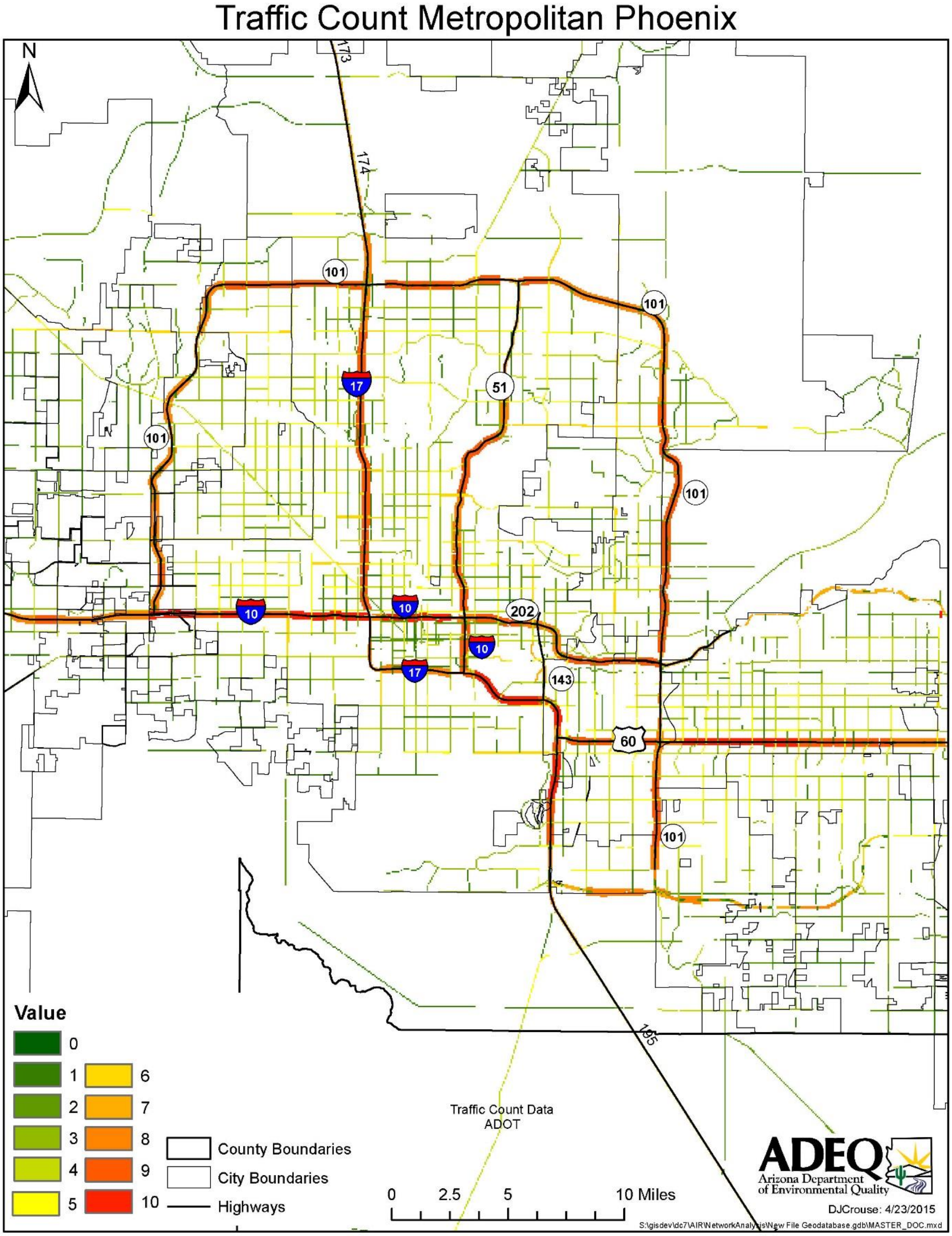
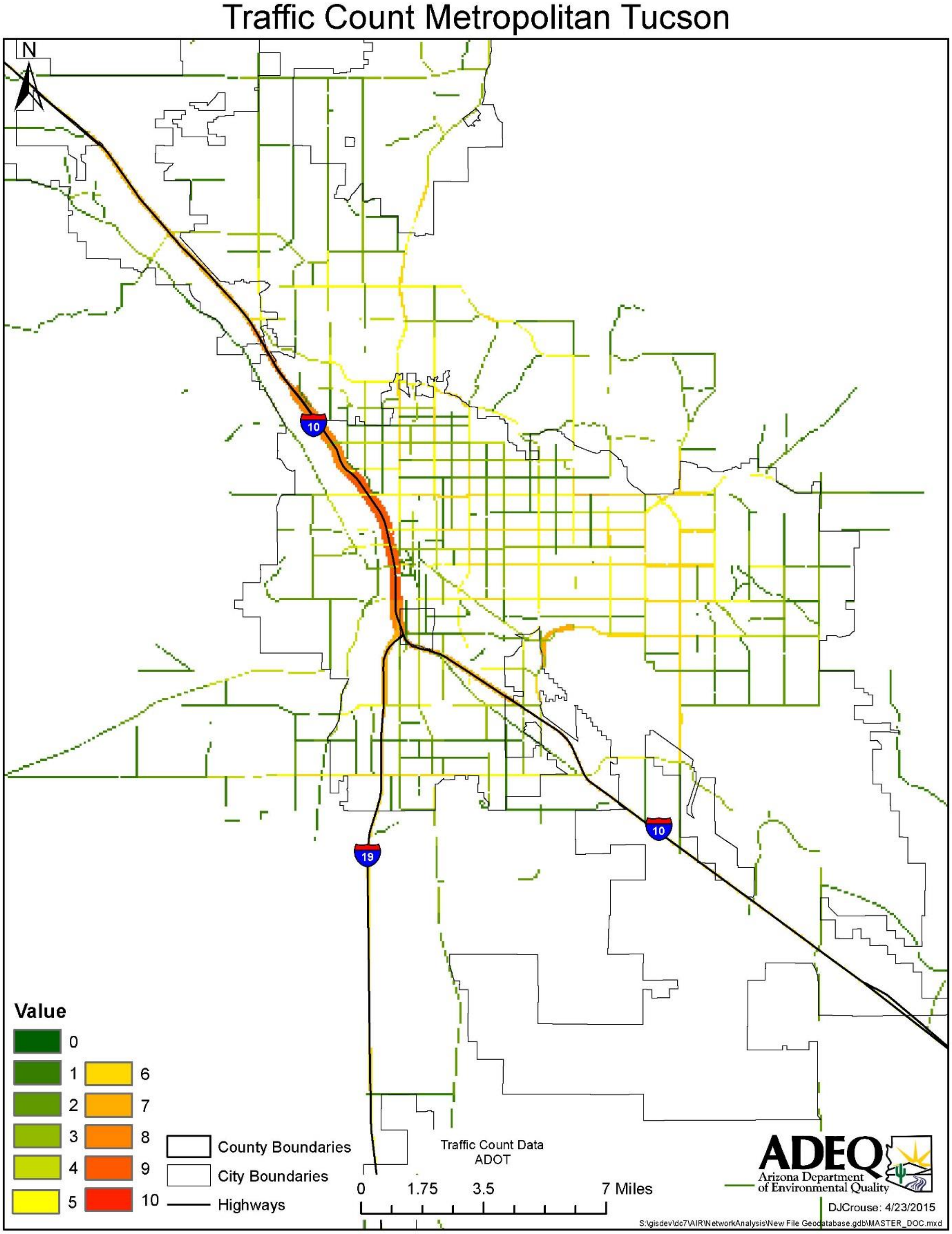


Figure 19: Tucson Traffic Count Map



F. Distance Between Monitors

This indicator values areas based on the how far in distance instruments are from existing monitoring instruments. This is achieved by calculating the straight-line distance away from an existing monitoring site. In practice this indicator creates concentric rings around each monitoring site at pre-defined distances. The scored value increases the farther away from existing monitoring sites to show that it is more desirable to place a monitor further from another monitor. Overlapping concentric rings use the shortest distance value to adjust for nearby instruments. The locations of all state, local, and tribal monitors in Arizona are used.

The assumption is that it is more desirable to have a new monitoring site farther away from an existing site to represent a different population and measure a unique air parcel. Concentric ring sizes are defined by pollutant in Table 52 and are taken from the Section I (E): Correlation Between Monitors (page 25) data set. By using the correlation values, it was determined the maximum distance of correlation. Monitors that do not correlate with each other are further in distance. This distance of correlation (influence) is the maximum distance set between monitors, with ten concentric rings leading up to that maximum. Each pollutant's distance of influence is dependent on its reactivity and longevity in the atmosphere.

This indicator has disadvantages in that it does not take into account pollutant sources or meteorological and geographic differences in Arizona.

The entire distribution of distances is divided into ten parts and assigned a score of 0-10, with 10 being the highest partition. This highest partition includes any area beyond the maximum concentric ring to extend the coverage to all of Arizona.

Monitor locations were taken from EPA's AQS web application database. The AMP500 Extract Site/Monitor Data report was run for all monitors in Arizona, including state, local, and tribal monitors. Only monitors that were in operation during the 2009-2013 time period were used.

Table 47: Distance Between Monitors Concentric Ring Sizes

Pollutant	Concentric Ring Size
SO_2	6 mile rings up to 60 miles
O_3	6 mile rings up to 60 miles
PM_{10}	3 mile rings up to 30 miles
$PM_{2.5}$	3 mile rings up to 30 miles
CO	3 mile rings up to 30 miles
NO_2	12 mile rings up to 120 miles
Pb	2 mile rings up to 20 miles

1. Results

The areas furthest away from monitors are shown as red areas.

Figure 20: SO_2 Distance Between Monitors Map

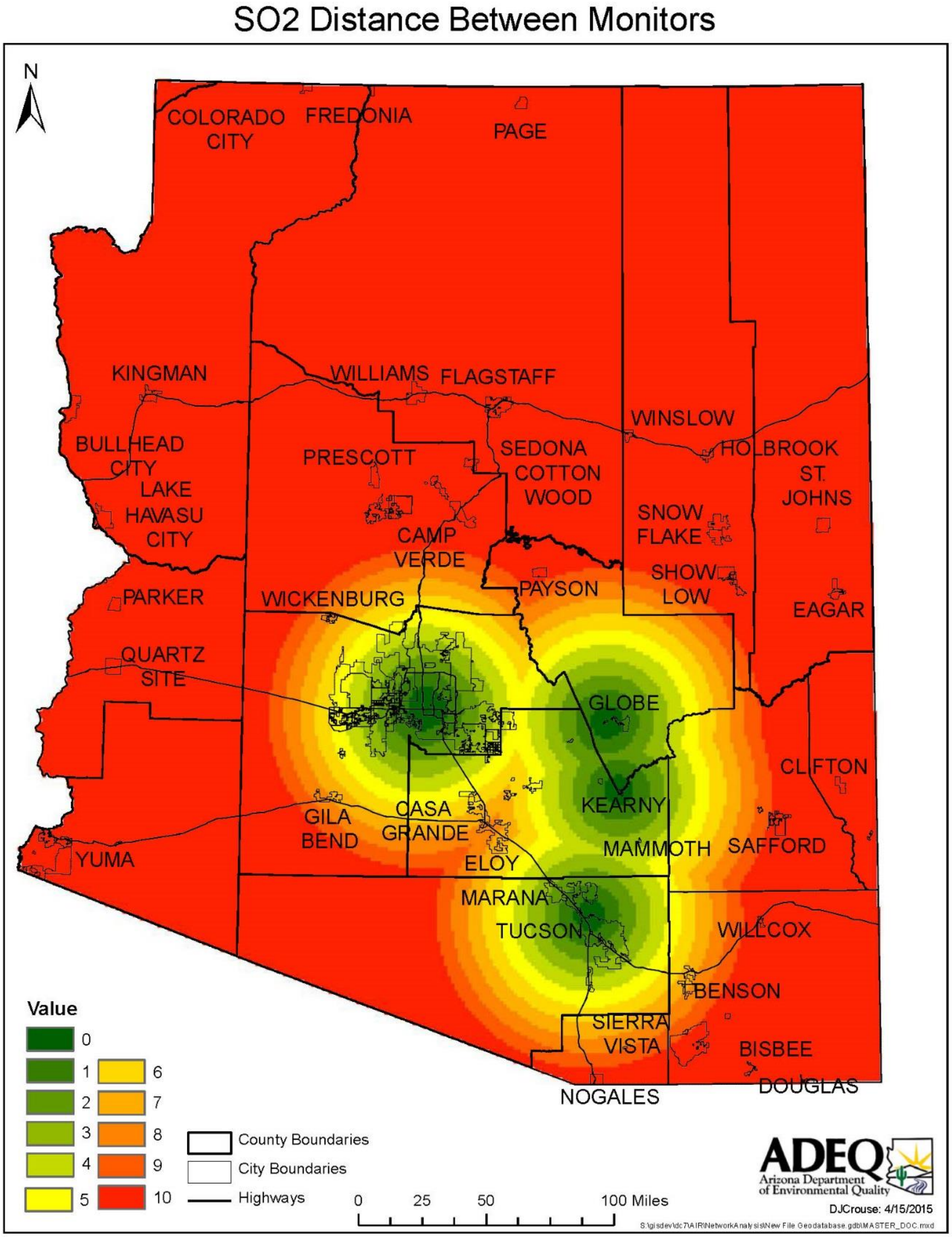


Figure 21: O_3 Distance Between Monitors Map

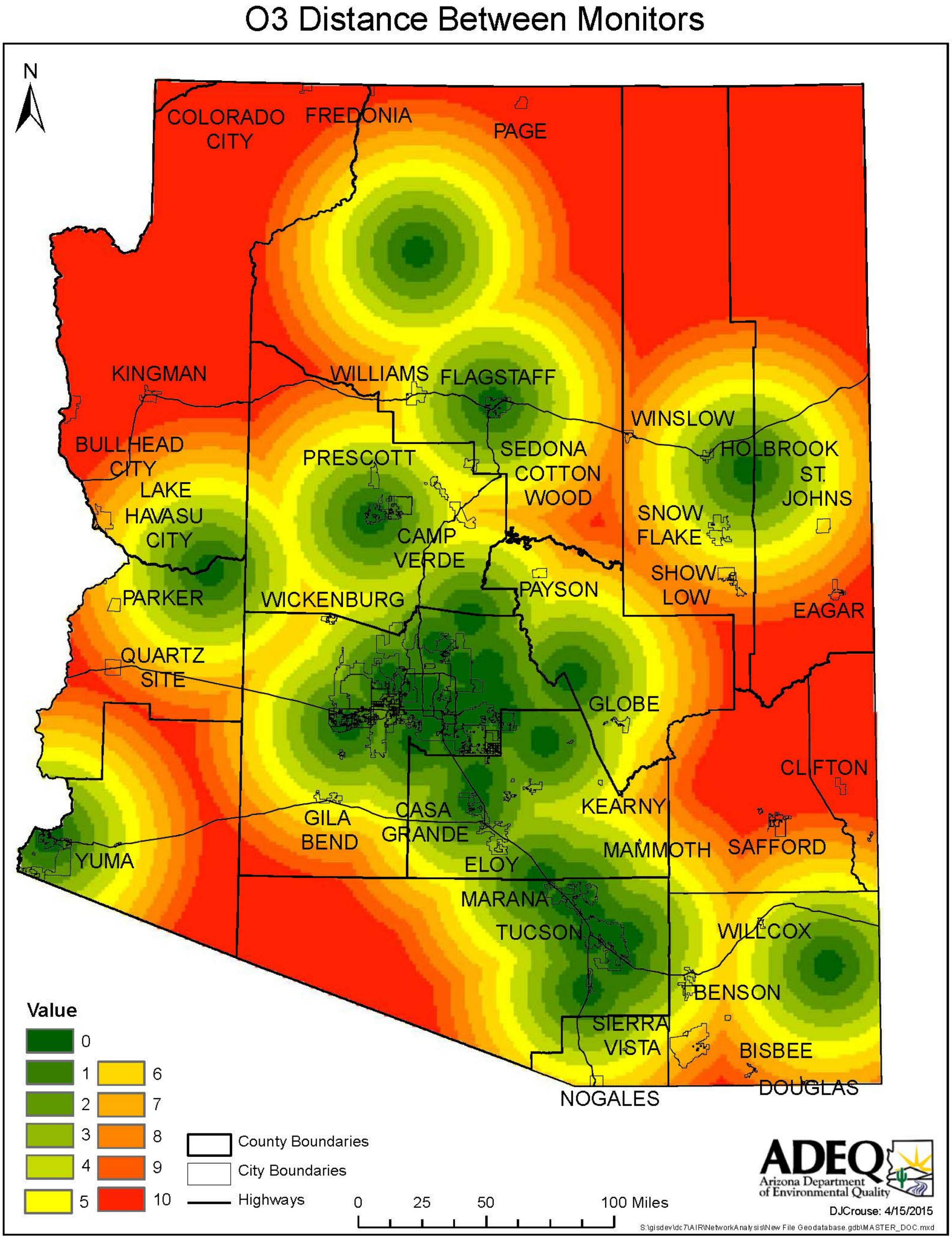


Figure 22: PM_{10} Distance Between Monitors Map

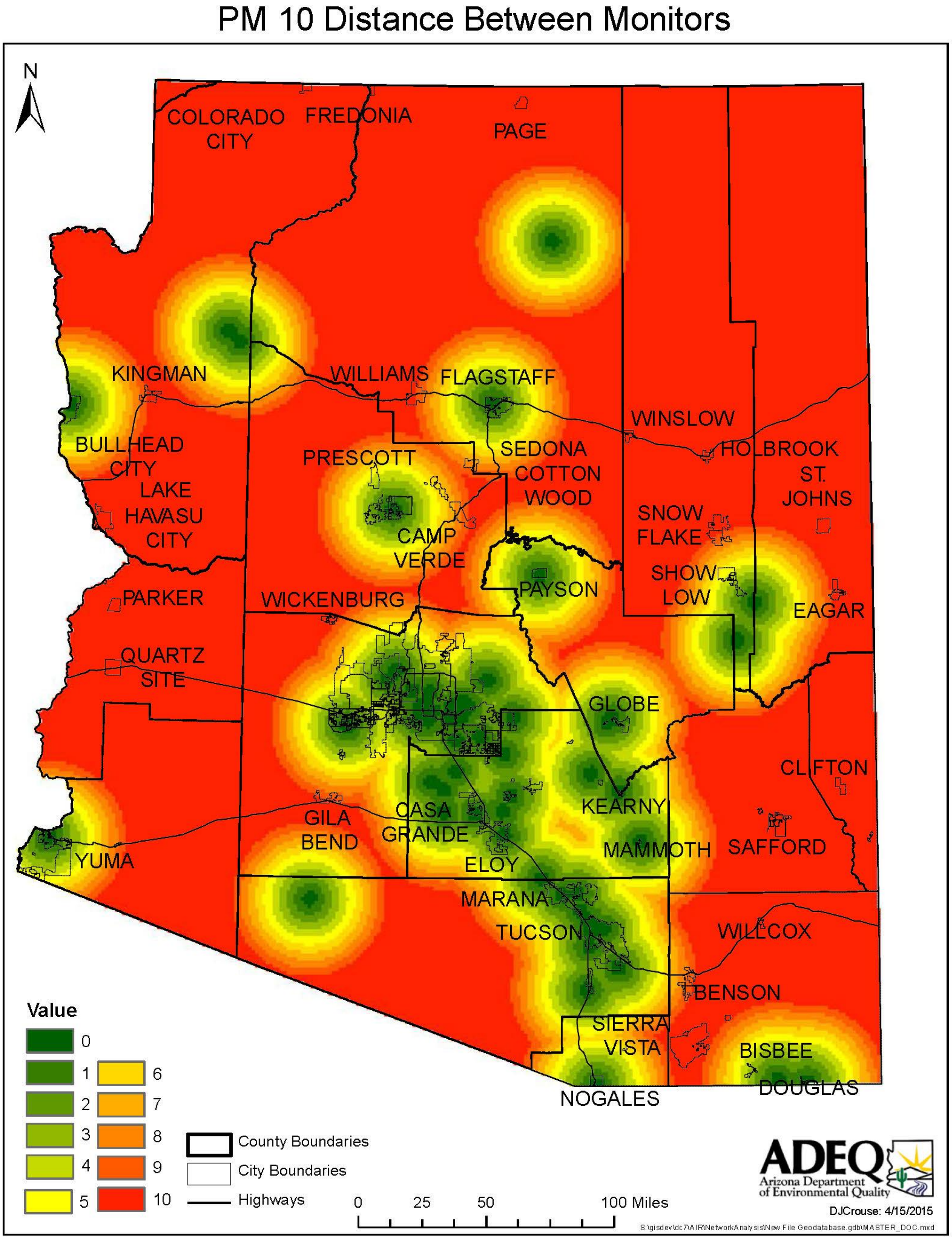


Figure 23: PM$_{2.5}$ Distance Between Monitors Map

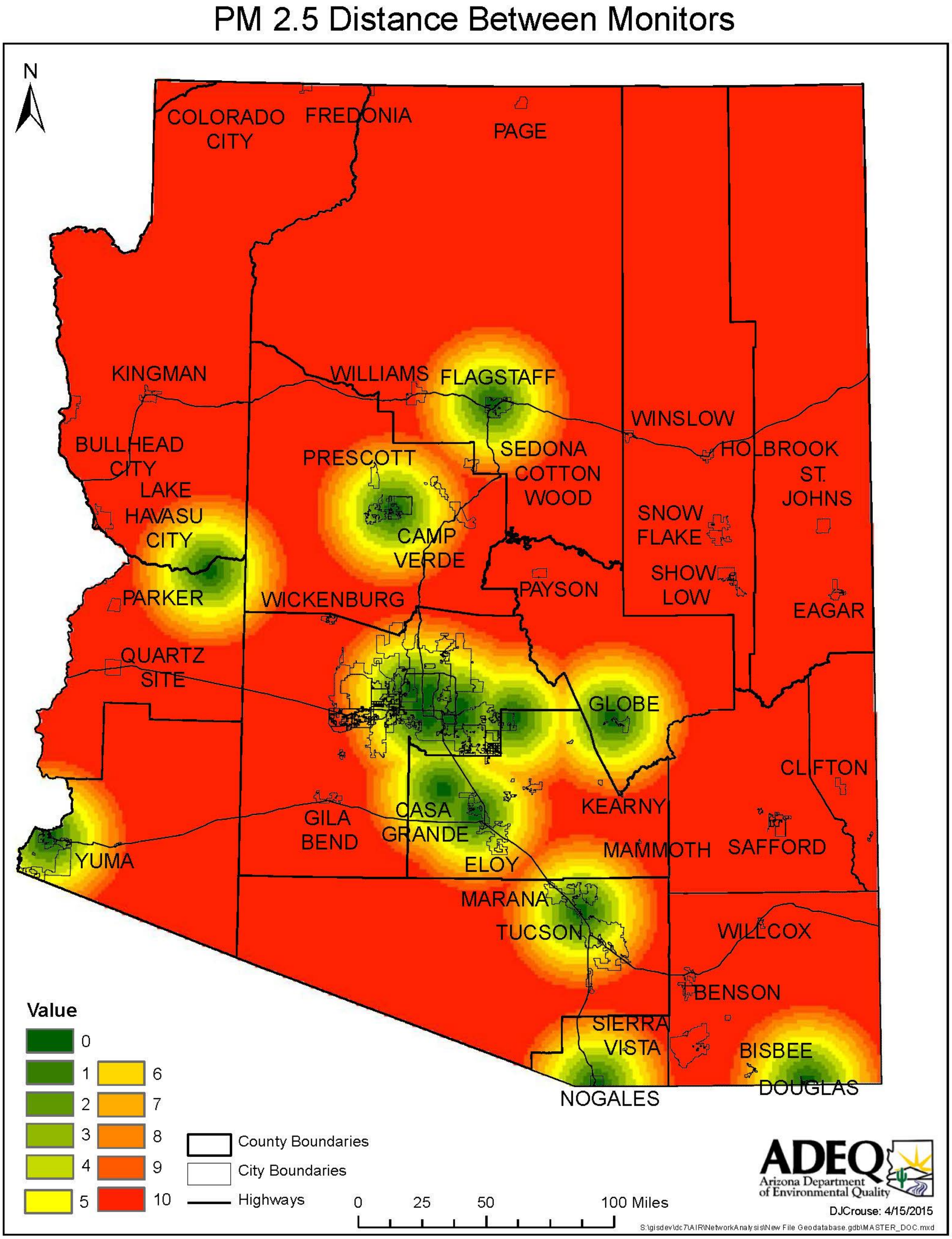


Figure 24: CO Distance Between Monitors Map

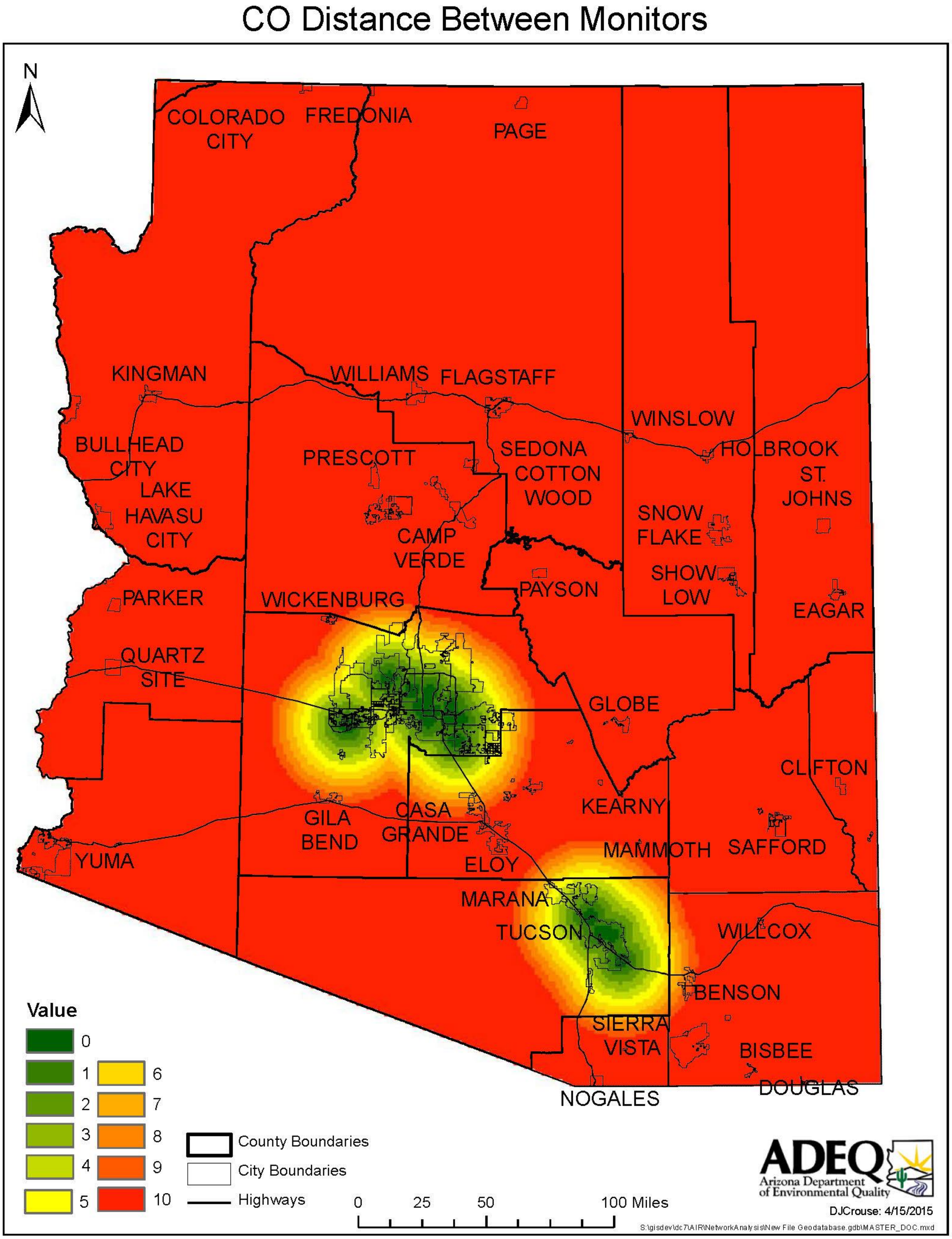


Figure 25: NO_2 Distance Between Monitors Map

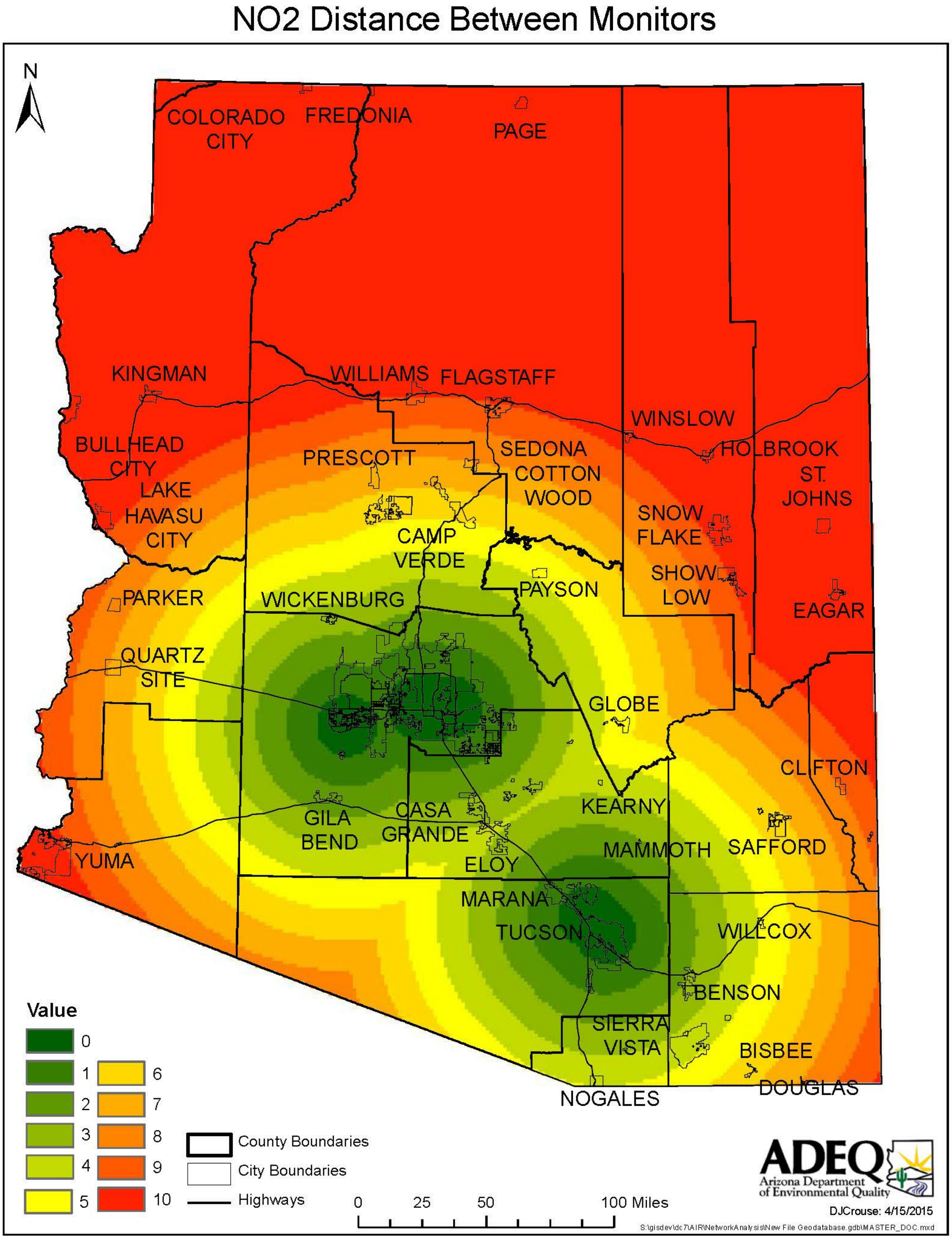
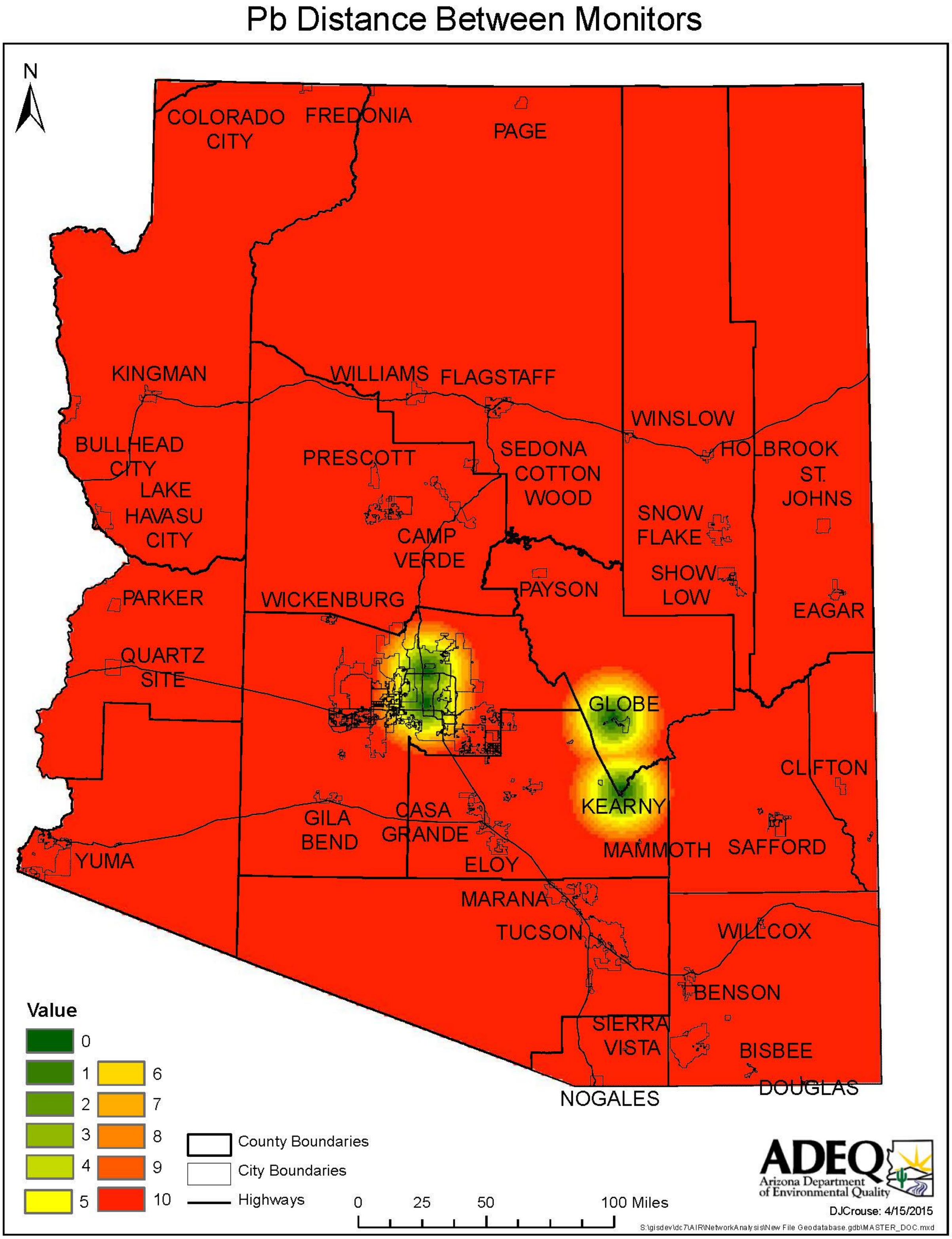


Figure 26: Pb Distance Between Monitors Map



G. Predicted Values

This indicator is a prediction model that uses a Kriging interpolation tool in ArcGIS to show predicted pollutant values. The Kriging interpolation uses average ambient concentrations but does not use topography, geographic, demographic, or meteorology in its prediction. The model uses average concentrations to estimate concentrations for all of Arizona. Predicted values are shown using 2009-2013 average design values by pollutant. This shows areas of higher and lower predicted concentration on a gradient similar to a topographic map. The Predicted Values indicator scores areas higher that have greater predicted concentrations.

It is assumed that areas with the highest predicted design values are most important to monitoring in Arizona. This indicator has disadvantages in that the predicted values have error in areas that are far from instruments. The interpolation of ambient concentrations in areas far away from recorded concentrations is not predicted well, therefore, this error should be taken into account when interpreting this indicator. The prediction Kriging interpolation was chosen over a Kriging error values option because the previous indicator (Section F: Distance Between Monitors page 59) closely represents standard error around the state. It is important to include a predicted value model in this analysis to estimate concentration levels around Arizona and therefore the Kriging interpolation ArcsGIS tool was used to create this unique dataset.

The entire distribution of values is divided in ten parts and assigned a score of 0-10, with 10 being the highest partition and highest predicted value.

Data were taken from the EPA's AQS web application database. The AMP480 Design Value Report was run for all monitors in Arizona, including state, local, and tribal monitors. Only monitors that were in operation during the 2009-2013 time period were used. Additional instruments outside of Arizona were used to lower the amount of error in the prediction models. The instruments outside of Arizona that were used are: Chamizal C41 in El Paso, TX, Del Norte High School in Albuquerque, NM, Denver Animal Shelter in Denver, CO, Hawthorne Elementary School in Salt Lake City, UT, Jerome Mack in Las Vegas, NV, Riverside – Rubidoux in Riverside, CA, and El Cajon in El Cajon, CA.

NOTE: Due to the low number of monitors in the CO, NO_2, and Pb networks, the Predicted Values indicator will not be used for the final spatial overlay map.

1. Results

The highest predicted values are shown as red areas.

Figure 27: SO_2 Predicted Values Map

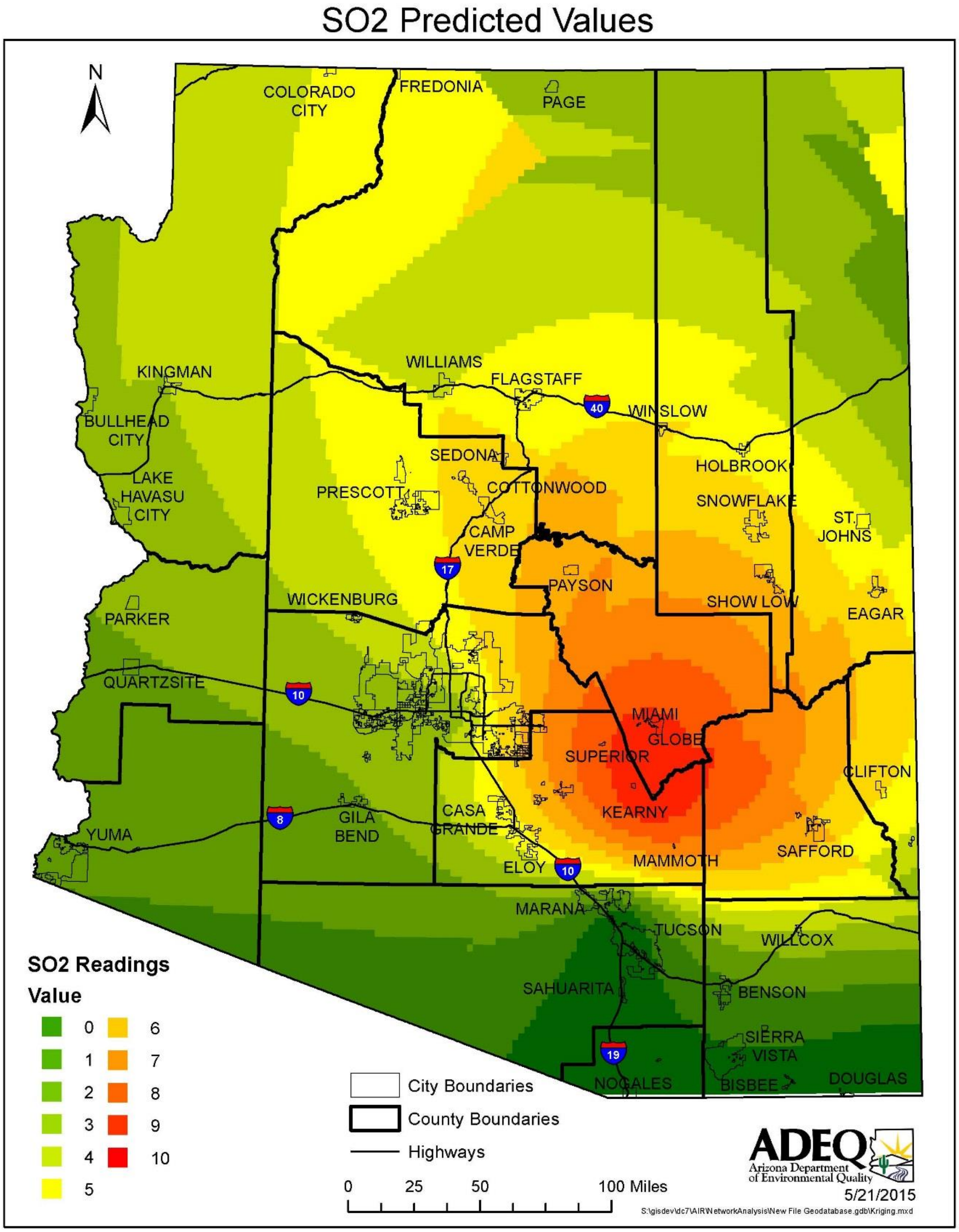


Figure 28: O_3 Predicted Values Map

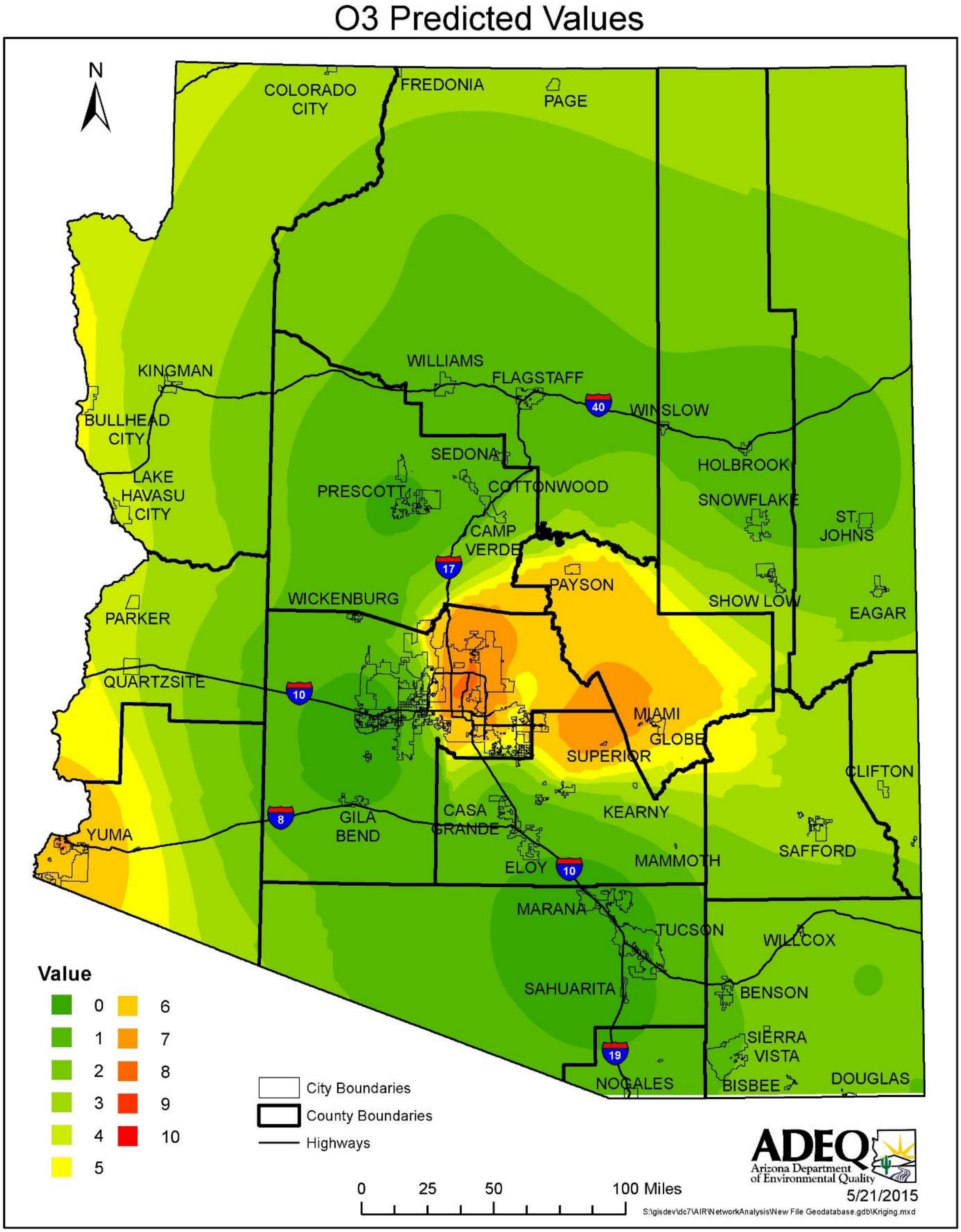


Figure 29: PM_{10} Predicted Values Map

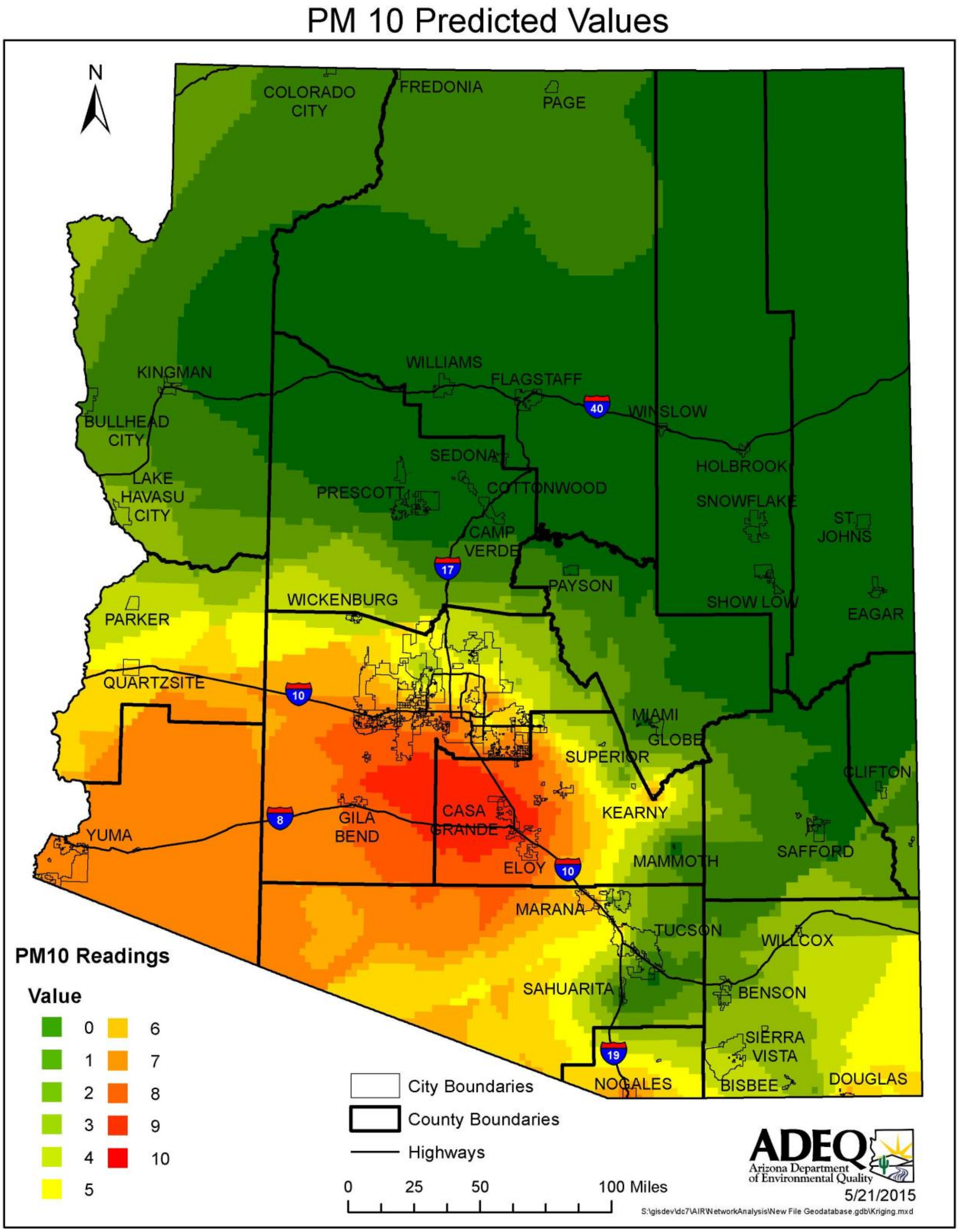
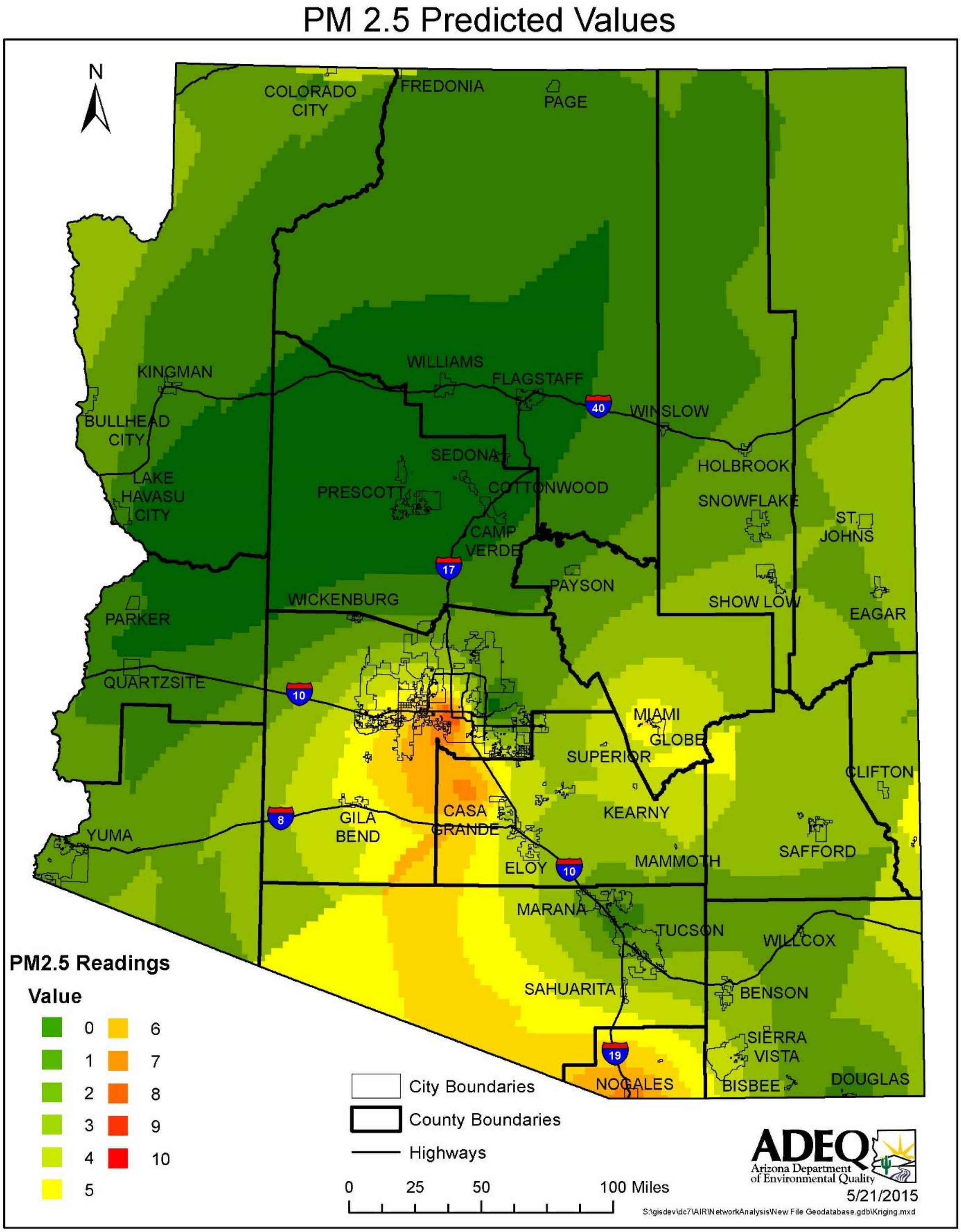


Figure 30: $PM_{2.5}$ Predicted Values Map



H. Final Weighted Overlay

The seven indicators in Section II (A-G) are combined together to form a single pollutant map that shows the final results of the Spatial Raster Analysis. The final map is called a weighted overlay and is produced to identify areas in Arizona that are of the highest importance to ambient air monitoring. This final map will be used for suggestions to possible relocations, removals, or additional monitors. See Section III page 80 for the final conclusions and recommendations of the Spatial Raster Analysis.

Before the creation of the final overlay map, the indicators were weighted according to their value to air monitoring in Arizona. Weights were derived from a survey given to ADEQ's Air Quality Division staff and others in Arizona's air monitoring community. The survey was conducted by asking each individual to rate the importance of each indicator listed in Section II page 40. In total 32 surveys were collected and averaged to determine a final rating weight for each indicator. That information was then applied to each ranking value in order to determine the final monitor rankings. It is not assumed that each indicator carries the same significance to the public welfare, regulatory actions, and to ambient air monitoring in Arizona. One indicator might be of greater significance than another, therefore the indicators needed to be ranked. Results were averaged from the survey and adjusted to a 0-1 scale listed in Table 48. They were adjusted to 0-1 because the weighted overlay tool in in ArcGIS requires the total weigh to be 1.0. All of the areas on the indicator maps were multiplied by the survey results to apply the weighting.

Table 48: Spatial Raster Analysis Survey Results

Indicator	SO_2	O_3	PM_{10}	$PM_{2.5}$	CO	NO_2	Pb
Hospitalization Density	0.14	0.17	0.16	0.16	0.13	0.14	0.14
Sensitive Age Density	0.15	0.17	0.16	0.17	0.15	0.15	0.18
Population Density	0.15	0.18	0.16	0.16	0.21	0.20	0.18
Point Sources	0.20	0.08	0.14	0.13	0.16	0.17	0.25
Traffic Count	0.09	0.15	0.12	0.13	0.23	0.23	0.11
Distance Between Monitors	0.11	0.10	0.11	0.11	0.11	0.12	0.14
Predicted Values	0.15	0.16	0.15	0.15	*N/A	*N/A	*N/A

*The Predicted Values indicator is not used for CO, NO_2, and Pb because there is insufficient monitoring data for these networks

1. Weighted Overlay

The areas that are most important to new monitoring are shown in red.

Figure 31: SO_2 Weighted Spatial Overlay

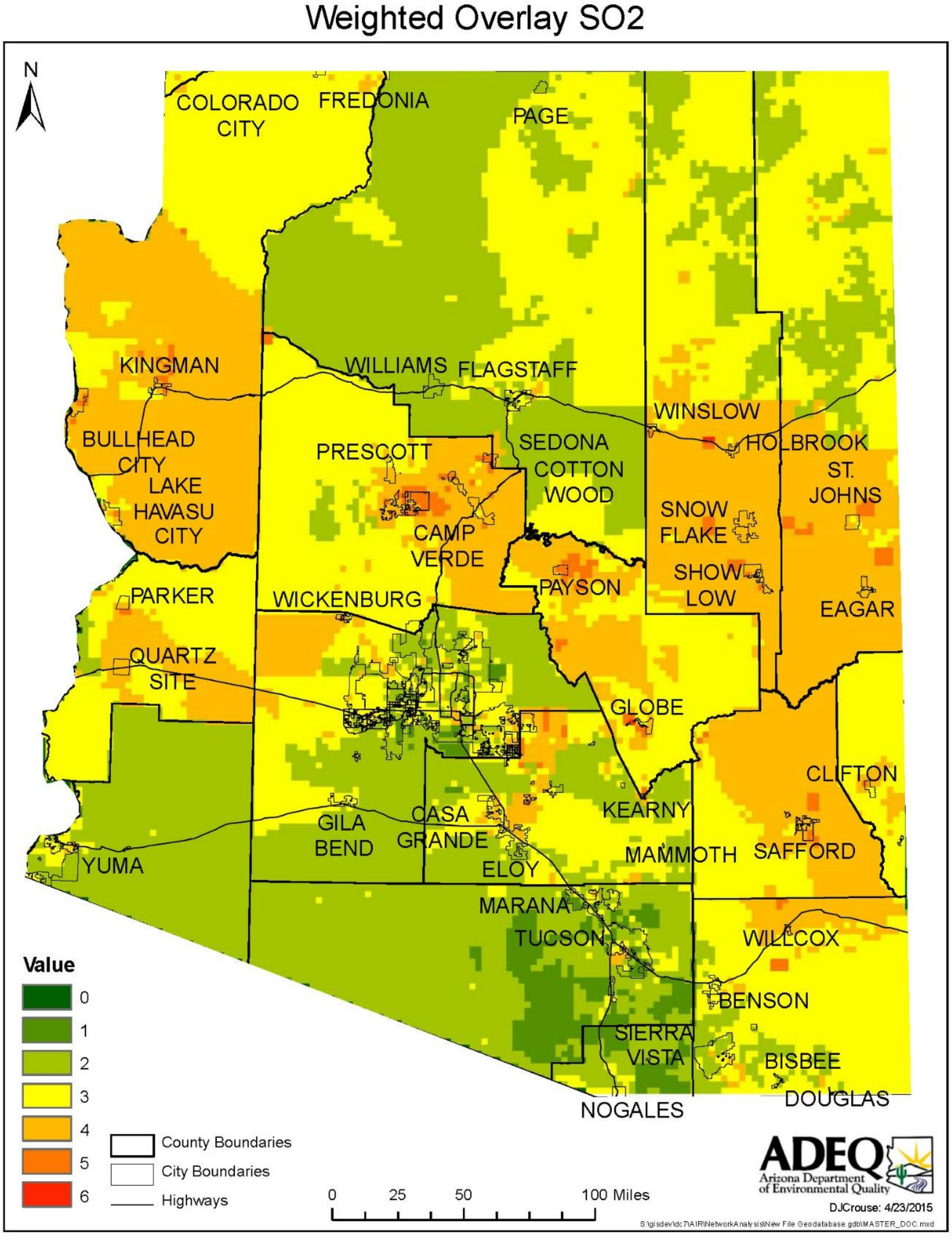


Figure 32: O_3 Weighted Spatial Overlay

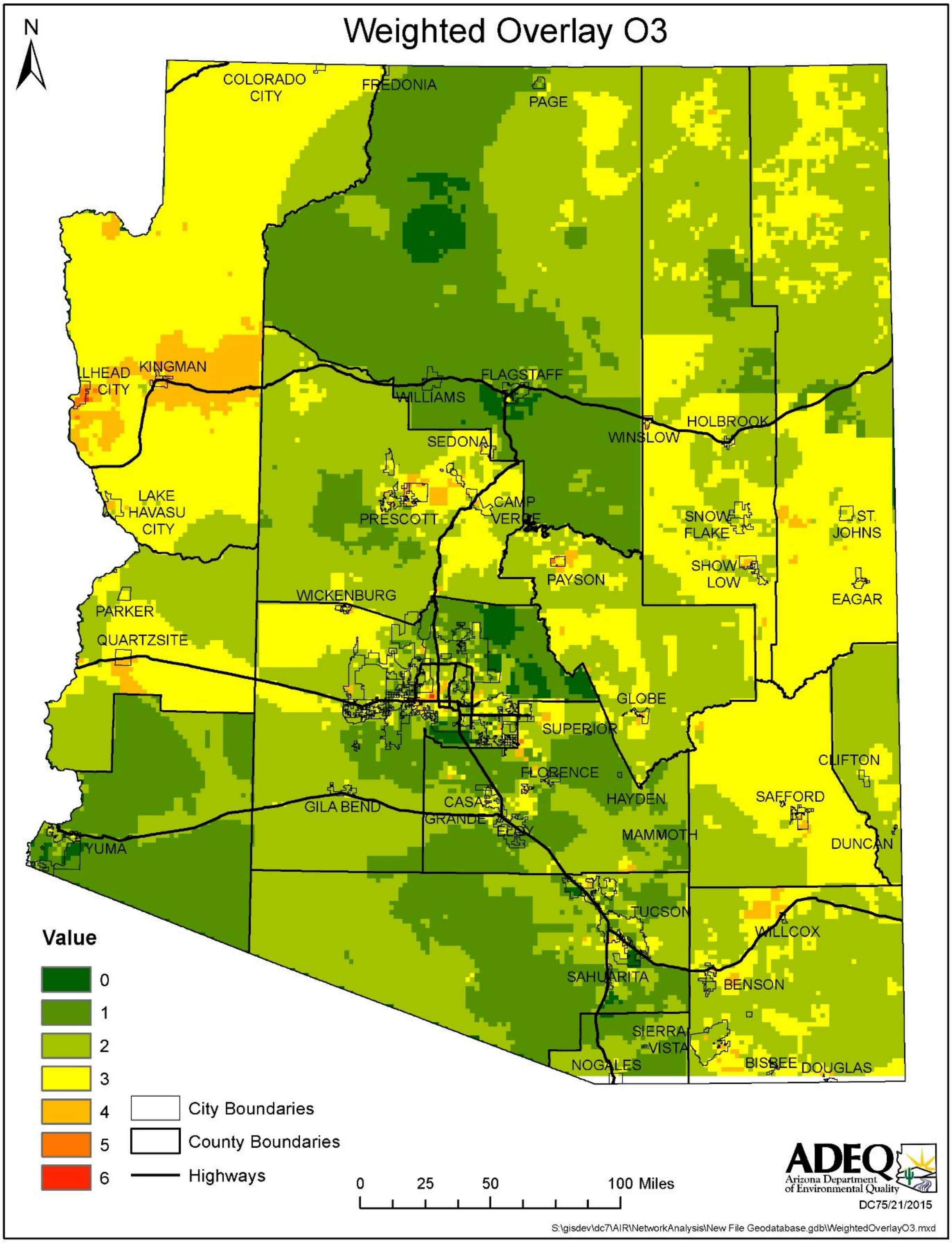


Figure 33: PM_{10} Weighted Spatial Overlay

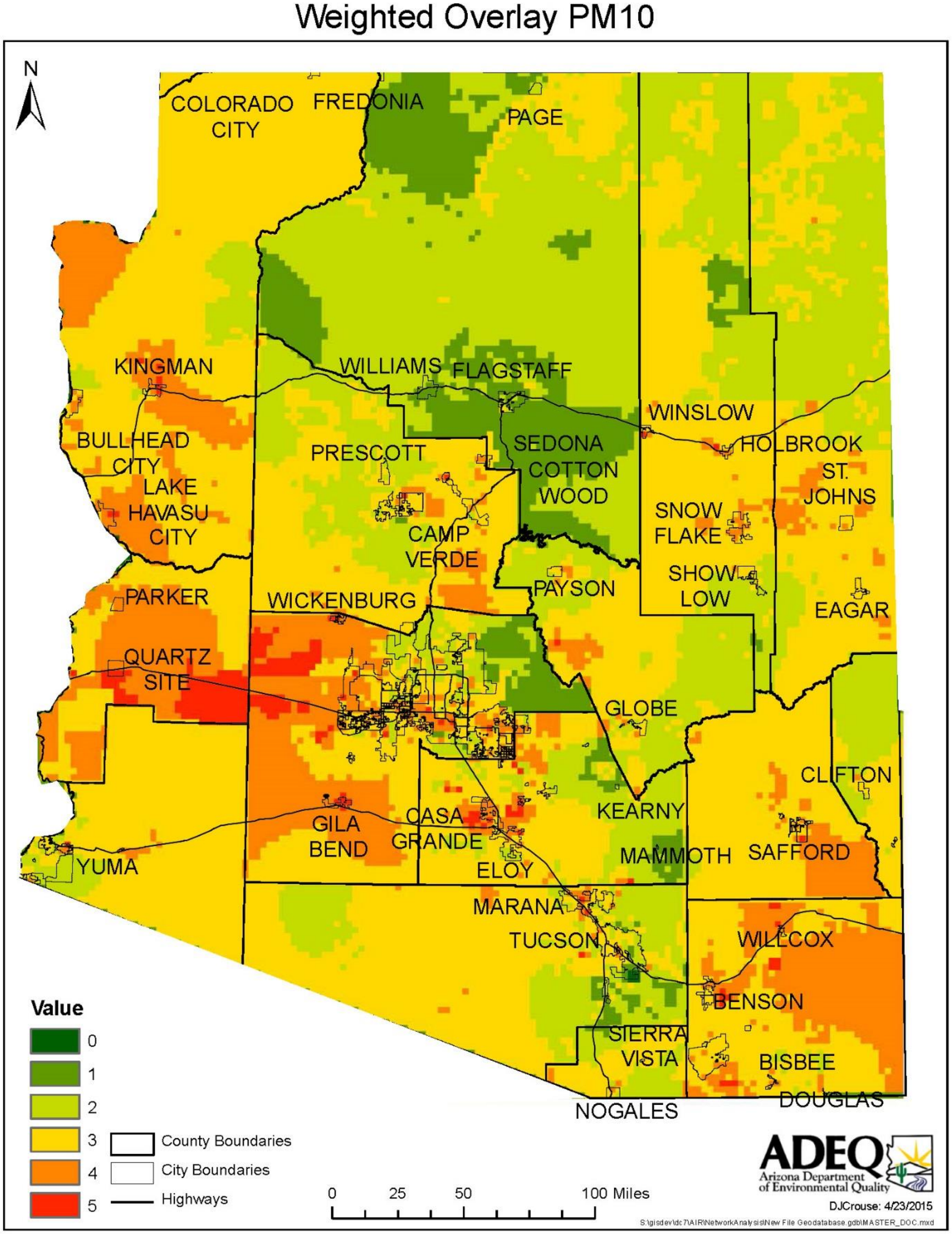


Figure 34: $PM_{2.5}$ Weighted Spatial Overlay

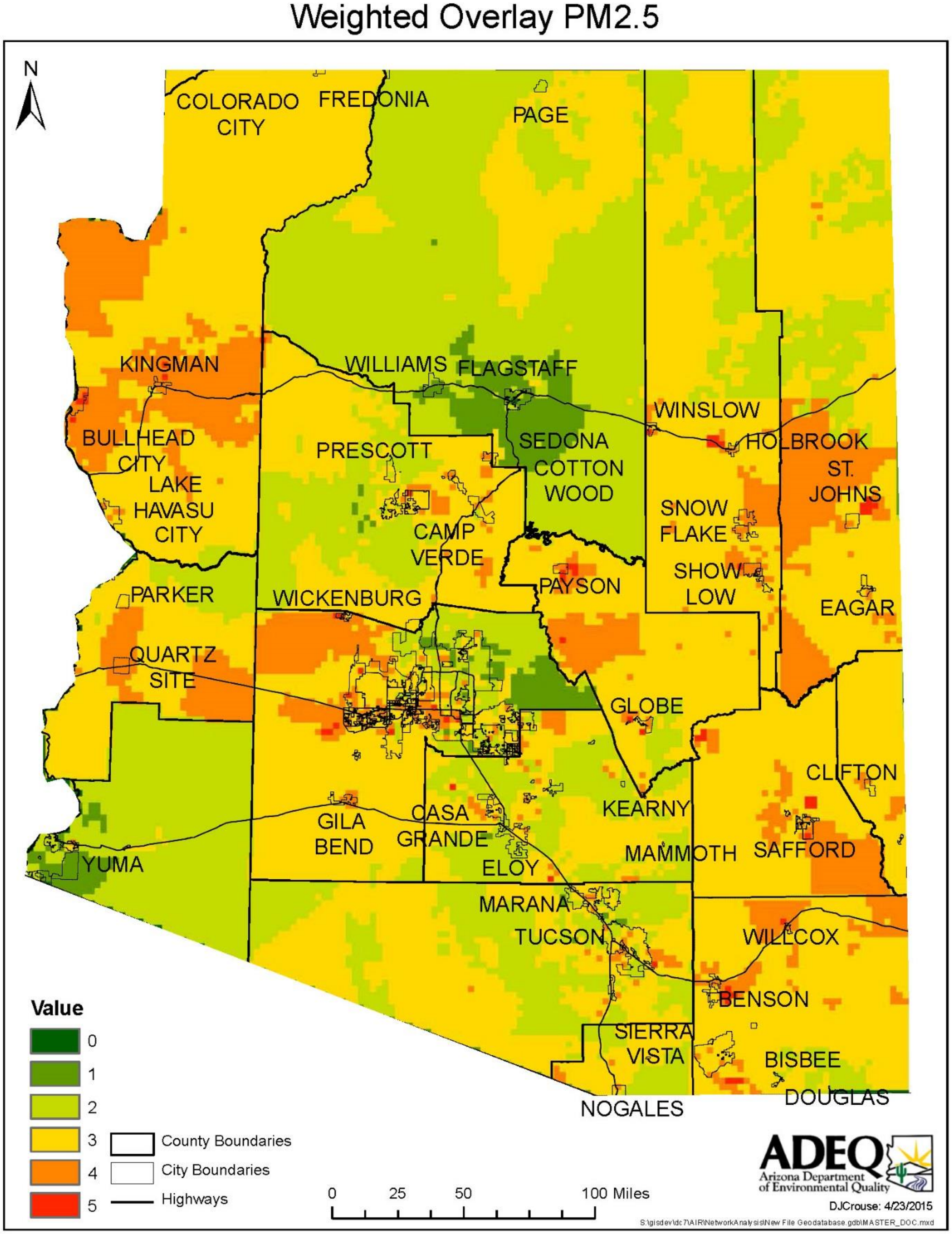


Figure 35: CO Weighted Spatial Overlay

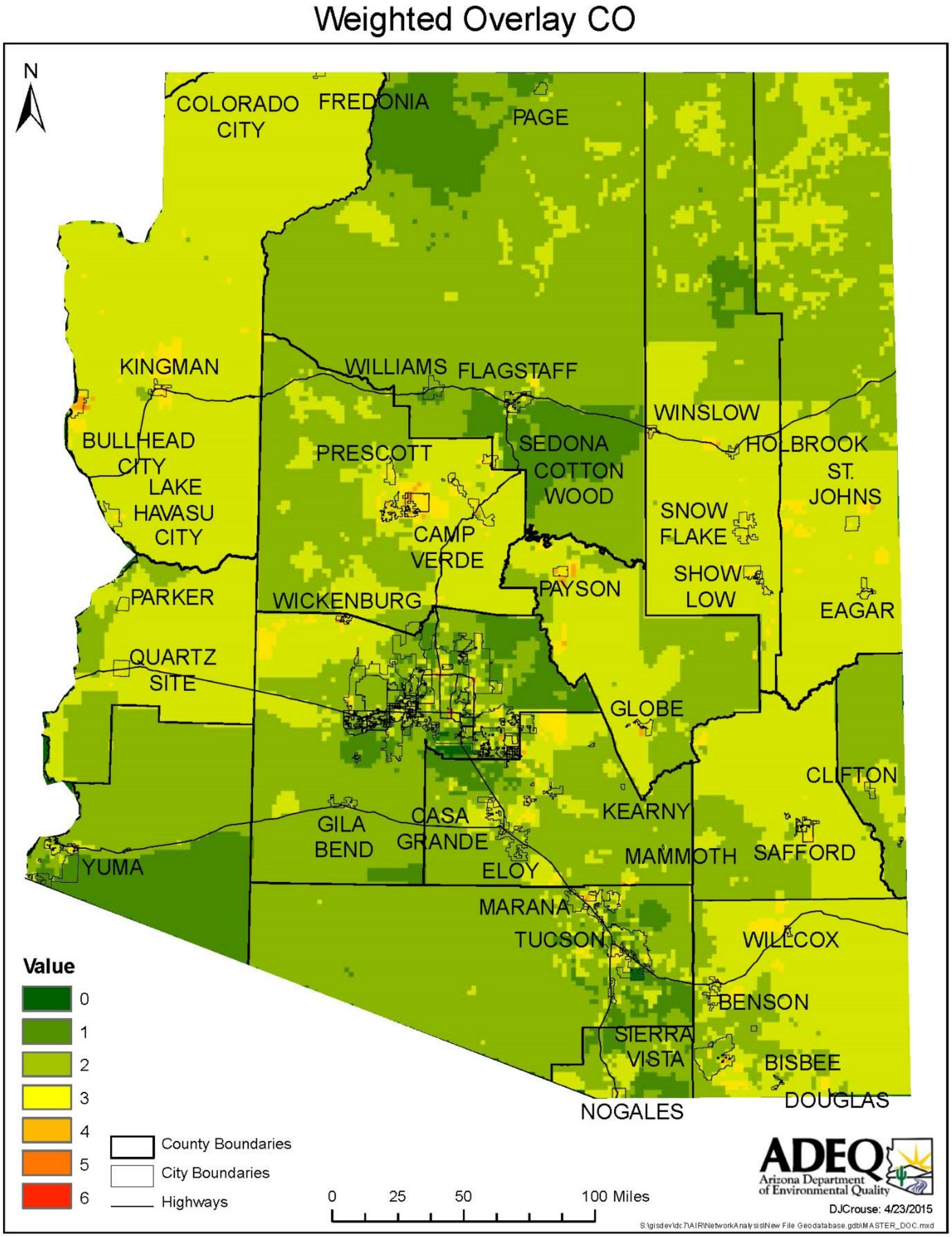


Figure 36: NO_2 Weighted Spatial Overlay

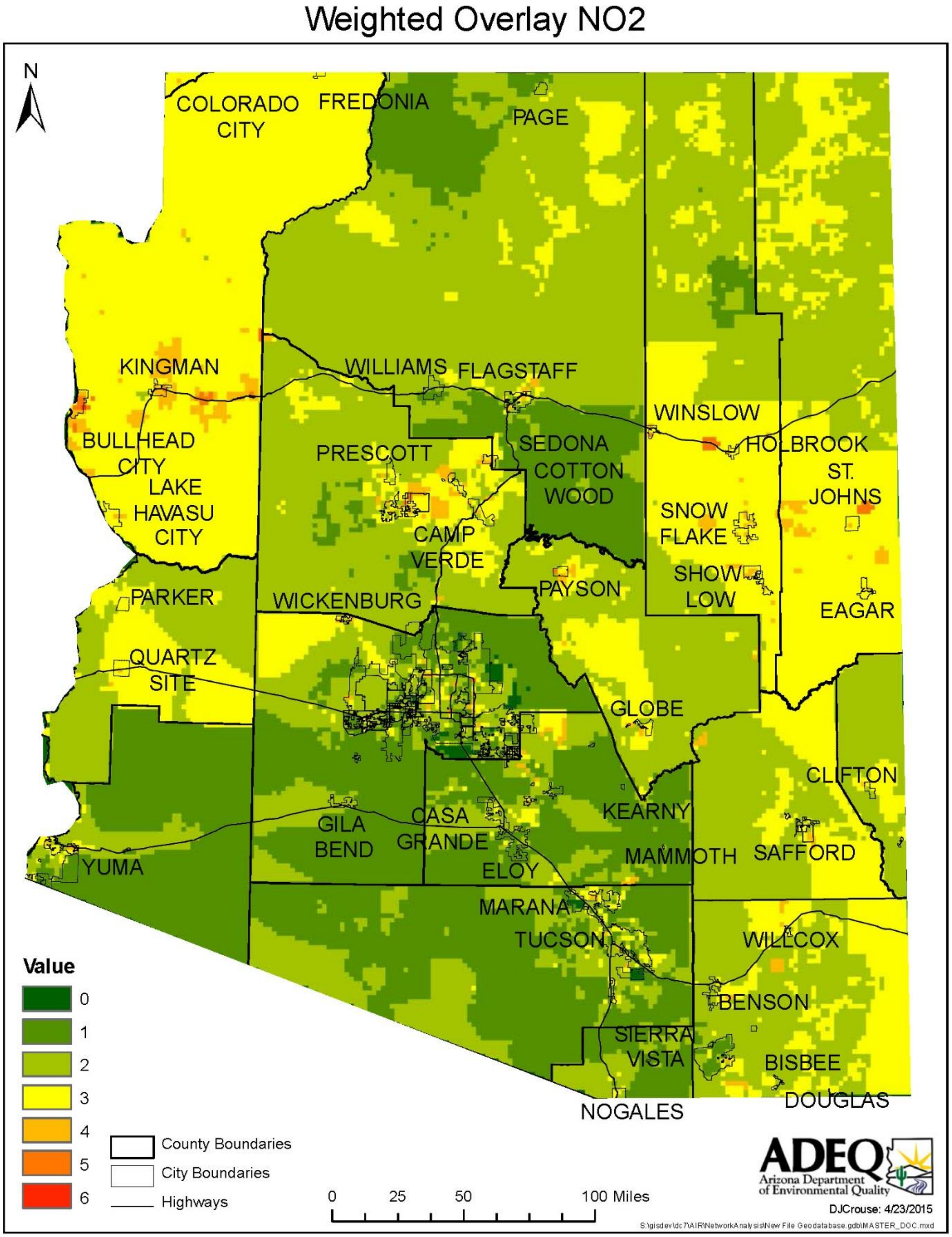
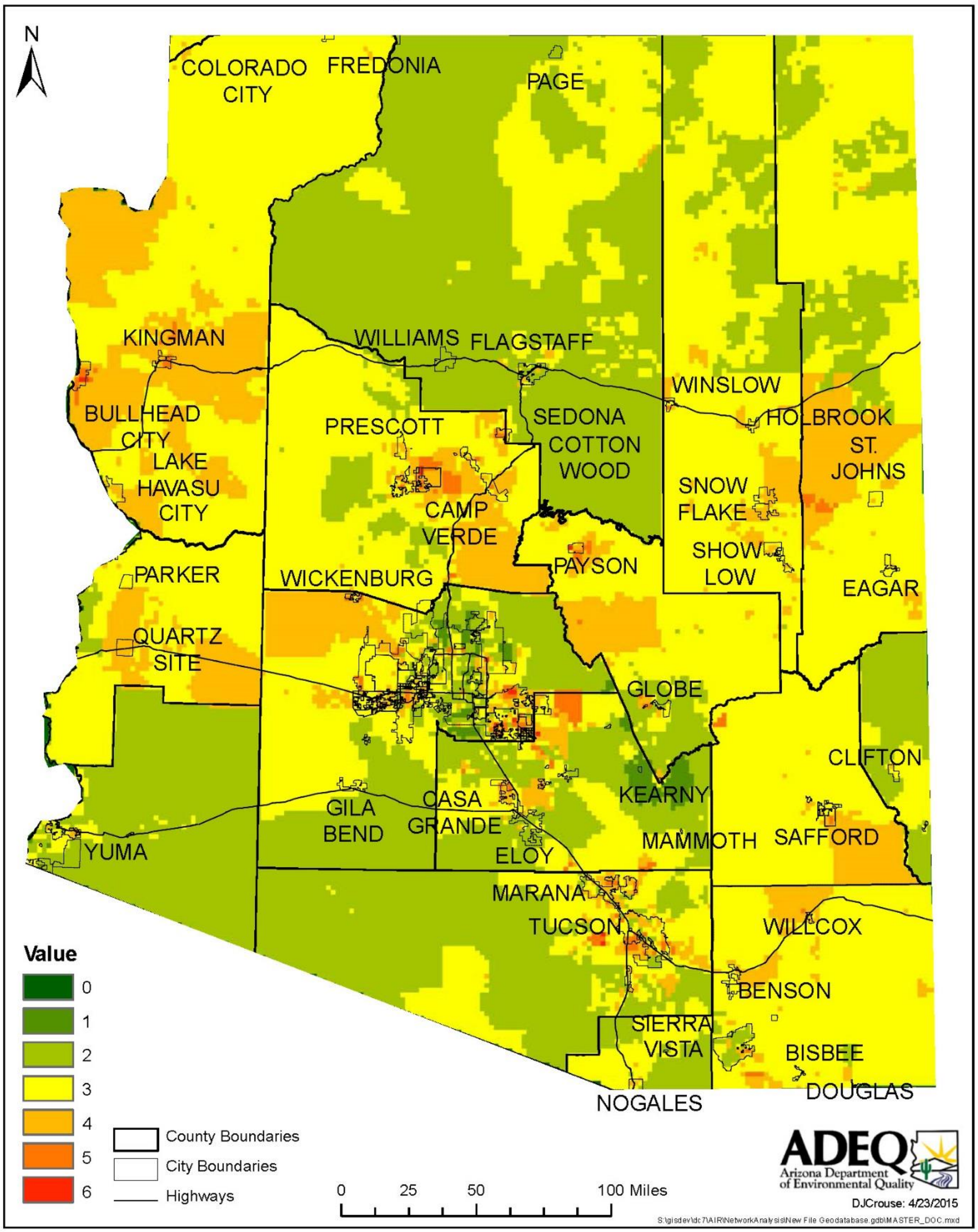


Figure 37: Pb Weighted Spatial Overlay



Section III: Final Conclusions and Recommendations

A. Final Conclusions and Recommendations by Pollutant Network

The final conclusion and recommendations were made by ADEQ's Air Quality management from both the Ranking Analysis and the Spatial Raster Analysis. These recommendations are only made from this 5-Year Network assessment and are intended to improve the quality and adequacy of ADEQ's air monitoring network. These conclusions and recommendations are made for the next five years and plans to modify the air monitoring network will be made in the 2016 Annual Network Plan.

1. General conclusions from the Ranking Analysis

Two sites stand out as particularly significant for ADEQ's networks based on the Monitor Ranking Analysis. The Yuma Supersite and JLG Supersite monitors are consistently ranked high across all pollutant networks as important to air monitoring. Specific attention to their operation should be in place to not lose important ambient air data at these sites. Technology and supporting equipment upgrades should be made to these sites first as modernizing and upgrading improved data security, quality, and quantity. Data from Yuma Supersite are particularity important to support regulatory actions for this area and for border air quality research. The JLG Supersite is specifically important to the trends analysis and air quality research for the Phoenix area.

2. SO_2

a. Ranking analysis

Currently, all monitors are required in the area and as such no recommendations are made at this time. However, the Ranking Analysis indicates that there can be some optimization of the Miami, AZ monitoring network. With the Miami Townsite monitor ranking the lowest, it indicates that this monitor could be re-sited to better represent a more unique area or be removed. However, both the Miami Townsite monitor and the Miami Jones Ranch monitor do not have long records and need to be in operation longer to make a recommendation. Future statistical analysis will be need to be done to remove or relocate any of the Miami area SO_2 monitors. Modifying networks is subject to regulatory and regional approval. Options for modifying a network are found in 40 CFR Part 58.14.

The Alamo Lake monitor is not required and is designated as a Special Purpose Monitor. Removal of the monitor is required before two full years of operation. It also does not have a long record and data are not available for the Measured Concentrations, Deviation from the NAAQS, and Correlation Between Monitors indicators. Rankings are still made using the other indicators and this qualification should be accounted for when looking at the final rankings.

b. Spatial Raster Analysis

No recommendations are made based on the Spatial Raster Analysis. The final weighted overlay map did not produce particular areas of interest sufficient to make any recommendations for the addition of new instrumentation. Specific point sources targeted by the upcoming SO_2 requirements rule were identified, but no recommendations for monitoring are made from this analysis. Areas of over representation were not found and the current SO_2 network was deemed satisfactory to represent SO_2 air pollution in Arizona.

3. O_3

a. Ranking Analysis

Currently all O_3 monitors are required and no recommendations are made based on the Ranking Analysis. All of ADEQ's O_3 monitors are considered important to O_3 monitoring.

b. Spatial Raster Analysis

Recommendations for improving the O_3 monitoring network involve additions to the current network. It was not determined that any monitors should be closed based on this analysis because ADEQ's monitors are not over representing any areas in Arizona. The areas of interest to O_3 are the Kingman, Payson, and Bullhead City areas. These areas were ranked highest and had the largest areas of high ranking. No monitoring in these areas has occurred in the past and thus would be beneficial to do exploratory monitoring to see if these areas are truly places that should be monitored continuously. This exploratory monitoring would benefit from using temporary and low cost monitoring sensors rather than traditional monitoring. Traditional monitoring capital and running costs are high and a significant amount of resource allocation would be needed. Low cost sensor technology and alternative monitoring techniques are recommended to use for this exploratory monitoring. The monitoring would be for public health and information purposes during the exploratory phase, not for regulatory comparisons.

4. PM_{10}

a. Ranking Analysis

Currently, twelve of the thirteen PM_{10} monitors are required monitors and no recommendations for those twelve monitors are made.

The Nogales Post Office (Primary PM_{10} Filter) instrument is not required and should be removed to optimize the PM_{10} network. It is also the lowest ranked monitor in the Ranking Analysis. The removal of this instrument will not cause data loss since it is a collocated instrument and only runs 1-in-6 days. The continuous instrument will remain and provide higher resolution data. A request for removal should be made in the 2015 Annual Network Plan.

The Alamo Lake monitor does not have a long record and data are not available for the Measured Concentrations, Deviation from the NAAQS, and Correlation Between Monitors indicators. Therefore excluding these Indicator Values produces a high rank which can be misleading. Alamo Lake was not excluded from this analysis resulting in Alamo Lake being the highest ranked monitor. This would likely change if these indicators were included.

b. Spatial Raster Analysis

Recommendations for improving the PM_{10} monitoring network involve additions to the current network. It was not determined that any monitors should be closed based on this analysis due to being over representative. The areas of interest identified to PM_{10} monitoring are the Quartzite, Kingman, and Benson/Willcox areas. These areas were ranked highest and had the largest areas of high ranking. No monitoring in these areas has occurred in the past and thus would be beneficial to do exploratory monitoring to see if these areas are truly places that should be monitored continuously. This exploratory monitoring would benefit from using temporary and low cost monitoring sensors rather than traditional monitoring.

Traditional monitoring capital and running costs are high and a significant amount of resource allocation would be needed. Low cost sensor technology and alternative monitoring techniques are recommended to use for this exploratory monitoring. The monitoring would be for public health and information purposes during the exploratory phase, not for regulatory comparisons.

5. $PM_{2.5}$

a. Ranking Analysis

Currently seven of the eight $PM_{2.5}$ monitors are required and no recommendations for those seven monitors are made.

The Nogales Post Office (Secondary $PM_{2.5}$ Filter) instrument is not required and should be removed to optimize the $PM_{2.5}$ network. It is also the lowest ranked monitor in the Ranking Analysis. The removal of this instrument will not cause data loss since it is a collocated instrument and only runs 1-in -6 days. Both the Nogales Post Office (Continuous) and the Nogales Post Office (Primary Filter) instruments will remain and provide the same level of data confidence. A request for removal should be made in the 2015 Annual Network Plan.

The Alamo Lake monitor does not have a long record and data are not available for the Measured Concentrations, Deviation from the NAAQS, and Correlation Between Monitors indicators. Therefore excluding these Indicator Values produces a high rank which can be misleading. Alamo Lake was not excluded from this analysis resulting in Alamo Lake being the highest ranked monitor. This would likely change if these indicators were included.

b. Spatial Raster Analysis

Recommendations for improving the $PM_{2.5}$ monitoring network involve additions to the current network. It was not determined that any monitors should be closed based on this analysis because there was over representation of ADEQ's $PM_{2.5}$ network. The areas of interest to $PM_{2.5}$ are the Bullhead City and Benson/Willcox areas. These areas were ranked highest and had the largest areas of high ranking. No monitoring in these areas has occurred in the past and thus would be beneficial to do exploratory monitoring to see if these areas are truly places that should be monitored continuously. This exploratory monitoring would benefit from using temporary and low cost monitoring sensors rather than traditional monitoring. Traditional monitoring capital and running costs are high and a significant amount of resource allocation would be needed. Low cost sensor technology and alternative monitoring techniques are recommended to use for this exploratory monitoring. The monitoring would be for public health and information purposes during the exploratory phase, not for regulatory comparisons.

The northeastern part of Arizona (Showlow, Snowflake, St. Johns) also shows a large area of interest for $PM_{2.5}$. Currently, an EBAM Network of informational monitors exists and was not included in this analysis. If these monitors were included, this area would not be of interest to monitoring. This EBAM Network is non-regulatory and is used for public health and information purposes.

6. CO

a. Spatial Raster Analysis

No areas were identified as areas of interest and no recommendations are made based on the Spatial Raster Analysis. The CO network is currently meeting all minimum monitoring requirements. A background

SPM at Alamo Lake is planned for operation for modeling and permitting purposes, not for regulatory comparisons.

7. NO_2

a. Spatial Raster Analysis

No areas were identified as areas of interest and no recommendations are made based on the Spatial Raster Analysis. The NO_2 network is current meeting all minimum monitoring requirements and no plans are being made for the operation of additional monitors.

8. Pb

a. Spatial Raster Analysis

No areas were identified as areas of interest and no recommendations are made based on the Spatial Raster Analysis. The Pb network is currently meeting all minimum monitoring requirements. An additional monitor is being planned for the Hayden area to ensure that the maximum concentration area is being measured.

Appendix A – Definitions and Abbreviations

AAS	Air Assessment Section
AADT	Annual Average Daily Traffic
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AMU	Air Monitoring Unit
ArcMap	GIS Analysis Software
ASARCO	American Smelting and Refining Company, LLC
AQS	Air Quality System (EPA database)
AZDHS	Arizona Department of Health Services
CAA	Clean Air Act
CBSA	Core Based Statistical Area
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CSN	Chemical Speciation Network
DM&QA	Data Management & Quality Assurance Unit
EPA	Environmental Protection Agency
FEM	Federal Equivalent Method
FMMI	Freeport McMoRan Copper and Gold Inc.
FRM	Federal Reference Method
GIS	Geographic Information System
IMPROVE	Interagency Monitoring of PROtected Visual Environments
MCAQD	Maricopa County Air Quality Department
MET	Meteorological Measurements (wind, temperature, relative humidity)
MSA	Metropolitan Statistical Area
$\mu g/m^3$	Micrograms per Cubic Meter
NAAQS	National Ambient Air Quality Standard

NCore	National Core multipollutant monitoring stations
NM	National Monument
NO_2	Nitrogen Dioxide
NOx	Nitrogen oxides
NOy	Reactive Nitrogen Oxides
NPS	National Park Service
O_3	Ozone
PAMS	Photochemical Assessment Monitoring Station
Pb	Lead
PCAQCD	Pinal County Air Quality Control District
PDEQ	Pima County Department of Environmental Quality
PM	Particulate Matter
PM_{10}	Particulate Matter ≤ 10 microns
PM_{coarse}	Coarse Particulate Matter between 2.5 to 10 micrometers aerodynamic diameter, may also be denoted as $PM_{10-2.5}$
$PM_{2.5}$	Particulate Matter ≤ 2.5 microns
POC	Parameter Occurrence Code
ppb	Parts Per Billion
ppm	Parts Per Million
PQAO	Primary Quality Assurance Organization
SIP	State Implementation Plan
SLAMS	State and Local Air Monitoring Stations
SO_2	Sulfur Dioxide
SPM	Special Purpose Monitor

Appendix B – References

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