APPENDIX 1

Memo from John S. Seitz, Director, Office of Air Quality Planning and Standards, U.S. EPA, to EPA Air Directors, "Boundary Guidance on Air Quality Designations for the 8-Hour Ozone National Ambient Air Quality Standards (NAAQS or Standard)", March 28, 2000

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

MAR 28 2000

MEMORANDUM

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

SUBJECT: Boundary Guidance on Air Quality Designations for the 8-Hour Ozone National Ambient Air Quality Standards (NAAQS or Standard)

FROM: John S. Seitz, Director
Office of Air Quality Planning and Standards (MD-10)

TO: Air Directors, Regions I-X

The purpose of this memorandum is to provide guidance to State and local air pollution control agencies and Tribes (States and Tribes) on designating areas as attainment/unclassifiable[1] or nonattainment and the Environmental Protection Agency's (EPA's) views on the boundaries for nonattainment areas for the 8-hour ground-level ozone NAAQS.

Area designations to attainment/unclassifiable or nonattainment are required after promulgation of a new or revised NAAQS. The EPA promulgated a new 8-hour ozone NAAQS in July 1997 and is, therefore, obligated to designate all areas by July 2000 as established by the Clean Air Act (CAA or Act) and the Transportation Equity Act for the 21 Century (TEA-21).[2] On May 14, 1999, the U.S. Court of Appeals for the District of Columbia Circuit issued a decision remanding, but not vacating, the 8-hour ozone standard. The court noted that EPA is required to designate areas for any new or revised NAAQS in accordance with §107(d)(1) of the Act. American Trucking Assoc. v. EPA, 175 F.3d 1027, 1047-48, on rehearing 195 F.3d 4 (D.C. Cir. 1999).

The process for designations following promulgation of a NAAQS is contained in §107(d)(1) of the Act. This section provides each State Governor an opportunity to recommend attainment/unclassifiable or nonattainment designations including appropriate boundaries to EPA and for EPA to make modifications to these designations and boundaries as it deems necessary. In June 1999, EPA requested that each State forward (or complete entering into the Aerometric Information Retrieval System data base) air quality data through 1998 and identify which

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[1]A designation to attainment/unclassifiable means that the area has sufficient data to determine that the area is meeting the 8-hour ozone NAAQS or that due to no data or insufficient data, EPA cannot make a determination.

[2]CAA §107(d)(1); TEA-21§6103(a).

monitors were exceeding the 8-hour standard during the 1996-1998 time frame. The EPA is now requesting that each State Governor submit their designation recommendations and supporting documentation to the appropriate EPA Regional Office, to the attention of the Regional Administrator, by June 30, 2000. These recommendations should generally be based on States' 1997-1999 quality-assured, Federal reference or equivalent air quality monitoring data.

In accordance with the CAA, EPA will review the recommended designations and may make modifications as deemed necessary to a State's recommendation. If EPA determines that a modification to the recommendation is necessary, EPA will notify the State no later than 120 days prior to promulgating a designation, which will provide an opportunity for the State to demonstrate why EPA's modification is not appropriate. In the case where a State does not submit recommendations, EPA will promulgate the designation it deems appropriate. As described in the attachment, Tribal designation activities are covered under a different legal authority.

This memorandum provides EPA's current views on how boundaries should be determined for designations. This guidance is not binding on States, Tribes, the public, or EPA. Issues concerning nonattainment area boundaries will be addressed in actions to designate nonattainment and attainment/unclassifiable areas under §107 of the CAA. When EPA promulgates designations, those determinations will be binding on States, Tribes, the public, and EPA as a matter of law.

The attachment contains the guidance on determining boundaries. Questions on this guidance may be directed to Sharon Reinders at 919-541-5284. The Regional Offices should make this guidance available to their States and Tribes and, where appropriate, work closely with them to ensure they submit their area recommendations by June 30, 2000.

Attachment

cc: Deputy Regional Administrators, Regions I-X
Margo Oge, OTAQ

Attachment

8-HOUR OZONE NAAQS
GUIDANCE ON NONATTAINMENT DESIGNATIONS

1. Why is EPA issuing this guidance on 8-hour ozone NAAQS nonattainment designations?

States have requested that EPA provide guidance on the appropriate boundaries for areas that will be designated nonattainment for the 8-hour standard. The EPA provided initial guidance on designations in a June 1999 memorandum.[1] That memorandum noted that EPA would provide additional information on designations at a future date. This guidance on how to determine the appropriate boundaries for areas that will be designated nonattainment for the current 8-hour ozone NAAQS is intended to meet that commitment. In addition, in light of the court decision remanding the 8-hour standard to EPA, States have asked what the implications are if EPA issues a revised ozone standard in response to the court's remand.

On July 18, 1997, EPA issued the revised NAAQS for ozone (62 FR 38856). The new standard is 0.08 parts per million (ppm) averaged over 8-hours; this compares to the pre-existing NAAQS of 0.12 ppm averaged over 1 hour. This action triggered the requirement under §107 of the Act and §6103 of TEA-21 for EPA to designate areas as attainment/unclassifiable or nonattainment for the revised NAAQS. Under these statutory provisions, EPA is required to designate areas for the revised standard by July 2000.

On May 14, 1999, the U.S. Court of Appeals for the District of Columbia Circuit issued a decision remanding, but not vacating, the 8-hour ozone standard. The court noted that EPA is required to designate areas for any new or revised NAAQS in accordance with §107(d)(1) of the Act. American Trucking Assoc. v. EPA, 175 F.3d 1027, 1047-48, on rehearing 195 F.3d 4 (D.C. Cir. 1999).

As provided in this guidance, EPA is planning to designate areas for the 8-hour ozone NAAQS promulgated in July 1997. If EPA promulgates a revised ozone NAAQS in response to a final unappealable court decision regarding the validity of the 8-hour standard, EPA would then be required to begin the designation process under §107 of the CAA for that revised ozone NAAQS. In such a case, EPA would issue guidance regarding designations for that revised NAAQS. At the time of promulgation of that revised NAAQS, EPA would establish, after an opportunity for public review, an appropriate transition scheme from the current 8-hour NAAQS to any revised NAAQS promulgated in response to the court's decision. Although this memorandum is not establishing the transition scheme, EPA does not anticipate requiring States or Tribes to comply with the statutory redesignation requirements to modify the designations for the replaced NAAQS.

2. What are the underlying requirements for designating areas for the 8-hour ozone NAAQS?

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[1]Memorandum of June 25, 1999, from John S. Seitz, "Designations for the 8-Hour Ozone National Ambient Air Quality Standard."

There are two relevant statutory provisions governing designations for the 8-hour ozone NAAQS. Section 107(d)(1) of the Act establishes the requirements for making designations for areas when a NAAQS is promulgated or revised. These are designations of nonattainment or attainment/unclassifiable. The provision provides an opportunity for each State to make a recommendation to EPA concerning the designation of areas in the State within 1 year after promulgation of a new or revised NAAQS. The EPA is required to designate areas across the country no later than 2 years following the promulgation of the NAAQS. The TEA-21 §6103 essentially extends by 1 year the 2-year designation process. Thus, States were provided 2 years to make their recommendations and EPA is required to designate areas 1 year after the State designation recommendations are due.

As authorized by the Tribal Authority Rule (TAR), Tribes may request an opportunity to submit designation recommendations to EPA. In cases where Tribes do not make their own recommendations, then EPA, in consultation with the Tribes, will promulgate the designation it deems appropriate on their behalf.[2]

In issuing the final designations, EPA is authorized to make such modifications it deems necessary to the recommended designations of the areas or portions thereof including the

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[2]The CAA, §301(d), authorizes EPA to treat eligible Indian Tribes in the same manner as States. Pursuant to §301(d)(2), EPA promulgated regulations known as the "Tribal Authority Rule" on February 12, 1999 that specifies those provisions of the Act for which it is appropriate to treat Tribes as States. 63 FR 7254, codified at 40 Code of Federal Regulations (CFR) §49 (1999). Under the TAR, Tribes may choose to develop and implement their own CAA programs, but are not required to do so. The TAR also establishes procedures and criteria by which Tribes may request from EPA a determination of eligibility for such treatment. The designations process contained in §107(d)(1) of the Act is included among those provisions determined appropriate by EPA for treatment of Tribes in the same manner as States. Therefore, EPA Regional Offices will work with the Tribes in their Regions that request an opportunity to submit designation recommendations. Eligible Tribes may choose to submit their own recommendations and supporting documentation. Since, currently, there is a lack of air quality monitoring data nationally throughout Indian country, the factors identified in this guidance should be considered in recommending designations for the 8-hour ozone standard. The EPA will review the recommendations made by Tribes and may, in consultation with the Tribes, make modifications as deemed necessary. Under the TAR, Tribes generally are not subject to the same submission schedules imposed by the CAA on States. Therefore, EPA Regional Offices will work with their Tribes in scheduling interim activities and final designation actions, insofar as practicable, within the time frames outlined in this memorandum.

Finally, certain aspects of this guidance may not be particularly suited for application to Tribes due to circumstances that presently exist throughout Indian country. Consequently, EPA intends to issue additional guidance in the near future to further address designation issues pertaining to Tribes.

boundaries of the areas or portions thereof. If EPA modifies a designation or boundary, it must notify the State or Tribe at least 120 days in advance of such action in order to give the State or Tribe an opportunity to demonstrate why the proposed modification is inappropriate. The EPA's designation of areas for the 8-hour ozone NAAQS will be based on the most recent 3 consecutive years of air quality data from Federal reference or equivalent method monitors.[3]

Tribes are not required to recommend designations; however, they may choose to make recommended designations for land under their jurisdiction. The EPA will review the Tribe's recommendation, and may, in consultation with the Tribe, make modifications to the Tribe's recommendation. In cases where Tribes do not make their own recommendations, then EPA, upon consultation with the respective Tribe(s), will make designations for them.

3. How should boundaries of nonattainment areas be drawn and what process must be followed?

Section 107(d)(1) of the CAA addresses the determination of whether an area is to be designated nonattainment. With respect to a specific NAAQS, such as the 8-hour ozone NAAQS, this provision requires all areas to be designated nonattainment if they do not meet the standard or contribute to ambient air quality in a nearby area that does not meet the standard.

The EPA believes that any county with an ozone monitor showing a violation of the NAAQS and any nearby contributing area needs to be designated as nonattainment. In reducing ozone concentrations above the NAAQS, EPA believes it is best to consider controls on sources over a larger area due to the pervasive nature of ground level ozone and transport of ozone and its precursors. Thus, EPA recommends that the Metropolitan Statistical Area or the Consolidated Metropolitan Statistical Area (C/MSA) serve as the presumptive boundary for 8-hour NAAQS nonattainment areas.[4] We believe this approach will best ensure public health protection from the adverse effects of ozone pollution caused by population density, traffic and commuting patterns, commercial development, and area growth. In the past, areas within C/MSAs have generally experienced higher levels of ozone concentrations and ozone precursor emissions than areas not in C/MSAs. In addition, the 1990 Amendments to the CAA established the C/MSA as the presumptive boundary for ozone nonattainment areas classified as serious, severe and extreme.

4. How should designation recommendations, including boundaries, be addressed when more than one State and/or Tribe might be affected?

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[3]For the 8-hour ozone NAAQS, it is 3 consecutive years of data in accordance with 40 CFR part 50, Appendix I; data used will be quality-assured and meet 40 CFR part 58 requirements (e.g., for monitor siting). Designations should generally be made based on 1997-1999 air quality, considering data availability.

[4]C/MSAs are identified by the U.S. Bureau of the Census and can be found at the following website: http://www.census.gov/population/www/estimates/aboutmetro.html.

Where more than one State is involved with respect to an area, close coordination is needed among the affected States and Tribes prior to the time the recommendation is made. In addition, the EPA Regional Office should coordinate where an area may be located in States or tribal lands located in two or more regions. There is a strong presumption that interstate areas making up one C/MSA will be designated as one nonattainment area. The EPA believes that it is important that consistent and coordinated boundary recommendations be made for the area from each State and Tribe.

5. What factors should a State or Tribe consider in determining whether to recommend area boundaries that are larger or smaller than a C/MSA or tribal land?

In some cases, the most appropriate nonattainment area boundary may be larger than the C/MSA. For example, if sources located in a county or on Indian lands outside the C/MSA contribute to violations within the C/MSA, States or Tribes should consider whether it would be appropriate to expand the nonattainment area to include the area in which those sources are located. In other cases, a smaller nonattainment area may be more appropriate. For example, one C/MSA may cover multiple air basins, or include counties or portions of counties which are rural in nature.

A State or Tribe wishing to propose larger or smaller nonattainment area boundaries (including partial counties or portions of areas on tribal lands) than those matching the C/MSA or boundary of the tribal land should address how each of the following factors affect the drawing of nonattainment area boundaries and how the resulting recommendation is consistent with the definition of nonattainment in §107(d)(1) of the Act. Additional information is provided below under question number 12 on documentation.

- Emissions and air quality in adjacent areas (including adjacent C/MSAs)
- Population density and degree of urbanization including commercial development (significant difference from surrounding areas)
- Monitoring data representing ozone concentrations in local areas and larger areas (urban or regional scale)
- Location of emission sources (emission sources and nearby receptors should generally be included in the same nonattainment area)
- Traffic and commuting patterns
- Expected growth (including extent, pattern and rate of growth)
- Meteorology (weather/transport patterns)
- Geography/topography (mountain ranges or other air basin boundaries)
- Jurisdictional boundaries (e.g., counties, air districts, existing 1-hour nonattainment areas, Reservations, etc.)
- Level of control of emission sources
- Regional emission reductions (e.g., NOx SIP call or other enforceable regional strategies)

A State or Tribe choosing to propose area boundaries smaller than a C/MSA or tribal land should consult with its EPA Regional Office. The EPA will consider alternative boundary recommendations on a case-by-case basis to assess whether the recommendation is consistent with §107(d)(1) of the Act.

The EPA will issue guidance on factors for Tribes to consider when submitting designation recommendations. Some of the factors, particularly for areas throughout Indian country that may not have adequate or any air quality ozone monitors, are geographic location of the land, proximity to the nearest C/MSA, prevailing meteorology, location of nearby ozone monitors, available ozone air quality data, and location of nearby emission sources both inside and outside of such areas.

6. What are the key timing activities for and implications of designation as nonattainment under the 8-hour ozone standard particularly for States?

The designation process has several steps. On June 25, 1999, EPA issued a guidance memorandum requesting that States submit the most recent, complete, quality-assured ozone monitoring data identifying the monitors where exceedances of the 8-hour standard have occurred. The EPA, with this memorandum, is providing guidance describing the criteria for drawing boundaries for nonattainment areas and setting deadlines for the steps in the designation process. States will then have several months to work with local governments and other stakeholders and submit their recommendations and supporting documentation to EPA for area designations and boundaries by June 30, 2000. The EPA will then review and respond to the State designations including boundaries by late summer. The EPA will not make final designations prior to late December because it cannot make them until at least 4 months (120 days) after responding to the States, pursuant to a CAA requirement. Given this process, designations could not become effective prior to early 2001 at the earliest, nor would conformity or other requirements. Conformity and other planning requirements would be triggered on the effective date of designations. The EPA Regional Offices should immediately begin to work with their States and Tribes on boundary recommendations to ensure that they have maximum input prior to the June 30, 2000 recommendation date and encourage States to coordinate with appropriate transportation planning agencies.

After EPA makes the final designations, it will publish them in the Federal Register and set a date on which they become effective. Historically, the effective date of a rule is usually 30 to 60 days after publication, but can be later. In the process of determining when to finalize the proposed designations and make them effective, EPA will carefully consider the time needed to prepare for any applicable requirements, as well as the status of ongoing litigation and administrative proceedings. The EPA is committed to ensuring that all State and local officials have ample time to comply with requirements that are applicable when designations become effective.

The EPA believes that the Court decision affirms the serious health risk posed by ozone. Thus, notwithstanding the schedule described above, EPA believes that it is important to issue a final action on designations to provide the public with information regarding the air quality in areas in which they live and work. In addition, areas can continue to take certain actions with respect to the 8-hour standard, such as operating monitoring sites, analyzing monitoring data, implementing public education and communications efforts regarding health impacts and potential solutions, collecting emissions inventory data, examining potential control measures such as major source Reasonably Available Control Technology and other Reasonably Available Control Measures, considering voluntary emission reduction measures and considering the integration of strategies for the attainment and maintenance of all NAAQS.

7. How should long-range transport be addressed in the boundary recommendation?

In addition to nearby areas with sources contributing to nonattainment, ozone concentrations are affected by long-range transport of ozone and its precursors (notably NOx). Thus, in certain parts of the country, such as the eastern U.S., ozone is a widespread problem. Where this is the case, the Act does not require that all contributing areas be designated nonattainment, only the nearby areas. Regional strategies, such as those employed in the Ozone Transport Region in the Northeast U.S., and in the EPA NOx SIP call, are needed to address the long-range transport component of ozone nonattainment, while the local component must be addressed through more local planning in and around the designated nonattainment area. Tribal areas may also be affected by transport.[5]

8. How should designation recommendations be handled for 8-hour ozone nonattainment areas that cover some of the same area as 1-hour ozone nonattainment areas?

In areas where the 1-hour NAAQS still applies, EPA's presumption is that the designated 8-hour nonattainment area boundary will be the C/MSA or the 1-hour nonattainment area boundary, whichever is larger.

9. What will happen if EPA does not receive a designation recommendation from a State or Tribe?

In the absence of a Governor's recommendation by June 30, 2000, EPA will determine the designation. The EPA plans to follow this guidance in designating areas. In cases where Tribes do not make their own recommendations, then EPA, upon consultation with the respective Tribe(s), will promulgate the designation it deems appropriate.

10. Must States recommend a classification for, or will EPA classify, nonattainment areas under the 8-hour ozone NAAQS?

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[5]The prohibitions and authority contained in sections 110(a)(2)(D)(i) and 126 of the Act apply to Tribes in the same manner as States.

The EPA will not classify nonattainment areas at this time; thus, States and Tribes should not submit recommendations for classifications. If EPA determines to classify areas in the future, it will provide an opportunity for State and Tribal involvement.

11. What technical information should a State consider in its designation recommendations?

To assist States and Tribes with their recommendations, the EPA is providing technical reports and maps showing locations where air quality was violating the 8-hour NAAQS based on 1997-1999 monitored data that States and Tribes may find useful in defining the boundaries of nonattainment areas. The information will be posted on EPA's web site in the immediate future.

12. What documentation should a State or Tribal government submit concerning the nonattainment area recommendations?

In addition to technical information documenting the recommendation for area boundaries noted in question number 5 above, the EPA is requesting that each State or Tribe in its submission provide certain air quality data and geographic information to support its nonattainment area recommendation. The EPA is asking for the following information:

For nonattainment areas:

a. Design value[6] for the area.
b. Period of time represented by the design value, e.g., 1997-1999.
c. Design value monitoring site location and identification number.

For attainment/unclassifiable and nonattainment areas:

d. Names of counties and tribal lands included, and
e. If partial counties or portions of tribal lands are included, the boundary definition/description as outlined below.

If the recommended nonattainment area boundary is less than a C/MSA, the State or Tribe should document its rationale for selecting the nonattainment area boundary. The documentation should address how the items in question number 5 affect the drawing of boundaries for each county or Reservation not included in the recommended nonattainment area such as population, traffic and commuting patterns, commercial development, projected growth, prevailing meteorology, nearby sources and air quality, and any other relevant or technical justification factors. In particular, where the recommended area boundary consists of parts of counties, C/MSAs, or Reservations, the State or Tribe must provide a technical analysis for its recommendation, explaining how the boundary is consistent with §107 (d)(1) of the Act.

If there is less than a full county or Reservation, the EPA is requesting a legal definition of the area, a detailed hard copy map, and, because EPA plans to map the definition, a digitized

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[6]The ozone air quality design value for a site is defined as the 3-year average annual fourth-highest daily maximum 8-hour average ozone concentration.

latitude and longitude description for mapping purposes if available. Regional Offices and States should include the names of contacts from their respective offices for this information. The EPA requests that each State and Tribe submit its attainment/unclassifiable and nonattainment area designation recommendation and boundary information to EPA in both a detailed written form and in electronic form in a format consistent with how designations are identified in Part 81 of the CFR. In addition to the formal letter making the recommendation, EPA requests the States provide an electronic record in a usable file which will be merged with all other States' and Tribes' recommendations for a final complete product. An example is shown below.

Format of Recommendations for Designations

State Name
Nonattainment Areas:
    Area Name
        County or Tribal Land Names
    Area Name
        County or Tribal Land Names
Attainment/Unclassifiable Areas:
    Rest of State or County or Tribal Land Names

This is how it would appear in the Code of Federal Regulations:

81.xxx [STATE NAME].

* * * * *

[STATE NAME]-OZONE (8-HOUR STANDARD)

Designated Area	Designation	Classification
	Type	Type
[NAME] Area:		
[NAME] County.....	Nonattainment	
[NAME] Area:	Nonattainment	
[NAME] County.....		
[NAME] County.....		
[NAME] County.....		
[NAME] County.....		LEAVE BLANK
[Name] Tribal Land		
[Name] County.....		
Rest of State.....	Attainment/ Unclassifiable	
Rest of Tribal Land.....	Attainment/ Unclassifiable	

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13. When should the recommendations be submitted?

The Governor should submit all recommendations and supporting documentation for designations for nonattainment and attainment/unclassifiable areas, boundaries, and boundary descriptions described above to the EPA Regional Office by June 30, 2000. The eligible Tribal governing body, with the assistance of the appropriate EPA Regional Office, should submit all recommendations and supporting documentation consistent with the statements in question

number 2 of this memorandum. The EPA will notify the State or Tribe no later than 120 days prior to the designation action where EPA plans to modify a recommendation.

14. Is there any special process for attainment/unclassifiable areas?

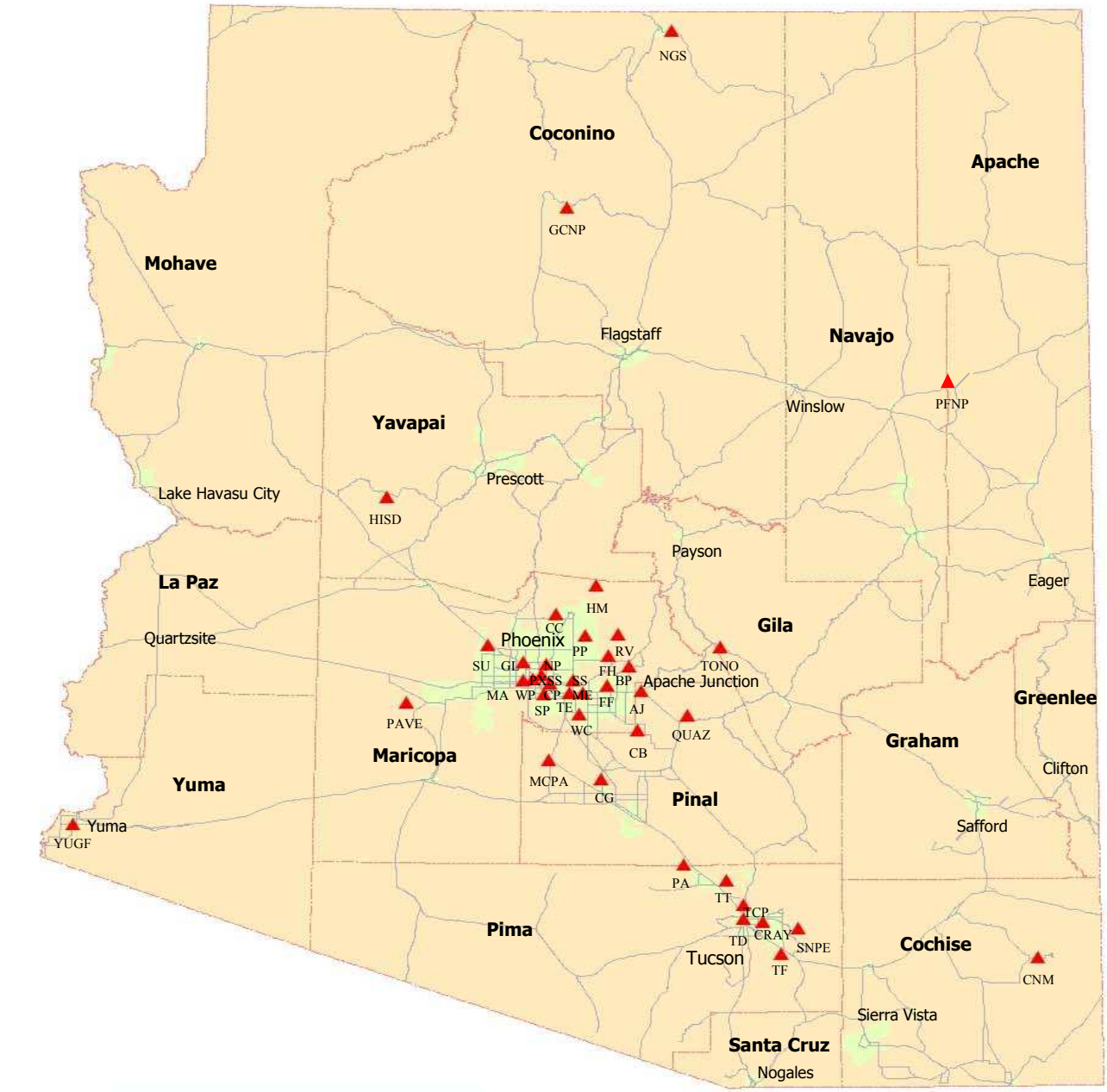
The EPA will not distinguish between attainment and unclassifiable areas. The State or Tribe should indicate if its preference is that EPA list each attainment/unclassifiable area individually (e.g., by county); otherwise, EPA will indicate that the "rest of State" or "rest of tribal land" is attainment/unclassifiable.

APPENDIX 2

Ozone Monitoring Sites in Arizona As of July 1, 2003

Ozone Monitoring Sites in Arizona

As of July 1, 2003



Legend

- Cities
- Ozone Monitoring Sites (Indian Reservations Not Included)
- Major Roadways
- County Boundaries

N

(This map is for general reference purposes only.)

0 30 60 120 Miles

Key to Monitoring Site Abbreviations on Map
"Ozone Monitoring Sites in Arizona As of July 1, 2003"

Abbreviation	Monitoring Site	I.D. Number	Location Lat. - Long.	Operator
Cochise County				
CNM	Chiricahua National Monument	04-003-8001	32°00' - 109°23'	ADEQ
Coconino County				
GCNP	Grand Canyon National Park - Hance Camp	04-005-8001	35°58' - 111°59'	NPS
NGS	Navajo Generating Station	n/a	36°55' - 111°24'	SRP
Gila County				
TONO	Tonto N.M. - new 5/02	04-007-0010	33°39' - 111°07'	ADEQ, USFS
Maricopa County				
BP	Blue Point	04-013-9702	33°33' - 111°36'	MCESD
CC	Cave Creek - new 8/01	04-013-4008	33°49' - 112°01'	MCESD
CP	Central Phoenix	04-013-3002	33°27' - 112°02'	MCESD
FF	Falcon Field	04-013-1010	33°27' - 112°04'	MCESD
FH	Fountain Hills	04-013-9704	33°37' - 111°43'	MCESD
GL	Glendale	04-013-2001	33°33' - 112°12'	MCESD
HM	Humboldt Mountain	04-013-9508	33°58' - 111°47'	MCESD
MA	Maryvale	04-013-3006	33°28' - 112°20'	MCESD
ME	Mesa	04-013-1003	33°24' - 111°51'	MCESD
NP	North Phoenix	04-013-1004	33°33' - 112°04'	MCESD
PAVE	Palo Verde	04-013-9993	33°20' - 112°50'	ADEQ
PP	Pinnacle Peak	04-013-2005	33°42' - 111°51'	MCESD
PXSS	Super Site	04-013-9997	33°30' - 112°05'	ADEQ
RV	Rio Verde	04-013-9706	33°43' - 111°40'	MCESD
SP	South Phoenix	04-013-4003	33°00' - 112°04'	MCESD
SS	South Scottsdale	04-013-3003	33°28' - 111°55'	MCESD
SU	Surprise - new 4/01	04-013-4007	33°39' - 112°33'	MCESD
TE	Tempe	04-013-4005	33°35' - 111°55'	MCESD
WC	West Chandler	04-013-4004	33°18' - 111°53'	MCESD
WP	West Phoenix	04-013-0019	33°29' - 112°08'	MCESD
Navajo County				
PFNP	Petrified Forest National Park - new 10/02	04-017-0119	35°04' - 109°46'	NPS
Pima County				
SNPE	Saguaro National Park East	04-019-0021	32°11' - 110°44'	PDEQ
TCP	Tucson Children's Park - new 8/97	04-019-1028	32°17' - 110°58'	PDEQ
CRAY	Tucson Craycroft	04-019-1011	32°12' - 110°52'	PDEQ
TD	Tucson Downtown	04-019-0002	32°13' - 110°58'	PDEQ
TF	Tucson Fairgrounds	04-019-1020	32°03' - 110°46'	PDEQ
TT	Tucson Tangerine	04-019-1018	32°25' - 110°04'	PDEQ
Pinal County				
AJ	Apache Junction	n/a	33°25' - 111°52'	PCAQCD
CG	Casa Grande	n/a	32°54' - 111°46'	PCAQCD
CB	Combs - new 7/02	n/a	33°13' - 111°33'	PCAQCD
MCPA	Maricopa - new 7/02	n/a	33°03' - 111°02'	PCAQCD
PA	Pinal Air Park - new 7/02	n/a	32°31' - 111°20'	PCAQCD
QUAZ	Queen Valley - new 5/01	04-021-8001	33°17' - 111°17'	ADEQ
Yavapai County				
HISD	Hillside - new 4/96	04-025-0005	34°25' - 112°57'	ADEQ
Yuma County				
YUGF	Yuma Game and Fish - not operational in 2002	04-027-0005	32°40' - 114°28'	ADEQ

ADEQ: Arizona Department of Environmental Quality
MCESD: Maricopa County Environmental Services Department
NPS: National Park Service
PDEQ: Pima County Department of Environmental Quality
PCAQCD: Pinal County Air Quality Control District
SRP: Salt River Project
USFS: U.S. Forest Service

APPENDIX 3

Annual Fourth Highest 8-Hour Ozone Concentration in Parts per Billion

Annual Fourth Highest 8-Hour Ozone Concentration in Parts per Billion*									
Monitor Site (operator)	**Abbreviation**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Apache County									
No Sites									
Cochise County									
Chiricahua National Monument	CNM	69	72	65	67	72	71	67	69
Coconino County									
Grand Canyon National Park – Hance Camp	GCNP	69	73	72	72	76	71	70	79
Navajo Generating Station	NGS			63		65	63	59	
Gila County									
Rye - closed 11/99	RY			56	65	80			
Tonto N.M. - new 5/02	TONO								**87**
Graham County									
No Sites									
Greenlee County									
No Sites									
La Paz County									
No Sites									
Maricopa County									
Blue Point	BP			83	**89**	**87**	**87**	80	**86**
Cave Creek - new 8/01	CC							83	**86**
Central Phoenix	CP	**85**	76	77	79	78	76	75	76
Emergency Management - closed 6/01	EM			**85**	81	**86**	70	63	
Falcon Field	FF			81	83	82	75	81	84
Fountain Hills	FH			**88**	**86**	**86**	**85**	83	**86**
Glendale	GL	80	72	76	70	81	81	78	83
Humboldt Mountain	HM			81	**90**	**86**	82	**85**	**90**
Lake Pleasant - closed 6/01	LP				82	81	82	73	
Maryvale	MA			78	**86**	77	80	73	84
Mesa	ME	**92**	**90**	84	80	83	75	74	72
Mt. Ord - closed 10/01	MO			84	**88**	**87**	**90**	77	
North Phoenix	NP	**92**	**95**	**91**	**89**	84	**86**	**86**	**85**
Palo Verde	PAVE		71	77	80	80	80	74	78
Pinnacle Peak	PP	**91**	**91**	82	**86**	83	**86**	**85**	84
Rio Verde	RV			**85**	79	**86**	**86**	83	**85**
Roosevelt – closed 1997	RO			84					
Salt River Pima - closed 10/99	SRPI	**92**	**92**	82	**87**	82			
South Phoenix	SP	84	**91**	75	80	75	83	76	81
South Scottsdale	SS	**89**	**87**	76	78	72	80	79	77
Super Site	PXSS		**87**	79	79		76	79	76
Surprise - new 4/01	SU							71	79
Tempe	TE						78	79	80

Annual Fourth Highest 8-Hour Ozone Concentration in Parts per Billion*									
Monitor Site (operator)	**Abbreviation**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Maricopa County (continued)									
Vehicle Emissions – closed 1997	VE	**92**	80						
West Chandler	WC			77	74	69	74	78	83
West Phoenix	WP	84	81	78	**86**	**91**	81	75	84
Mohave County									
No Sites									
Navajo County									
Petrified Forest National Park - new 10/02	PFNP								55
Pima County									
Saguaro National Park East	SNPE	83	76	79	76	69	74	66	77
Tucson Children's Park - new 8/97	TCP			65	72	71	77	69	73
Tucson Craycroft	CRAY	80	77	77	73	71	75	69	75
Tucson Downtown	TD	70	69	65	62	64	67	65	72
Tucson Fairgrounds	TF	76	70	65	71	68	74	66	72
Tucson Pomona - closed 9/96	TP	80	74						
Tucson Sabino Canyon - closed 7/96	TSC	62	65						
Tucson Tangerine	TT	74	71	70	70	73	73	67	75
Pinal County									
Apache Junction	AJ	**91**	**85**	82	82	80	82	78	80
Casa Grande	CG	71	79	72	68	78	75	74	78
Combs - new 7/02	CB								69
Maricopa - new 7/02	MCPA								68
Pinal Air Park - new 7/02	PA								70
Queen Valley - new 5/01	QUAZ							79	83
Santa Cruz County									
No Sites									
Yavapai County									
Hillside - new 4/96	HISD		**85**	76	83	84	83	76	**89**
Yuma County									
Yuma 2nd Ave. - closed 7/96	Y2	73	83						
Yuma Western College - closed 2002	YWC			79	**89**	79	60	68	

*Values in blue indicate an exceedance of the 8-hour ozone standard

Sources: Arizona Department of Environmental Quality, Maricopa County Environmental Services Department, U.S. National Park Service, Pima County Department of Environmental Quality, Pinal County Air Quality Control District

APPENDIX 4

Three-Year Average of the Annual Fourth Highest 8-Hour Ozone Concentration in Parts per Billion

Three-Year Average of the Annual Fourth Highest 8-Hour Ozone Concentration in Parts per Billion*							
Monitor Site	**Abbreviation**	**1995-1997**	**1996-1998**	**1997-1999**	**1998-2000**	**1999-2001**	**2000-2002**
Apache County							
No Sites							
Cochise County							
Chiricahua National Monument	CNM	68	68	68	70	69	69
Coconino County							
Grand Canyon National Park – Hance Camp	GCNP	71	72	73	73	72	73
Navajo Generating Station	NGS						
Gila County							
Rye - closed 11/99	RY			67			
Tonto N.M. - new 5/02	TONO						
Graham County							
No Sites							
Greenlee County							
No Sites							
La Paz County							
No Sites							
Maricopa County							
Blue Point	BP			**86**	**87**	84	84
Cave Creek - new 8/01	CC						
Central Phoenix	CP	79	77	78	77	76	75
Emergency Management - closed 6/01	EM			84	79	73	
Falcon Field	FF			82	80	79	80
Fountain Hills	FH			**86**	**85**	84	84
Glendale	GL	76	72	75	77	80	80
Humboldt Mountain	HM			**85**	**86**	84	**85**
Lake Pleasant - closed 6/01	LP				81	78	
Maryvale	MA			80	81	76	79
Mesa	ME	**88**	84	82	79	77	73
Mt. Ord	MO			**86**	**88**	84	
North Phoenix	NP	**92**	**91**	**88**	**86**	**85**	**85**
Palo Verde	PAVE		76	79	80	78	77
Pinnacle Peak	PP	**88**	**86**	83	**85**	84	**85**
Rio Verde	RV			83	83	**85**	84
Roosevelt – closed 1997	RO						
Salt River Pima - closed 10/99	SRPI	**88**	**87**	83			
South Phoenix	SP	83	82	76		74	80
South Scottsdale	SS	84	80	75	76	77	78
Super Site	PXSS		81	68	67	67	77
Surprise - new 4/01	SU						
Tempe	TE						79

Three-Year Average of the Annual Fourth Highest 8-Hour Ozone Concentration in Parts per Billion*							
Monitor Site	**Abbreviation**	**1995-1997**	**1996-1998**	**1997-1999**	**1998-2000**	**1999-2001**	**2000-2002**
Maricopa County (continued)							
Vehicle Emissions – closed 1997	VE						
West Chandler	WC			73	72		79
West Phoenix	WP	81	81	**85**	**86**	82	80
Mohave County							
No Sites							
Navajo County							
Petrified Forest National Park - new 10/02	PFNP						
Pima County							
Saguaro National Park East	SNPE	79	77	74	73	69	72
Tucson Children's Park - new 8/97	TCP			69	73	72	73
Tucson Craycroft	CRAY	78	75	73	73	71	73
Tucson Downtown	TD	68	65	63	64	65	68
Tucson Fairgrounds	TF	70	68	68	71	69	70
Tucson Pomona - closed 9/96	TP						
Tucson Sabino Canyon - closed 7/96	TSC						
Tucson Tangerine	TT	71	70	71	72	71	71
Pinal County							
Apache Junction	AJ	**86**	83	81	81	80	80
Casa Grande	CG	74	73	72	77	79	79
Combs - new 7/02	CB						
Maricopa – new 7/02	MCPA						
Pinal Air Park - new 7/02	PA						
Queen Valley - new 5/01	QUAZ						
Santa Cruz County							
No Sites							
Yavapai County							
Hillside - new 4/96	HISD		81	81	83	81	82
Yuma County							
Yuma 2nd Ave. - closed 7/96	Y2						
Yuma Western College – closed 2002	YWC			82	76	69	

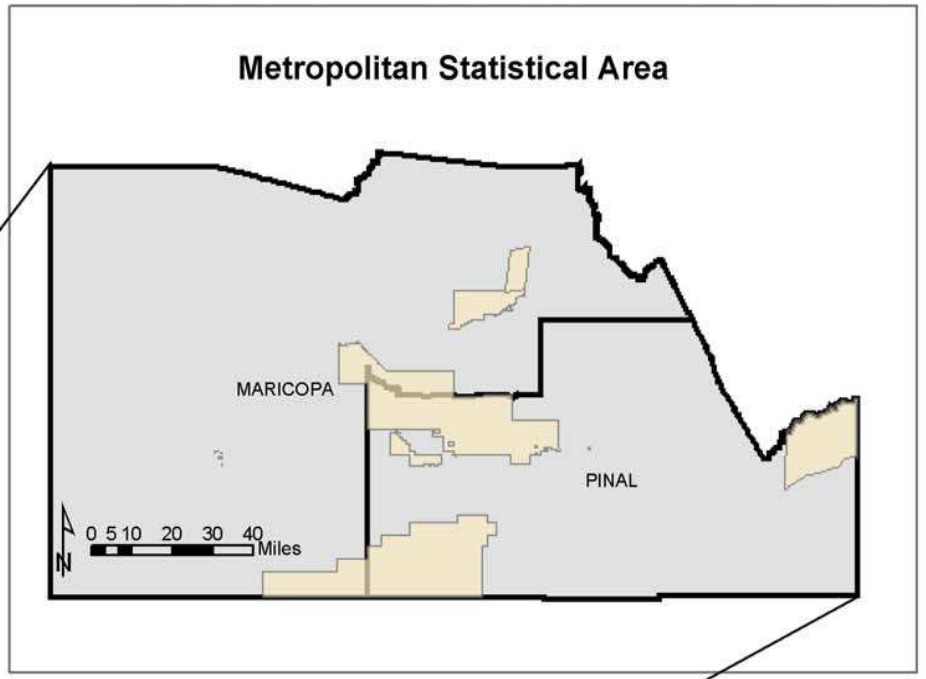
*Values in red indicate a violation of the 8-hour ozone standard

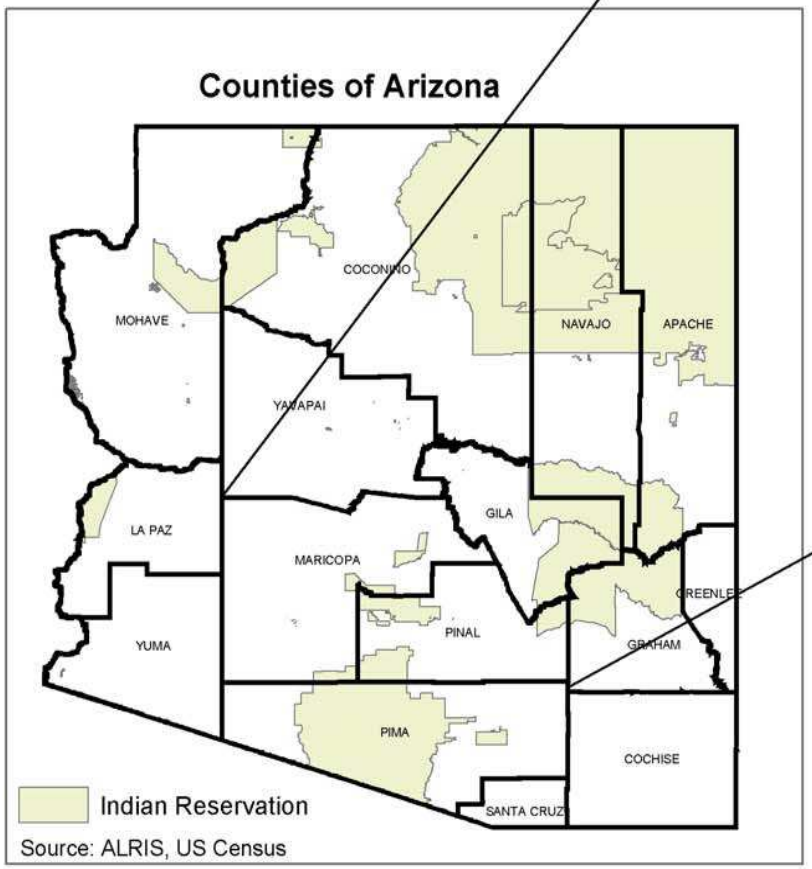
Sources: Arizona Department of Environmental Quality, Maricopa County Environmental Services Department, U.S. National Park Service, Pima County Department of Environmental Quality, Pinal County Air Quality Control District

APPENDIX 5

Phoenix-Mesa Metropolitan Statistical Area Map

Phoenix-Mesa Metropolitan Statistical Area





APPENDIX 6

Presentation from June 17, 2003, Stakeholder Meeting

Description of June 17, 2003, Presentation Maps

Technical Analysis Used to Develop Optional Nonattainment Boundaries for 8-Hour Ozone for the Greater Phoenix Area, July 2003

Overview of Technical Analysis And Presentation Of 8-Hour Ozone Boundary Options

June 17, 2003

Gary Neuroth, Air Pollution Evaluations & Solutions
Jana Hutchins, Arizona State University

- Meteorology
- Modeling
- Air Quality Monitoring Data
- Receptor Areas
- Existing and Potential Source Areas
- 8-Hour Ozone Boundary Options

Data Providers

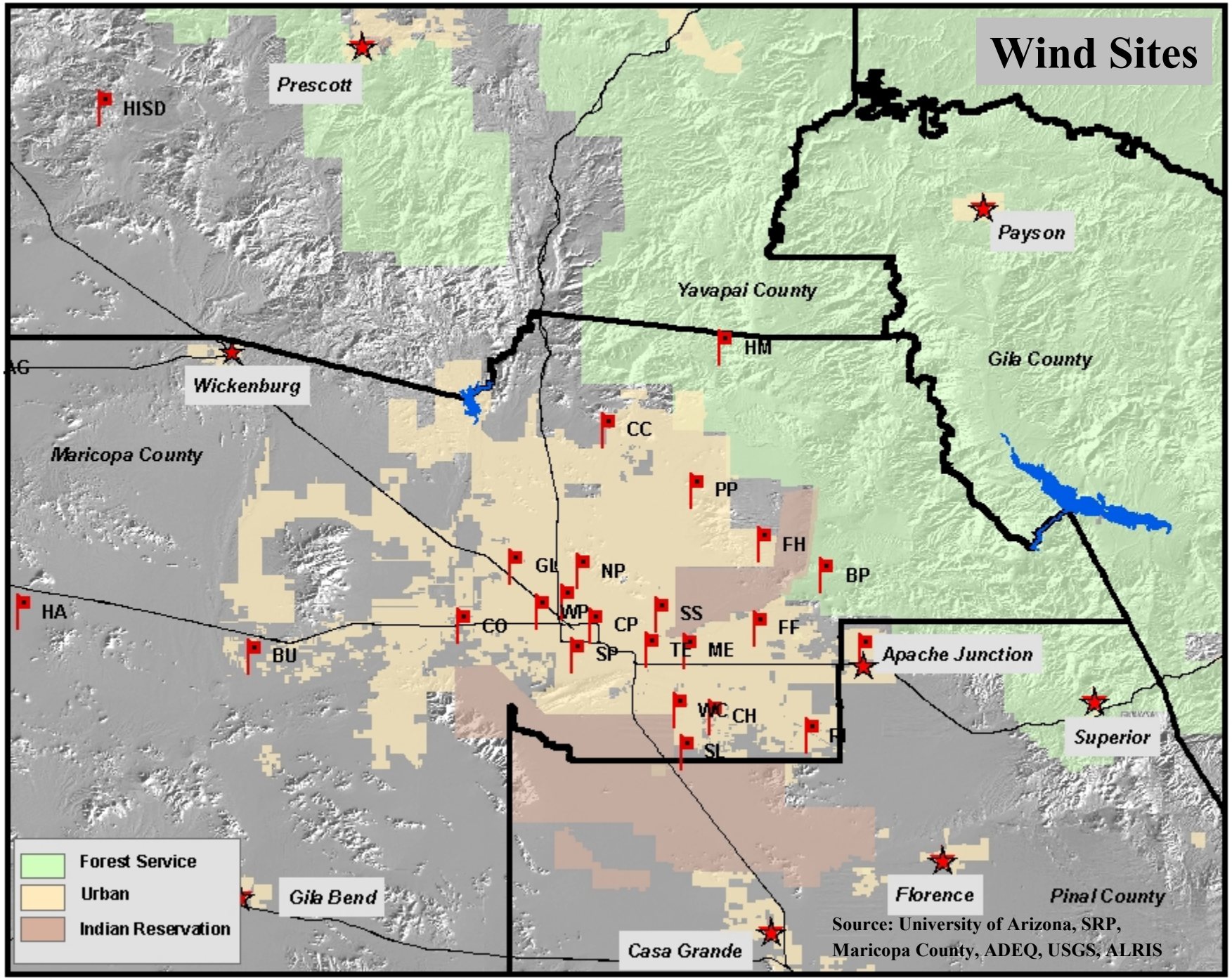
- Arizona Department of Environmental Quality (ADEQ)
- Arizona Land Resource Information Systems (ALRIS)
- Arizona State University (ASU) – Department of Mechanical and Aerospace Engineering - Drs. Fernando, Grossman-Clarke, and Lee
- Gila River Indian Community
- Maricopa County
- Maricopa Association of Governments (MAG)
- Pinal County
- Salt River Project
- Town of Payson
- U.S. EPA
- U.S. Geological Survey (USGS)
- University of Arizona
- Yavapai County
- Air Pollution Evaluations & Solutions - Gary Neuroth
- Western Regional Air Partnership (WRAP)

Maps Prepared by:

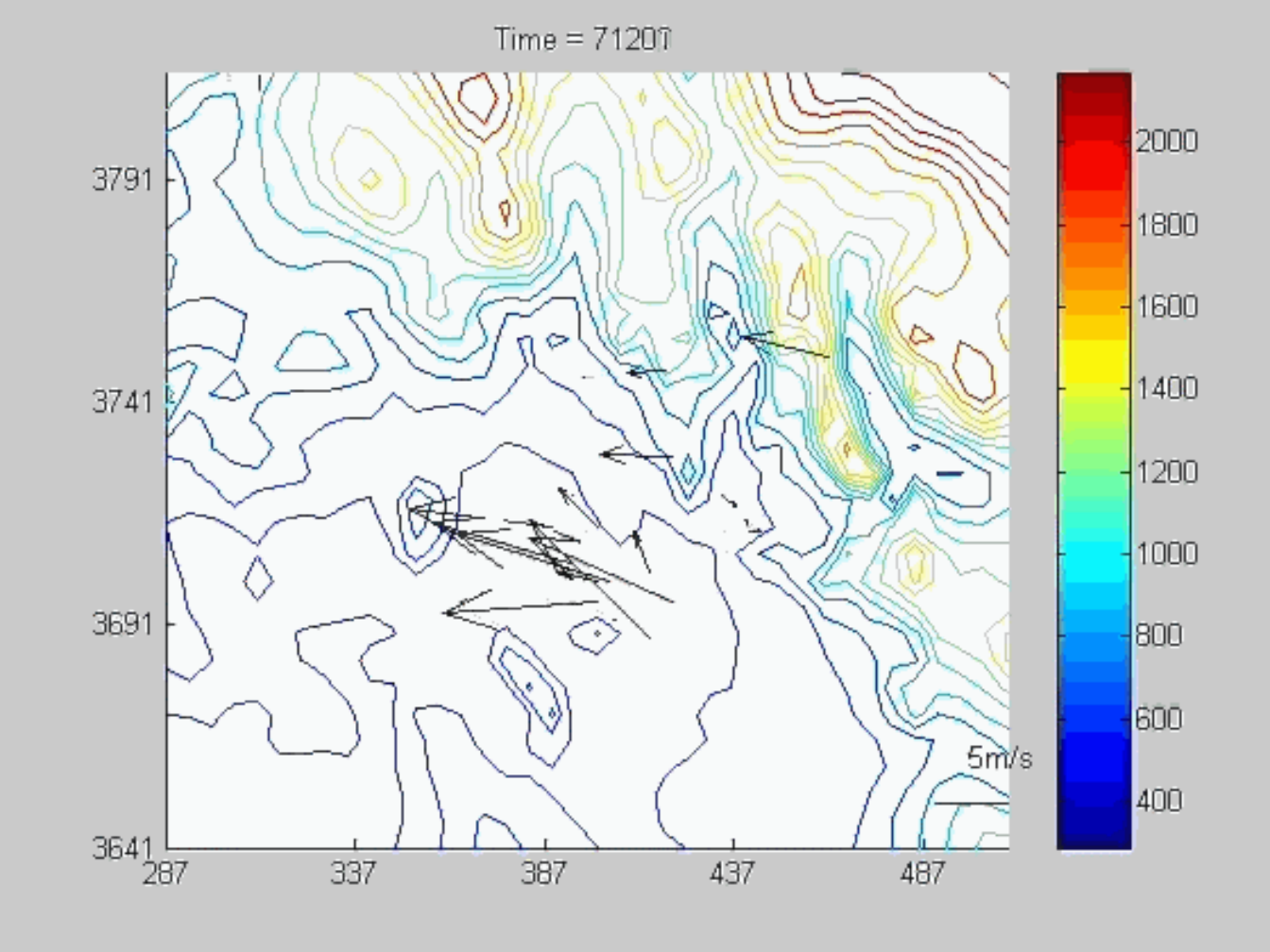
ASU - GIS Services, Information Technology

Jana Hutchins, Michael Zoldak and Robert Murray

Meteorology

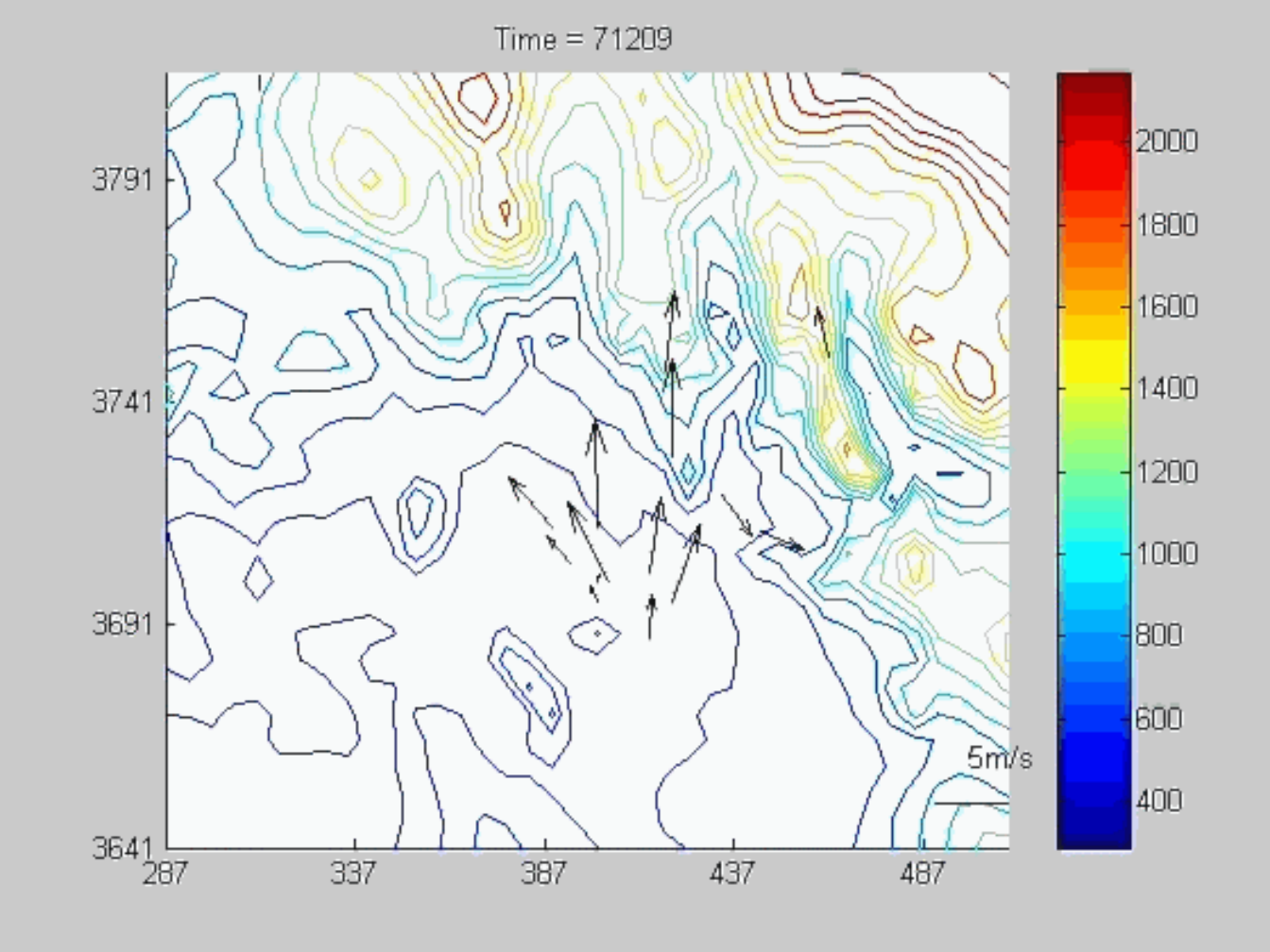

Wind Sites
Prescott
HISD
Payson
Yavapai County
HM
Gila County
Wickenburg
Maricopa County
CC
PP
FH
BP
GL
NP
WP
CP
SS
FF
HA
CO
BU
SP
TE
ME
Apache Junction
WC
CH
SL
Superior
Forest Service
Urban
Indian Reservation
Gila Bend
Florence
Pinal County
Casa Grande
Source: University of Arizona, SRP,
Maricopa County, ADEQ, USGS, ALRIS

Drainage Winds



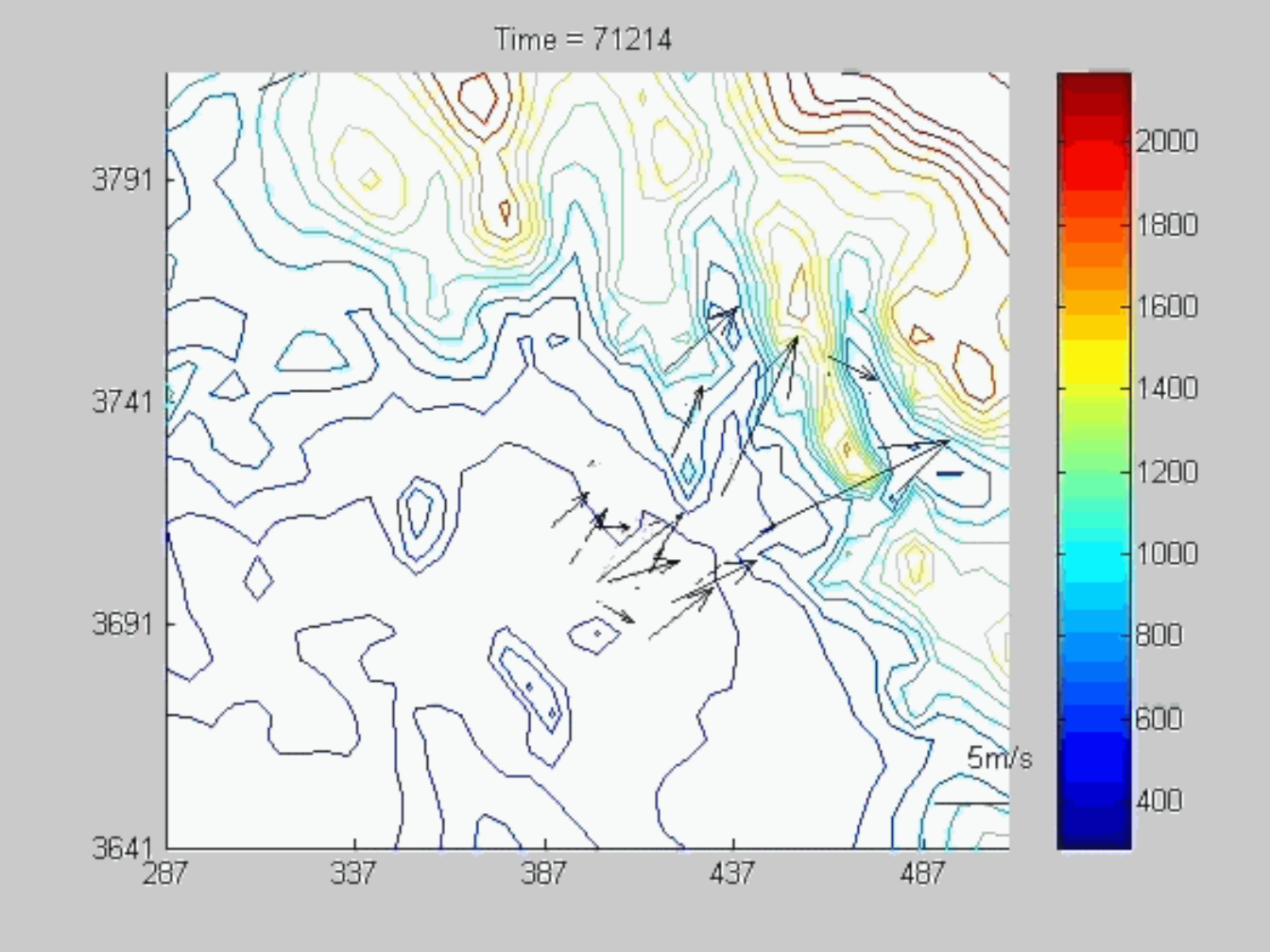
Source: ADEQ, Maricopa County Monitoring sites

A.M. Transition Winds



Source: ADEQ, Maricopa County Monitoring sites

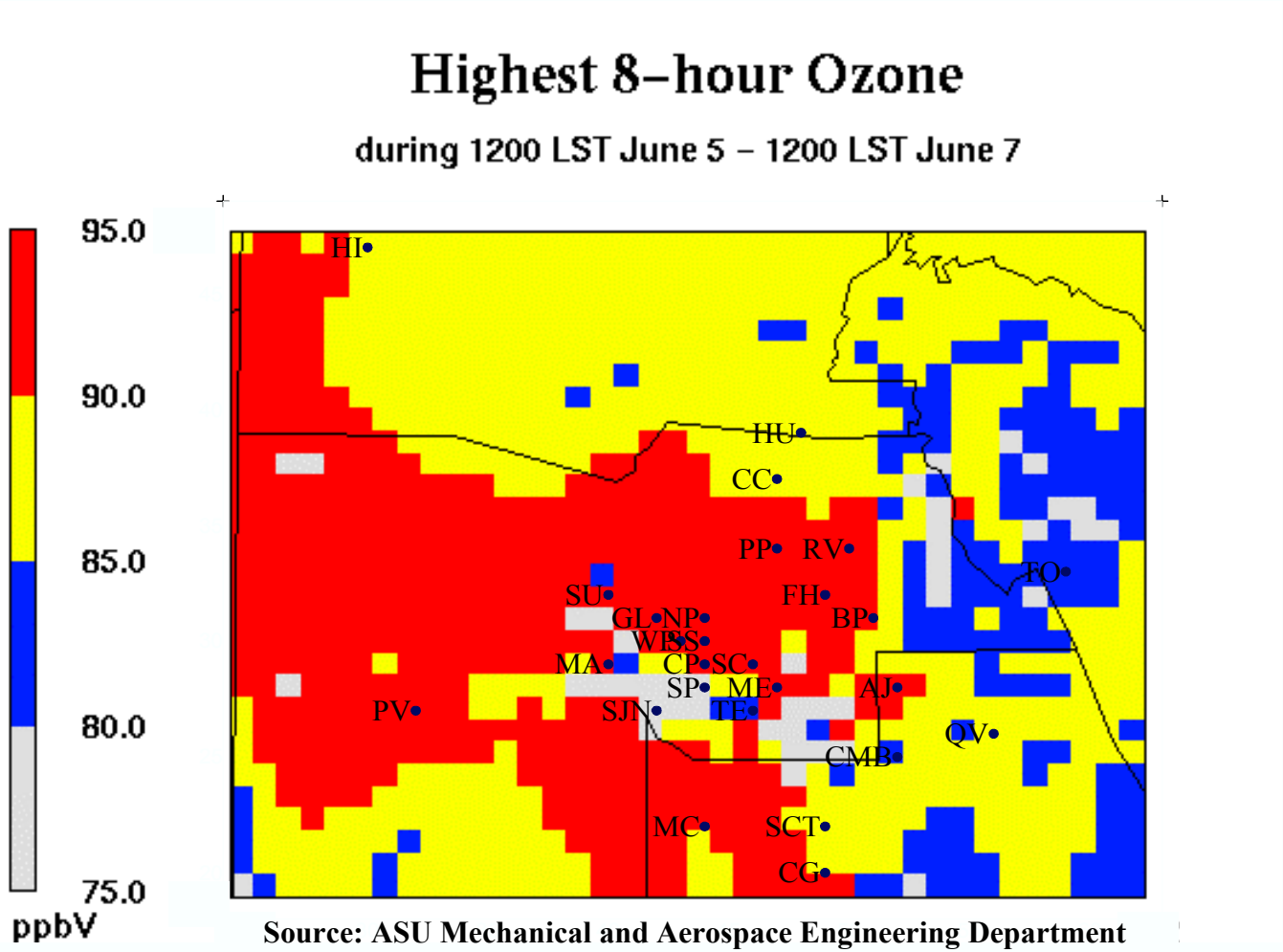
Upslope Winds



Source: ADEQ, Maricopa County Monitoring sites

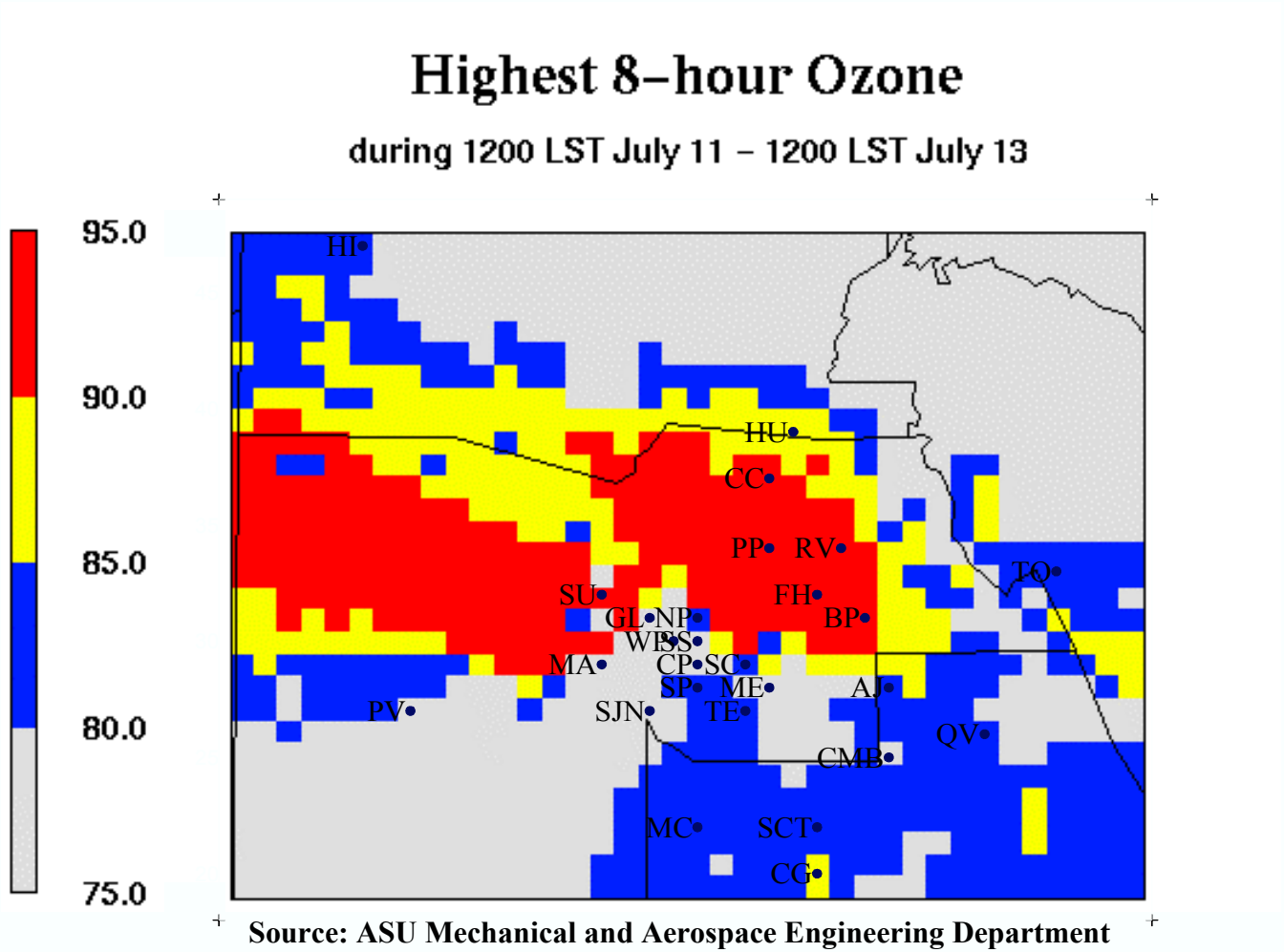
Modeling

Highest 8hr Ozone: June 6th



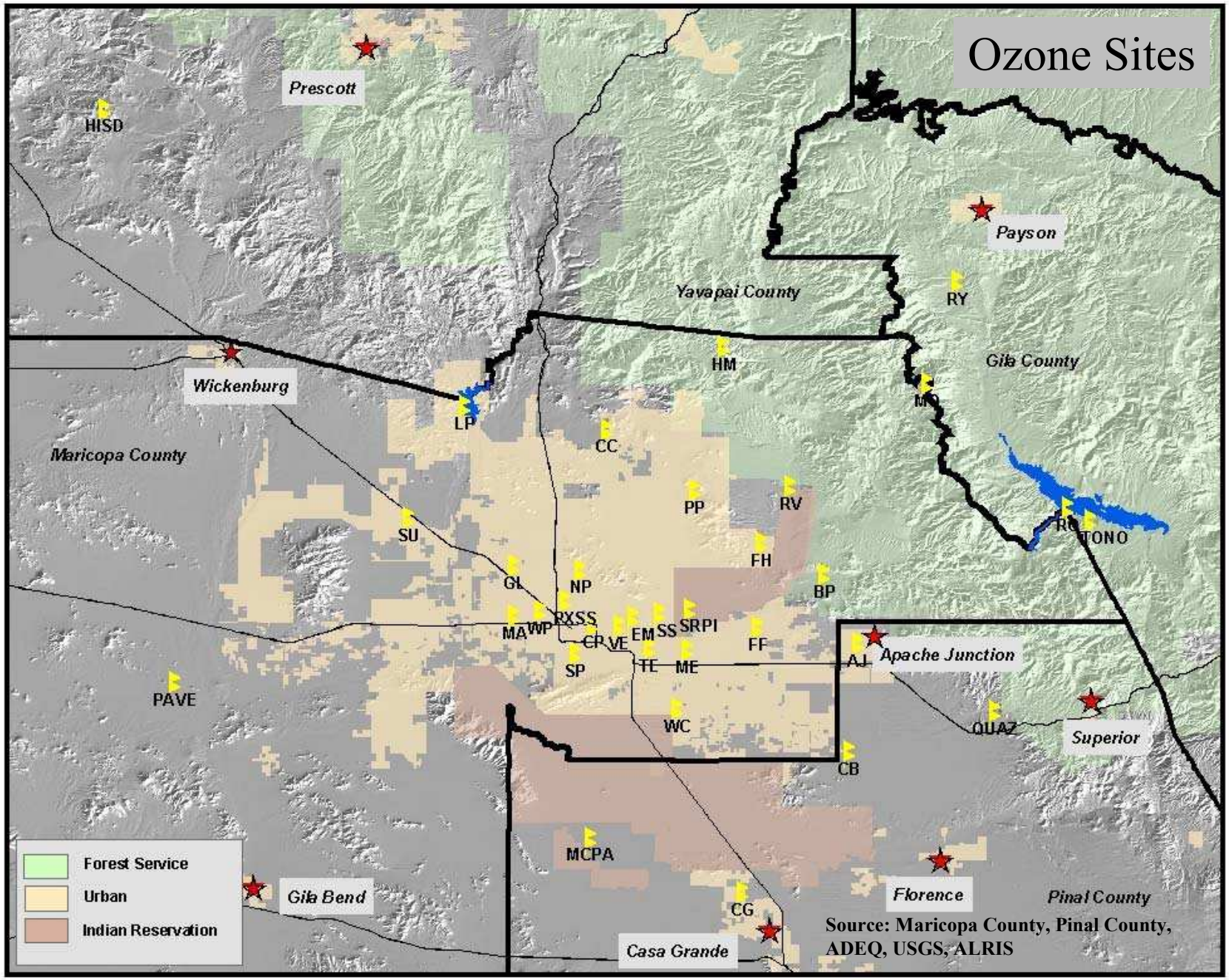
Source: ASU Mechanical and Aerospace Engineering Department

Highest 8hr Ozone: July 12th



Source: ASU Mechanical and Aerospace Engineering Department

Air Quality Monitoring Data


Ozone Sites
Prescott
HISD
Payson
Yavapai County
RY
Gila County
HM
Wickenburg
LP
CC
Maricopa County
PP
RV
SU
FH
GL
NP
BP
MA
WP
RX
SS
CP
VE
EM
SS
SRPI
FF
SP
TE
ME
AJ
Apache Junction
PAVE
WC
QUAZ
Superior
CB
MCPA
Florence
Pinal County
CG
Casa Grande
Gila Bend
Forest Service
Urban
Indian Reservation
Source: Maricopa County, Pinal County, ADEQ, USGS, ALRIS

Annual Fourth Highest 8-Hour Ozone Concentration in Parts per Billion (PPB)									
Monitor Site	**Abbreviation**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Maricopa County									
Blue Point	BP			83	**89**	**87**	**87**	80	**86**
Cave Creek	CC							83	**86**
Central Phoenix	CP	**85**	76	77	79	78	76	75	76
Falcon Field	FF			81	83	82	75	81	84
Fountain Hills	FH			**88**	**86**	**86**	**85**	83	**86**
Glendale	GL	80	72	76	70	81	81	78	83
Humboldt Mountain	HM			81	**90**	**86**	82	**85**	**90**
Lake Pleasant	LP				82	81	82	73	
Maryvale	MA			78	**86**	77	80	73	84
Mesa	ME	**92**	**90**	84	80	83	75	74	72
Mt. Ord	MO			84	**88**	**87**	**90**	77	
North Phoenix	NP	**92**	**95**	**91**	**89**	84	**86**	**86**	**85**
Palo Verde	PAVE		71	77	80	80	80	74	78
Emergency Management	EM			**85**	81	**86**	70	63	
Super Site	PXSS		**87**	79	79		76	79	76
Pinnacle Peak	PP	**91**	**91**	82	**86**	83	**86**	**85**	84
Rio Verde	RV			**85**	79	**86**	**86**	83	**85**
Roosevelt	RO			84					
Salt River Pima	SRPI	**92**	**92**	82	**87**	82			
South Phoenix	SP	84	**91**	75	80	75	83	76	81
South Scottsdale	SS	**89**	**87**	76	78	72	80	79	77
Surprise	SU							71	79
Tempe	TE						78	79	80
Vehicle Emissions	VE	**92**	80						
West Chandler	WC			77	74	69	74	78	83
West Phoenix	WP	84	81	78	**86**	**91**	81	75	84
Gila County									
Rye	RY			56	65	80			
Tonto N.M.	TONO								**87**
Pinal County									
Apache Junction	AJ	**91**	**85**	82	82	80	82	78	80
Casa Grande	CG	71	79	72	68	78	75	74	78
Queen Valley	QUAZ							79	83
Yavapai County									
Hillside	HISD		**85**	76	83	84	83	76	**89**

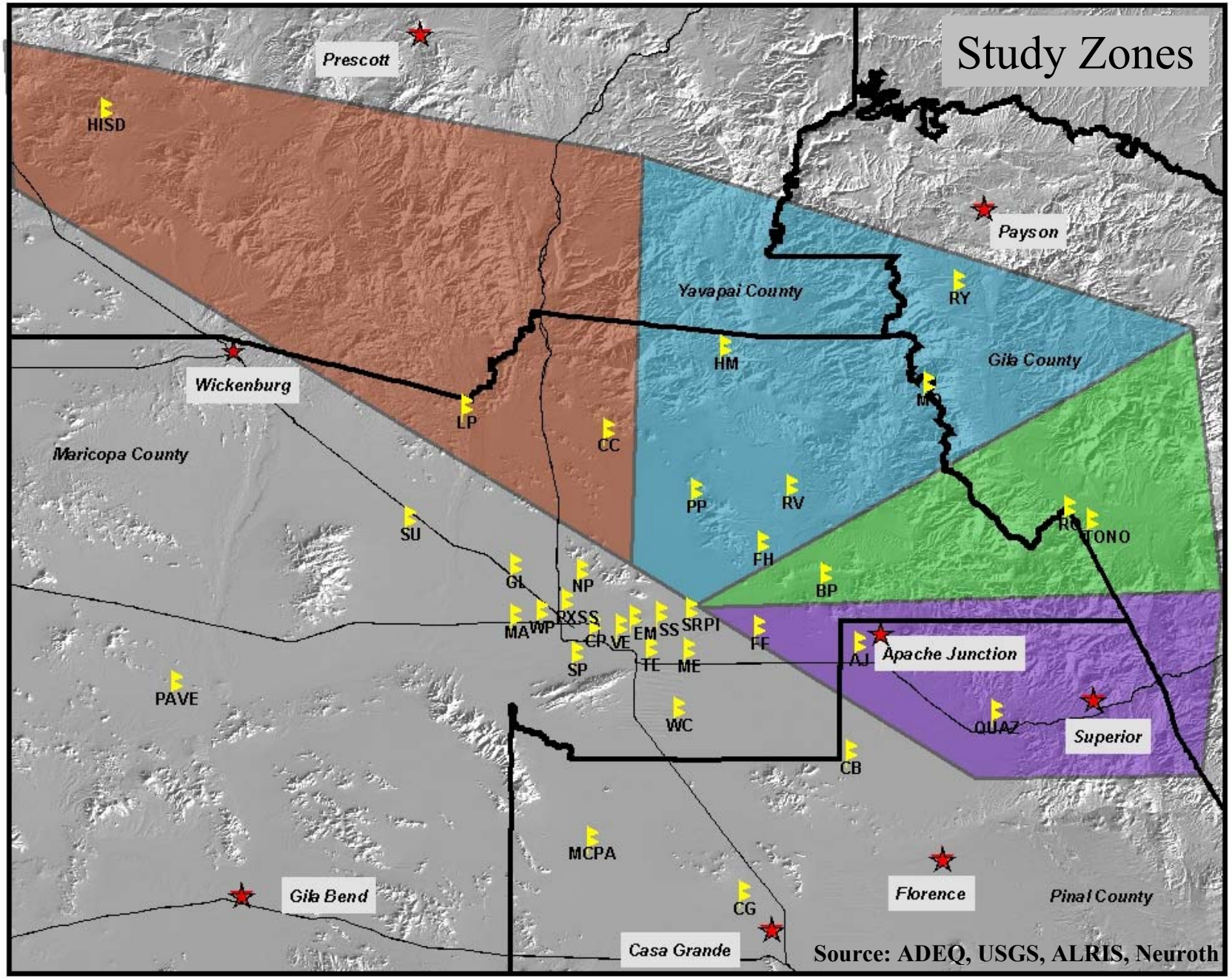
Values in blue indicate an exceedance of the 8-hour ozone standard

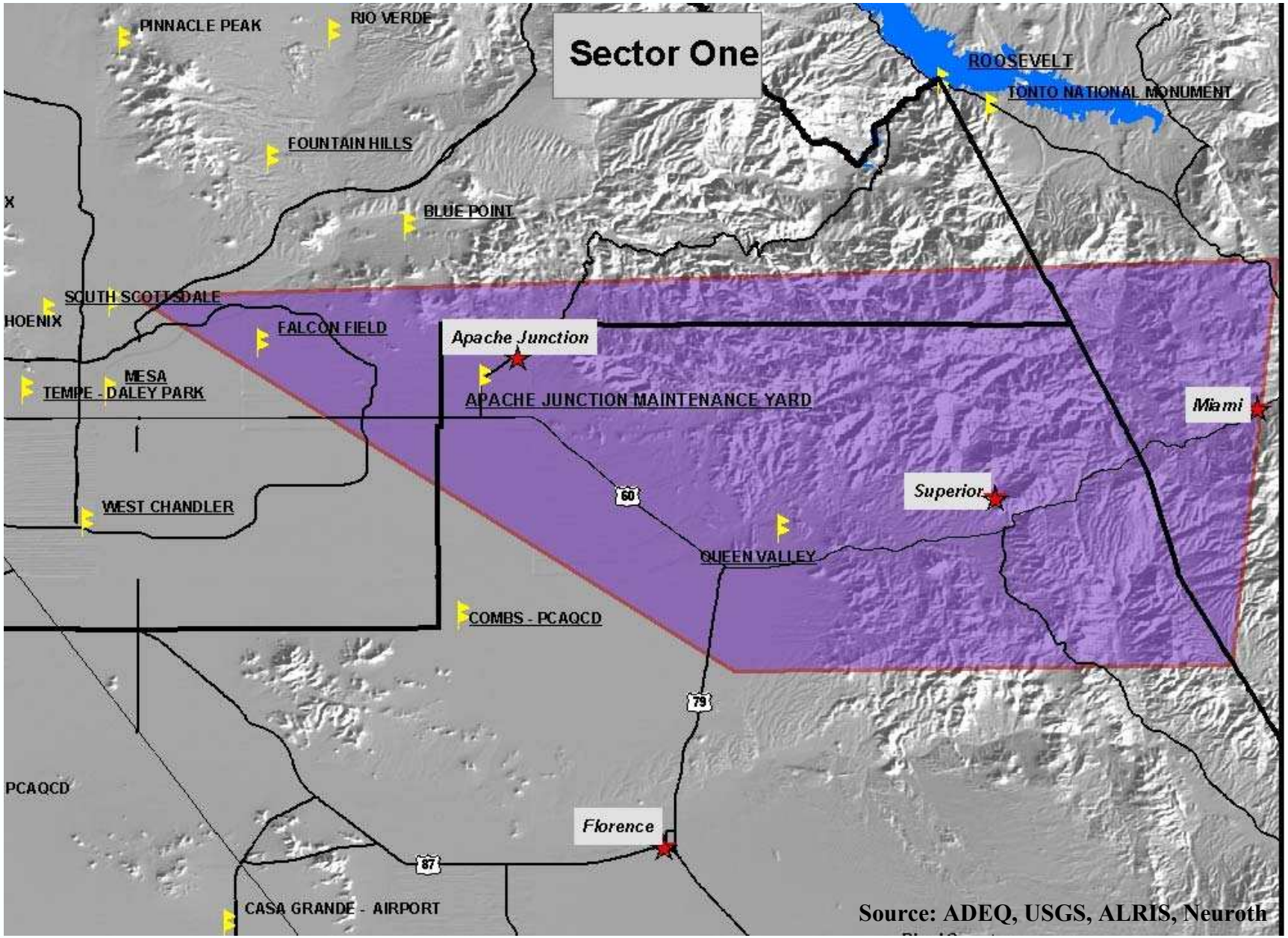
Three-Year Average of the Annual Fourth Highest 8-Hour Ozone Concentration in Parts per Billion (PPB)							
Monitor Site	**Abbreviation**	**1995-1997**	**1996-1998**	**1997-1999**	**1998-2000**	**1999-2001**	**2000-2002**
Maricopa County							
Blue Point	BP			**86**	**87**	84	84
Cave Creek	CC						
Central Phoenix	CP	79	77	78	77	76	75
Falcon Field	FF			82	80	79	80
Fountain Hills	FH			**86**	**85**	84	84
Glendale	GL	76	72	75	77	80	80
Humboldt Mountain	HM			**85**	**86**	84	**85**
Lake Pleasant	LP				81	78	
Maryvale	MA			80	81	76	79
Mesa	ME	**88**	84	82	79	77	73
Mt. Ord	MO			**86**	**88**	84	
North Phoenix	NP	**92**	**91**	**88**	**86**	**85**	**85**
Palo Verde	PAVE		76	79	80	78	77
Emergency Management	EM			84	79	73	
Super Site	PXSS		81	68	67	67	77
Pinnacle Peak	PP	**88**	**86**	83	**85**	84	**85**
Rio Verde	RV			83	83	**85**	84
Roosevelt	RO						
Salt River Pima	SRPI	**88**	**87**	83			
South Phoenix	SP	83	82	76		74	80
South Scottsdale	SS	84	80	75	76	77	78
Surprise	SU						75
Tempe	TE						79
Vehicle Emissions	VE						
West Chandler	WC			73	72		79
West Phoenix	WP	81	81	**85**	**86**	82	80
Gila County							
Rye	RY			67			
Tonto N.M.	TONO						
Pinal County							
Apache Junction	AJ	**86**	83	81	81	80	80
Casa Grande	CG	74	73	72	77	79	79
Queen Valley	QUAZ						
Yavapai County							
Hillside	HISD		81	81	83	81	82

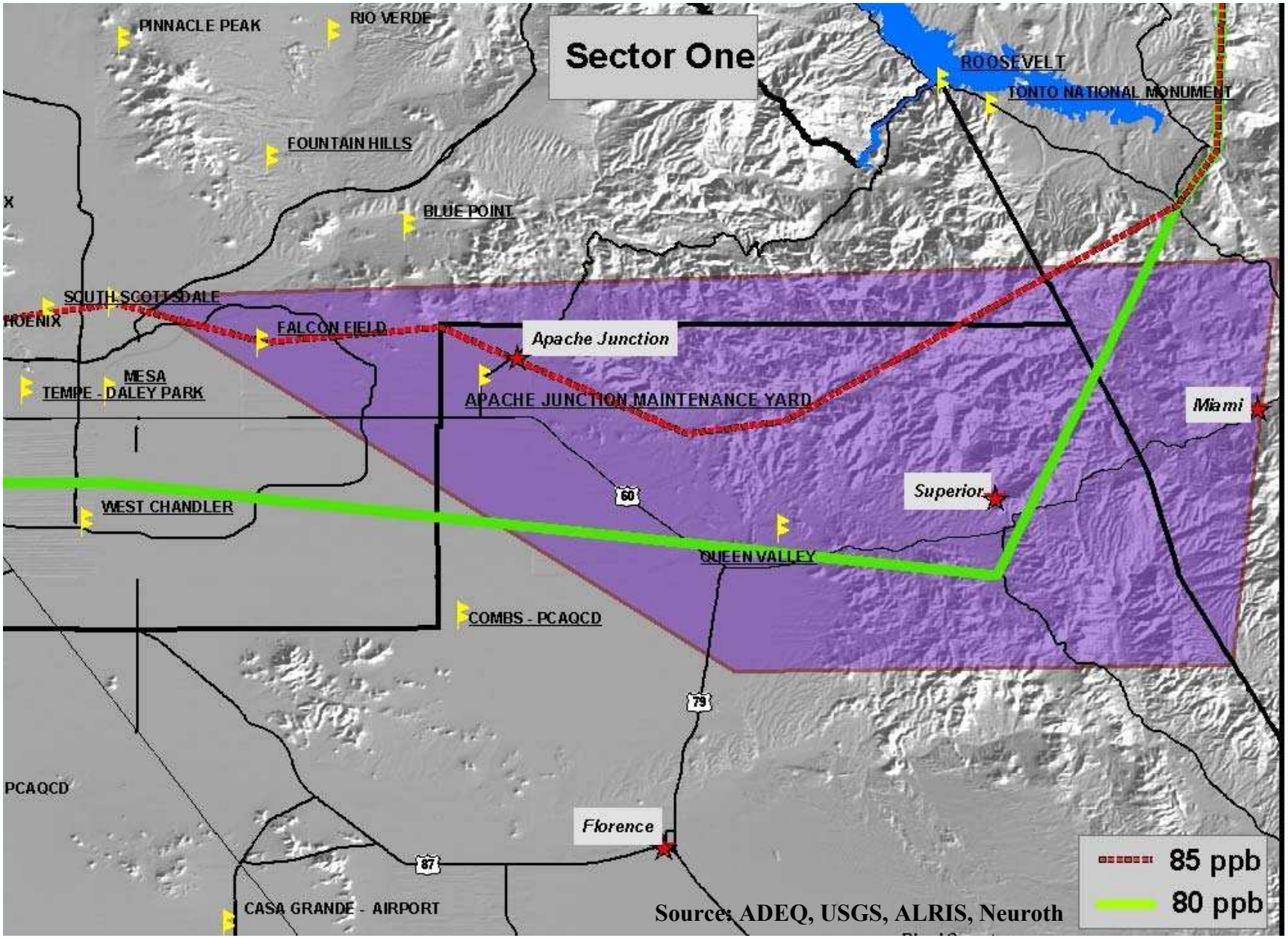
Values in red indicate a violation of the 8-hour ozone standard

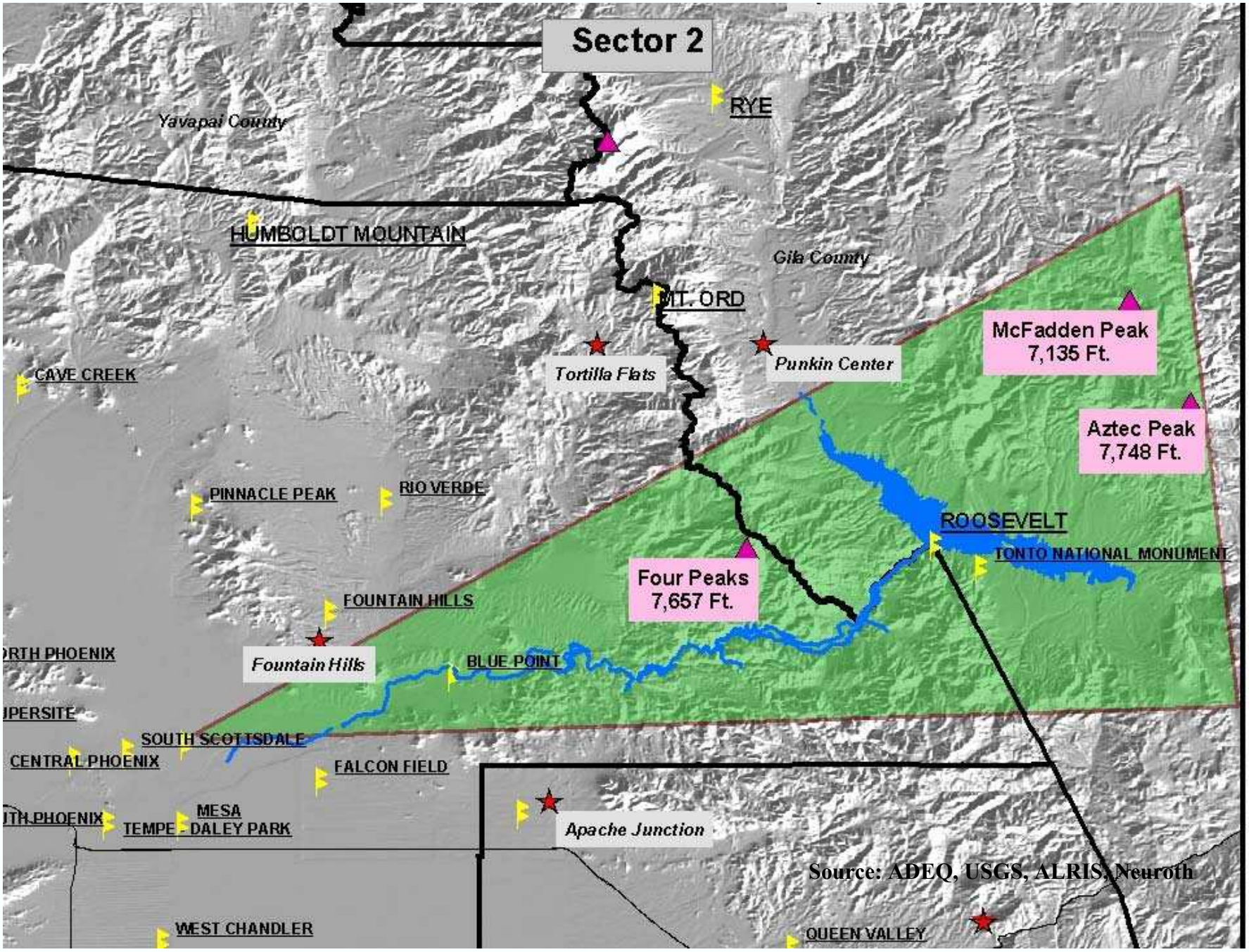
2003, 8-Hour Ozone Standard Exceedances to Date in Parts per Billion (PPB) (Preliminary data as of June 11, 2003)					
Monitor Site	**Abbreviation**	**May 11**	**May 21**	**May 22**	**May 27**
Maricopa County					
Blue Point	BP				**86**
Cave Creek	CC	**87**			**88**
Central Phoenix	CP				
Falcon Field	FF				
Fountain Hills	FH				
Glendale	GL	**88**	**85**		
Humboldt Mountain	HM	**90**		**87**	**89**
Lake Pleasant	LP				
Maryvale	MA	**86**			
Mesa	ME				
Mt. Ord	MO				
North Phoenix	NP	**88**			
Palo Verde	PAVE				
Emergency Management	EM				
Super Site	PXSS				
Pinnacle Peak	PP	**89**			**85**
Rio Verde	RV				
Roosevelt	RO				
Salt River Pima	SRPI				
South Phoenix	SP				
South Scottsdale	SS	**85**			
Surprise	SU				
Tempe	TE				
Vehicle Emissions	VE				
West Chandler	WC				
West Phoenix	WP				
Gila County					
Rye	RY				
Tonto N.M.	TONO				
Pinal County					
Apache Junction	AJ				
Casa Grande	CG				
Queen Valley	QUAZ				
Yavapai County					
Hillside	HISD				

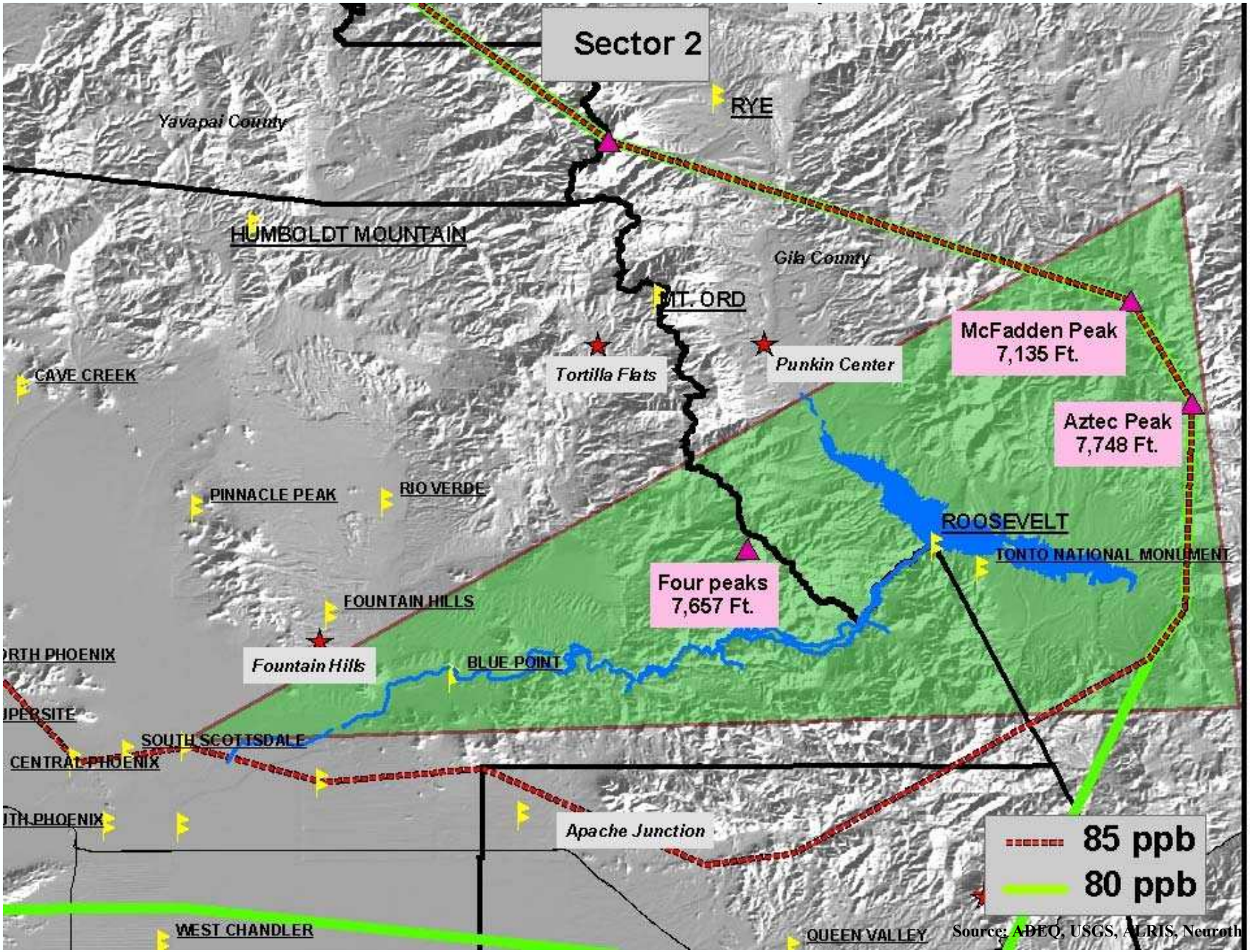
Receptor Areas

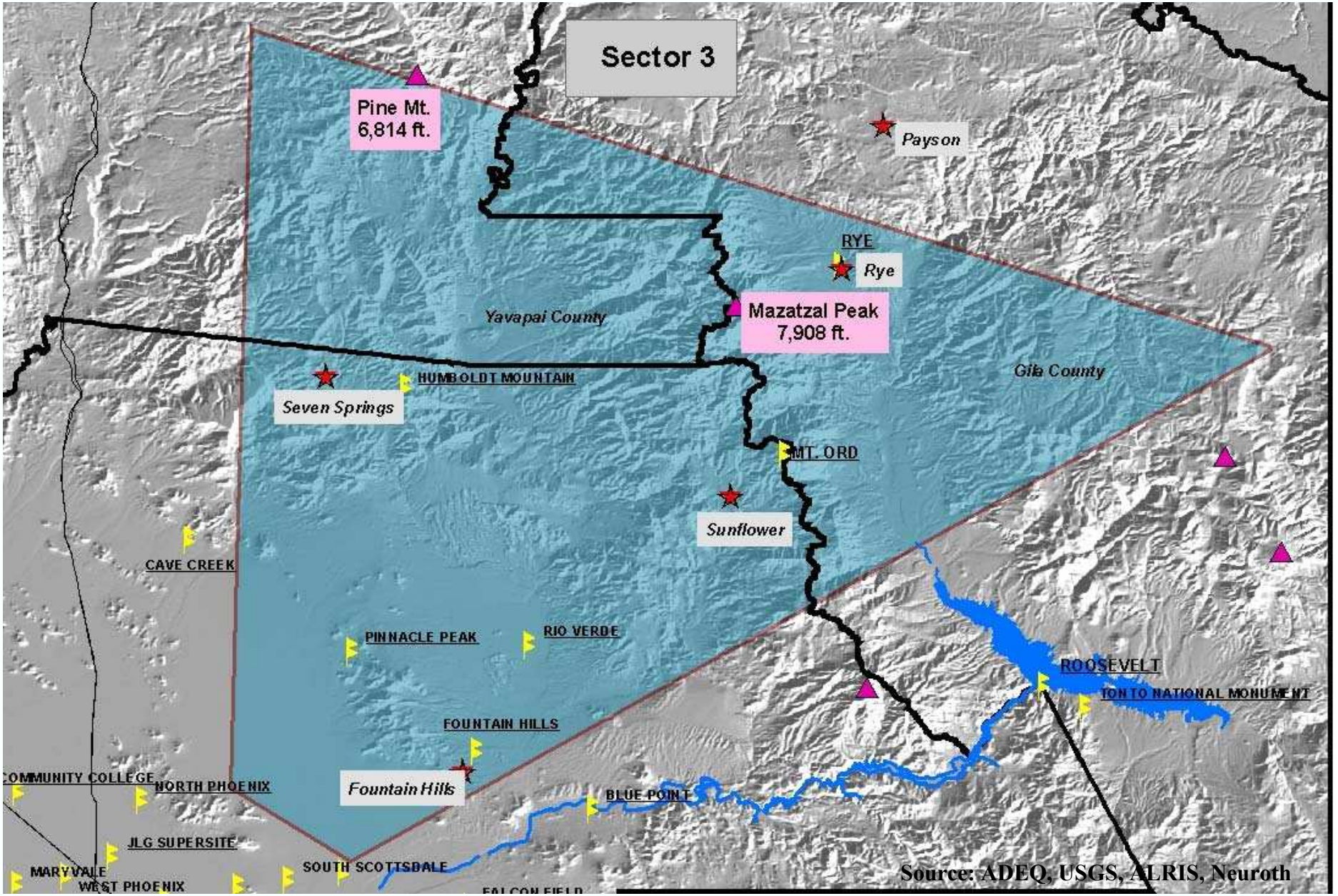

Study Zones
Prescott
HISD
Payson
Yavapai County
RY
Gila County
HM
Wickenburg
LP
CC
Maricopa County
PP
RV
SU
FH
TONO
GL
NP
BP
MA
WP
RX
SS
SRPI
CR
VE
EM
SS
FF
AJ
Apache Junction
SP
TE
ME
PAVE
WC
QUAZ
Superior
CB
MCPA
Florence
Pinal County
Gila Bend
CG
Casa Grande
Source: ADEQ, USGS, ALRIS, Neuroth

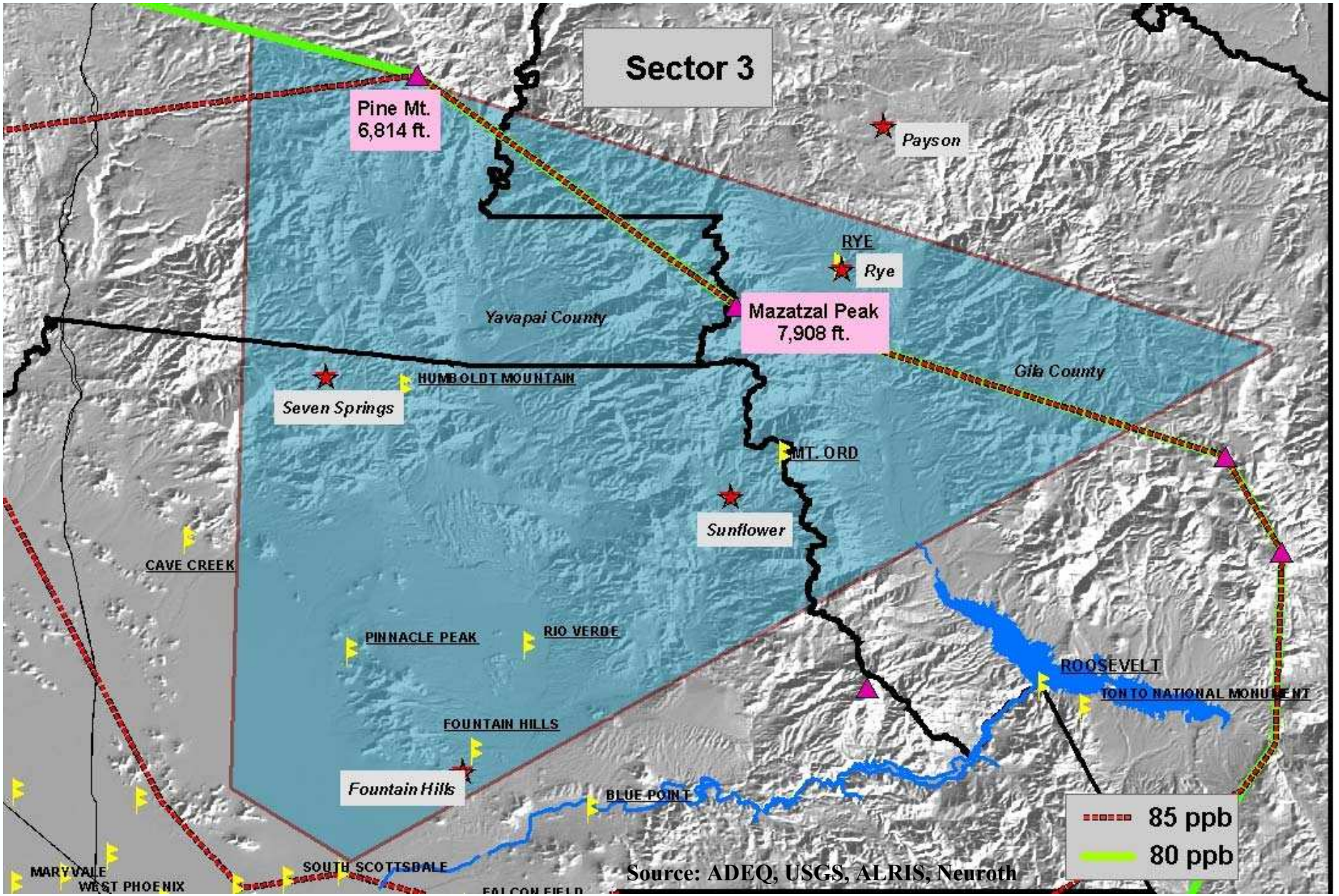

Sector One
PINNACLE PEAK
RIO VERDE
ROOSEVELT
TONTO NATIONAL MONUMENT
FOUNTAIN HILLS
BLUE POINT
SOUTH SCOTTSDALE
HOENIX
FALCON FIELD
Apache Junction
APACHE JUNCTION MAINTENANCE YARD
MESA
TEMPE - DALEY PARK
Miami
Superior
WEST CHANDLER
60
QUEEN VALLEY
COMBS - PCAQCD
79
PCAQCD
Florence
87
CASA GRANDE - AIRPORT
Source: ADEQ, USGS, ALRIS, Neuroth

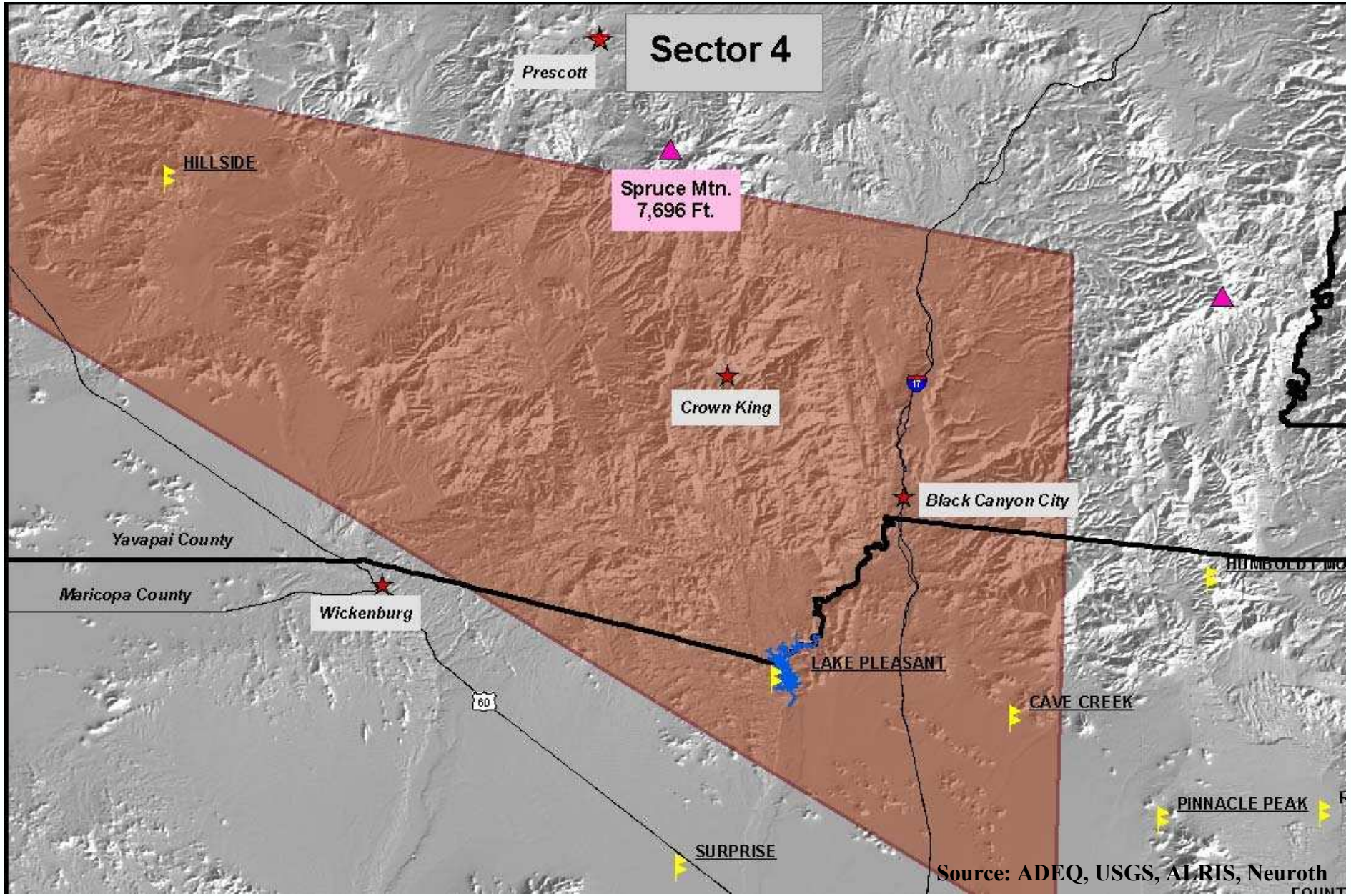

Sector One
PINNACLE PEAK
RIO VERDE
ROOSEVELT
TONTO NATIONAL MONUMENT
FOUNTAIN HILLS
BLUE POINT
SOUTH SCOTTSDALE
FALCON FIELD
Apache Junction
APACHE JUNCTION MAINTENANCE YARD
MESA
TEMPE - DALEY PARK
Miami
Superior
WEST CHANDLER
60
QUEEN VALLEY
COMBS - PCAQCD
79
PCAQCD
Florence
87
CASA GRANDE - AIRPORT
85 ppb
80 ppb
Source: ADEQ, USGS, ALRIS, Neuroth


Sector 2
RYE
Yavapai County
HUMBOLDT MOUNTAIN
Gila County
MT. ORD
McFadden Peak
7,135 Ft.
Punkin Center
Tortilla Flats
CAVE CREEK
Aztec Peak
7,748 Ft.
PINNACLE PEAK
RIO VERDE
ROOSEVELT
TONTO NATIONAL MONUMENT
Four Peaks
7,657 Ft.
FOUNTAIN HILLS
Fountain Hills
BLUE POINT
SOUTH SCOTTSDALE
CENTRAL PHOENIX
FALCON FIELD
MESA
TEMPE - DALEY PARK
Apache Junction
WEST CHANDLER
QUEEN VALLEY
Source: ADEQ, USGS, ALRIS, Neuroth


Sector 2
RYE
Yavapai County
HUMBOLDT MOUNTAIN
Gila County
MT. ORD
McFadden Peak
7,135 Ft.
Tortilla Flats
Punkin Center
CAVE CREEK
Aztec Peak
7,748 Ft.
PINNACLE PEAK
RIO VERDE
ROOSEVELT
TONTO NATIONAL MONUMENT
Four peaks
7,657 Ft.
FOUNTAIN HILLS
Fountain Hills
BLUE POINT
SOUTH SCOTTSDALE
CENTRAL PHOENIX
Apache Junction
85 ppb
80 ppb
WEST CHANDLER
QUEEN VALLEY
Source: ADEQ, USGS, ALRIS, Neuroth


Sector 3
Pine Mt.
6,814 ft.
Payson
RYE
Rye
Mazatzal Peak
7,908 ft.
Yavapai County
Gila County
HUMBOLDT MOUNTAIN
Seven Springs
MT. ORD
Sunflower
CAVE CREEK
PINNACLE PEAK
RIO VERDE
ROOSEVELT
TONTO NATIONAL MONUMENT
FOUNTAIN HILLS
Fountain Hills
COMMUNITY COLLEGE
NORTH PHOENIX
BLUE POINT
JLG SUPERSITE
MARYVALE
WEST PHOENIX
SOUTH SCOTTSDALE
Source: ADEQ, USGS, ALRIS, Neuroth


Sector 3
Pine Mt.
6,814 ft.
Payson
RYE
Rye
Mazatzal Peak
7,908 ft.
Yavapai County
Gila County
HUMBOLDT MOUNTAIN
Seven Springs
MT. ORD
Sunflower
CAVE CREEK
PINNACLE PEAK
RIO VERDE
ROOSEVELT
TONTO NATIONAL MONUMENT
FOUNTAIN HILLS
Fountain Hills
BLUE POINT
MARYVALE
WEST PHOENIX
SOUTH SCOTTSDALE
85 ppb
80 ppb
Source: ADEQ, USGS, ALRIS, Neuroth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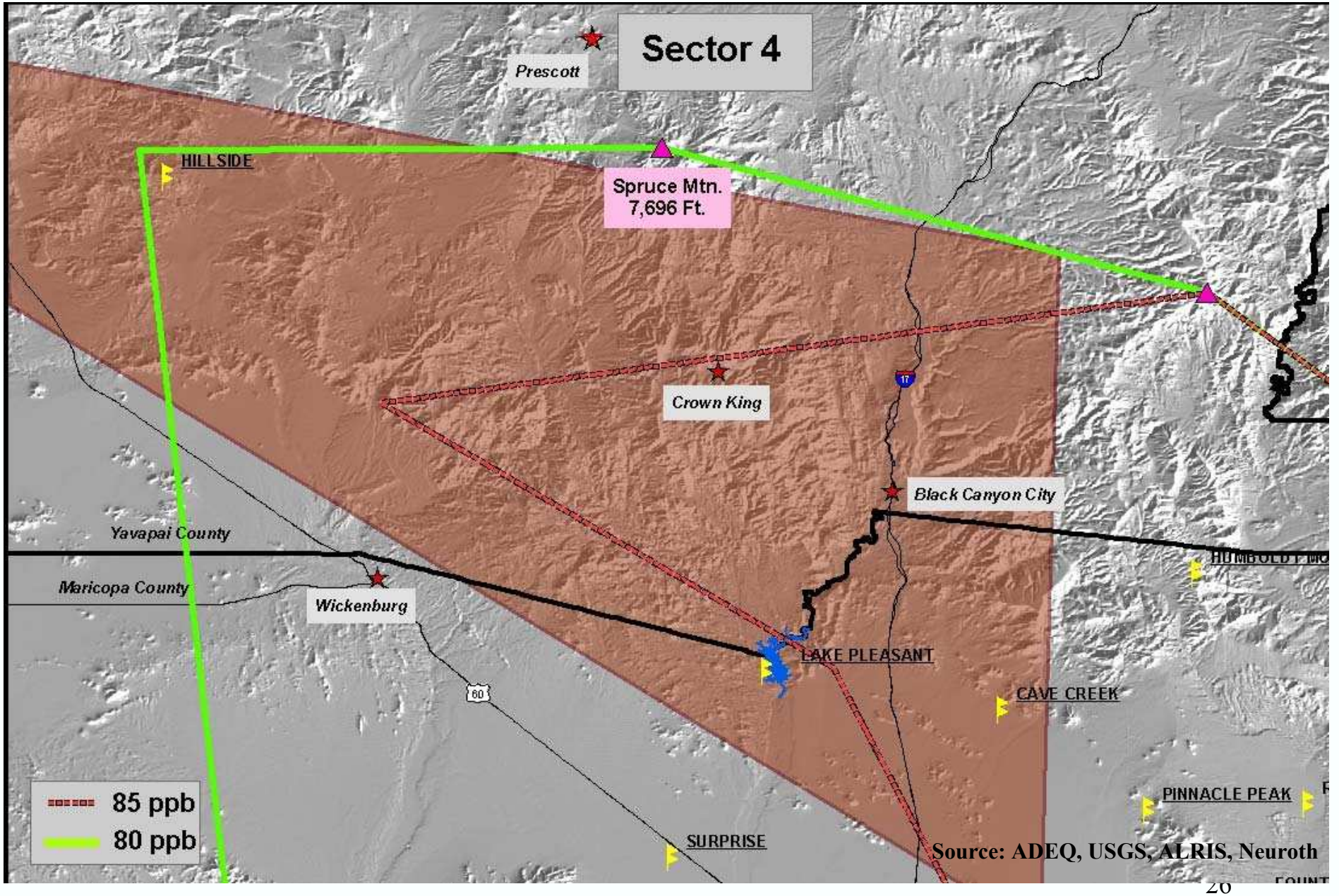
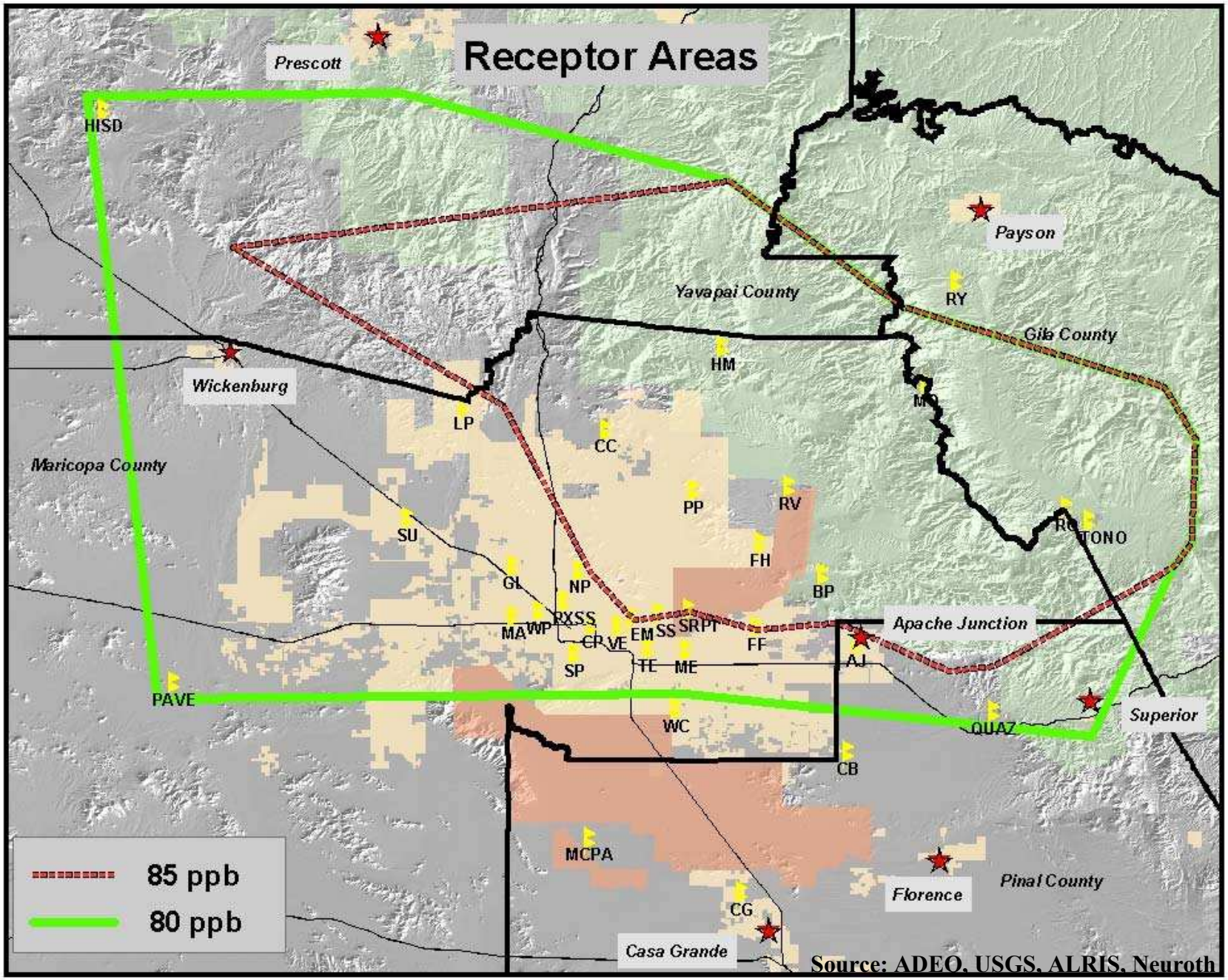
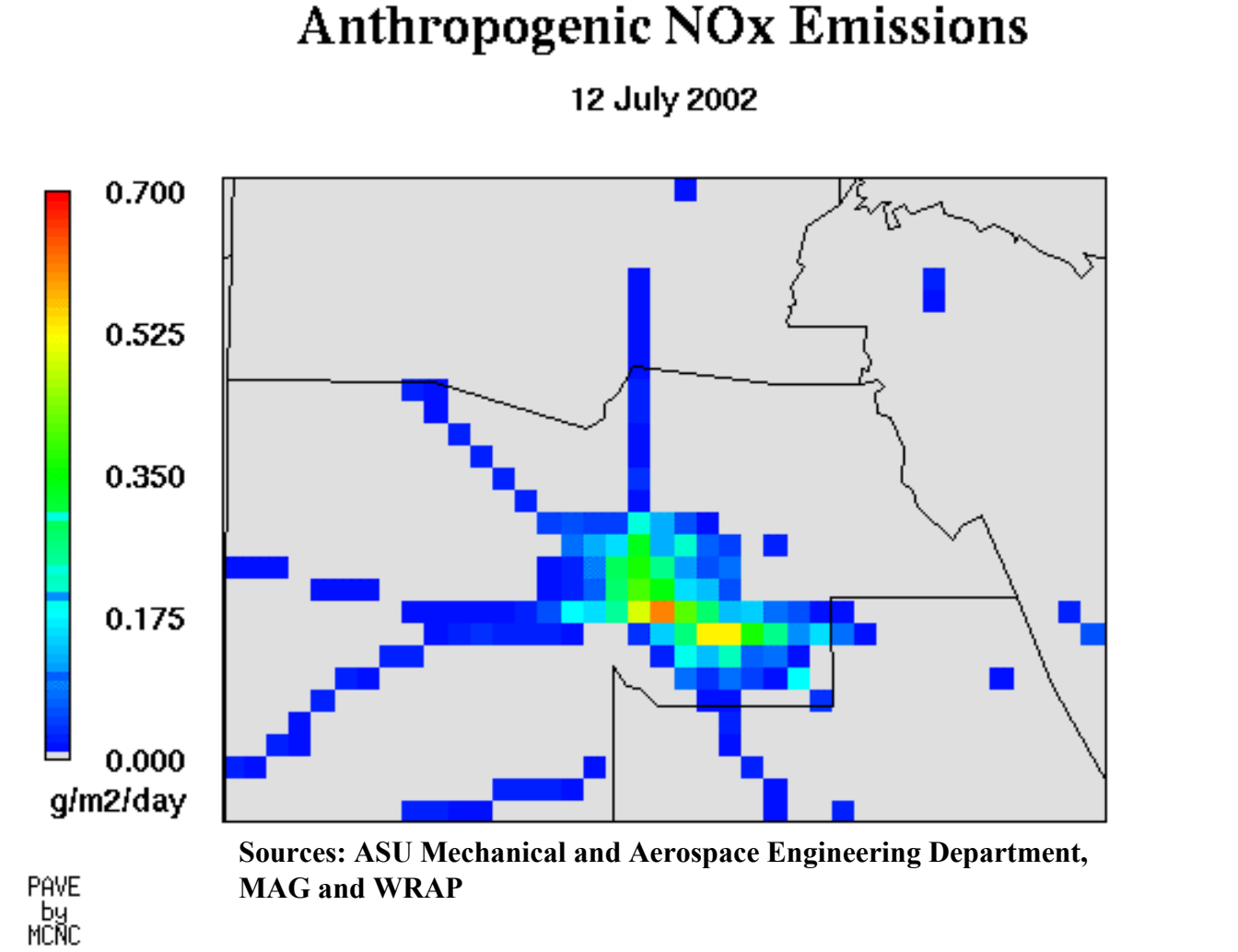
Prescott
HILLSIDE
Spruce Mtn.
7,696 Ft.
Crown King
17
Black Canyon City
Yavapai County
Maricopa County
Wickenburg
LAKE PLEASANT
60
CAVE CREEK
PINNACLE PEAK
SURPRISE
Source: ADEQ, USGS, ALRIS, Neuroth


Sector 4
Prescott
HILLSIDE
Spruce Mtn.
7,696 Ft.
Crown King
Black Canyon City
Yavapai County
Maricopa County
Wickenburg
LAKE PLEASANT
CAVE CREEK
PINNACLE PEAK
SURPRISE
85 ppb
80 ppb
Source: ADEQ, USGS, ALRIS, Neuroth


Receptor Areas
Prescott
HISD
Payson
Yavapai County
RY
Gila County
HM
Wickenburg
LP
CC
Maricopa County
PP
RV
SU
TONO
FH
GL
NP
BP
MA
WP
RXSS
EM
SS
SRPT
CR
VE
FF
Apache Junction
AJ
SP
TE
ME
PAVE
WC
QUAZ
Superior
CB
MCPA
Florence
Pinal County
CG
Casa Grande
85 ppb
80 ppb
Source: ADEQ, USGS, ALRIS, Neuroth

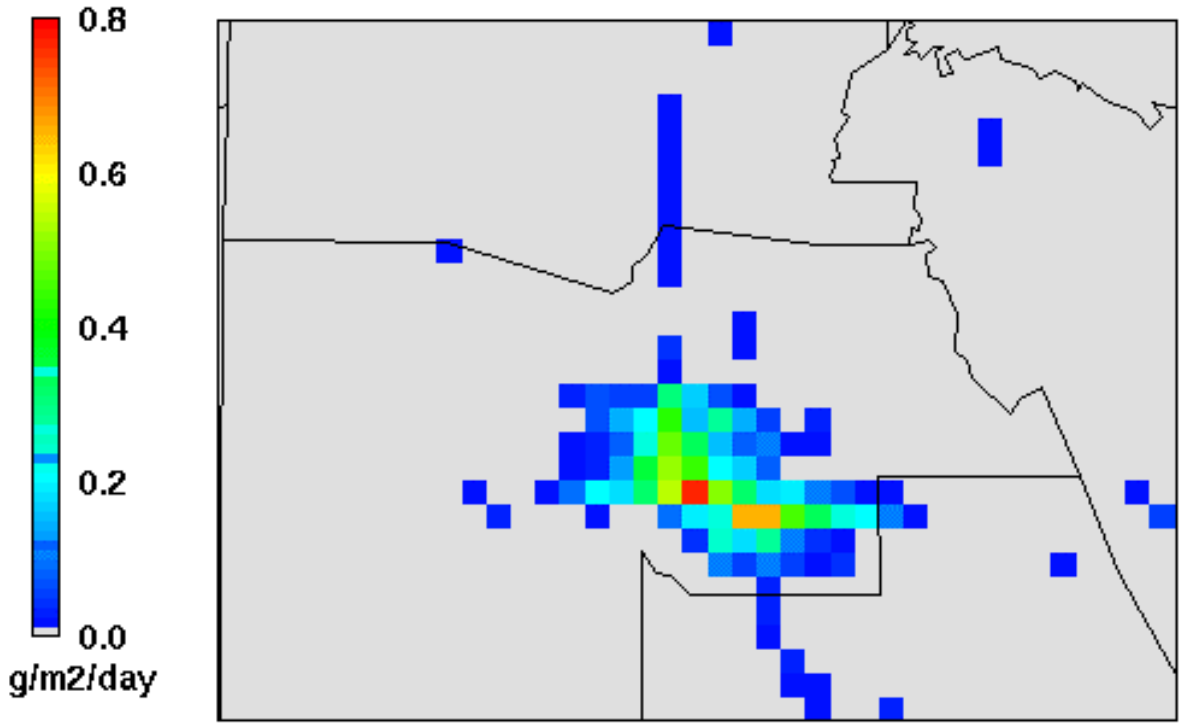
Existing and Potential Source Areas

Smoke Results

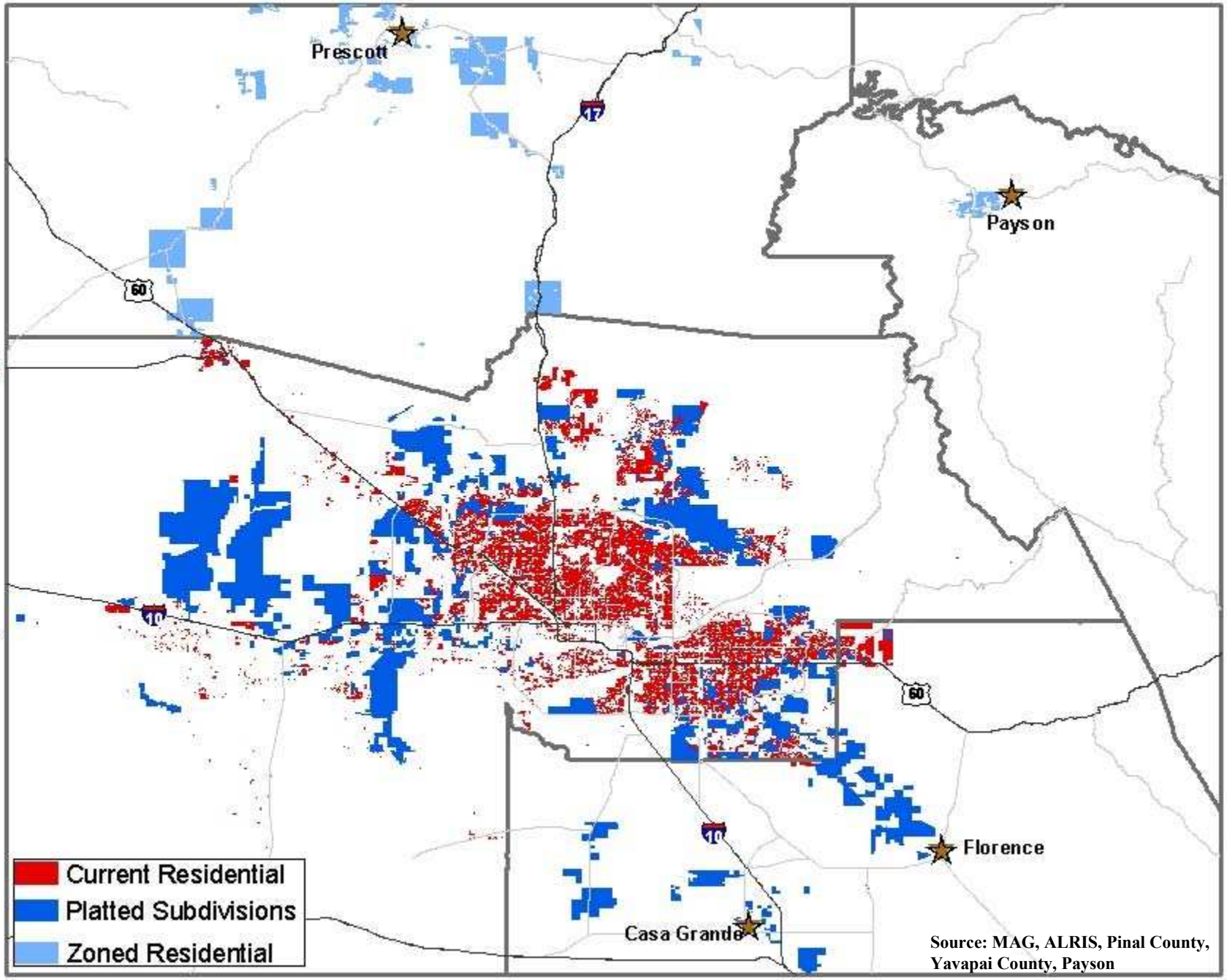


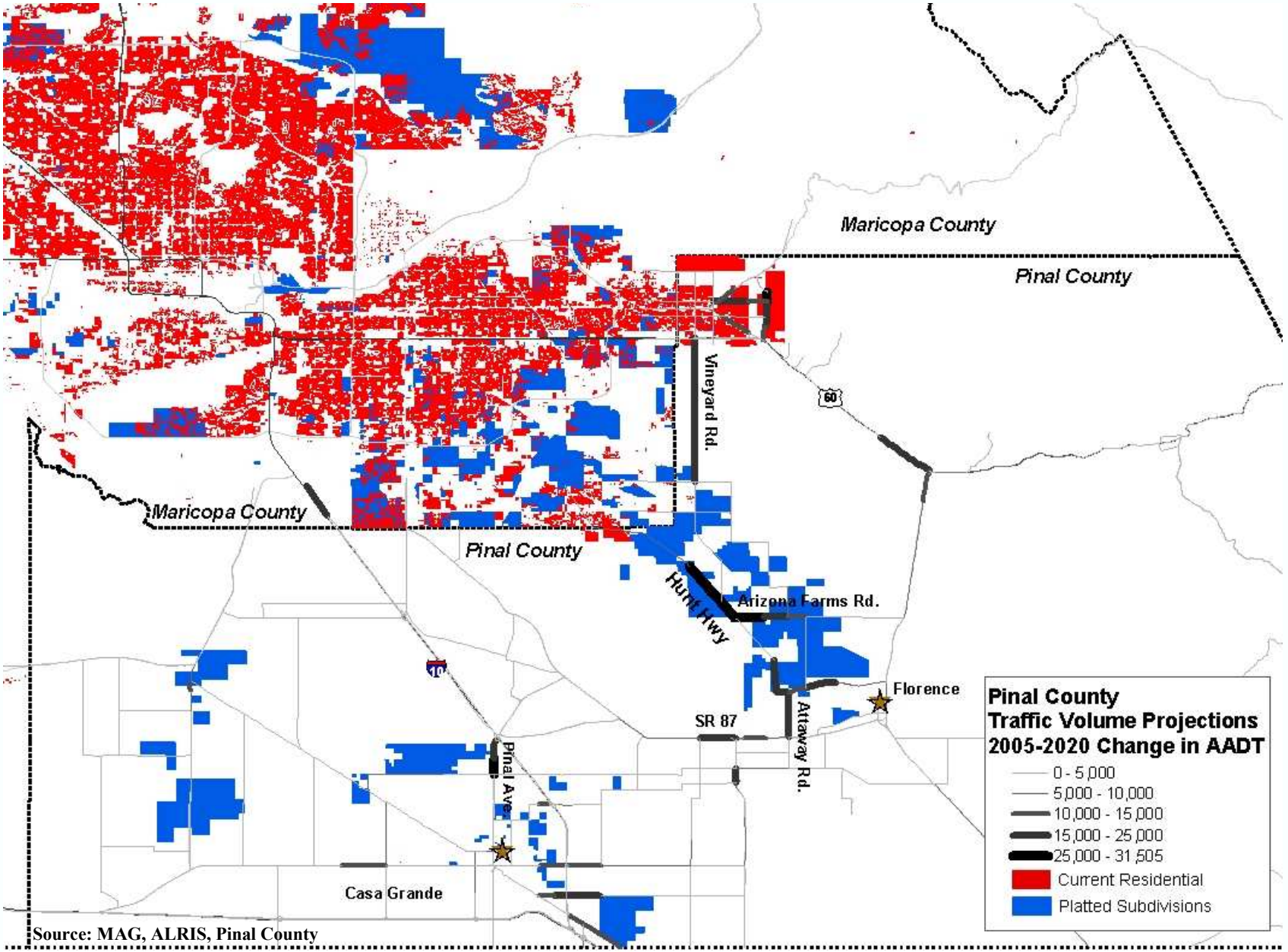
Sources: ASU Mechanical and Aerospace Engineering Department, MAG and WRAP

Smoke Results

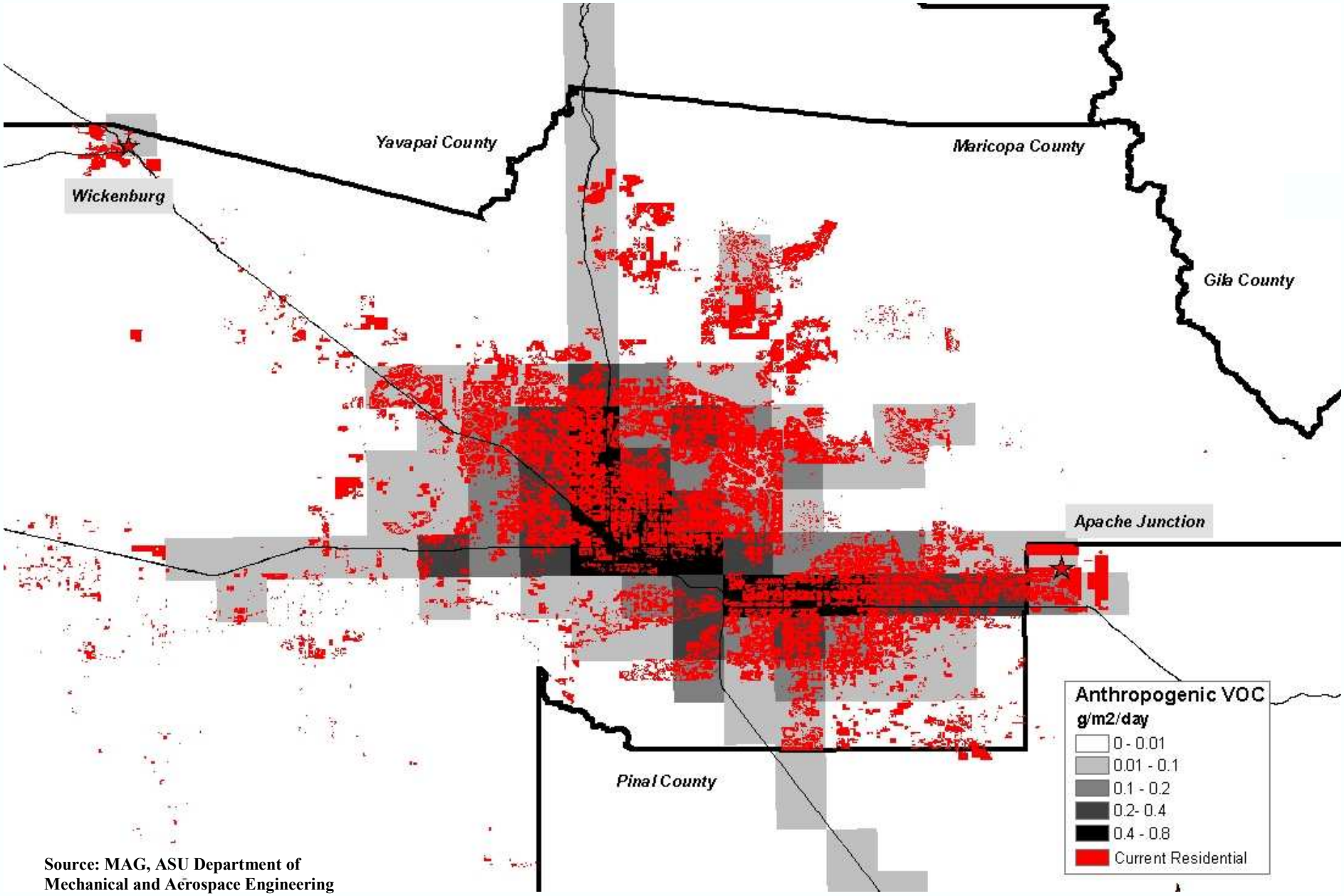


Sources: ASU Mechanical and Aerospace Engineering Department, MAG and WRAP

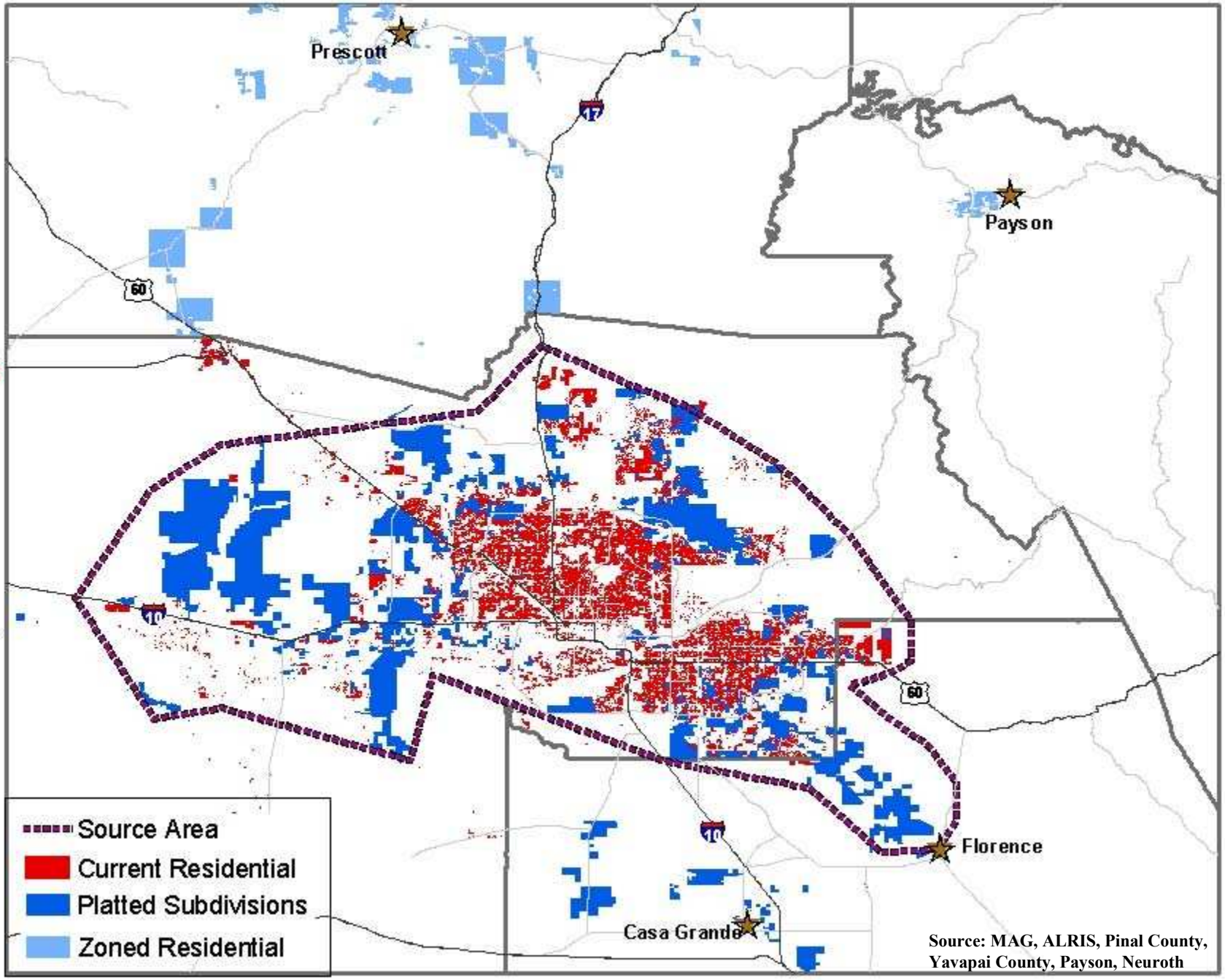

Prescott
Payson
Florence
Casa Grande
17
60
10
Current Residential
Platted Subdivisions
Zoned Residential
Source: MAG, ALRIS, Pinal County, Yavapai County, Payson

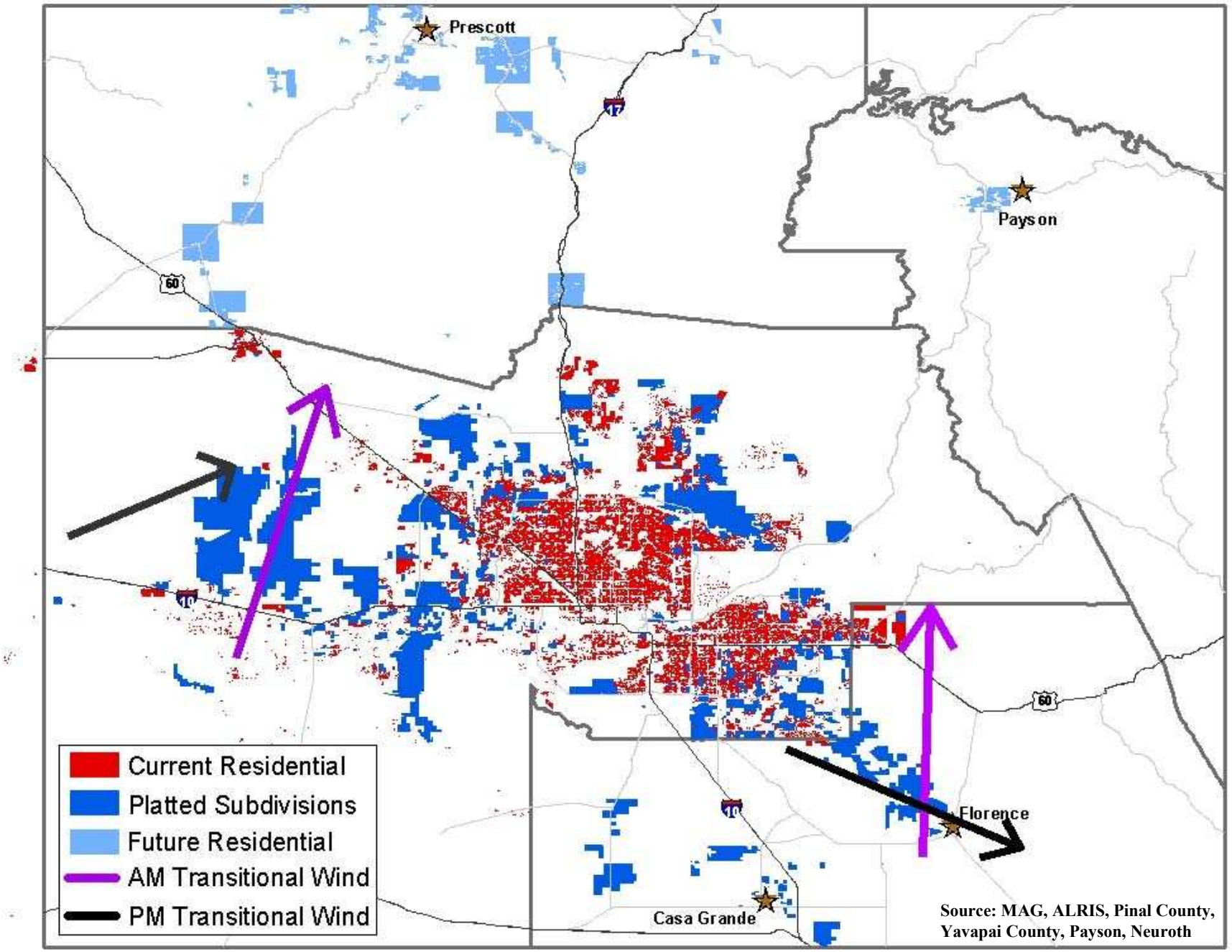


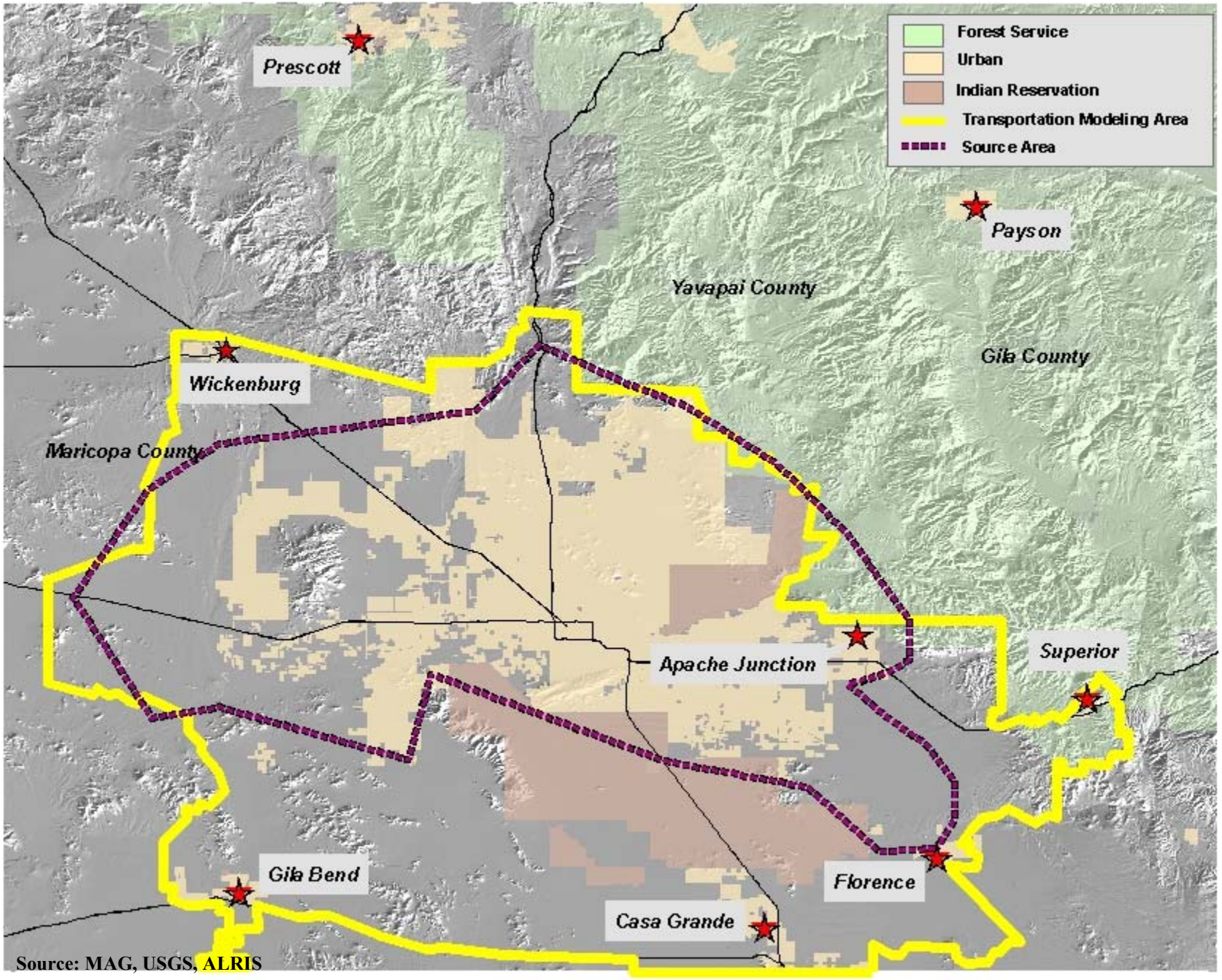
Source: MAG, ALRIS, Pinal County

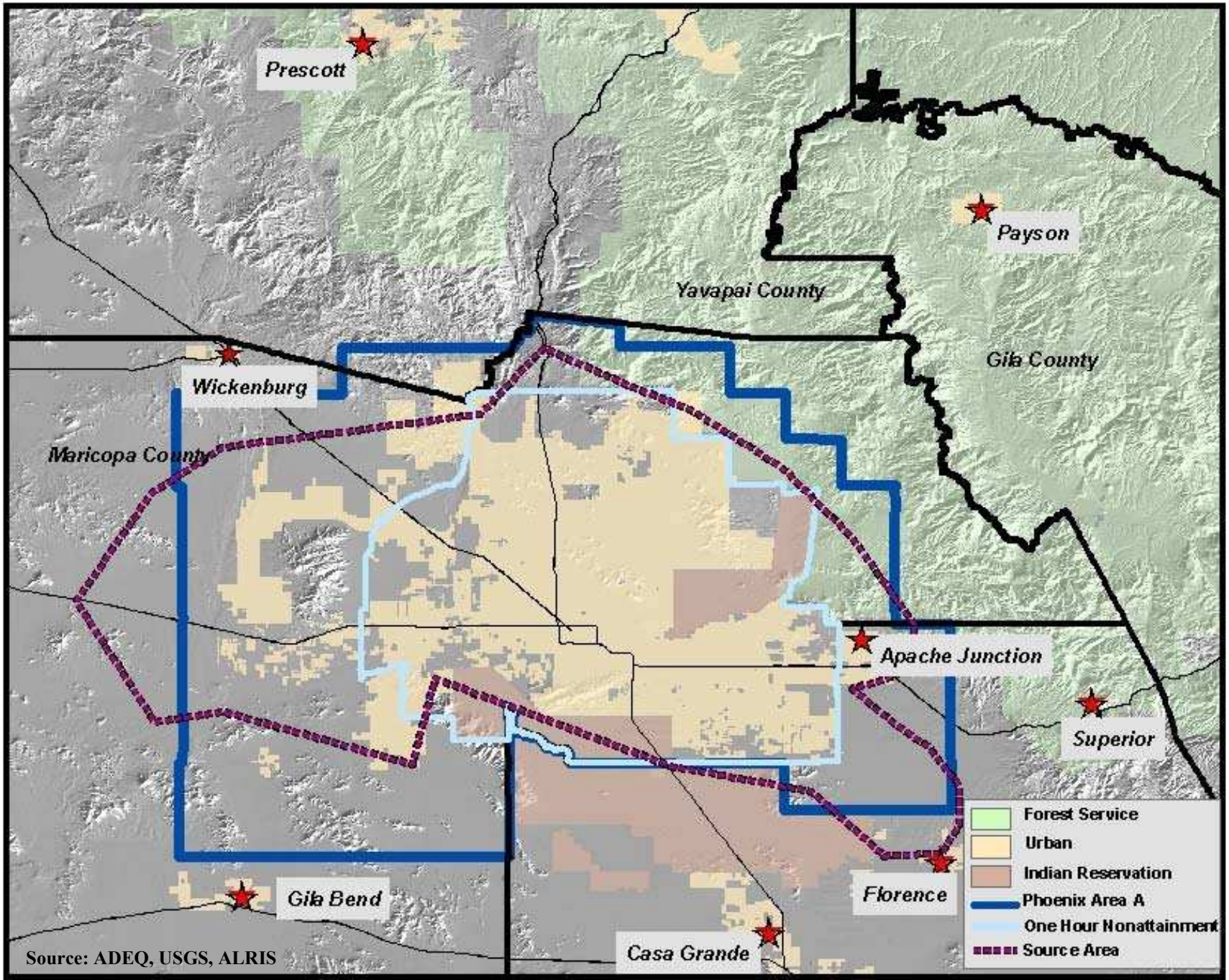


Source: MAG, ASU Department of Mechanical and Aerospace Engineering

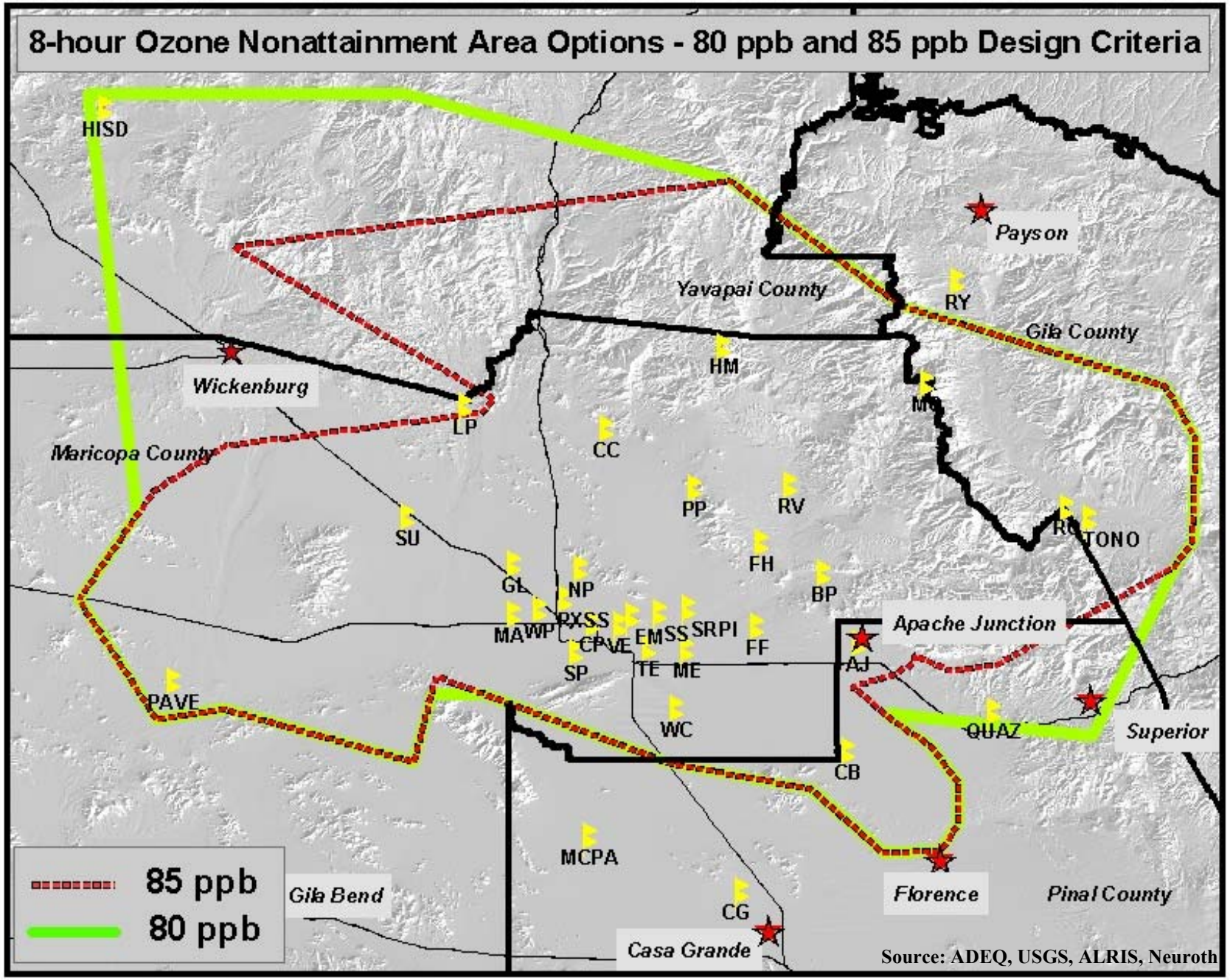

Prescott
Payson
Florence
Casa Grande
17
60
10
Source Area
Current Residential
Platted Subdivisions
Zoned Residential
Source: MAG, ALRIS, Pinal County, Yavapai County, Payson, Neuroth

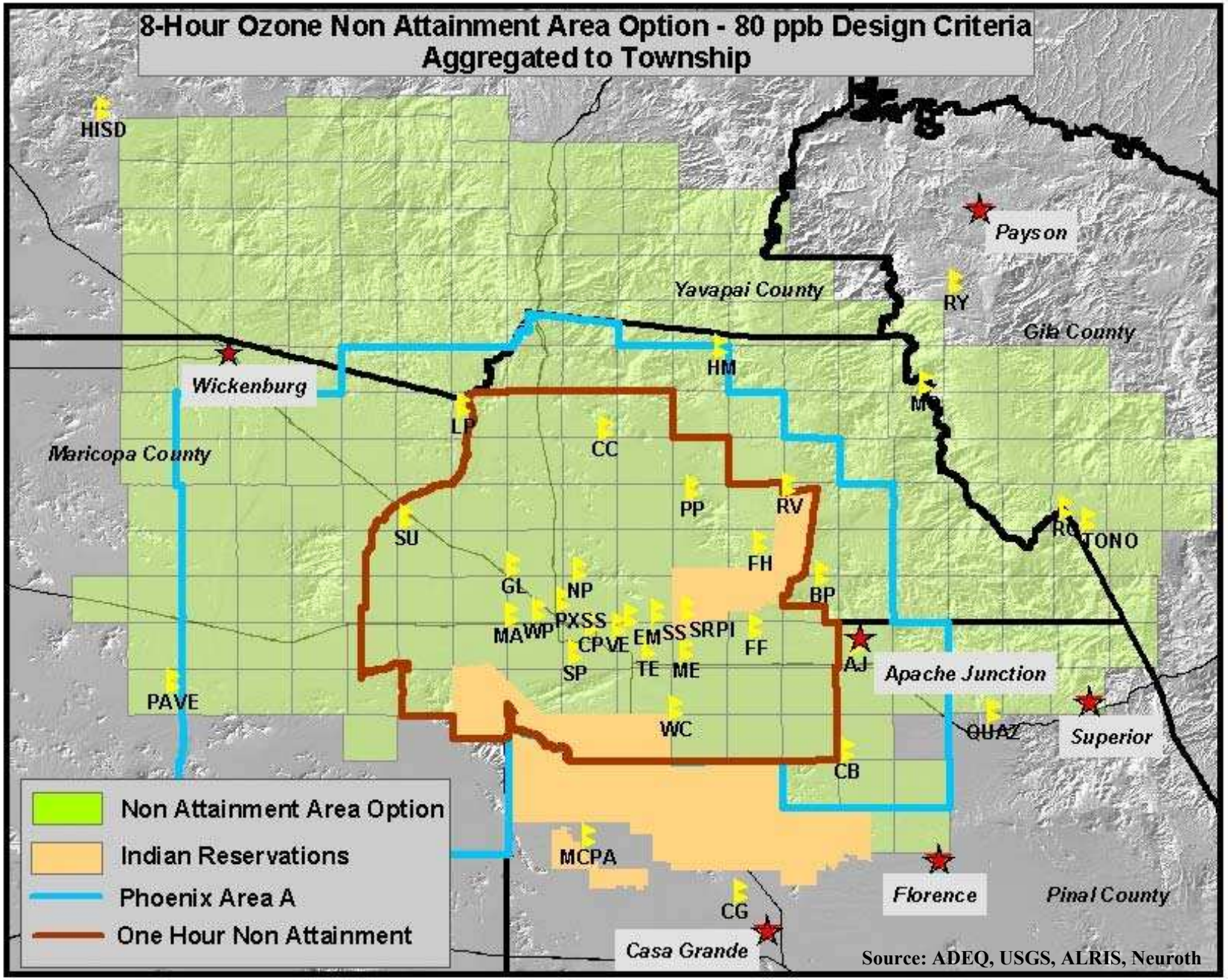

Prescott
Payson
Florence
Casa Grande
17
60
10
Current Residential
Platted Subdivisions
Future Residential
AM Transitional Wind
PM Transitional Wind
Source: MAG, ALRIS, Pinal County, Yavapai County, Payson, Neuroth

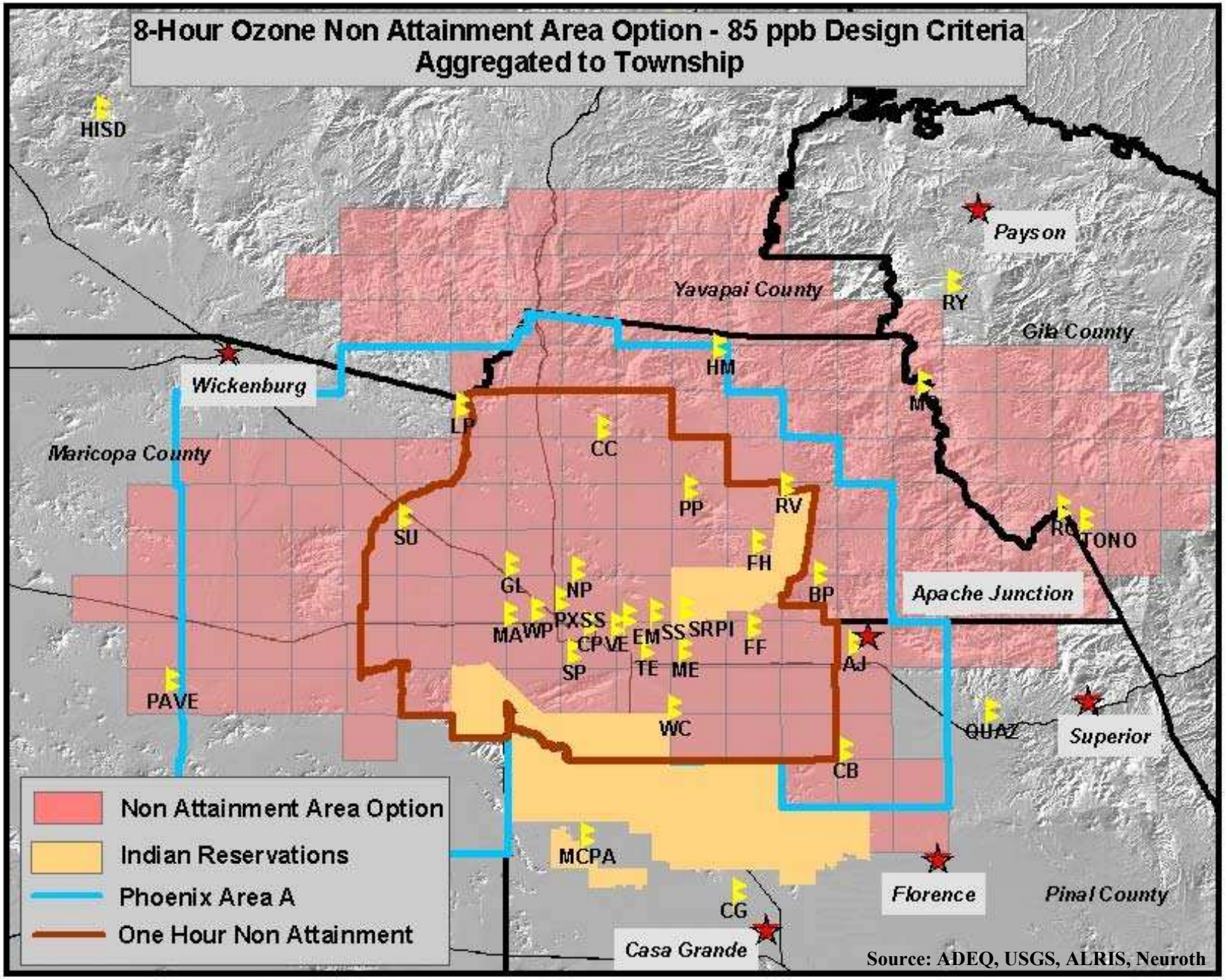

Forest Service
Urban
Indian Reservation
Transportation Modeling Area
Source Area
Prescott
Payson
Yavapai County
Gila County
Wickenburg
Maricopa County
Apache Junction
Superior
Florence
Gila Bend
Casa Grande
Source: MAG, USGS, ALRIS


Prescott
Payson
Yavapai County
Gila County
Wickenburg
Maricopa County
Apache Junction
Superior
Florence
Gila Bend
Casa Grande
Forest Service
Urban
Indian Reservation
Phoenix Area A
One Hour Nonattainment
Source Area
Source: ADEQ, USGS, ALRIS

8-Hour Ozone Boundary Options


8-hour Ozone Nonattainment Area Options - 80 ppb and 85 ppb Design Criteria
HISD
Payson
Yavapai County
RY
Gila County
HM
Wickenburg
LP
Maricopa County
CC
PP
RV
SU
FH
BP
GL
NP
MA
WP
RX
SS
CP
VE
EM
SS
SRPI
FF
Apache Junction
AJ
SP
TE
ME
PAVE
WC
QUAZ
Superior
CB
MCPA
Gila Bend
CG
Florence
Pinal County
Casa Grande
85 ppb
80 ppb
Source: ADEQ, USGS, ALRIS, Neuroth


8-Hour Ozone Non Attainment Area Option - 80 ppb Design Criteria
Aggregated to Township
HISD
Payson
Yavapai County
RY
Gila County
Wickenburg
HM
LP
CC
Maricopa County
PP
RV
SU
FH
GL
NP
BP
MA
WP
PXSS
CPVE
EM
SS
SRPI
FF
AJ
Apache Junction
SP
TE
ME
PAVE
WC
QUAZ
Superior
CB
MCPA
Florence
Pinal County
CG
Casa Grande
Source: ADEQ, USGS, ALRIS, Neuroth
Non Attainment Area Option
Indian Reservations
Phoenix Area A
One Hour Non Attainment


8-Hour Ozone Non Attainment Area Option - 85 ppb Design Criteria
Aggregated to Township
HISD
Payson
Yavapai County
RY
Gila County
Wickenburg
HM
LP
CC
Maricopa County
PP
RV
SU
FH
GL
NP
BP
Apache Junction
MA
WP
PXSS
CP
VE
EM
SS
SRPI
FF
AJ
SP
TE
ME
PAVE
WC
QUAZ
Superior
CB
MCPA
Florence
Pinal County
CG
Casa Grande
Non Attainment Area Option
Indian Reservations
Phoenix Area A
One Hour Non Attainment
Source: ADEQ, USGS, ALRIS, Neuroth

Description of June 17, 2003, Presentation Maps

Wind Sites

This map was created by overlaying wind monitor locations that were made available by ADEQ by latitude/longitude with general topography and political boundaries. Significant lakes and cities are also shown, as well as general urban, forest, and Indian reservation landuse.

Data Sources: University of Arizona, SRP, Maricopa County, ADEQ, USGS, ALRIS

Ozone Sites

This map was created by overlaying ozone monitor locations that were made available by ADEQ by latitude/longitude with general topography and political boundaries. Significant lakes and cities are also shown, as well as general urban, forest, and Indian reservation landuse.

Data Sources: University of Arizona, SRP, Maricopa County, ADEQ, USGS, ALRIS

Receptor Area Study Zones

This map was created by overlaying receptor area study zones that were made available by Gary Neuroth, Air Pollution Evaluations & Solutions with general topography and political boundaries. Significant lakes and cities are also shown.

Data Source: ADEQ, USGS, ALRIS, Neuroth

Receptor sectors with and without 80/85 ppb boundaries

This series of maps was created by overlaying receptor area boundaries and 80 ppb and 85 ppb boundaries that were made available by Gary Neuroth, Air Pollution Evaluations & Solutions, with general topography and political boundaries. Significant lakes and cities are also shown.

Data Source: ADEQ, USGS, ALRIS, Neuroth

80 and 85 ppb Receptor Areas

This map was created by overlaying 80 ppb and 85 ppb receptor area boundaries that were made available by Gary Neuroth, Air Pollution Evaluations & Solutions, with general topography and political boundaries. Significant lakes and cities are also shown, as well as general urban, forest, and Indian reservation landuse.

Data Source: ADEQ, USGS, ALRIS, Neuroth

Current and Future Residential land use

This map was created using data obtained from the City of Payson, Yavapai County, and MAG.

The Payson zoning data was manually digitized from a hardcopy zoning map, using USGS township, range, and section lines as a guideline. Only the residential zones are shown on this map, in red.

Yavapai County provided its zoning data in a digital format, which was then queried to extract the residential zones, which are shown in red.

Two datasets from MAG were used for this map. The first was land use for the year 2000, and residential land use was extracted and is shown in red. Second, a dataset that showed platted subdivisions was used. Platted subdivisions are shown in blue, indicating development that will take place in the near future, or perhaps is already taking place. Platted subdivisions have been through the planning process and are approved to be built.

Data Sources: MAG 2000 Landuse digital GIS file, Yavapai County Zoning digital GIS file, Payson Zoning hardcopy map

Current and Future Land use with Pinal Traffic Projections

Two datasets from MAG were used for this map. The first was land use for the year 2000, and residential land use was extracted and is shown in red. Second, a dataset that showed platted subdivisions was used. Platted subdivisions are shown in blue, indicating development that will take place in the near future, or perhaps is already taking place. Platted subdivisions have been through the planning process and are approved to be built.

Data from the Pinal County Transportation Plan 2000 Update was also used. The map depicts change for Annual Average Daily Traffic Counts for Pinal County from 2005-2020.

Data sources: Lima and Associates digital GIS file, MAG digital GIS files

Current Residential land use with Emissions:

This map shows the Anthropogenic VOC emissions that were produced by the SMOKE model overlayed by current residential landuse. The SMOKE dataset was provided by the ASU Department of Mechanical and Aerospace Engineering and is displayed by 6km cell output, which is the resolution of the model.

Data Source: MAG 2000 Landuse digital GIS file, ASU Department of Mechanical and Aerospace Engineering (Ascii file)

Current Residential land use with Source Area:
This map was created by overlaying a source area boundary that was made available by Gary Neuroth, Air Pollution Evaluations & Solutions, with current and future landuse.

Data Sources: MAG 2000 Landuse digital GIS file, ALRIS, Neuroth

Current Residential land use with Wind Arrows:
This map was created by overlaying wind direction arrows that were made available by Gary Neuroth, Air Pollution Evaluations & Solutions, with current and future landuse.

Data Sources: MAG 2000 Landuse digital GIS file, ALRIS, Neuroth

Source with Transportation Modeling Area:
This map was created by overlaying a source area boundary that was made available by Gary Neuroth, Air Pollution Evaluations & Solutions, with the Transportation Modeling Area. The map is shown with general topography and political boundaries. The transportation modeling area was scanned and georeferenced from "Preliminary Draft, Initial Analysis for an Eight-Hour Ozone Boundary Option for the Maricopa County Nonattainment Area," May 2003, Maricopa Association of Governments.

Data Sources: Neuroth, MAG

Source Area with Area A and One-Hour Nonattainment Areas
This map was created by overlaying a source area boundary that was made available by Gary Neuroth, Air Pollution Evaluations & Solutions, with Phoenix Area A and the one hour nonattainment boundaries which were provided by ADEQ. The map is shown with general topography and political boundaries.

Data Sources: Neuroth, ADEQ

80 and 85 Receptor areas combined with Source area:
The 80 ppb receptor area was combined with the source area and the 85 ppb receptor area was combined with the source area to create this map. The map shows the boundaries for the 8 hour ozone nonattainment options for 80 ppb and 85 ppb. The map is shown with general topography and political boundaries.

Data Sources: *ADEQ, USGS, ALRIS, Neuroth*

80 area aggregated to township
The nonattainment boundary line was used to cut out the township data within it. Townships that crossed the boundary were clipped. The newly calculated area

of each township in the cut out layer was divided by the original area of the township to get the percentage of each that fell within the boundary. These percentages were linked back to the original townships by their ID numbers. Townships were interactively selected for display in the map based on having at least 50% of their area within the nonattainment boundary.

Data Sources: *ADEQ, USGS, ALRIS, Neuroth*

85 area aggregated to township;

The nonattainment boundary line was used to cut out the township data within it. Townships that crossed the boundary were clipped. The newly calculated area of each township in the cut out layer was divided by the original area of the township to get the percentage of each that fell within the boundary. These percentages were linked back to the original townships by their ID numbers. Townships were interactively selected for display in the map based on having at least 50% of their area within the nonattainment boundary.

Data Sources: *ADEQ, USGS, ALRIS, Neuroth*

TECHNICAL ANALYSIS USED TO DEVELOP OPTIONAL NONATTAINMENT BOUNDARIES FOR 8-HOUR OZONE FOR THE GREATER PHOENIX AREA

July 2003

Prepared For

Arizona Department of Environmental Quality

Prepared By

Air Pollution Evaluations and Solutions
Gary R. Neuroth

Introduction

Ozone concentrations in the Greater Phoenix Area exceed the U.S. Environmental Protection Agency (EPA) 8-hour ozone standard of 0.08 parts per million (ppm), or an equivalent value of 80 parts per billion (ppb). Due to rounding conventions, a concentration of 85 ppb or higher exceeds the standard. Compliance with the standard is based on three-year averages of the fourth highest value for each year, at each monitor. Ozone concentrations in areas influenced by emissions in the Phoenix area have exceeded the standard for each three-year period since the standard was proposed by EPA in 1997. Maximum values have been in the range of 85 to 88 ppb.

The methods used to develop the optional nonattainment area boundaries for 8-hour ozone described in this report use information covering each of the eleven designation criteria in EPA Guidance on establishing boundaries for the 8-hour standard, dated March 28, 2000. The actual technical approach directly follows the requirements in Section 107 (d) (1) of the Clean Air Act Amendments which, "requires all areas to be designated non-attainment if they do not meet the standard or contribute to ambient air quality in a nearby area that does not meet the standard."

Per the requirement quoted above, the nonattainment boundary options were developed by separate analyses to map the areas of ozone impact where the standard is exceeded, and a separate but closely-related analysis, to determine the geographic area where pollutant emissions contribute to the ozone concentrations above the standard. The area where ozone exceeds the ambient standard is referred to in this report as the "Receptor Area", and the area where emissions occur which contribute to ozone violations is referred to as the "Source Area."

Two alternative design criteria were used to produce the optional boundaries. One design criterion is an 85 ppb, three-year average of the fourth high value, which is the effective level of the standard. Under this criterion, the boundary was constrained to enclose the geographic area where there is high confidence that the standard is exceeded. The other design criterion value is 80 ppb.

The boundary developed using the 80-ppb criterion is a larger area because it includes the entire 85-ppb area as well as additional areas where concentrations are generally in the 80-85 ppb range, but without any measurements indicating ozone levels above the standard.

Receptor Area Analysis

An attempt was made to use all available information relevant to determine the geographic extent of ozone violations in the vicinity of the Phoenix area under current emissions. The three basic information tools: ozone monitoring data, ozone simulation modeling, and wind measurement analysis, were used in this evaluation. These tools and their specific roles in the development of the boundary options are described below.

Ozone Monitoring

Maricopa County, Pinal County, and ADEQ, operate an extensive network of ozone monitors in and around the Greater Phoenix Area. Currently there are 26 monitors in operation, mostly in the urbanized area, but a significant number are located in rural and even remote locations as far as 80 miles from central Phoenix.

A concern with using historical ozone measurement records for the purpose of designating a nonattainment area occurs when there is any evident trend in the data. Over time, ozone concentrations have decreased in the Phoenix area, as is evident by the attainment of the 1-hour standard in 1997. The measurement record of 8-hour ozone concentrations from 1995 through 2002 was evaluated for possible use in this project. It was concluded that ozone concentrations decreased through 1996 but that no apparent trend has occurred since then.

Table 1 shows the fourth highest ozone concentrations for the ozone monitoring network for the period 1995 through 2002. The last row on this table shows the average concentration for the network by year. These averages reveal a drop in concentration levels after 1996, with stable values thereafter. Average values for a subset of the network comprised of ten monitors that were in operation for all eight years reveals the same pattern of stable concentrations from 1997 through 2002, see Table 2. Therefore, the 1997 through 2002 portion of the historical record was used in the development of the boundary options and is considered representative of current conditions.

All ozone ambient measurements available for the 1997through 2002 time period were used in this evaluation including data from discontinued monitors, those with fewer than three years of data, and new monitors. The monitoring record and judgments regarding the spatial representation of each monitor were the principle tools used in developing the boundary options.

Table 1. Annual Fourth Highest 8-Hour Ozone Concentrations, 1995 – 2002

Annual Fourth Highest 8-Hour Ozone Concentration in Parts per Billion (PPB)									
Monitor Site	**Abbreviation**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Gila County									
Rye	RY			56	65	80			
Tonto N.M.	TONO								**87**
Maricopa County									
Blue Point	BP			83	**89**	**87**	**87**	80	**86**
Cave Creek	CC							83	**86**
Central Phoenix	CP	**85**	76	77	79	78	76	75	76
Emergency Management	EM			**85**	81	**86**	70	63	
Falcon Field	FF			81	83	82	75	81	84
Fountain Hills	FH			**88**	**86**	**86**	**85**	83	**86**
Glendale	GL	80	72	76	70	81	81	78	83
Humboldt Mountain	HM			81	**90**	**86**	82	**85**	**90**
Lake Pleasant	LP				82	81	82	73	
Maryvale	MA			78	**86**	77	80	73	84
Mesa	ME	**92**	**90**	84	80	83	75	74	72
Mt. Ord	MO			84	**88**	**87**	**90**	77	
North Phoenix	NP	**92**	**95**	**91**	**89**	84	**86**	**86**	**85**
Palo Verde	PAVE		71	77	80	80	80	74	78
Pinnacle Peak	PP	**91**	**91**	82	**86**	83	**86**	**85**	84
Rio Verde	RV			**85**	79	**86**	**86**	83	**85**
Roosevelt	RO			84					
Salt River Pima	SRPI	**92**	**92**	82	**87**	82			
South Phoenix	SP	84	**91**	75	80	75	83	76	81
South Scottsdale	SS	**89**	**87**	76	78	72	80	79	77
Super Site	PXSS		**87**	79	79		76	79	76
Surprise	SU							71	79
Tempe	TE						78	79	80
Vehicle Emissions	VE	**92**	80						
West Chandler	WC			77	74	69	74	78	83
West Phoenix	WP	84	81	78	**86**	**91**	81	75	84
Pinal County									
Apache Junction	AJ	**91**	**85**	82	82	80	82	78	80
Casa Grande	CG	71	79	72	68	78	75	74	78
Queen Valley	QUAZ							79	83
Yavapai County									
Hillside	HISD		**85**	76	83	84	83	76	**89**
Gila, Maricopa, Pinal, and Yavapai Counties									
Average All Monitors		87	84	80	81	82	81	78	82

Table 2. Annual Fourth Highest 8-Hour Ozone Concentrations for Monitors in Operation, 1995 - 2002

Annual Fourth Highest 8-Hour Ozone Concentration in Parts per Billion (PPB) – for monitors in operation 1995 through 2002									
Monitor Site	**Abbreviation**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Maricopa County									
Central Phoenix	CP	**85**	76	77	79	78	76	75	76
Glendale	GL	80	72	76	70	81	81	78	83
Mesa	ME	**92**	**90**	84	80	83	75	74	72
North Phoenix	NP	**92**	**95**	**91**	**89**	84	**86**	**86**	**85**
Pinnacle Peak	PP	**91**	**91**	82	**86**	83	**86**	**85**	84
South Phoenix	SP	84	**91**	75	80	75	83	76	81
South Scottsdale	SS	**89**	**87**	76	78	72	80	79	77
West Phoenix	WP	84	81	78	**86**	**91**	81	75	84
Pinal County									
Apache Junction	AJ	**91**	**85**	82	82	80	82	78	80
Casa Grande	CG	71	79	72	68	78	75	74	78
Maricopa and Pinal Counties									
Average All Monitors		86	85	79	80	81	81	78	80

Exceedances of the 8-hour ozone standard are represented in blue.

The density and distribution of ozone monitors in the urbanized area is adequate to define the portions of the urbanized area that exceed either the 80- or 85-ppb design criteria. However, in rural areas there are relatively large distances between monitors. The extensive areas with mountainous and complex terrain complicate the interpretation of the measurement data and require the consideration of such phenomena as plume impingement on high terrain, and ozone shadows on the leeward side of mountains. Furthermore, some of the highest concentrations of ozone have been measured at the periphery of the monitoring network, which begs the question as to the extent of ozone at levels that exceed the standard beyond these monitor locations.

The first step in attempting to fill the gaps between and beyond the rural monitors is to determine the spatial representation of each monitor. This was accomplished by a careful review of the measurements record of each monitor and comparisons between measurements at different sites. This evaluation was done in the consideration of topographic influences, airflow patterns, and ozone formation dynamics.

The results of the dispersion modeling and an analyses of wind conditions during the two ozone episode periods in 2002 were used in this exercise to interpret the ambient ozone data record.

Modeling

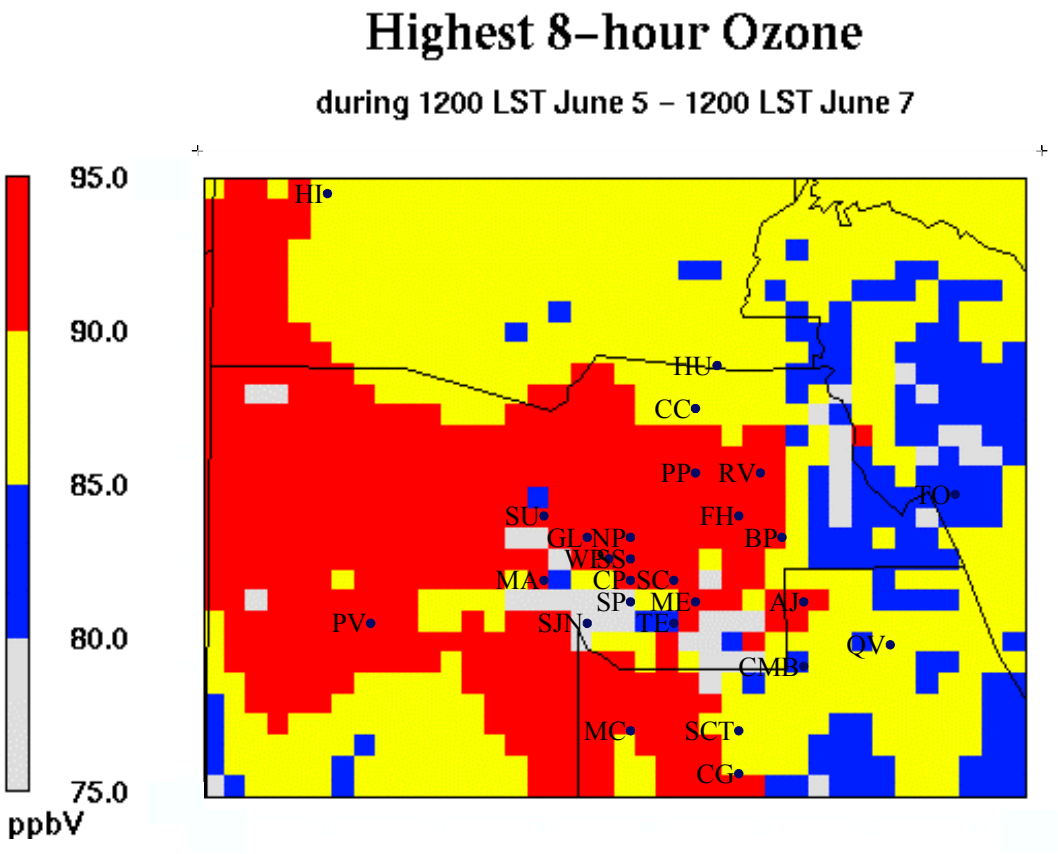
ADEQ contracted with the Arizona State University's, Environmental Fluid Dynamics Program to perform ozone modeling for two episode periods in 2002, June 4 through 7 and July 9 through 13. Emissions inventories for the two episodes were developed by Dr. Susanne Grossman-Clark, using the EPA approved SMOKE model for anthropogenic and biogenic emissions of nitrogen oxides (NOx) and volatile organic compounds (VOC's). Ozone dispersion modeling was performed by Dr.Sang-Mi Lee and Dr. S. Fernando. The ozone modeling employed EPA approved models. The MM5 model was used for the meteorological modeling which was input to the CMAQ model for ozone simulations.

Both the MM5 and CMAQ modeling results were validated by comparison with measured meteorological and ozone data, and were found to exceed EPA criteria for acceptable model performance. Although the models performed well, the winds predicted by MM5 tended to be late on the timing of the daily wind shift from nighttime drainage winds, generally from the east, to upslope flow, generally from the southwest. Unfortunately, this shift actually occurs within a few hours after sunrise at the beginning of the daily ozone production period. The effect is modeled over-predictions of the geographic extent and concentrations of ozone to the west of the urbanized area and a delay in transport to the northeast resulting in under-predictions of ozone to the northeast.

The modeling results were not used to explicitly to determine the non-attainment boundaries but rather provided a theoretical input, not otherwise available, as to the potential extent of high 8-hour ozone downwind of the Greater Phoenix Area. The

modeling indicates the potential for 8-hour ozone concentrations above 85 ppb at distances greater than 80 miles from central Phoenix, as can be seen on Figure 1, which shows the modeling results for June 6, 2002. This potential is considered in the interpretation of monitored ozone concentrations in light of actual wind persistence from a given direction in estimating the downwind extent of the non-attainment area.

Figure 1. Highest 8-Hour Ozone Concentrations: 1200 LST June 5 through 7, 2002

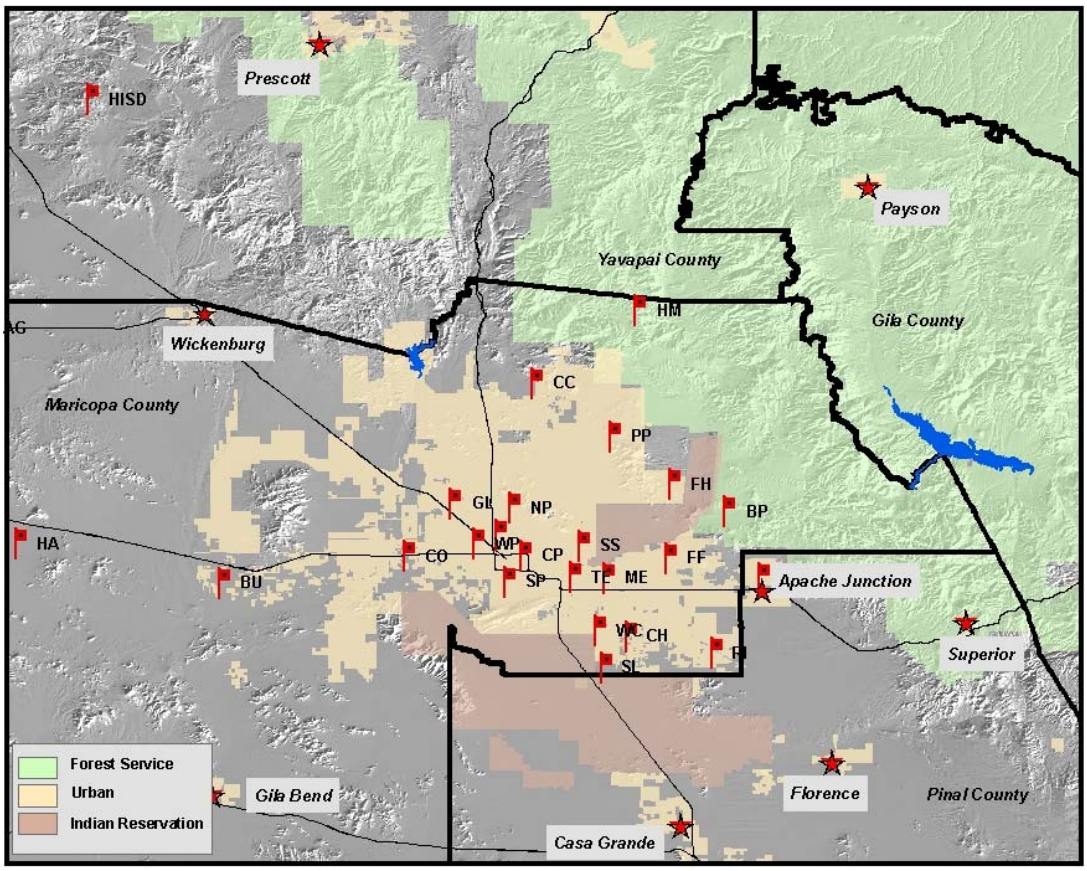


Source: ASU Mechanical and Aerospace Engineering Department

Wind Analysis

ADEQ provided hourly records of wind direction and speed from instruments operated by Maricopa County, Salt River Project, University of Arizona, and ADEQ for the nine days of the two ozone episode periods in 2002 which had ozone concentrations higher than 85 ppb. The wind data were used to characterize general airflow patterns and their variations on the nine days with 8-hour ozone values exceeding the standard. The location of the wind sites are shown on Figure 2.

Figure 2. Wind Monitoring Sites



Sources: University of Arizona, Salt River Project (SRP), Maricopa County, Arizona Department of Environmental Quality (ADEQ), U.S. Geological Survey (USGS), ALRIS

Each episode day exhibited the same general pattern and consequent ozone transport. Downslope or drainage winds, generally from the east, usually persisted till a few hours after sunrise which is typical during the summer ozone season. The transition from drainage to upslope typically lasts for two to three hours, but during the nine days studied the transition varied from one to eight hours. The transitional period corresponds with the beginning of the daily photochemical ozone formation period. During the transition, winds rotate in a clockwise fashion through south before completing the shift to blowing from the southwest quadrant which is typical upslope flow for this area. Upslope winds generally begin about noon and last till near sunset. During the nine days studied upslope flow varied from six to twelve hours duration.

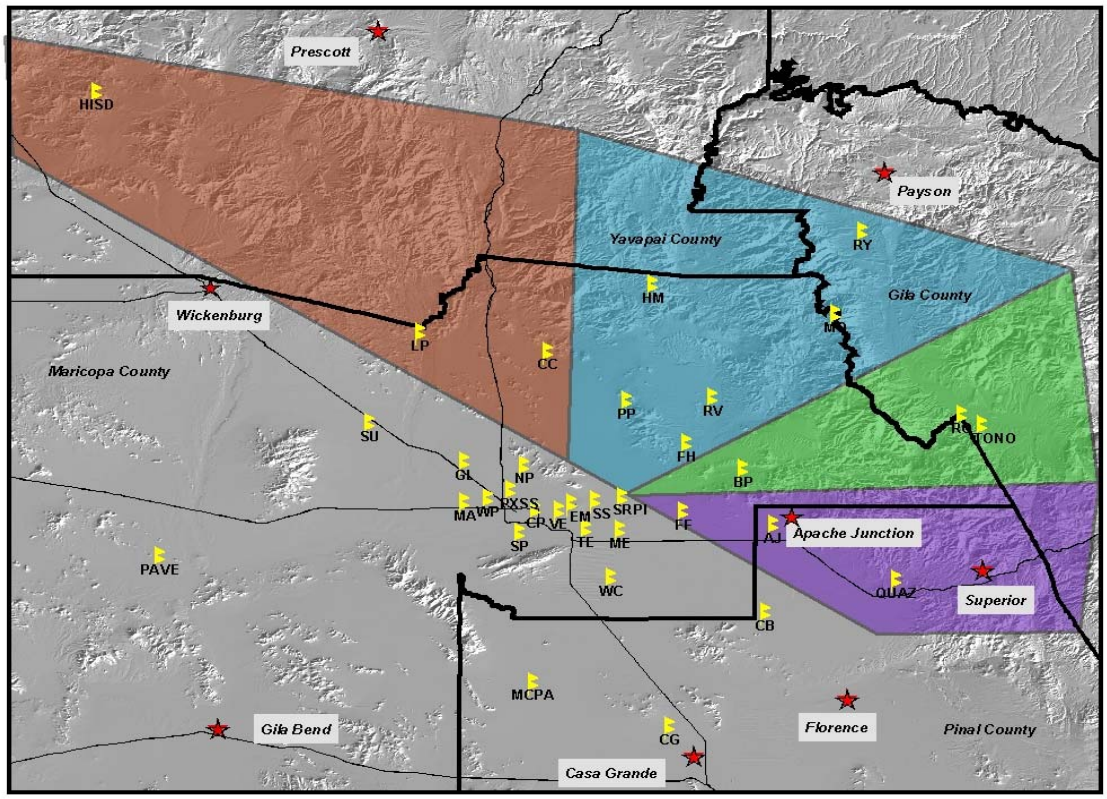
The few hours of drainage flow during the early daylight hours added to the early portion of the transitional winds, transported the urban plume toward the northwest under ozone formation conditions for three to ten hours on the episode days. The later part of the

transition period coupled with the upslope period pushed the plume into the mountainous northeast quadrant for periods of time ranging from eight to twelve hours. Wind speeds averaged five to ten MPH during the upslope period and were somewhat lighter during transition and drainage periods. These wind direction patterns were useful in interpreting the ozone measurements on these ozone episode days, and the persistence of wind in the different directions provided a sound basis for estimating the transport distance of the urban plume and the extent of geographic extent of ozone violations.

As previously mentioned, ozone concentration levels are well defined in the urbanized area by the relatively dense array of monitors. In the outlying areas there are large gaps between monitors which begs the question as to the extent of high ozone concentrations beyond the peripheral monitors which have recorded violations of the standard.

In consultation with ADEQ, a geographic area was identified that required further analysis to identify the portions that exceed the 80 and 85 ppb design criteria. The map in Figure 3 shows the area in question broken into four study sectors. The following section of this report describes how the boundary options for each sector were derived using the informational tools described above.

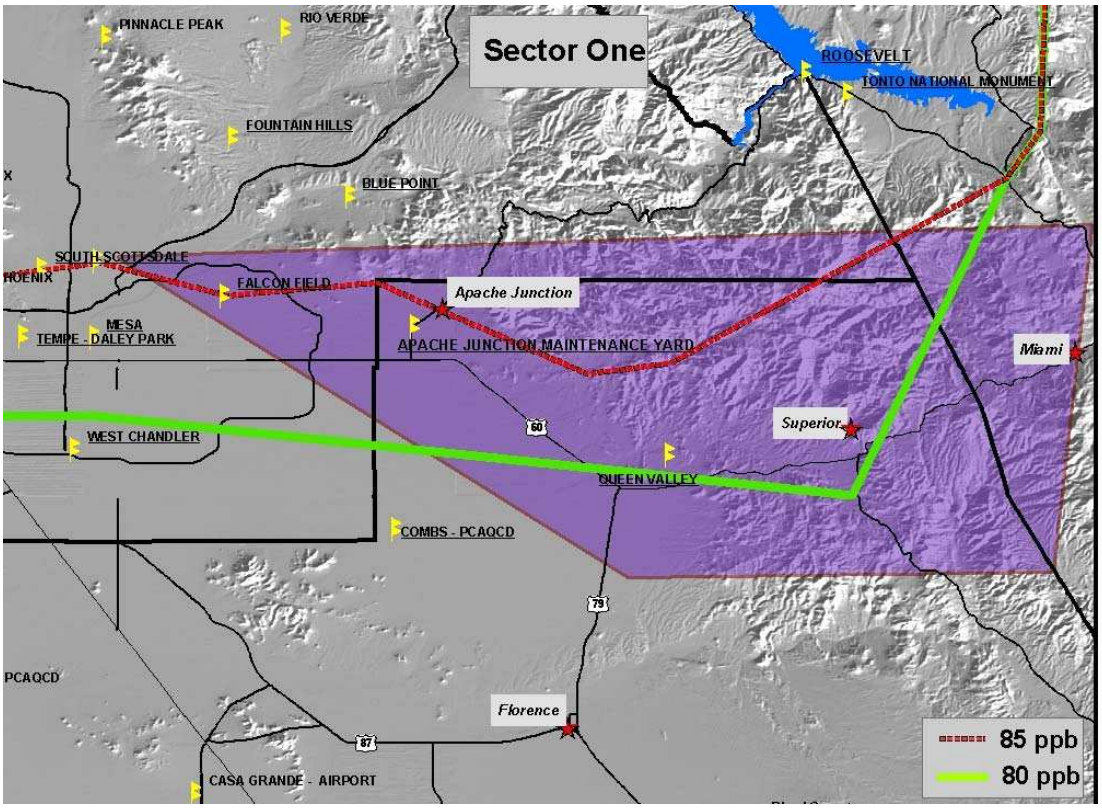
Figure 3. Map of Receptor Area Study Zones



Sources: ADEQ, USGS, ALRIS, Neuroth

Sector 1- This sector, shown in Figure 4, lies to the east of the Phoenix area mostly in Pinal County extends towards the town of Superior. There are three ozone monitors located in this sector: Falcon Field, Apache Junction, and Queen Valley. Ozone concentrations measured at Falcon Field and Apache Junction have been close to the standard. The Queen Valley monitor has only operated for two years with fourth high values of 79 and 83 ppb in 2001 and 2002, respectively. Ozone concentrations to the south of this sector in west Chandler and Pinal County have been below 80 ppb while measurements to the north have exceeded the standard.

Figure 4. Map of Receptor Area Study Zones – Sector 1



Sources: ADEQ, USGS, ALRIS, Neuroth

Prevailing upslope winds provides insight into the ozone pattern described above. Typical airflow during the critical ozone formation hours transports the urban plume mostly to the area north of this sector, the higher concentrations of ozone at Falcon Field and Apache Junction compared to measurements to the south indicate that the northerly portion of this sector is grazed by the transported urban plume.

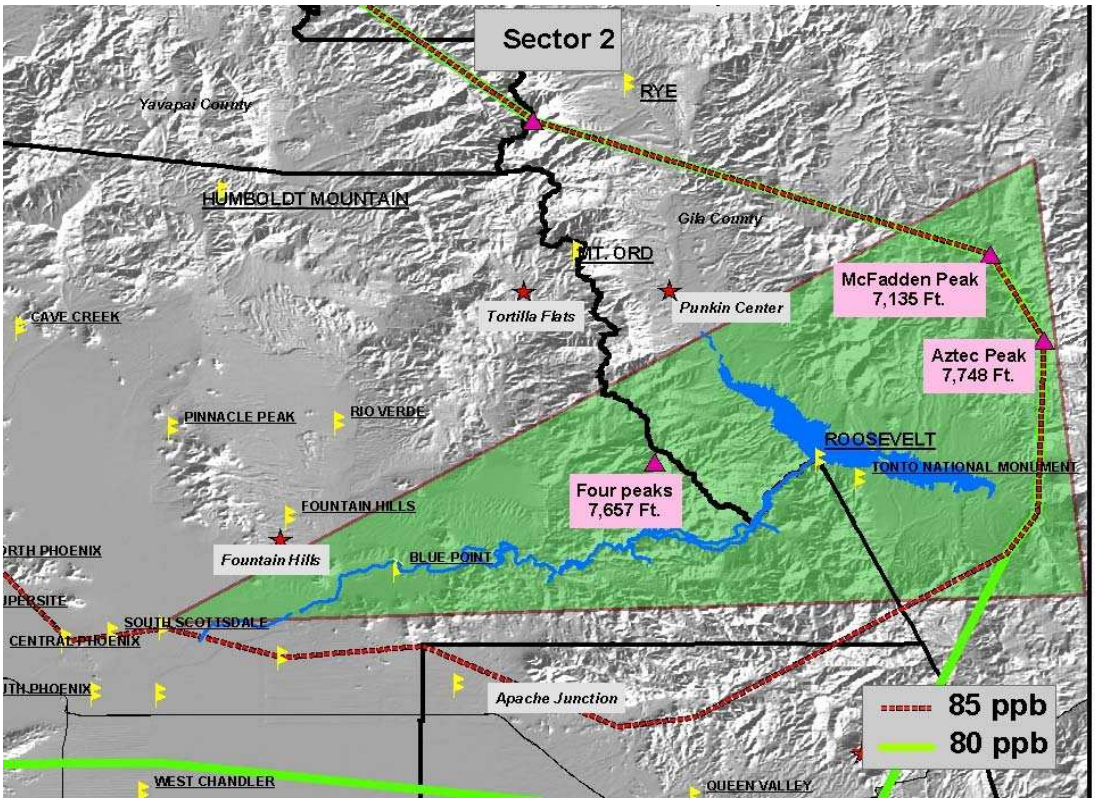
Modeling and monitoring data support the idea that the highest ozone concentrations in this sector occur in the elevated terrain in the north portion of this sector. Remote areas of the Superstition Mountains including elevations over 5000 feet, without the ozone

scavenging effect of fresh NO emissions almost certainly experience higher ozone than the Falcon Field and Apache Junction monitors which have recorded levels near the standard.

The boundary for the 80-ppb area is largely based on measurements at Tempe and Queen Valley and also on the expectation of higher concentrations in the remote portions of the sector. The 85-ppb boundary includes the Falcon Field monitor location and the northern portion of the Superstition Mountains nearest to Phoenix.

Sector 2- Figure 5 shows the location of this sector to the east-northeast of Phoenix, roughly centered on the Salt River valley to Roosevelt Lake and the Sierra Ancha Mountains, and the Mogollon Rim beyond.

Figure 5. Map of Receptor Area Study Zones – Sector 2



Sources: ADEQ, USGS, ALRIS, Neuroth

Two monitors are currently operated in this sector: Blue Point and Tonto. Both of these monitors are located at relatively low elevations in the Salt River valley. The Blue Point monitor, which is located about 28 miles east-northeast of Phoenix, has measured violations of the 8-hour ozone standard. The Tonto monitor located at Tonto National Monument near Roosevelt Lake is about 50 miles from Phoenix. The Tonto monitor has

only operated for one full ozone season and measured a fourth high concentration of 87 ppb in 2002. In 1997, an ozone monitor identified as Roosevelt operated near the location of the current Tonto monitor. The Roosevelt monitor measured a fourth high concentration of 84 ppb.

Much of the land in this sector is mountainous, with peaks above 7,000 feet. An ozone monitor was operated near the top of7,300-foot Mount Ord, located in the nearby portion of sector 3, from 1997 through 2001. Concentrations of ozone at Mount Ord exceeded the standard and this record was used to estimate high terrain impacts in sector 2. The use of Mount Ord monitor data for this sector is supported by the similarity in ozone measurements seen when comparing the Blue Point monitor measurements in sector 2 with corresponding measurements at the Fountain Hills monitor in sector 3. The Fountain Hills monitor is about the same distance from Phoenix and at a comparable elevation to Blue Point. It is also on the same trajectory for receipt of the Phoenix area plume as Mount Ord. The remarkably similar ozone concentrations at Blue Point and Fountain Hills can be seen on Table 1. The wind analysis for the nine ozone episode days also supports the conclusion that airflow from the urbanized area into sectors 2 and 3 are very similar.

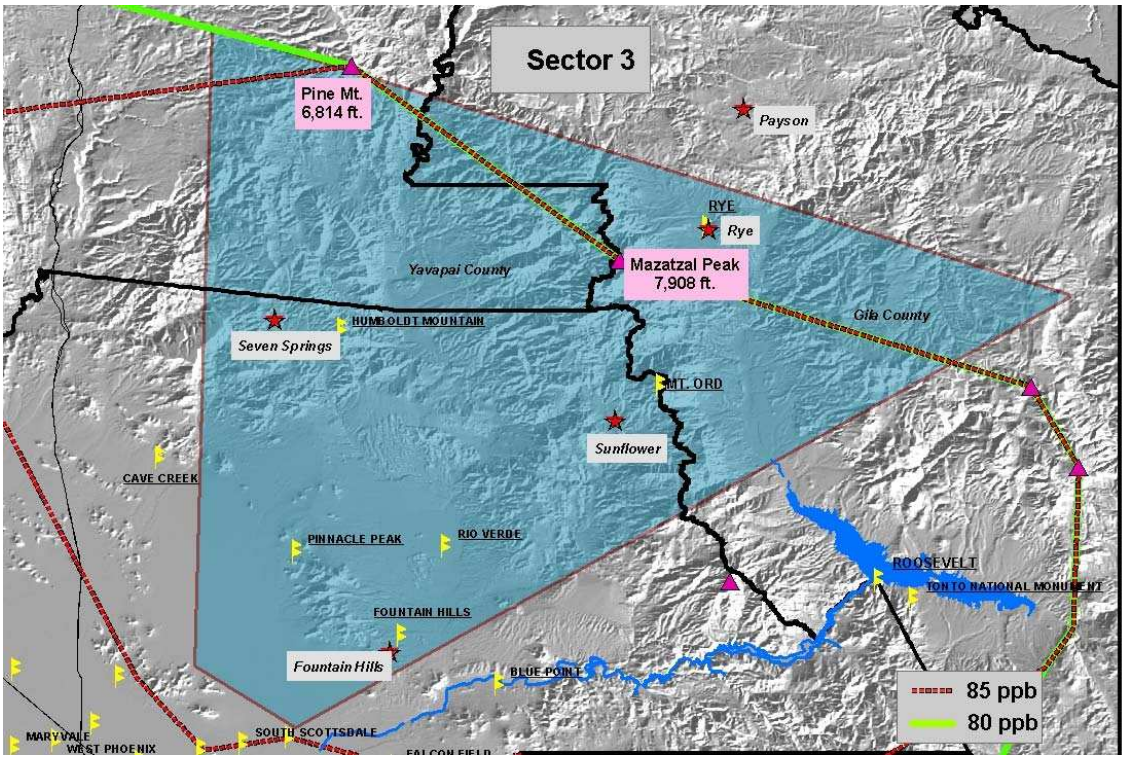
The 80- and 85-ppb boundaries shown on Figure 5, are virtually the same. Although concentrations above 80-ppb probably occur beyond the most distant portion of the boundary, there is no ambient record to guide a boundary line beyond that shown. It is concluded that the concentrations measured at Blue Point and Tonto indicate that concentrations of ozone, at or above the standard, occur throughout the Salt River valley at relatively low elevations. The high elevation areas around Four Peaks and in the Sierra Ancha Mountains are also considered to experience ozone violations based on the Mount Ord record as well as modeling predictions and the occurrence of transport winds from the Phoenix area into this area for up to twelve hours at velocities in the five to ten MPH range during hours of high ozone formation potential.

Sector 3- This sector, shown in Figure 6, is to the north-northeast of Phoenix, and is predominantly mountainous National Forest land. Three of the four ozone monitors that have operated in this sector have recorded concentrations above the standard. The Fountain Hills monitor referenced in the sector 2 discussion, is located in a residential area about 20 miles from Phoenix. The Mount Ord monitor, installed at about 7,300 feet, 50 miles northeast of Phoenix, was operated from 1997 until 2001, when it was discontinued due to difficulties with instrument access at the mountain-top location. The Humboldt Mountain monitor is located about 40 miles north-northeast of Phoenix at 4,900 feet. Both of these mountain monitors have measured 8-hour violations, and the Humboldt Mountain monitor recorded a network high 90 ppb in 2002. ADEQ operated an ozone monitor at the small town of Rye, located about 67 miles northeast of Phoenix at an elevation of 3,000 feet between 1997 and 1999. Ozone concentrations at this site were below 80 ppb.

The ozone violation level concentrations measured at Mount Ord and Humbolt Mountain, at distances of 50 and 40 miles from central Phoenix, and to a lesser extent, the 80-85 ppb

concentrations at the Hillside monitor located 80 miles northwest of Phoenix in sector 4, demonstrate the influence of the urban plume at high elevation locations, long distances from ozone producing emissions. The low ozone concentrations at Rye are thought to indicate that an ozone shadow occurs at low elevations leeward (downwind) of high terrain.

Figure 6. Map of Receptor Area Study Zones – Sector 3



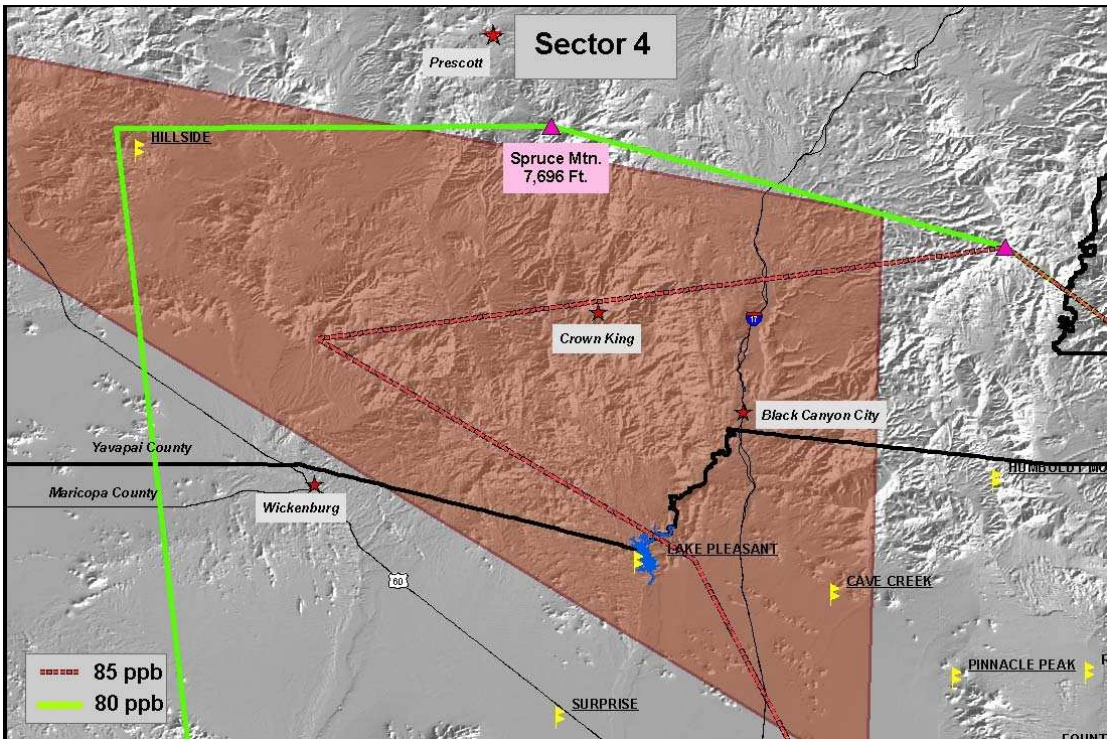
Sources: ADEQ, USGS, ALRIS, Neuroth

The 80- and 85-ppb boundary lines are virtually the same in this sector. Pine Mountain at 6,300 feet was chosen as the northernmost boundary limit. Pine Mountain is about 20 miles beyond Humboldt Mountain, along the same trajectory from Phoenix, and is about 1,800 feet higher. Modeling, wind persistence during ozone formation hours, and mountaintop ozone data, support the boundaries selected for this sector.

Sector 4- This sector, shown in Figure 7, is a large area to the north through northwest of Phoenix. Winds from the Phoenix area, during ozone formation hours, blow toward this direction during the final hours of drainage flow and continue during the transition to upslope. Three ozone monitors have operated in this sector, however only one has a lengthy record. The Hillside monitor, located about 80 miles northwest of Phoenix at an elevation of 5,000 feet, has operated since 1996. Fourth high ozone concentrations have been in the 80-83 ppb range, except in 2002 when a 89-ppb concentration was recorded. The Cave Creek monitor began operation in 2001, and has recorded fourth high values of

83 and 86 ppb in 2001 and 2002. An ozone monitor was operated at Lake Pleasant from 1998 to 2001 with concentrations averaging about 80 ppb.

Figure 7. Map of Receptor Area Study Zones – Sector 4



Sources: ADEQ, USGS, ALRIS, Neuroth

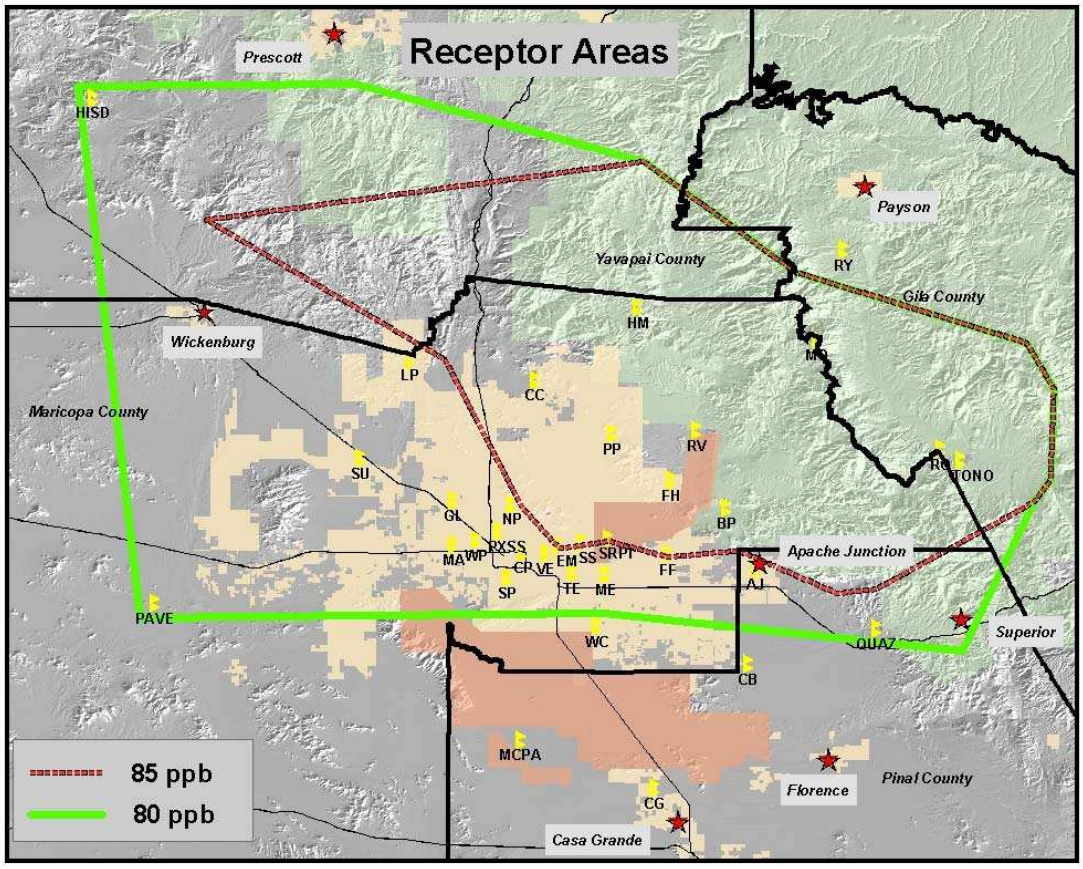
The higher ozone concentrations at Cave Creek compared to Lake Pleasant are expected because of the higher frequency and duration of winds from the south than from the southeast during ozone formation hours. The still higher ozone at the Humboldt Mountain monitor located just 4 miles east of this sector also reflect greater transport influence plus the lack of local emissions scavenging ozone. The ozone concentrations at Hillside at 5,000 feet and 80 miles from Phoenix suggest that concentrations on higher terrain along this trajectory and closer to Phoenix experience higher ozone concentrations. The high ozone history at Humboldt Mountain also lends credence to this idea.

Thus, it is concluded that emissions transported into this sector cause concentrations greater than 85 ppb in the Bradshaw and New River Mountains, to the north and north-northwest of the urbanized area, and the lower lying areas represented by the Cave Creek monitor. The larger 80-ppb boundary is drawn to include the Lake Pleasant and Hillside monitors locations. The western boundary line simply connects the northwest corner

anchored by the Hillside values with the Palo Verde monitor which is located south of sector 4, with measured ozone concentrations about 80 ppb.

The 80- and 85-ppb boundaries for the Receptor Study Area described above were extended into the urbanized area to complete the Receptor Area mapping. The 80- and 85-ppb boundaries in the urbanized area were drawn strictly to fit the actual measurements in this area. The completed maps with the combined rural and urban areas are shown in Figure 8.

Figure 8. Map of 80 and 85 ppb Receptor Area Boundaries



Sources: ADEQ, USGS, ALRIS, Neuroth

APPENDIX 7

Felicia Marcus, Regional Administrator, U.S. EPA Region IX, letter to the Honorable Jane Dee Hull, Governor of Arizona, January 19, 2001

Wayne Nastri, Regional Administrator, U.S. EPA Region IX, letter to Stephen A. Owens, Director, Arizona Department of Environmental Quality, July 2, 2003

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

OFFICE OF THE
REGIONAL ADMINISTRATOR

January 19, 2001

Honorable Jane Dee Hull
Governor of Arizona
1700 West Washington
Phoenix, Arizona 85007

Dear Governor Hull:

As part of our responsibility to inform the public about the quality of air they breathe, I am writing to inform you that EPA has released staff recommendations setting out potential nonattainment area boundaries for the 8-hour ozone (smog) national ambient air quality standard (NAAQS). In preparing these initial recommendations, EPA gave significant deference to boundaries recommended by States. Arizona, however, has not provided a boundary recommendation to EPA. EPA's current recommendation for Arizona therefore defaults to the Phoenix Metropolitan Statistical Area (MSA), pursuant to our March 28, 2000 guidance entitled "Boundary Guidance on Air Quality Designations for the 8-Hour Ozone NAAQS." (See Attachment 1). The Phoenix MSA consists of all of Maricopa and Pinal Counties.

We continue to urge you to submit a recommended boundary to EPA with documentation supporting that recommendation. Section 107(d)(1) of the Clean Air Act requires all areas to be designated nonattainment if they do not meet the standard or contribute to ambient air quality in a nearby area that does not meet the standard. Because of the pervasive nature of ground level ozone and transport of ozone and its precursors, it is EPA's policy to designate as nonattainment any Metropolitan Statistical Area or Consolidated Metropolitan Statistical Area (C/MSA) that has a violating monitor. We do recognize, however, that there may be unique circumstances (e.g., traffic and commuting patterns, geography/topography, jurisdictional boundaries, etc.) that would support making the boundaries either larger or smaller than the C/MSA.

Based on demographic and growth information we have for the Phoenix area, retaining the current 1-hour ozone nonattainment boundary as the 8-hour ozone boundary would not protect public health and is therefore not an option for Arizona. If the State provides to EPA information addressing the boundary criteria (see enclosed guidance, p. 4), it may be possible to justify an 8-hour nonattainment boundary smaller than the MSA. We also respectfully request boundary criteria information on Yavapai and Gila counties because we are concerned about violating monitors at or near the borders of those counties. The national direction has been to include adjacent areas with large emissions sources or other characteristics such as growth.

EPA is ultimately responsible for promulgating nonattainment area boundaries based on sound air quality data and for providing comprehensive protection against population exposure to unhealthful air. We look forward to working with the Arizona Department of Environmental Quality, the Maricopa Association of Governments, the Maricopa County Environmental Services Department, and other Arizona agencies to arrive at an appropriate boundary based on the best available data. If you have any questions, please do not hesitate to call me at (415) 744-1001 or Colleen McKaughan, Associate Director of the Air Division, at (520) 498-0118.

Yours,

Felicia Marcus
Regional Administrator

Enclosure

cc: Jacqueline E. Schafer, ADEQ
Nancy Wrona, ADEQ
James Bourey, MAG
Al Brown, Maricopa County

January 19, 2001

MEMORANDUM

SUBJECT: Compilation of States' Recommendations and Initial Regional Office Responses on Areas That Are Not Attaining the 8-Hour Ground-Level Ozone NAAQS

FROM: Lydia Wegman, Director /s/ by Jack Edwardson for Lydia Wegman
Air Quality Strategies and Standards Division (MD-15)

TO: Air Division Directors, Regions I-X

The purpose of this memorandum is to forward the attached compilation of information sent to us from the Regions and States in response to the statutory requirement to submit recommended designations and EPA guidance regarding how to determine boundaries for nonattainment areas for the 8-hour ground level ozone national ambient air quality standards (NAAQS or standards).

The tables show a summary of recommendations sent to us by States identifying the boundaries of areas that are not attaining and/or are contributing to areas that are not attaining the standards. The second and third columns show a summary of the Regional offices' initial responses to the scope of the boundaries recommended by the States and their explanation of their responses. Where the State did not provide a recommendation, the tables contain only the Region's initial view, based on our guidance, on the boundaries for areas that are not attaining or are contributing to areas that are not attaining the 8-hour standards.

There appear to be differences among the Regions and States in their application of the guidance. The tables indicate next to the name of each state whether further discussion is needed with the Regional office to assure that we apply the guidance nationally in a fair and equitable manner. We will work with you in the future to resolve these differences prior to responding formally to the States.

The States' recommendations and Regional office responses are based on air quality data collected during 1997-1999. When designations are promulgated, EPA will use the most recent 3 years of quality assured data.

This memorandum does not include tribal recommendations on boundaries for tribal land located in or near areas that are not attaining or contributing to areas that are not attaining the standard. In response to a request from several tribes, the EPA and tribal representatives are initiating a process to discuss the unique problems for tribes associated with implementing air quality designations and standards for tribal land. The EPA will address designations of tribal land after these discussions.

I expect each Director to review the entire table, looking again at your responses to your states' recommendations and at the other Regional offices' responses with respect to the guidance. I look forward to working with you as we proceed with the review of State recommendations prior to taking regulatory action.

Questions on this memorandum may be directed to Sharon Reinders at 919/541-5284.

Attachment

cc: Deputy Regional Administrators
Margo Oge

Arizona		
State Recommendation	*RO Initial Response*	*Comments*
None	Maricopa Co*	Presumptive MSA. Excludes Indian lands. See Note 1.
	Pinal Co*	Presumptive MSA. Excludes Indian lands. See Note 1.

Notes

Region 9

Arizona

Note 1 - Maricopa and Pinal Cos, AZ - Additional data are needed from the State to determine whether the boundaries should remain as the default MSA or made either larger or smaller in accordance with EPA guidance. Designations on Indian lands is being addressed through a separate process.

*County or part county not recommended by State in the C/MSA and any adjacent county added by EPA.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

July 2, 2003

OFFICE OF THE
REGIONAL ADMINISTRATOR

Stephen A. Owens, Director
Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, Arizona 85007

Dear Director Owens:

I am writing to give you an update on the Environmental Protection Agency's (EPA) schedule for officially designating areas as "attainment/unclassifiable" or "nonattainment" for two important air pollutants, ground-level ozone and fine particles. I am following up on letters sent to your Governor in March 2003 for ozone and June 2003 for fine particles ($PM_{2.5}$). I am also writing to enlist your support in working with the communities in your State to take the necessary steps to reduce air pollution and help protect public health.

Breathing ozone (the primary constituent of smog) and fine particles can cause serious respiratory and cardiovascular effects. Many health studies have correlated increased exposure to fine particles with increases in premature death. In 1997, EPA revised its national ambient air quality standards for these two pollutants. After prevailing in a lengthy court battle, we are now working with States to take the steps necessary to protect the public from these pollutants.

As you know, some important dates are fast approaching. For ground-level ozone, our schedule requires States to make their attainment/nonattainment designation recommendations to EPA by July 15, 2003. The EPA must make its final official designations decisions by April 15, 2004. For the fine particle standards, States are to make these recommendations by February 2004, and the Agency will make its final decisions by December 15, 2004. Because recent air quality data show that a number of metropolitan areas are violating both the ozone and fine particle standards, we encourage you to consider each area's probable $PM_{2.5}$ status when developing your recommendations for ozone. At this time, it appears that the Phoenix Metropolitan Statistical Area (MSA) is the only area within the State of Arizona that violates the 8-hour ozone standard, however, it does not appear to violate the $PM_{2.5}$ standard. Based on the data we have seen to date, the State of Arizona appears to have no $PM_{2.5}$ nonattainment areas.

We want to highlight several issues for you as you review the 8-hour ozone information in preparation for briefing Governor Napolitano. Because of the pervasive nature of ground-level ozone and the transport of ozone and its precursors, it is EPA's policy to presume that the 8-hour ozone nonattainment area will be the MSA, which in Arizona's case is all of Maricopa and Pinal Counties. EPA also expects the State to include with the MSA any violating counties, any

contributing counties, and any counties with large sources such as power plants that are adjacent to the MSA. If the State wants to recommend an area different than the nonattainment area just described, the State must submit a boundary recommendation that addresses the eleven factors in the March 28, 2000 John Seitz memorandum. These factors allow a state to address unique circumstances (e.g., geography/topography, traffic and commuting patterns, jurisdictional boundaries, etc.) that would support making the boundaries larger or smaller than the MSA. If the State chooses to submit a boundary recommendation addressing the eleven factors, it must be made clear to EPA that the State has analyzed the 8-hour ozone data first and has drawn the boundary to fit the data.

We would also like to draw your attention to a letter that we sent to Governor Hull on January 19, 2001. In that letter, we stated that "based on demographic and growth information we have for the Phoenix area, retaining the current 1-hour ozone nonattainment boundary as the 8-hour boundary would not protect public health and is therefore not an option for Arizona. If the State provides to EPA information addressing the boundary criteria, it may be possible to justify an 8-hour boundary smaller than the MSA. We also respectfully request boundary criteria information on Yavapai and Gila counties because we are concerned about the violating monitors at or near the borders of those counties. The national direction has been to include adjacent areas with large emission sources or other characteristics such as growth." We expect you will consider including any unique areas in the nonattainment area in order to avoid backsliding problems unless there is a compelling demonstration of why they should not be included. EPA's policy on anti-backsliding requires that any existing measures that were used to bring the area into attainment for the 1-hour ozone standard must be retained.

Once EPA officially designates an area as not meeting an air quality standard, your State will be required to develop and submit to EPA a plan for cleaning up the air in those designated nonattainment areas. For Indian Country, either the Tribe or EPA will develop implementation plans. State Implementation Plans will be due no later than three years after the date that an area is designated as nonattainment. The level of emission control programs and the dates for achieving clean air in your nonattainment areas will vary depending upon the severity of the problem.

We hope that you will encourage the communities in your State to take early actions to improve their air quality. My staff and I stand ready to help your State and communities identify pollution control measures that could be implemented to help clean the air. We will also work with other affected States and Tribes to take necessary steps to reduce air pollution.

In addition, our analysis shows that the Clear Skies legislation introduced in Congress in 2002 would reduce the long-range transport of ozone and fine particles and result in wide-spread improvement in air quality.

Thank you for your continued leadership on these matters. I look forward to working with you as we clean up the nation's air pollution.

Sincerely yours,

Wayne Nastri
Regional Administrator

cc: Nancy Wrona, ADEQ
Dennis Smith, MAG
Al Brown, Maricopa County
Ursula Kramer, Pima County
Charles Matthewson, PAG
Don Gabrielson, Pinal County
John Gross, YMPO

APPENDIX 8

Presentation from May 21, 2003, Stakeholder Meeting on CMAQ Modeling and Inventory Development

ASU Contract Report - Simulation of 8-Hour Ozone Concentrations for the State of Arizona

8-hr Ozone Simulation: Further Work

Sang-Mi Lee, Susanne Grossman-Clarke,
H. Joseph. S. Fernando

Environmental Fluid Dynamics Program
Arizona State University

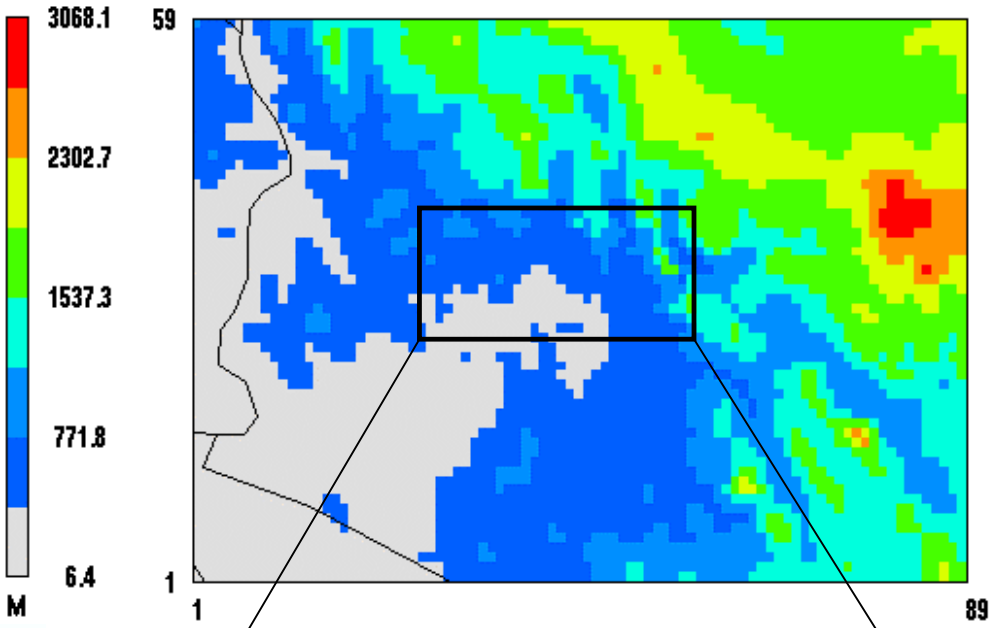
May 21, 2003, Presentation

Summary of March 3, 2003 Presentation

- MM5 simulation for meteorology
- Validation of MM5
- Preparation of pollutant inventory
  - ✓ MAG domain
  - ✓ Outer domain
- Models-3/CMAQ
- Model Validation
- 8-hr Ozone boundaries
- Socio-Economic analysis
- Projected ‘2018 inventory

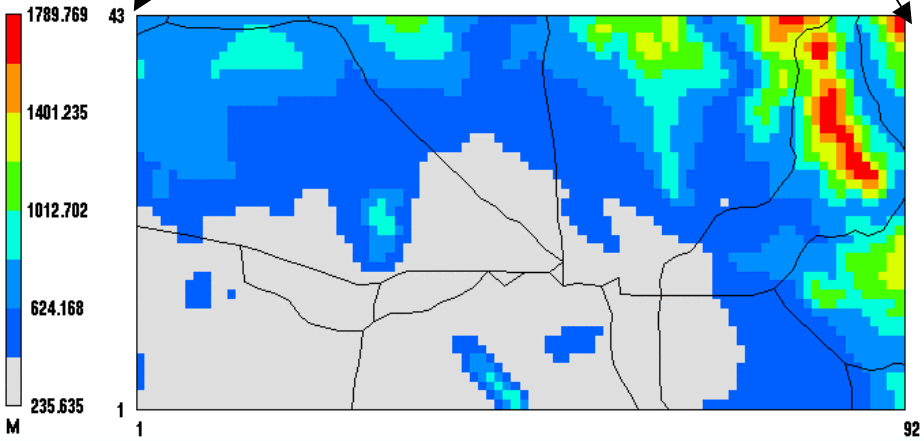
Topography

Extended domain with 6 km resolution

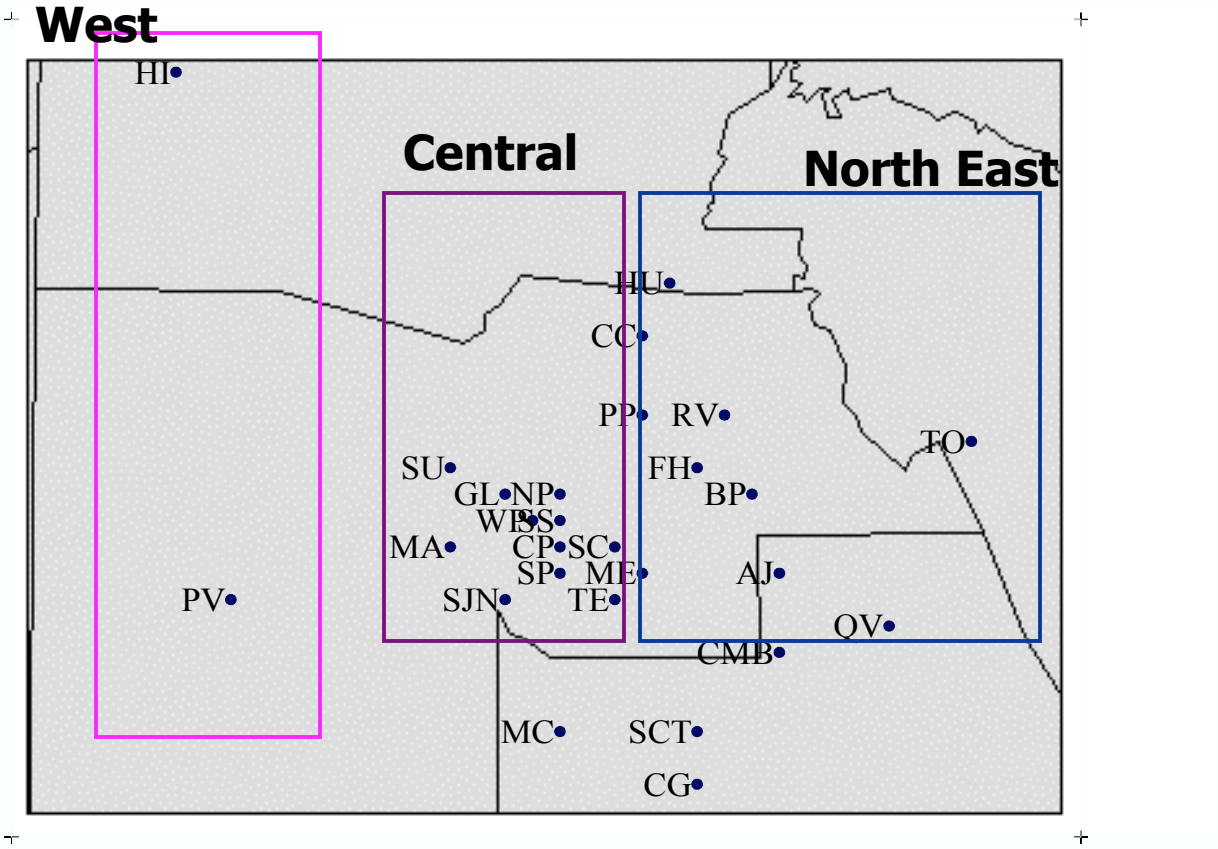


Terrain Height

MAG Domain



Monitor Areas



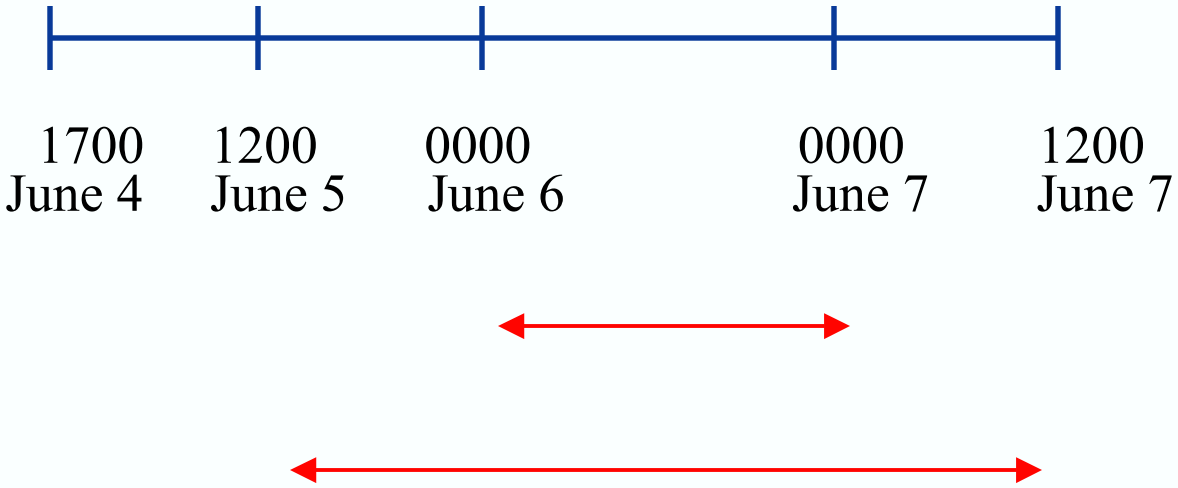
Design Days

- June 6th
  - High ozone in the Northeast Area (Fountain Hills, Blue Point Bridge, Rio Verde, Tonto)

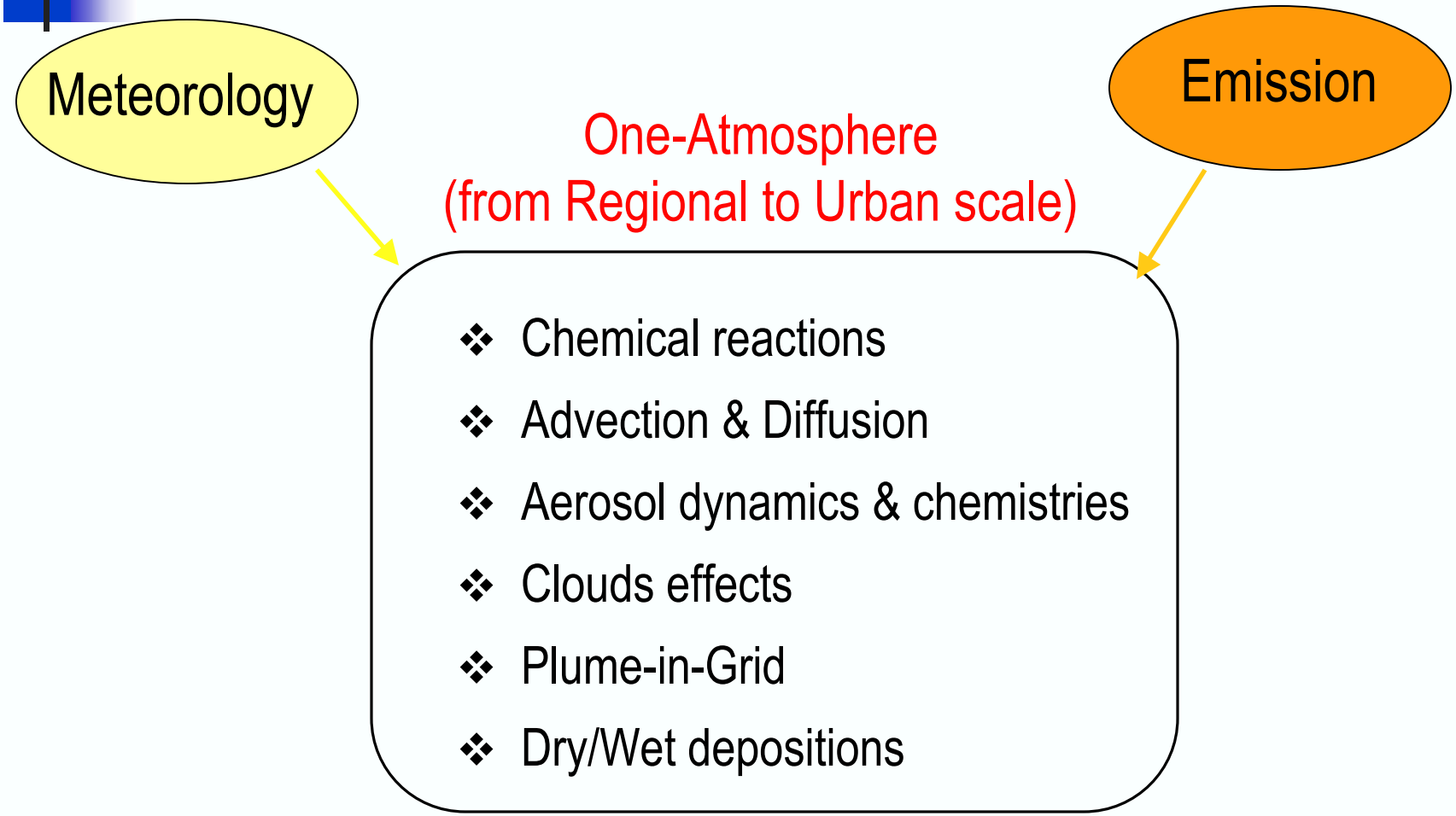
- July 12th
  - High ozone at Humboldt Mt.
  - Elevated values in the Central Area

Design of Numerical Simulation

- **Study Case: 19 hrs of spin-up for MM5**
  - →1700 LST June 4 – 1700 LST June 7, 2002
  - →1700 LST July 10 – 1700 LST July 13, 2002

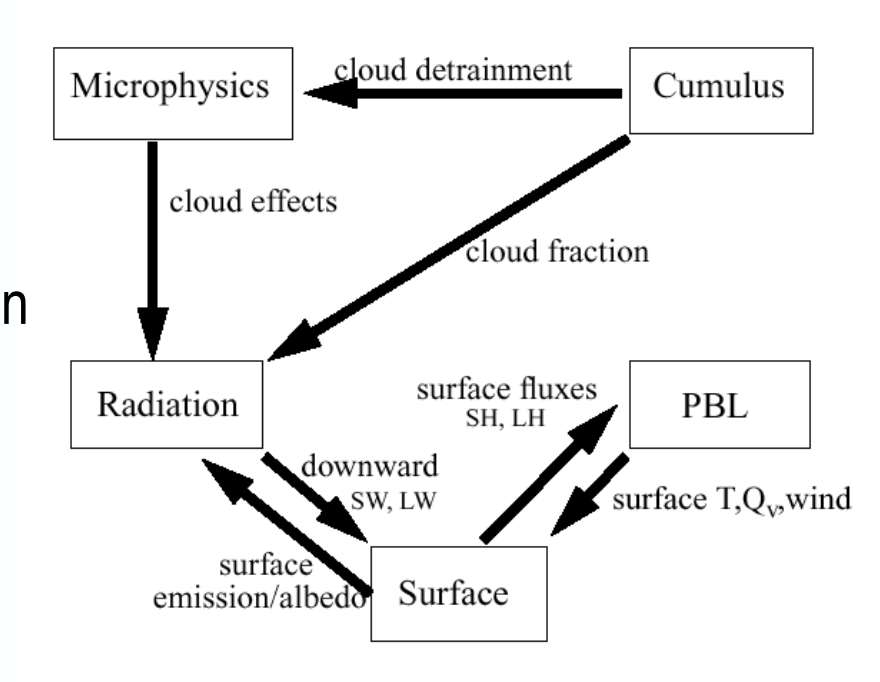


Models-3/CMAQ (Community Multi-scale Air Quality)



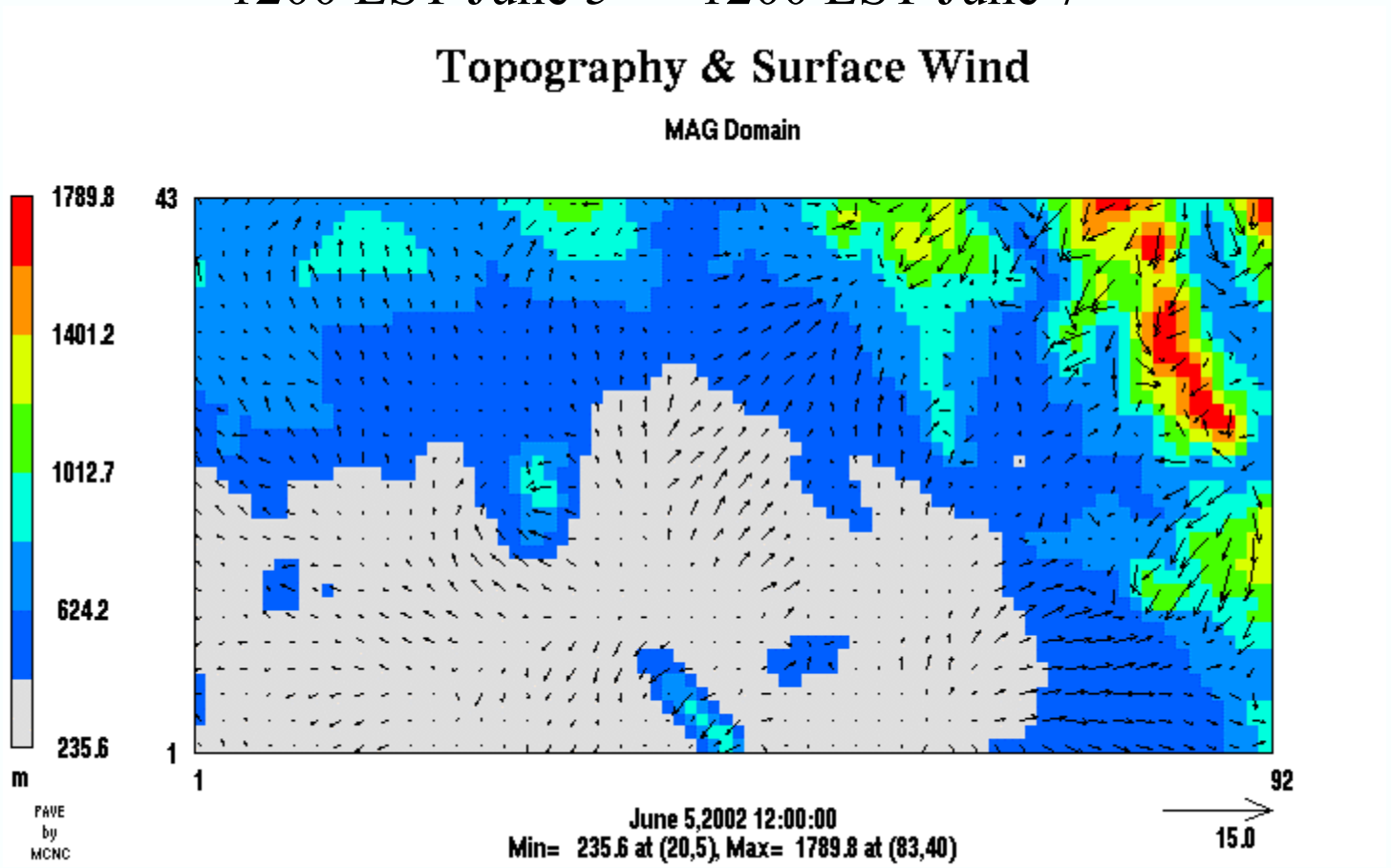
The Fifth-generation Penn State/NCAR Mesoscale Model (MM5)

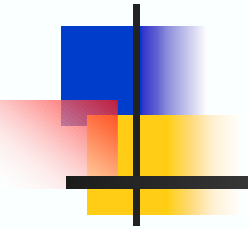
- Terrain following σ - coordinate
- Non-hydrostatic dynamics
- Four-dimensional data assimilation
- Multiple nest capability
- Physics



Ground Level Wind Field

1200 LST June 5th – 1200 LST June 7st





SMOKE

Sparse Matrix Kernel Emissions Modeling System

SMOKE

- Emissions processing system for area, mobile and point sources.
- Biogenic emissions modeling.
- Provides specialized emission inputs for air quality models: gridded hourly 3-dimensional.

SMOKE Input Data

Emissions Inventory

Western Regional Air Partnership (WRAP)
1996 Base Case Scenario
County data for area, mobile and point source emissions
Inventory species: NO_x CO NH_3 SO_2 VOC

Meteorological Data

MM5 simulation results for episode days June 4-7, 2002 & July 10-13, 2002

SMOKE Input Data

Land Use Data

U.S. EPA's Biogenic Emissions Landcover Database (BELD3),1 km x 1km resolution, 230 land use types

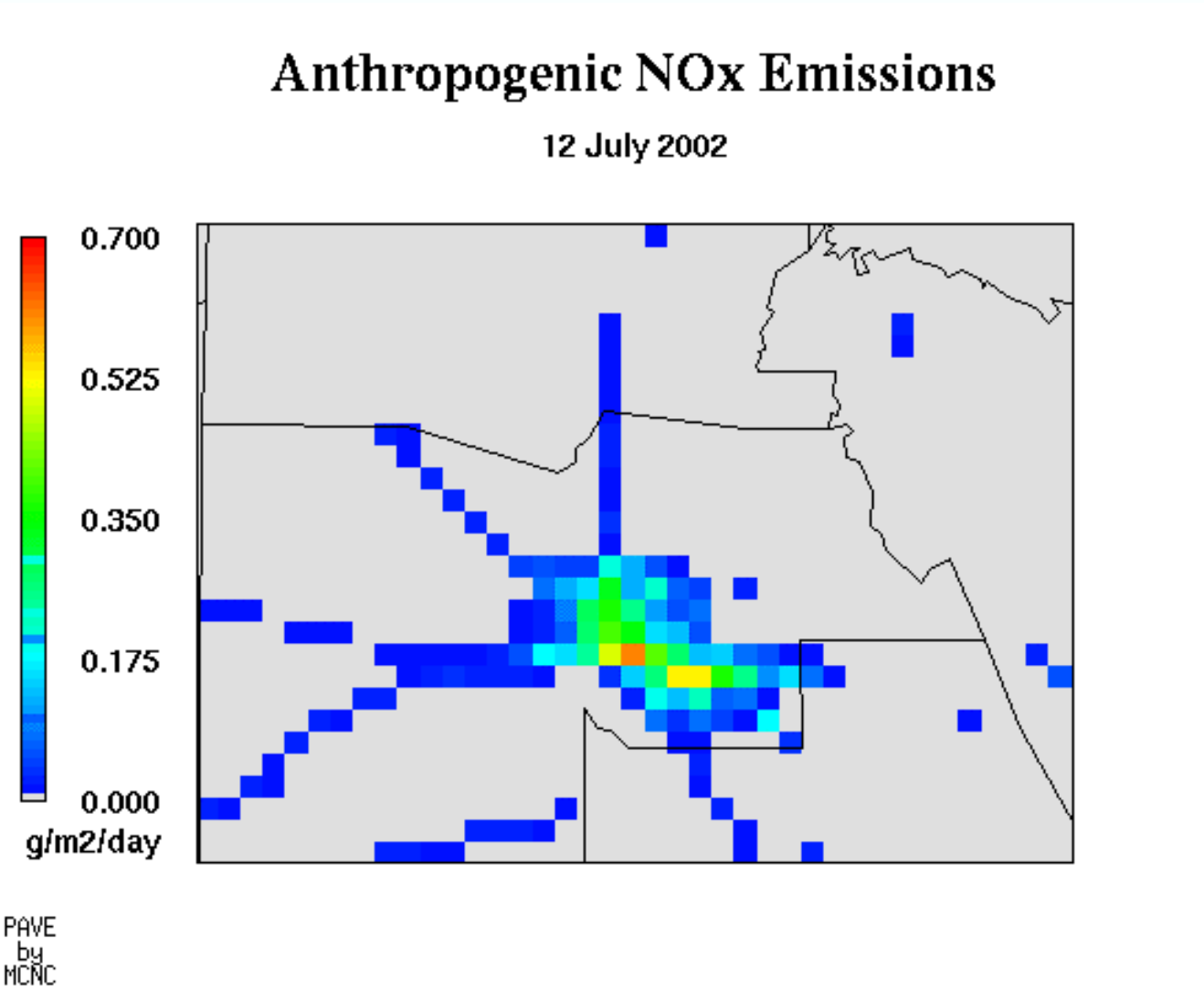
ftp://ftp.epa.gov/amd/asmd/beld3

Spatial Surrogate Data

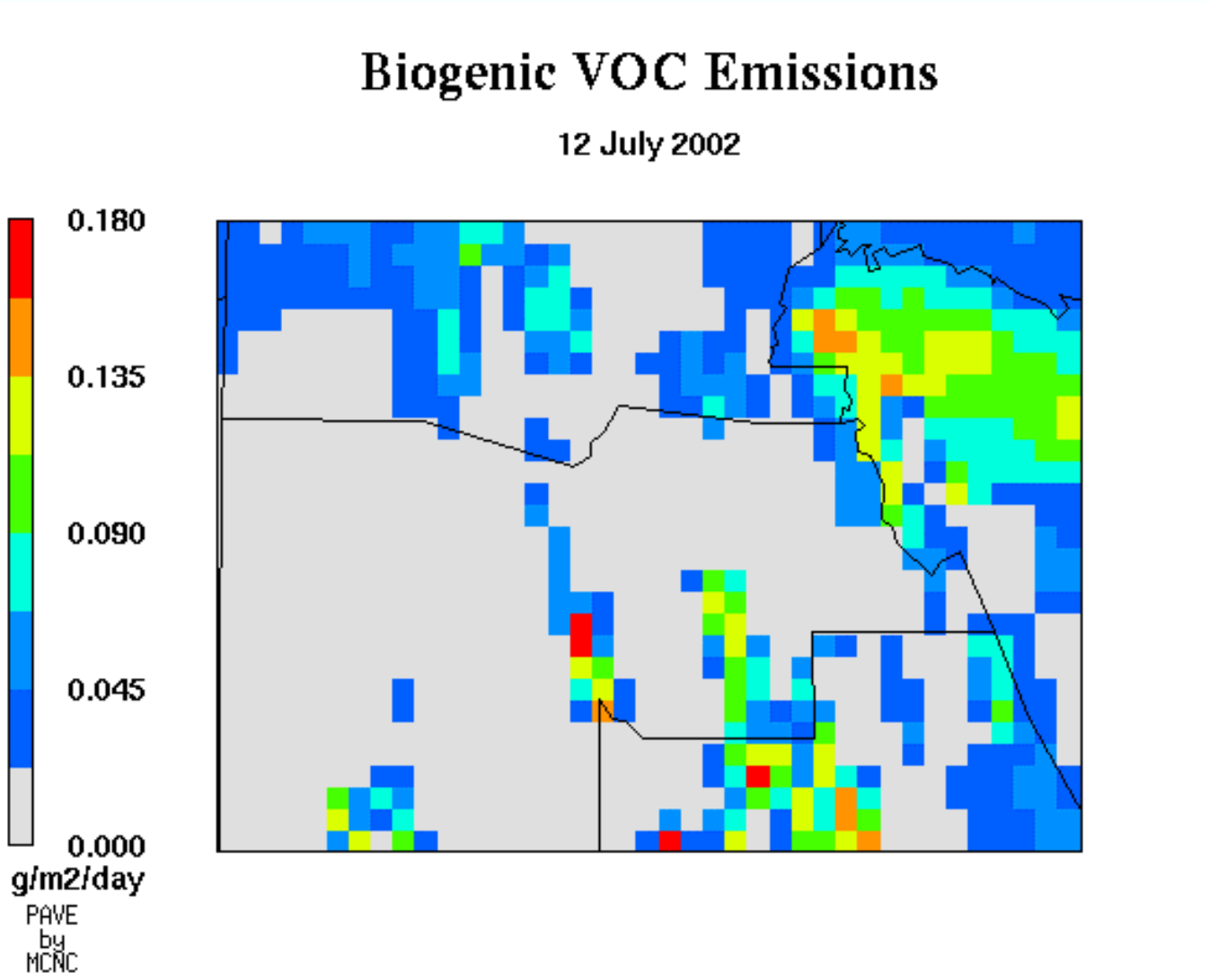
U.S. EPA's 4km Spatial Surrogate Data covering the United States

http://www.epa.gov/ttn/chief/emch/spatial/

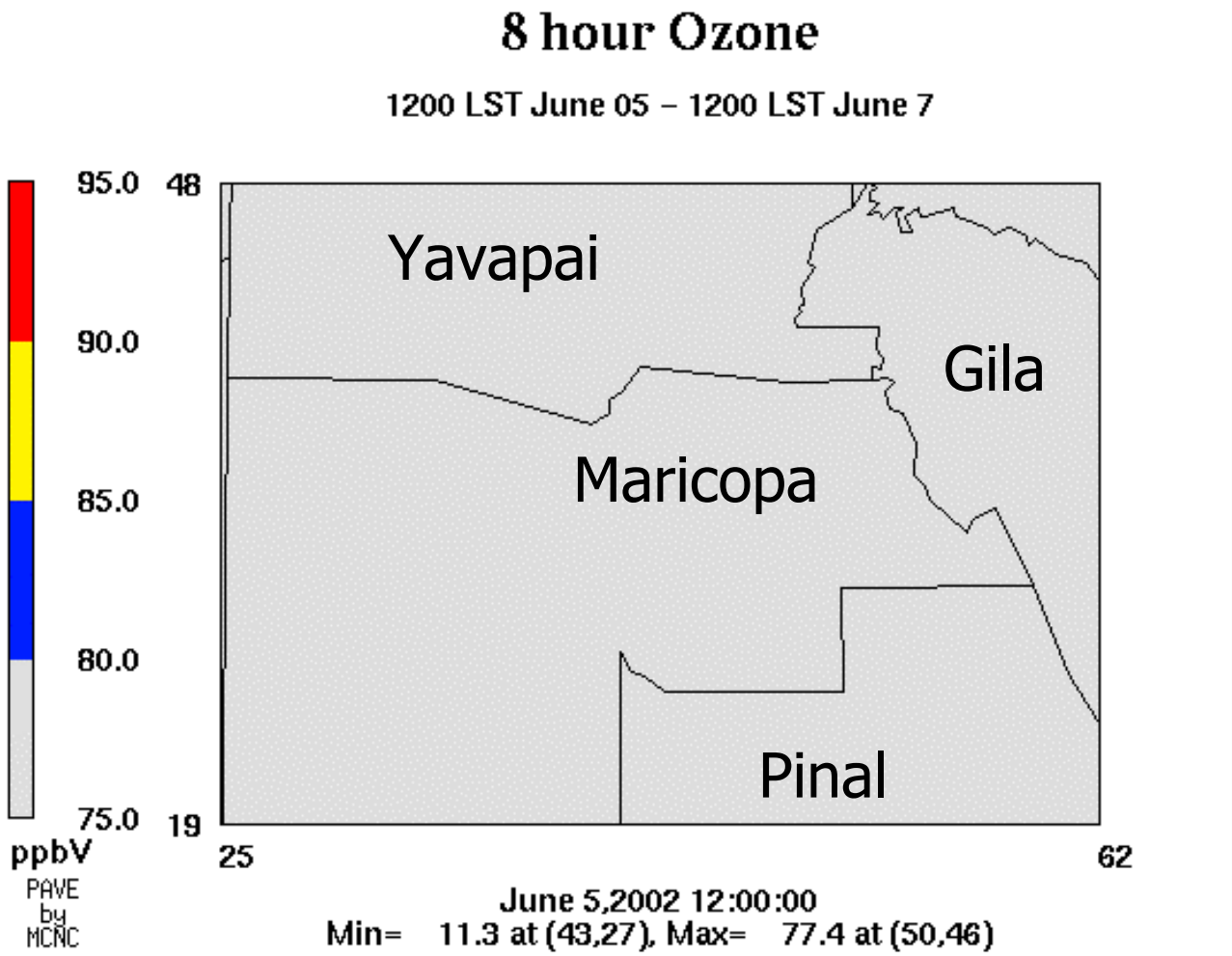
Smoke Results



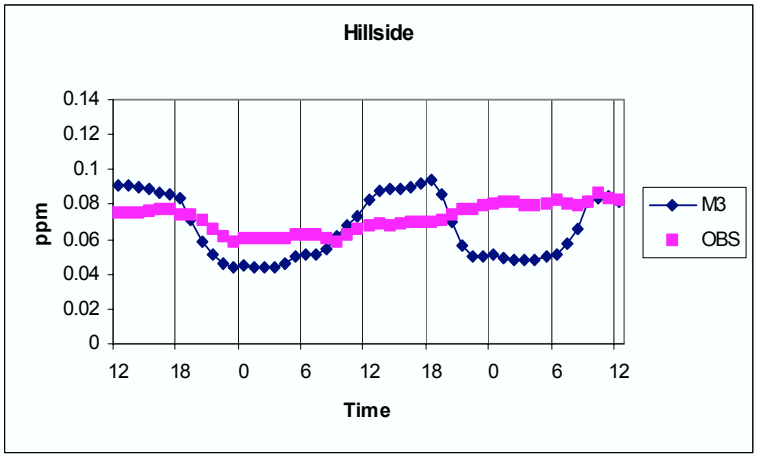
Smoke Results

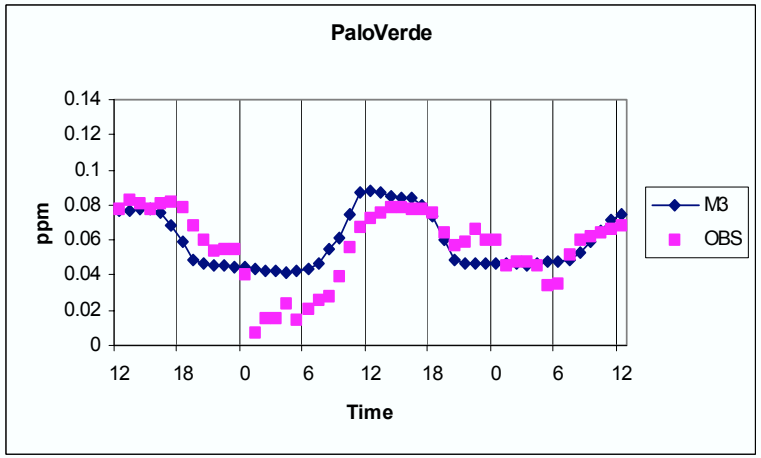


8hr Averaged Ozone: June 6th

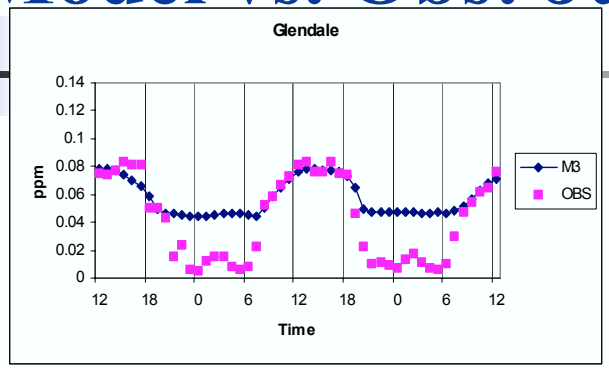


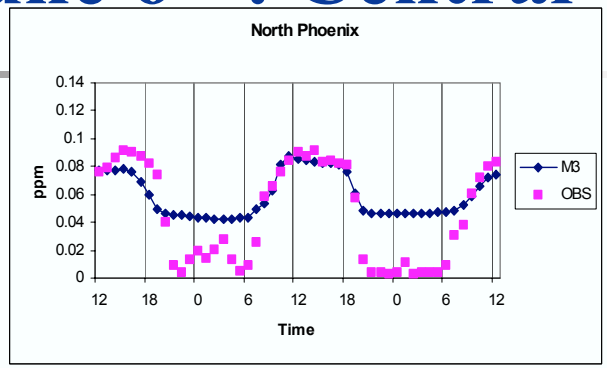
Model vs. Obs: June 6th : West

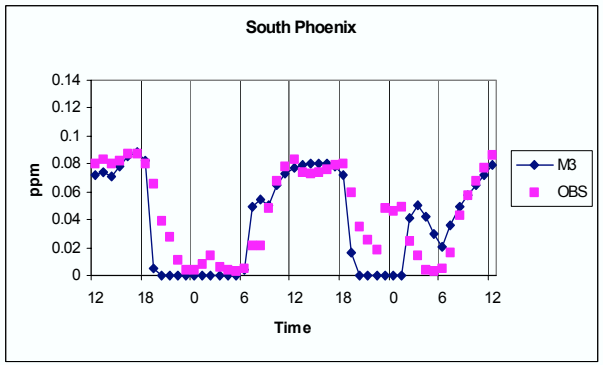


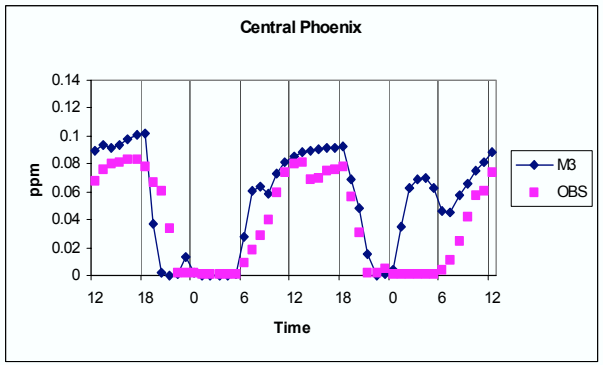


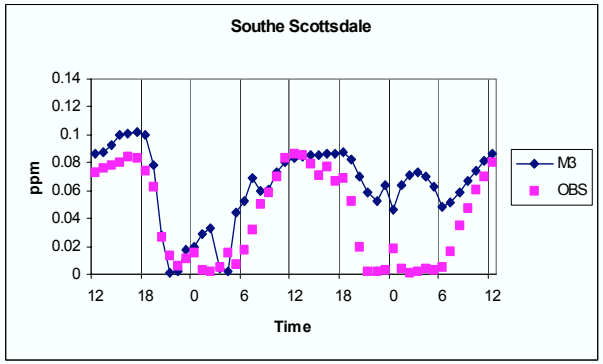
Model vs. Obs: June 6th : Central

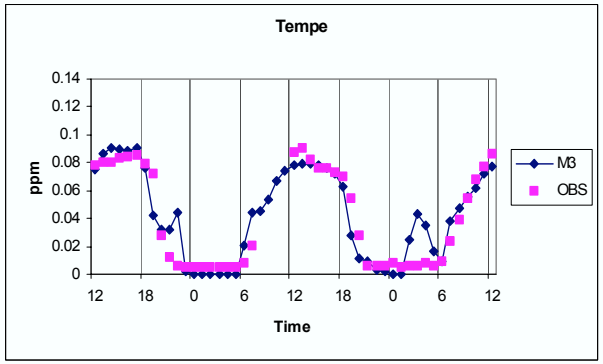




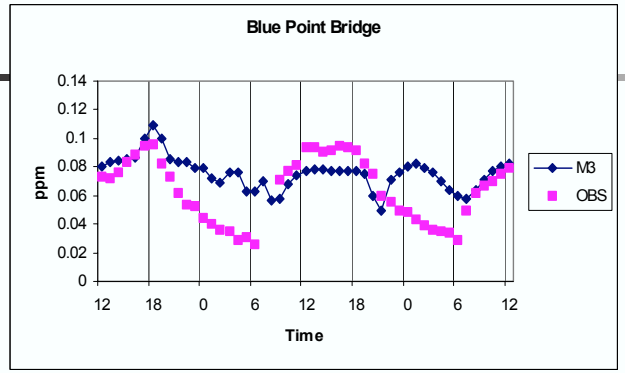


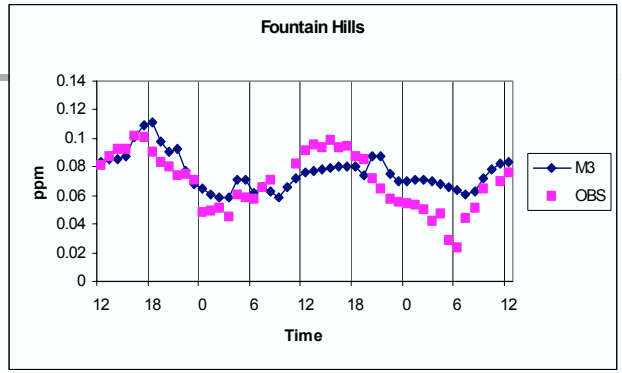


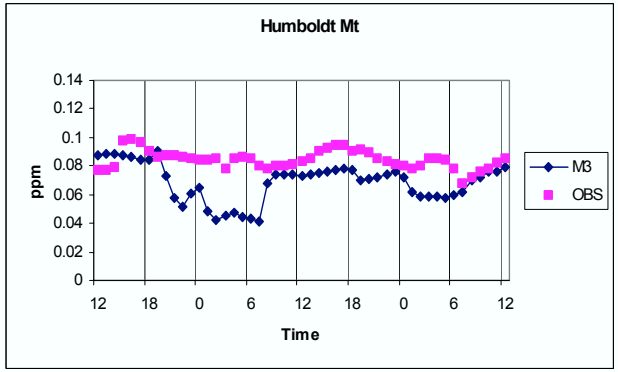


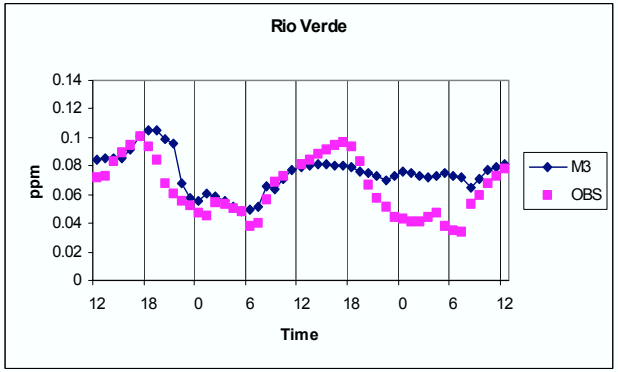


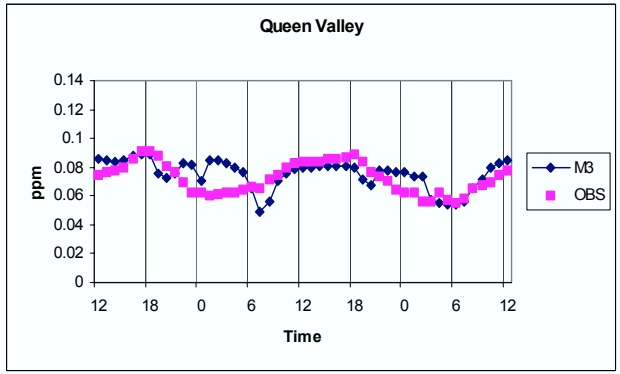
Model vs. Obs: June 6th : Northeast

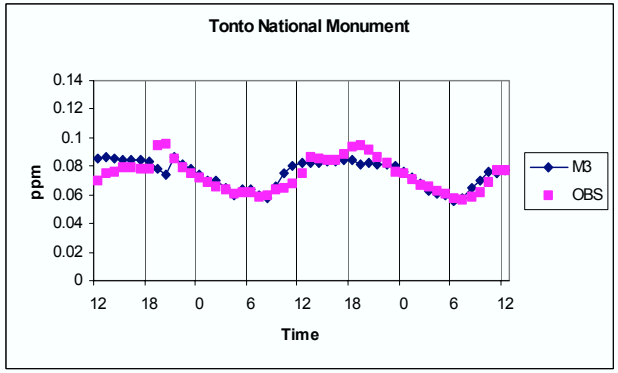




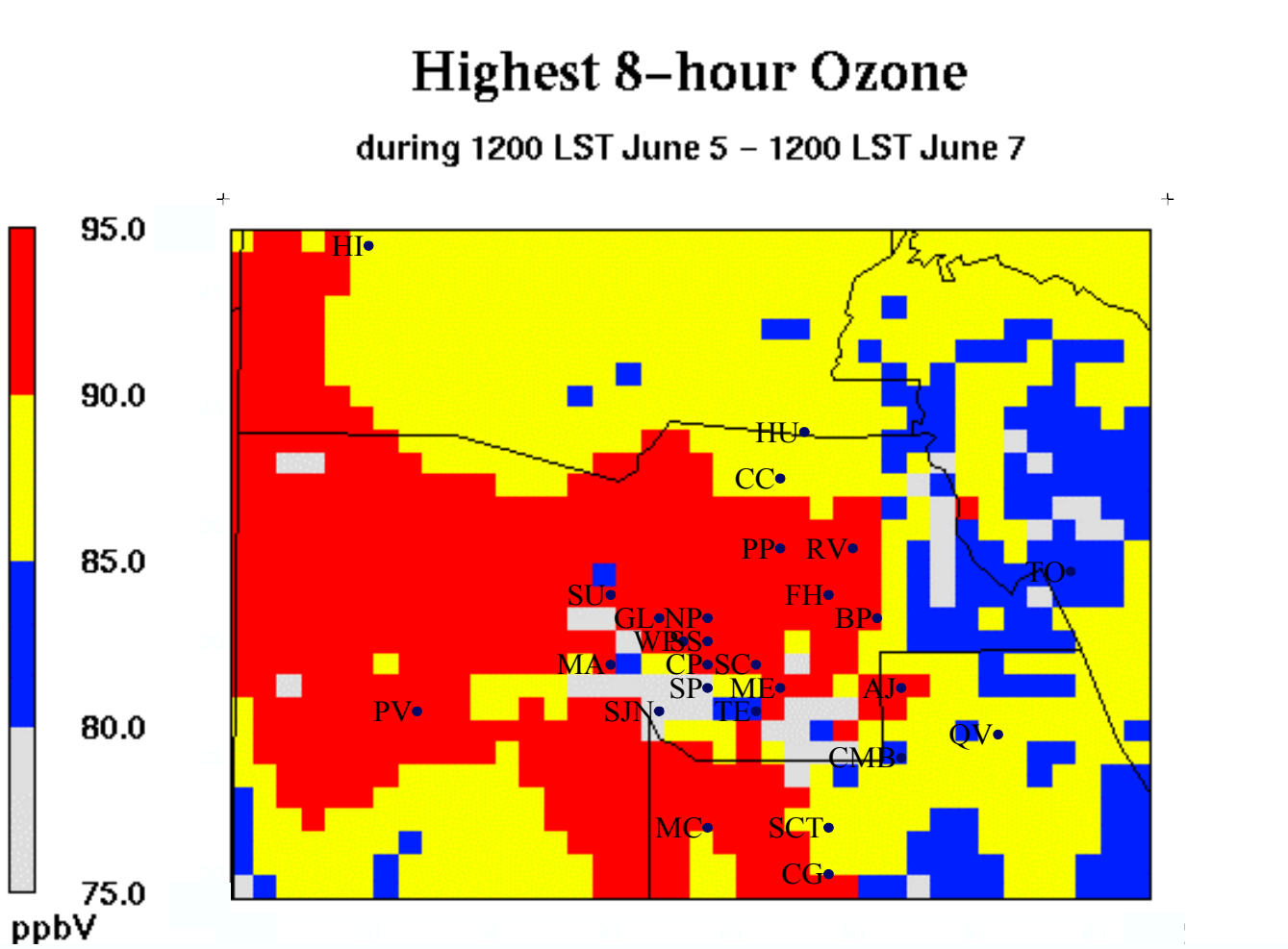




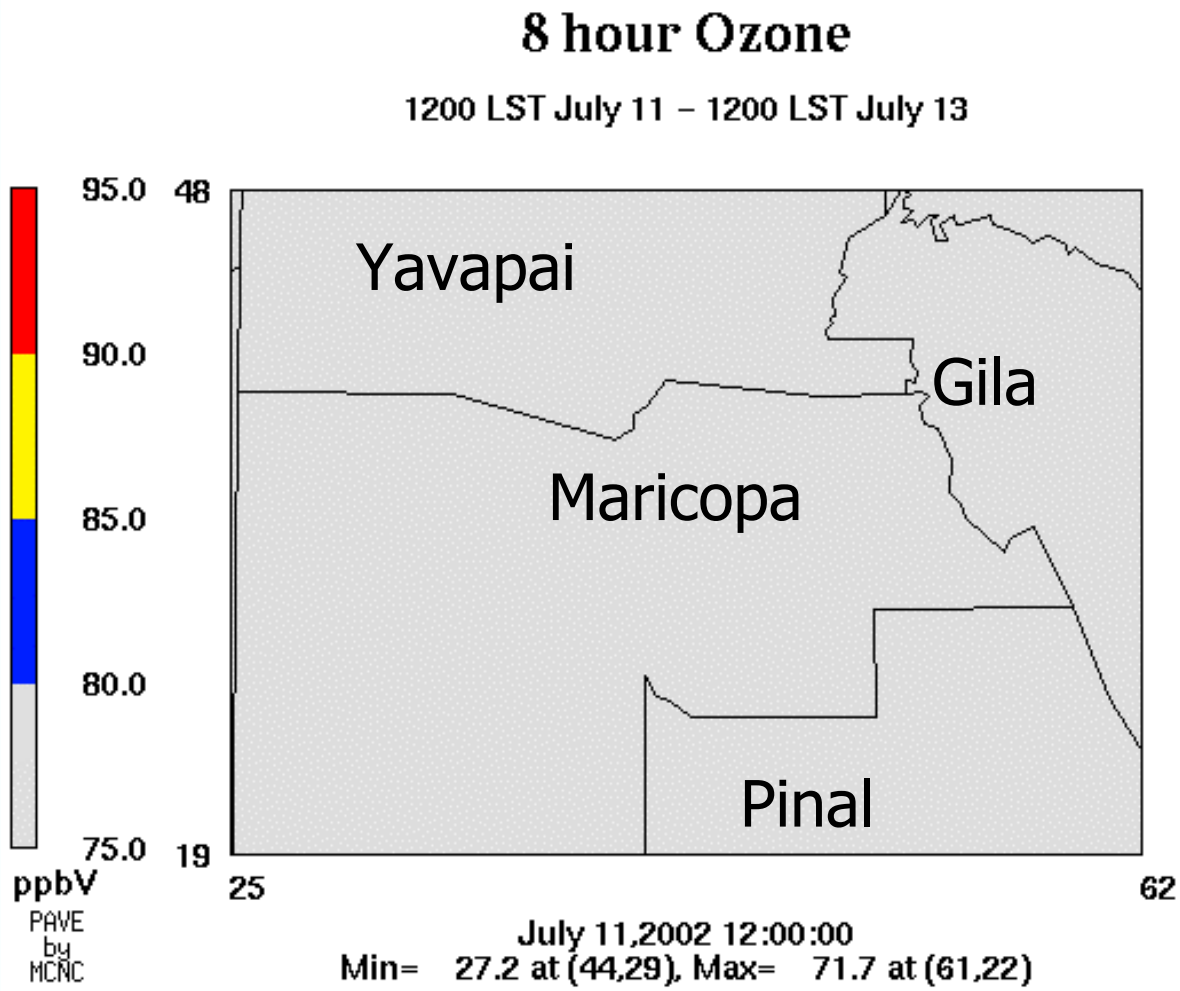




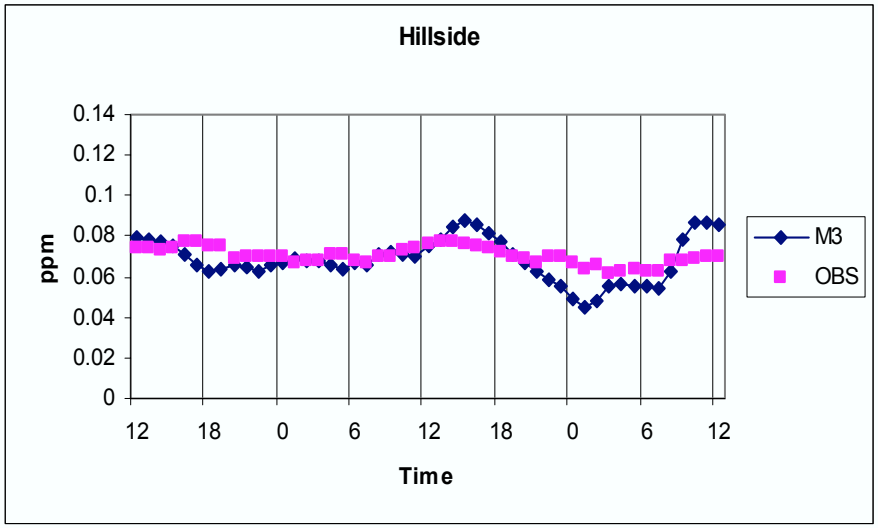
Highest 8hr Ozone: June 6th

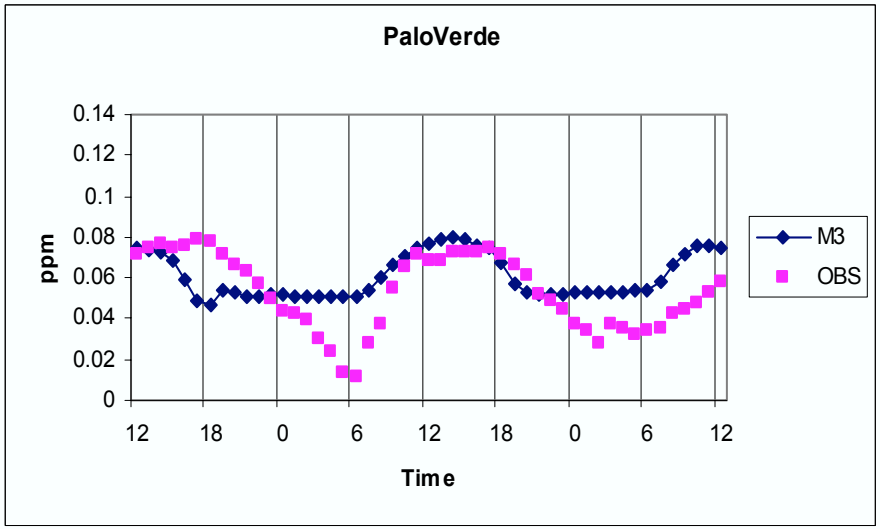


8hr Averaged Ozone: July 12th

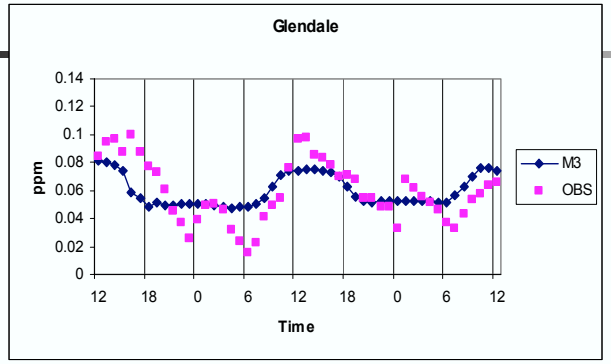


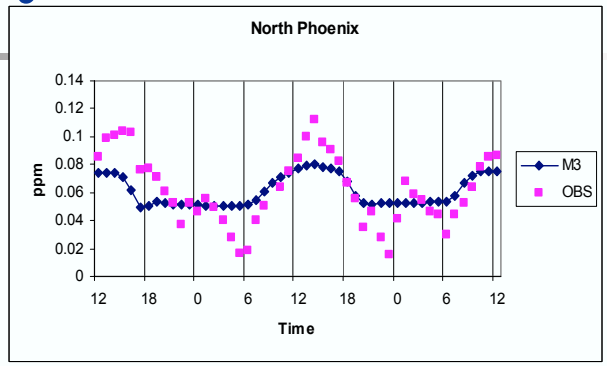
Model vs. Obs: July 12th : West

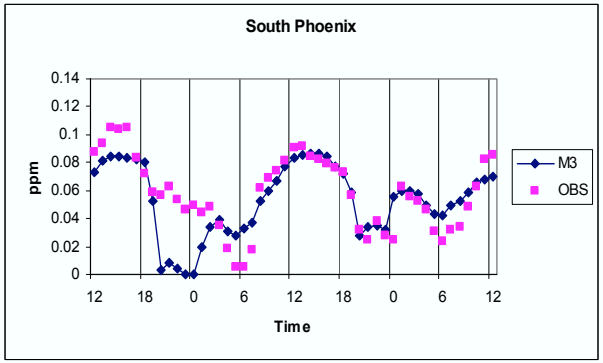


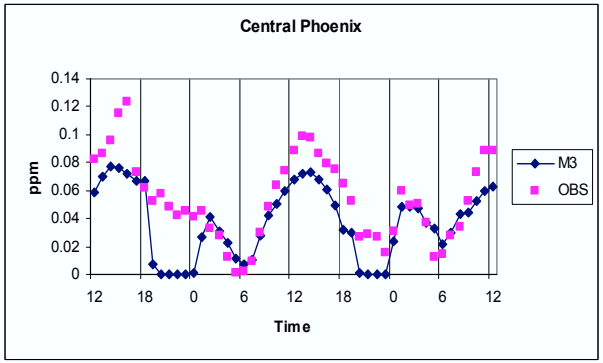


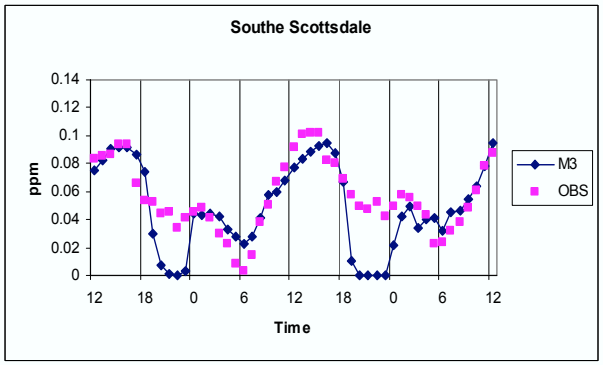
Model vs. Obs: July 12th : Central

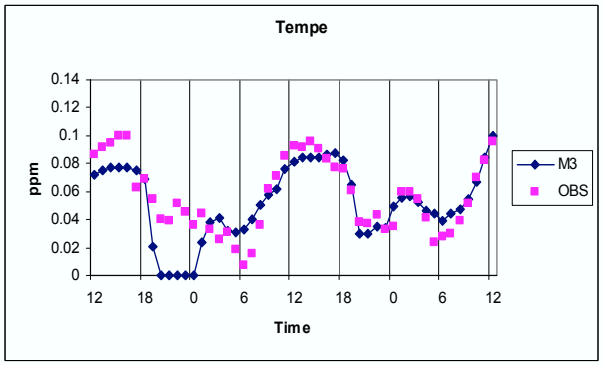




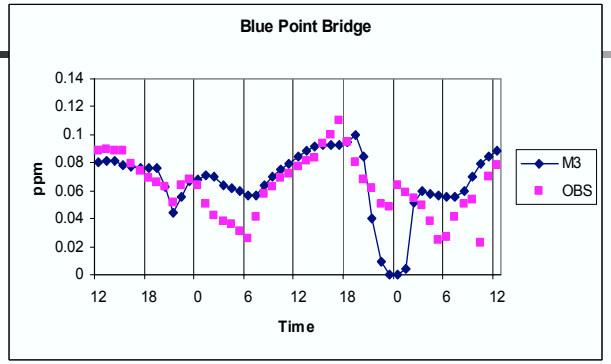


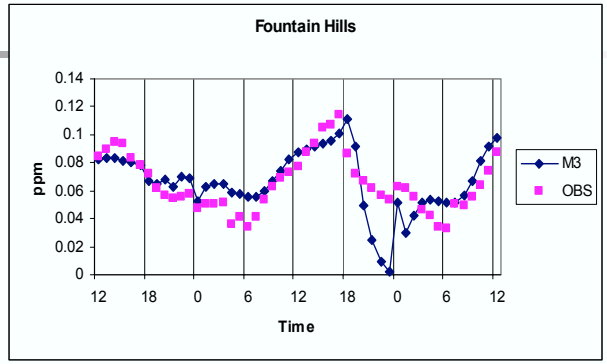


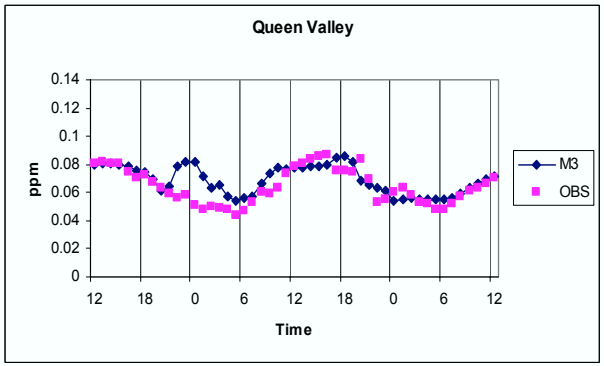


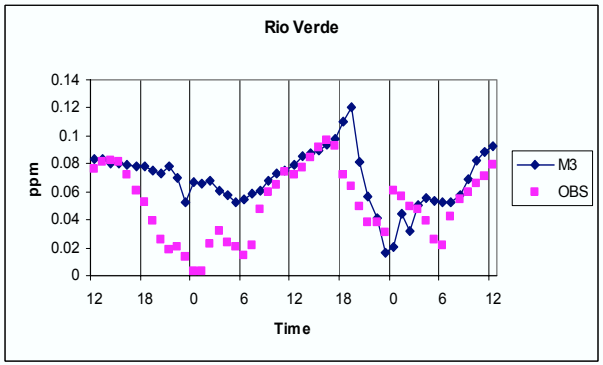


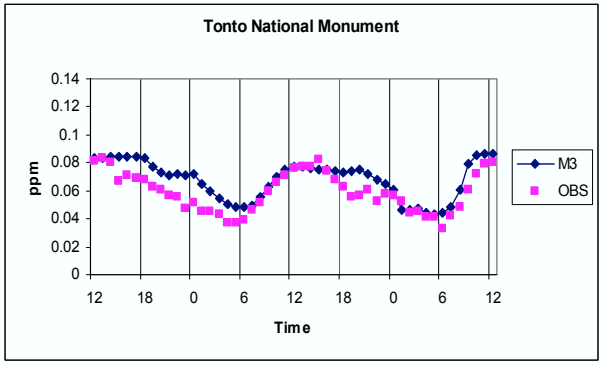
Model vs. Obs: July 12th : Northeast

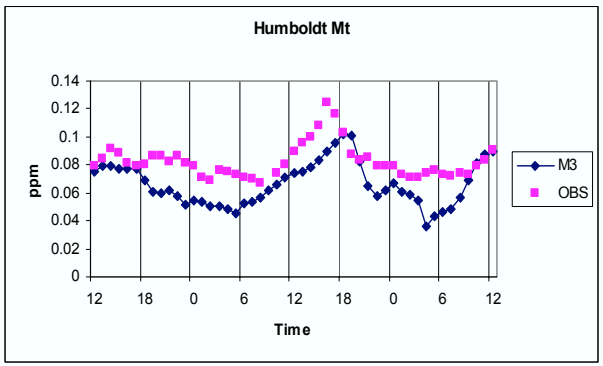




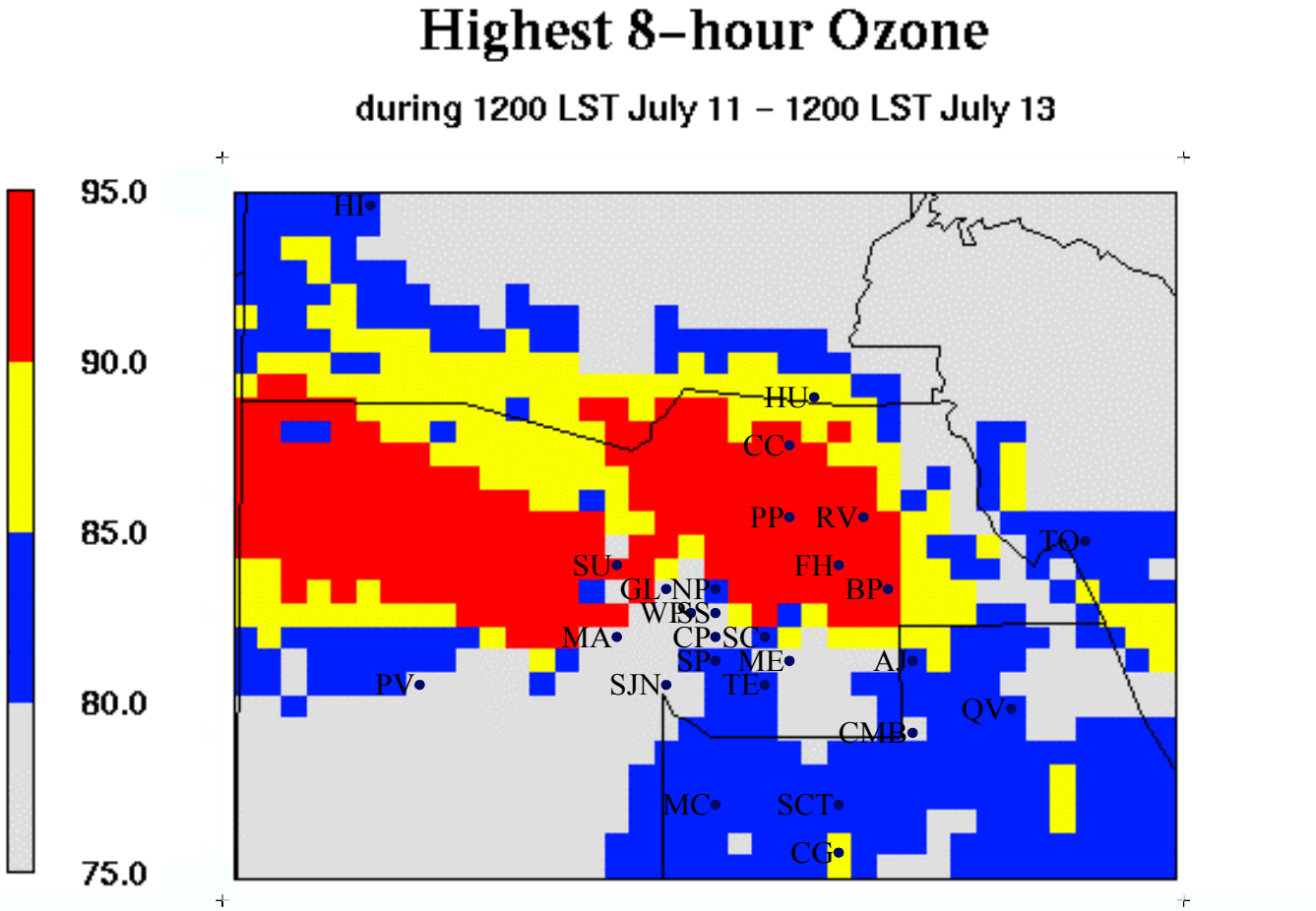








Highest 8hr Ozone: July 12th

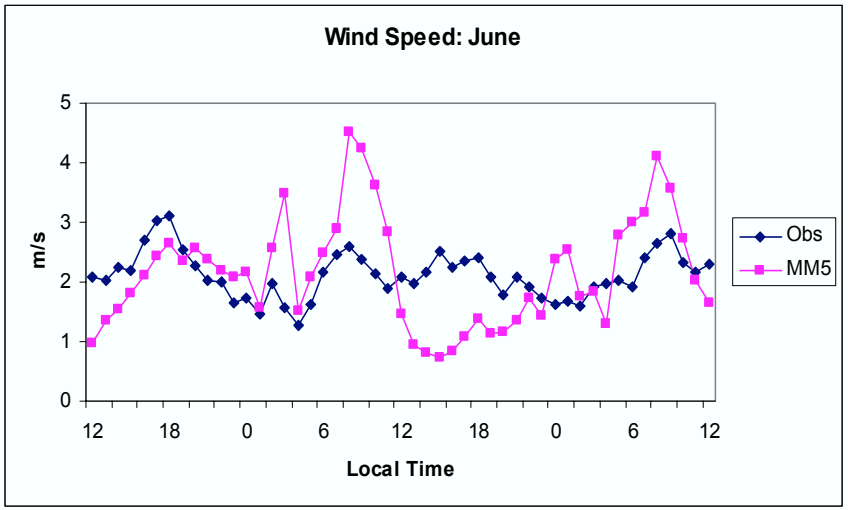


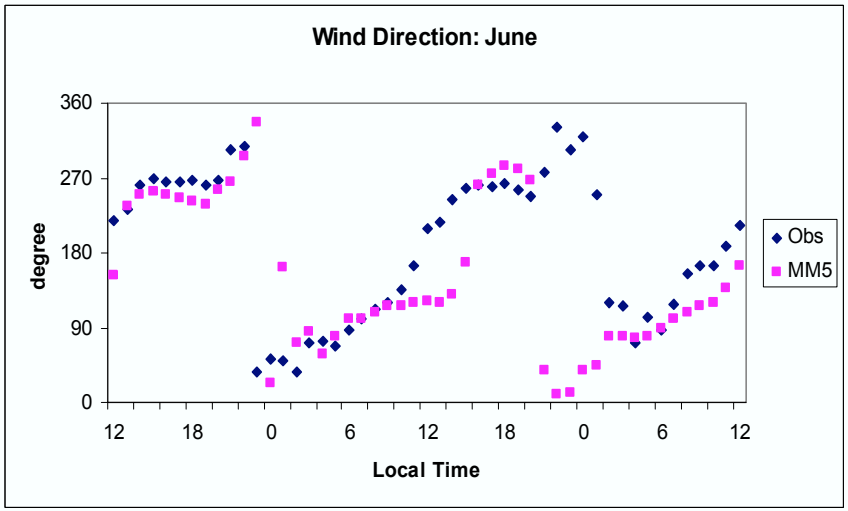
New Work:

Phoenix 8hr ozone simulation:

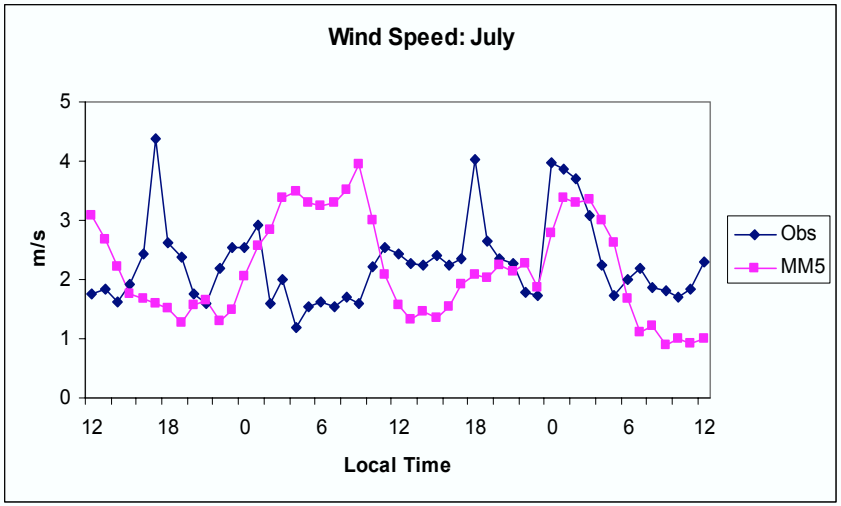
MM5 Validation

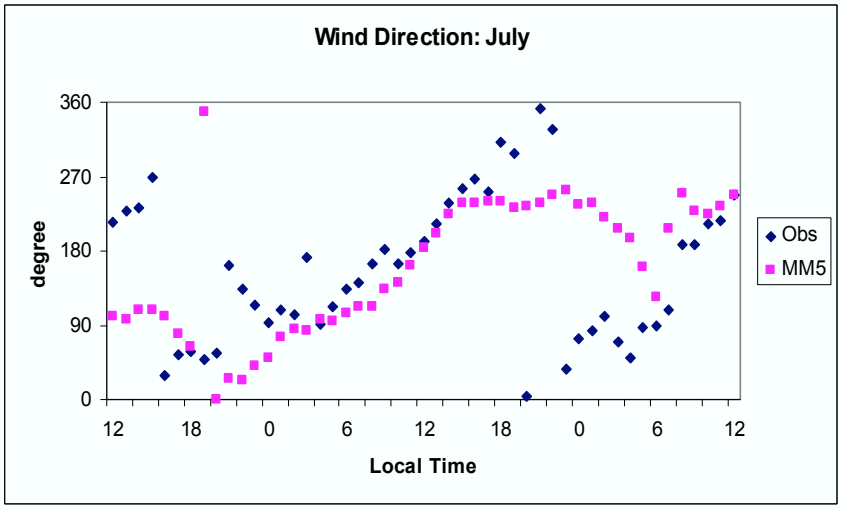
Surface Wind Measurements





Surface Wind Measurements





Performance Measures

- Relative Mean Bias $\dfrac{\overline{x_o} - \overline{x_p}}{0.5\left(\overline{x_o} + \overline{x_p}\right)}$

- Mean Difference $\overline{x_o - x_p}$

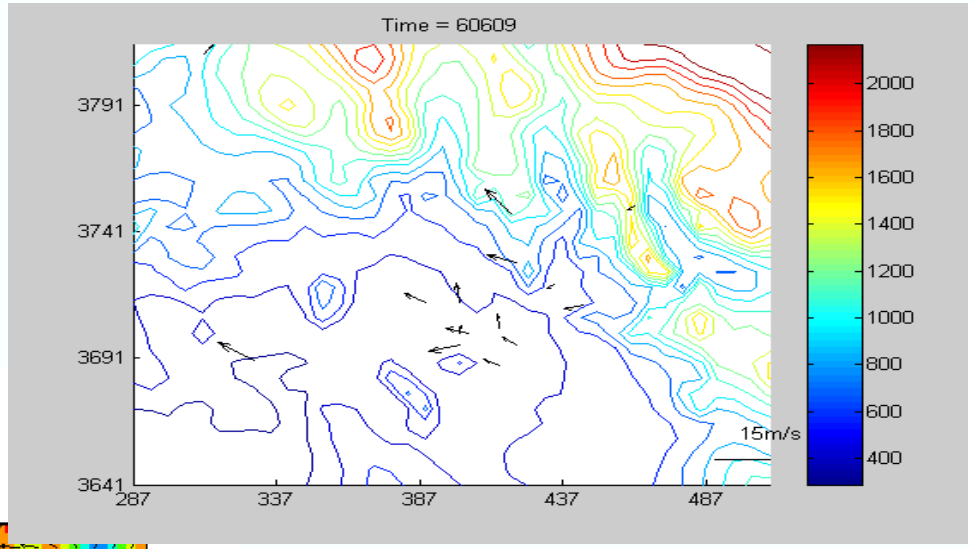
- Index of Agreement $1 - \dfrac{\sum \left(x_o - x_p\right)^2}{\sum \left(x_o - \overline{x_o} + x_p - \overline{x_o}\right)^2}$

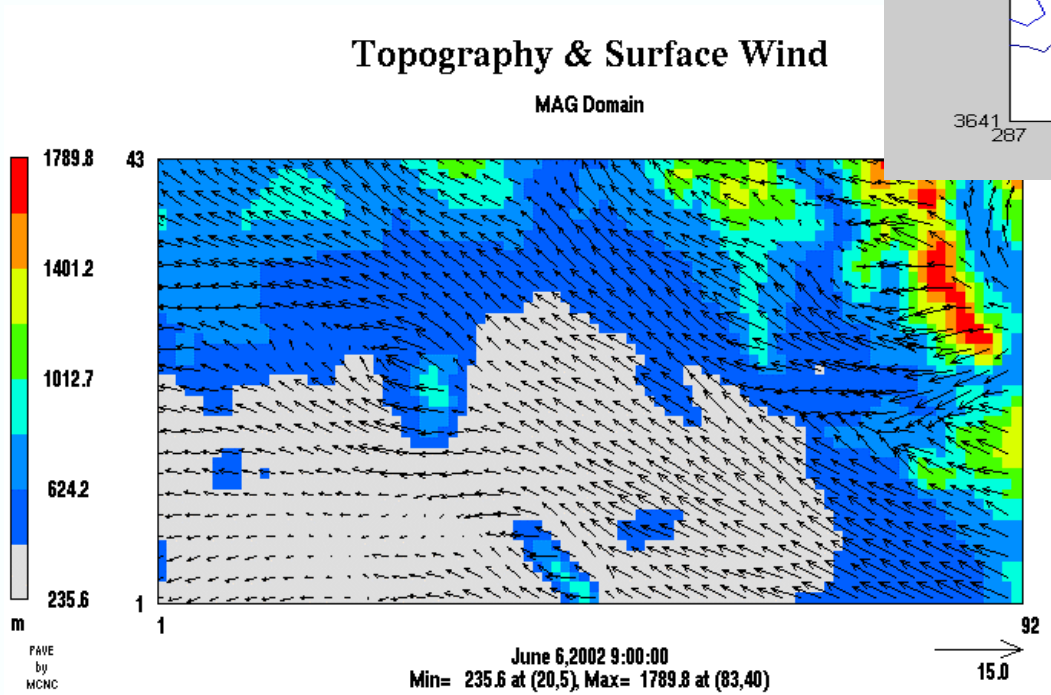
- RMS Vector Error $\left\{ \dfrac{1}{N} \sum (u_p - u_o)^2 + (v_p - v_o)^2 \right\}^{1/2}$

Model Performance

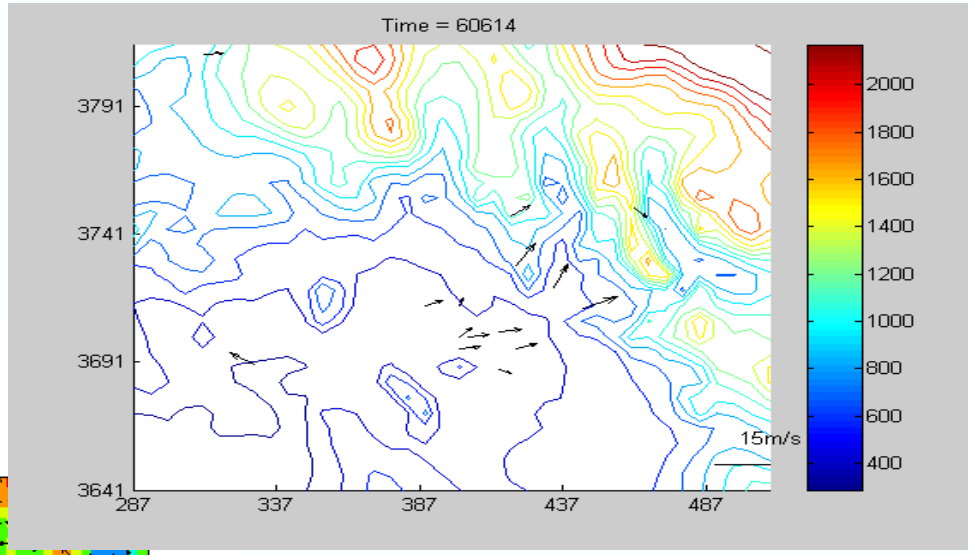
	June WS	June WD	July WS	July WD
Mean of Obs	2.2	192.4	2.4	171.0
STD of Obs	0.9	83.1	1.3	93.8
Mean	2.1	180.3	2.1	146.6
STD of Obs	1.4	109.5	1.2	123.6
Relative Mean Bias	0.0	0.1	0.1	0.2
Mean Difference	0.1	12.1	0.3	24.3
Index of Agreement	0.5	0.9	0.4	0.8
RMSE	1.5	71.5	1.7	92.7
RMS Vector Error	2.3		3.3	

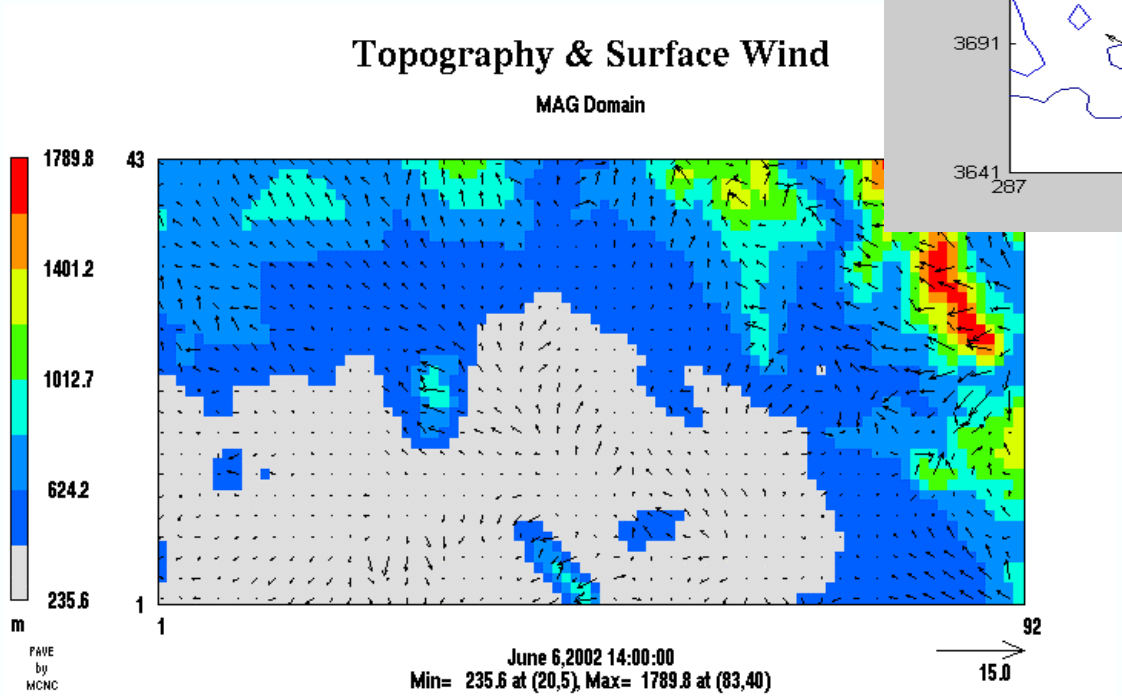
High O3 in the W & NW: 0900 LST, June 6



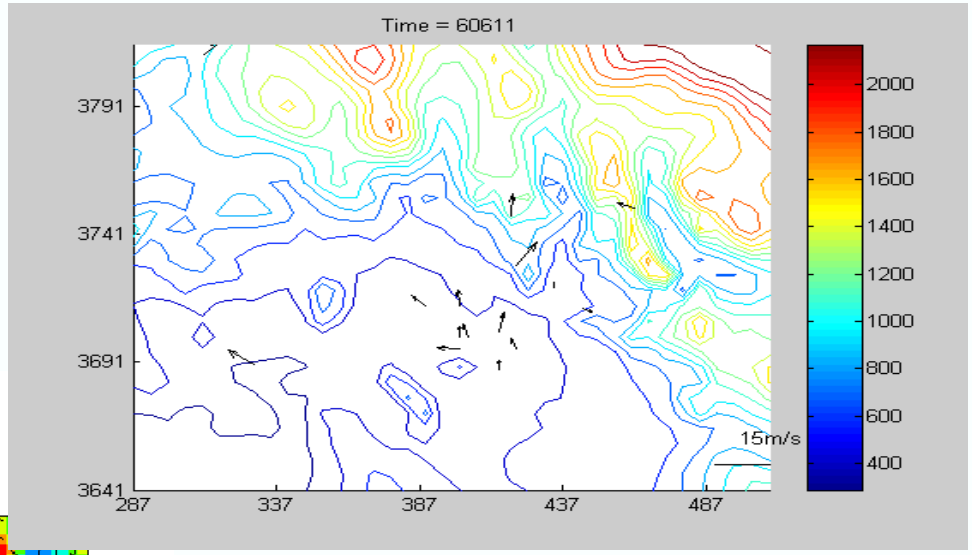


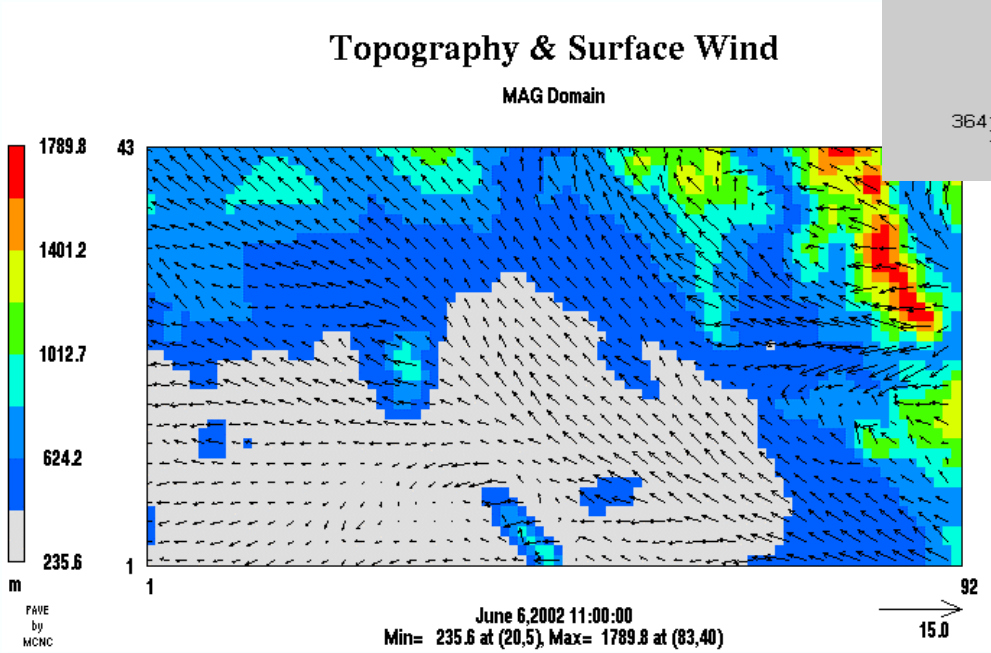
High O3 in the W & NW: 1400 LST, June 6



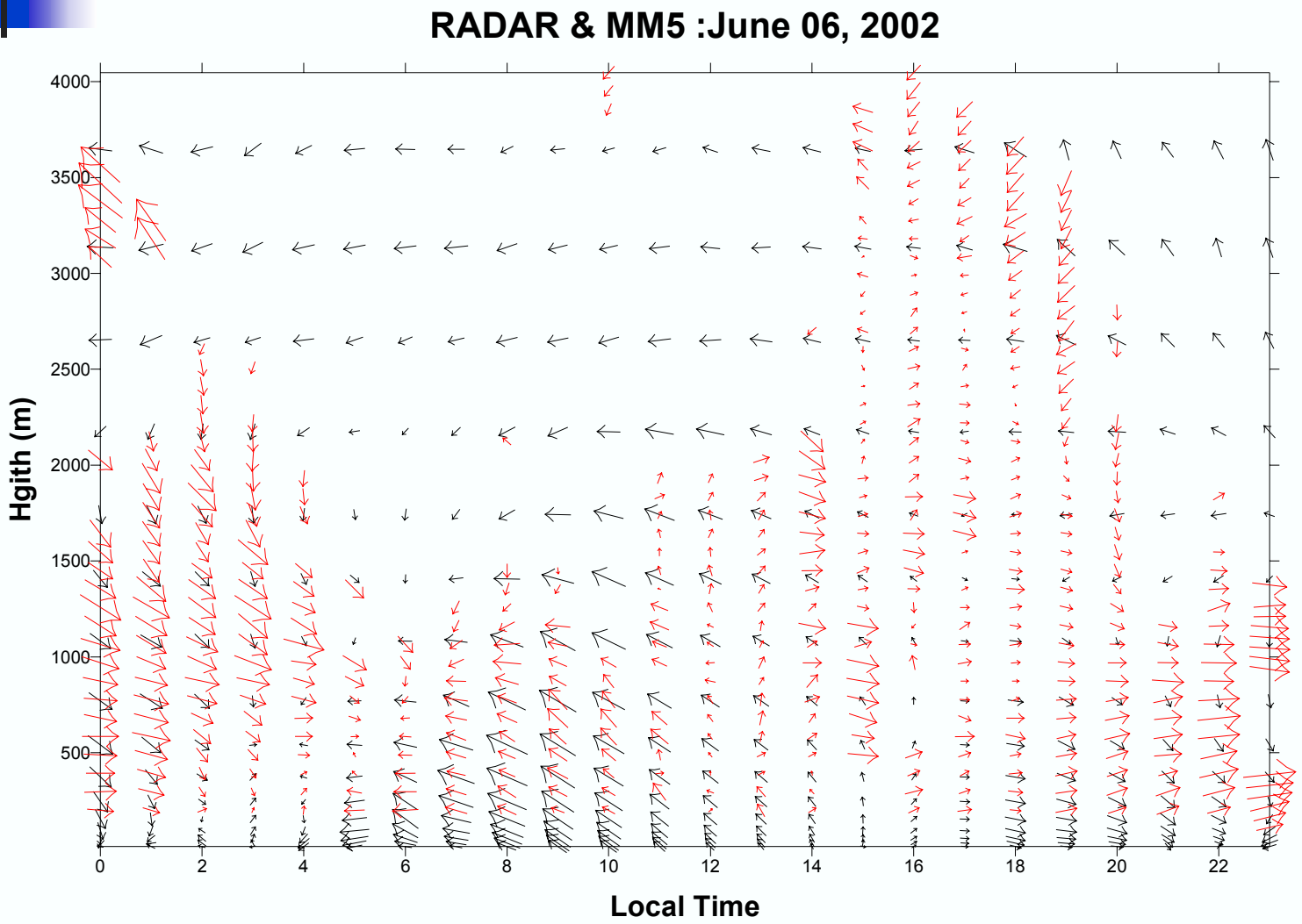


High O3 in the W & NW: 1100 LST, June 6



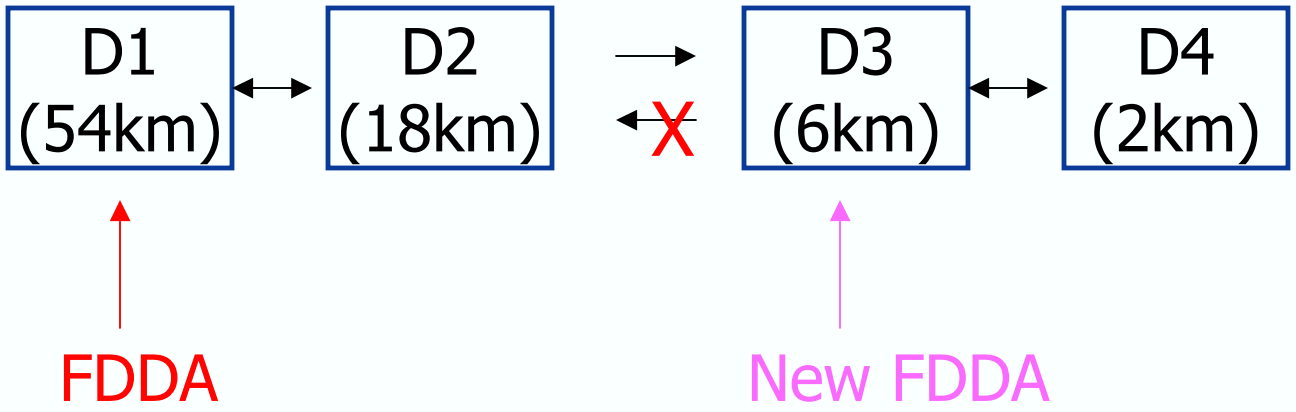


MM5 vs RADAR: June 06

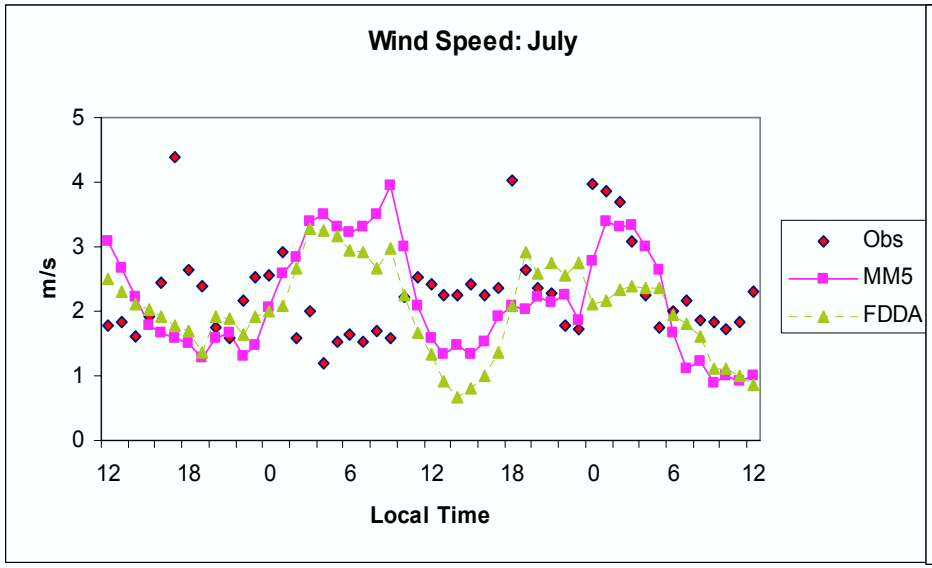


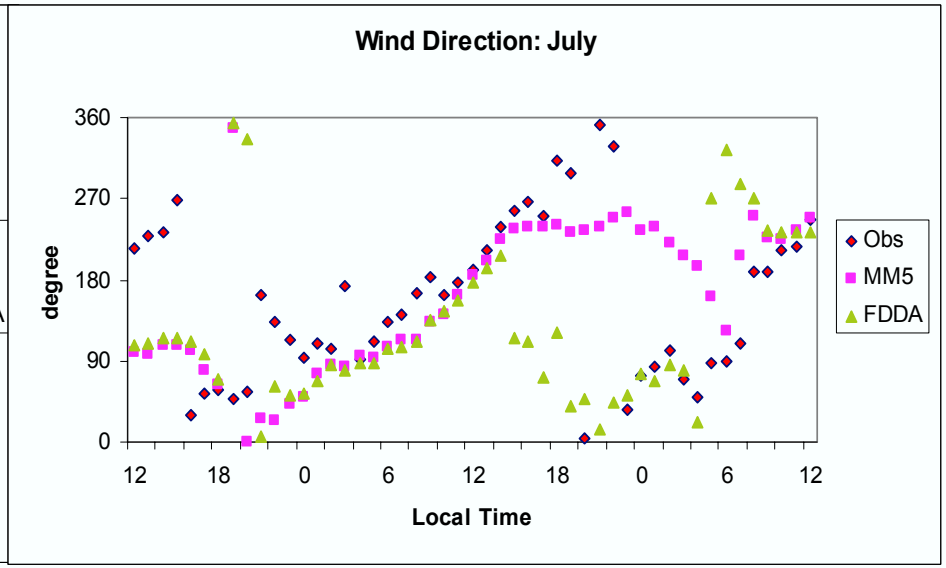
MM5 FDDA
(Four Dimensional Data Assimilation)

July Case



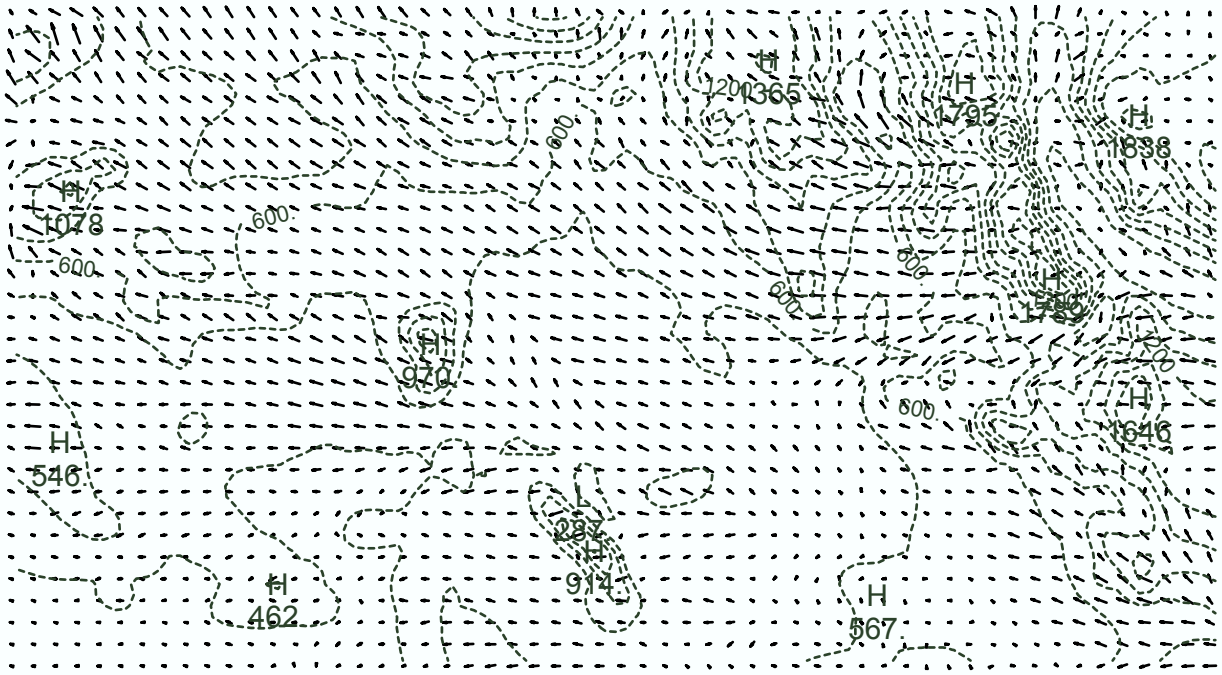
MM5 w/o vs w/ FDDA





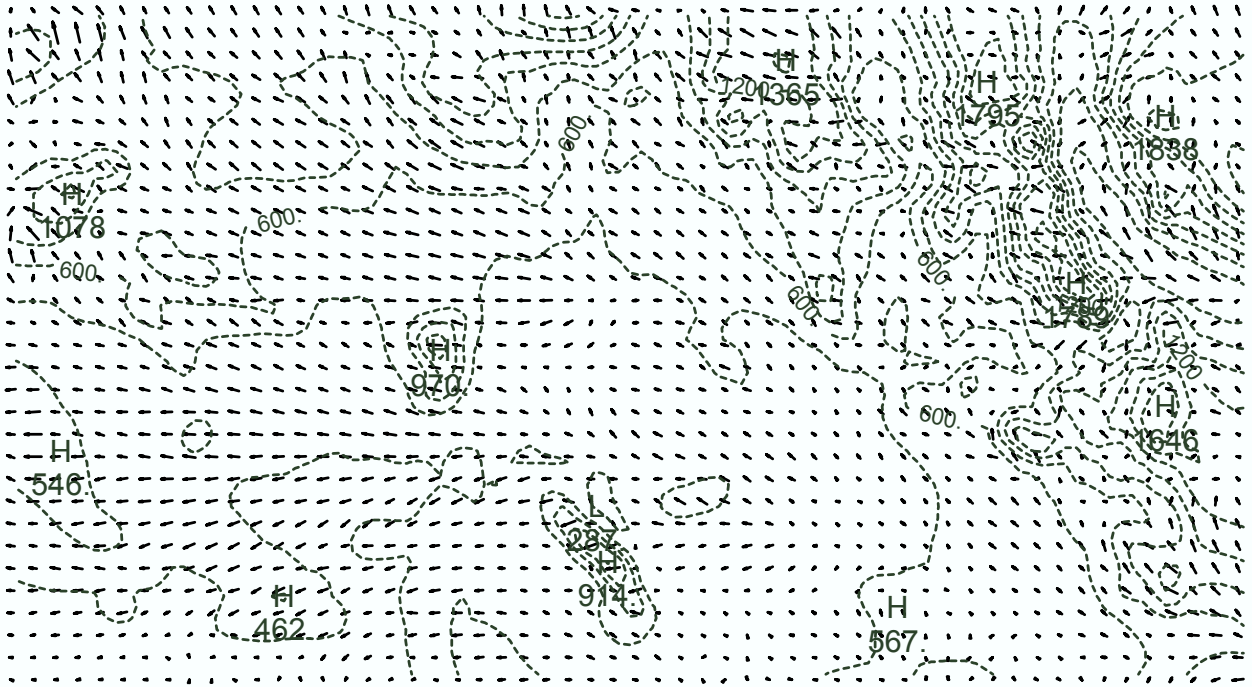
SIGMA =0.999 BARB UV (m/s) 2002-07-11_19:00:00 = 2002-07-10_12 + 31.00H SMOOTH= 0
SIGMA =1.000 TERRAIN (m) 2002-07-11_19:00:00 = 2002-07-10_12 + 31.00H SMOOTH= 0

MM5 w/o FDDA: 1200 LST July 11



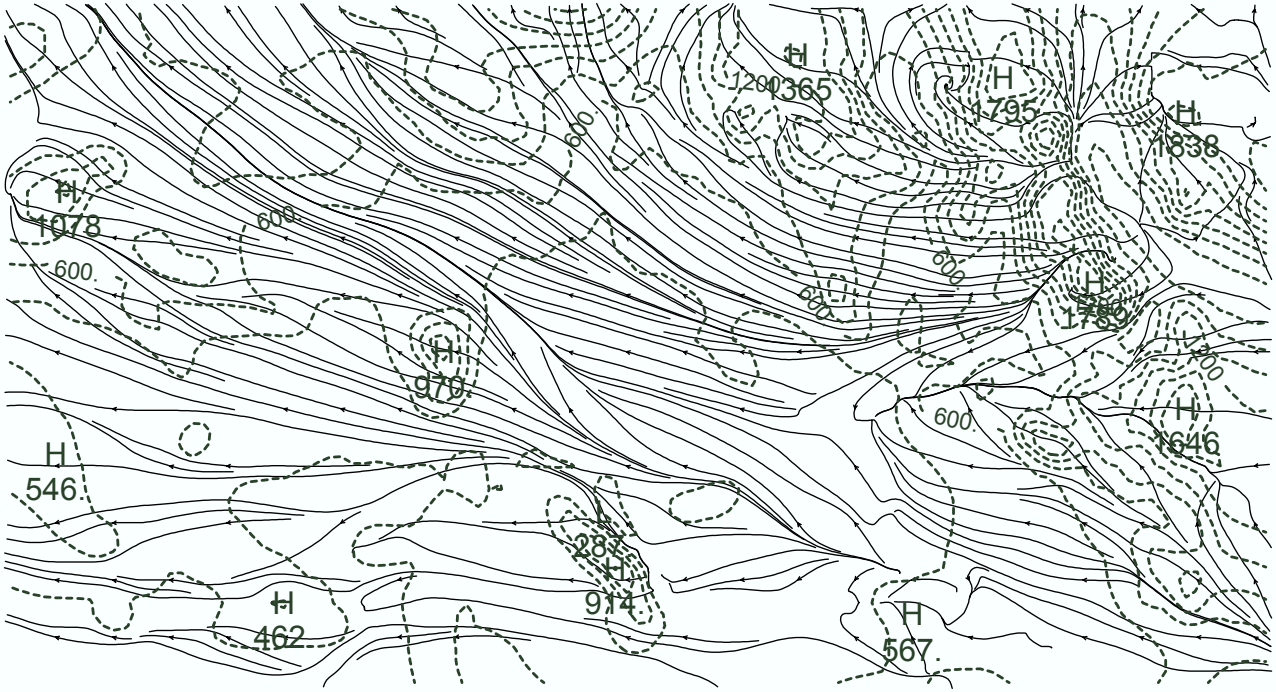
SIGMA =0.999 BARB UV (m/s) 2002-07-11_19:00:00 = 2002-07-11_00 + 19.00H SMOOTH= 0
SIGMA =1.000 TERRAIN (m) 2002-07-11_19:00:00 = 2002-07-11_00 + 19.00H SMOOTH= 0

MM5 w/ FDDA: 1200 LST July 11



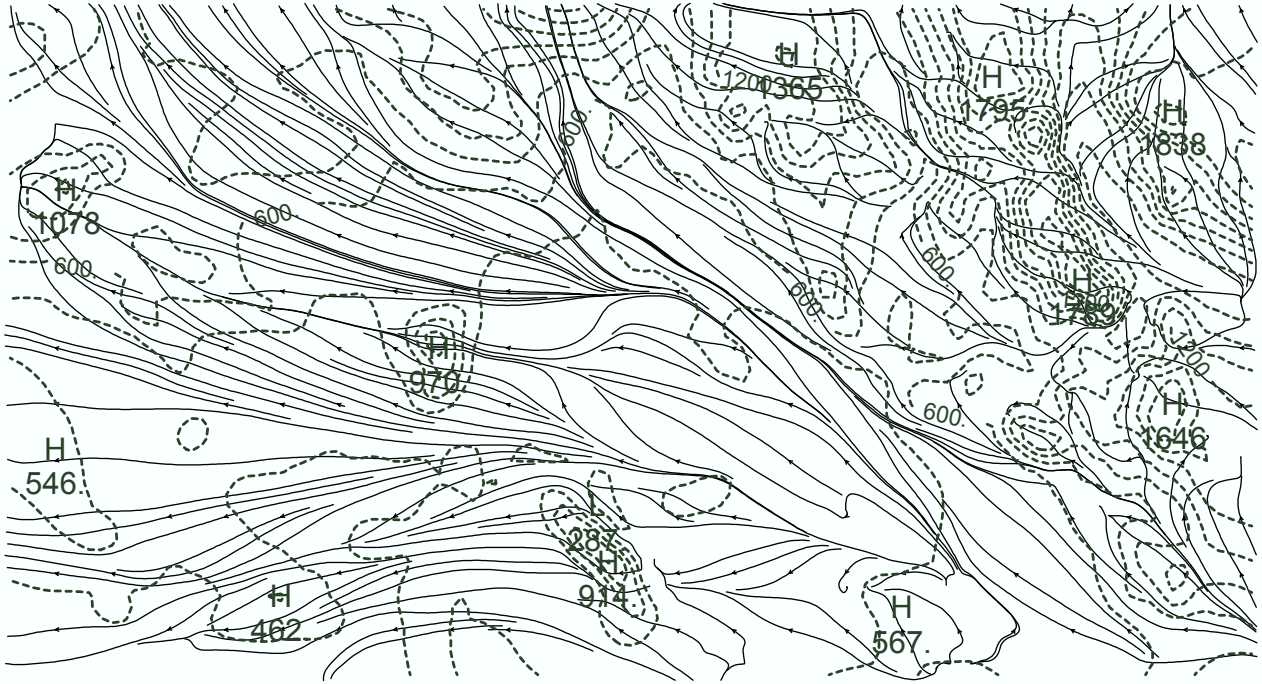
SIGMA =0.999 BARB UV (m/s) 2002-07-11_19:00:00 = 2002-07-10_12 + 31.00H SMOOTH= 0
SIGMA =1.000 TERRAIN (m) 2002-07-11_19:00:00 = 2002-07-10_12 + 31.00H SMOOTH= 0

MM5 w/o FDDA: Streamlines



SIGMA =0.999 BARB UV (m/s) 2002-07-11_19:00:00 = 2002-07-11_00 + 19.00H SMOOTH= 0
SIGMA =1.000 TERRAIN (m) 2002-07-11_19:00:00 = 2002-07-11_00 + 19.00H SMOOTH= 0

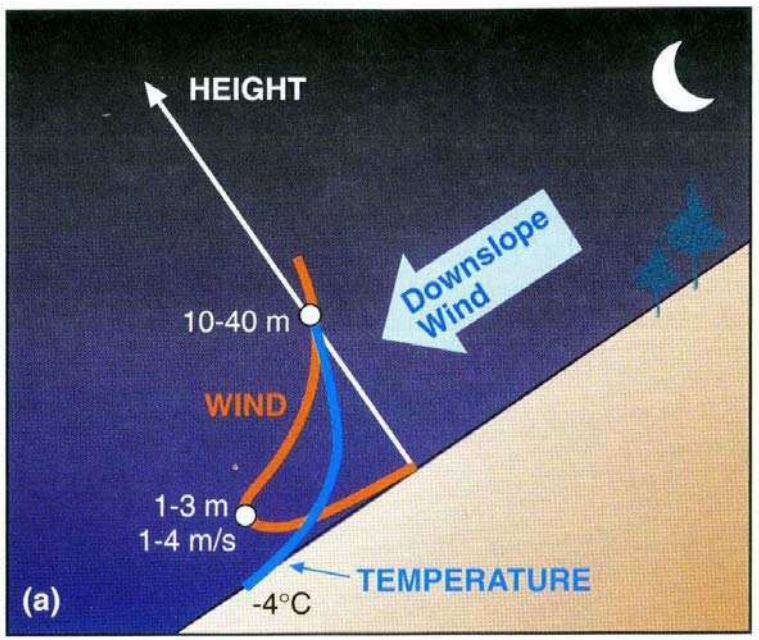
MM5 w/ FDDA: Streamlines

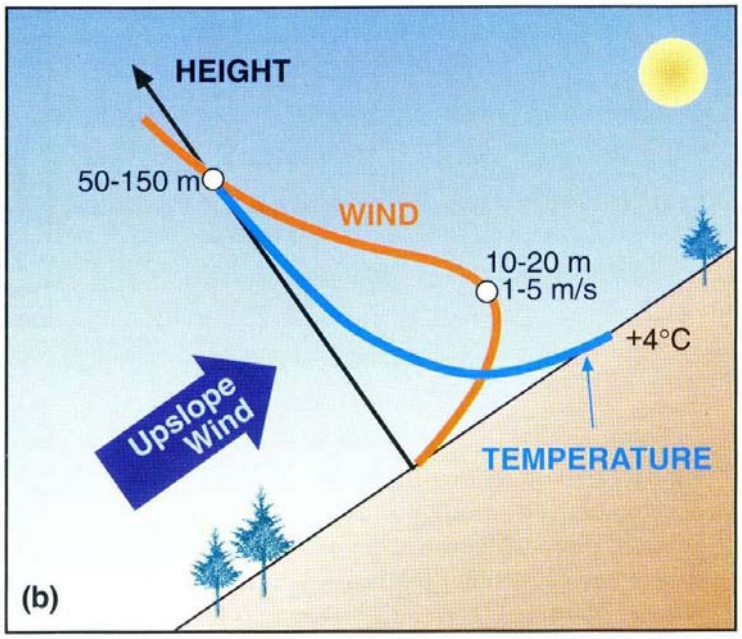


Transition Periods

- Morning Transition
- Evening Transition

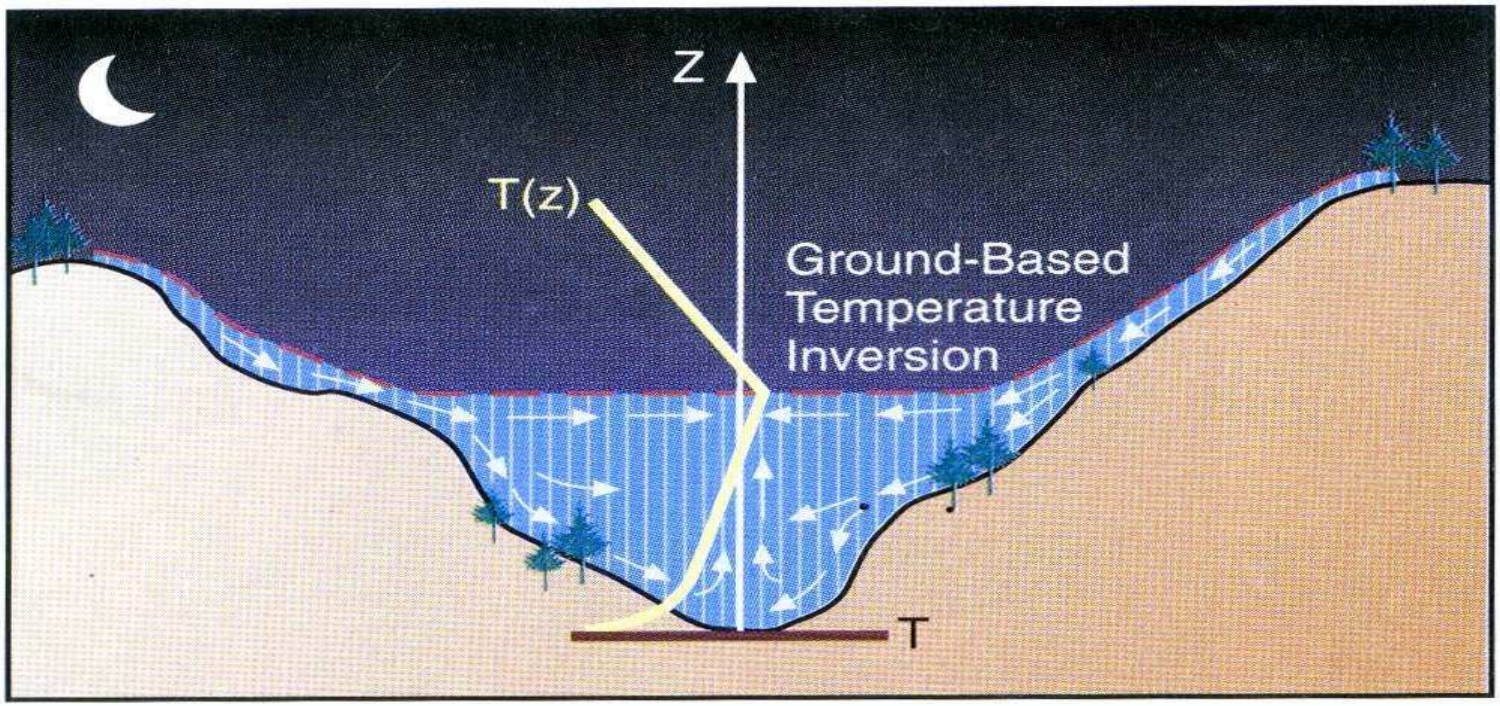
Thermally Driven Slope Flows





Reproduced from *Mountain Meteorology* (2000). Courtesy of Dr. Whiteman, PNNL.

Morning Transition



Reproduced from *Mountain Meteorology* (2000), and *Observations of thermally developed wind systems in mountainous terrain* (1990). Courtesy of Dr. Whiteman, PNNL.

Cold Pool Breakup

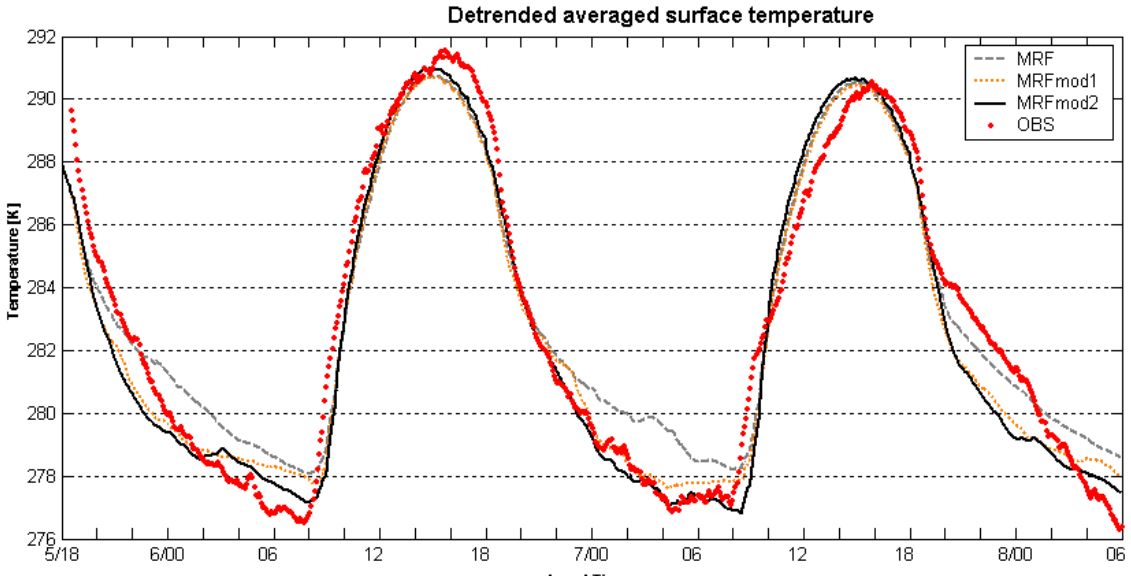
Low B

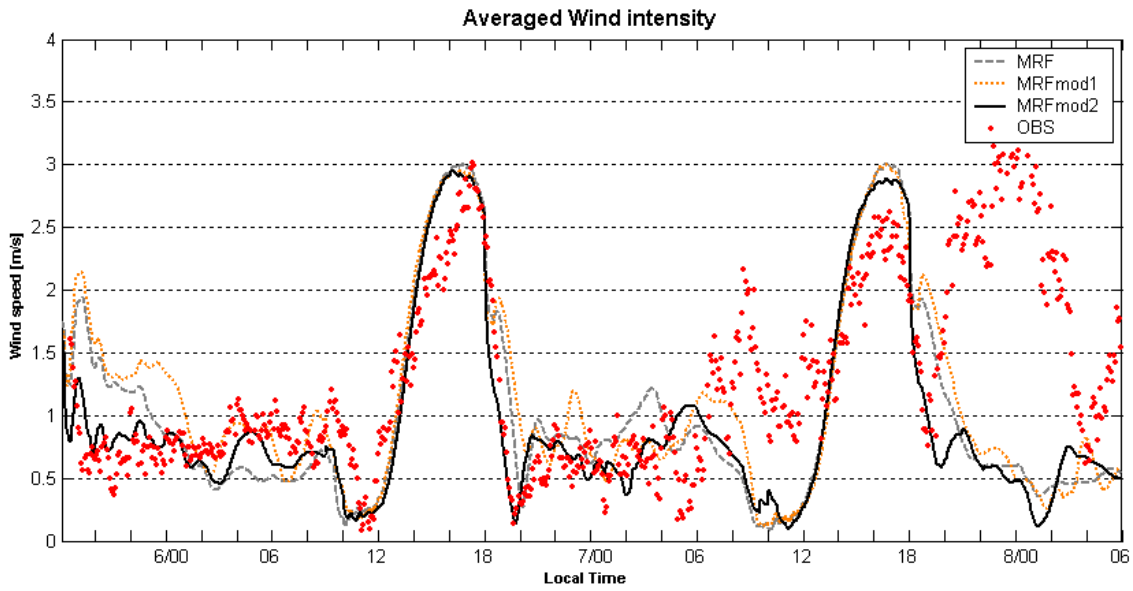
Run 11 - Thermally Stratified

See Run11-temp.avi
for Temperature Profiles

Click in the window to play (will take a few seconds to load).

Temperature & Wind comparison





Second modification to MRF (only below PBL and STABLE conditions.)

$$\frac{K_m}{\sigma_w^2 / \left| d\tilde{V}/dz \right|} = (0.34)\overline{Rig}^{-0.02} \approx 0.34$$

$$\frac{K_m}{\sigma_w^2 / \left| d\tilde{V}/dz \right|} = (0.08)\overline{Rig}^{-0.49} \approx (0.08)\overline{Rig}^{-0.5}$$

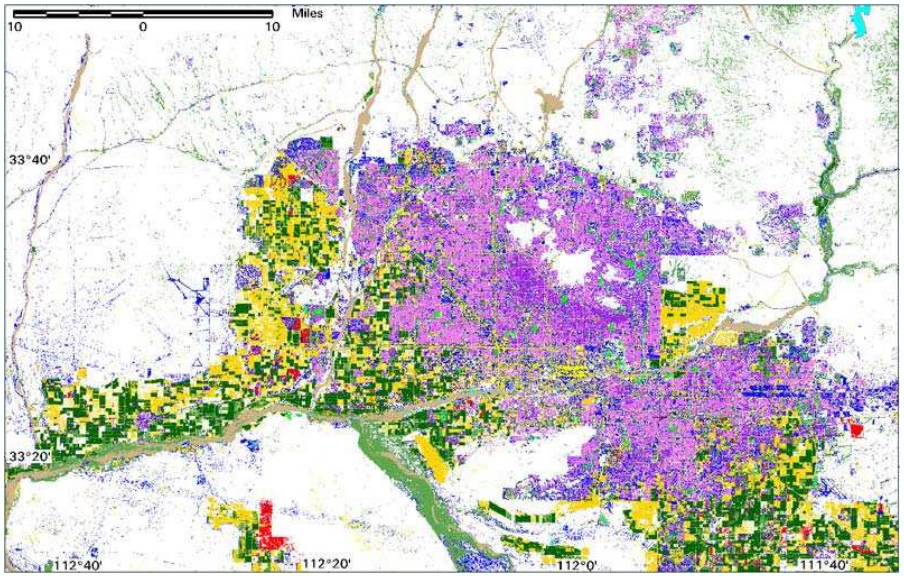
$$K_m \approx 0.34\,\sigma_w^2 / \left| d\tilde{V} / dz \right|$$

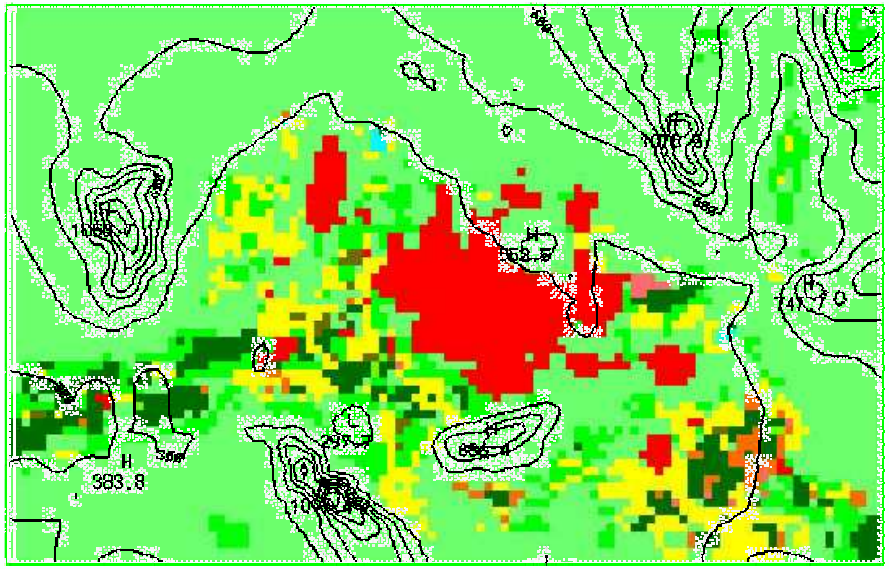
$$K_h \approx 0.08\,\sigma_w^2 / N$$

$$\frac{\sigma_w^2}{u_*^2} = 2.5\left[1 - \left(\frac{z}{h}\right)^{0.6}\right]$$

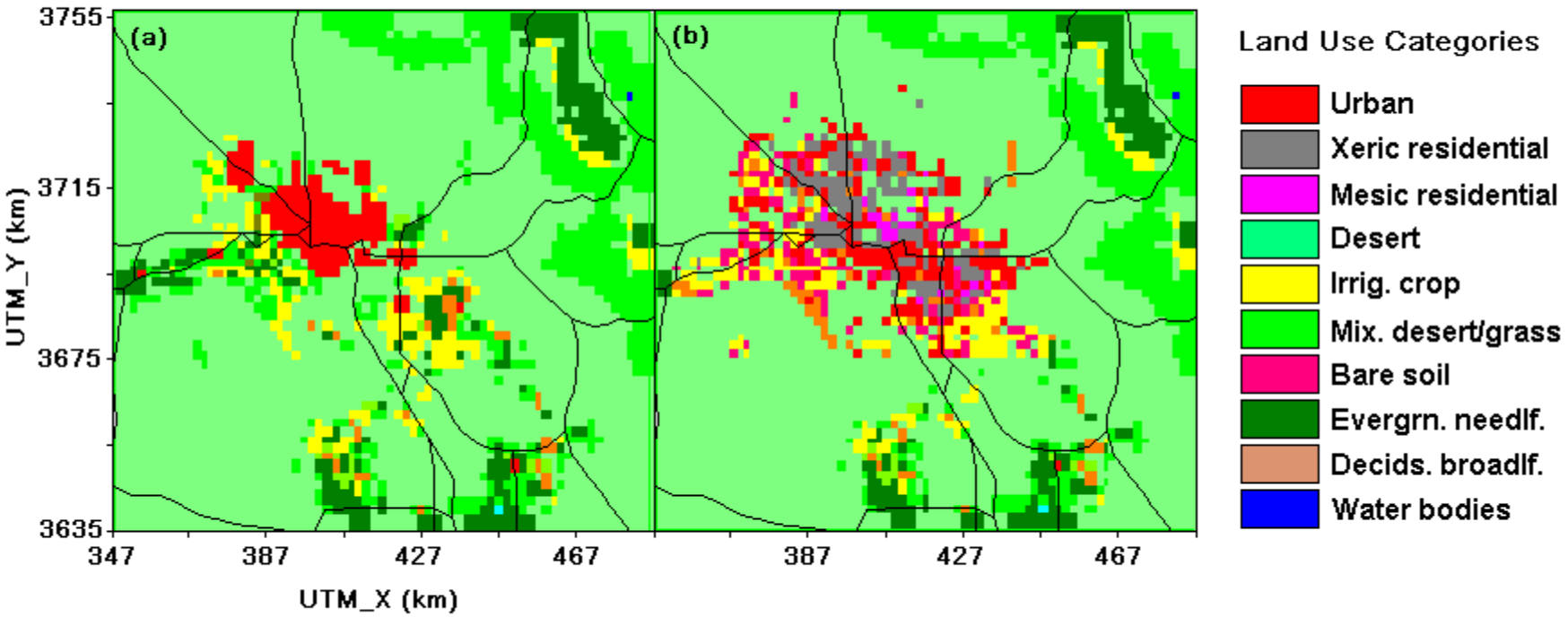
Land Cover Comparison

Actual (1998 AVHRR, Will Stefanov, ASU) MM5 (1976 USGS 25 category)





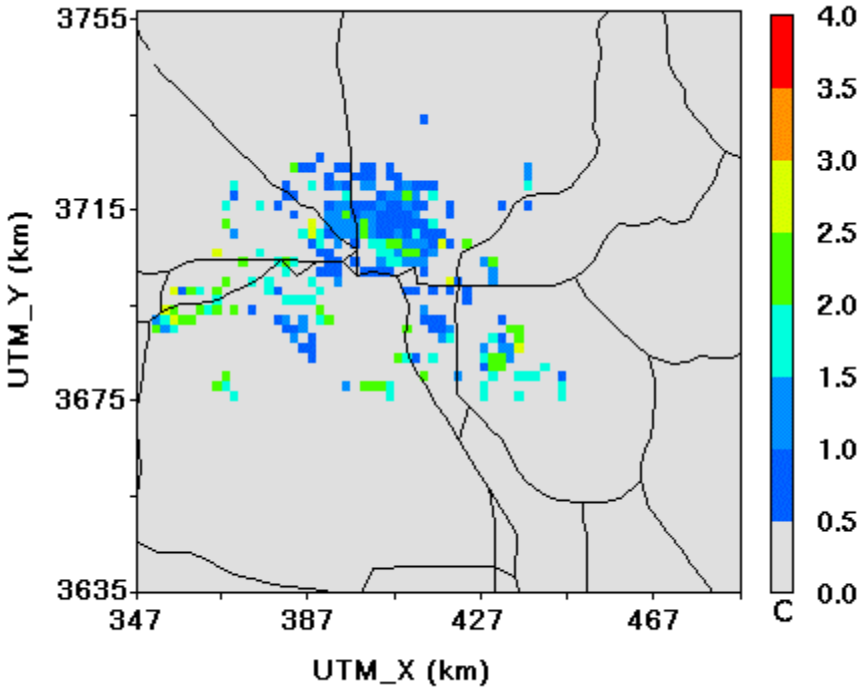
Large portions of urban area missing
Active agricultural areas misclassified
Large effect on surface energy budget and regional scale circulation


(a)
(b)
3755
3715
3675
3635
UTM_Y (km)
347
387
427
467
387
427
467
UTM_X (km)
Land Use Categories
Urban
Xeric residential
Mesic residential
Desert
Irrig. crop
Mix. desert/grass
Bare soil
Evergrn. needlf.
Decids. broadlf.
Water bodies

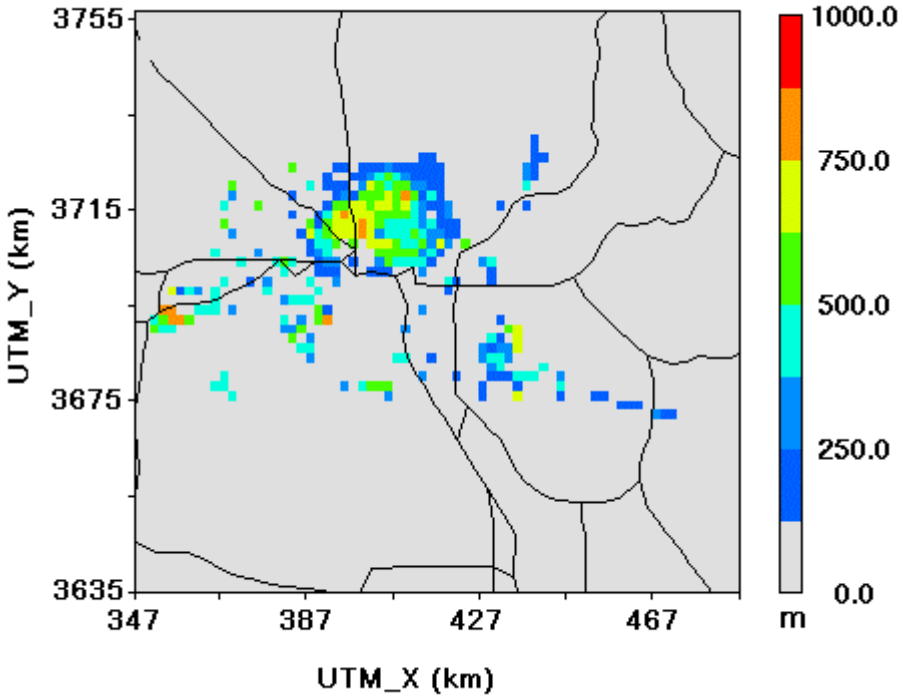
USGS less 1998 Land Use Classification

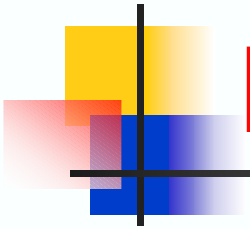
Simulated differences at 2 pm in:

2m Air Temperature



Boundary Layer Height





END

Simulation of 8-Hour Ozone Concentrations for the State of Arizona

Contract Report Submitted to the
Arizona Department of Environmental Quality

By

S.M. Lee[*]
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1. Introduction

On November 14, 2002, the USEPA issued a memorandum entitled "Schedule for 8-Hour Ozone Designations and its Effect on Early Action Compacts," wherein the states and tribes were requested to provide recommendations for 8-hour ozone designations no later than April 15,th 2003. This was to include specific boundaries of the proposed non-attainment areas, supporting (2001-2003) air quality data and any other documentation relevant to the states' designations. In a follow-up memo by the EPA dated February 27, 2003, an extension was granted until July 15, 2003, to comply with this request, and the date of promulgation of non-compliance areas has been set for April 15, 2004.

In support of their efforts in meeting the EPA guidelines, the Arizona Department of Environmental Quality (ADEQ) contracted the Environmental Fluid Dynamics (EFD) Program at ASU to undertake the following tasks: (i) develop an emission inventory by combining the Maricopa Association of Governments (MAG) emissions inventory with the Western Region Air Partnership (WRAP) inventory to expand the present MAG modeling domain while including such population centers as Casa Grande, Coolidge and Florence; (ii) conduct 8-hour ozone simulations using Models-3/CMAQ and MM5 meteorological models for one or two design dates (in 2001 or 2002) selected by the ADEQ staff; this selection is to be based on the zone concentrations on the eastern fringe of the metro area and the availability of measurements from the far eastern part of the valley, such as Queen Valley and Tonto National Monument; (iii) validate the model's ozone output against the observations; (iv) develop a 2018 emission inventory, similar in nature to the CMAQ emissions for WRAP, by considering growth and control factors; (iv) conduct a socio-economic analysis based on GIS techniques that will outline growth scenarios for the greater Phoenix area.

Some of the work listed above was subcontracted to carefully selected experts in air quality modeling and analysis, from within and outside ASU. The GIS laboratory at ASU performed the socioeconomic analysis, and Mark Houyoux of the North Carolina Super Computer Center, Environmental programs, compiled the 2018 pollution inventory. These groups will submit separate reports to ADEQ. The present report contains the building of the pollution inventory beyond the MAG domain, Models-3/CMAQ simulations and the validation of meteorological and ozone modeling conducted by the EFD Program.

2. Design Days For Numerical Simulations

ADEQ recommended two design days for simulations based on the observations of elevated 8-hour ozone concentrations. The first is June 6, 2002 wherein high ozone concentrations were measured in the northeast part of the valley. The second day is July 12, 2002, where elevated 8-hour concentrations were recorded at Humboldt Mountain and in the central valley area.

On June 6, 2002, 8-hour ozone concentrations at Fountain Hills, Blue Point Bridge, Rio Verde and Tonto National Monument were respectively, 93, 92, 90, and 89 ppb.

During this episode, hot and clear weather was observed due to a high pressure system located over Arizona and a thermal low was found to form over the arid area in the vicinity of the Arizona, California and Mexico border. A meteorological condition with light surface wind and strong shortwave radiation was favorable for photochemical production of ozone and for the transport of a high-ozone laden air mass to far downwind of the valley.

The highest 8-hour ozone concentration on July 12th was measured at the Humboldt Mountain (103 ppb), and the next highest concentrations of 94, 93, 90, and 89 ppb were recorded at Falcon Field, Fountain Hills, Blue Point Bridge, and North Phoenix, respectively. Persistent easterly flow due to a strong high-pressure system centered at northern Utah brought monsoon moisture into Arizona. Consequently, convection cells and thunderstorm activities were observed in the northeastern mountains and the southern part of Arizona. Contrary to the June 6th case, cloudiness and micro-scale convective cells confined elevated ozone to the source emission area (central valley) rather than further downwind.

3. Emission Inventory and Processing

3.1 Emission Inventories

Emission inventories were required for both of the Models-3/CMAQ modeling domains, which consists of an "inner domain" with a grid resolution of 2 km x 2 km and an "outer" domain with a grid cell size of 6 km x 6 km to which the inner domain is nested (Figure 3-1).

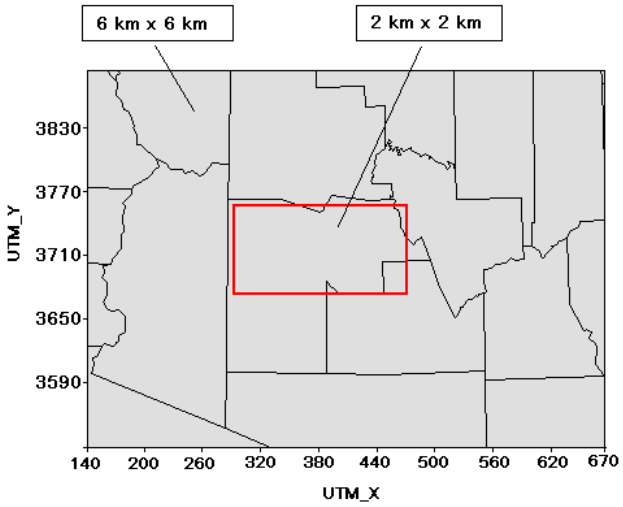

Figure 3-1. Models-3/CMAQ modeling domains with grid resolutions of 2 km x 2 km (inner domain) and 6 km x 6 km (outer domain), respectively.

The 1999 "Ozone Maintenance Plan" emissions inventory was provided by the MAG for the inner modeling domain with a grid resolution of 2 km x 2 km. This 24-hour emissions inventory for a typical summer day contains hourly gridded emissions for the species CO, NO, NO_2, OLE, PAR, TOL, XYL, FORM, ALD_2, ETH, MEOH, ETOH, ISOP, SO_2 and AERO. The Southwest corner of the inventory grid is located at the Universal Transverse Mercator (UTM) coordinates Zone 12,297 km Easting and 3675 km Northing. The extent of the emissions grid is 92 columns and 43 rows.

The emissions inventory for the modeling domain with the 6 km x 6 km grid was processed based on the inventory data of the WRAP base-case scenario 1996 Emissions Inventory. WRAP implemented a regional planning process to provide the necessary technical and policy tools needed by states and tribes to comply with the Clean Air Act goals of protecting the visibility of many national parks and wilderness areas. The regional haze analyses over the western United States is being performed by employing regional scale, three-dimensional air quality models that simulate emissions and their chemical transformations as well as the transport of criteria pollutants and fine particulate matter (PM).

Daily county emissions were used to quantify stationary area sources. Month-specific data for non-road and on-road mobile sources as well as average daily point source emissions were available. Relevant inventory species were CO, NO_x, VOC, SO_2, SO_4, NH_3, PM_{10} and $PM_{2.5}$. All emissions are presented in terms of tons per day per county, except for the point sources where emissions were provided by the location.

3.2 Emissions Processing

The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system was used to process the WRAP emissions inventory into the formatted emission files required by the Models-3/CMAQ Air Quality Model. SMOKE supports area, mobile, and point source emission processing and also includes biogenic emissions modeling. SMOKE employs the Biogenic Emission Inventory System, version 2 (BEIS2) and version 3 (BEIS3 prototype). The emissions processing used in the present study includes the steps of chemical speciation, temporal allocation and spatial allocation. This means the conversion of pollutant data to chemical species needed for the air quality model, which involves converting spatial-source data from the county to the grid-cell based information and the processing of temporal data with an hourly temporal resolution in a format commensurate with the air quality model.

For the source type specific temporal allocation, WRAP-based temporal profiles and cross-reference profiles for the different source types were applied. The chemical speciation of the inventory species was done according to the Carbon Bond 4 photochemical mechanism leading to thirteen Models-3/CMAQ species – CO, NO, NO2, NR, ALD2, ISOP, TOL, XYL, TERPB, OLE, FORM, ETH, PAR.

The spatial allocation of the mobile and area source emissions to the grid cells of the modeling domain is based on the spatial distribution of the so-called "gridding

surrogate data." This is a dataset developed using the data corresponding to a resolution finer than those used to spatially allocate county emissions to the grid cells. U.S. EPA's 4 km Spatial Surrogate Data set (http://www.epa.gov/ttn/chief/emch/spatial/) covering the entire US was processed using techniques based on Geographical Information System (GIS) technology. The result is a spatial surrogate data file, which contains the fraction of the county surrogate data in each grid cell of the Models-3/CMAQ modeling domain. The surrogates considered are: agricultural and forest areas, airports, land area, housing, major highways, population, railroads, water area, urban and rural areas, urban primary and secondary roads, rural primary and secondary roads as well as urban and rural population. Each emission source type is spatially allocated with a particular type of surrogate data.

The SMOKE model was applied for the periods encompassing the two episodes June 4-7, 2002 and July 10-13, 2002. In addition to the temporal allocation, the hourly plume rise was calculated for the point source emissions based on meteorological data provided by MM5 meteorological model simulations. The emission data of individual sources were merged into gridded hourly emissions. The total daily anthropogenic NO_x and VOC emissions for July 12, 2002 for a part of the modeling domain are shown in Figure 3-2.

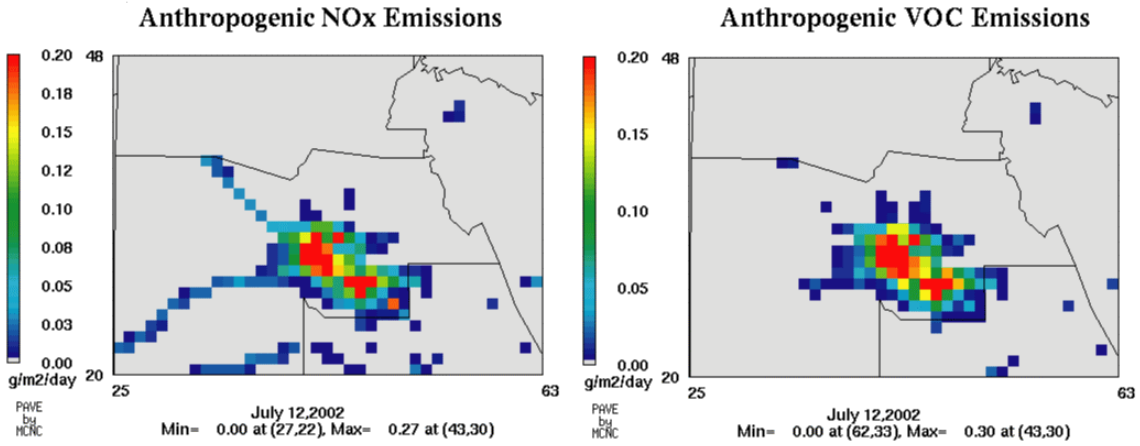

Figure 3-2. Anthropogenic NO_x and VOC emissions for July 12, 2002 as processed by SMOKE based on the WRAP base-case 1996 scenario emissions inventory.

3.3 Biogenic Emissions Modeling

The biogenic emissions were modeled by using SMOKE, which includes a version of the Biogenic Emissions Inventory System 2 (BEIS2) that estimates volatile organic compound (VOC) emissions from vegetation and nitric oxide (NO) emissions from soils. Apart from the land use data, the biogenic emissions depend on the meteorological conditions, in particular the air temperature, incoming solar radiation, wind speed and humidity. Those atmospheric variables were provided for each grid cell

of the modeling domain by the MM5 simulation results. Biogenic emission modeling was carried out for both ozone episodes (Figure 3-3).

Gridded vegetation land use data were prepared using USEPA's Biogenic Emissions Landcover Database (BELD3) that covers the United States, Canada and Mexico with a 1 km x 1 km grid resolution (ftp://ftp.epa.gov/amd/asmd/beld3). Two hundred and thirty land use types are considered in this database. ASU's GIS laboratory helped determine the fraction of each land use type encapsulated in each grid cell of the modeling domain with a 6 km x 6 km spatial resolution.

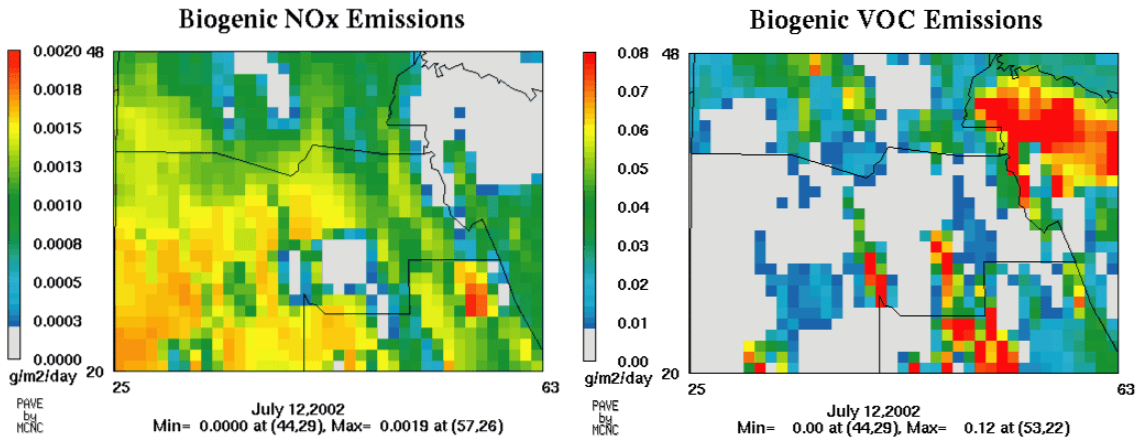

Figure 3-3. Biogenic NO_x and VOC emissions for July 12, 2002 as modeled by SMOKE.

The air-quality model ready inventory data were prepared by merging anthropogenic and biogenic emissions. On-road and off-road mobile sources were the major contributors to the emissions for carbon monoxide, nitrogen oxides and volatile compounds. In order to achieve a higher accuracy for the emissions inventory for the 6 km x 6 km modeling domain, the emissions data of the grid cells, which are in spatial alignment with the extent of the 1999 MAG Ozone Maintenance Plan emissions inventory, were replaced with data from the latter inventory. Those were compiled from their original 2 km x 2 km spatial resolution to 6 km x 6 km grid cells. This procedure is expected to improve the WRAP-derived 1996 inventory for the major source area via incorporating 1999 emissions data.

4. Meteorology Modeling

4.1 Numerical Configuration

The Penn State/NCAR Mesoscale Model, MM5, was employed to provide spatial and temporal distribution of meteorological fields to the air quality model (Models-3/CMAQ). MM5 has been applied to a broad range of studies, including land-sea breeze, mountain-valley circulation, frontogenesis and real-time weather forecasting. The MM5 simulation was performed with 4 nested domains, with respective grid resolutions of 54

km, 18 km, 6 km, and 2 km. The innermost domain spans 224 km x 122 km in E-W and N-S direction, respectively, encompassing the Phoenix valley and surrounding mountains. The 6 km x 6 km grid covers a region 600 km x 420 km in E-W and N-S directions, which is centered at the Phoenix valley. Vertically, 27 layers were used with approximately 10 m agl as the lowest computational layer. The NCEP (National Center for Environmental Prediction) *Eta* model output (Grid 212 with 40 km spacing) was used to provide initial and boundary values for the MM5 simulations and the data assimilation was performed using NWS (National Weather Service) soundings and surface measurements. A period of 67 hours was simulated for each episode: the first 19 hours were considered as the spin-up period, followed by 48 hours of prediction, which included the 24-hour ozone episodes in point and 12 hours of buffer periods fore and aft of the episode.

4.2 Results of Meteorology Simulations

Given that near surface winds are critical for dispersion of pollutants, the analysis was mainly focused on the flow fields. As expected, local thermally driven wind circulation within the valley – up-slope (westerly) flow during day and down-slope (easterly) wind during night – was well simulated by the model. Available wind measurements from ADEQ routine monitoring stations and vertical wind profiles from a Radar Wind Profiler located at the Vehicle Emissions Testing Laboratory site were used to evaluate the model results. Qualitatively, both near surface and upper level winds showed reasonable agreement with the observations. The model performance was evaluated quantitatively using standard statistical tools based on variables such as relative mean bias, mean difference, index of agreement, and RMS vector error. The relative mean bias indicates the fractional difference between the predicted and measured mean to the average of the two. The mean difference is a mean of the difference between the predictions and measurements, whereas the RMS vector error is the RMS of the difference between prediction and measurement of each vector component. The index of agreement and RMSE are measures of the accuracy and error between the predictions and the data; for an ideal model, the former is unity while the latter being zero. Generally, the values of the statistical variables were within the acceptable limits articulated in previous studies: e.g. Pielke and Pearce (1994), Sivacoumar and Thanasekaran (2001), Hanna and Yang (2001), and Lee et al. (2003). These statistical measures are presented in Table 1.

Table 1. MM5 performance measures for surface wind speed and direction for June 6th and July 12th, 2002 cases

	June WS	WD	July WS	WD
Mean of Obs	2.2	192.4	2.4	171.0
STD of Obs	0.9	83.1	1.3	93.8
Mean	2.1	180.3	2.1	146.6
STD of Obs	1.4	109.5	1.2	123.6
Relative Mean Bias	0.0	0.1	0.1	0.2
Mean Difference	0.1	12.1	0.3	24.3
Index of Agreement	0.5	0.9	0.4	0.8
RMSE	1.5	71.5	1.7	92.7
RMS Vector Error	2.3		3.3	

5 Ozone Modeling

5.1 Numerical Set Up

The Eulerian photochemical model, Models-3/CMAQ (Community Multiscale Air Quality) system, developed by the USEPA was employed to simulate ozone concentrations in the valley and its surrounding areas. Two nested CMAQ domains were used, which are identical to the innermost two domains of MM5, except that several lateral boundary cells were excluded. Observations from ADEQ routine monitoring stations and special measurements during the Phoenix '98 field experiment (i.e. ozone and nitrogen oxides taken by the DOE's G-1 research aircraft as well as hydrocarbon concentrations) were used as initial and lateral boundary values for the outer domain. In order to ameliorate the uncertainty associated with specifying initial conditions, 19 hours of spin-up time was introduced. The selection of a sufficiently large outer domain allowed the typical distances traveled by pollutants by thermal circulation to be smaller than the domain size, thus reducing uncertainties associated with lateral boundary values. The results obtained for the outer domain were used as the initial and boundary values for the inner domain.

5.1 Simulation results.

The monitoring stations were grouped into three categories of West, Central, and Northeast according to their geographic location. Hillside and Palo Verde belong to the West and Pinnacle Peak, Rio Verde, Fountain Hills, Blue Point Bridge, Tonto National Monument, Queen Valley and Humboldt Mountain were classified as the Northeast. The Central category contains Central, South and North Phoenix, Glendale, Maryvale, Surprise, Supersite, South Scottsdale, Tempe, Mesa and Cave Creek. Note that, of the monitoring stations listed above, the Hillside and Tonto National Monument are located outside the inner modeling domain. Therefore, predictions from the outer domain were compared with the observations from those stations while inner domain results were used for the rest of the stations.

Generally, predicted daytime maximum ozone concentration showed fairly good agreement with the observations, while nocturnal ozone concentration showed a deviation from the observations. The nocturnal period, however, is beyond the scope of the present study, which is mainly focused on maximum 8-hour ozone occurring during the daytime.

For the June 6th case, daytime elevated ozone concentration was well captured by the model, except an over-prediction for the western part of the valley (Figs. 5-1,2,3). The elevated ozone in the west of the valley was found to be due to a delay in transition from the nighttime to daytime flows. MM5 simulated persistent southeasterly winds when observation showed a shift from southeasterly to southerly during 1000 – 1200 LST. This prolonged easterly wind transported more ozone and its precursors to the west than in reality. The difficulty of predicting transition is a bane of meteorological models, and the said anomaly points to the necessity of developing accurate parameterizations for transition.

For the July 12th case, the predicted daytime maximum ozone concentrations showed a good agreement with the observations in the west and the central area. The maximum ozone concentration at the Humboldt Mountain was, however, underpredicted (Figs. 5-4,5,6).

When averaged over the 8-hour period (Fig 5-7), the central part of Maricopa county was simulated to be higher than 90 ppb, and its adjacent areas also were found to have elevated ozone > 85 ppb for the June 6th case. The elevated ozone concentration over most of the domain was possibly contributed by the meteorological conditions that were characterized by light wind, clear sky, and deep thermal convection. Conversely, for the July 12th case, the elevated 8-hour ozone was mainly predicted in the vicinity of the Phoenix valley, which was due to limited transport resulting from moist convective cells and thunderstorm activities that were prevalent during that day.

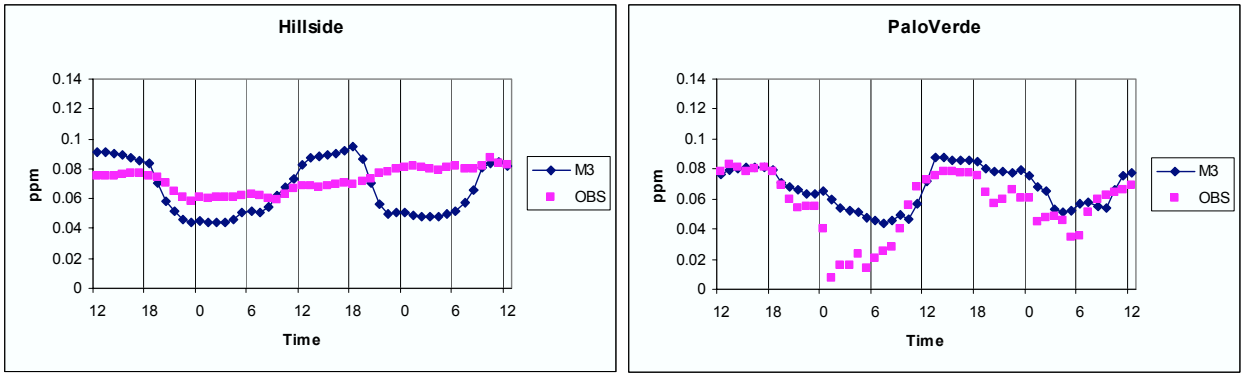

Fig. 5-1. Time series of observed and simulated hourly ozone concentration at stations belong to the 'West' category for the June 6th case.

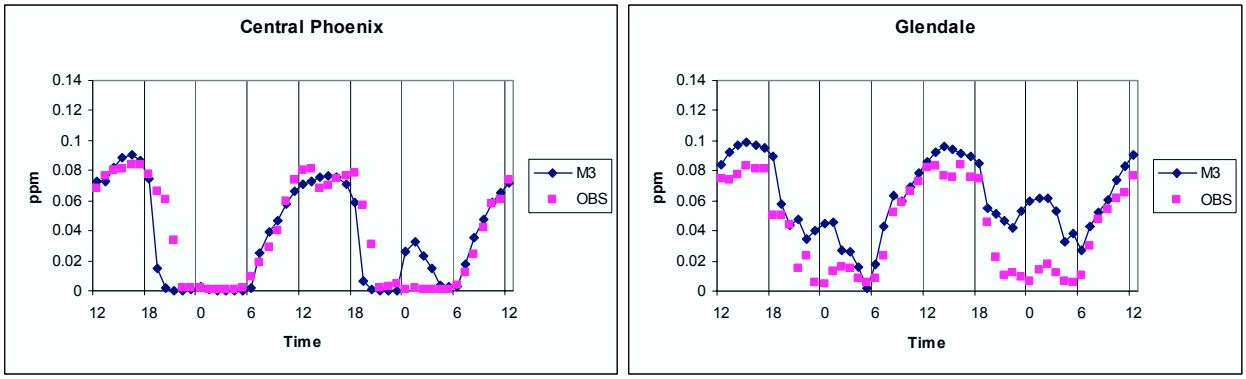

Fig. 5-2. Same as Fig. 5-1, except for the 'Central' category.

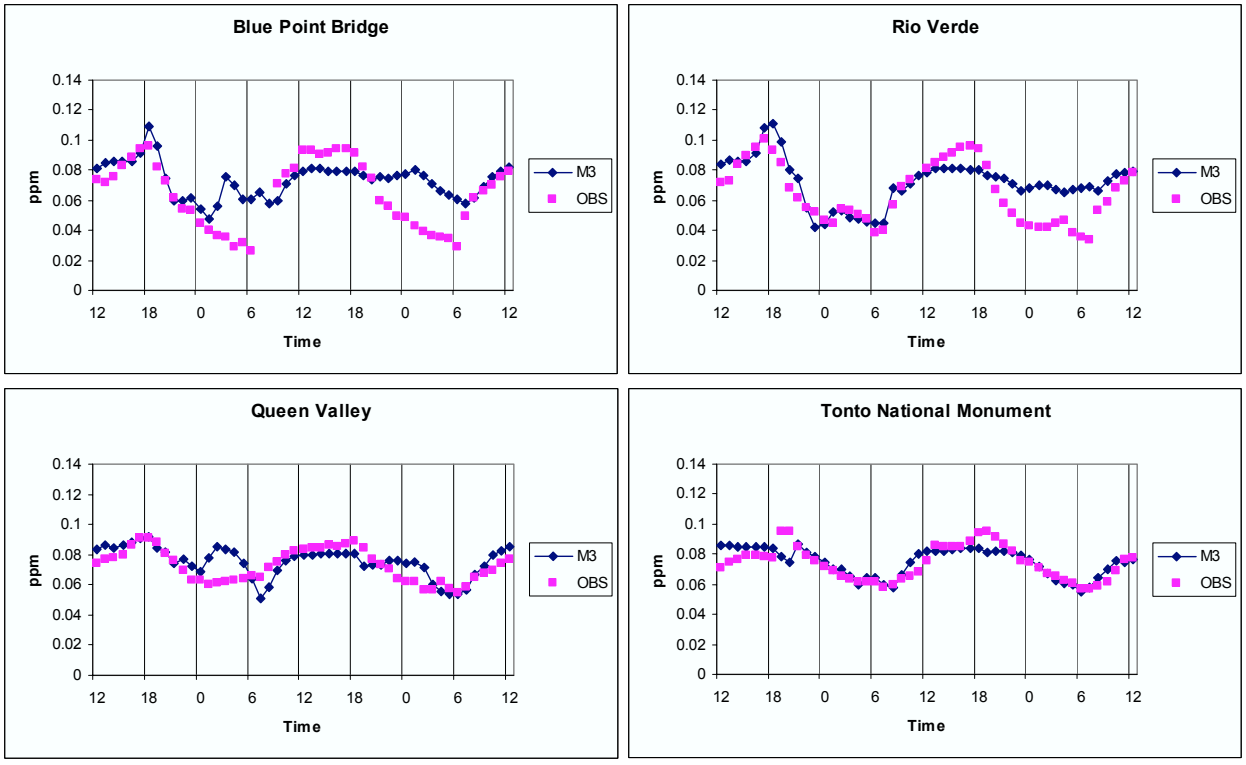

Fig. 5-3. Same as Fig. 5-1 except for the 'Northeast' category.

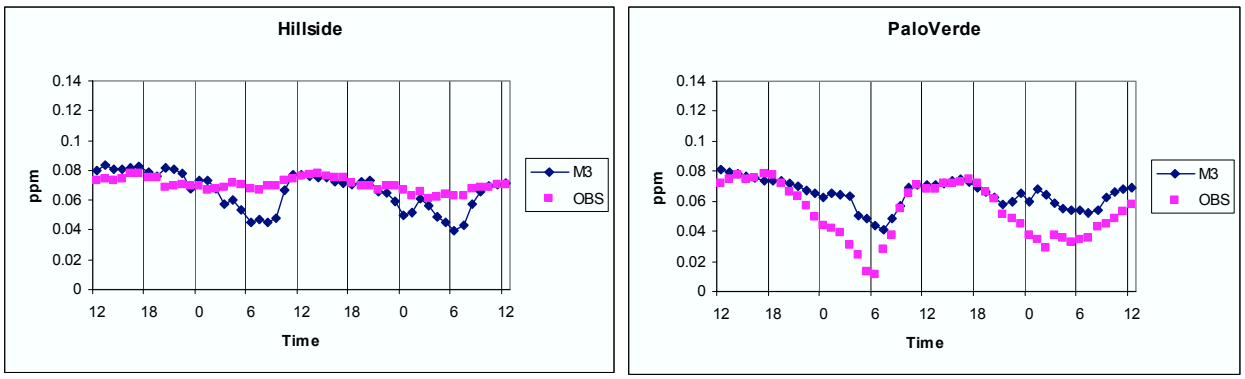

Fig. 5-4. Same as Fig. 5-1, except for the July 12th case.

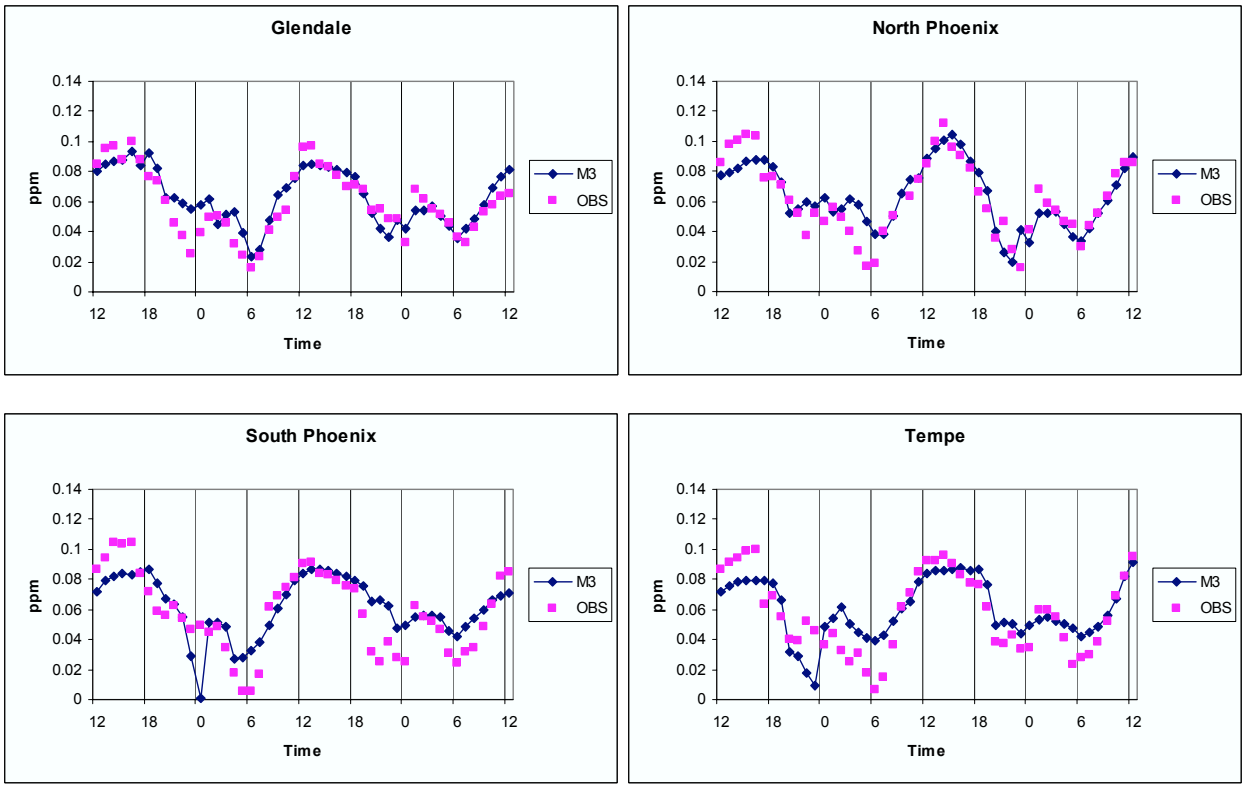

Fig. 5-5. Same as Fig. 5-4, except for the 'Central' category.

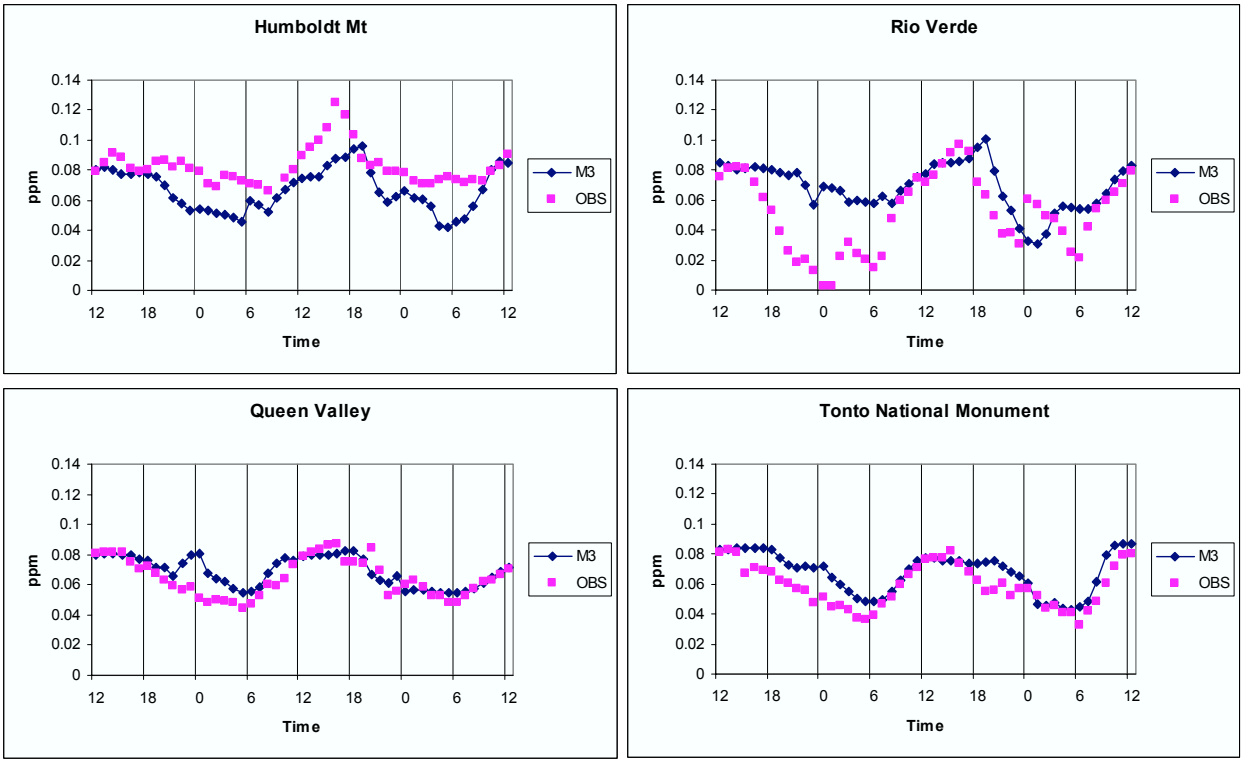

Fig. 5-6. Same as Fig. 5-4, except for the 'Northeast' category.

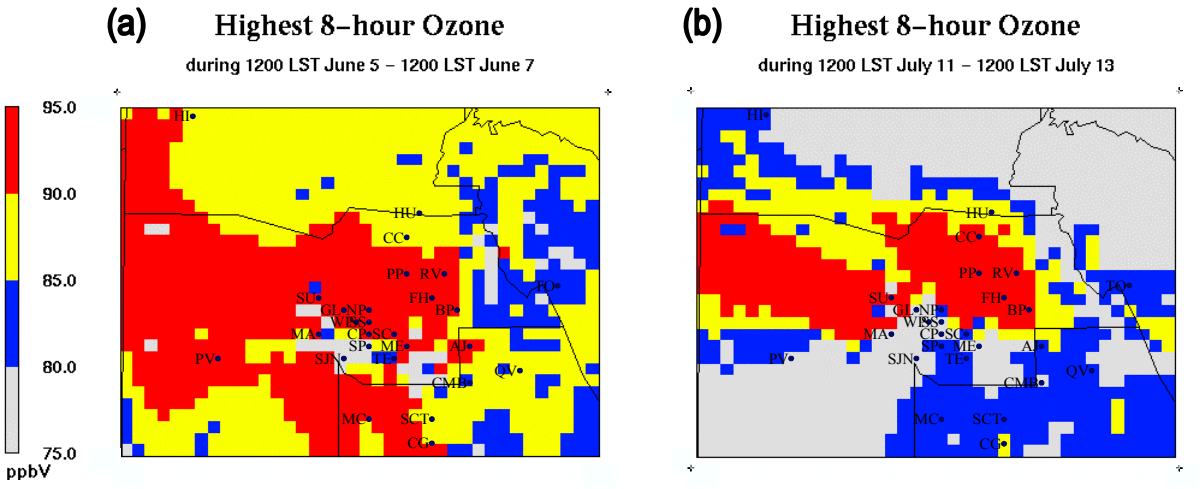

Fig. 5-7. The highest 8-hour averaged ozone concentration during a 48-hour period. (a) June 6th, and (b) July 12th case.

6 Summary

Two design days of elevated 8-hour ozone concentration were simulated by CMAQ, MM5, and SMOKE modeling systems. Two modeling domains were employed: the inner domain is identical to the 1999 MAG Ozone Maintenance Plan emissions domain and the outer domain spans 534 km x 354 km in E-W and N-S direction and is centered on the Phoenix valley. The mesoscale meteorological model MM5 was employed to provide meteorological fields to the CMAQ simulation. Emission inventories for CMAQ are the 1999 MAG Ozone Maintenance Plan and the SMOKE output based on the 1996 WRAP inventory, respectively, for the inner and the outer domains. For each episode, the CMAQ simulation was executed for 69 hours, and the output was analyzed for 48 hours, which encompassed the day of interest and 12 hours ahead and behind of the day.

In general, CMAQ-simulated 1-hour ozone concentration showed a good agreement with the observations for both episodes. For the June 6th case, however, due to the prolonged morning southeasterly flow (or delayed transition) predicted by MM5, CMAQ overpredicted the ozone concentrations in the northwestern part of the valley, and slightly underpredicted those in the northeastern part where the Blue Point Bridge, Rio Verde, Fountain Hill, Humboldt Mountain sites are located. When averaged over an 8-hour period, depending on the meteorological conditions, the central part of the Maricopa County and its immediate surroundings were simulated to have 8-hour ozone concentrations higher than 85 ppb.

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APPENDIX 9

Summaries of WRAP 1996 and MAG's 1999 Emissions Inventories

Appendix 9: Summary of Emissions Data Development for July 12, 2002 SMOKE Modeling Run

Emissions modeling for the greater Phoenix area was conducted by Arizona State University for ozone episode days June 6, 2002, and July 12, 2002. The air quality modeling domain for the VOC and NOx simulations was approximately 350 miles wide in the east-west (New Mexico to Colorado River) and 200 km in the north-south (Flagstaff to Nogales) directions, with metropolitan Phoenix in the center. This area included all of Maricopa, Pima, and Pinal Counties. A modeling domain of this size ensures that emissions and air quality in areas near greater Phoenix, the area of greatest interest, are accounted for in the analysis; as source and receptor areas are included and boundary conditions characterized.

The modeling domain was then divided into two - an inner 2 km grid resolution domain and an outer domain with a grid resolution of 6 km in which the inner domain was nested. The emissions inventory for the outer domain, which covers almost the entire State of Arizona, was based on the inventory data of the Western Regional Air Partnership (WRAP) base case scenario 1996 Emissions Inventory. Previously, issues regarding this inventory were identified by the Arizona Regional Haze SIP Emission Inventory Work Group, another stakeholder group assisting ADEQ. The Work Group submitted a letter to WRAP with suggested improvements to the emissions inventory (see Attachment 1). However, time constraints necessitated that, for this 8-hour ozone analysis, the available WRAP inventory be used.

For the inner modeling domain the emissions inventory for the MAG 1-hour ozone maintenance plan was used. (see Attachment 2).

Monthly and weekday adjustments were applied to anthropogenic emissions estimates for the two ozone episodes, and emissions were processed for typical weekdays in June and July.

In addition, biogenic emissions were modeled for the June and July 2002 episodes. The biogenic emissions modeling for the inner modeling domain, covering the Phoenix Metropolitan area was carried out by MAG. The biogenic emissions modeling for the outer domain was based on land cover data obtained from EPA's BELD3.0 km resolution database (ftp://ftp.epa.gov/amd/asmd/beld3/ascii/). The BELD3.0 land cover database has been developed for use with regional and urban air quality simulation models. Its immediate application is to provide spatial and vegetation species resolution for the Biogenic Emissions Inventory System (BEIS). The BELD3.0 land cover data are relatively current, and include 232 different plant species. BELD3.0 has been assembled from three major land cover databases:

(1) The USGS North America Land Cover Characteristics Data Base with a 1-km nominal spatial resolution is based on 1-km AVHRR satellite data spanning April

1992 through March 1993. In addition, a core set of derived thematic maps produced through the aggregation of seasonal land cover regions are included. Information on this database can be found in http://edcwww.cr.usgs.gov/landdaac/glcc/na_int.html.

(2) The US Forest Service's Forest Inventory Analysis (FIA) data set.

(3) The US Department of Agriculture crop acreage statistics at the county level for 1992.

As can be expected, relatively high VOC emissions were simulated for areas with agricultural land use as well as in areas where a significant fraction of desert trees such as mesquite and acacia (usually found in riparian areas and high desert) or, for the higher elevations, juniper, oak and pine trees. Low desert areas were not characterized by an abundance of desert trees and, therefore, low VOC emissions were estimated. Emissions estimates for higher elevation areas, where chaparral, pinion-juniper woodland and pine forest occur, were significantly higher than for the desert areas.

Attachment 1

Review of 1996 WRAP Emissions Inventory For Use in Arizona's Regional Haze State Implementation Plan

Emissions Inventory Workgroup

November 25, 2002

EXECUTIVE SUMMARY

The Emissions Inventory Work Group (EIWG) reviewed the 1996 Western Regional Air Partnership's (WRAP) Emissions Inventory (EI) for use in Arizona's Regional Haze SIPs submitted after Year 2003. The majority of the review was based on comparisons between the WRAP EI and local emissions inventories developed by Maricopa County, Maricopa Association of Governments, Pima County, Pima Association of Governments, and Pinal County. Following is a summary of the EIWG's review and recommendations to ADEQ for working with WRAP to enhance WRAP emission source categories:

1. **Onroad Emissions** - The vehicle miles traveled (VMT) data in the 1996 WRAP EI were larger than the VMT data in local emissions inventories and did not match the seasonal allocation of VMT. The EIWG suggests that local VMT data be used for developing the mobile onroad emissions for Arizona Regional Haze SIPs submitted after Year 2003, with particular attention to allocating VMT by season, because Arizona does not follow the national pattern for maximum VMT occurring during the summer season.

2. **Nonroad Emissions** - Generally, the nonroad emissions data in the 1996 WRAP EI were higher than the nonroad emissions data in local emissions inventories. Since the temporal pattern of nonroad equipment activity in Arizona can be quite different from the national average, the EIWG recommends that local Arizona nonroad emissions data be used in the Arizona Regional Haze SIPs submitted after Year 2003.

3. **Point Sources** - Emissions data for point sources, greater than 100 tons per year, in the 1996 WRAP EI were larger than the emissions data for Maricopa County, and much larger than the point source emissions data in Pima County and Pinal County emissions inventories (e.g., as much as an order of magnitude for PM10 emissions from point sources in Pima County). In July 2002, both Maricopa and Pima Counties submitted corrected point source emissions data to WRAP's contractor. The EIWG recommends that emissions data from the state, local governments, and tribal entities be used instead of national surrogates for Arizona Regional Haze SIPs submitted after Year 2003. The EIWG also recommends that a decision be made whether fugitive dust emissions should be included as part of the point source inventory for Arizona Regional Haze SIPs submitted after Year 2003.

4. **Area Sources** - Emissions data for area sources in the 1996 WRAP EI were in relatively good agreement with the emissions data in Maricopa County (except for certain subcategories such as NOx from stationary source fuel combustion, which were grossly overestimated), but were not in good agreement with the emissions data for area sources in Pima County. The EIWG suggests that area source emissions in the WRAP EI be reviewed for accuracy before these data are used in Arizona Regional Haze SIPs submitted after Year 2003.

5. **Forest Fires** - The WRAP EI and the Arizona Smoke Management Program may use different emission factors (but use the same activity data) to estimate emissions from forest fires. The EIWG suggests that forest fire emissions from the WRAP EI be compared to the Arizona Smoke Management Program's and for WRAP to lobby USEPA to use the most current emission factors for estimating emissions from forest fires (currently WRAP is using AP-42 emission factors).

6. **Agricultural / Rangeland Burning** - Emissions data on agricultural / rangeland burning are planned to be included in the WRAP's Year 2018 Fire EI. The EIWG suggests that the WRAP's emissions estimates for this category be used, since little data are collected on agricultural / rangeland burning in Arizona. In the future, a statewide tracking system for the location, size, fuel type, fuel loading, and time of burning would greatly benefit the understanding of the contribution of this emission source to regional haze.

7. **Biogenics** - The WRAP biogenic emission estimates for Maricopa County are much smaller than those calculated by the Maricopa Association of Governments (MAG) estimates. The EIWG plans to investigate this discrepancy further after receiving biogenic emissions data grouped by counties from the WRAP Modeling Center at the University of California - Riverside.

8. **Wind Erosion** - This emission category is scheduled to be added to the WRAP EI after completion of a WRAP research contract. Estimating emissions from wind erosion entails accounting for a number of factors including local variations in soil type, wind patterns, precipitation patterns, vegetation growth, and topography. Due to the inherent complexity of developing wind erosion estimates for a region as large as Arizona, the EIWG suggests that the wind erosion data produced by the WRAP's contractor be used in Arizona Regional Haze SIPs submitted after Year 2003.

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ACRONYMS AND ABBREVIATIONS

ADEQ Arizona Department of Environmental Quality
ATR Automated Traffic Recorders
CO Carbon Monoxide
EI Emissions Inventory
EIWG Emissions Inventory Work Group
EPA United States Environmental Protection Agency
GCVTC Grand Canyon Visibility Transport Commission
GIS Geographic Information System
HPMS Highway Performance Monitoring System
MAG Maricopa Association of Governments
MCESD Maricopa County Environmental Services Division
NEI National Emissions Inventory
NH3 Ammonia
NOx Nitrogen Oxides
PAG Pima Association of Governments
PM10 Particulate Matter Less Than Or Equal To 10 Microns
PM2.5 Particulate Matter Less Than or Equal to 2.5 Microns
SIP State Implementation Plan
SO2 Sulfur Dioxide
U.S. United States
USEPA United States Environmental Protection Agency
VMT Vehicle Miles Traveled
VOC Volatile Organic Compounds
WRAP Western Regional Air Partnership

BACKGROUND

Federal Mandate

As part of the Clean Air Act Amendments in 1977, Congress set a national goal of remedying existing visibility impairment, and preventing future impairment, from manmade pollution at the 156 national parks and wilderness areas across the United States (see Figure 1 for map of Arizona Class I Areas). Section 169 A was added to the Clean Air Act to address visibility impairment from existing stationary sources operating in and near national parks or wilderness areas. In this case, the visibility impairment could be found directly associated with or caused by the stationary source (i.e., reasonably attributable). Section 169B was added to address visibility impairment due to regional haze. Regional haze is defined as, "visibility impairment that is caused by the emission of air pollutants from numerous sources located over a wide geographic area. Such sources include, but are not limited to, major and minor stationary sources, mobile sources, and area sources." (40 CFR § 51.301). The Regional Haze Rule, adopted July 1, 1999, requires states to develop programs to assure reasonable progress toward meeting the national visibility goal. The way in which states develop and implement programs to address air pollution is through a state implementation plan (SIP) [1].

History - ADEQ

The state of Arizona has been actively involved in visibility and regional haze issues, beginning with the Grand Canyon Visibility Transport Commission (GCVTC) and continuing with the Western Regional Air Partnership (WRAP), the successor organization to the GCVTC. Each Arizona work group has a designated person to monitor the WRAP process and report items of interest and concern to the relevant group. The WRAP forums are expected to produce many work products that will be available for Arizona's consideration as it develops its Regional Haze SIP.

Beginning in August 2001, ADEQ launched Phase 1 of a stakeholder process to determine which schedule to follow in its development of a Regional Haze SIP. The federal Regional Haze Rule provides two choices for states and Indian tribes in the nine state GCVTC region. States submitting SIPs in 2003 will be implementing GCVTC recommendations per 40 CFR § 51.309 ("309 SIP"). States submitting SIPs in the 2004-2008 time frame will be focusing on a broader range of sources and programs, per 40 CFR § 51.308 ("308 SIP").

The stakeholder process that began in August 2001 ended in early November 2001 with a consensus that ADEQ pursue the option to submit a SIP by December 31, 2003, in accordance with 40 CFR § 51.309. The stakeholders further agreed that the SIP should include the eight Arizona mandatory Federal Class I areas outside of the GCVTC region in addition to the four GCVTC region Class I areas [1].

ARIZONA CLASS I AREAS

ALL CLASS I AREAS

- Federal Class I Areas
- GCVTC Class I Areas
- State Boundaries
- Major Freeways
- Major Cities

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Disclaimer Information:
This map is a (WORKING DOCUMENT), it is designed for presentation and discussion and is subject to change and further refinement.

July 2000

Author: [illegible]

Role of Emissions Inventory Workgroup

The Emissions Inventory Work Group is responsible for the review and recommendation of emission baseline and projections used in the SIP analysis. Specific responsibility areas include:

- Develop and review emission inventory work products, as needed.
- Review WRAP emission inventories/projections.
- Consult with long-term strategy work groups to identify data gaps, and review projections of the effect of long-term strategies on emissions.
- Develop updates for emission inventories/projections to be forwarded to the WRAP Regional Modeling Center [1].

WRAP Emissions Inventory

The 1996 WRAP emissions inventory (EI) includes four separate inventories for point sources, mobile sources, area sources, and fire by county for the thirteen states that are WRAP members. ADEQ and some counties in Arizona supplied point source emission estimates to the WRAP point source EI. The mobile source emissions were compiled by the WRAP Mobile Sources Forum using EPA's MOBILE6 and NONROAD emissions models for onroad and offroad sources. Arizona area source emissions in the WRAP EI were based on estimates from the 1996 National Emissions Inventory and did not include geogenic wind blown dust from undisturbed natural soils. Fire emissions were compiled by the WRAP Fire Emissions Joint Forum [2].

DISCUSSION

The Emissions Inventory Workgroup (EIWG) has met four times: June 19, 2002; July 17, 2002; August 14, 2002, and September 16, 2002. During these meetings, EIWG members reviewed the Arizona portion of the WRAP EI, discussed the methodology used to develop the WRAP EI and how to utilize the WRAP EI in Arizona Regional Haze SIPs submitted after Year 2003 (e.g., 309G / 308 SIPs), and suggested enhancements to the WRAP EI for making Year 2018 forecasts. The following sections summarize the EIWG members' review of the methodology and emissions data for the 1996 WRAP EI source categories.

Mobile Sources

Onroad Emissions - Maricopa County

Based on very limited model-compatible data, the WRAP EI's onroad CO emission rates for 1996 are comparable to MAG estimates for 1994 (Table 1). The WRAP EI does overstate 1996 Maricopa County VMT by about 8% in the winter (CO), 13% on an average annual day (PM-10), and 25% in the summer (VOC, NOx). In addition, WRAP summer season VMT in 1996 (from onroad spreadsheet) is 13% higher than winter VMT. This is opposite to MAG's VMT data that shows higher VMT in the winter than in the summer.

Table 1 – Maricopa County Vehicle Miles Traveled	
1996 WRAP Onroad Inventory	71,538,442 mi/day
1996 MCESD Onroad Inventory	51,329,514 mi/day
Difference	20,208,928 mi/day
% Difference	-28.2%

Both emissions inventories did use the MOBILE6 emissions model. The higher WRAP VMT estimates in the summer would explain some, but not all, of the higher VOC and NOx emissions listed for Maricopa County in the WRAP EI.

Onroad Emissions - Pima County

For Pima County, the local VMT value used for the Pima Association of Government's (PAG) 2003 Transportation Improvement Program (TIP) is 10.93% lower than the Year 2003 VMT (average over 4 seasons) used for the WRAP EI. It is also important to note that the Year 2003 VMT used for the TIP only applies to eastern Pima County, which is the transportation planning area. The results are displayed in Table 2.

Table 2 – Pima County Vehicle Miles Traveled	
2003 WRAP Onroad Inventory	21,760,515 mi/day
2003 TIP	19,382,125 mi/day
Difference	2,378,390 mi/day
% Difference	-10.93%

The WRAP average annual daily VMT for Pima County (1996) is 19.4% higher than the Highway Performance Monitoring System (HPMS) average annual daily VMT for Pima County (1996). A discrepancy also exists with the seasonal VMT allocation in the WRAP EI for Pima County. The highest VMT for the WRAP Onroad EI was applied to the summer season. However, the summer season in Pima County typically yields the lowest VMT, with the spring season having the highest VMT. Table 3 lists the onroad emissions in the WRAP EI and the PAG EI.

Table 3 – Pima County Onroad Emissions (tons per day)			
	VOC	**NOx**	**CO**
2003 WRAP EI	57.8	53.6	517.7
2003 PAG Onroad Mobile	37.3	55.9	370.7
% Difference	-35.5%	+4.3%	-28.4%

Nonroad Emissions - Maricopa County
1996 Maricopa County periodic inventories are lower than the WRAP EI for VOC (-43%) and NOx (-84%), and slightly higher (+21%), for CO (Table 4). Note that the periodic inventories were developed for a smaller CO/Ozone Nonattainment Area of about 2,000 square miles versus Maricopa County, which is 9,200 square miles in area, which was used for the WRAP EI. The EPA NONROAD model used by WRAP is known to overstate nonroad activity levels. It is understood that a new and improved NONROAD model will be used by WRAP in the future. This should reduce some, if not all, of the disparity between WRAP's and Maricopa County's estimates of VOC and NOx emissions.

Table 4 – Maricopa County Nonroad Emissions (tons per day)				
	VOC	**NOx**	**CO (winter)**	**PM10**
1996 WRAP EI	115.4	196.7	375.1	13.8
1996 MCESD EI	66.3	32.0	452.4	NA
%Difference	-42.5%	-83.7%	+20.6%	NA

Nonroad Emissions - Pima County
PAG developed a nonroad mobile source inventory for the Year 2000. The PAG EI nonroad mobile emission estimates were compared with the Year 1996 nonroad mobile emissions estimates (tons/day) for the WRAP EI and are listed in Table 5.

Table 5 – Pima County Nonroad Emissions (tons per day)						
	VOC	**NOx**	**CO**	**PM10**	**PM2.5**	**SO2**
1996 WRAP EI	19.30	35.30	220.89	3.82	3.57	6.74
2000 PAG EI	16.53	20.75	198.90	2.56	2.35	4.90
%Difference	-14.4%	-41.2%	-10.0%	-33.0%	-34.2%	-27.3%

Note that the area included in the PAG nonroad EI was the Tucson Air Planning Area (TAPA), which includes the bulk of the population within eastern Pima County (~96.5%), while the estimate for the WRAP EI includes all of Pima County.

Point Sources
Maricopa County
The accuracy of the data on large point sources (>100 TPY) in the ***revised*** WRAP EI appears to be in generally good agreement with Maricopa County's EI (Maricopa County submitted updated point source emissions data to WRAP contractors to revise

the WRAP EI). Table 6 compares Maricopa County's emissions with the emissions in the ***original*** WRAP EI. The emissions data that Maricopa County submitted to WRAP in 2001 contained all point sources included in the 1999 periodic emissions inventory for Maricopa County, with some sources having annual emissions as small as ten tons per year. Since the WRAP point source data only includes those sources greater than 100 tons per year, Maricopa County submitted a revised set of point source data to WRAP contractors in July 2002.

Table 6 – Comparison of Maricopa County and Original WRAP Point Source Emissions (tons per year)

	VOC	NO_X	CO
WRAP Maricopa County 1996 EI Base Case	5,866	3,319	736
Maricopa County 1996 EI	1,489	2,536	266
% Difference between local and original WRAP/NEI data	-75%	-24%	-64%
Difference between local and original WRAP/NEI data in Tons	-4,377	-783	-469

Pinal County

There appear to be large discrepancies between the WRAP EI and Pinal County's data on point source emissions. Tables 7 lists the results of comparing the Pinal County's point source emissions with the WRAP EI.

Table 7 – Comparison of Pinal County and Original WRAP Point Source Emissions (tons per year)

	VOC	NO_X	CO	SO2	PM10	PM2.5	NH3
WRAP Pinal County 1996 EI Base Case	144	2,076	483	27,974	2,531	990	2
Pinal County 1996 EI	188	1,059	254	16,678	3,252	267	0.00
% Differences (Increases from using WRAP/NEI data)	*-23.4*	*+96*	*+90.2*	*+67.7*	*-22.2*	*+270.7*	*Na*
Differences (Increases from using WRAP/NEI data) in Tons	*-44*	*+1,017*	*+229*	*+11,296*	*-721*	*+723*	*+2*
Grand Total [Differences (Increases from using WRAP/NEI data) in tons]: +10,552							

Pima County

There also appear to be large discrepancies between the ***original*** WRAP EI and Pima County's data on point source emissions. Table 8 lists the results of comparing the Pima County's point source emissions with the original WRAP EI. In July 2002, Pima County also submitted corrected point source emissions data to WRAP contractors and the mentioned discrepancies in Pima County's point source emissions should have been corrected in the ***revised*** WRAP EI.

Table 8 – Comparison of 1995 Pima County and 1996 Original WRAP Point Source Emissions (tons per year)

	VOC	NO_X	CO	SO2	PM10	PM2.5	NH3
WRAP Pima County 1996 EI Base Case	358	9,312	4,827	8,338	11,236	6,308	4
Pima County 1995 EI	56	7,142	5,520	2,787	1,167 (5,116)	NA	NA
% Differences (Increases from using WRAP/NEI data)	*+539*	*+30.4*	*-12.5*	*+199*	*+862 (+119)**	*NA*	*NA*
Differences (Increases from using WRAP/NEI data) in Tons	*+302*	*+2170*	*-693*	*+5551*	*+10,069 (+6,120)**	*+6,308*	*+4*

Grand Total [Differences (Increases from using WRAP/NEI data) in Tons]: +13,995; (+10,046)*

* Totals with Fugitives

Five facilities in Pima County were identified as PM_{10} point sources that emitted more than 100 tons per year in 1996 based on Pima County and ADEQ permitted source records. These facilities and their associated PM_{10} emissions are listed in Table 9.

Table 9 – 1996 Pima County Point Sources (> 100 tons per year)

Permitted By	Facility Name	PM_{10} Total With Fugitives	PM_{10} Total Without Fugitives
ADEQ	Cypress Sierrita (now known as Phelps Dodge Sierrita)	2,633 tons	185 tons
ADEQ	Arizona Portland Cement	1,585 tons	84 tons
ADEQ	Tucson Electric Power	121 tons	121 tons
PDEQ	ASARCO	Unknown	650 tons

PDEQ	Silver Bell Mining L.L.C.	Unknown	127 tons
Total		**4,339**	**1,167**

As shown in Table 9, fugitive PM_{10} emissions can make a significant difference in the PM_{10} emission totals, especially with respect to sources such as mines. Thus, a determination needs to be made whether or not fugitive dust emissions should be included as part of the point source inventory that will be used in Arizona Regional Haze SIPs submitted after Year 2003. If it is determined that fugitive dust emissions should be included in the point source inventory, then this needs to be applied consistently among all of Arizona counties' emissions inventories.

In order to ensure more accurate point and area source emission inventory reporting for future WRAP EI's, the EIWG recommends that WRAP rely more on state/local/tribal entities for emissions data wherever possible, rather than using national surrogates. For example, there was little or no communication between WRAP's contractor and Pinal and Pima counties during the building of the 1996 WRAP EI base case. This resulted in some discrepancies in the emissions for these counties that could have been corrected with input from the counties.

Area Sources

The EIWG reviewed the WRAP EI at the county level, and selected several subcategories for comparison with locally developed emissions estimates.

Maricopa County

Four emissions subcategories, that had the potential for large discrepancies between WRAP and Maricopa County values, were investigated further:

- PM10: WRAP data for PM10 from industrial processes agree well with local 1995 estimates.

- VOC: WRAP estimates of VOC emissions from solvent use appear to be reasonably close to local numbers.

- NOx: WRAP emission values for NOx from stationary source fuel combustion are grossly overestimated for Maricopa County and presumably statewide.

- CO: WRAP data on emissions from waste disposal, treatment and recovery show nearly 9,000 tons of CO emissions from residential incineration in Maricopa County. However, there should be nearly no emissions from this source category because residential incineration is rare in Maricopa County.

Table 10 compares WRAP estimates of area source emissions in Maricopa County with values from the County's 1995 Periodic Emission Inventory.

Table 10 – Comparison of 1995 Maricopa County and 1996 WRAP Area Source Emissions (tons per year)			
	VOC	**NO_X**	**CO**
WRAP Maricopa County 1996 EI Base Case	64,712	36,797	22,470
Maricopa County 1995 EI	39,550	4,589	1,678
% Difference (Increases from using WRAP/NEI data)	-39%	-88%	-93%
Difference (Increases from using WRAP/NEI data) in Tons	-25,162	-32,207	-20,792

Pima County

Area source emission totals in the Pima County portion of the WRAP EI were compared with Pima County's emissions data. The difference in the seven emission categories ranged from a negative 24% to a plus 107%. Table 11 lists the total emissions and differences for area sources in Pima County.

Table 11 – Comparison of 1995 Pima County and 1996 WRAP Area Source Emissions (tons per year)							
	VOC	**NO_X**	**CO**	**SO2**	**PM10**	**PM2.5**	**NH3**
WRAP Pima County 1996 EI Base Case	19,627	4,185	8,435	400	7,294	2,697	1,503
Pima County 1996 EI	9,443	7,822	11,106	2,213	5,786	NA	NA
% Differences (Increases from using WRAP/NEI data)	*+107*	*-46.5*	*-24.1*	*-81.3*	*+26*	*NA*	*NA*
Differences (Increases from using WRAP/NEI data) in Tons	*+10,184*	*--3637*	*-2671*	*-1813*	*+1,508*	*+2,697*	*+1,503*
Grand Total (Difference / Increases from using WRAP/NEI data in tons): +12,029							

Forest Fire

The Arizona Smoke Management Program, conducted by the U.S. Forest Service in conjunction with ADEQ, makes daily decisions on which prescribed fires should be approved based on weather conditions, fuel loading, location of fires, size of fires, and other fires in an air basin. The Arizona Smoke Management Program also tracks wildfire activity in Arizona. Annually, there are approximately 100 days when prescribed burning can take place in Arizona. The decision to approve a prescribed burn must balance both the need to promote forest health and the negative effects of fire on air quality. In the future, the number of prescribed fires will likely increase, while the number of wildfires will probably remain constant. The WRAP EI uses the activity data collected by the Arizona Smoke Management Program. The WRAP EI may use different emission factors than the ones use by Arizona Smoke Management Program; therefore, the EIWG suggests that forest fire emissions from the WRAP EI be compared to the Arizona Smoke Management Program's and for WRAP to lobby USEPA to use the most current emission factors for estimating emissions from forest fires (WRAP is currently using AP-42 emission factors).

Agricultural / Rangeland Burning

Agricultural burning was not included in the 1996 WRAP Fire EI, but it is planned to be included in the 2018 Fire Emissions Inventory. Currently, there are little specific data collected on agricultural / rangeland burning by WRAP, by counties, or the state of Arizona. (See appendix for overview of recommendations for improving collection of activity data for agricultural burning emissions).

Biogenics

Maricopa County

A comparison of the WRAP estimates of biogenic VOC and NOx emissions with those developed as part of the Maricopa County ozone nonattainment area inventory for 1996 shows that WRAP EI estimates are much smaller (30 to 70 times) than the county-derived estimates. The WRAP modeling center in Riverside, California has been requested to prepare biogenic emissions, by county in Arizona, to facilitate further investigation of these large discrepancies.

Pima County

In 1998, PAG contracted with the University of Arizona to develop a biogenic emissions inventory for roughly the eastern half of Pima County. This inventory indicated that 50% of the total VOCs for this study area are emitted by biogenic sources. In contrast, for the Tucson metropolitan study area (developed urban and suburban area without surrounding elevated regions), 6% of the total VOCs are emitted by biogenic sources. Pima County biogenic emissions will be compared to the WRAP's biogenic emissions when these data are received from the WRAP Modeling Center.

Ammonia
The ammonia emission factors used for the WRAP EI are lower than those used to develop the 1994 Maricopa County PM10 inventory. Only livestock emissions could be compared, since Maricopa County did not calculate ammonia emissions from crops. The difference in the two sets of livestock emissions is proportional to the difference in emission factors, thus the activity numbers used in the WRAP EI and the 1994 Maricopa County PM10 Inventory are in good agreement.

Power Plants
The EIWG assumed that power plant emissions in the WRAP EI would be fairly accurate because these data are based on the acid rain reports submitted to U.S. agencies.

Wind Erosion
Emissions from wind erosion were not included in the 1996 WRAP EI. However, WRAP recently submitted a Request for Proposal for a contractor to add this emissions category to the WRAP EI.

CONCLUSIONS

The WRAP is to be commended for developing a comprehensive emissions inventory for the western states. The Arizona portion of the WRAP EI will be an integral part of Arizona Regional Haze SIPs submitted after Year 2003. Following are the EIWG's review and recommendations for enhancing certain emission source categories in the WRAP EI for use in Arizona Regional Haze SIPs submitted after Year 2003.

Onroad Emissions

WRAP's VMT in Maricopa County overstates Maricopa County's VMT with the discrepancy being largest for the summer season (e.g., 8% more in winter and 25% more in summer). Pima County's VMT may be also overstated (11%), and as with Maricopa County's VMT, the WRAP seasonal allocation does not agree with Pima County's data. The EIWG suggests that local VMT data be used for developing the mobile onroad emissions for Arizona Regional Haze SIPs submitted after Year 2003 with particular attention to allocating VMT by season, because Arizona does not follow the national pattern for high VMT occurring during the summer season.

Nonroad Emissions

The WRAP used an updated NONROAD model for developing their nonroad emissions. However, a new NONROAD model, to be released soon by EPA, shows significantly lower nonroad activity levels. The technical support document being developed by ENVIRON will shed more light on the differences in assumptions and models that produced the WRAP EI estimates. However, since the temporal pattern of nonroad equipment activity in Arizona can be quite different from the national average, the EIWG recommends that local Arizona nonroad emissions data be used in the Arizona Regional Haze SIPs submitted after Year 2003.

Point Sources

Emissions data for point sources, greater than 100 tons per year, in the 1996 WRAP EI were larger than the emissions data for Maricopa County, and much larger than the point source emissions data in Pima County and Pinal County emissions inventories (e.g., as much as an order of magnitude for PM10 emissions from point sources in Pima County). In July 2002, both Maricopa and Pima Counties submitted corrected point source emissions data to WRAP's contractor.

In order to ensure more accurate point and area source emission inventory reporting for future WRAP EIs, the EIWG suggests that emissions data from the state, local governments, and tribal entities be used, instead of national surrogates, for Arizona Regional Haze SIPs submitted after Year 2003. The EIWG also recommends that a decision be made whether fugitive dust emissions should be included as part of the point source inventory for Arizona Regional Haze SIPs submitted after Year 2003.

Area Sources
WRAP data for PM10 emissions from industrial processes and VOC emissions from solvent use agree well with Maricopa County data. However, WRAP emission values for NOx from stationary source fuel combustion are grossly overestimated for Maricopa County and presumably statewide. WRAP data on area source emissions for Pima County were not in good agreement with Pima County's EI data. The EIWG suggests that area source emissions in the WRAP EI be reviewed for accuracy before these data are used in Arizona Regional Haze SIPs submitted after Year 2003.

Forest Fires
The WRAP EI and Arizona Smoke Management Program may use different emission factors (but same activity data) to estimate emissions from forest fires. The EIWG suggests that forest fire emissions from the WRAP EI be compared to the Arizona Smoke Management Program's and for WRAP to lobby USEPA to use the most current emission factors for estimating emissions from forest fires.

Agricultural / Rangeland Burning
Emissions data on agricultural / rangeland burning are planned to be included in the WRAP's Year 2018 Fire EI. The EIWG suggests that the WRAP' emissions estimates for this category be used, since there are little data collected on agricultural / rangeland burning in Arizona. In the future, a statewide tracking system for the location, size, fuel type and loading, and time of burning would greatly benefit the understanding of the contribution of this emission source to regional haze.

Biogenics
The WRAP biogenic emission estimates for Maricopa County are much smaller than Maricopa County's estimates. The EIWG plans to investigate this discrepancy further after receiving biogenic emissions data grouped by counties from the WRAP modeling center.

Ammonia
Ammonia emissions from livestock in the WRAP EI appear to be reasonable when compared to Maricopa County's ammonia emissions data.

Power Plants
The EIWG assumes that the power plant emissions in the WRAP EI are fairly accurate, because these data are based on the acid rain reports submitted to U.S. agencies.

Wind Erosion
This emission category is scheduled to be added to the WRAP EI after completion of a WRAP research contract. Estimating emissions from wind erosion will entail taking into account local variations in soil type, wind patterns, precipitation patterns, vegetation growth, and topography. Due to the inherent complexity of developing wind erosion estimates for a region as large as Arizona, the EIWG suggests that the wind erosion data

produced by WRAP's contractor be used in Arizona Regional Haze SIPs submitted after Year 2003.

REFERENCES

1. ADEQ Website (Regional Haze): http://www.adeq.state.az.us/environ/air/plan/haze.html

2. WRAP Website (Emissions Forum): http://www.wrapair.org/forums/ef/index.html

3. Eastern Research Group Inc. (ERG) and Enviro-Tech Communications, technical paper, dated February 15, 2002: "Non-Burning Management Alternatives on Agricultural Lands in the Western United States, Draft Final, Prepared for The Fire Emissions Joint Forum of the Western Regional Air Partnership."

APPENDIX

Maricopa County Onroad Mobile Source Data (MAG)
The following data and assumptions were used in developing MAG's onroad emission estimates:

- The 1996 average annual vehicle miles of travel (VMT) used by WRAP in developing onroad emissions is 13% higher than comparable 1996 MAG VMT estimates and 15% higher than the Highway Performance Monitoring System (HPMS).

    - VMT from 1996 MAG traffic assignment = 58.85 million/weekday in the transportation modeling area

    - Factor to expand from MAG modeling area to Maricopa County = 1.11
        - Maricopa County average weekday VMT = 58.85 x 1.11 = 65.32 million/day
        - Factor to convert from average weekday to average annual day (including weekends) = .91
        - 1996 Maricopa County average annual daily VMT = 65.32 x .91 = 59.44 million/day
        - 1996 HPMS average annual daily VMT for Maricopa County reported to the Federal Highway Administration = 58.66 million/day
        - 1996 WRAP average annual daily VMT (from ENVIRON onroad spreadsheet) for Maricopa County = 67.26 million/day

- Seasonal variations in VMT used by WRAP are not consistent with traffic counts in Maricopa County.
    - WRAP summer season VMT in 1996 (from onroad spreadsheet) is 13% higher than winter VMT.
    - The WRAP 1996 seasonal VMT estimates are 7.5% higher than the automatic traffic recorder-based estimates in winter and 25.3% higher in summer.
    - Automated traffic recorders (ATR) in Maricopa County indicate winter season traffic is consistently higher than summer traffic.
    - Based on ATR data, the 1996 VMT in the winter was 59.04 million/day and in the summer was 57.08 million/day.

- The conclusions for Maricopa County onroad and nonroad emissions are derived from analyses of spreadsheets obtained from ENVIRON in July 2002.

Pima County Onroad Mobile Source Data (PAG)

PAG calculated the Year 2003 onroad emissions factors using the MOBILE6 emissions model with the following inputs:

- Low altitude only
- Averaging summer and winter
- Average freeway speed = 44.8 mph
- Arterial speed = 35.4 mph
- Local speed = 12.9 mph
- The MOBILE6 emission factors were then applied to the estimated VMT for each roadway type (provided by PAG-Transportation Planning Division).

Average Annual Daily VMT for Pima County

- 1996 HPMS average annual daily VMT for Pima County = 15.71 million/day
- 1996 WRAP average annual daily VMT for Pima County = 18.75 million/day, an increase of +19.4% over the HPMS data.

Seasonal VMT Allocations - Tucson Permanent Traffic Count Recorders

- March daily VMT is generally 7% higher than average daily VMT
- July daily VMT is generally 5% less than average daily VMT

Improving the Estimation of Emissions from Agricultural Burning

- As stated in the draft report, Non-Burning Management Alternatives in Agricultural Lands in the Western U.S. [3]: "...obtaining agricultural burning data presented a significant challenge... Documented agricultural burning activity data exist for only a portion of the 15-state domain, although agricultural burning is known to occur in nearly every state". Accordingly, all 15 western states should consider having mandatory organized smoke management programs that track agricultural burning activities.

- Require all sources which obtain agricultural open burn permits to expand reporting parameters to include acres burned, duration of burn, exact location, (example: section/township/range) fuel loading specifications, and crop species to permitting agencies. This should be accomplished by amending current open burn permit regulations throughout the western region.

- Capture agricultural burn permit parametric information in a regional database with a common/ consistent computerized format that can be easily utilized by various governmental agencies.

- Display agricultural burning data utilizing a geographic information system (GIS). The goal is to illustrate the level of open burning in acres and to show, county by county, burning locations and type of residue burned.

- Every state, local and tribal entity should implement a single agricultural burning reporting standard for continuity and consistency of parametric data.

- Periodic agricultural burn site visits (i.e., random checks) should be conducted by governmental personnel to verify the accuracy and completeness of burning information provided by sources.

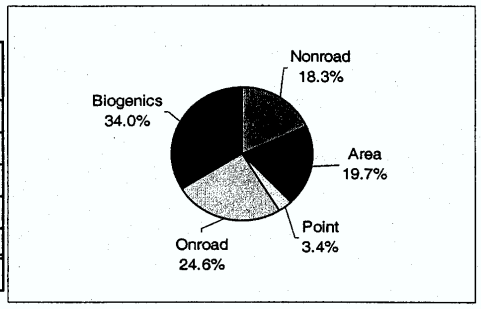
- Resolve, or at least note differences, in permitted agricultural burn restrictions between counties or other localities. For example, Pima County and Maricopa County no longer allow the burning of agricultural fields as part of their counties' open burning programs, whereas Pinal County continues to allow burning of agricultural fields. Pima County and Maricopa County do allow burning of ditch banks.

- Establish a statewide agricultural burning program for tracking agricultural burning for location, size, fuel type and loading, and time of burning. To take it a step further, this program could be used as a control measure by making daily approval / disapproval of agricultural burning similar to the Arizona Smoke Management Program for prescribed forest fires. Currently, ADEQ's statewide open burn permits are issued in advance for one year and only have restrictions on the time of day and season to conduct the agricultural burning. No data are collected on size, fuel type and loading, and time of burning as part of ADEQ's open burn permits.

TABLE 2: Summary of Volatile Organic Compound (VOC) Emissions for the Maricopa County One-Hour Ozone Modeling Area

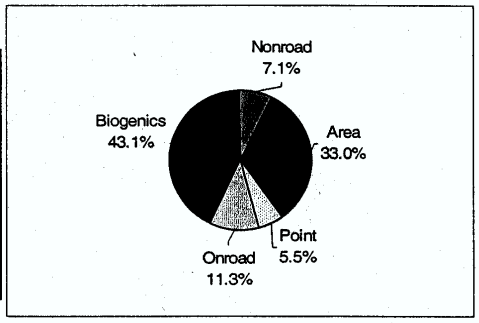
1999

Source Category	VOC (mt/day)	Percent of Total
Nonroad	83.4	18.3%
Area	89.6	19.7%
Point	15.6	3.4%
Onroad	112.1	24.6%
Biogenics	155.1	34.0%
Total	455.8	100%



2015

Source Category	VOC (mt/day)	Percent of Total
Nonroad	31.5	7.1%
Area	145.4	33.0%
Point	24.3	5.5%
Onroad	50.1	11.3%
Biogenics	190.2	43.1%
Total	441.5	100%

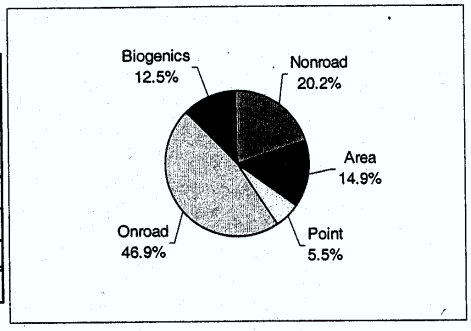


Source: Preliminary modeling for the MAG One-Hour Ozone Maintenance Plan, based on the July 17, 1999 episode.

TABLE 3: Summary of Nitrogen Oxide (NOx) Emissions for the Maricopa County One-Hour Ozone Modeling Area

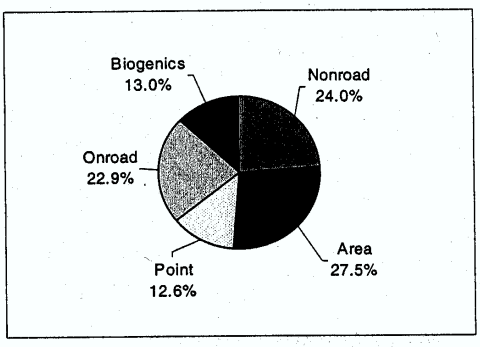
1999

Source Category	NOx (mt/day)	Percent of Total
Nonroad	61.5	20.2%
Area	45.3	14.9%
Point	16.7	5.5%
Onroad	143.1	46.9%
Biogenics	38.2	12.5%
Total	304.8	100%



2015

Source Category	NOx (mt/day)	Percent of Total
Nonroad	63.9	24.0%
Area	73.2	27.5%
Point	33.4	12.6%
Onroad	60.8	22.9%
Biogenics	34.7	13.0%
Total	266.0	100%



Source: Preliminary modeling for the MAG One-Hour Ozone Maintenance Plan, based on the July 17, 1999 episode.

APPENDIX 10

Presentation from May 21, 2003, Stakeholder Meeting on Socioeconomic Information

Description of Maps

Overview

The Arizona Department of Environmental Quality has requested that the ASU GIS Lab provide spatially allocated demographic information as available for 2000 and 2018.

The following maps include depictions of:

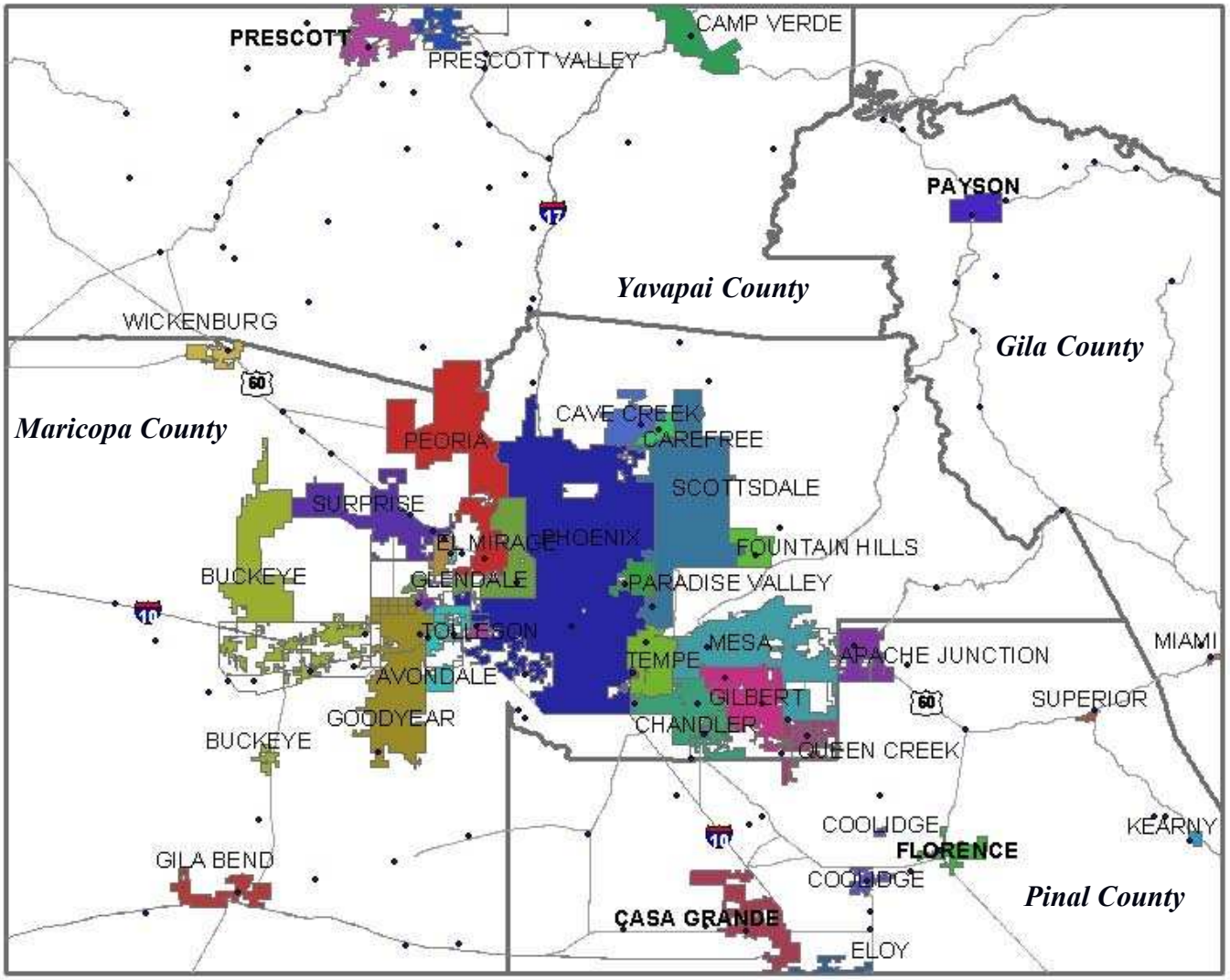
- Change in population Density from 2000-2018
- Commercial Land use (current)
- Employment Centers (current)
- Traffic Volume Projections
- Future Land use

Study Area Map

The following map shows the study area which includes portions of Maricopa, Yavapai, Pinal, and Gila Counties.

Incorporated cities on this map are shown as color-coded polygons, while non-incorporated towns are shown as points.

Incorporated Cities and Towns (shown as points)

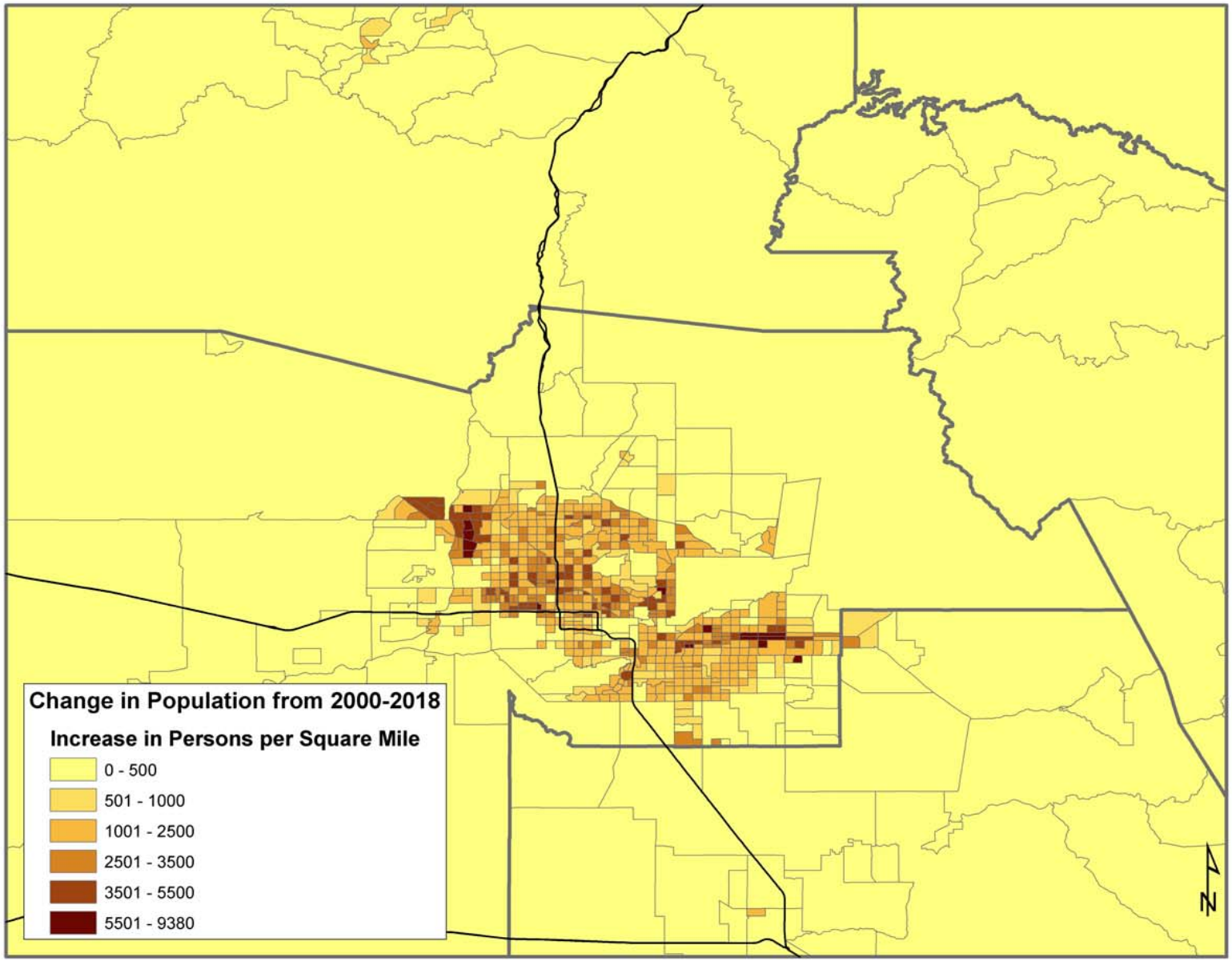


Population Growth

The following map shows change in persons per square mile from 2000-2018. The calculations for population projection are based on the description for projections provided by the Arizona Department of Economic Security.

Population density is mapped by here by 2000 Census Tract delineation.

When looking at population density, it is important to keep in mind that the size of the tract influences density in such a way that smaller tracts may depict data in a way that is more spatially accurate than larger tracts.


Change in Population from 2000-2018
Increase in Persons per Square Mile
0 - 500
501 - 1000
1001 - 2500
2501 - 3500
3501 - 5500
5501 - 9380
N

Commercial Land Use

The following map depicts the Percent Commercial area per Square Mile.

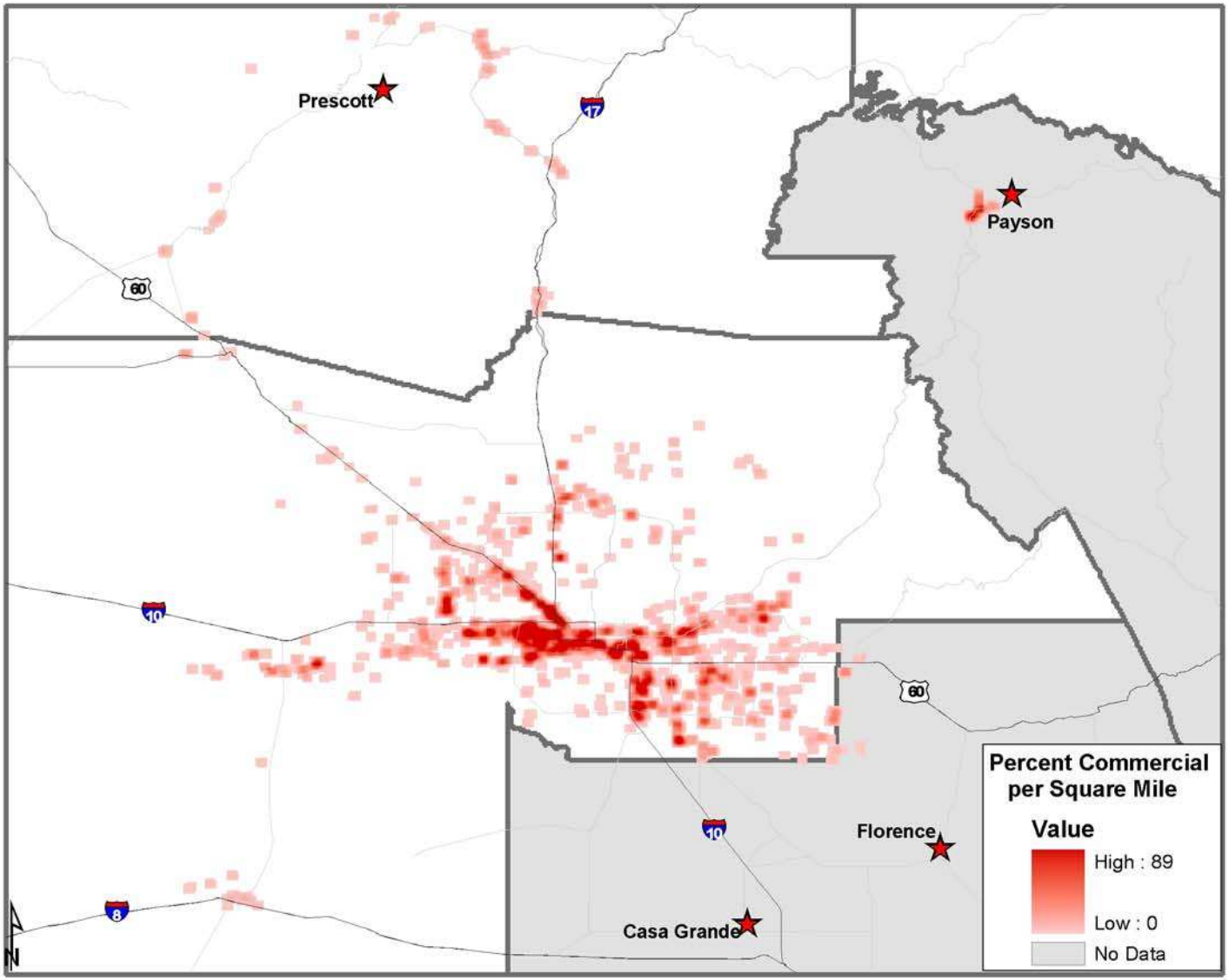
For Maricopa County – Commercial land use calculations are based on a photo-interpreted Land Use cover and includes Specialty, Neighborhood, and Community categories.

For Yavapai County – Commercial Land Use calculations are based on zoning and includes categories:

C1 DISTRICT - (Commercial; Neighborhood Sales and Services)
C2 DISTRICT - (Commercial; General Sales and Services)
C3 DISTRICT - (Commercial and Minor Industrial)

For Pinal County – Zoning to show Commercial Land Use is not available in digital format.

For Payson – Commercial Land Use calculations are based on zoning.


Prescott
17
Payson
60
10
60
Florence
10
Casa Grande
8
N
Percent Commercial per Square Mile
Value
High : 89
Low : 0
No Data

Employment Centers

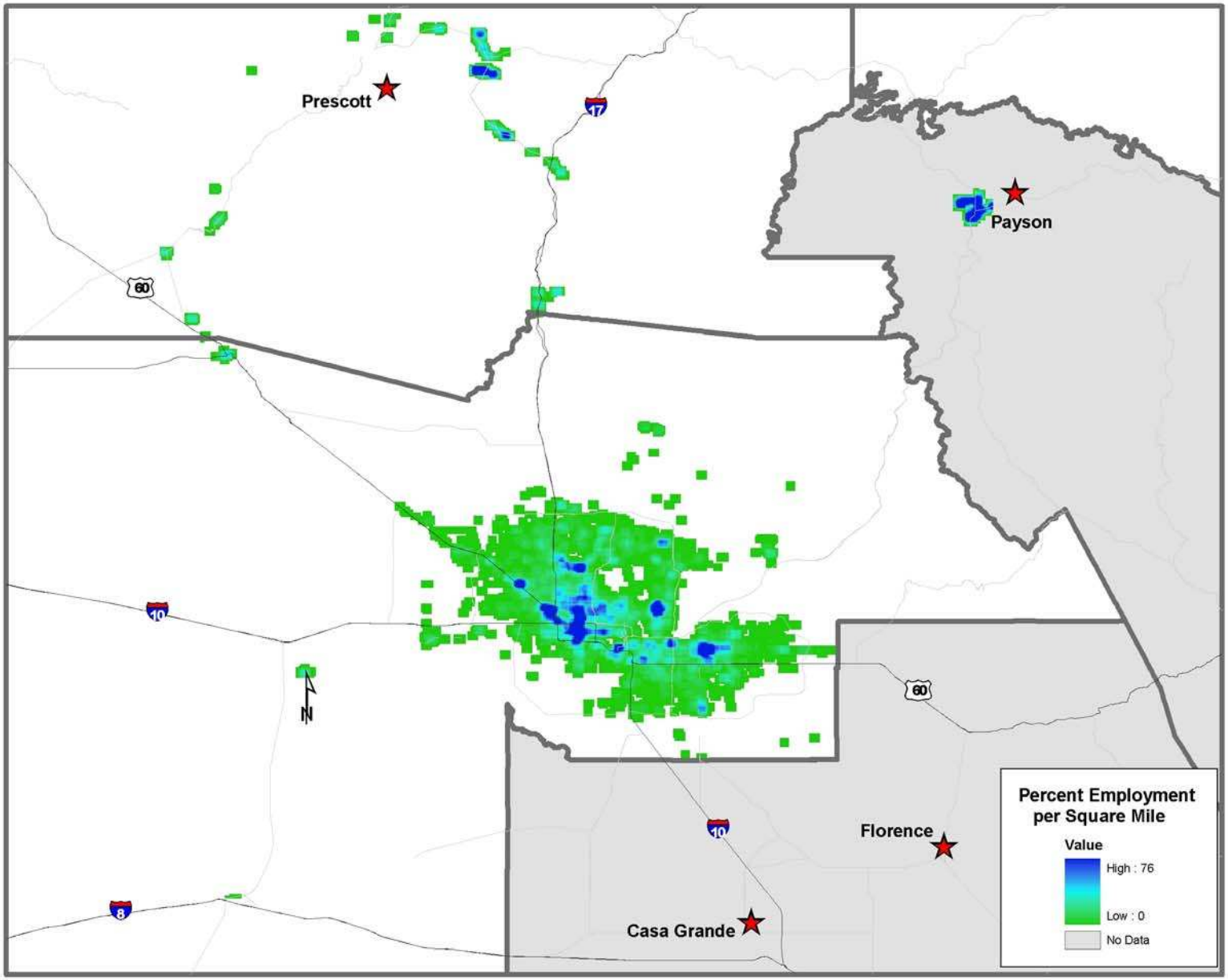
The following map depicts Percent Employment Centers per Square Mile.

For Maricopa County – Employment Center Percentages were calculated using employer point locations.

For Yavapai County – Employment Centers Percentages were calculated using Commercial and Industrial zoned areas.

For Pinal County – Employment Center information was not available in in digital format.

For Payson – Employment Centers Percentages were calculated from a general Land Use map on which "employment centers" were delineated.


Prescott
Payson
Florence
Casa Grande
17
60
10
8
N
Percent Employment per Square Mile
Value
High : 76
Low : 0
No Data

Traffic Volume Projections

The Arizona Department of Transportation as well as individual counties and COGS (Councils of Government) generate traffic volume projections.

The following maps show Annual Average Daily Traffic (**AADT**) Volume Projections created by

- ADOT – For Rural Arizona
- MAG – For Maricopa County
- Pinal County – For Pinal County

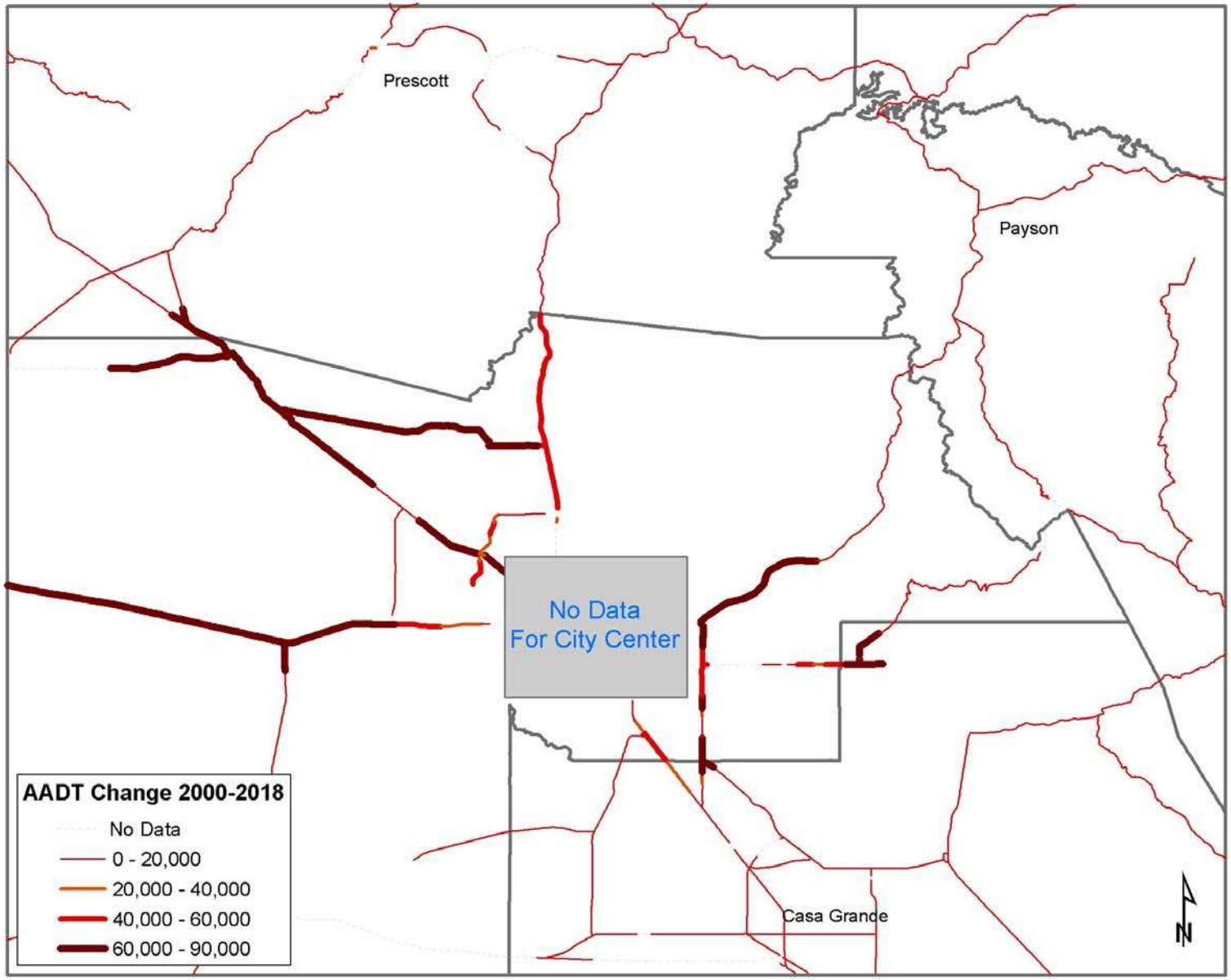
ADOT Traffic Projections

The scope of coverage of these data have three limitations...

1) They includes only those routes of the Arizona State Highway System (those on which ADOT has jurisdiction over),

2) forecasts are only available for rural, non-urbanized portions of those routes, and

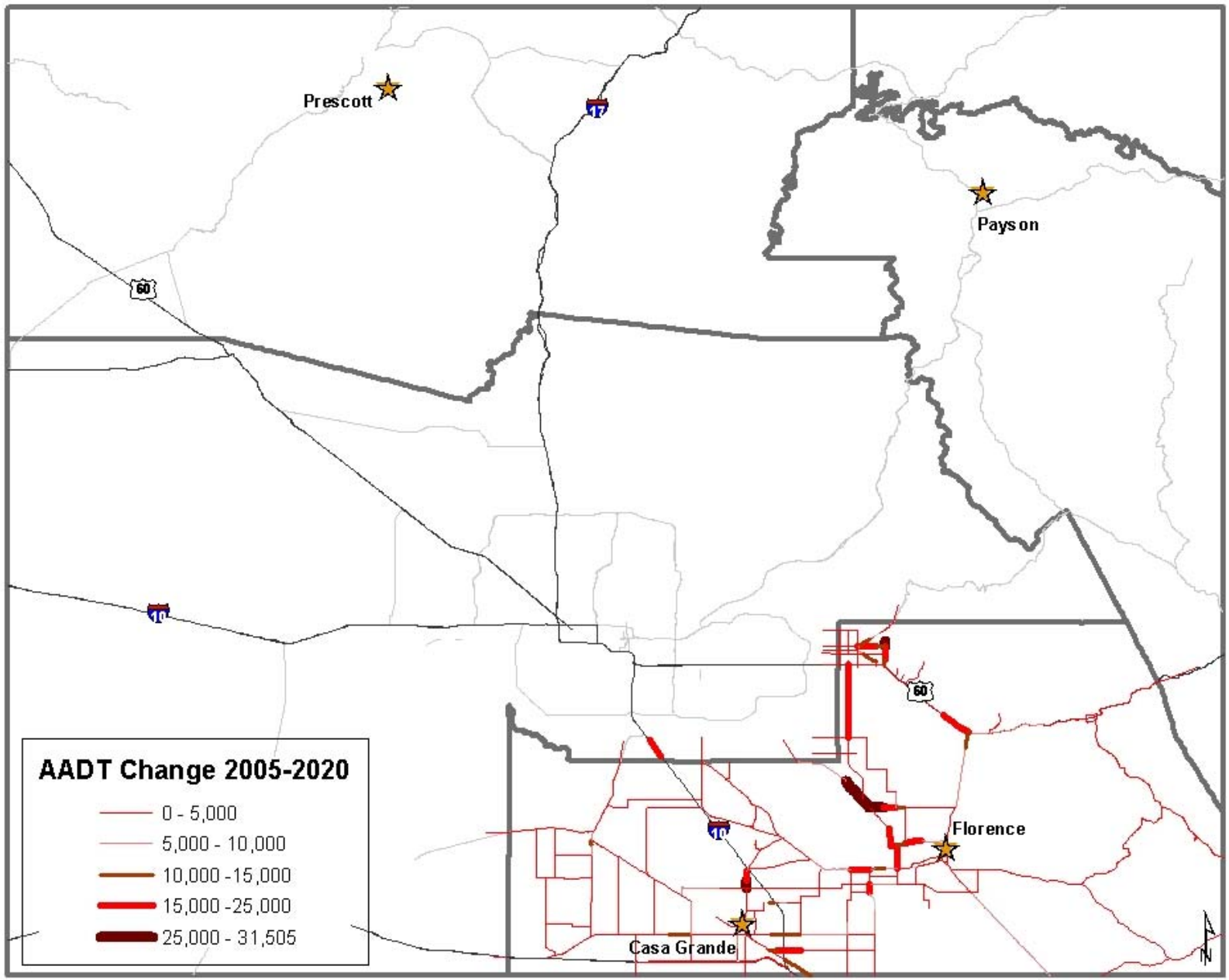
3) the forecasts only go out 20 years from the latest year ADOT has current volumes.


Prescott
Payson
No Data
For City Center
Casa Grande
AADT Change 2000-2018
No Data
0 - 20,000
20,000 - 40,000
40,000 - 60,000
60,000 - 90,000
N

Pinal County

The following map was calculated from data available from the Pinal County Transportation Plan 2000 Update.

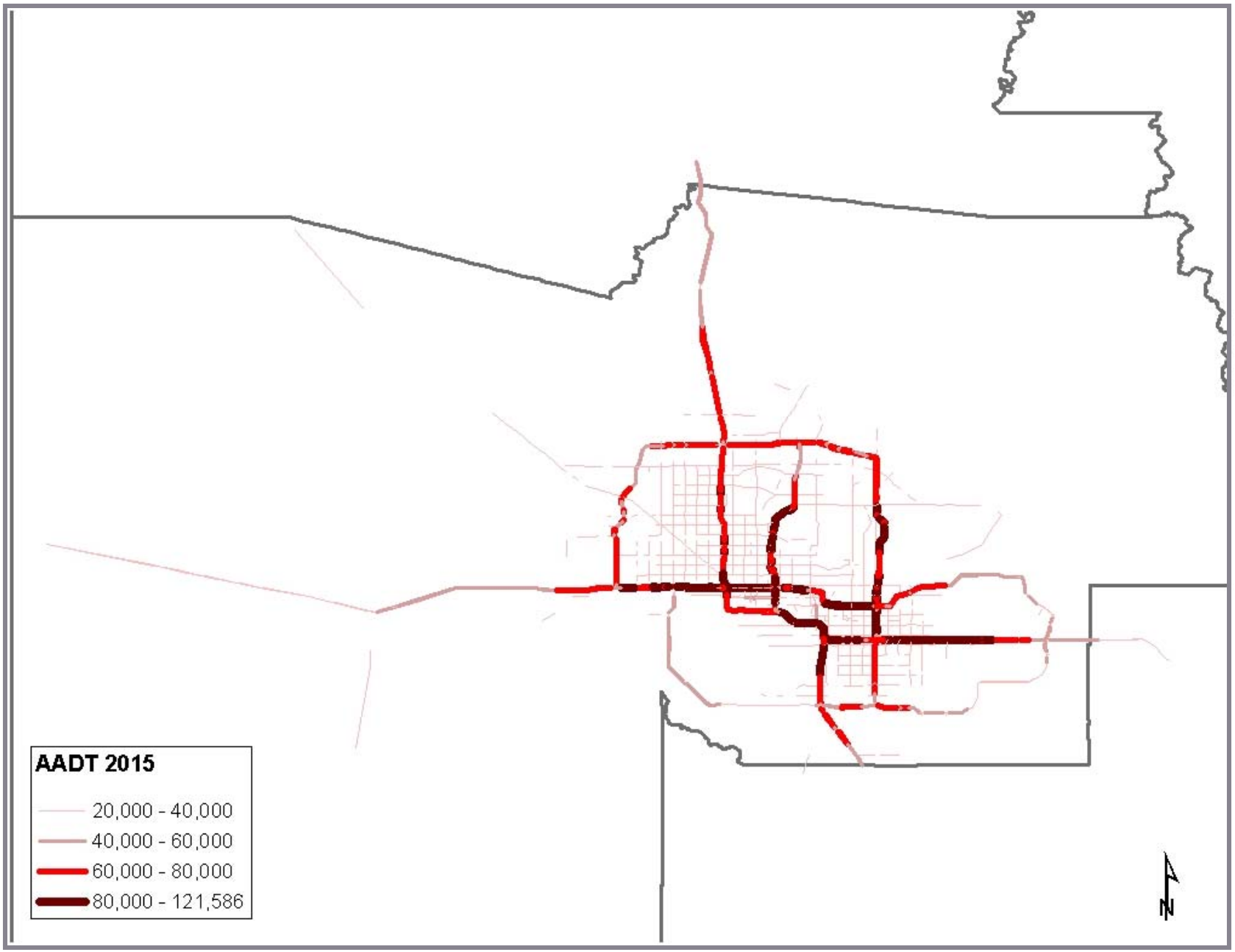
The map depicts change for Annual Average Daily Traffic Counts for Pinal County from 2005-2020.


Prescott
Payson
Florence
Casa Grande
AADT Change 2005-2020
0 - 5,000
5,000 - 10,000
10,000 -15,000
15,000 -25,000
25,000 - 31,505

MAG

The map depicted here is based on draft preliminary estimates of emissions and have not been used in any Air Quality Plan adopted by MAG. They are subject to change.

These traffic volume projections are for the year 2015 and are shown by Annual Average Daily Traffic Counts.


AADT 2015
20,000 - 40,000
40,000 - 60,000
60,000 - 80,000
80,000 - 121,586
N

Current and Future Residential Land Use*

The following maps depict where residential land use *will take place in the near future*.

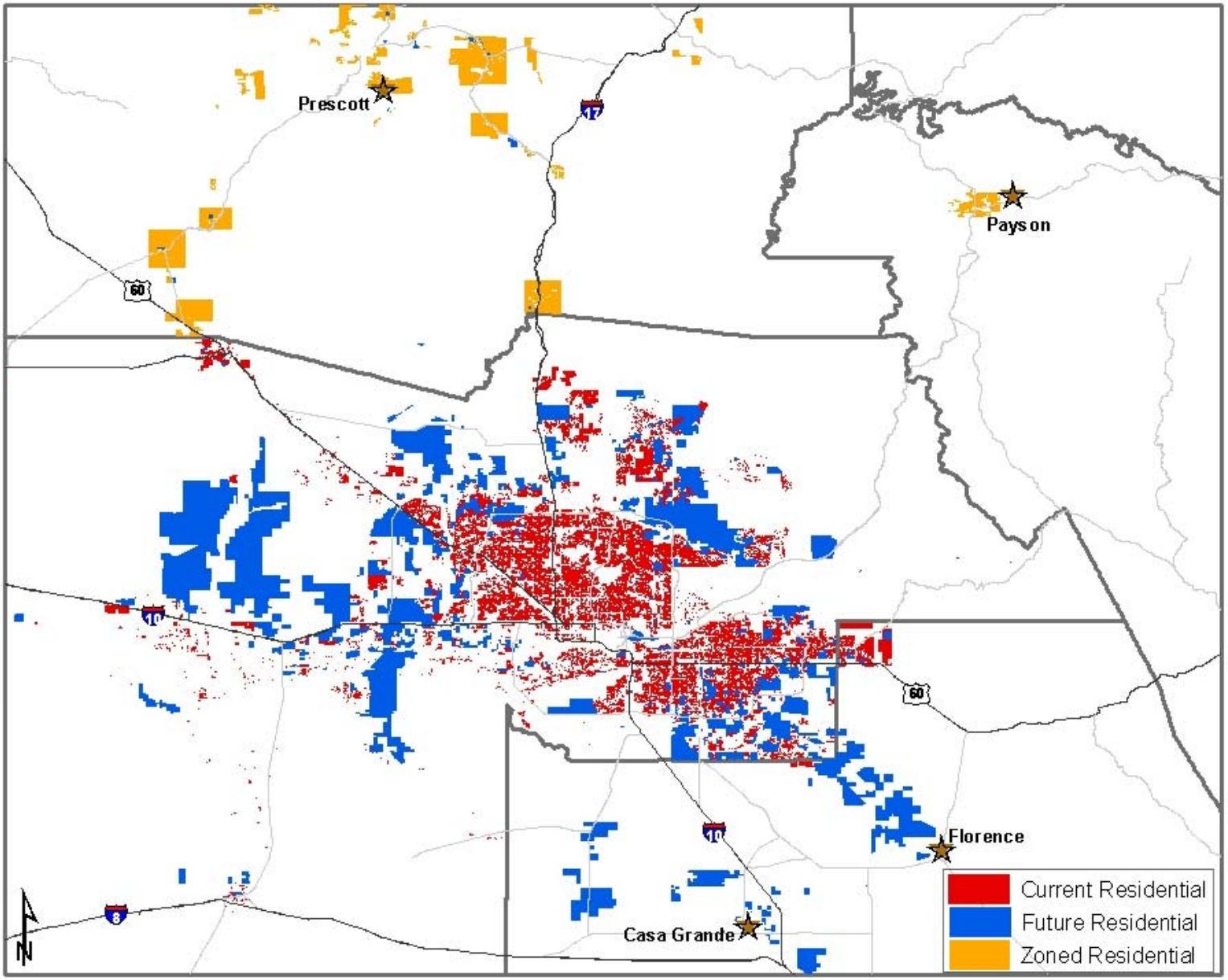
Red areas represent **current** residential landuse.

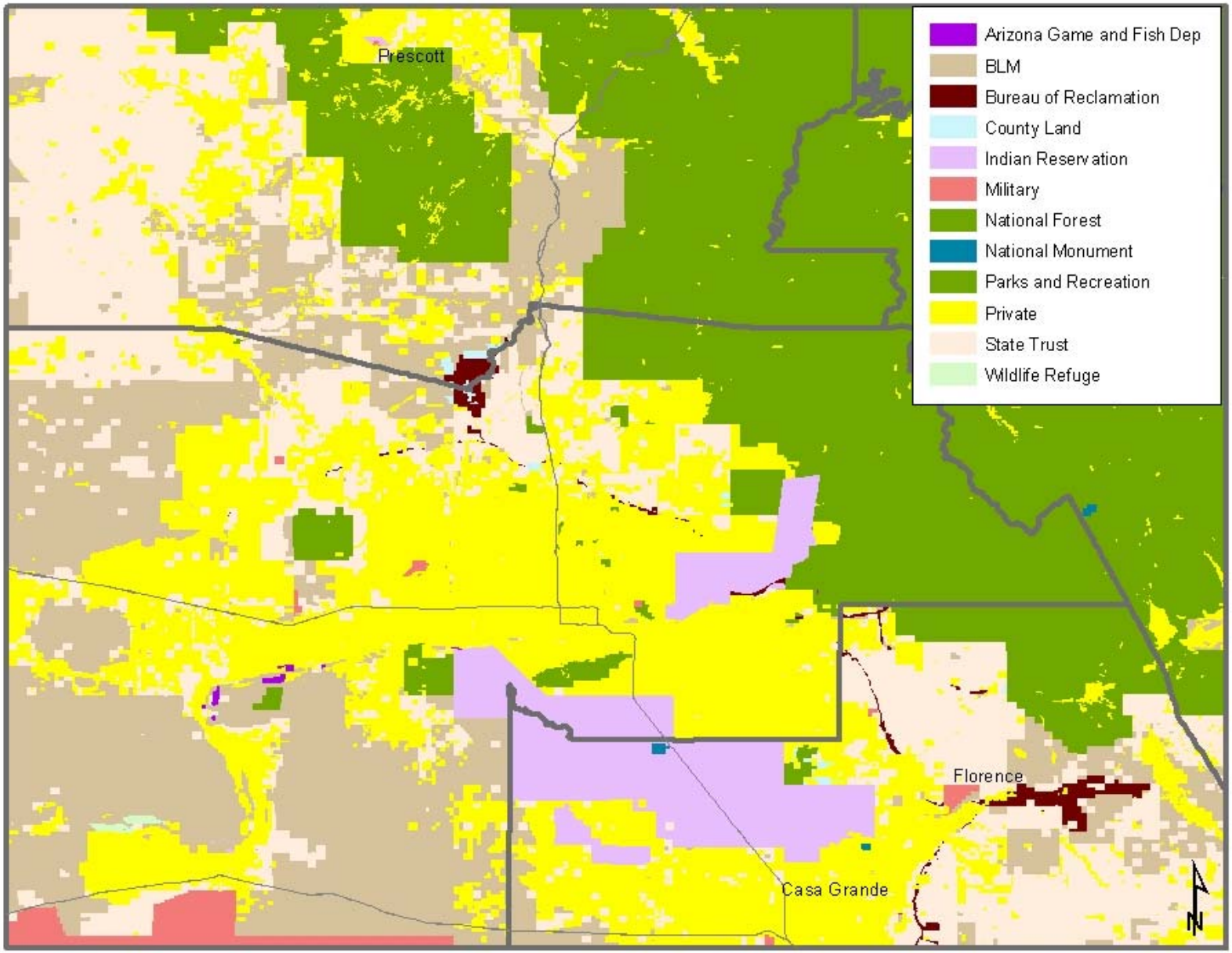
Blue areas represent areas where subdivisions have been approved to be built. The Blue areas are either already **under construction, or are scheduled to be in the near future.**

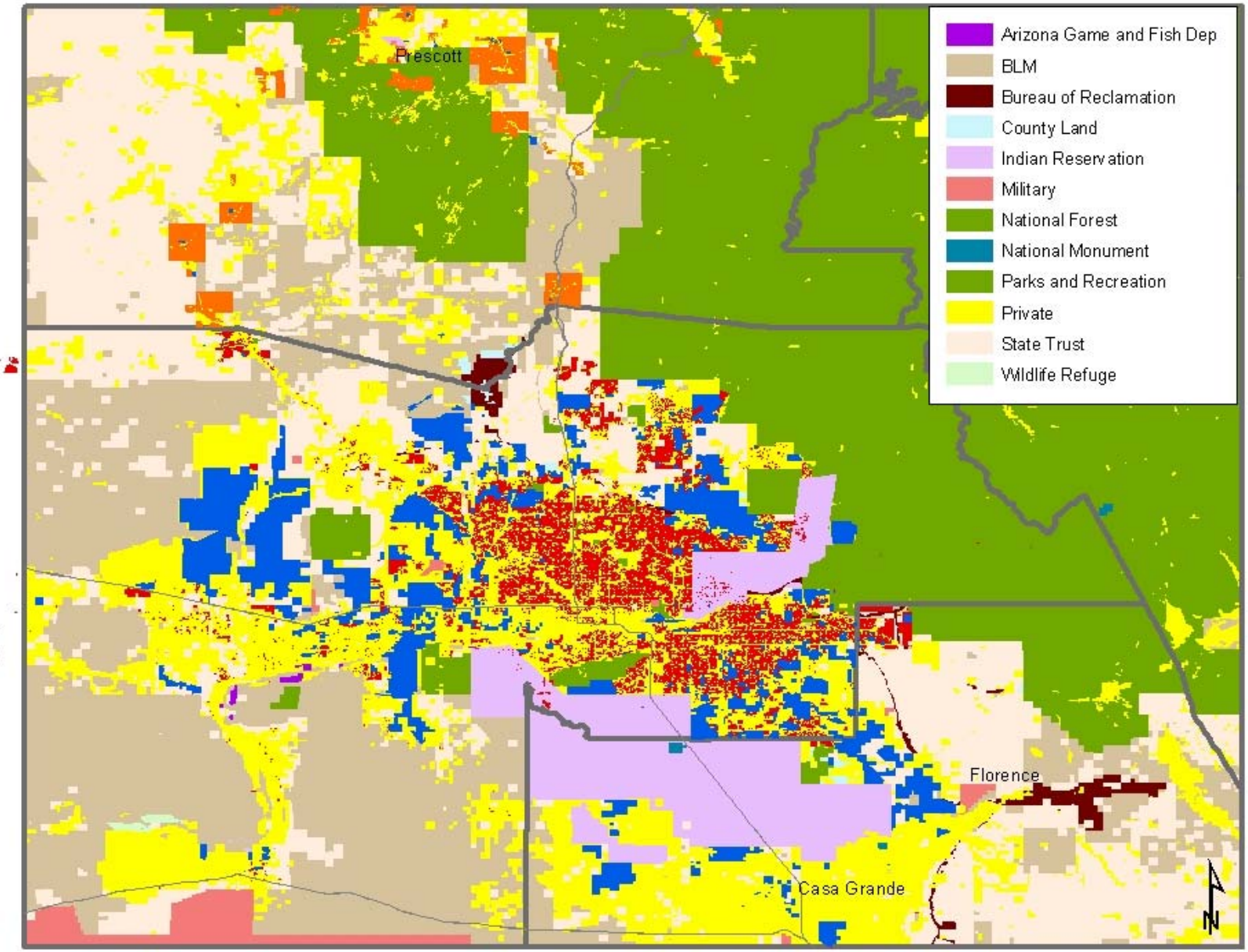
Gold areas represent areas that are **zoned** for residential use.

Land ownership is overlaid on the second map in this series to indicate that future land development is taking place on private land which is not as abundant as federal and state owned land.

**Maricopa Landuse is based on photo-interpretation and subdivision plans Yavapai County and Payson Landuses are based on zoning.*


Prescott
Payson
Florence
Casa Grande
Current Residential
Future Residential
Zoned Residential


Prescott
Florence
Casa Grande
N
Arizona Game and Fish Dep
BLM
Bureau of Reclamation
County Land
Indian Reservation
Military
National Forest
National Monument
Parks and Recreation
Private
State Trust
Wildlife Refuge


Arizona Game and Fish Dep
BLM
Bureau of Reclamation
County Land
Indian Reservation
Military
National Forest
National Monument
Parks and Recreation
Private
State Trust
Wildlife Refuge
Prescott
Florence
Casa Grande
N

Future Land Use – General Plans

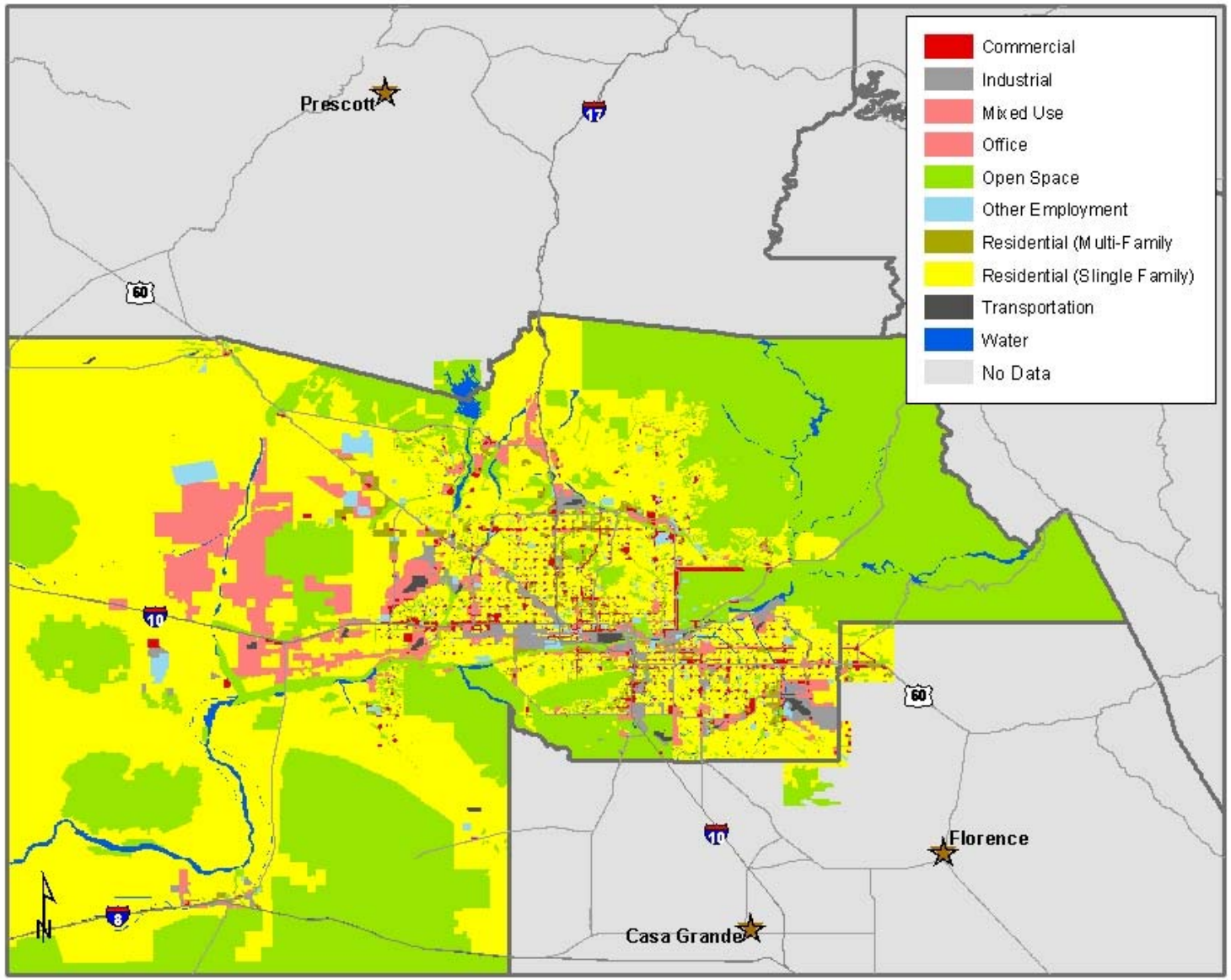
The following maps depict land use according to *General Plans* which depict a shared 'vision' of *where future land use should take place*.

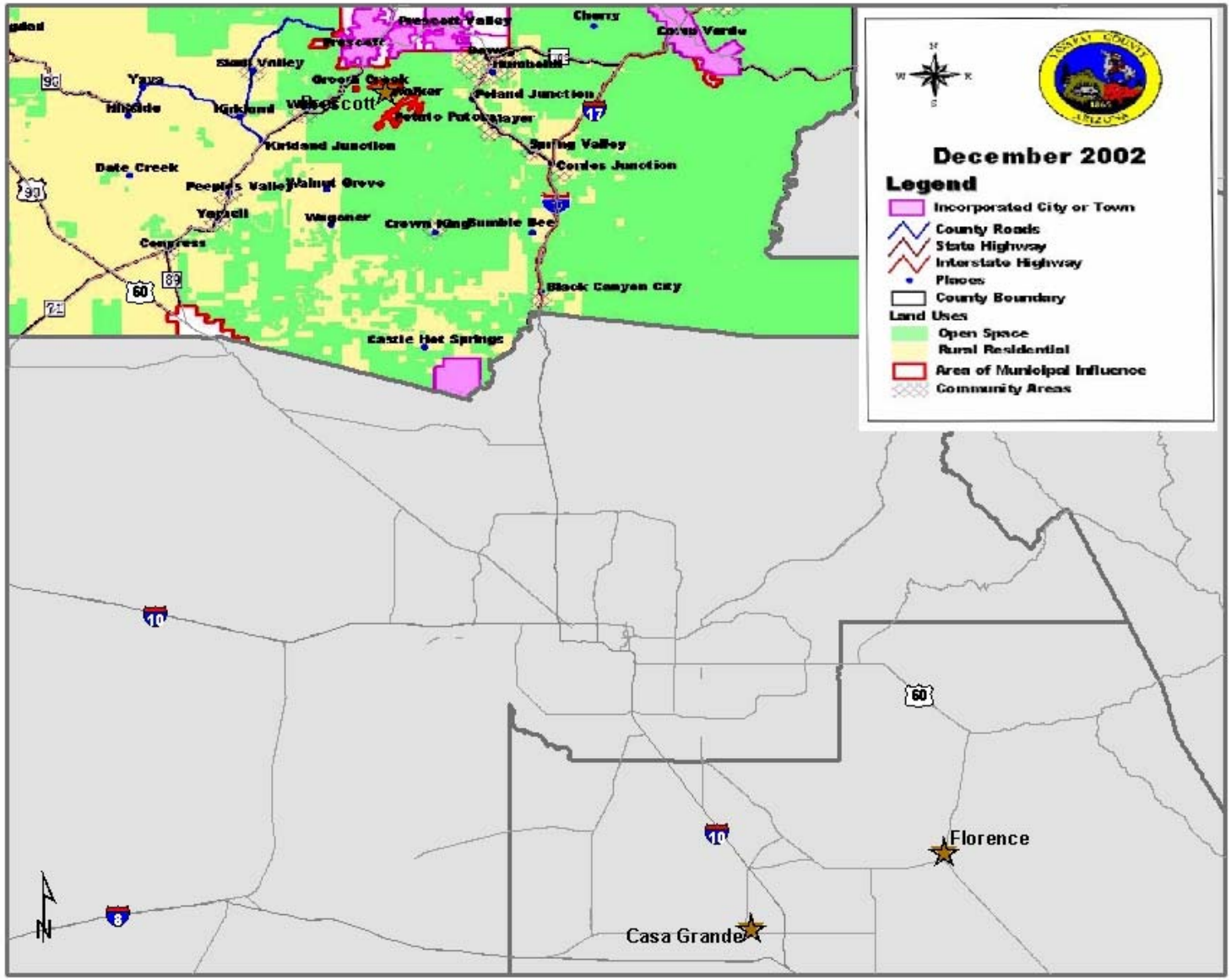
Maricopa County – The Future Land Use coverage was created by MAG by aggregating data from our draft General Plan Land Use coverage into condensed categories. Therefore, this coverage contains some General Plan data along with some draft General Plan data and conceptual plans.

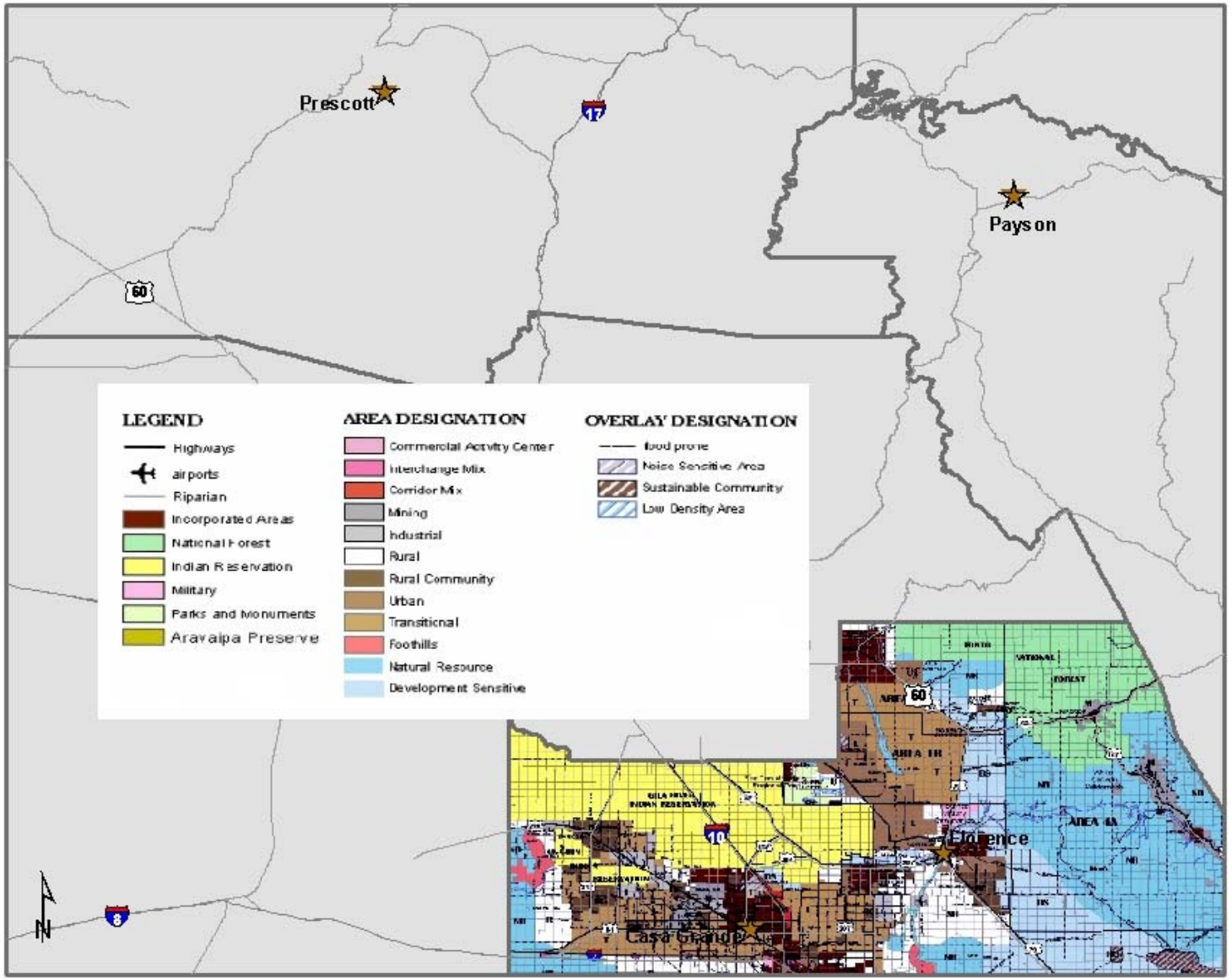
Yavapai County – Shown is a generalized plan for Future Land Use. Community plans which will show greater detail are currently being created.

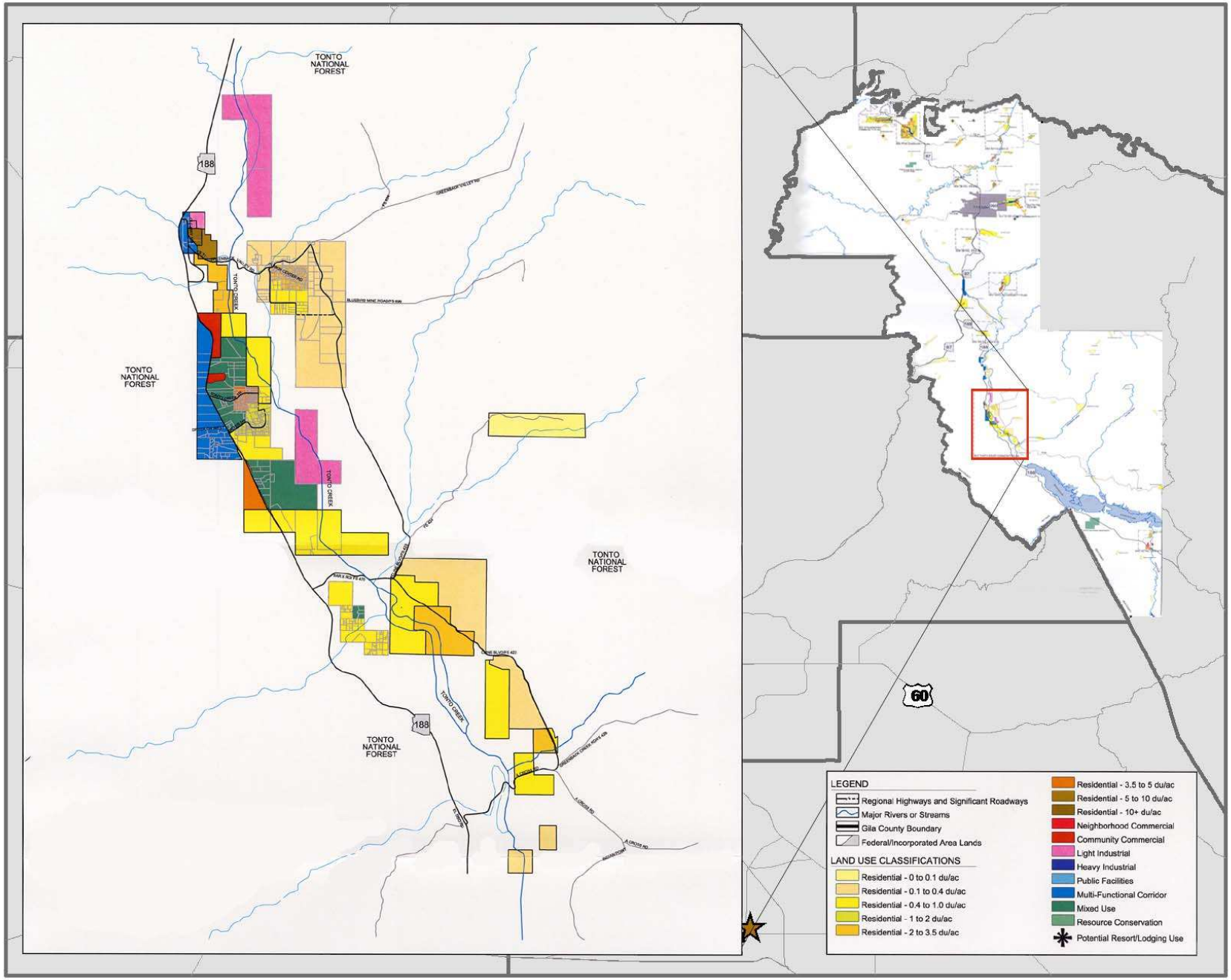
Pinal County – The general plan shown here for Pinal County is in draft form and will be released for public comment on June 1st.

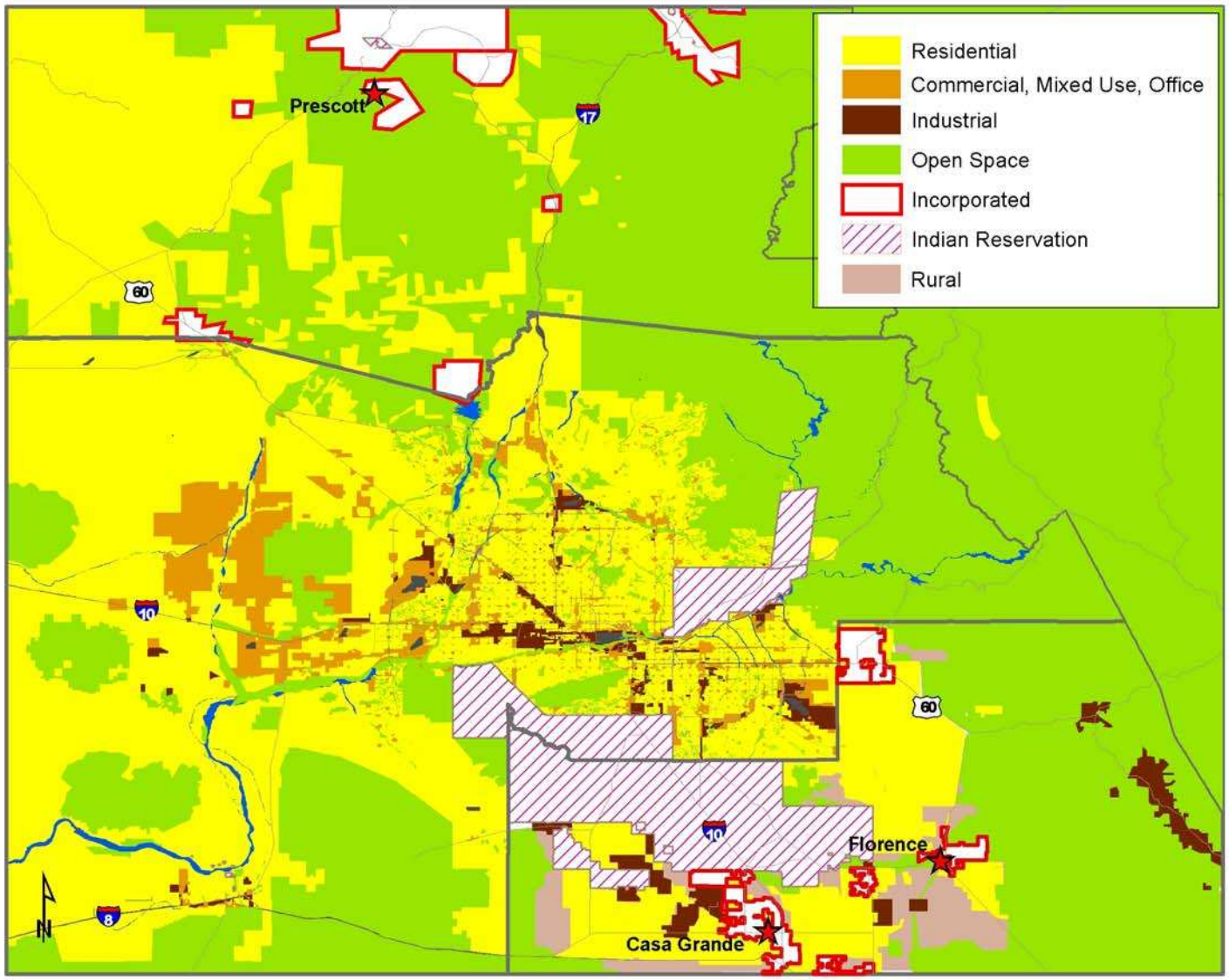
Gila County – The general plan shown here for Gila County is in draft form and is currently available for public comment.


Commercial
Industrial
Mixed Use
Office
Open Space
Other Employment
Residential (Multi-Family
Residential (Slingle Family)
Transportation
Water
No Data
Prescott
Florence
Casa Grande
N
17
60
10
8


December 2002
Legend
Incorporated City or Town
County Roads
State Highway
Interstate Highway
Places
County Boundary
Land Uses
Open Space
Rural Residential
Area of Municipal Influence
Community Areas
Prescott Valley
Chino Valley
Yarnell
Wagoner
Crown King
Bumble Bee
Black Canyon City
Florence
Casa Grande
N


Prescott
17
Payson
60
LEGEND
Highways
airports
Riparian
Incorporated Areas
National Forest
Indian Reservation
Military
Parks and Monuments
Aravaipa Preserve
AREA DESIGNATION
Commercial Activity Center
Interchange Mix
Corridor Mix
Mining
Industrial
Rural
Rural Community
Urban
Transitional
Foothills
Natural Resource
Development Sensitive
OVERLAY DESIGNATION
flood prone
Noise Sensitive Area
Sustainable Community
Low Density Area
AREA IB
AREA IA
Florence
10
Casa Grande
8
N


TONTO NATIONAL FOREST
188
TONTO NATIONAL FOREST
TONTO NATIONAL FOREST
TONTO NATIONAL FOREST
188
TONTO CREEK
60
LEGEND
Regional Highways and Significant Roadways
Major Rivers or Streams
Gila County Boundary
Federal/Incorporated Area Lands
LAND USE CLASSIFICATIONS
Residential - 0 to 0.1 du/ac
Residential - 0.1 to 0.4 du/ac
Residential - 0.4 to 1.0 du/ac
Residential - 1 to 2 du/ac
Residential - 2 to 3.5 du/ac
Residential - 3.5 to 5 du/ac
Residential - 5 to 10 du/ac
Residential - 10+ du/ac
Neighborhood Commercial
Community Commercial
Light Industrial
Heavy Industrial
Public Facilities
Multi-Functional Corridor
Mixed Use
Resource Conservation
Potential Resort/Lodging Use


Residential
Commercial, Mixed Use, Office
Industrial
Open Space
Incorporated
Indian Reservation
Rural
Prescott
Florence
Casa Grande
17
60
10
8
N

Description of May 21, 2003, Socioeconomic Presentation Maps

Study Area

This map was created using data from the Arizona Land Resource Information System (ALRIS). A statewide file for incorporated city boundaries was clipped to the study area. The city boundary file available through ALRIS is updated on a regular basis to reflect changing city boundaries.

Data source: ALRIS

Projected Population Growth 2000 – 2018

This map was created using a population growth model based on the Arizona Department of Economic Security's (DES) general description of their growth model and was written in the Arc Macro Language (AML). Readily available 2000 U.S. Census and Immigration and Naturalization Service (INS) data were used as model inputs. The data is displayed by tract; increase in persons per square mile.

Projection method:

The model was run at the census tract scale. In the 2000 Census data, each tract had population totals broken down by sex and five-year age groups, or cohorts. At one year time-steps each cohort population was modified by death rate, foreign immigration rate, U.S. migration rate and aging (20% subtracted from one cohort and added to the next highest in age). Additionally, births rates were applied to female cohorts of the right age and the total was added to the lowest age cohort, divided among males and females according to the U.S. averages. The rates themselves did not change from one time-step to the next. The model needed little calibration, but was adjusted slightly to match DES model results at three validation points.

Ideally, each census tract would have unique values, by cohort, for each of the four main factors (birth, death, migration, immigration). Each tract would also have a built-in limit to the population based on zoning and other factors. Limited by timeframe (less than a week) and resources (free and readily available data only), this was not the case. The different factors available had differing data scales and cohort divisions:

Birth rates: Available at the county level by cohort. Each tract was given a set of rates based on its county.

Death rates: Available at the county level by age cohort only. Death rates by sex were at the national level. Death rates were calculated for the age cohorts of both sexes then split by sex according the national rate and assigned to tract by its county.

Immigration rates: Available at the state level by age cohort and, independently, by sex. Processed in the same fashion as death rates.

Migration rates: Available at the regional (western U.S.) level by age cohort and, Independently, sex. Processed in a similar fashion to death rates except that the Tract assignments were statewide.

Data Sources: U.S. Census Bureau digital GIS file, Immigration and Naturalization Service, Department of Economic Security.

Percent Commercial per Square Mile

This map was created using data from Maricopa Association of Governments (MAG), the City of Payson, and Yavapai County.

The City of Payson map used data from November 27, 2002, and was digitized manually using USGS township, range, and section lines as a reference. These lines are present on the hardcopy map, as well as in digital format. The City of Payson had a single "Commercial" zoning category designated. This category is shown on the map.

MAG data used was a digital Land Use file for the year 2000. All commercial land use categories were mapped – this included Specialty, Neighborhood, and Community Commercial land use.

Yavapai County provided a digital map, and this was queried for commercial zoning and extracted directly into the map. Categories of Commercial zoning from Yavapai County included Neighborhood, General Sales and Service and Minor Industrial Commercial.

Because of the fragmentary nature of the commercial polygons and the disparity between the extent of the mapped area and the size of the polygons, an alternate method of display was devised. Firstly, the data were converted to a 100-foot resolution continuous surface representation, or a 'grid.' Secondly, a square moving window one square mile in area was systematically passed over the grid, summing the number of commercial grid cells and assigning the value to the cell at the window's center. Finally, the cell values were divided by the number of cells in a square mile, resulting in a surface showing the percentage of commercial territory surrounding any point on the map.

Data Sources: MAG 2000 Landuse digital GIS file, Yavapai County Zoning digital GIS file, Payson Zoning hardcopy map

Percent Employment per Square Mile

This map was created using data from Maricopa Association of Governments (MAG), the City of Payson, and Yavapai County.

The City of Payson zoning map, last updated November 27, 2002 was digitized manually using the township, range, and section lines as a reference, since these were present on the hardcopy map as well as in digital format from the USGS (United States Geological Survey). The Payson zoning map clearly indicates "Employment Centers" in Payson and thus, this is the category of data mapped for Payson.

MAG data used was a digital employment file for the year 2000. Employers are mapped by point location and include information regarding the number of employees for each site.

A Yavapai county zoning digital file was also used and categories for Commercial and Industrial land use were used to map Employment Regions. There was not an "office" category available in the Yavapai County zoning dataset.

The definition of a core employment region used to transform employer point clusters to areas was at least three employers within 500 feet of each other. This allowed the creation of triangle-shaped polygons using Delaunay triangulation. More than one contiguous triangle was formed where there were clusters of more that three points, which was almost always the case. At this point, the method used to visualize the commercial data was applied to the employment data.

Because of the fragmentary nature of the employment polygons and the disparity between the extent of the mapped area and the size of the polygons, an alternate method of display was devised. Firstly, the data were converted to a 100-foot resolution continuous surface representation, or a 'grid.' Secondly, a square moving window one square mile in area was systematically passed over the grid, summing the number of employer grid cells and assigning the value to the cell at the window's center. Finally, the cell values were divided by the number of cells in a square mile, resulting in a surface showing the percentage of employer territory surrounding any point on the map.

Data Sources: MAG 2000 Landuse digital GIS file, Yavapai County Zoning digital GIS file, Payson Zoning hardcopy map

ADOT Traffic Projections:

This was obtained directly from ADOT to be used with the following stipulations:

The scope of coverage of these data have three limitations...
1) They includes only those routes of the Arizona State Highway System (those on which ADOT has jurisdiction over),

2) forecasts are only available for rural, non-urbanized portions of those routes, and
3) the forecasts only go out 20 years from the latest year ADOT has current volumes.

Conversion of this file was made from point to line by the following method:

This map uses traffic volume data from the Arizona Department of Transportation and major roads of Arizona from ALRIS.

The ADOT average annual daily traffic data was assigned to points, while easy visualization of the data required that it be assign to lines (roads). There were four processing steps:

1) Segmented the roads layer into one-mile segments. This is the effective resolution of the data.
2) Extracted the line segment endpoints (nodes) as points with its source line segment ID number as an attribute.
3) Performed a one-to-many spatial proximity join between the ADOT points and the extracted segment endpoints.
4) Join the endpoint data table to the segmented roads data table based on the segment ID number.

Data source: ADOT digital GIS file, ALRIS digital GIS file

Pinal County Traffic Projections:
This map was created from data available from the Pinal County Transportation Plan 2000 Update. The map depicts change for Annual Average Daily Traffic Counts for Pinal County from 2005-2020.

Data source: Lima and Associates digital GIS file

MAG Traffic Projections:
According to MAG: the map depicted here is based on draft preliminary estimates of emissions and have not been used in any Air Quality Plan adopted by MAG. They are subject to change. These traffic volume projections are for the year 2015 and are shown by Annual Average Daily Traffic Counts.

Data Source: MAG digital GIS file

Current and Future Residential Land Use:
This map was created using data obtained from the City of Payson, Yavapai County, and MAG.

The Payson zoning data was manually digitized from a hardcopy zoning map, using USGS township, range, and section lines as a guideline. Only the residential zones are shown on this map, in red.

Yavapai County provided its zoning data in a digital format, which was then queried to extract the residential zones, which are shown in red.

Two datasets from MAG were used for this map. The first was land use for the year 2000, and residential land use was extracted and is shown in red. Second, a dataset that showed platted subdivisions was used. Platted subdivisions are shown in blue, indicating development that will take place in the near future, or perhaps is already taking place. Platted subdivisions have been through the planning process and are approved to be built.

Data Sources: MAG 2000 Landuse digital GIS file, Yavapai County Zoning digital GIS file, Payson Zoning hardcopy map

Land Ownership:
The base layer of this map is a land ownership file created by ALRIS. This map shows privately owned land, along with state and federally owned lands. This map is included mainly to illustrate that future growth is quickly filling up remaining privately held land.

Data Source: MAG 2000 Landuse digital GIS file, Yavapai County Zoning digital GIS file, Payson Zoning hardcopy map, ALRIS digital GIS files

MAG General Plan:
The Future Land Use coverage was created by MAG by aggregating data from their draft General Plan Land Use coverage into condensed categories. Therefore, this coverage contains some General Plan data along with some draft General Plan data and conceptual plans. This map does not depict data for any particular year – just for the future, in general.

Data Source: MAG digital GIS file

Yavapai County General Plan:
This map was created by using a digital GIS file supplied by Yavapai County. The file represents a generalization of future land use and currently Yavapai County is working on several Community Plans that go into greater detail.

Data Source: Yavapai County digital GIS file

Pinal County General Plan:

This map was created by using a graphic file provided by Pinal County Planning Department. The .jpg was georeferenced, and then heads-up digitized. The Pinal County General Plan is currently in draft format, and available for review.

Data Source: Pinal County .jpg file

Gila County General Plan:

This map was created from a hardcopy of the Draft General Plan made available for review by Gila County. The map was scanned and the are was shown in relation to where it lies in Gila County.

Data Source: Gila County General Plan hardcopy document

Generalized General Plan:

This map was created by combining and generalizing landuse shown in the Maricopa, Yavapai, and Pinal County general plans. Categories of landuse were aggregated into seven basic categories for Residential, Commercial/Mixed Use/ Office, Industrial, Open Space, Incorporated, Indian Reservation, and Rural.

Data Sources: MAG digital GIS file, Yavapai County digital GIS file, Pinal County .jpg file, Gila County General Plan hardcopy document

APPENDIX 11

Memo from Jeffrey R. Holmstead, Assistant Administrator, U.S. EPA, to EPA Regional Administrators, "Schedule for 8-Hour Ozone Designations and its Effect on Early Action Compacts", November 14, 2002

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 14 2002

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Schedule for 8-Hour Ozone Designations and its Effect on Early Action Compacts

FROM: Jeffrey R. Holmstead
Assistant Administrator

TO: Regional Administrators, Regions I-X

The purpose of this memorandum is to inform State and local air pollution control Agencies and Tribes (States and Tribes) about the Environmental Protection Agency's (EPA's or Agency's) schedule for designating areas for the 8-hour ozone National Ambient Air Quality Standards (NAAQS or standard) and the impact of the designation schedule on areas that are developing early action compacts (compacts). Please share this memorandum with your States and Tribes. This memorandum does not replace earlier guidance on the designation process and determining nonattainment area boundaries based on case-by-case application of air quality-related factors and presumptions. These earlier memoranda, titled "Boundary Guidance on Air Quality Designations for the 8-Hour Ozone National Ambient Air Quality Standards" dated March 28, 2000 and "Guidance on 8-Hour Ozone Designations for Indian Tribes" dated July 18, 2000, provide more detail on these issues and are located at http://www.epa.gov/ttn/oarpg.

Part A of this memorandum describes the schedule for designations, Part B addresses designation of Tribal areas and Part C addresses the effect of this schedule on States and Tribes that are developing compacts pursuant to the Texas "Protocol for Early Action Compacts Designed to Achieve and Maintain the 8-Hour Ozone Standard" (protocol) endorsed by EPA on June 19, 2002. The protocol can be found at http://www.epa.gov/eart1r6/6pd/air/pd-1/8hourozone.pdf.

A. Schedule for Designations for the 8-Hour Ozone NAAQS

On May 30, 2002 representatives of nine environmental organizations filed a notice of citizen suit under the Clear Air Act (Act) alleging that the Administrator failed to promulgate air

quality designations by the required statutory deadline.[1] On November 13, 2002, the nine environmental groups filed their lawsuit in the U.S. District Court for the District of Columbia. The EPA and the environmental groups have agreed upon a schedule for EPA to promulgate air quality designations for the 8-hour ozone standards by April 15, 2004. This agreement is embodied in a consent decree that was lodged with the U.S. District Court for the District of Columbia on November 13, 2002. In accordance with §113(g) of the Act, prior to finalizing the consent decree, EPA will publish a notice in the Federal Register providing a 30-day period for public review. If the public review results in revisions to the consent decree, EPA will modify this guidance as appropriate.

The EPA is now requesting that each State Governor and Tribal Chief or Leader submit their updated, revised, or new designation recommendations and documentation to the Regional Administrator of the appropriate Regional Office by April 15, 2003. It should be noted that State recommendations do not apply to Indian country. The recommendations should generally be based on 2000-2002 quality assured, Federal reference or equivalent air quality monitoring data. This date will provide time for States and Tribes to quality assure the data for use in developing their recommendations and for EPA to carefully review and evaluate each recommendation prior to promulgating designations. To the extent that 2001-2003 air quality data are available and quality assured at the time of final designations, EPA will use 2001-2003 data when promulgating the designations. Therefore, EPA encourages Regional Offices, States and Tribes to prioritize and accelerate quality assurance of 2003 ozone monitoring data for use in promulgating designations. In the case where a State or Tribe does not submit a recommendation by April 15, 2003, EPA will promulgate the designation it deems appropriate.

In accordance with the Act, EPA will review the recommended designations and may make modifications as deemed necessary. If EPA determines that a modification to a recommendation is necessary, EPA will notify the State or Tribe no later than 120 days prior to promulgating the designations, which will provide an opportunity for the State or Tribe to demonstrate why EPA's modification is not appropriate. The EPA anticipates that it would provide such notification no later than October 15, 2003.

The EPA believes this timetable for promulgating designations is reasonable and appropriate and provides adequate time for States, Tribes, and local communities to develop effective ozone abatement strategies. Accordingly, EPA believes that there is no need for legislative action to alter the statutory deadline for ozone designations or related implementation

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[1]Section 6103 of the Transportation Equity Act for the 21st Century ("TEA-21") provided that EPA was required to designate areas for the 8-hour ozone NAAQS no later than July 18, 2000. See CAA section 107 Note. As part of Pub. L. 106-377, enacted in October 2000, Congress prohibited EPA from spending funds to designate areas for the 8-hour NAAQS until the earlier of a decision by the Supreme Court in Whitman v. American Trucking Assoc. or June 15, 2001. The Supreme Court issued its decision in Whitman v. American Trucking Assoc. on February 27, 2001.

requirements. In addition, EPA believes that it is possible to harmonize implementation of the 8-hour ozone and particulate matter NAAQS for 2.5 microns or less ($PM_{2.5}$) without seeking legislation because EPA will work with States to ensure that area designations for both NAAQS will occur in 2004. Indeed, the designation of areas for the $PM_{2.5}$ standard by December 2004 is one of the Agency's highest priorities, due to the serious public health implications of $PM_{2.5}$ exposure and the corresponding importance of initiating the air quality planning process for both the ozone and $PM_{2.5}$ standards. This will enable States and Tribes to plan for implementation of both NAAQS at the same time. In addition, EPA intends to promulgate an implementation rule and release guidance addressing the 8-hour ozone program by the end of 2003 to aid States in planning for implementation prior to promulgation of designations.

The EPA is committed to ensuring that all stakeholders have an opportunity to participate in the designation process for the 8-hour ozone NAAQS, and that State, local and Tribal officials have ample time to comply with obligations that are triggered by designations. States are encouraged to involve their stakeholders in developing their recommendations. Regional Offices should work with States and Tribes, particularly those Tribes located in or near an area where a monitor is recording a violation of the 8-hour ozone NAAQS.

B. Designation of Tribal Areas

Tribes have raised a number of concerns and questions to EPA about the designation process in discussions held by the Tribal Designations and Implementation Work Group. For instance, many Tribes believe that consolidated metropolitan statistical area (C/MSA) boundaries should not include reservations which are often politically and economically not integrated with the surrounding or adjacent urban area. The C/MSA presumption for the recommended nonattainment area plus nearby contributing areas in EPA's guidance recognizes the need for broader nonattainment areas associated with urban areas because of transport of pollution and precursor emissions within and into urban areas, widespread poor air quality in and near urban areas and protection of health and welfare of citizens living in the area. While EPA's guidance establishes a presumption that the metropolitan area[2] is the initial default area, the guidance offers a method to arrive at a different conclusion other than C/MSA through case-by-case evaluation and documentation based on the factors in the guidance. Therefore, a Tribe may make a recommendation that their area not be included in a C/MSA nonattainment area and/or that a nonattainment designation is not appropriate for the area by addressing the factors in the guidance. Another concern that Tribes have raised with the designation process is that Tribes may not have the resources to do the detailed analysis necessary to prepare recommendations. Therefore, EPA offers to work with Tribes on their recommendation upon request.

Tribes are encouraged, but not required, to submit designation recommendations for their reservations, or other area under their jurisdiction, to EPA. The Tribal Authority Rule (TAR)

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[2] "Metropolitan area" means the Metropolitan Statistical Area (MSA) or, in areas with multiple contiguous MSAs, the Consolidated Metropolitan Statistical Area (CMSA).

offers flexibility to Tribes for specific plan submittal and implementation deadlines for NAAQS-related requirements, including but not limited to such deadlines in CAA sections 110(a)(1), 172(a)(2), 182, 187, 189, and 191. However, EPA is required by the Act and the consent decree to make designations according to a timetable. Therefore, if a Tribe wishes to participate in the designation process, it must submit a recommendation in time for EPA to consider that recommendation when making a designation. In cases where Tribes do not make recommendations, the EPA, after consultation with the respective Tribe(s), will promulgate the designation it deems appropriate.

The EPA will continue to work with the Tribes to address their concerns, consistent with the TAR. Because many of the Tribal concerns about designations will be area specific, it is important for the Tribes to work with their EPA Regional Office on their recommendations. For more information on ozone designations for Tribes, see EPA's Guidance on 8-Hour Ozone Designations for Indian Tribes, available on the Office of Air and Radiation's Tribal AIR website, www.epa.gov/oar/tribal/airprogs/tribe8hd.html. The EPA plans to contact Tribes regarding consultation prior to promulgating actual designations.

C. Early Action Compacts

In this section, EPA is addressing how it anticipates the designation schedule will work for areas that develop voluntary 8-hour compacts, as provided in the protocol. The EPA endorsed this protocol on June 19, 2002. The purpose of a signed 8-hour compact is to provide a local area with flexibility to control air emissions from their sources and offer a means to achieve cleaner air faster than the Act would otherwise require. Areas that currently approach or monitor exceedances of the 8-hour ozone standard, but are designated attainment and "clean" for the 1-hour ozone standard, i.e., no monitored violations, would be eligible to qualify for the compact approach, provided the milestones and schedules discussed in the next section of this memorandum are met. Under this approach, 8-hour air quality plans would be developed consistent with a cooperative agreement between local, State or Tribe and EPA officials. These early 8-hour plans would consist of local, enforceable measures that would achieve air quality reductions earlier than otherwise would be required and that would be approved as part of the State implementation plan (SIP). In cases where a Tribe elects to participate, the local controls would be included as part of the Tribal implementation plan (TIP). For participating areas that are monitoring a violation of the 8-hour ozone standard, EPA would recognize the local area's commitment to early action by provisionally deferring the effective date of the nonatttainment designation. The deferral of the effective date of the designation would be contingent upon the participating area's meeting all terms and milestones of the compact. The Agency believes that these compacts can result in early environmental progress, and we continue to support local areas' commitments to develop plans that are designed to achieve clean air faster than the Act would otherwise require.

We strongly encourage States, Tribes and local areas to begin broad-based stakeholder outreach early, and to maintain an effective and inclusive collaborative process. The early action

program is based upon, and cannot effectively operate without, broad-based support from all interests.

One of the principles of the protocol concerns deferral of the effective date of the nonattainment designation for areas that are in compliance with applicable milestones in the compact. For these areas, EPA would plan to defer the effective date of the nonattainment designation on a rolling basis such that each deferral is linked to a key milestone, as described below in the next section of this memorandum. We have included a schedule for deferrals later in this memorandum in the section entitled "Provisional Deferral of the Effective Date of Nonattainment Designation."

Key Compact Milestones and Schedules

Below EPA sets forth the key milestones, which are also outlined in the protocol, that should be included in each compact. The milestones have been supplemented as described below and in a letter dated October 18, 2002, from Gregg Cooke, EPA, to Robert Huston, Texas Commission on Environmental Quality. The Regional Offices should work closely with States, Tribes and local areas to emphasize the importance of adhering to these critical milestones and schedules, as well as the importance of implementing an effective stakeholder process.

1. December 31, 2002 - The compact must be completed, signed by local, State or Tribal and EPA officials, and submitted to EPA no later than December 31, 2002. Areas that submit compacts after that date will not qualify for the deferred effective date. These agreements represent commitments of States and local areas or Tribes that culminate in the development of the SIPs or TIPs that will achieve local reductions earlier than otherwise required, and which demonstrate attainment of the 8-hour ozone NAAQS by December 31, 2007. The compacts should follow the principles outlined in the protocol and should address the following components described in the protocol: milestones and reporting; emissions inventory; modeling; control strategies; maintenance for growth; public involvement; and local, State or Tribal and EPA commitments.

2. June 16, 2003 - The protocol requires that, after all adopted Federal and State or Tribal controls that have been or will be implemented by the attainment date of December 31, 2007 are accounted for in the modeling, the local area must adopt additional local controls, as necessary, to achieve reductions earlier than otherwise would be required, and to demonstrate attainment of the 8-hour ozone NAAQS by December 31, 2007. Therefore, by June 16, 2003, the first step in complying with this requirement, the local area will identify and describe the local control measures that are being considered during the local planning process. The June 16, 2003 deadline for describing the control measures under consideration must be met to maintain eligibility in the program. While failure to list a measure at this stage would not preclude its adoption later, it is important to develop a reasonably complete initial list of measures. We recognize that the modeling may not be complete at this stage, and that control measures may need to be modified. This milestone, therefore, will provide the public with clear information on

the measures under consideration, will help ensure that interested parties are fully aware of the level of effort and local commitment that is necessary, and will demonstrate that the local area is making progress toward meeting the critical March 31, 2004 deadline for adoption of local measures.

3. March 31, 2004 - The resulting local plan must be completed and submitted to the State or Tribal leader by March 31, 2004 for inclusion in the SIP or TIP and a copy must be provided to EPA by that date. The local plan shall include measures that are specific, quantified, and permanent, and that if approved by EPA, will be Federally enforceable as part of the SIP or TIP. The March 31, 2004 submission also must include specific implementation dates for the adopted local controls. In addition, the local plan must include detailed documentation supporting the plan and reports outlined in the protocol, as well as a modeling analysis based on local controls demonstrating attainment of the 8-hour ozone NAAQS by December 31, 2007.

4. December 31, 2004 - No later than December 31, 2004, States or Tribes will submit to EPA a SIP or TIP consisting of the local plan, including all adopted control measures, and a demonstration that the area will attain the 8-hour ozone standard by December 31, 2007. If a SIP or TIP has been submitted by that date, EPA will review it for completeness and approvability.

5. September 30, 2005 - EPA will take final action on any SIP or TIP revisions submitted by December 31, 2004, pursuant to the compact.

6. December 31, 2005 - No later than December 31, 2005, the area will implement the local control measures that have been incorporated into the SIP or TIP. The EPA strongly recommends that these local measures be implemented earlier (no later than the beginning of the local area's 2005 ozone season) to ensure that the area will have timely and sufficient air quality data (2005-2007) to show attainment by December 31, 2007.

7. June 30, 2006 progress assessment - The protocol requires 6-month progress reports. No later than June 30, 2006, the State or Tribe must submit to EPA a report attesting to the local area's progress since the December 31, 2005 milestone. To determine whether the effective date of the nonattainment designations should continue to be deferred, EPA will review the mid-2006 report to ensure that the area continues to implement its control measures, that emission reductions attributed to local measures are being achieved, and that improvements in air quality are being made. This 6-month report should contain sufficient information to ensure that EPA can make a comprehensive assessment of air quality progress in the local area.

8. December 31, 2007 - No later than December 31, 2007, the area must attain the 8-hour ozone NAAQS. If the area has attained the standard by December 31, 2007, EPA will withdraw the deferred nonattainment designation and replace it with an attainment designation. If the area fails to attain by this date, the nonattainment designation will become effective on April 15, 2008. In addition, pursuant to the terms of the compact, the State must submit a revised attainment demonstration SIP for the nonattainment area by December 31, 2008.

Provisional Deferral of the Effective Date of Nonattainment Designation

If an area meets the first two compact milestones, EPA anticipates that it will propose in October 2003 to defer the effective date of the nonattainment designation for that area until September 30, 2005, contingent upon the area's submission of local control measures by March 31, 2004, as required by the third compact milestone. If the area submits the required control measures, and after consideration of public comment, EPA intends to take final action by April 15, 2004 on the deferred effective date.

Under the terms of the protocol, EPA has committed to approve the SIP or TIP by September 30, 2005. Assuming the SIP or TIP is approvable, the Agency intends to propose, as part of the approval action, the second deferral of the effective date until December 31, 2006. This will allow the Agency time to determine if implementation of control measures has occurred by the December 31, 2005 milestone before further extending the effective date. If the June 30, 2006 progress assessment (described in the previous section) has been submitted, implementation has occurred, and air quality improvement is taking place, EPA will propose and, if appropriate, take final action on the third deferral of the effective date until April 15, 2008. By that date EPA will determine if an area has attained the 8-hour ozone NAAQS by December 31, 2007, as required by the protocol.

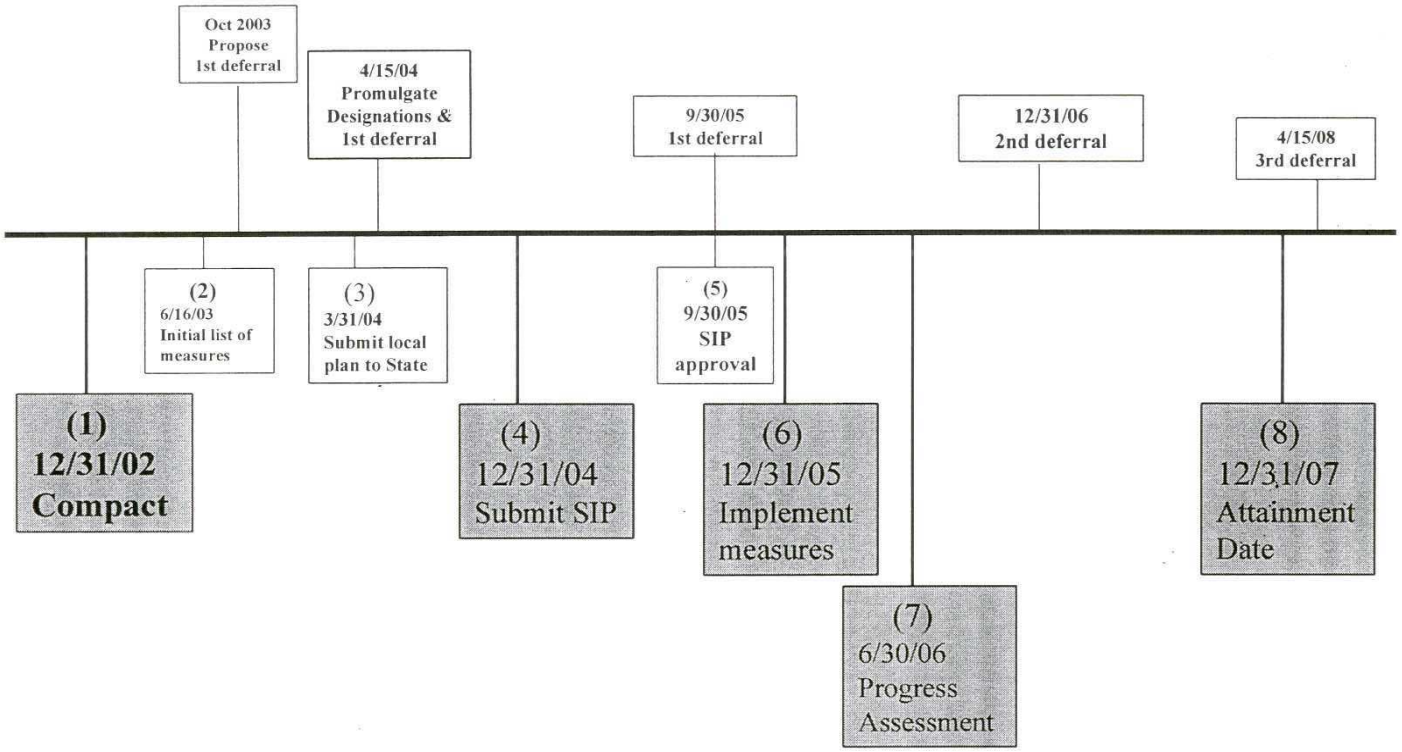
In the event of any missed key milestone, EPA will take action to propose and promulgate a finding of failure to meet the milestone, and to withdraw any deferred effective date of the nonattainment designation shortly after the missed milestone. The deferred effective dates will expire unless EPA determines, as part of the rulemaking actions described above, that all intervening milestones have been achieved. If any milestone is missed and EPA withdraws the deferred effective date, thereby triggering a nonattainment designation and applicable statutory requirements, a nonattainment SIP would have to be submitted to EPA within 1 year of the new effective date of the nonattainment designation. A timeline of key compact milestones and deferred effective dates is attached.

Questions on designations should be directed to Sharon Reinders at 919/541-5284. Questions on 8-hour compacts should be directed to David Cole at 919/541-5565.

cc: Air Directors, Regions I-X
Margo Oge, OTAQ

EPA:OAR:OAQPS:AQSSD:OPSG:DCOLE\LLassiter:New Campus C545E\C539-02\1-5526
File Name: I:\SEC\COLE\8HRO3_EACs11_13_02.WPD November 13, 2002

Early Action Compact Timeline



APPENDIX 12

MAG Regional Freeway Bottleneck Study, Task 5, Traffic Data Working Paper, May 7, 2002

MAG REGIONAL FREEWAY BOTTLENECK STUDY

TASK 5
TRAFFIC DATA WORKING PAPER

MAY 7, 2002

***Submitted to*:**
THE MARICOPA ASSOCIATION OF GOVERNMENTS

***Prepared by*:**

TRAFFIC DATA WORKING PAPER

An extensive amount of traffic data was collected for the Regional Freeway Bottleneck Study. The data was collected to meet two objectives:

- To have one representative 24-hour estimate of directional traffic volumes on approximately every three miles of the freeway mainline

- To collect the traffic data necessary to evaluate the bottleneck locations.

Traffic data was collected through an aerial photo-survey flown by Skycomp, Inc., video photography using both the ADOT Freeway Management System (FMS) cameras and portable cameras operated by ATD Northwest (ATD), and manual counts set by Traffic Research & Analysis (TRA). Data collection began on September 11, 2001 and continued into October. The methodology followed and the results of each are discussed in this chapter.

The data collection tasks of the Regional Freeway Bottleneck Study resulted in four products:

- An aerial photo-survey report, *Traffic Quality on the MAG Regional Freeway System*, prepared by Skycomp;

- A traffic data validation binder of data, prepared by Olsson Associates (because of its size, just one copy was prepared);

- An MS Access traffic count database, also prepared by Olsson Associates;

- A series of maps presenting the data, which are included in this working paper.

NOTE: THE TEXT OF THIS WORKING PAPER DOCUMENTS THE PROCESSES FOR COLLECTING, VALIDATING, AND REPORTING THE TRAFFIC DATA. THE COUNT DATA IS PRESENTED IN A SERIES OF MAPS IN APPENDIX C OF THE WORKING PAPER.

- *2001 Daily Traffic Volume (Figures 1 and 1A)*
- *2001 Daily HOV Lane Volume (Figure 2)*
- *2001 AM Peak Hour Traffic Volume (Figures 3 and 3A)*
- *2001 PM Peak Hour Traffic Volume (Figures 4 and 4A)*
- *2001 AM Peak Hour HOV Lane Volume (Figure 5)*
- *2001 PM Peak Hour HOV Lane Volume (Figure 6)*
- *2001 Daily Truck Volume (Figure 7)*
- *2001 AM Peak Hour Truck Volume (Figure 8)*
- *2001 PM Peak Hour Truck Volume (Figure 9)*

APPENDICES D, E AND F DEPICT THE DAILY, MORNING PEAK AND EVENING PEAK VARIATION IN TRAFFIC VOLUMES ON I-10 WB BETWEEN RIGGS ROAD AND OGLESBY ROAD

AERIAL PHOTO-SURVEY

In the fall of 2001, Skycomp conducted a series of aerial photo-surveys of highway traffic conditions in the planning region of the Phoenix metropolitan area. The purpose was to update information on traffic conditions and obtain other materials to support regional planning activities. Using the mobility and vantage point of fixed-wing aircraft, a photographic inventory of traffic conditions was made on approximately 175 miles of freeways during the peak morning and evening periods of commuter travel.

In the fall of 1998, a similar survey of the MAG regional freeway system was conducted, with approximately 110 miles of highway included. The 2001 survey was conducted using the same methodology, except that survey coverage was expanded by one hour for both the morning and evening peak periods.

During this aerial survey program, overlapping photographic coverage of designated freeways was obtained – repeated once an hour over four morning and four evening commuter periods. The morning times of coverage were 6:00-9:00 AM, and evening times were 3:30-6:30 PM Survey flights were conducted only on weekdays, except that Monday mornings, Friday evenings, and mornings after holidays were excluded. Data were extracted from the aerial photographs such that, by link and by time slice, average recurring daily traffic conditions could be measured.

The *Traffic Quality on the MAG Regional Freeway System* report, prepared by Skycomp as a product of its efforts, presents the aerial photo-survey data in the following ways:

- Performance rating tables of traffic conditions on the 175 miles of surveyed freeways are presented for morning and evening peak periods. The ratings are presented in tables by highway segment, by direction, and by time slice. Each rating represents the average of approximately four flyovers (from four different days), minus any data affected by incidents (the half-hour time slices represent the average of two flyovers). The ratings are density-based level-of-service (LOS) designations "A", "B", "C", "D", "E" and "F", as defined in the *2000 Highway Capacity Manual* (HCM).

- The report also includes highway maps containing narratives that clarify the severity and frequency of all congestion found along each highway segment. Where evident, apparent causes of the problems are also described. Congestion on crossing freeways and on interchange ramps are also depicted and discussed.

Other aerial photo-survey results produced and submitted to MAG include:

- Queue populations at freeway on-ramps (ramp meters) and off-ramps (signal queues) have been recorded for each observation. Each entry also includes physical

characteristics of the ramp, including the number of lanes associated with each turning movement.

- An electronic version of the Survey Database (built in Microsoft Access) was produced. This database contains all of the collected data, from vehicle counts and road segmentation, to flight information and the variables used to calculate densities.

- An interactive CD-ROM *Congestion Highlights* slide show presents the findings of the report, plus many highlight aerial photographs of congestion. This product can be projected to audiences "as is"; the interactive feature allows a presenter to respond to audience interests by going to specific locations as they come up in the discussion.

- A second slide show, the *Peak-Traffic Photolog*, contains overlapping photographic coverage of the entire 175-mile system -- twice. Using actual survey photographs, typical peak-hour passes were selected during both morning and evening survey periods. These passes represent a snapshot of how the highway system looked on a typical day (as much as possible, passes were selected that did not include the effects of major incidents).

CAMERA/VIDEO COUNTS

ATD collected traffic data using video photography at 44 locations – 23 ADOT FMS locations and 21 locations where portable cameras were used. Of the 44 sites, 36 were mainline locations, where video was recorded in both directions, and 8 were ramp locations. The locations, type of camera used (FMS or portable), date the data was collected, and data prepared from the videos are provided in Appendix A. Ramp metering sites that were operational in September 2001 are listed in Appendix B.

The camera location counts utilized videotapes and a sampling procedure. The videotapes were viewed and the vehicles were manually counted for five-minute intervals for 20 hours, 4:00 AM to 12:00 midnight. From 4:00 to 6:00 AM, the first five-minute interval of each hour was counted. From 6:00 to 9:00 AM, the first five-minute interval of each fifteen minutes was counted. From 9:00 AM to 3:00 PM, the first five-minute interval of each hour was counted. From 3:30 to 6:15 PM, the first five-minute interval of each fifteen minutes was counted. From 7:00 PM to midnight, the first five-minute interval of each hour was counted.

The camera location counts were expanded to a full 24-hour volume. Each five-minute interval counted was multiplied by three to obtain an estimated 15-minute volume. During the periods when a five-minute interval was counted once per hour (off-peak hours), the 15-minute volume was utilized four times to represent a one-hour volume. The volumes for the time period from midnight to 4:00 AM were estimated by utilizing counts from similar stations with complete twenty-four hour counts – either tube or loop counts.

MANUAL COUNTS

TRA was responsible for all manual counts. Directional manual counts were collected by either pneumatic tubes (117 sites) or, when available and functional, using permanent loops (34 sites). The locations and data prepared at each location are also provided in Appendix A.

In summary, 233 ground directional traffic counts were obtained from four different sources. Arizona Department of Transportation Freeway Management System video cameras were utilized for 46 counts. ATD Northwest cameras were utilized for 36 counts. Pneumatic tubes were utilized for 117 counts. Arizona Department of Transportation permanent detector loops were utilized for 34 counts. One hundred sixteen tube and fifteen loop locations were counted for 15-minute intervals over a 48-hour period. One tube location and nineteen loop locations were counted for one-hour intervals over a 48-hour period.

COUNT VALIDATION PROCESS

With the large number of ground counts collected and counts coming from a variety of sources, it was important to critically investigate the counts to ensure the validity of the data. The validation process is discussed in this section.

All of the graphics and charts prepared and evaluated in the validation process were inserted into a three-ring binder and submitted to MAG. All attachments referred to in this section are included in the binder. Attachment 1 in the binder is the Data Collection Plan map.

Initial Inspection

In order to assess the reasonability of the data, the counts for each individual location were plotted. The standard plot consisted of a solid diamond connected by a solid line. Those locations with 15-minute counts were plotted in both 15-minute intervals and one-hour intervals. Those counts with five-minute counts were expanded to 15-minute intervals and plotted in both 15-minute and one-hour intervals. The camera counts that were expanded to 15-minute interval volumes for 24 hours were plotted with a long dashed line and an asterisk.

The locations with 48 hours of volume data were carefully examined. An average 24-hour total was calculated. If apparent differences occurred between the two 24-hour periods, then separate 24-hour totals were calculated for each day. If differences greater than 1,000 vehicles per day occurred between the average daily volume and the highest daily volume, the higher daily volume data was utilized. The plot of the discarded daily volume was changed to a short dashed line and an open diamond.

Attachment 2 (in binder) is a listing of the count stations that required traffic volume adjustments. Attachment 3 (in binder) is the individual plots of the fifteen-minute and hourly volumes for each of the 233 count stations.

Subsequent Inspection

Thirteen separate maps of mainline freeways were developed. The daily traffic counts were rounded to the nearest 500 vehicles per day and indicated on the maps. These counts were reviewed for logical progression. For example, US-60 experiences low traffic volumes in each direction at its eastern terminus. The traffic volumes increase in the western direction. Each count on each facility was examined from a similar perspective to ensure logical increase or decreases.

Nine separate maps of freeway-to-freeway interchanges were developed. The entering and exiting traffic counts were examined to ensure logical increases or decreases. Where possible, the percent difference between the measured counts and calculated counts was determined. The measured counts were at the approaches and departures of each interchange. The calculated counts began with the approach count, subtracted exit ramp counts and added entrance ramp counts resulting in a departure volume. The percent difference was determined as the difference between the counts divided by the average of the counts.

The percent difference at each of the count locations for all of the interchanges was relatively small. A percent difference between the measured count and the calculated count of 10% or less is accepted as valid. All but two interchanges had a percent difference of less than 10%. Considering that three different counting devices were utilized, and that counts occurred on different days of the week and months of the year, it is exceptional that the counts balanced within 10% or less for all but two locations. One interchange – I-10 to SR-101 – had a percent difference for the westbound traffic of 18%. Another interchange – I-10 to SR-202 to SR-51 – had a southbound percent difference of 11%.

At three freeway-to-freeway interchanges, it was not possible to calculate percent differences as the count stations were too far from the interchanges. At these locations, several entrance and exit ramps were present between the freeway-to-freeway interchanges and the closest count station. These interchanges were: I-17 to SR-101, I-17 to I-10, and SR-101 to SR-202. At these interchanges, some of the approach and departure volumes were calculated based on the exiting and entering counts at the freeway-to-freeway interchanges.

Attachment 4 (in binder) is a series of maps that provide the directional daily traffic volumes rounded to the nearest 500 vehicles and the count stations in various subsections of the freeway system. Attachment 5 (in binder) is a single map that provides the daily traffic volumes rounded to the nearest 1,000 vehicles for the entire freeway system.

In summary, the careful examination of the traffic counts verified the validity of the counts for future analysis.

MS ACCESS TRAFFIC COUNT DATABASE

The relational Traffic Count Database (MS Access) was compiled from three principal tables:

1. Count Sites
2. Counts-All Sites
3. Peak Periods & Hours-All Sites

The *Count Sites* table consists of one record for each count location/direction (totaling 791 records). Each record is uniquely identified by a Site ID. Each record fully identifies and describes a single site: its freeway, direction, location, the name of the file containing its counts, the date on which the counts were taken, the number of counts in the file, its count intervals (15-minute or 1-hour), etc.

The *Counts - All Sites* table contains the actual traffic count values for each site spanning a period of 24 hours in 15-minute increments. Thus the table contains 96 count records (24 hours times four 15-minute periods per hour) for each count site. The table is related to the *Count Sites* table via field the Site ID. This table includes fields for Total Volume, General Purpose Lanes Volume, HOV Lane Volume, Volumes in Lanes 1-6, and Class Volumes (for Light Duty, Medium Duty, and Heavy Duty Vehicles). Not all of these volume types are included for every count site. For example, relatively few of the count sites collected classification volumes. The table contains blanks wherever information was not collected.

The *Peak Periods & Hours - All Sites* table contains a single record for each count site (791 records), and again relates to the other tables via the Site ID. This table contains summed count volumes for four periods during the day: the AM Period (6:00 AM - 9:00 AM), the Mid Day Period (9:00 AM - 3:00 PM), the PM Period (3:00 PM - 6:00 PM), and the Night Period (6:00 PM - 6:00 AM). The table gives Total Volumes, General Purpose Lanes Volumes, and HOV Lane Volumes over each of these periods. The table also gives the Peak Hour (e.g.- 8:00 AM - 9:00 AM) during which the highest volume occurred in both the AM Period and the PM period.

The Traffic Count Database contains a number of smaller tables that are subsets of the *Counts - All Sites* table. The name of each of these subset tables begins with "Counts." For example, the table named *Counts - Mainline By Class* includes only count values for count sites at which Class volumes were collected.

APPENDIX A

DATA COLLECTION INFORMATION

Mainline Camera Site Locations:

Site #	Fwy	Between	Camera Type	Date	Direction	Data
1	I-10	Ray Rd. and Chandler Blvd.	ATD	Tue, 9/11	Both	Total Volume (TV)
2	I-10	Elliot Rd. and Warner Rd.	ATD	Tue, 9/11	Both	TV, Classification (Class)
3	I-10	Broadway Rd. and US-60	ATD	Tue, 9/11	Both	TV by Lane
4	I-10	32nd St. and 40th St.	FMS	Tue, Wed 9/11,9/12	EB, WB	TV
5	I-17	16th St. and 24th St.	FMS	Tue, Wed 9/11,9/12	EB, WB	TV, Class
6	I-17	Buckeye Rd. and 19th Ave.	FMS	Tue, Wed 9/11,9/12	EB, WB	TV
7	I-17	I-10 and Van Buren St.	FMS	Tue, Wed 9/11,9/12	EB, WB	TV
8	I-17	Camelback Rd. and Indian School Rd.	FMS	Tue, Wed 9/11,9/12	EB, WB	TV
9	I-17	Northern Ave. and Glendale Ave.	FMS	Tue, Wed 9/11,9/12	EB, WB	TV, Class
10	US-60	Cooper Rd. and Gilbert Rd.	ATD	Thurs, 9/13	Both	TV
11	US-60	Country Club Dr. and Mesa Dr.	ATD	Thurs, 9/13	Both	TV, Class
12	US-60	I-10 and Priest Rd.	ATD	Thurs, 9/13	Both	TV
13	I-10	SR-202 and Van Buren St.	FMS	Thurs,Tue 9/13,9/18	NB, SB	TV
14	I-10	7th St. and 16th St.	FMS	Thurs,Tue 9/13,9/18	EB, WB	TV by Lane

15	I-10	19th Ave. and 7th Ave.	FMS	Thurs,Tue 9/13,9/18	EB, WB	TV
16	I-10	35th Ave. and 27th Ave.	FMS	Thurs,Tue 9/13,9/18	EB, WB	TV by Lane, Class
17	I-10	59th Ave. and 51st Ave.	FMS	Thurs,Tue 9/13,9/18	EB, WB	TV
18	I-10	83rd Ave. and 75th Ave.	FMS	Thurs,Tue 9/13,9/18	EB, WB	TV, Class
19	SR-101 (E)	Guadalupe Rd. and Elliot Rd.	ATD	Wed, 9/19	Both	TV
20	SR-101 (E)	Broadway Rd. and Southern Ave.	ATD	Wed, 9/19	Both	TV by Lane, Class
21	SR-202	Dobson Rd. and Alma School Rd.	ATD	Wed, 9/19	Both	TV
22	SR-202	32nd St. and 40th St.	FMS	Wed,Thurs 9/19,9/20	EB, WB	TV
23	SR-51	Thomas Rd. and McDowell Rd.	FMS	Wed,Thurs 9/19,9/20	NB, SB	TV by Lane
24	SR-51	Colter Rd. and Camelback Rd.	FMS	Wed,Thurs 9/19,9/20	NB, SB	TV, Class
25	SR-51	Shea Blvd. and Northern Ave (closest)	FMS	Wed,Thurs 9/19,9/20	NB, SB	TV
26	SR-51	Cactus Rd. and Shea Blvd.	FMS	Wed,Thurs 9/19,9/20	NB, SB	TV
27	SR-51	Bell Rd and Greenway Rd	FMS	Wed,Thurs 9/19,9/20	NB, SB	TV
28	SR-101 (E)	SR-202 and University Dr.	ATD	Wed, 9/12	Both	TV

29	SR-101 (E)	McKellips Rd. and SR-202	ATD	Wed, 9/12	Both	TV by Lane, Class
30	SR-101 (E)	Indian School Rd. and Thomas Rd.	ATD	Wed, 9/12	Both	TV
31	SR-101 (W)	Indian School Rd. and Thomas Rd.	ATD	Tue, 9/19	Both	TV
32	I-17	Greenway Rd. and Thunderbird Rd.	ATD	Tue, 9/19	Both	TV, Class
33	I-17	Carefree Hwy and Happy Valley Rd.	ATD	Tue, 9/19	Both	TV
34	SR-202	Center Pkwy. and Scottsdale Rd.	ATD	Thurs 9/20	Both	TV
35	SR-143	University Dr. and I-10	FMS	Tue, Wed 9/25,9/26	NB, SB	TV
36	SR-143	SR-202 and Van Buren St.	FMS	Tue, Wed 9/25,9/26	NB, SB	TV

System Interchange Camera Site Locations						
Site #	**To**	**From**	**Camera Type**	**Date**	**Direction**	**Data**
37	US-60 on ramp	I-10 SB	ATD	Thurs, 9/20	EB ramp	TV
38	I-10 on ramp NB	US-60 WB	ATD	Thurs, 9/20	NB ramp	TV
39	I-10 on ramp SB	US-60 WB	ATD	Thurs, 9/20	SB ramp	TV
40	US-60 on ramp WB	SR-101 SB	ATD	Thurs, 9/20	WB ramp	TV
41	I-10 on	I-17	FMS	Tue, Wed	EB ramp	TV

	ramp EB	NB and SB		9/25,9/26		
42	I-10 on ramp WB	SR-51 WB	FMS	Tue, Wed 9/25,9/26	WB ramp	TV
43	SR-51 and SR-202	I-10 off ramp EB	FMS	Tue, Wed 9/25,9/26	EB ramp	TV
44	SR-202 on ramp WB	SR-101 WB	ATD	Thurs, 9/20	WB ramp	TV

Mainline Tube Site Locations:

Site #	Fwy	Between	Date	Direction	Data
45	I-10	Oglesby Rd. and Miller Rd.		Both	TV
46	I-10	East of Miller Rd.		None – duplicate station	
47	I-10	West of Jackrabbit Rd.		Both	TV
48	I-10	Jackrabbit Tr. and Citrus Rd.		Both	TV
49	I-10	Cotton Lane and Estrella Pkwy.		Both	TV
50	I-10	Litchfield Rd. and Dysart Rd.		Both	Tv
51	I-10	115th Ave. and 107th Ave.		Both	TV
52	I-10	SR-101 and 91st Ave.		Both	TV
53	SR-101	I-10 and Thomas Rd.		Both	TV
54	SR-101	Camelback Rd. and Glendale Ave.		Both	TV

55	I-17	SR-101 and Deer Valley Dr.		Both	TV
56	SR-101	I-17 and 19th Ave.		Both	TV
57	I-17	Carefree Hwy. and Pioneer Rd.		Both	TV
58	I-17	Pioneer Rd. and Anthem Way		Both	TV
59	I-17	New River Rd. and Anthem Way		Both	TV
60	SR-101	7th St. and Cave Creek Rd.		Both	TV
61	SR-101	Cave Creek Rd. and Tatum Blvd.		Both	TV
62	SR-101	Tatum Blvd. and Scottsdale Rd.		Both	TV
63	SR-101	Frank Lloyd Wright Blvd. and Cactus Rd.		Both	TV
64	SR-101	Shea Blvd. and Via De Ventura		Both	TV
65	SR-101	Indian Bend Rd. and McDonald Dr.		SB	TV
66	US-60	Val Vista Dr. and Greenfield Rd.		Both	TV
67	US-60	East of Goldfield Rd.		Both	TV
68	I-10	Maricopa Rd. and Queen Creek Rd.		Both	TV
69	I-10	North of Riggs Rd.		Both	TV

System Interchange Tube Site Locations					
Site #	**To**	**From**	**Date**	**Direction**	**Data**
70	I-10 on ramp SB	Baseline Rd.		SB	TV
71	Baseline Rd.	I-10 off ramp NB		NB	TV
72	US-60 on ramp EB	I-10 off ramp NB		NB	TV
73	I-10 on ramp NB	Baseline Rd.		NB	TV
74	US-60 on ramp EB	Baseline Rd.		EB	TV
75	Baseline Rd.	I-10 off ramp SB		SB	TV
76	Broadway Rd.	I-10 off ramp NB		NB	TV
77	I-10 on ramp SB	Broadway Rd.		SB	TV
78	I-10 on ramp WB	Broadway Rd.		WB	TV
79	SR-143 on ramp NB	I-10 off ramp WB		NB	TV
80	I-10 on ramp SB	SR-143 off ramp SB		SB	TV
81	Broadway Rd.	I-10 off ramp SB		SB	TV
82	US-60 on ramp WB	SR-101 off ramp SB		WB	TV
83	SR-101 on ramp SB	US-60 off ramp EB		SB	TV
84	US-60 WB and EB on ramps	SR-101 off ramp NB		NB	TV
85	SR-101 on ramp NB	US-60 off ramp EB		EB	TV
86	US-60 on ramp EB	SR-101 off ramp NB		EB	TV
87	SR-101 on ramp NB	US-60 off ramp WB		WB	TV
88	SR-101 on ramp SB	US-60 off ramp WB		WB	TV
89	US-60 on ramp WB	SR-101 off ramp NB		WB	TV
90	McClintock Dr.	US-60 off ramp WB		WB	TV
91	I-10 on ramp WB	I-17 off ramp SB		WB	TV
92	I-17 on	I-10 off		EB	TV

	ramp NB	ramp EB			
93	I-10 EB and WB on ramps	I-17 off ramp SB		SB	TV
94	I-10 off ramps	I-17 on ramps NB		NB	TV
95	I-17 on ramp SB	I-10 off ramp EB		SB	TV
96	19th Ave.	I-17 off ramp NB		NB	TV
97	I-17 on ramp SB	19th Ave.		SB	TV
98	I-17 on ramp SB	I-10 off ramps		SB	TV
99	I-10 on ramps	I-17 off ramp NB		NB	TV
100	I-17 on ramps	I-10 off ramp WB		WB	TV
101	I-10 WB HOV	SR-202 WB HOV		WB	TV
102	SR-202 EB HOV	I-10 EB HOV		EB	TV
103	I-10 on ramp SB	SR-51 SB		SB	TV
104	SR-51 and SR-202 on ramps	I-10 off ramp NB		NB	TV
105	SR-202 on ramp EB	SR-51 and I-10 off ramps		EB	TV
106	SR-202 EB	I-10 off ramp EB		EB	TV
107	SR-51 on ramp NB	SR-202 off ramp WB		WB	TV
108	SR-51 on ramp NB	SR-202 and I-10 off ramps		NB	TV
109	SR-51 NB	I-10 off ramp NB		NB	TV
110	I-10 on ramp WB	SR-202 off ramp WB		WB	TV
111	I-10 on ramp WB	SR-51 off ramp SB		WB	TV
112	SR-101 on ramp SB	SR-202 off ramps		SB	TV
113	SR-202 on ramps	SR-101 off ramp NB		NB	TV
114	SR-101	8th St.		NB	TV

	NB				
115	8th St.	SR-101 SB		SB	TV
116	SR-101 on ramps	SR-202 off ramp EB		EB	TV
117	SR-202 on ramp EB	SR-101 off ramps		EB	TV
118	SR-101 on ramps	SR-202 off ramp WB		WB	TV
119	SR-101 on ramp NB	SR-202 off ramps		NB	TV
120	SR-202 on ramps	SR-101 off ramp SB		SB	TV
121	SR-202 on ramp WB	SR-143 off ramps		WB	TV
122	SR-143 on ramps	SR-202 off ramp EB		EB	TV
123	SR-143 on ramp SB	SR-202 off ramp EB		SB	TV
124	SR-202 on ramp WB	SR-143 off ramp NB		NB	TV
125	SR-143 on ramp NB	SR-202 off ramp EB		NB	TV
126	SR-202 on ramp WB	SR-143 off ramp SB		SB	TV
127	I-17 on ramp SB	SR-101 off ramps		SB	TV
128	SR-101 on ramps	I-17 off ramp NB		NB	TV
129	I-17 on ramps	SR-101 off ramp EB		EB	TV
130	SR-101 off ramp WB	I-17 off ramps		WB	TV
131	SR-101 on ramps	I-17 off ramp SB		SB	TV
132	I-17 on ramp NB	SR-101 off ramps		NB	TV
133	I-17 on ramps	SR-101 off ramp WB		WB	TV
134	SR-101 on ramp EB	I-17 off ramps		EB	TV
135	SR-101 on ramp NB	I-10 off ramp EB		EB	TV
136	I-10 on ramp WB	SR-101 off ramp SB		WB	TV
137	SR-101 on ramp NB	I-10 off ramp WB		WB	TV
138	I-10 on ramp EB	SR-101 off ramp SB		EB	TV

ADOT Mainline Loop Site Locations					
Site #	**Fwy**	**Between**	**Date**	**Direction**	**Data**
145	SR-101	Olive Ave. and Northern Ave.		Both	TV
146	SR-101	Bell Rd. and Thunderbird Rd.		Both	TV
147	SR-101	67th Ave. and 75th Ave.		Both	TV
148	SR-101	35th Ave. and 51st Ave.		Both	TV
149	I-17	Cactus Rd. and Peoria Ave.		Both	TV
150	I-17	Carefree Hwy and Happy Valley Rd.		Both	TV
151	I-10	Warner Rd. and Ray Rd.		Both	TV
152	I-10	Guadalupe Rd. and Baseline Rd.		Both	TV
153	SR-101	Warner Rd. and Ray Rd.		Both	TV
154	US-60	SR-101 and McClintock Rd.		Both	TV
155	US-60	Dobson Rd. and SR-101		Both	TV
156	US-60	Power Rd. and Sossaman Rd.		Both	TV
157	US-60	Ellsworth Rd. and Crismon Rd.		Both	TV
158	US-60	Ironwood		Both	TV

		Dr. and Signal Butte Rd.			
159	SR-101	McDowell Rd. and McKellips Rd.		Both	TV
160	SR-101	Chaparral Rd. and Indian School Rd.		Both	TV
161	SR-101	Indian Bend Rd. and McDonald Dr.		Both	TV

APPENDIX B

RAMP METERING SITES

HIGHWAY	DIRECTION	CROSS STREET	TIMES
I-10	EB	83rd Avenue	05:30 - 09:00
I-10	EB	75th Avenue	05:30 - 09:00
I-10	EB	67th Avenue	05:30 - 09:00
I-10	EB	59th Avenue	05:30 - 09:00
I-10	EB	51st Avenue	05:30 - 09:00
I-10	EB	43rd Avenue	05:30 - 09:00
I-10	EB	35th Avenue	05:30 - 09:00
I-10	EB	19th Avenue	05:30 - 09:00 15:00 - 19:00
I-10	EB	7th Street	15:00 - 19:00
I-10	EB	Broadway Road	15:00 - 19:00
I-10	EB	Baseline Road	15:00 - 19:00
I-10	WB	Washington Street	15:00 - 19:00
I-10	WB	7th Avenue	15:00 - 19:00
I-10	WB	27th Avenue	15:00 - 19:00
I-10	WB	35th Avenue	15:00 - 19:00
I-10	WB	43rd Avenue	15:00 - 19:00
I-10	WB	51st Avenue	15:00 - 19:00
I-10	WB	59th Avenue	15:00 - 19:00
I-17	NB	Grant Street	15:00 - 19:00
I-17	NB	Adams Street	15:00 - 19:00
I-17	NB	McDowell Road	15:00 - 19:00
I-17	NB	Thomas Road	15:00 - 19:00
I-17	NB	Indian School Road	15:00 - 19:00
I-17	NB	Camelback Road	15:00 - 19:00
I-17	NB	Bethany Home Road	15:00 - 19:00
I-17	NB	Glendale Avenue	15:00 - 19:00
I-17	NB	Northern Avenue	15:00 - 19:00
I-17	NB	Dunlap Avenue	15:00 - 19:00
I-17	NB	Peoria Avenue	15:00 - 19:00
I-17	SB	Greenway Road	05:30 - 09:00
I-17	SB	Thunderbird Road	05:30 - 09:00
I-17	SB	Cactus Road	05:30 - 09:00
I-17	SB	Peoria Avenue	05:30 - 09:00
I-17	SB	Dunlap Avenue	05:30 - 09:00
I-17	SB	Northern Avenue	05:30 - 09:00
I-17	SB	Glendale Avenue	05:30 - 09:00
I-17	SB	Bethany Home Road	05:30 - 09:00
I-17	SB	Camelback Road	05:30 - 09:00
I-17	SB	Indian School Road	05:30 - 09:00
I-17	SB	Thomas Road	05:30 - 09:00
I-17	SB	McDowell Road	05:30 - 09:00

I-17	SB	Grant Street	05:30 - 09:00
SR-51	NB	McDowell Road	14:00 - 19:00
SR-51	NB	Thomas Road	14:00 - 19:00
SR-51	NB	Indian School Road	14:00 - 19:00
SR-51	NB	Colter Street	14:00 - 19:00
SR-51	NB	Bethany Home Road	14:00 - 19:00
SR-51	SB	Cactus Road	05:30 - 09:00
SR-51	SB	26th Street	05:30 - 09:00
SR-51	SB	Northern Avenue	05:30 - 09:00
SR-51	SB	Glendale Avenue	05:30 - 09:00
SR-51	SB	Bethany Home Road	05:30 - 09:00 15:00 - 19:00
SR-51	SB	Highland Avenue	05:30 - 09:00 15:00 - 19:00
SR-51	SB	Indian School Road	05:30 - 09:00 14:00 - 19:00
SR-51	SB	Thomas Road	05:30 - 09:00 14:00 - 19:00
SR-202	EB	24th Street	05:30 - 09:00 15:00 - 19:00
SR-202	EB	32nd Street	05:30 - 09:00 15:00 - 19:00
SR-202	EB	44th Street	05:30 - 09:00 15:00 - 19:00
SR-202	WB	40th Street	05:30 - 09:00 15:00 - 19:00
SR-202	WB	32nd Street	05:30 - 09:00 15:00 - 19:01
SR-202	WB	24th Street	05:30 - 09:00 15:00 - 19:02
SR-101	WB	27th Avenue	14:00 - 19:00
US-60	EB	Priest Drive	14:00 - 19:00
US-60	EB	Mill Avenue	14:00 - 19:00
US-60	EB	Rural Road	14:00 - 19:00
US-60	EB	McClintock Drive	15:00 - 19:00
US-60	EB	Dobson Road	14:00 - 19:00
US-60	EB	Alama School Road	14:00 - 19:00
US-60	EB	Country Club Drive	14:00 - 19:00
US-60	EB	Mesa Drive	14:00 - 19:00
US-60	EB	Stapely Drive	14:00 - 19:00
US-60	EB	Gilbert Road	14:00 - 19:00
US-60	EB	Val Vista Road	14:00 - 19:00
US-60	EB	Greenfield Road	14:00 - 19:00

US-60	EB	Higley Road	14:00 - 19:00
US-60	EB	Power Road	14:00 - 19:00
US-60	WB	Power Road	05:30 - 09:00
US-60	WB	Superstition Blvd	05:30 - 09:00
US-60	WB	Higley Road	05:30 - 09:00
US-60	WB	Greenfield Road	05:30 - 09:00 15:00-18:00
US-60	WB	Val Vista Road	05:30 - 09:00 15:00-18:000
US-60	WB	Gilbert Road	05:30 - 09:00 15:00-18:00
US-60	WB	Stapley Drive	05:30 - 09:00 15:00-18:00
US-60	WB	Mesa Drive	05:30 - 09:00
US-60	WB	Country Club Drive	05:30 - 09:00
US-60	WB	Alma School Road	05:30 - 09:00
US-60	WB	McClintock Drive	05:30 - 09:00
US-60	WB	Rural Road	05:30 - 09:00
US-60	WB	Mill Avenue	05:30 - 09:00

.

MAG REGIONAL FREEWAY BOTTLENECK STUDY

TASK 5
TRAFFIC DATA WORKING PAPER
TRAFFIC VOLUME MAPS
(DRAFT)

MAY 23, 2002

***Submitted to*:**
THE MARICOPA ASSOCIATION OF GOVERNMENTS

***Prepared by*:**

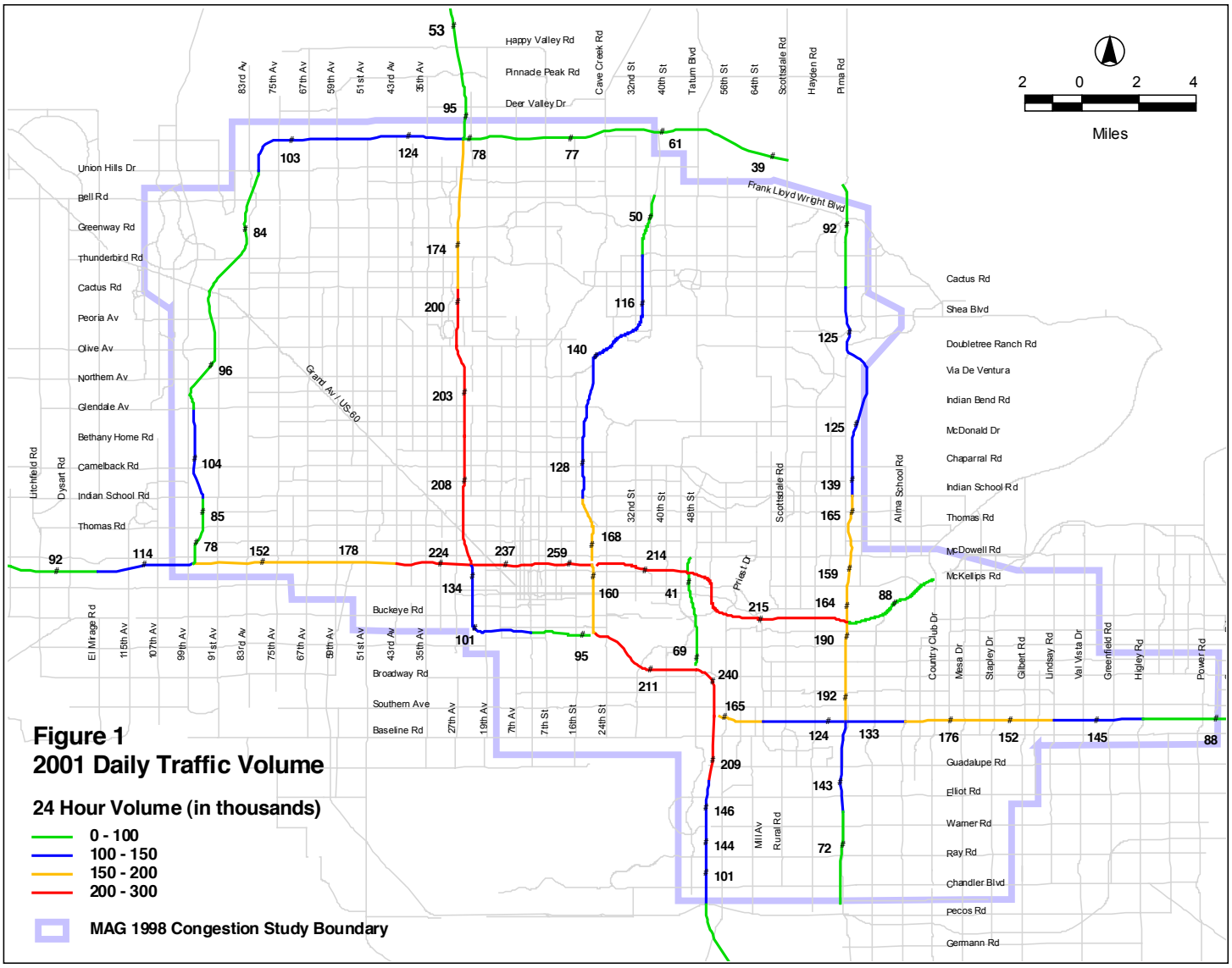
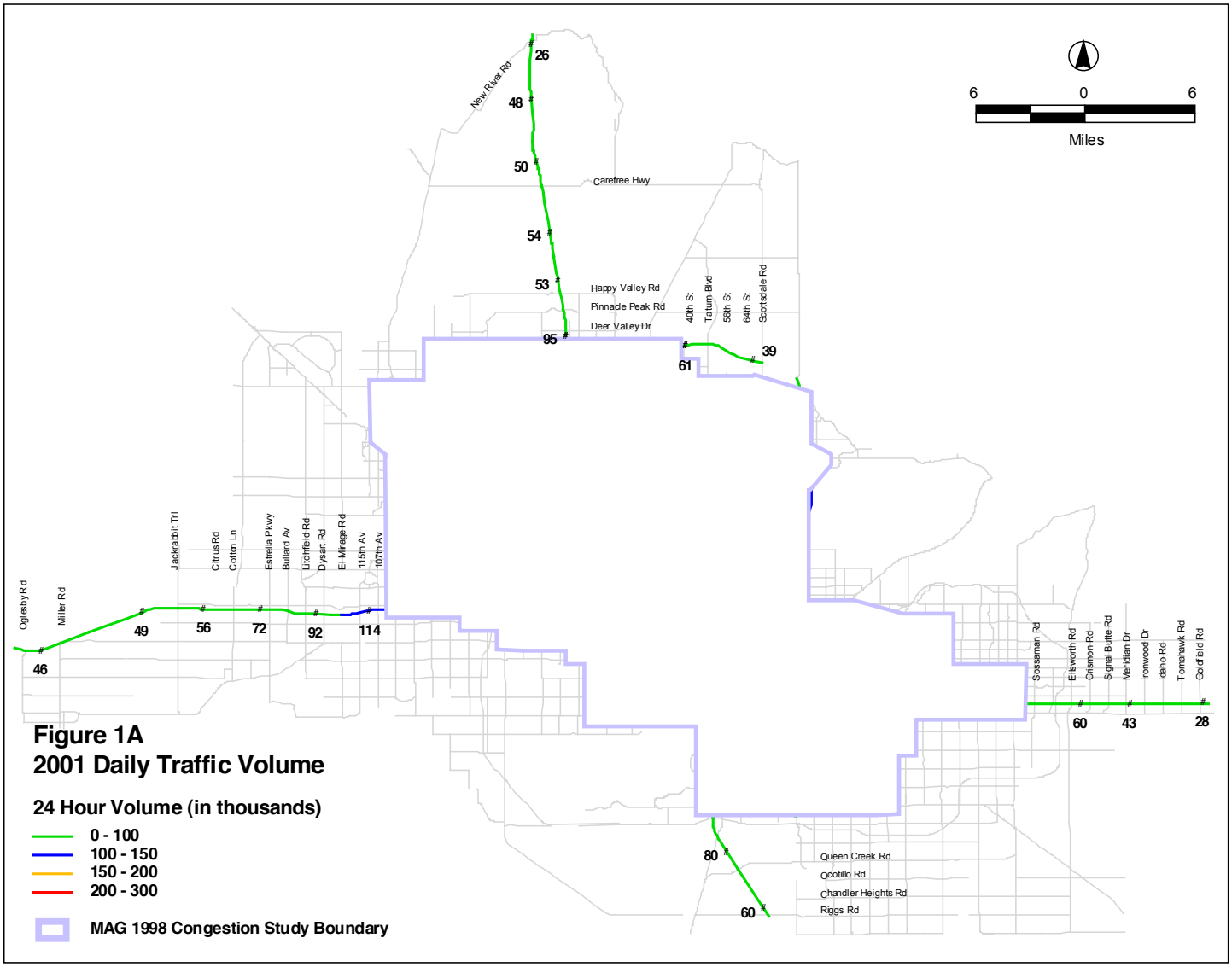


Figure 1
2001 Daily Traffic Volume

24 Hour Volume (in thousands)

- 0 - 100
- 100 - 150
- 150 - 200
- 200 - 300

MAG 1998 Congestion Study Boundary


6 0 6
Miles
New River Rd
Carefree Hwy
Happy Valley Rd
Pinnacle Peak Rd
Deer Valley Dr
40th St
Tatum Blvd
56th St
64th St
Scottsdale Rd
Ogleby Rd
Miller Rd
Jackrabbit Trl
Citrus Rd
Cotton Ln
Estrella Pkwy
Bullard Av
Litchfield Rd
Dysart Rd
El Mirage Rd
115th Av
107th Av
Sossaman Rd
Ellsworth Rd
Crismon Rd
Signal Butte Rd
Meridian Dr
Ironwood Dr
Idaho Rd
Tomahawk Rd
Goldfield Rd
Queen Creek Rd
Ocotillo Rd
Chandler Heights Rd
Riggs Rd
26
48
50
54
53
95
61
39
46
49
56
72
92
114
60
43
28
80
60
Figure 1A
2001 Daily Traffic Volume
24 Hour Volume (in thousands)
0 - 100
100 - 150
150 - 200
200 - 300
MAG 1998 Congestion Study Boundary

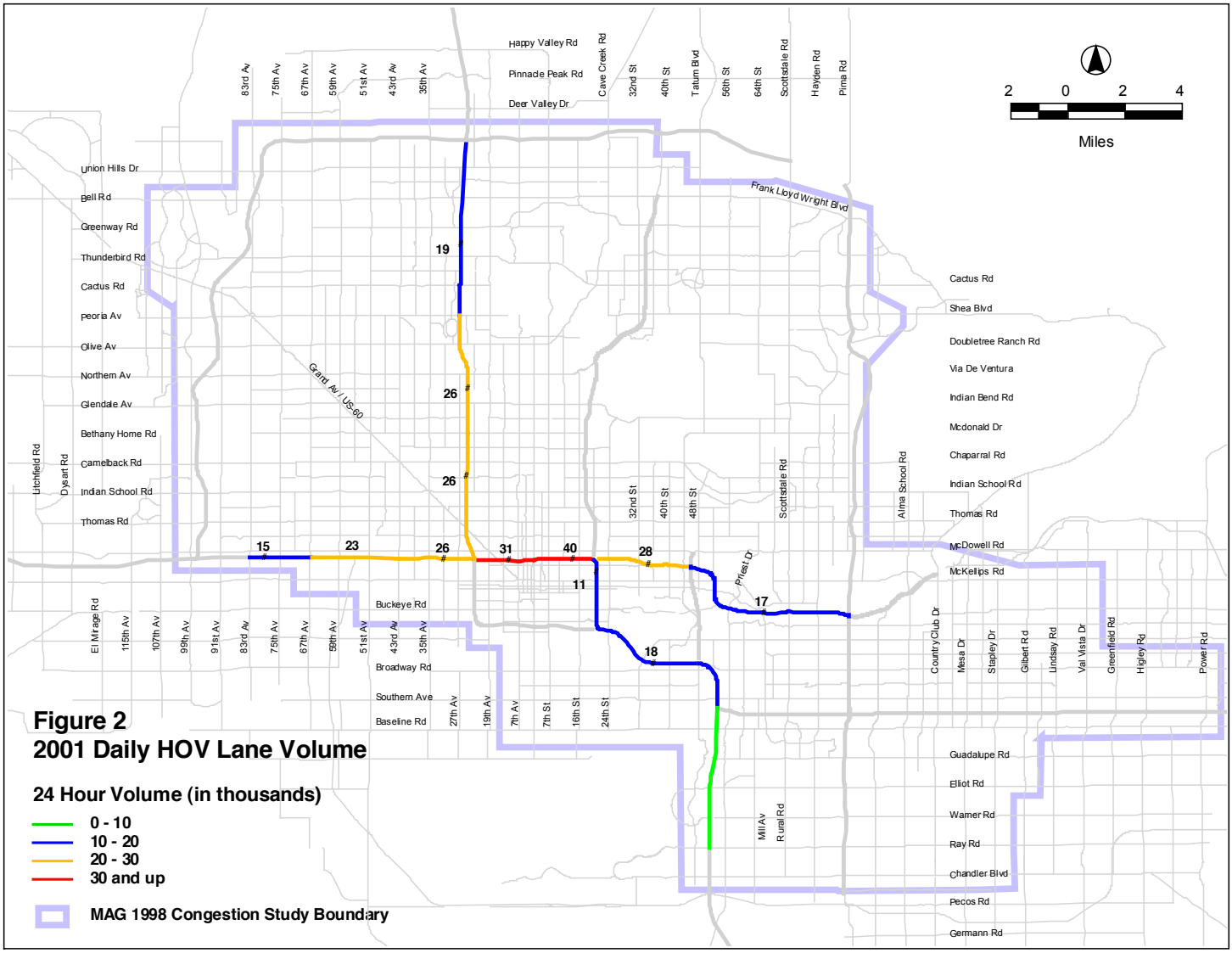


Figure 2
2001 Daily HOV Lane Volume

24 Hour Volume (in thousands)

- 0 - 10
- 10 - 20
- 20 - 30
- 30 and up

MAG 1998 Congestion Study Boundary

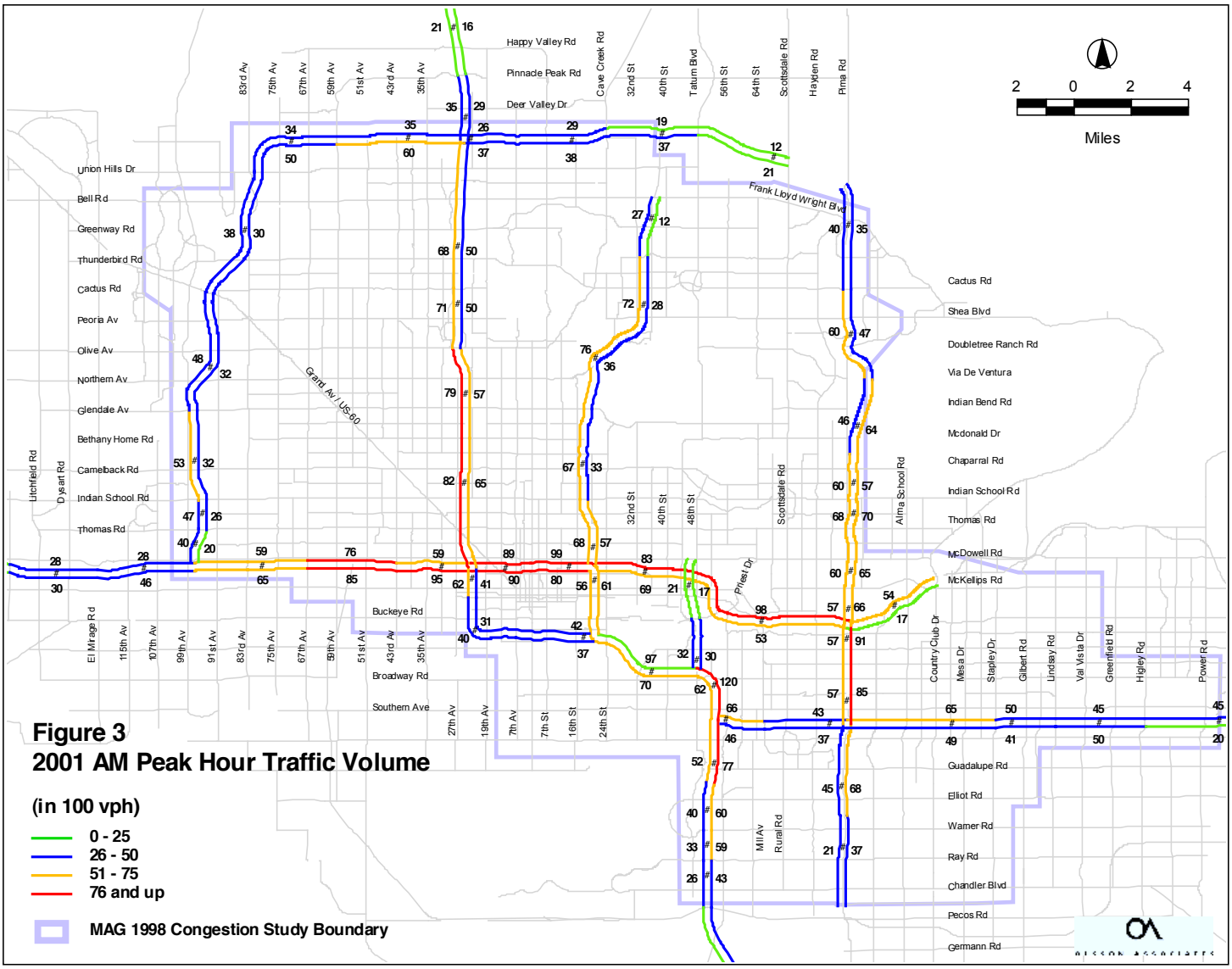
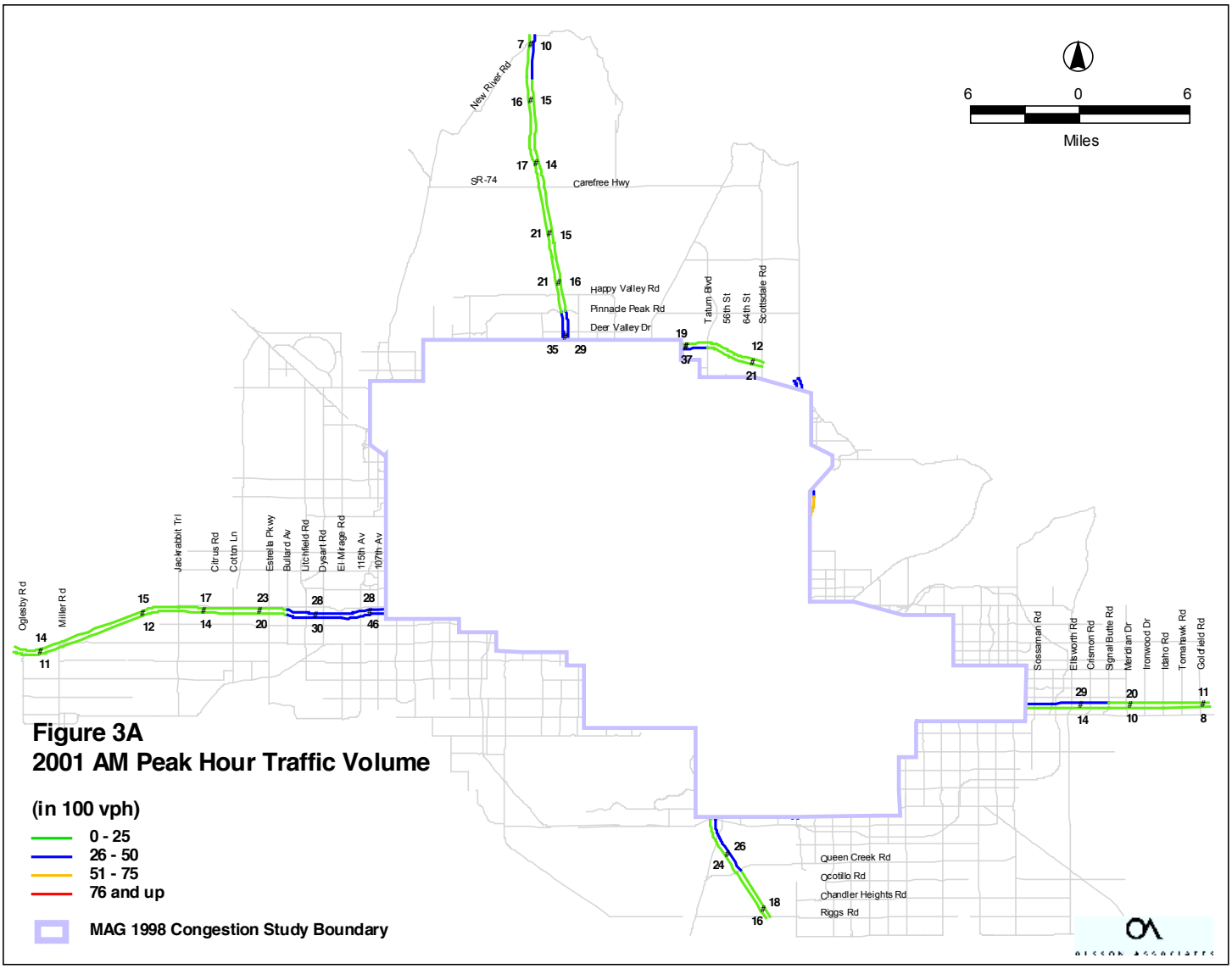


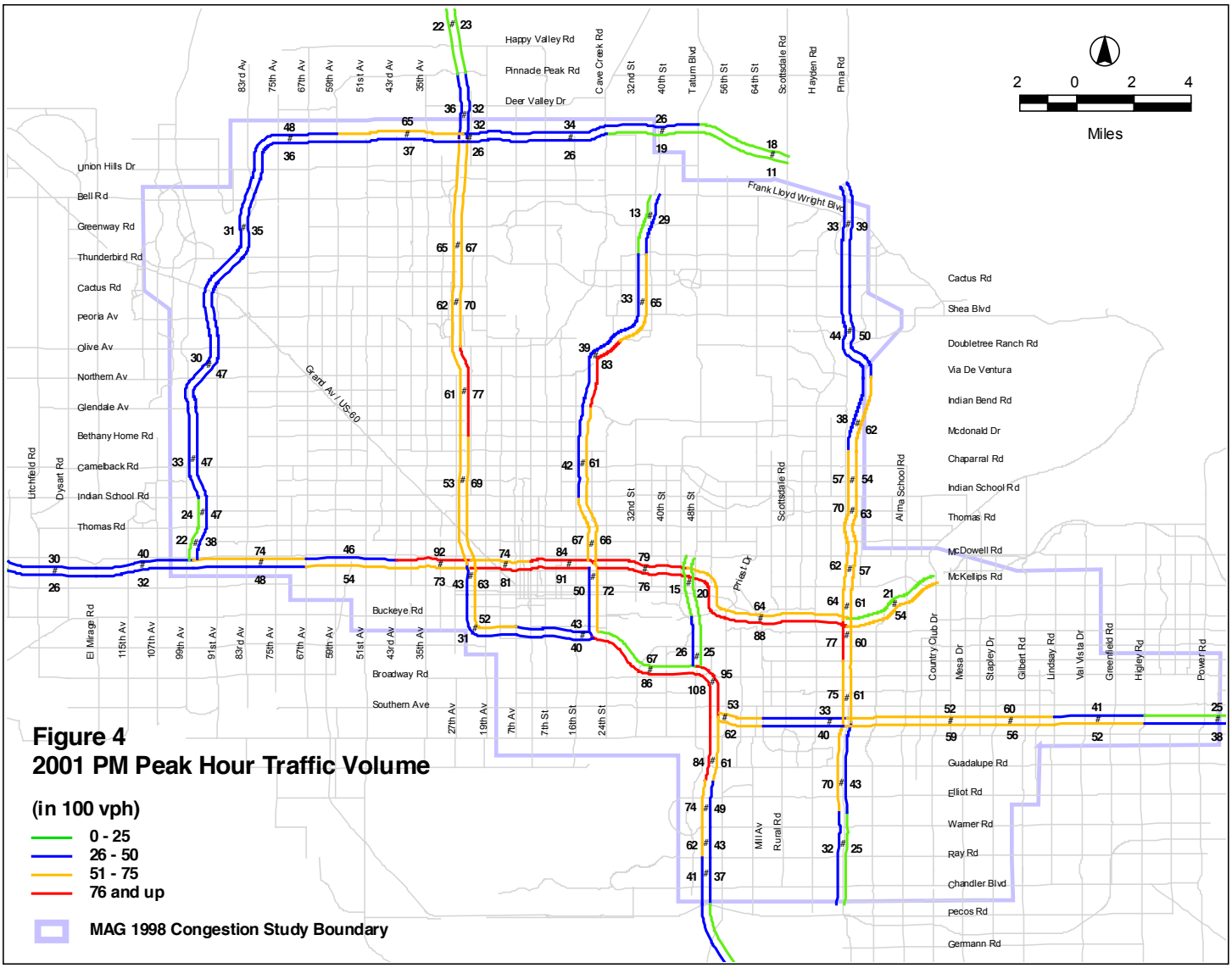
Figure 3
2001 AM Peak Hour Traffic Volume

(in 100 vph)

- 0 - 25
- 26 - 50
- 51 - 75
- 76 and up

MAG 1998 Congestion Study Boundary


6 0 6
Miles
New River Rd
SR-74
Carefree Hwy
Happy Valley Rd
Pinnacle Peak Rd
Deer Valley Dr
Tatum Blvd
56th St
64th St
Scottsdale Rd
Ogilesby Rd
Miller Rd
Jackrabbit Trl
Citrus Rd
Cotton Ln
Estrella Pkwy
Bullard Av
Litchfield Rd
Dysart Rd
El Mirage Rd
115th Av
107th Av
Sossaman Rd
Ellsworth Rd
Crismon Rd
Signal Butte Rd
Meridian Dr
Ironwood Dr
Idaho Rd
Tomahawk Rd
Goldfield Rd
Queen Creek Rd
Ocotillo Rd
Chandler Heights Rd
Riggs Rd
Figure 3A
2001 AM Peak Hour Traffic Volume
(in 100 vph)
0 - 25
26 - 50
51 - 75
76 and up
MAG 1998 Congestion Study Boundary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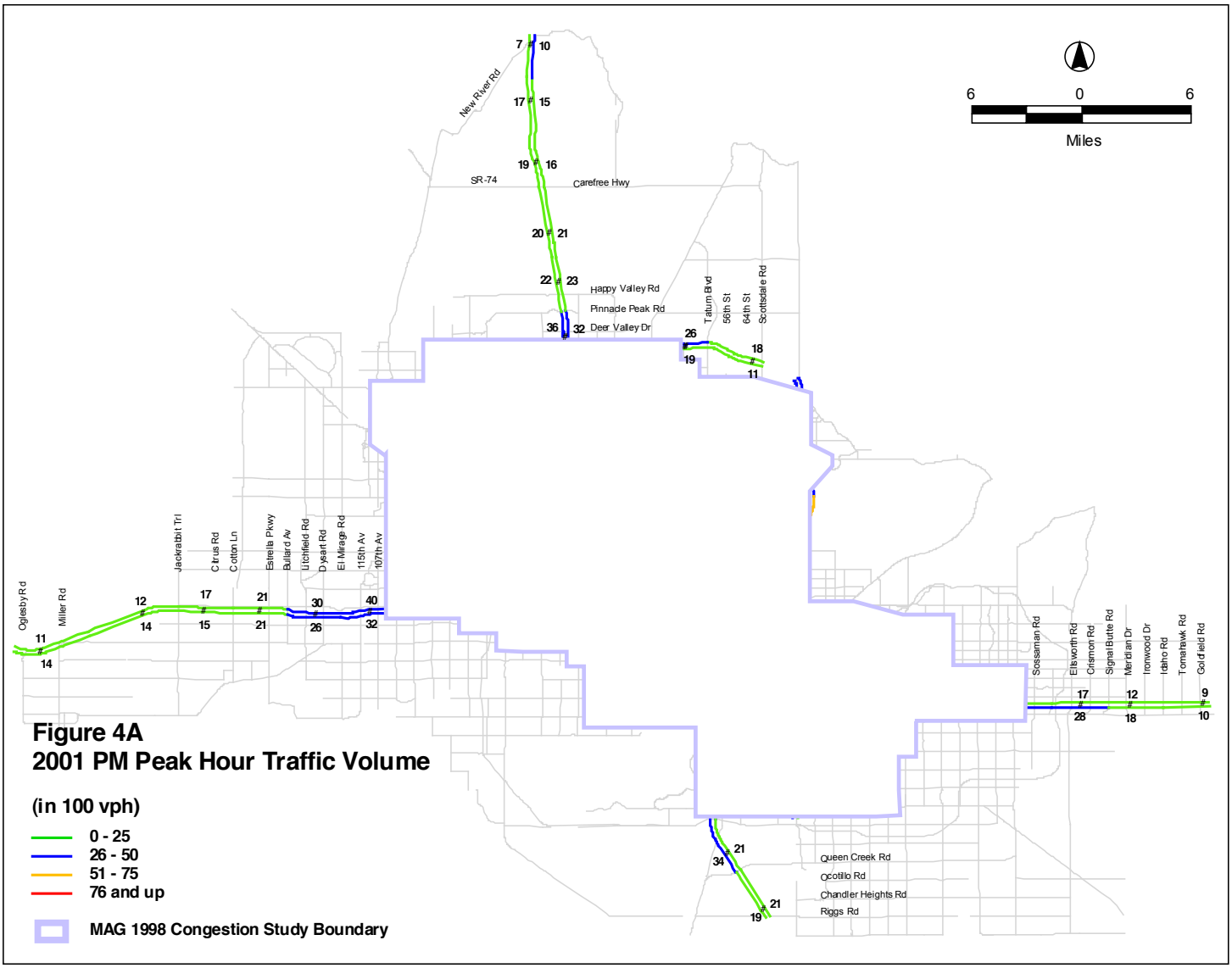
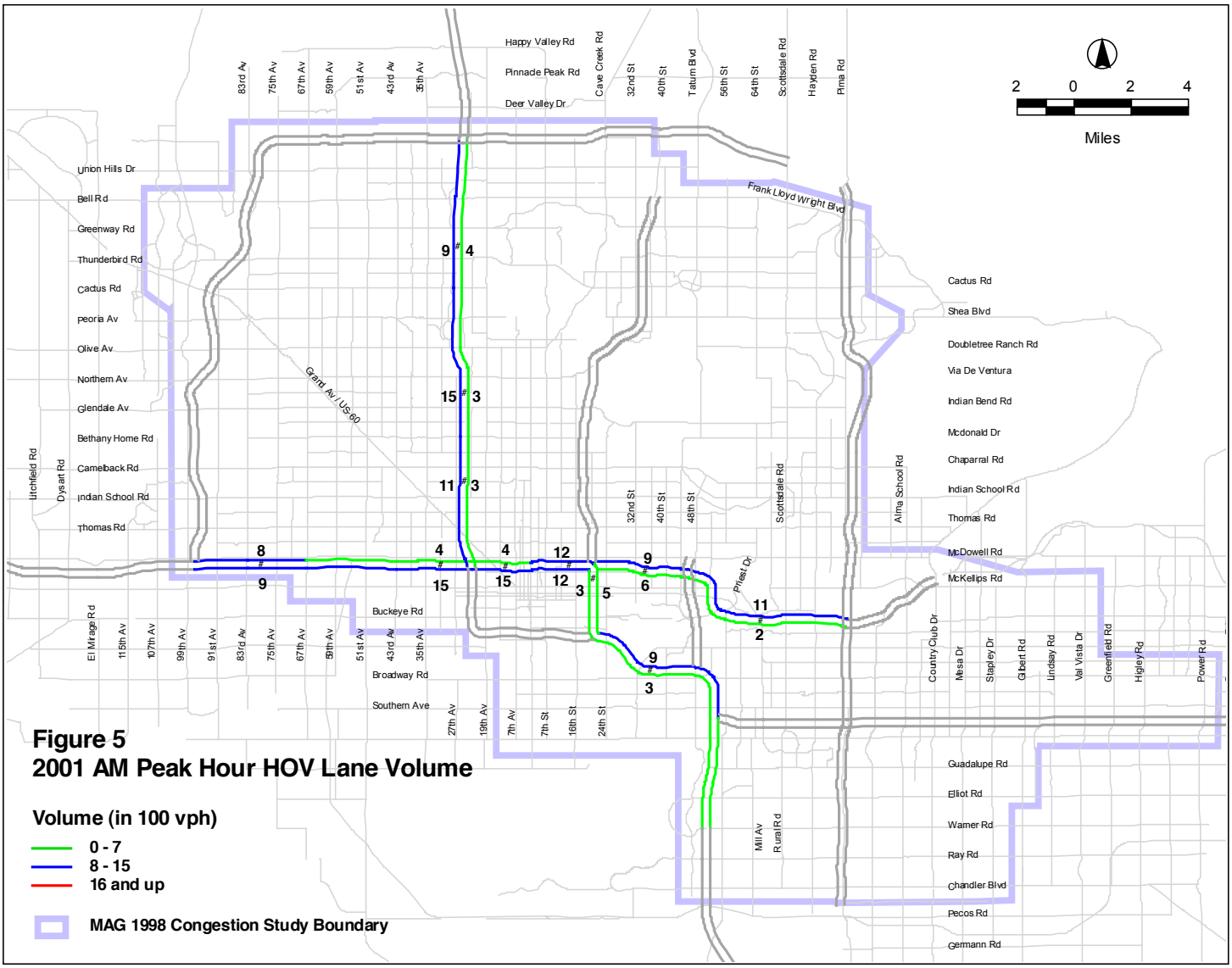
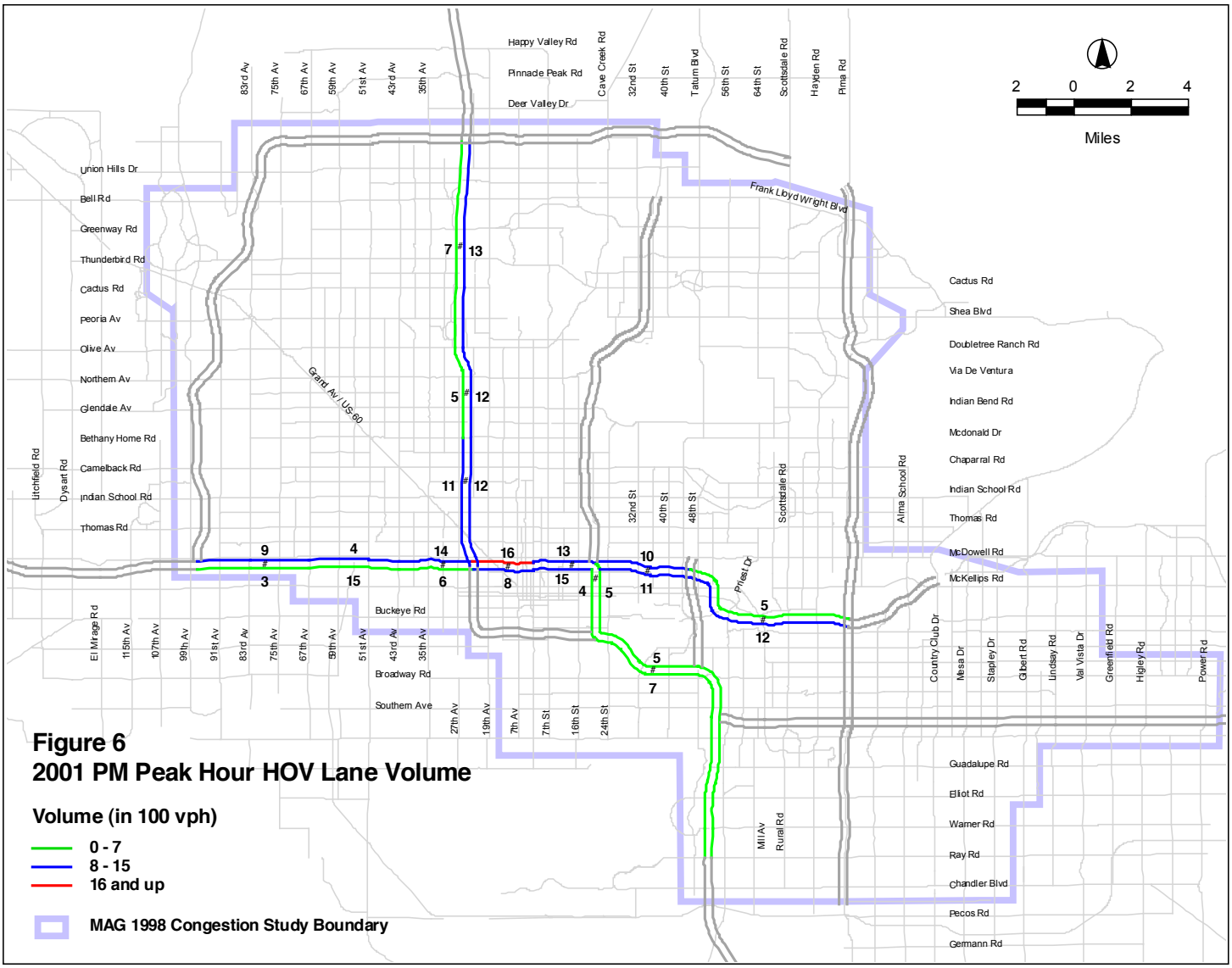
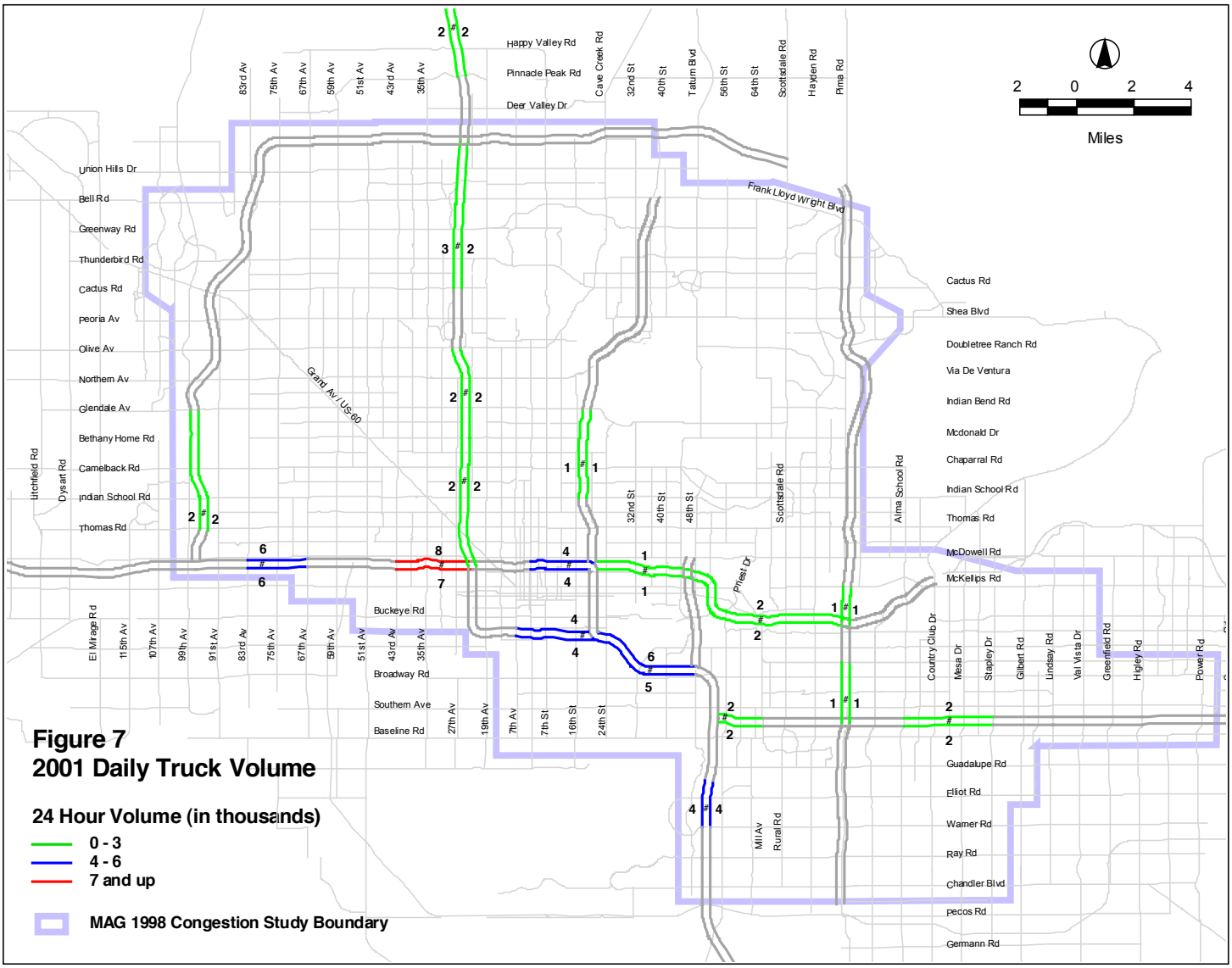
Pinnacle Peak Rd
Deer Valley Dr
Union Hills Dr
Bell Rd
Greenway Rd
Thunderbird Rd
Cactus Rd
Peoria Av
Olive Av
Northern Av
Glendale Av
Bethany Home Rd
Camelback Rd
Indian School Rd
Thomas Rd
Buckeye Rd
Broadway Rd
Southern Ave
Grand Av / US-60
Frank Lloyd Wright Blvd
Cactus Rd
Shea Blvd
Doubletree Ranch Rd
Via De Ventura
Indian Bend Rd
Mcdonald Dr
Chaparral Rd
Indian School Rd
Thomas Rd
McDowell Rd
McKellips Rd
Guadalupe Rd
Elliot Rd
Warner Rd
Ray Rd
Chandler Blvd
Pecos Rd
Germann Rd
Litchfield Rd
Dysart Rd
El Mirage Rd
115th Av
107th Av
99th Av
91st Av
83rd Av
75th Av
67th Av
59th Av
51st Av
43rd Av
35th Av
27th Av
19th Av
7th Av
7th St
16th St
24th St
32nd St
40th St
48th St
56th St
64th St
Scottsdale Rd
Hayden Rd
Pima Rd
Cave Creek Rd
Tatum Blvd
Alma School Rd
Priest Dr
Mill Av
Rural Rd
Country Club Dr
Mesa Dr
Stapley Dr
Gilbert Rd
Lindsay Rd
Val Vista Dr
Greenfield Rd
Higley Rd
Power Rd
2 0 2 4
Miles
Figure 4
2001 PM Peak Hour Traffic Volume
(in 100 vph)
0 - 25
26 - 50
51 - 75
76 and up
MAG 1998 Congestion Study Boundary


6 0 6
Miles
New River Rd
SR-74
Carefree Hwy
Happy Valley Rd
Pinnacle Peak Rd
Deer Valley Dr
Tatum Blvd
56th St
64th St
Scottsdale Rd
Ogilesby Rd
Miller Rd
Jackrabbit Trl
Citrus Rd
Cotton Ln
Estrella Pkwy
Bullard Av
Litchfield Rd
Dysart Rd
El Mirage Rd
115th Av
107th Av
Sossaman Rd
Ellsworth Rd
Crismon Rd
Signal Butte Rd
Meridian Dr
Ironwood Dr
Idaho Rd
Tomahawk Rd
Goldfield Rd
Queen Creek Rd
Ocotillo Rd
Chandler Heights Rd
Riggs Rd
Figure 4A
2001 PM Peak Hour Traffic Volume
(in 100 vph)
0 - 25
26 - 50
51 - 75
76 and up
MAG 1998 Congestion Study Boundary


Happy Valley Rd
Pinnacle Peak Rd
Deer Valley Dr
Cave Creek Rd
32nd St
40th St
Tatum Blvd
56th St
64th St
Scottsdale Rd
Hayden Rd
Pima Rd
83rd Av
75th Av
67th Av
59th Av
51st Av
43rd Av
35th Av
2 0 2 4
Miles
Union Hills Dr
Bell Rd
Greenway Rd
Thunderbird Rd
Cactus Rd
Peoria Av
Olive Av
Northern Av
Glendale Av
Bethany Home Rd
Camelback Rd
Indian School Rd
Thomas Rd
Litchfield Rd
Dysart Rd
Grand Av / US-60
Frank Lloyd Wright Blvd
Cactus Rd
Shea Blvd
Doubletree Ranch Rd
Via De Ventura
Indian Bend Rd
Mcdonald Dr
Chaparral Rd
Indian School Rd
Thomas Rd
McDowell Rd
McKellips Rd
Alma School Rd
Scottsdale Rd
Priest Dr
32nd St
40th St
48th St
9 # 4
15 # 3
11 # 3
8 # 9
4 # 15
4 # 15
12 # 12
3 5
9 # 6
11 # 2
9 # 3
Buckeye Rd
Broadway Rd
Southern Ave
El Mirage Rd
115th Av
107th Av
99th Av
91st Av
83rd Av
75th Av
67th Av
59th Av
51st Av
43rd Av
35th Av
27th Av
19th Av
7th Av
7th St
16th St
24th St
Country Club Dr
Mesa Dr
Stapley Dr
Gilbert Rd
Lindsay Rd
Val Vista Dr
Greenfield Rd
Higley Rd
Power Rd
Guadalupe Rd
Elliot Rd
Warner Rd
Ray Rd
Chandler Blvd
Pecos Rd
Germann Rd
Mill Av
Rural Rd
Figure 5
2001 AM Peak Hour HOV Lane Volume
Volume (in 100 vph)
0 - 7
8 - 15
16 and up
MAG 1998 Congestion Study Boundary


Happy Valley Rd
Pinnacle Peak Rd
Deer Valley Dr
Cave Creek Rd
Scottsdale Rd
Hayden Rd
Pima Rd
83rd Av
75th Av
67th Av
59th Av
51st Av
43rd Av
35th Av
32nd St
40th St
Tatum Blvd
56th St
64th St
2 0 2 4
Miles
Union Hills Dr
Bell Rd
Greenway Rd
Thunderbird Rd
Cactus Rd
Peoria Av
Olive Av
Northern Av
Glendale Av
Bethany Home Rd
Camelback Rd
Indian School Rd
Thomas Rd
Frank Lloyd Wright Blvd
Grand Av / Us 60
Litchfield Rd
Dysart Rd
Cactus Rd
Shea Blvd
Doubletree Ranch Rd
Via De Ventura
Indian Bend Rd
Mcdonald Dr
Chaparral Rd
Indian School Rd
Thomas Rd
McDowell Rd
McKellips Rd
Alma School Rd
48th St
Priest Dr
Buckeye Rd
Broadway Rd
Southern Ave
El Mirage Rd
115th Av
107th Av
99th Av
91st Av
27th Av
19th Av
7th Av
7th St
16th St
24th St
Country Club Dr
Mesa Dr
Stapley Dr
Gilbert Rd
Lindsay Rd
Val Vista Dr
Greenfield Rd
Higley Rd
Power Rd
Guadalupe Rd
Elliot Rd
Warner Rd
Ray Rd
Chandler Blvd
Pecos Rd
Germann Rd
Mill Av
Rural Rd
Figure 6
2001 PM Peak Hour HOV Lane Volume
Volume (in 100 vph)
0 - 7
8 - 15
16 and up
MAG 1998 Congestion Study Boundary


Happy Valley Rd
Pinnacle Peak Rd
Deer Valley Dr
Union Hills Dr
Bell Rd
Greenway Rd
Thunderbird Rd
Cactus Rd
Peoria Av
Olive Av
Northern Av
Glendale Av
Bethany Home Rd
Camelback Rd
Indian School Rd
Thomas Rd
Grand Av / US 60
Frank Lloyd Wright Blvd
Cactus Rd
Shea Blvd
Doubletree Ranch Rd
Via De Ventura
Indian Bend Rd
Mcdonald Dr
Chaparral Rd
Indian School Rd
Thomas Rd
McDowell Rd
McKellips Rd
Buckeye Rd
Broadway Rd
Southern Ave
Baseline Rd
Priest Dr
Guadalupe Rd
Elliot Rd
Warner Rd
Ray Rd
Chandler Blvd
pecos Rd
Germann Rd
Miles
2 0 2 4
Figure 7
2001 Daily Truck Volume
24 Hour Volume (in thousands)
0 - 3
4 - 6
7 and up
MAG 1998 Congestion Study Boundary

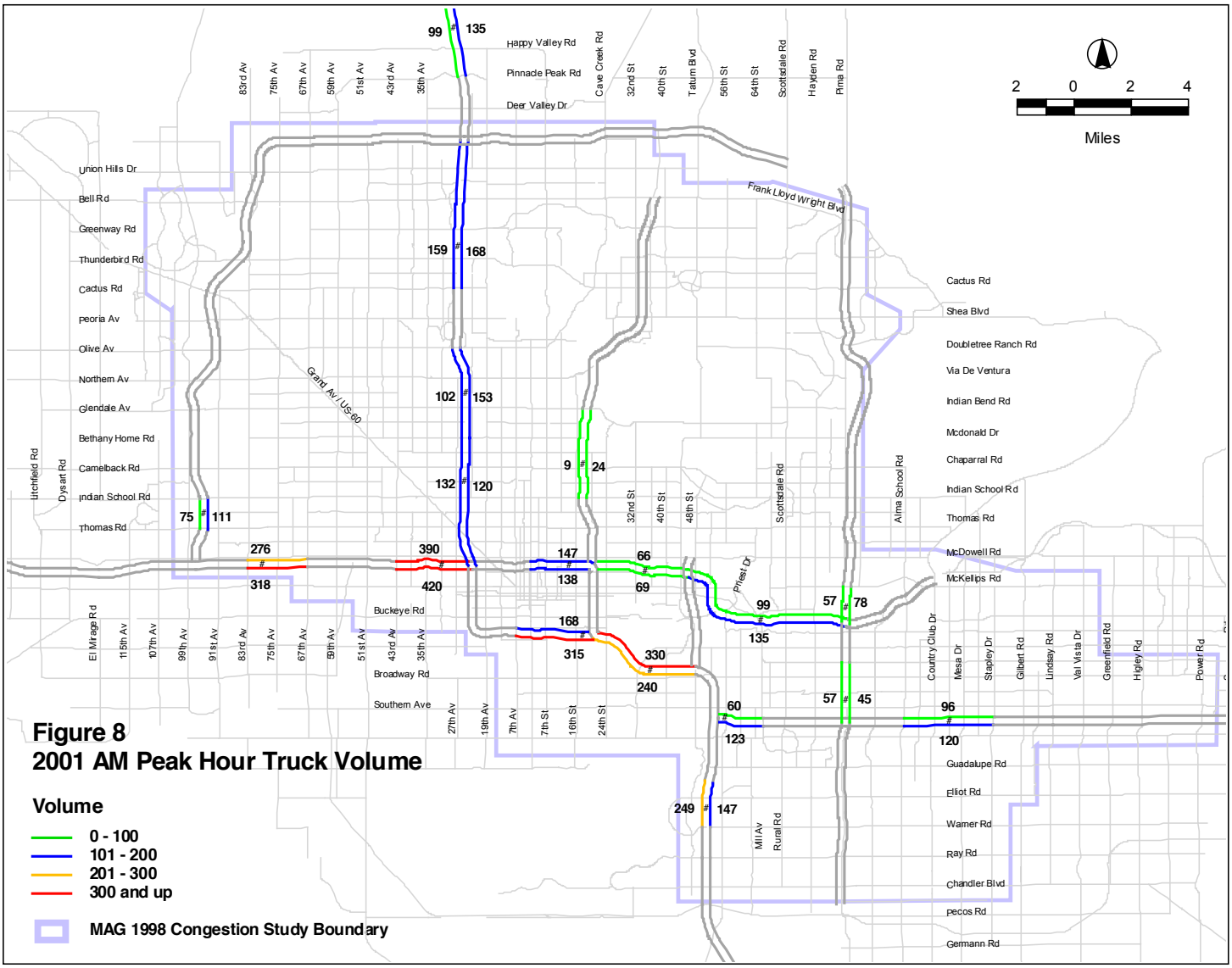


Figure 8
2001 AM Peak Hour Truck Volume

Volume

- 0 - 100
- 101 - 200
- 201 - 300
- 300 and up

MAG 1998 Congestion Study Boundary

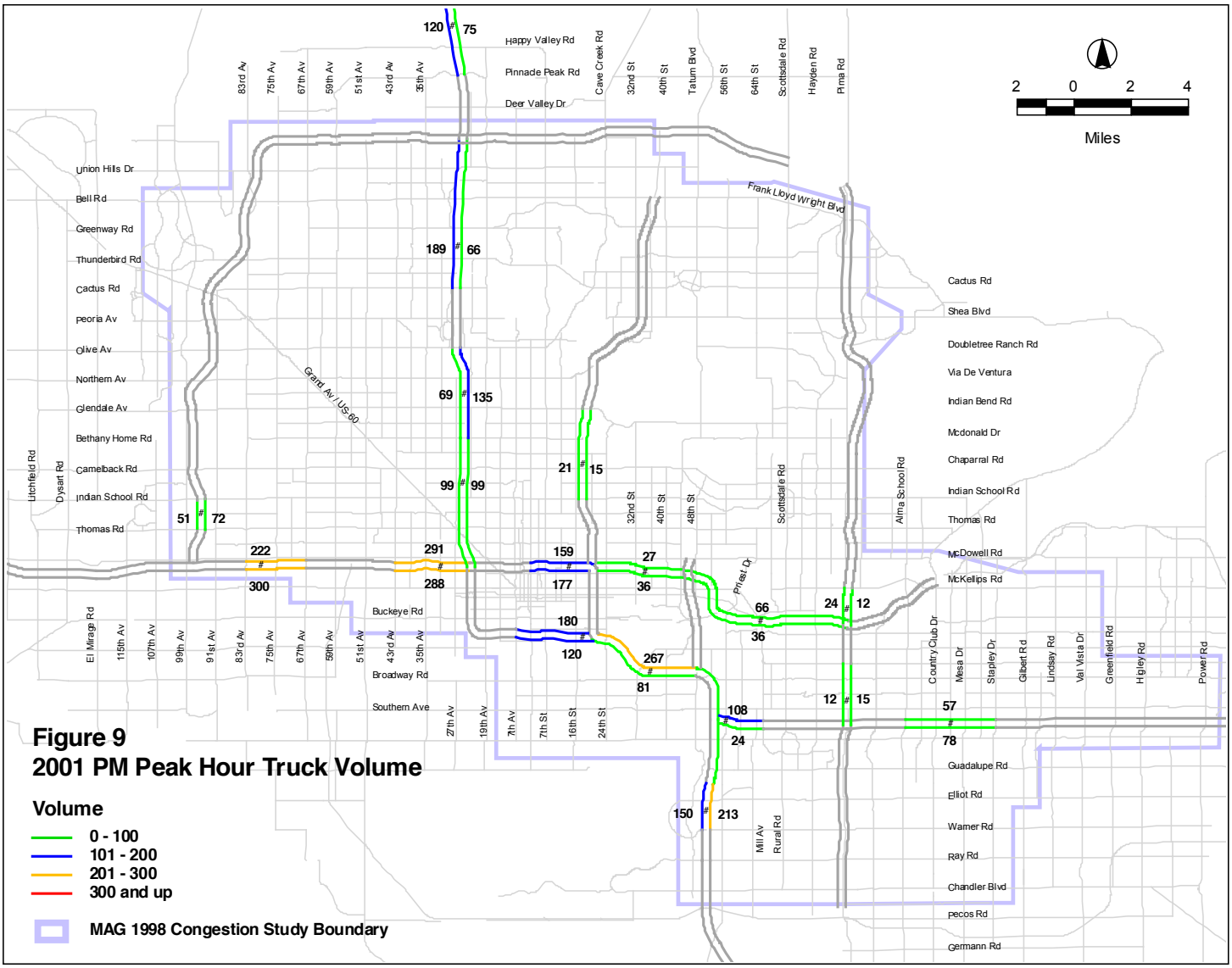


Figure 9
2001 PM Peak Hour Truck Volume

Volume

- 0 - 100
- 101 - 200
- 201 - 300
- 300 and up

MAG 1998 Congestion Study Boundary

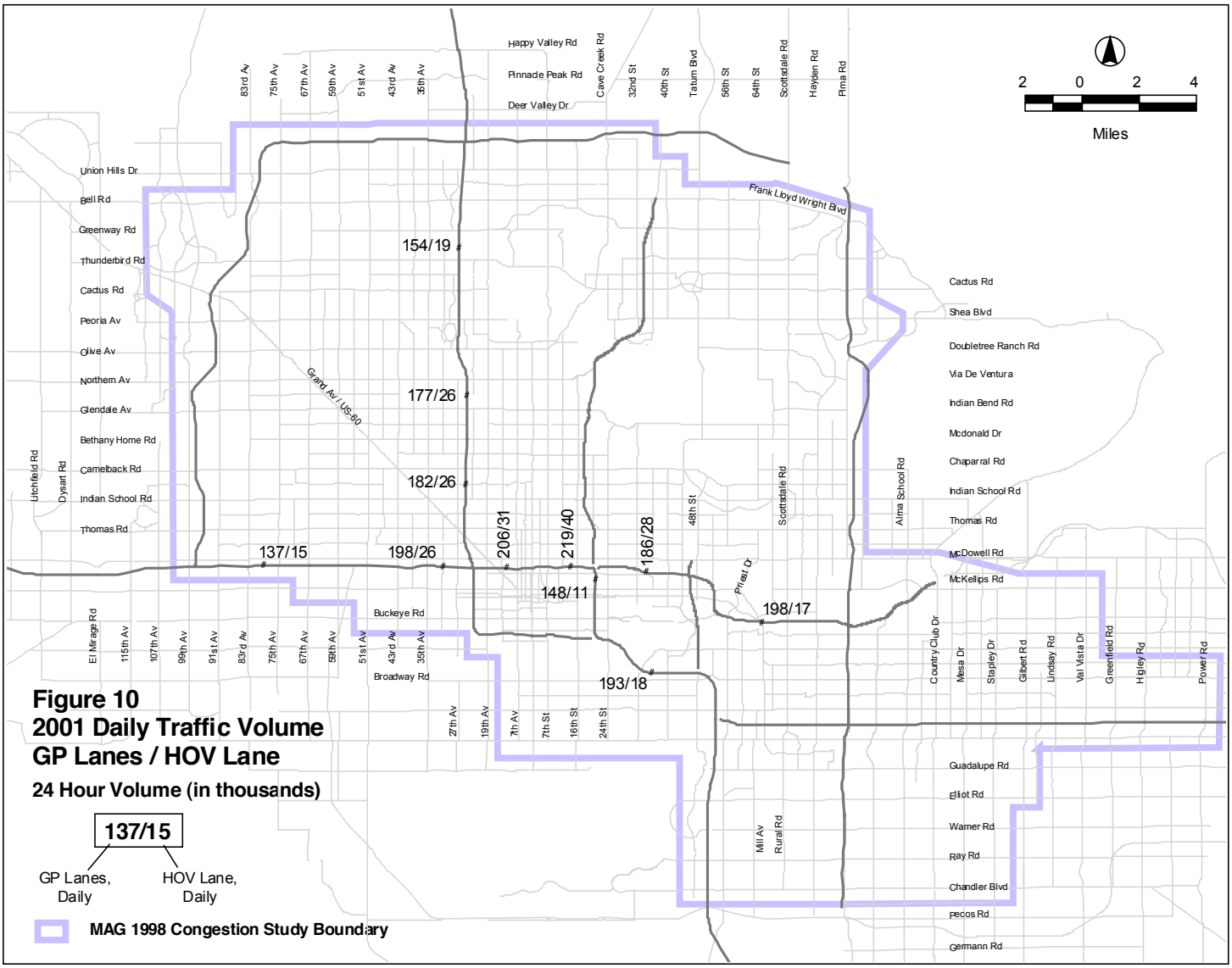


Figure 10
2001 Daily Traffic Volume
GP Lanes / HOV Lane
24 Hour Volume (in thousands)

137/15

GP Lanes, Daily — HOV Lane, Daily

MAG 1998 Congestion Study Boundary

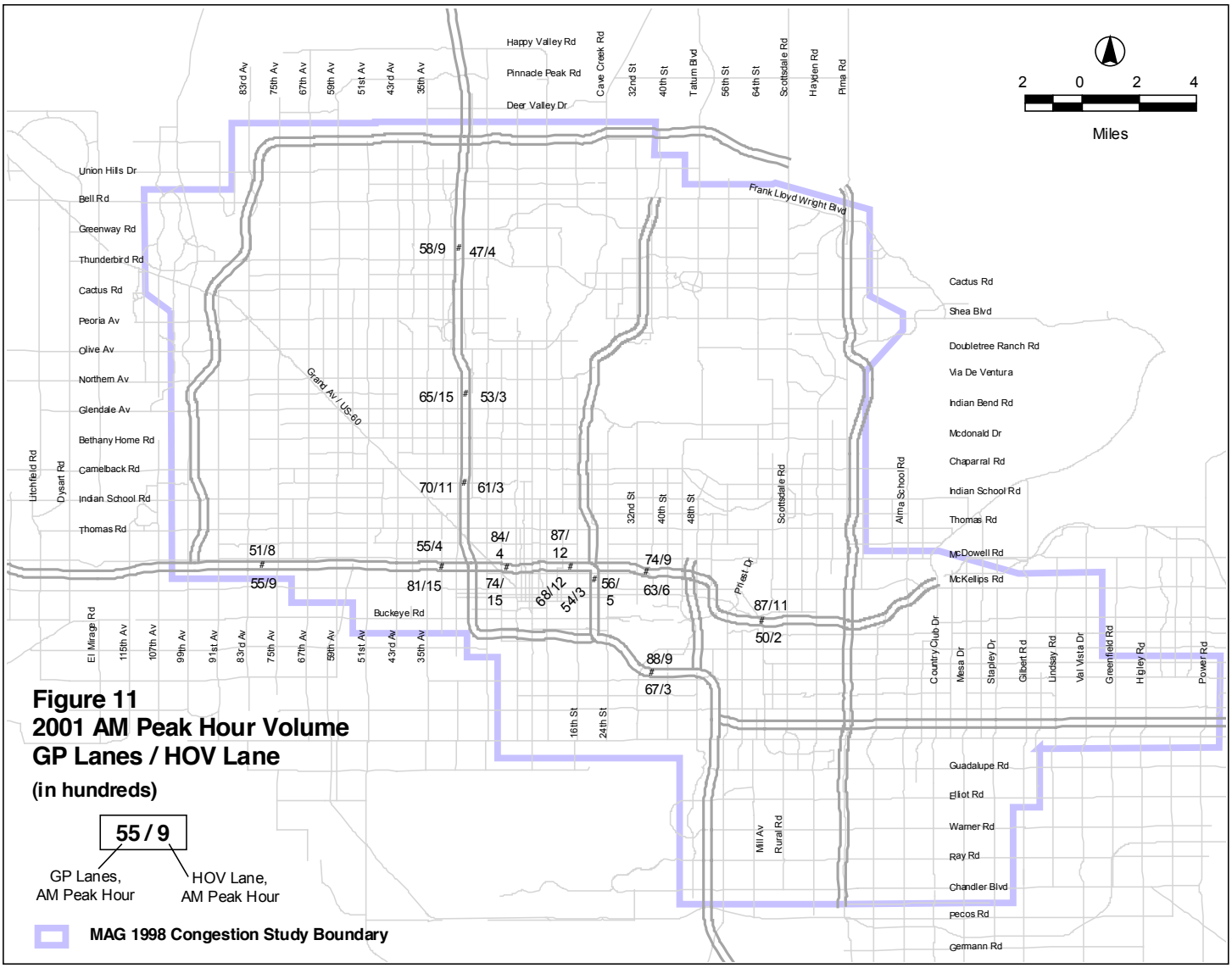


Figure 11
2001 AM Peak Hour Volume
GP Lanes / HOV Lane
(in hundreds)

55 / 9

GP Lanes, AM Peak Hour

HOV Lane, AM Peak Hour

MAG 1998 Congestion Study Boundary

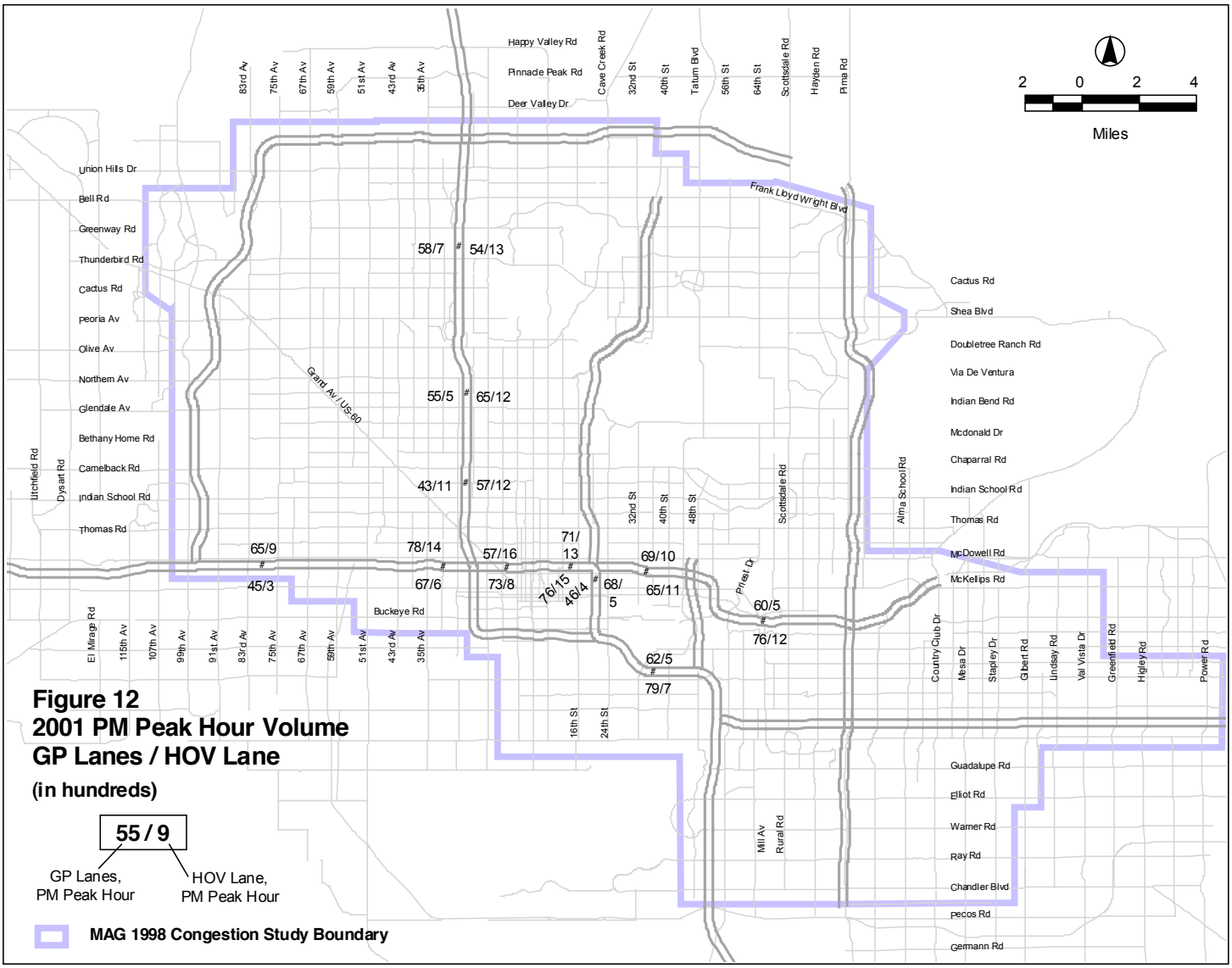


Figure 12
2001 PM Peak Hour Volume
GP Lanes / HOV Lane
(in hundreds)

55 / 9

GP Lanes, PM Peak Hour

HOV Lane, PM Peak Hour

MAG 1998 Congestion Study Boundary

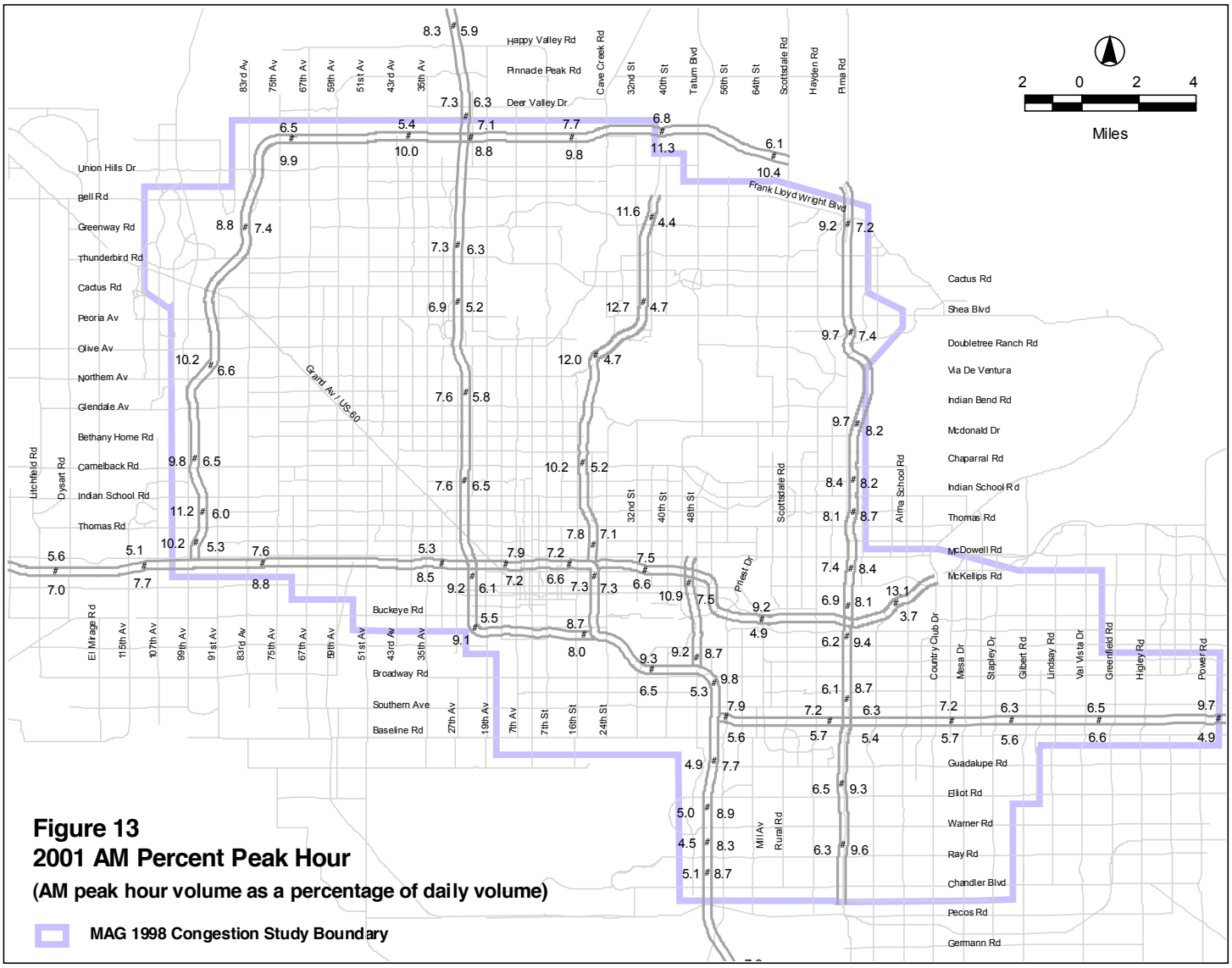


Figure 13
2001 AM Percent Peak Hour
(AM peak hour volume as a percentage of daily volume)

MAG 1998 Congestion Study Boundary

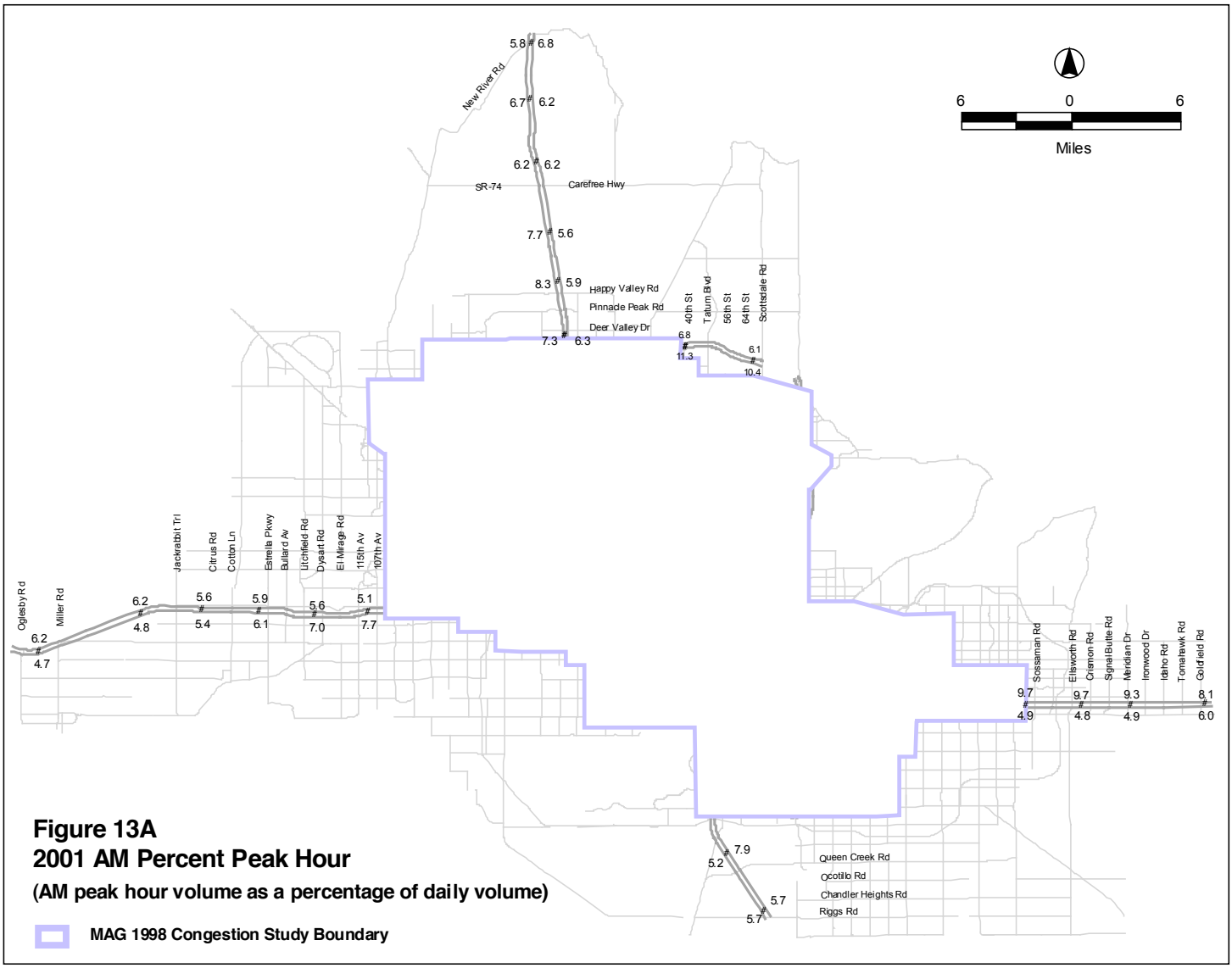


Figure 13A
2001 AM Percent Peak Hour
(AM peak hour volume as a percentage of daily volume)

MAG 1998 Congestion Study Boundary

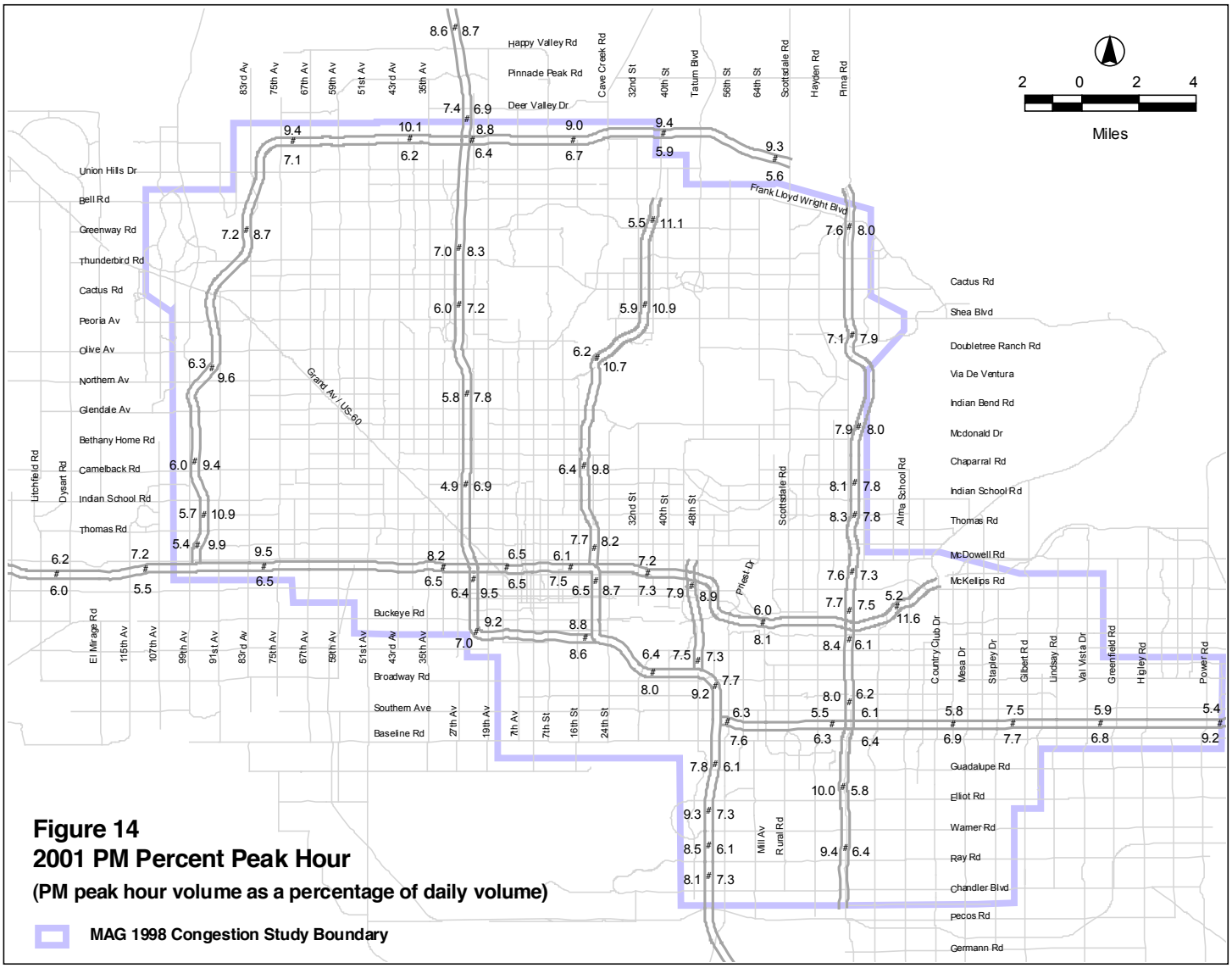


Figure 14
2001 PM Percent Peak Hour
(PM peak hour volume as a percentage of daily volume)

MAG 1998 Congestion Study Boundary

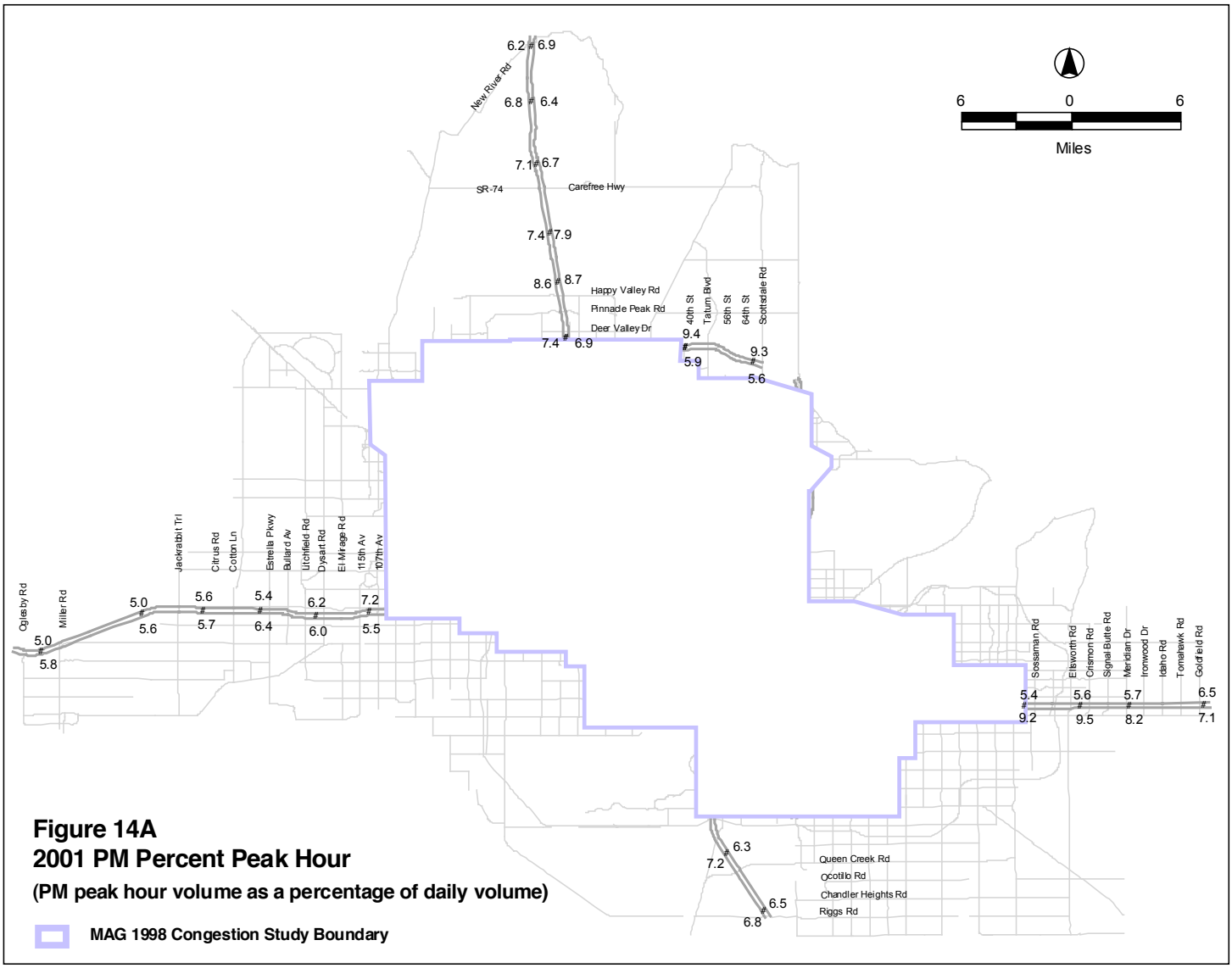


Figure 14A
2001 PM Percent Peak Hour
(PM peak hour volume as a percentage of daily volume)

MAG 1998 Congestion Study Boundary

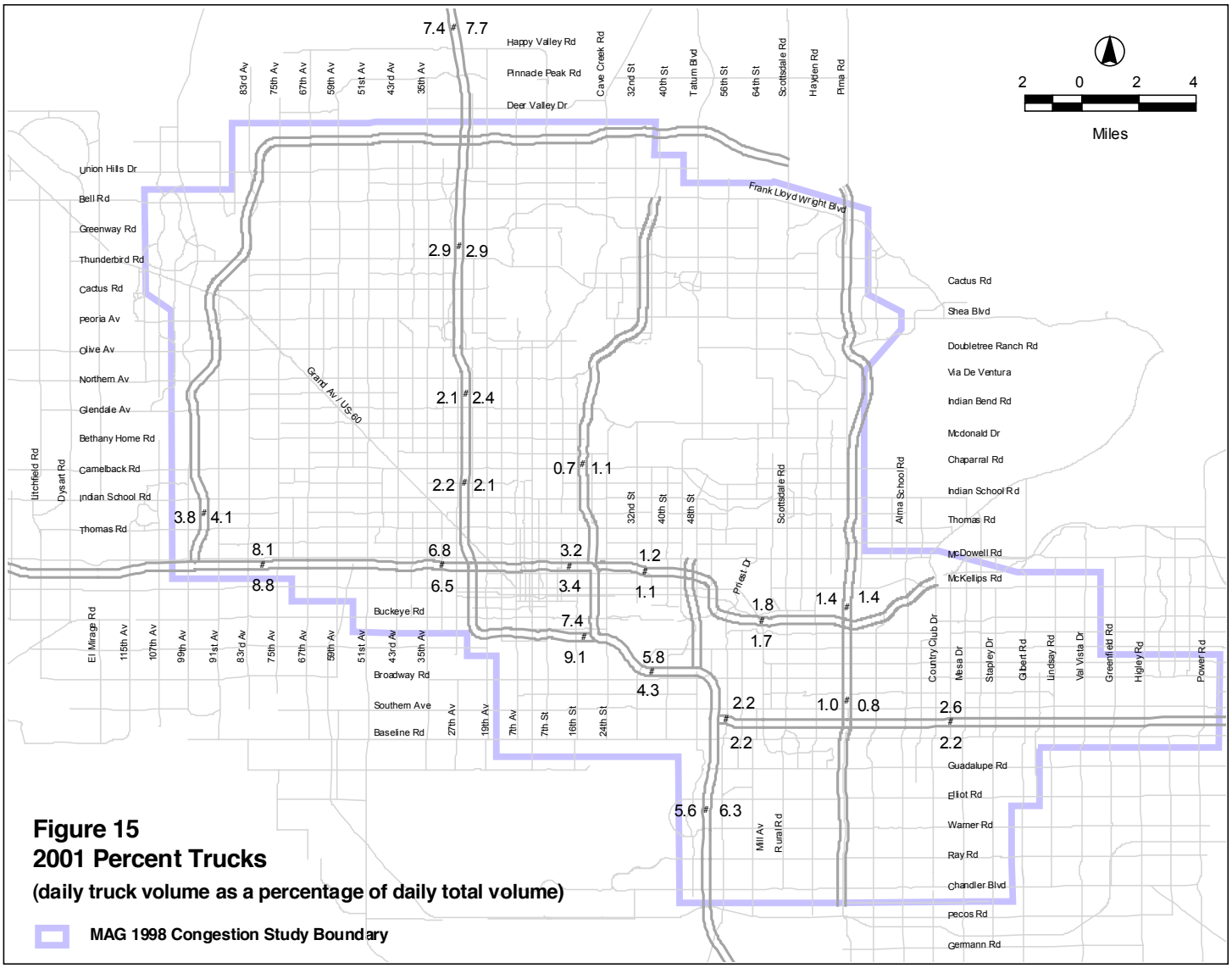


Figure 15
2001 Percent Trucks
(daily truck volume as a percentage of daily total volume)

MAG 1998 Congestion Study Boundary

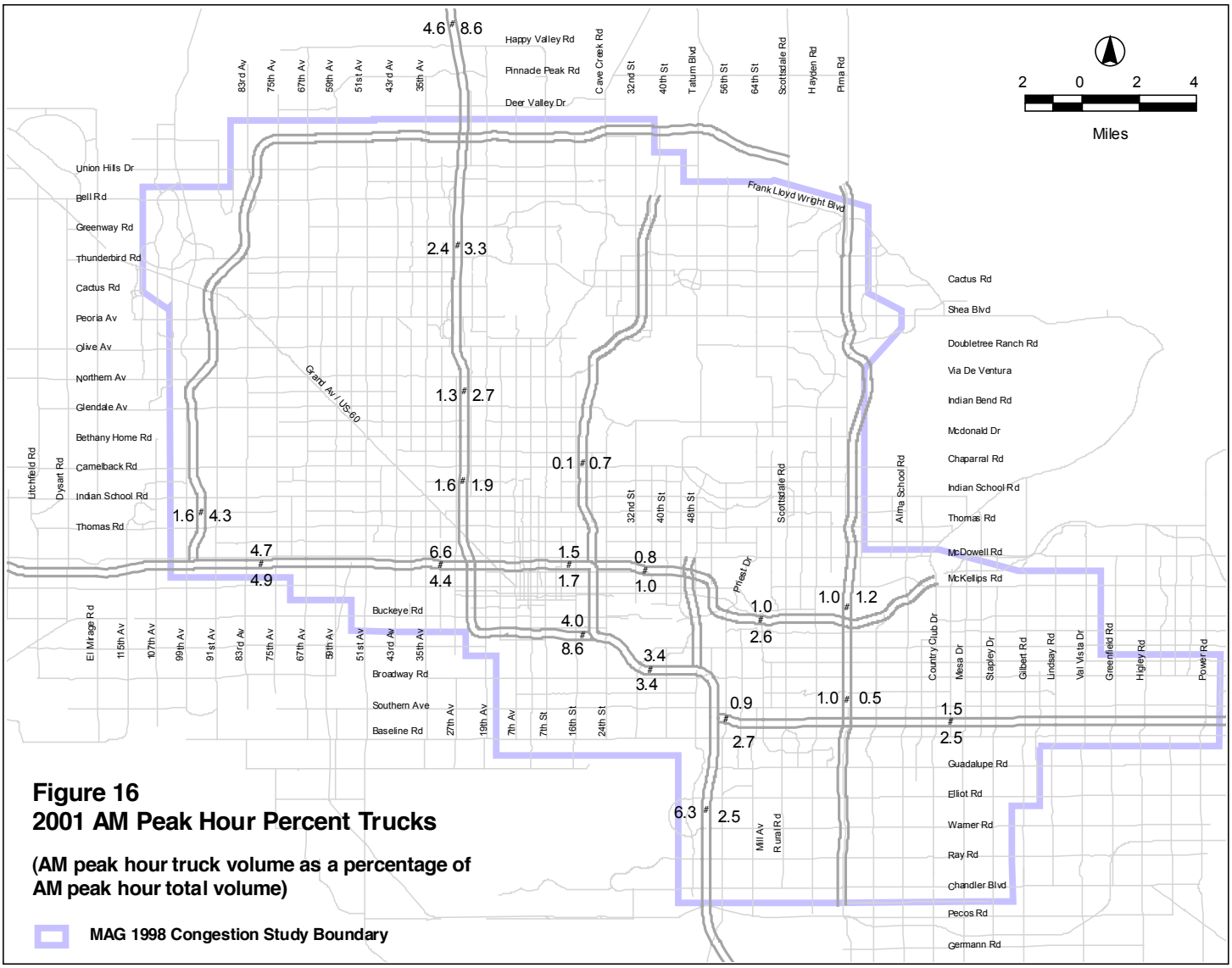


Figure 16
2001 AM Peak Hour Percent Trucks

(AM peak hour truck volume as a percentage of AM peak hour total volume)

MAG 1998 Congestion Study Boundary

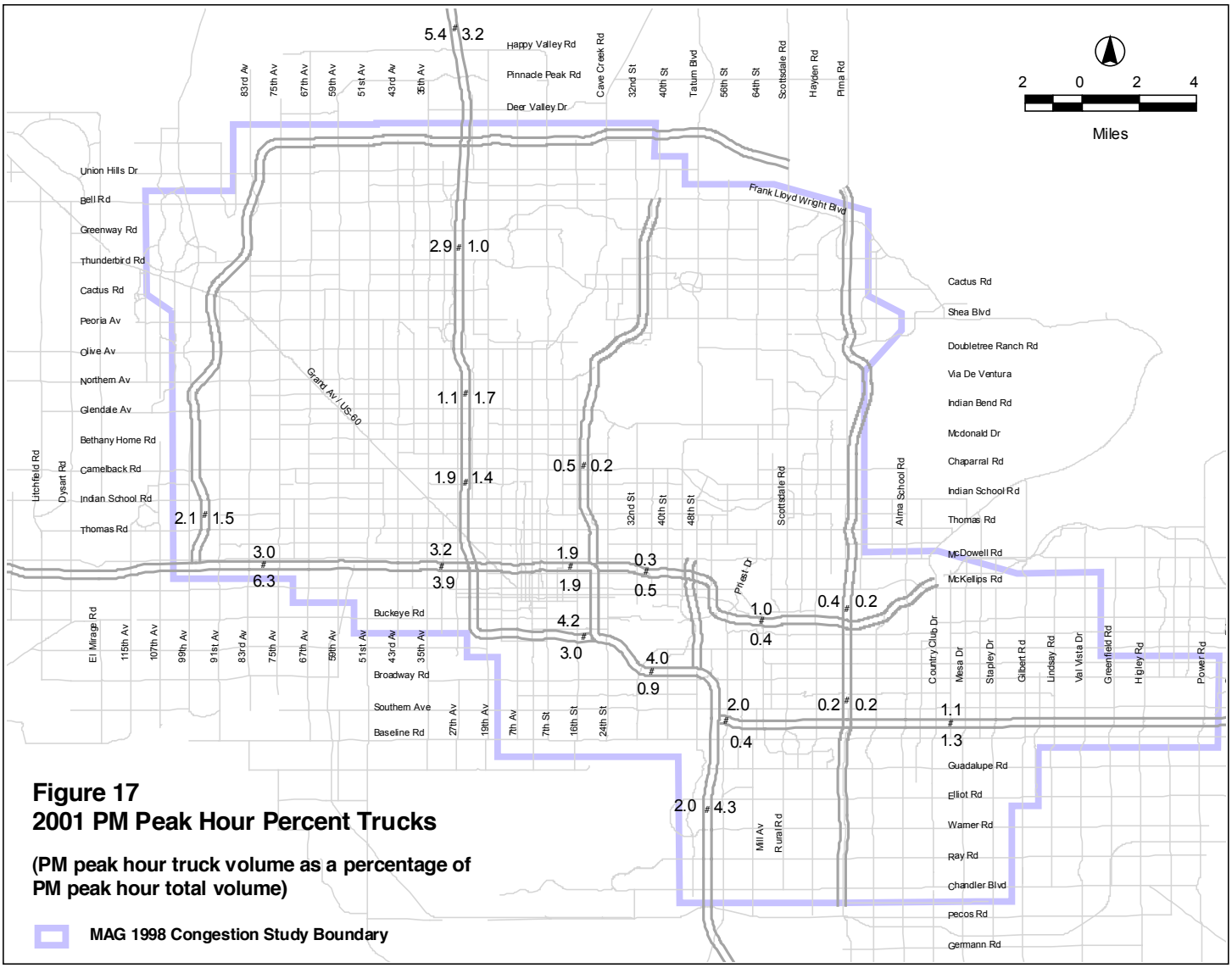


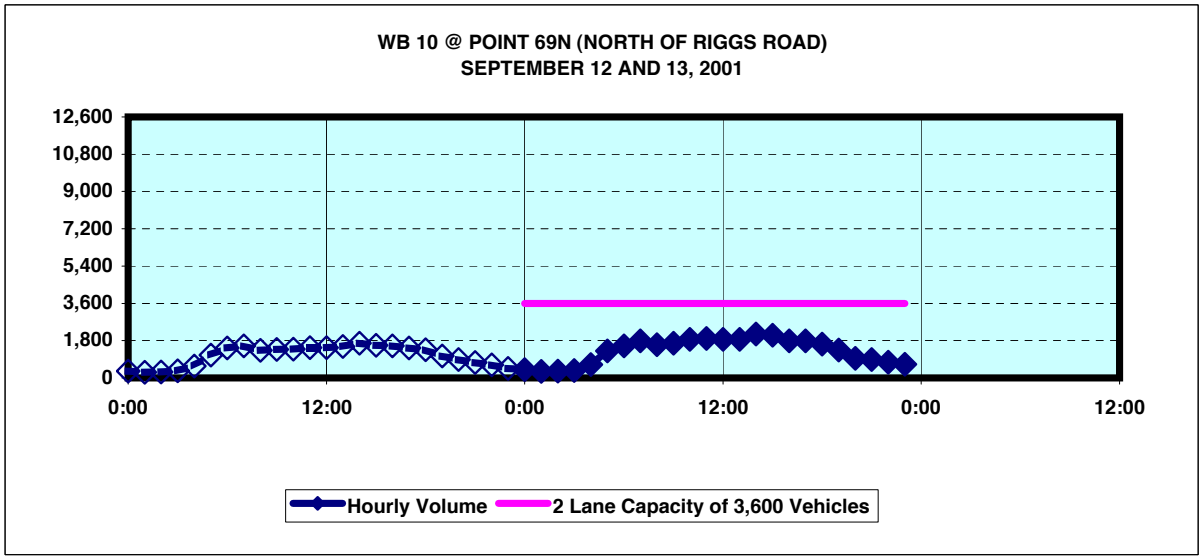
Figure 17
2001 PM Peak Hour Percent Trucks

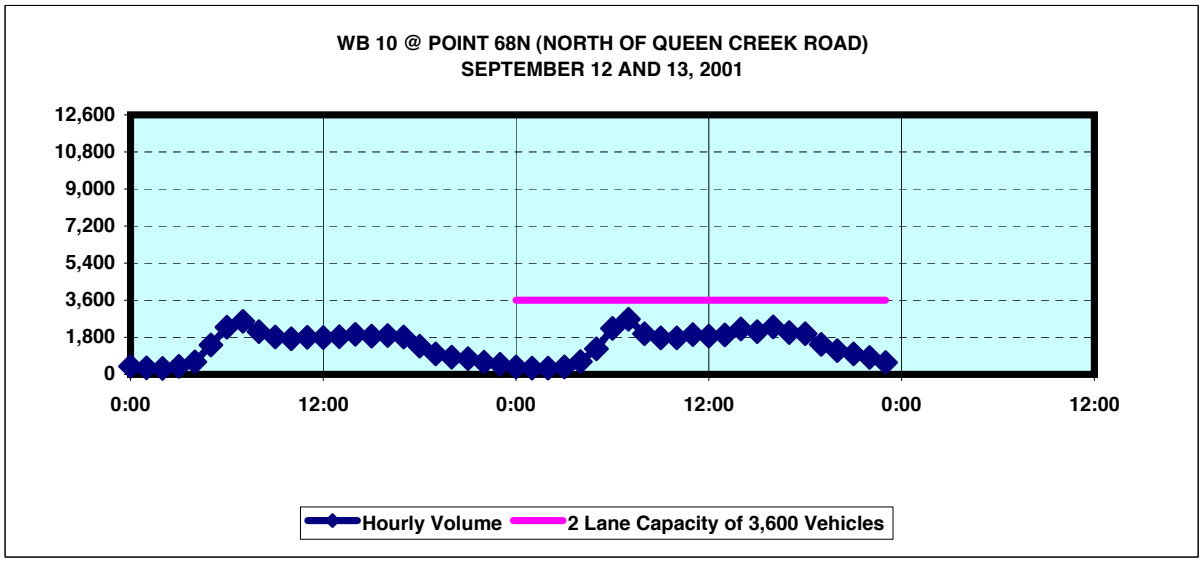
(PM peak hour truck volume as a percentage of PM peak hour total volume)

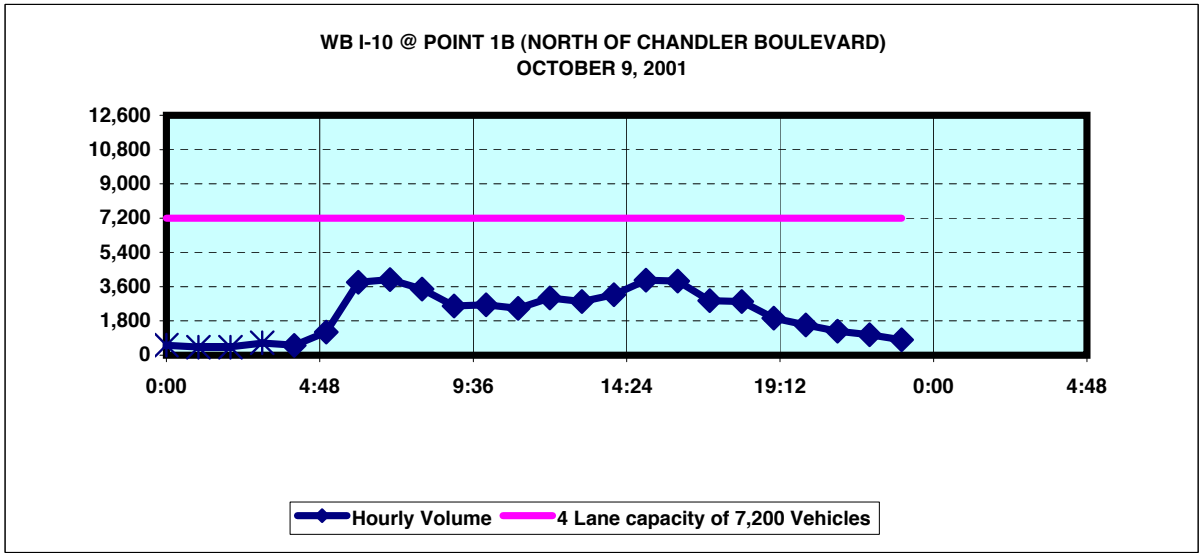
MAG 1998 Congestion Study Boundary

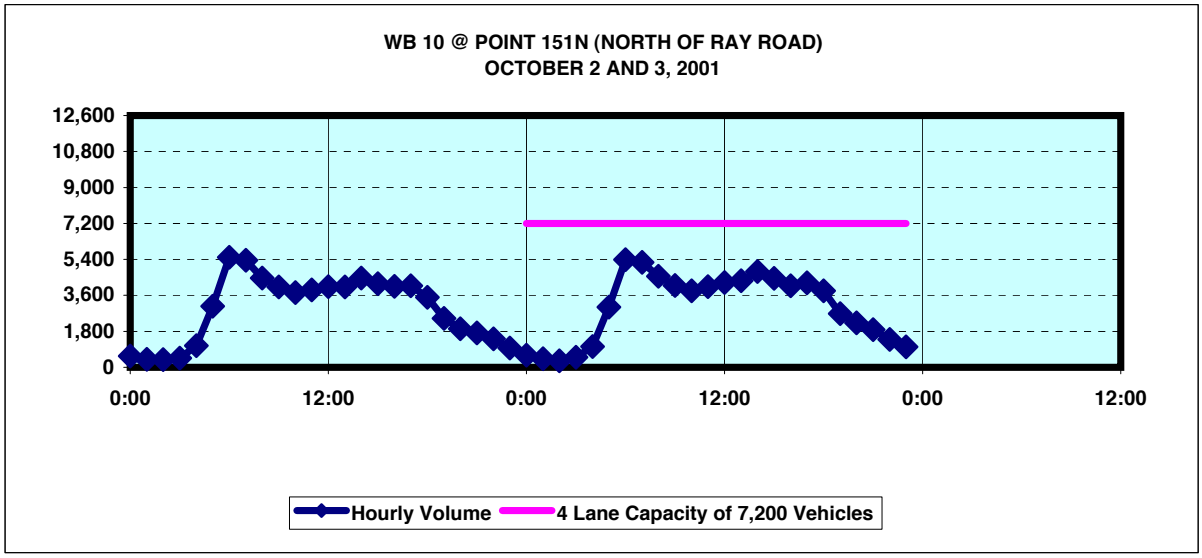
APPENDIX D

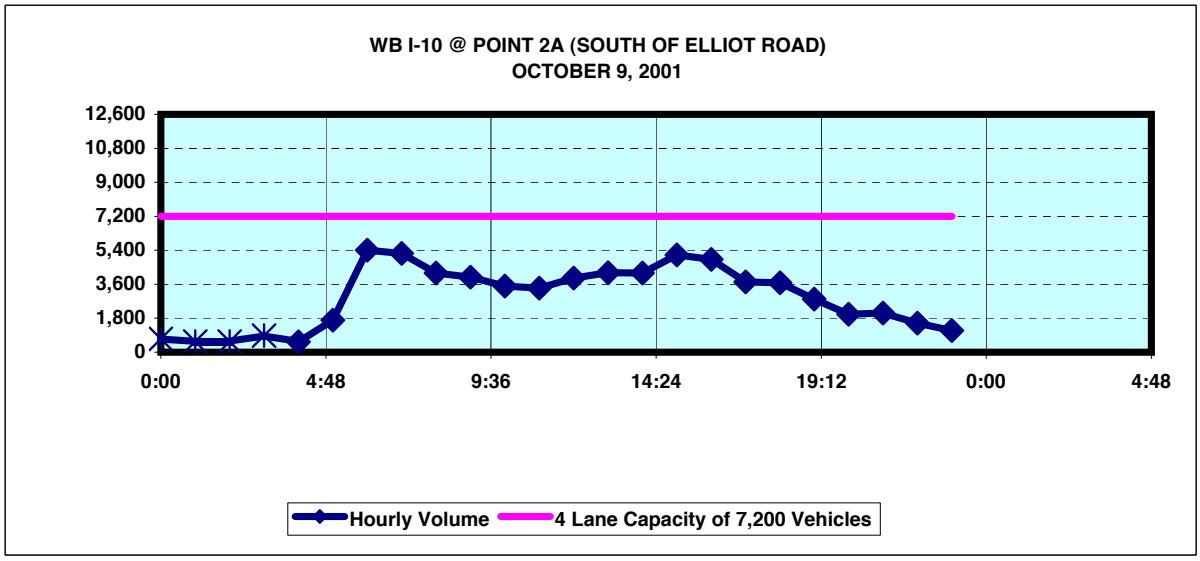
I-10 WESTBOUND
DAILY TRAFFIC VOLUMES

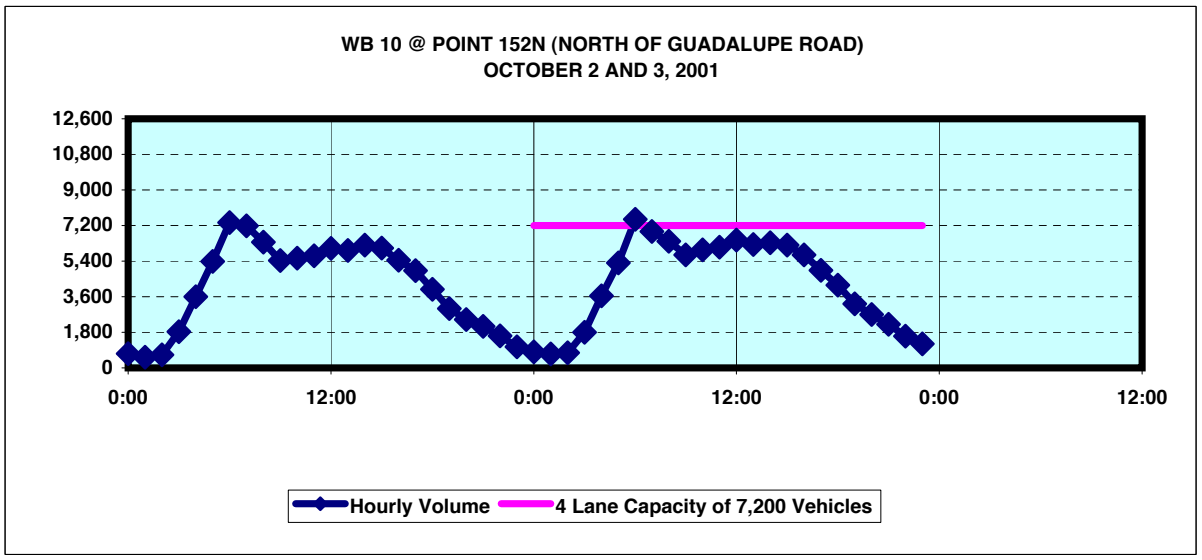

WB 10 @ POINT 69N (NORTH OF RIGGS ROAD)
SEPTEMBER 12 AND 13, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
12:00
0:00
12:00
0:00
12:00
Hourly Volume
2 Lane Capacity of 3,600 Vehicles

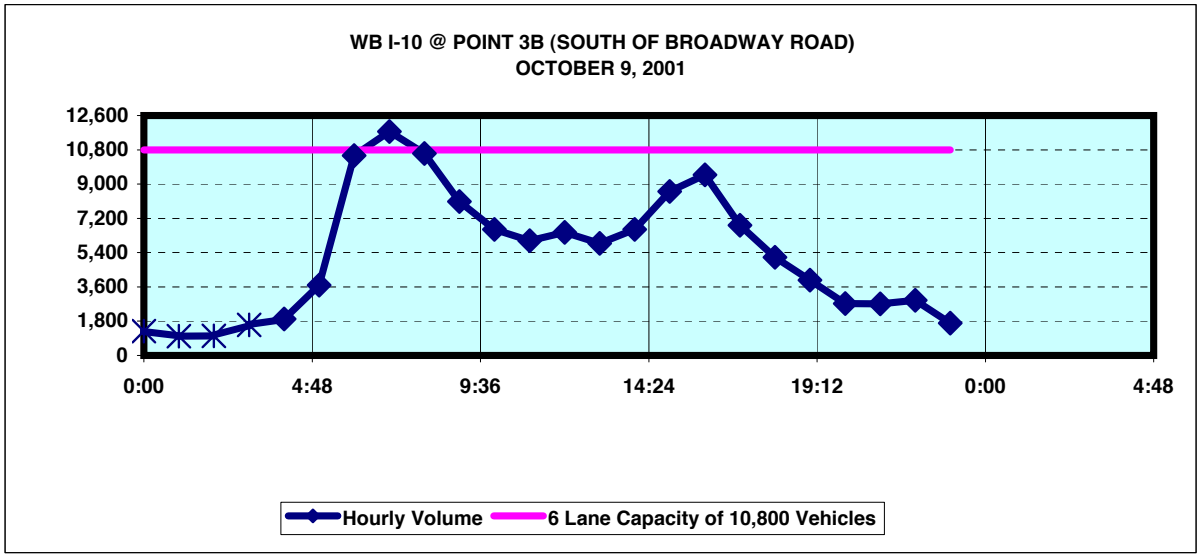

WB 10 @ POINT 68N (NORTH OF QUEEN CREEK ROAD)
SEPTEMBER 12 AND 13, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
12:00
0:00
12:00
0:00
12:00
Hourly Volume
2 Lane Capacity of 3,600 Vehicles

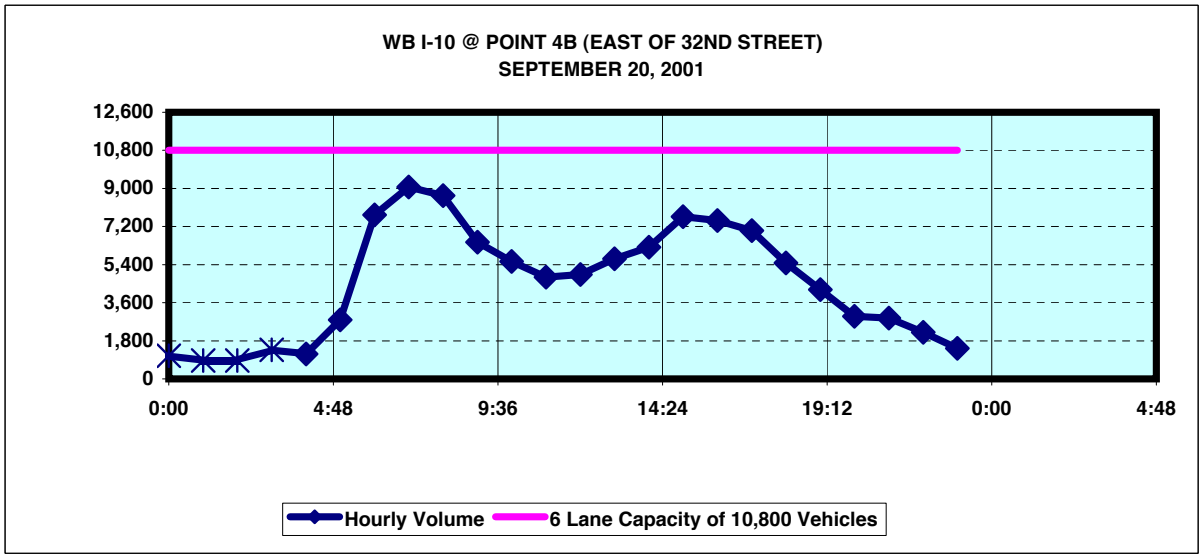

WB I-10 @ POINT 1B (NORTH OF CHANDLER BOULEVARD)
OCTOBER 9, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Hourly Volume
4 Lane capacity of 7,200 Vehicles

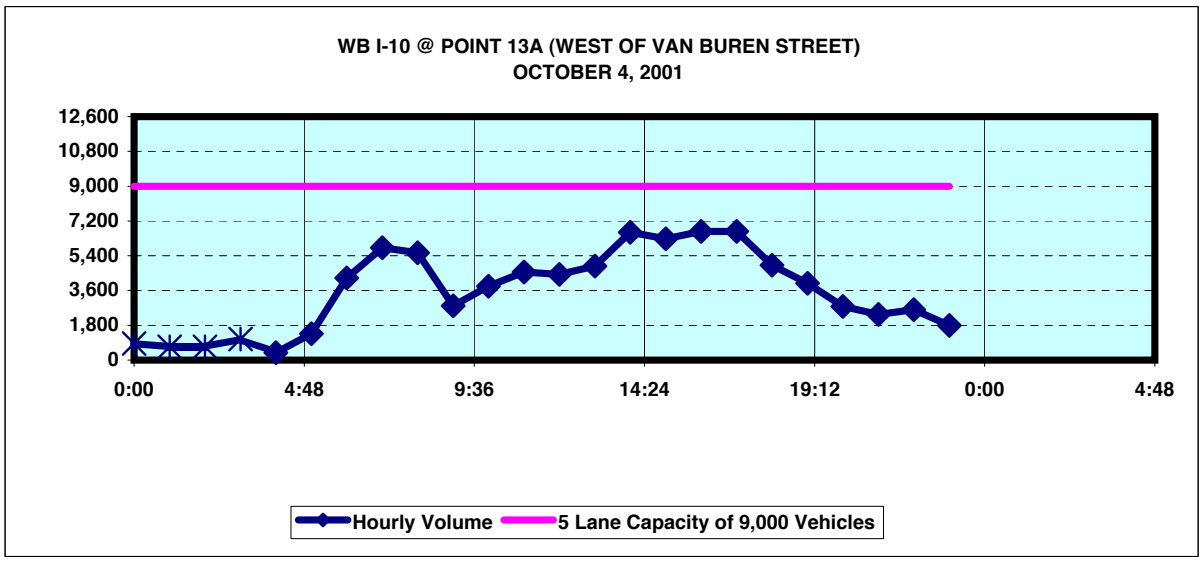

WB 10 @ POINT 151N (NORTH OF RAY ROAD)
OCTOBER 2 AND 3, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
12:00
0:00
12:00
0:00
12:00
Hourly Volume
4 Lane Capacity of 7,200 Vehicles

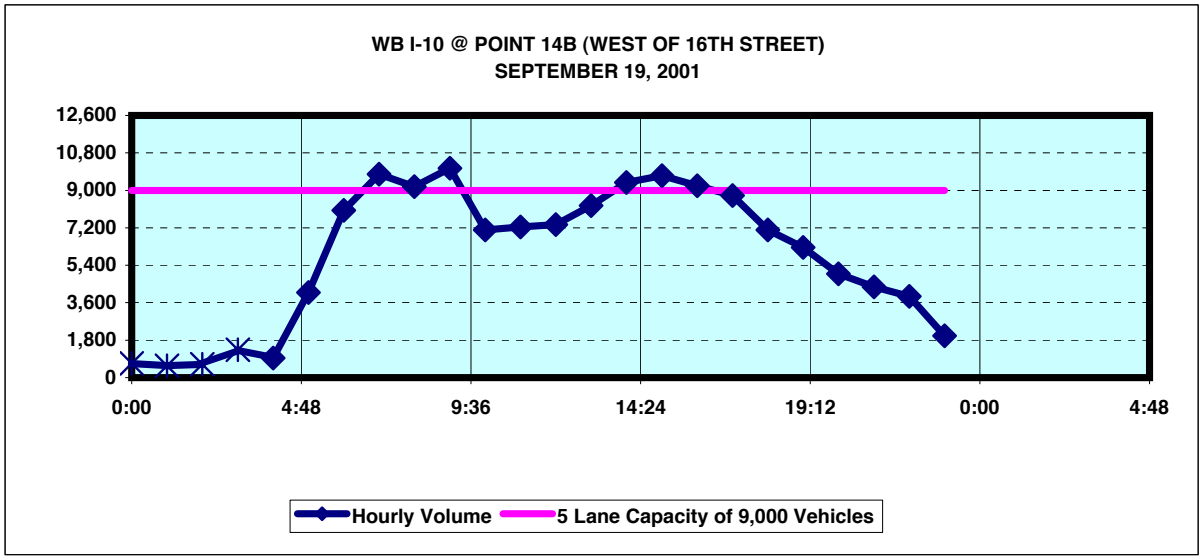

WB I-10 @ POINT 2A (SOUTH OF ELLIOT ROAD)
OCTOBER 9, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Hourly Volume
4 Lane Capacity of 7,200 Vehicles

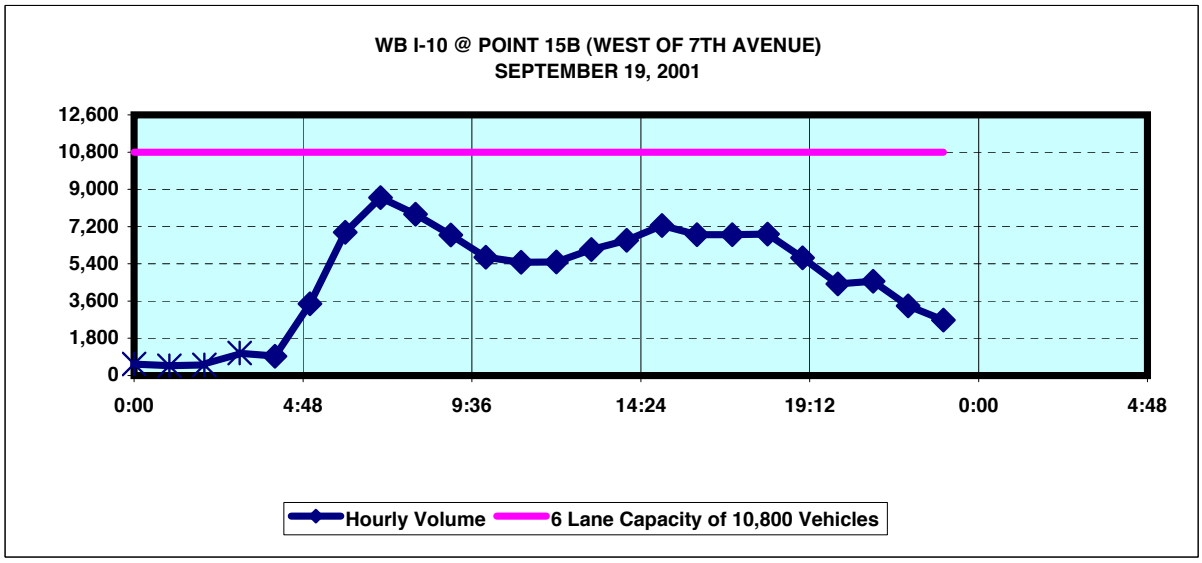

WB 10 @ POINT 152N (NORTH OF GUADALUPE ROAD)
OCTOBER 2 AND 3, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
12:00
0:00
12:00
0:00
12:00
Hourly Volume
4 Lane Capacity of 7,200 Vehicles

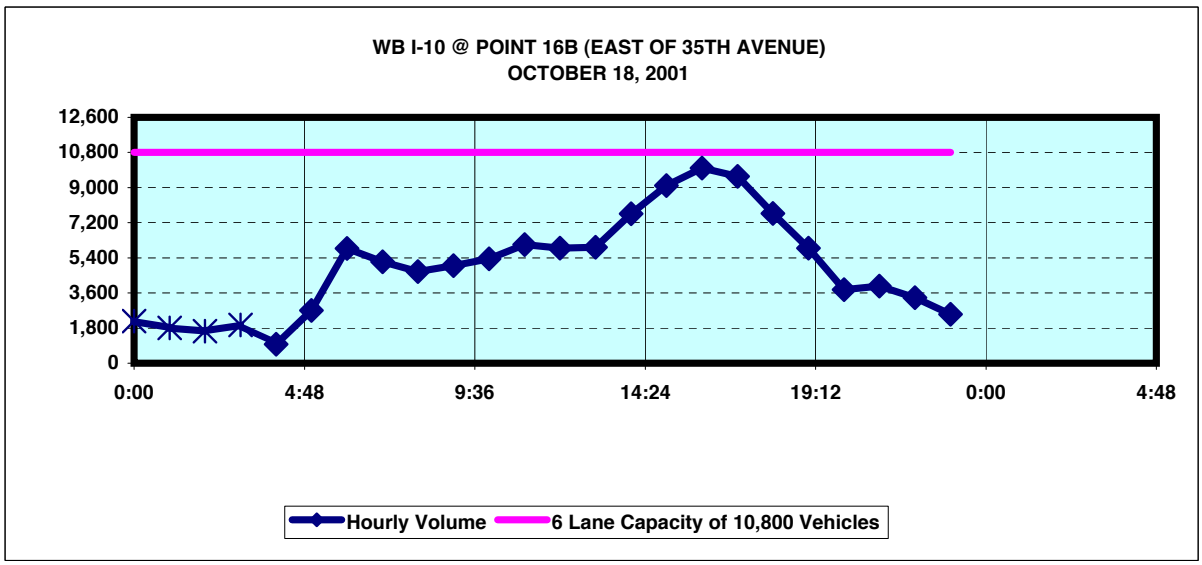

WB I-10 @ POINT 3B (SOUTH OF BROADWAY ROAD)
OCTOBER 9, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Hourly Volume
6 Lane Capacity of 10,800 Vehicles

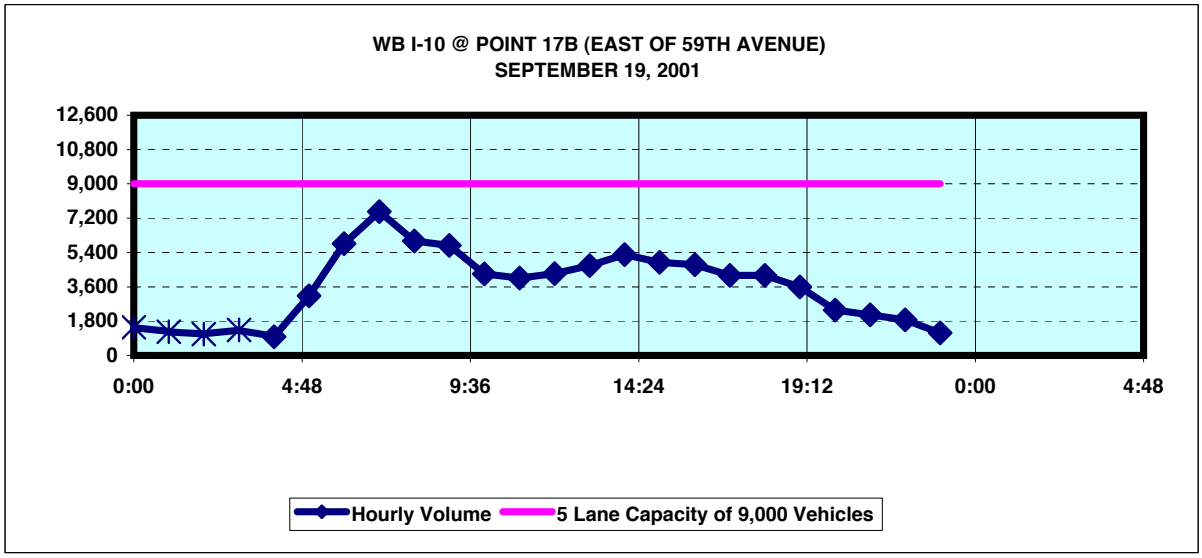

WB I-10 @ POINT 4B (EAST OF 32ND STREET)
SEPTEMBER 20, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Hourly Volume
6 Lane Capacity of 10,800 Vehicles

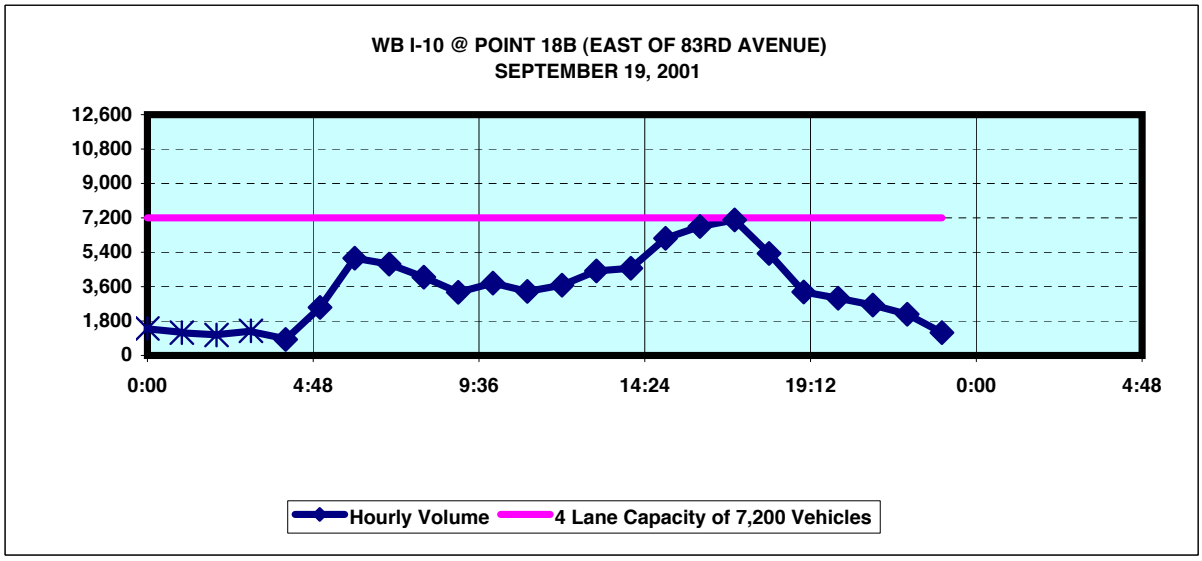

WB I-10 @ POINT 13A (WEST OF VAN BUREN STREET)
OCTOBER 4, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Hourly Volume
5 Lane Capacity of 9,000 Vehicles

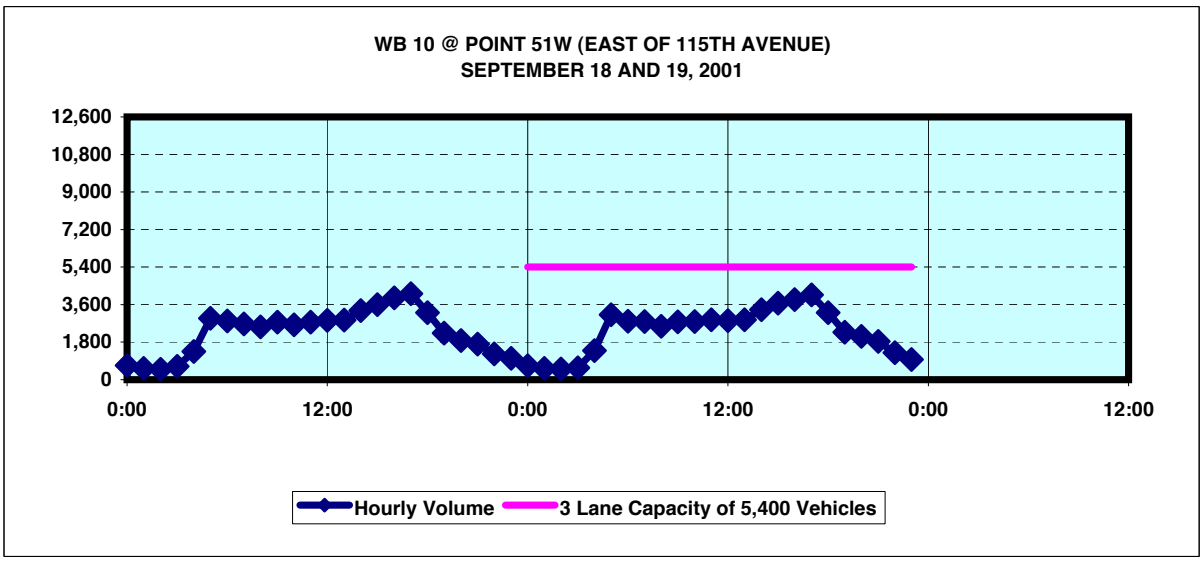

WB I-10 @ POINT 14B (WEST OF 16TH STREET)
SEPTEMBER 19, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Hourly Volume
5 Lane Capacity of 9,000 Vehicles

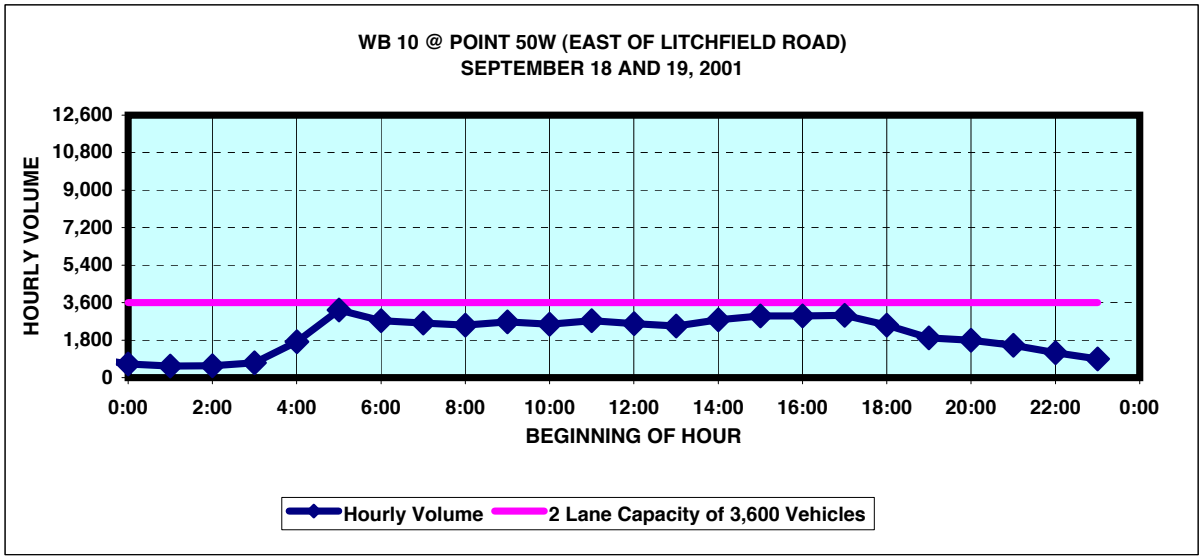

WB I-10 @ POINT 15B (WEST OF 7TH AVENUE)
SEPTEMBER 19, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Hourly Volume
6 Lane Capacity of 10,800 Vehicles

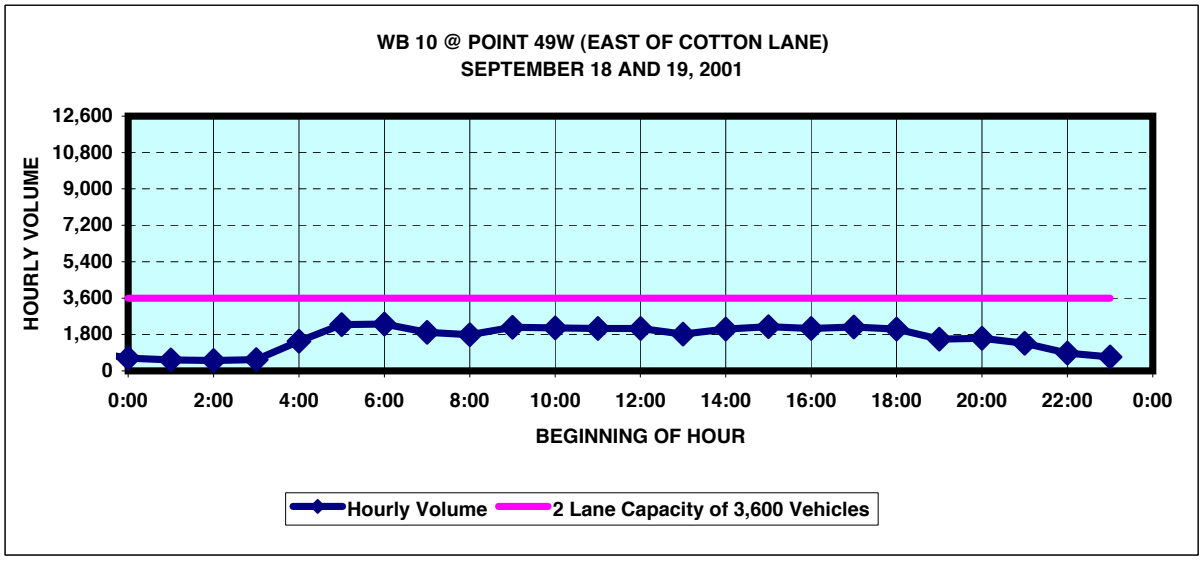

WB I-10 @ POINT 16B (EAST OF 35TH AVENUE)
OCTOBER 18, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Hourly Volume
6 Lane Capacity of 10,800 Vehicles

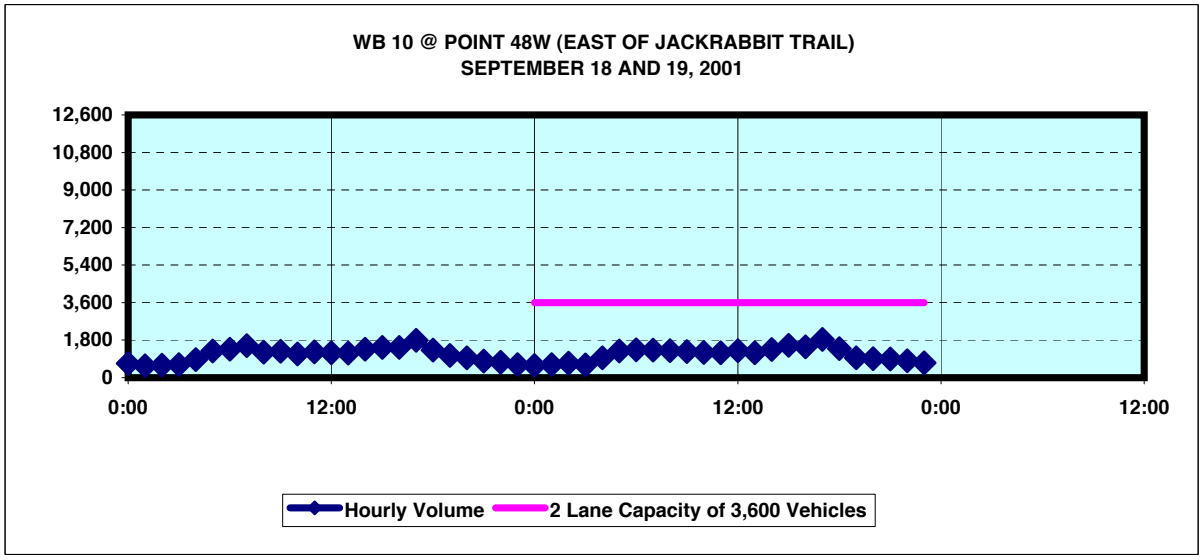

WB I-10 @ POINT 17B (EAST OF 59TH AVENUE)
SEPTEMBER 19, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Hourly Volume
5 Lane Capacity of 9,000 Vehicles

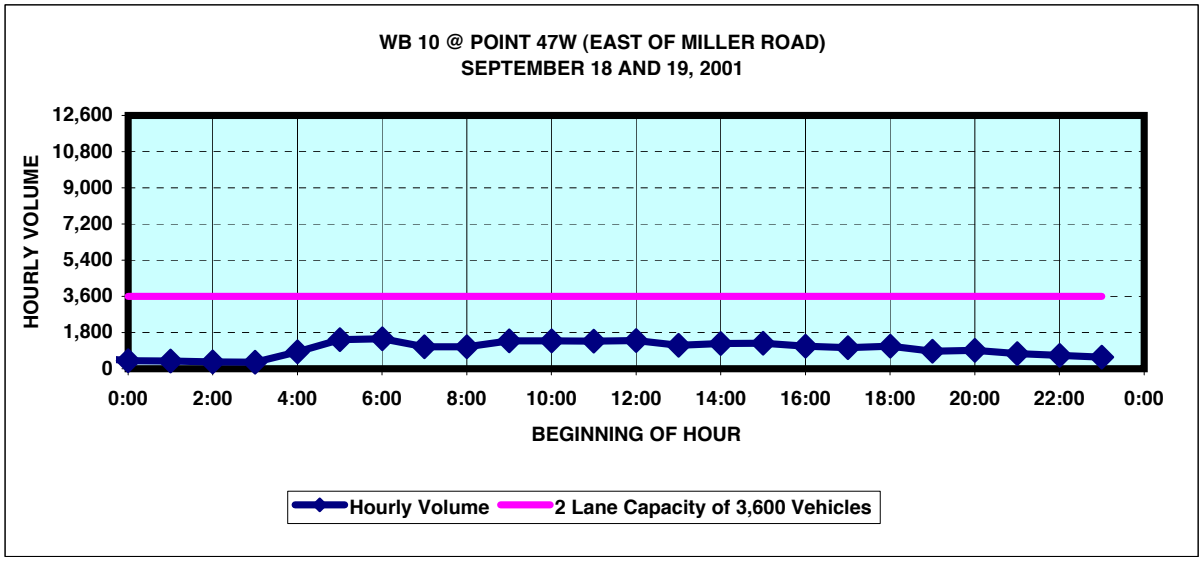

WB I-10 @ POINT 18B (EAST OF 83RD AVENUE)
SEPTEMBER 19, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Hourly Volume
4 Lane Capacity of 7,200 Vehicles

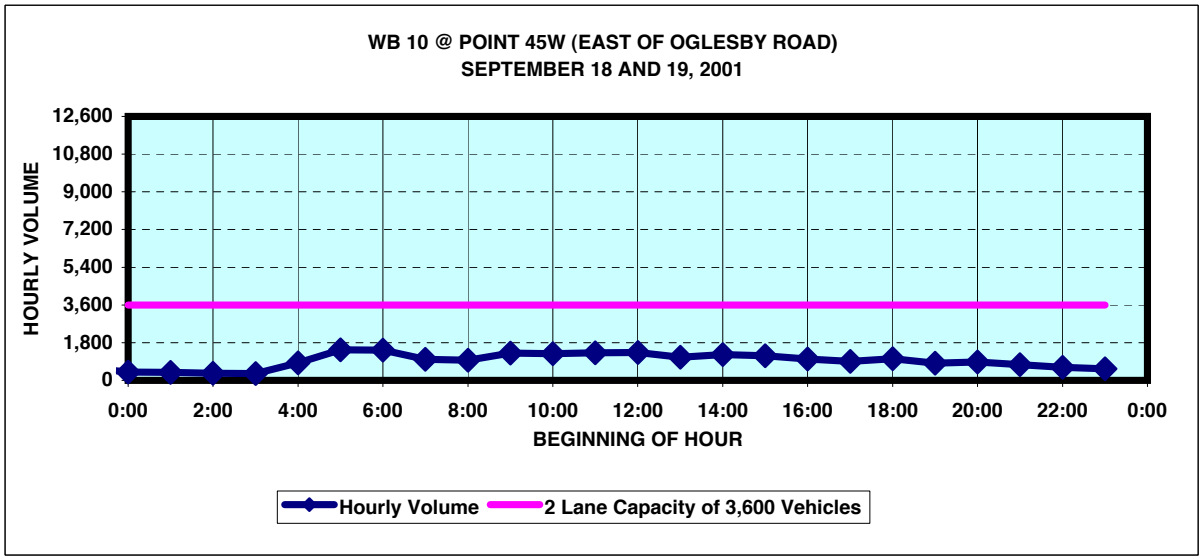

WB 10 @ POINT 51W (EAST OF 115TH AVENUE)
SEPTEMBER 18 AND 19, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
12:00
0:00
12:00
0:00
12:00
Hourly Volume
3 Lane Capacity of 5,400 Vehicles


WB 10 @ POINT 50W (EAST OF LITCHFIELD ROAD)
SEPTEMBER 18 AND 19, 2001
HOURLY VOLUME
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
BEGINNING OF HOUR
Hourly Volume
2 Lane Capacity of 3,600 Vehicles


WB 10 @ POINT 49W (EAST OF COTTON LANE)
SEPTEMBER 18 AND 19, 2001
HOURLY VOLUME
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
BEGINNING OF HOUR
Hourly Volume
2 Lane Capacity of 3,600 Vehicles

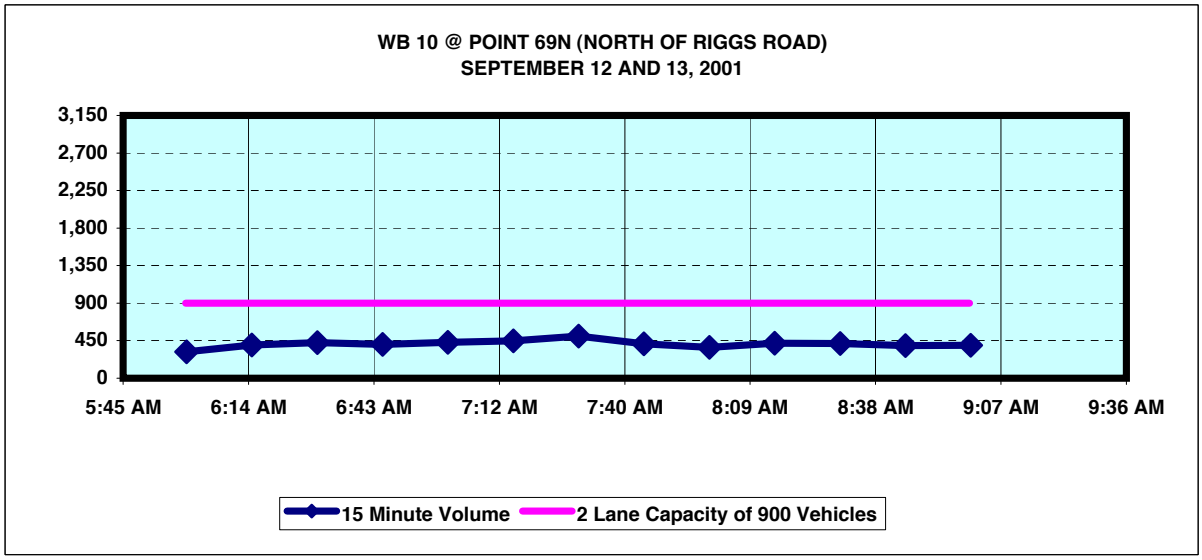

WB 10 @ POINT 48W (EAST OF JACKRABBIT TRAIL)
SEPTEMBER 18 AND 19, 2001
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
12:00
0:00
12:00
0:00
12:00
Hourly Volume
2 Lane Capacity of 3,600 Vehicles

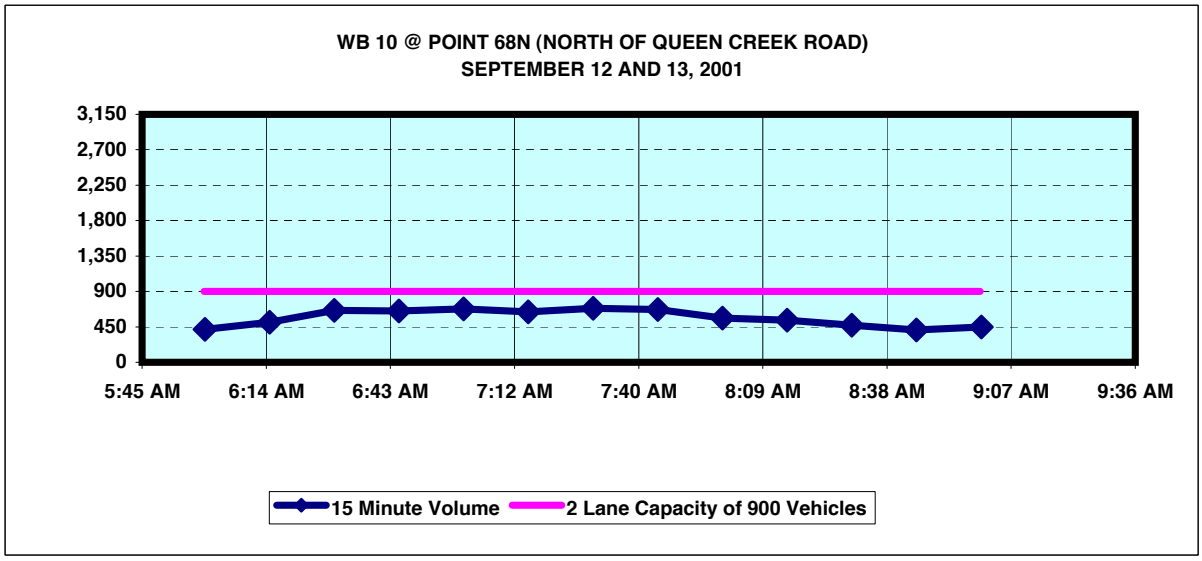

WB 10 @ POINT 47W (EAST OF MILLER ROAD)
SEPTEMBER 18 AND 19, 2001
HOURLY VOLUME
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
BEGINNING OF HOUR
Hourly Volume
2 Lane Capacity of 3,600 Vehicles

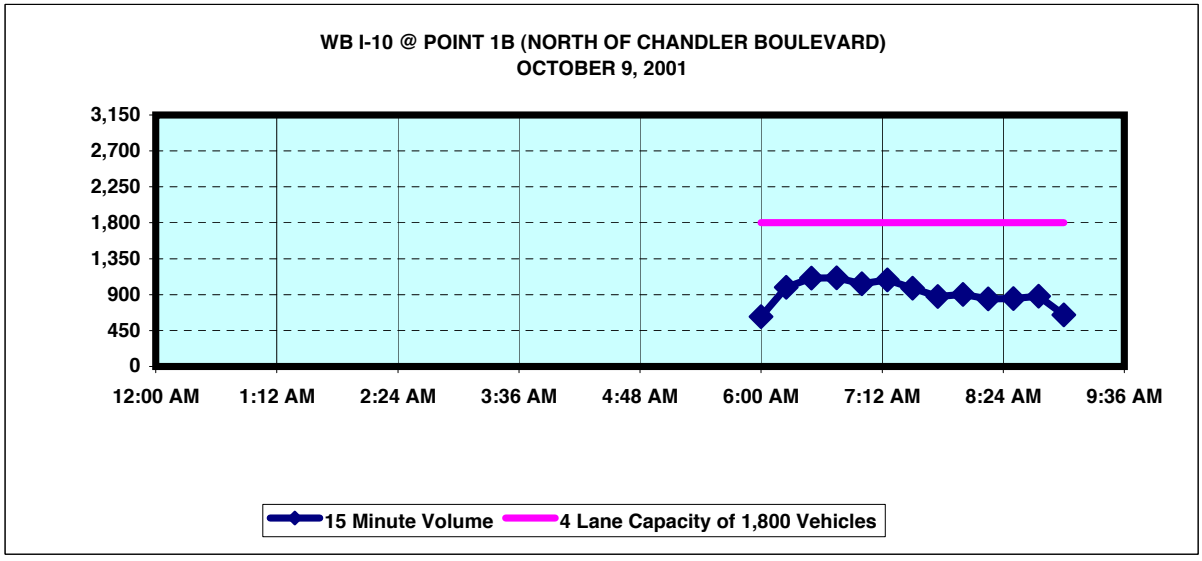

WB 10 @ POINT 45W (EAST OF OGLESBY ROAD)
SEPTEMBER 18 AND 19, 2001
HOURLY VOLUME
12,600
10,800
9,000
7,200
5,400
3,600
1,800
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
BEGINNING OF HOUR
Hourly Volume
2 Lane Capacity of 3,600 Vehicles

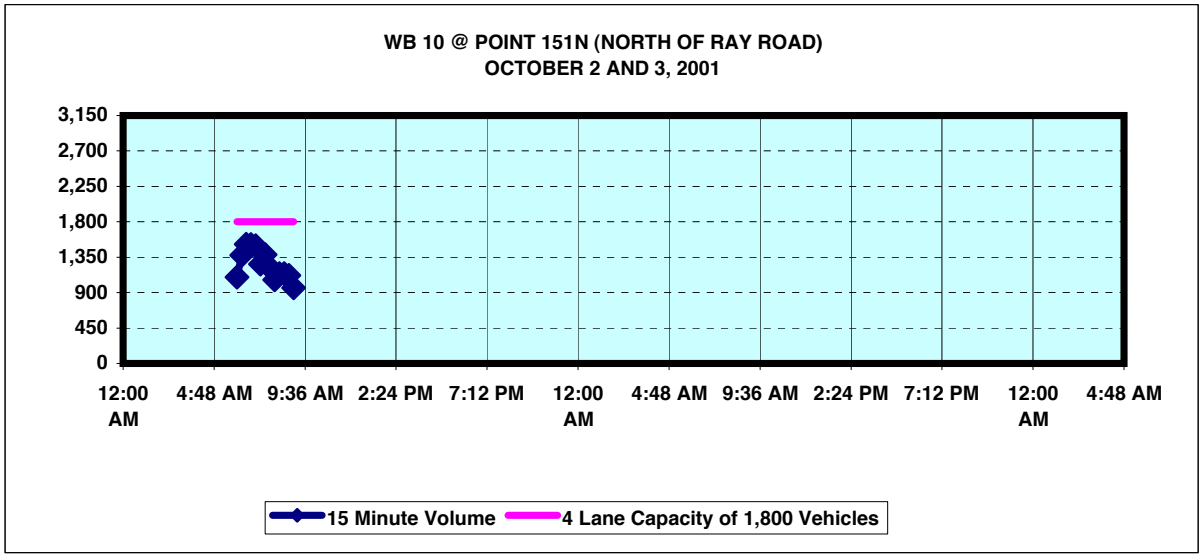
APPENDIX E

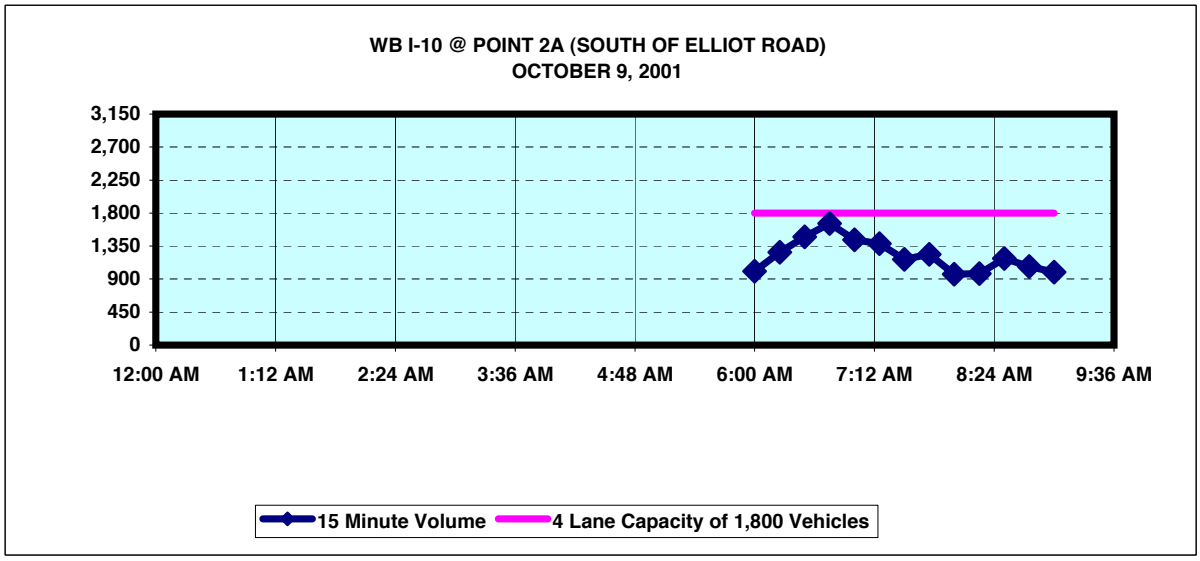
I-10 WESTBOUND
AM PEAK TRAFFIC VOLUMES

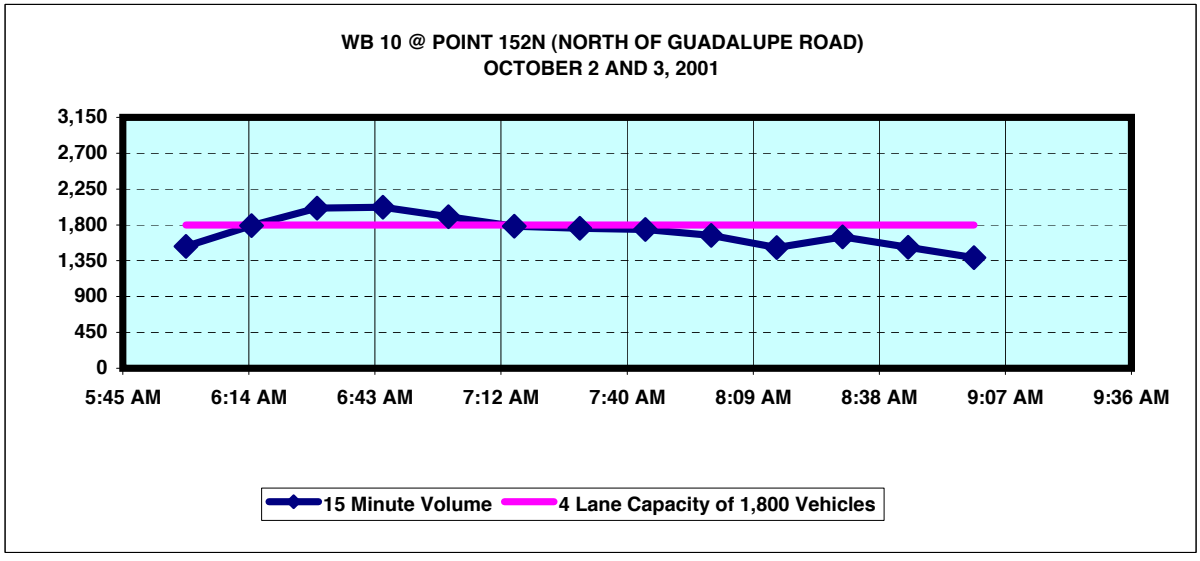

WB 10 @ POINT 69N (NORTH OF RIGGS ROAD)
SEPTEMBER 12 AND 13, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
5:45 AM
6:14 AM
6:43 AM
7:12 AM
7:40 AM
8:09 AM
8:38 AM
9:07 AM
9:36 AM
15 Minute Volume
2 Lane Capacity of 900 Vehicles

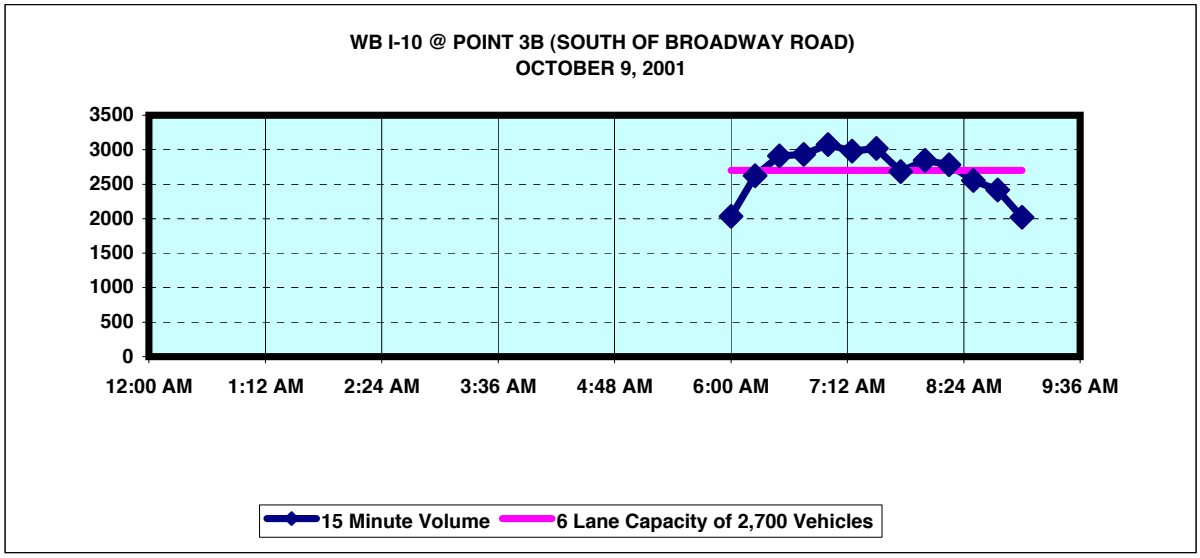

WB 10 @ POINT 68N (NORTH OF QUEEN CREEK ROAD)
SEPTEMBER 12 AND 13, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
5:45 AM
6:14 AM
6:43 AM
7:12 AM
7:40 AM
8:09 AM
8:38 AM
9:07 AM
9:36 AM
15 Minute Volume
2 Lane Capacity of 900 Vehicles

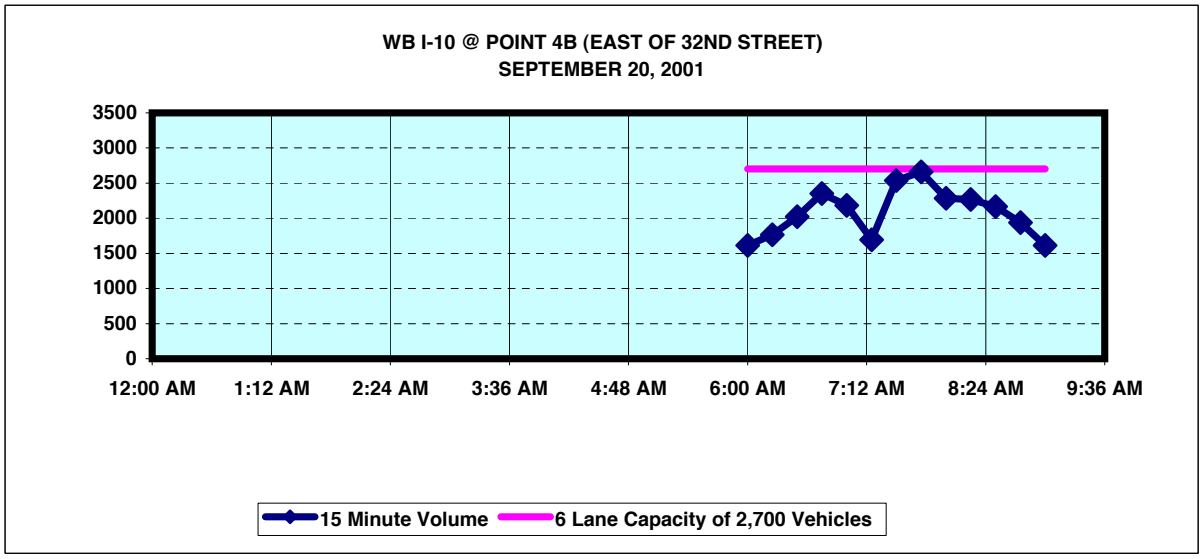

WB I-10 @ POINT 1B (NORTH OF CHANDLER BOULEVARD)
OCTOBER 9, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
1:12 AM
2:24 AM
3:36 AM
4:48 AM
6:00 AM
7:12 AM
8:24 AM
9:36 AM
15 Minute Volume
4 Lane Capacity of 1,800 Vehicles

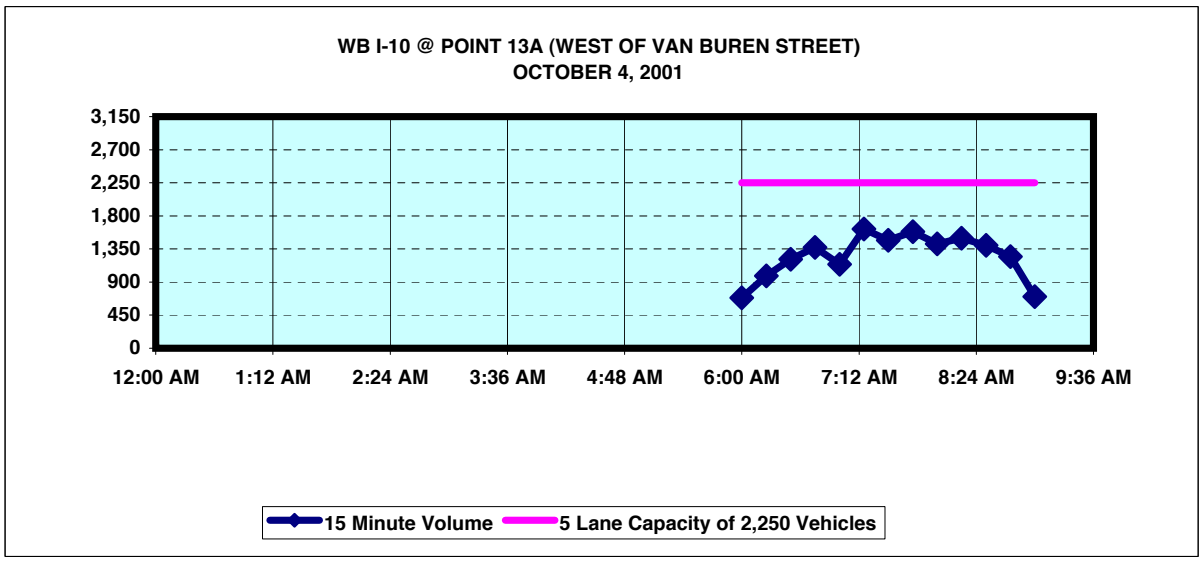

WB 10 @ POINT 151N (NORTH OF RAY ROAD)
OCTOBER 2 AND 3, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
4:48 AM
9:36 AM
2:24 PM
7:12 PM
12:00 AM
4:48 AM
9:36 AM
2:24 PM
7:12 PM
12:00 AM
4:48 AM
15 Minute Volume
4 Lane Capacity of 1,800 Vehicles

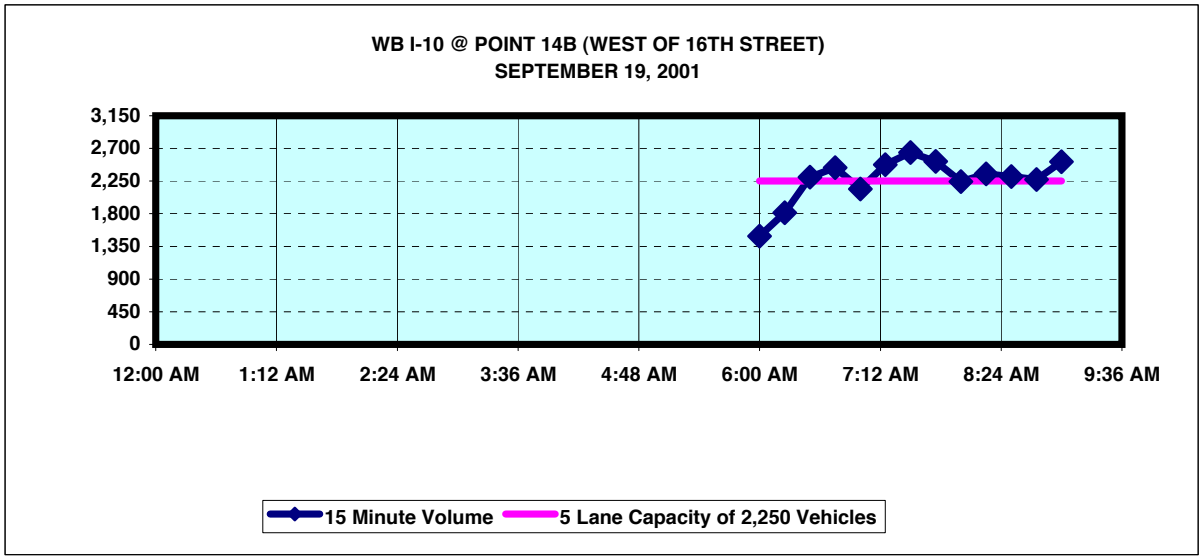

WB I-10 @ POINT 2A (SOUTH OF ELLIOT ROAD)
OCTOBER 9, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
1:12 AM
2:24 AM
3:36 AM
4:48 AM
6:00 AM
7:12 AM
8:24 AM
9:36 AM
15 Minute Volume
4 Lane Capacity of 1,800 Vehicles

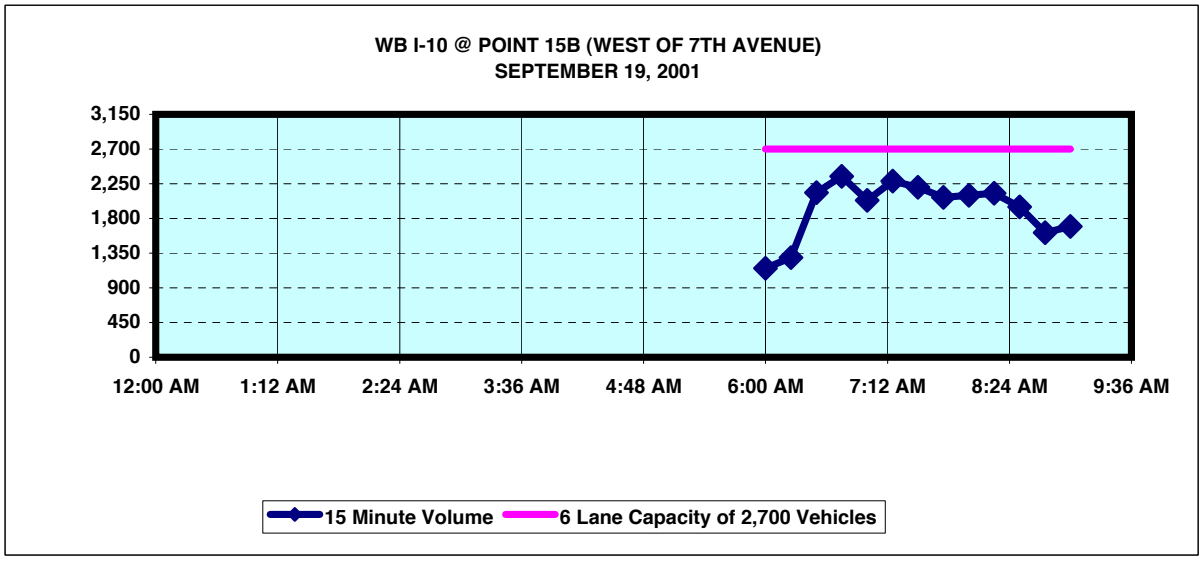

WB 10 @ POINT 152N (NORTH OF GUADALUPE ROAD)
OCTOBER 2 AND 3, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
5:45 AM
6:14 AM
6:43 AM
7:12 AM
7:40 AM
8:09 AM
8:38 AM
9:07 AM
9:36 AM
15 Minute Volume
4 Lane Capacity of 1,800 Vehicles

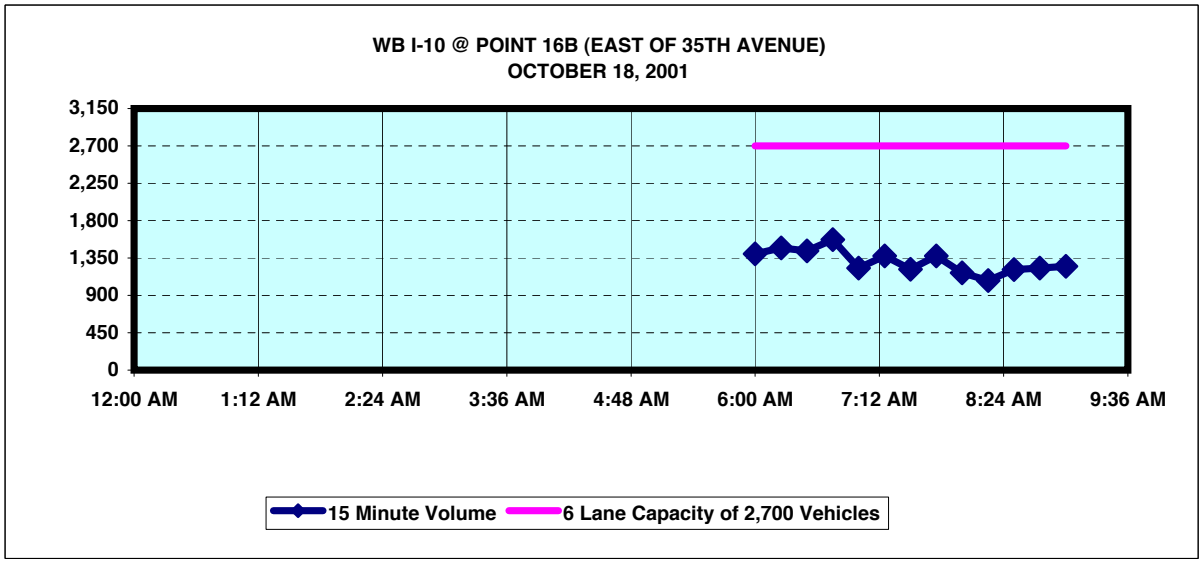

WB I-10 @ POINT 3B (SOUTH OF BROADWAY ROAD)
OCTOBER 9, 2001
3500
3000
2500
2000
1500
1000
500
0
12:00 AM
1:12 AM
2:24 AM
3:36 AM
4:48 AM
6:00 AM
7:12 AM
8:24 AM
9:36 AM
15 Minute Volume
6 Lane Capacity of 2,700 Vehicles

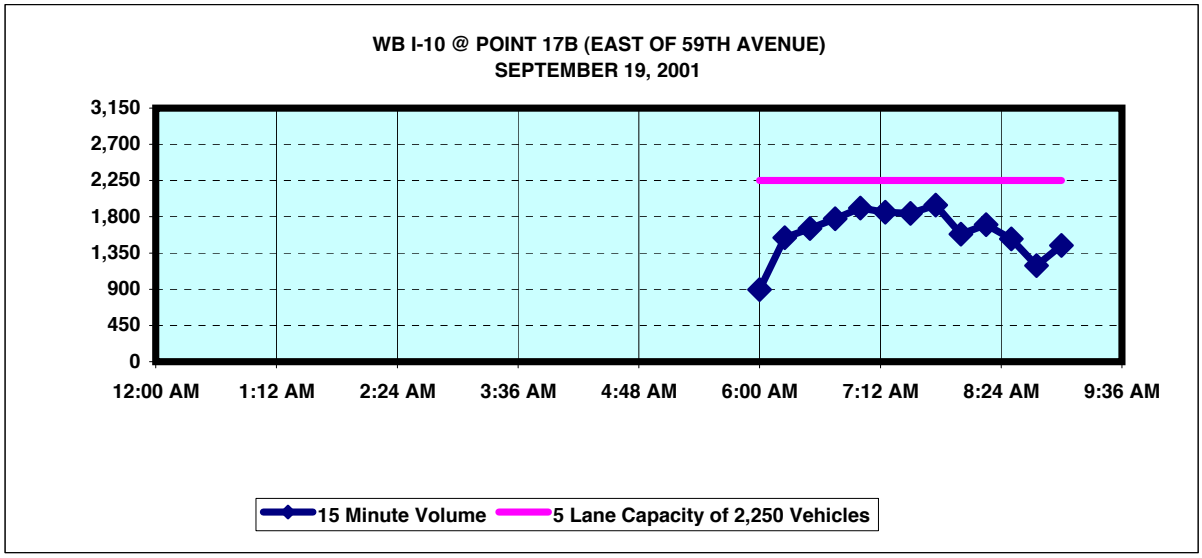

WB I-10 @ POINT 4B (EAST OF 32ND STREET)
SEPTEMBER 20, 2001
3500
3000
2500
2000
1500
1000
500
0
12:00 AM
1:12 AM
2:24 AM
3:36 AM
4:48 AM
6:00 AM
7:12 AM
8:24 AM
9:36 AM
15 Minute Volume
6 Lane Capacity of 2,700 Vehicles

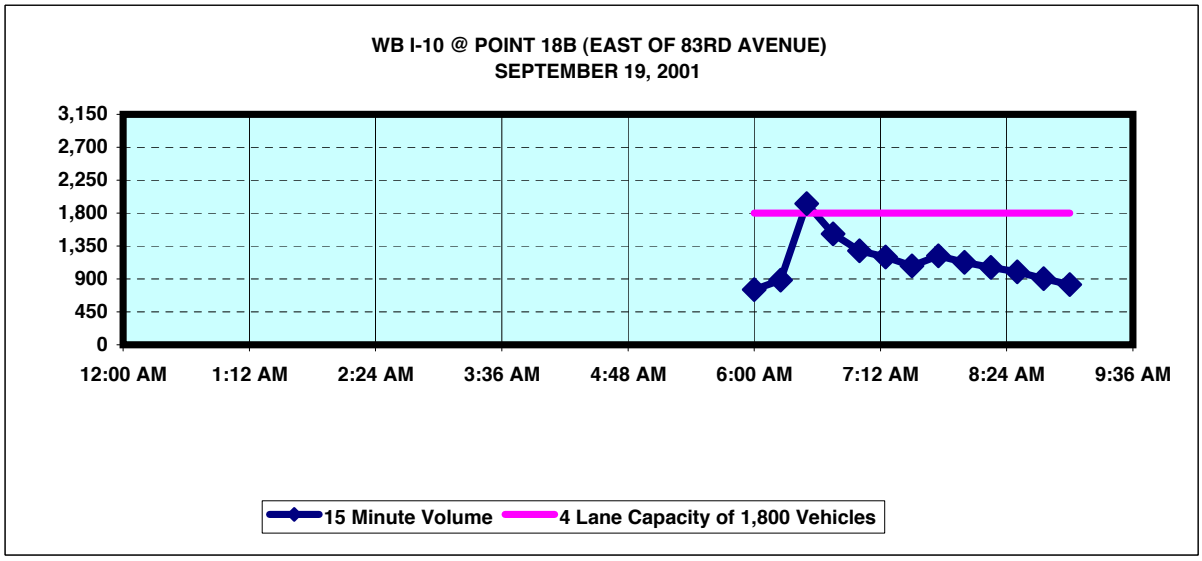

WB I-10 @ POINT 13A (WEST OF VAN BUREN STREET)
OCTOBER 4, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
1:12 AM
2:24 AM
3:36 AM
4:48 AM
6:00 AM
7:12 AM
8:24 AM
9:36 AM
15 Minute Volume
5 Lane Capacity of 2,250 Vehicles

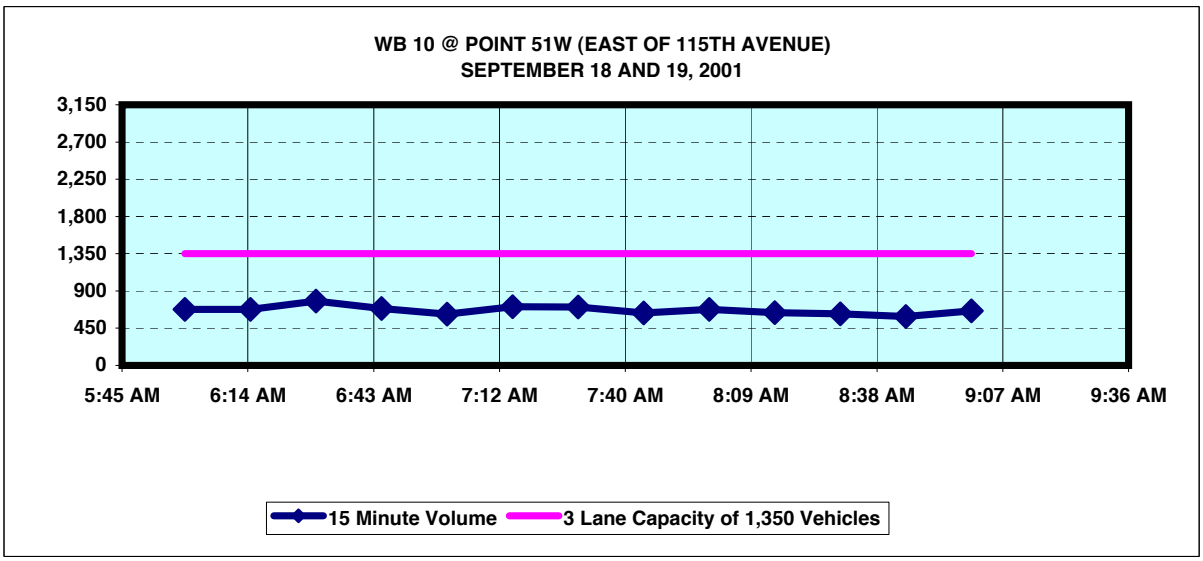

WB I-10 @ POINT 14B (WEST OF 16TH STREET)
SEPTEMBER 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
1:12 AM
2:24 AM
3:36 AM
4:48 AM
6:00 AM
7:12 AM
8:24 AM
9:36 AM
15 Minute Volume
5 Lane Capacity of 2,250 Vehicles

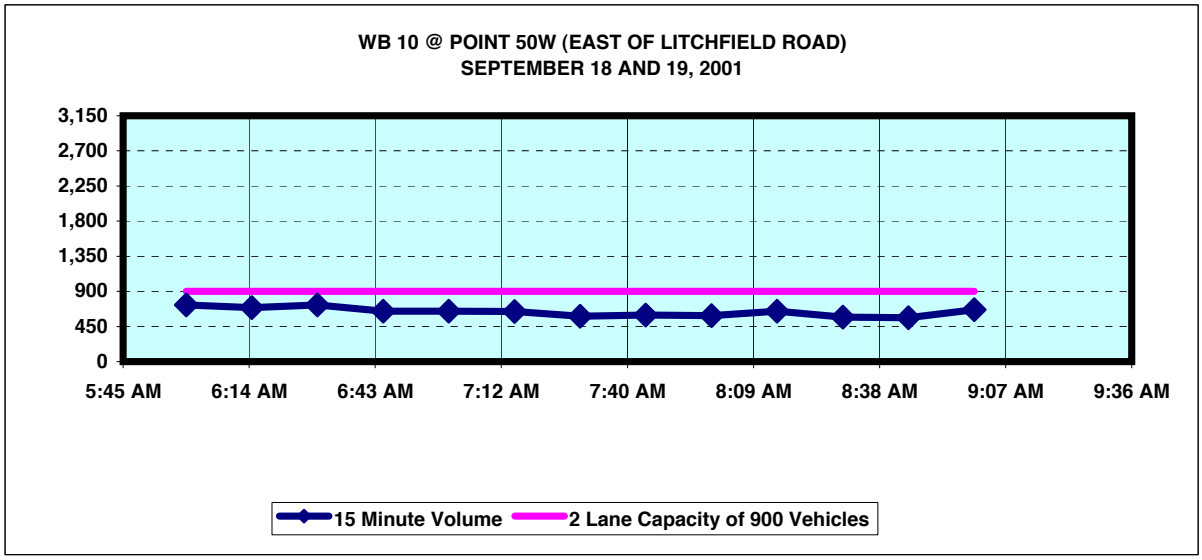

WB I-10 @ POINT 15B (WEST OF 7TH AVENUE)
SEPTEMBER 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
1:12 AM
2:24 AM
3:36 AM
4:48 AM
6:00 AM
7:12 AM
8:24 AM
9:36 AM
15 Minute Volume
6 Lane Capacity of 2,700 Vehicles

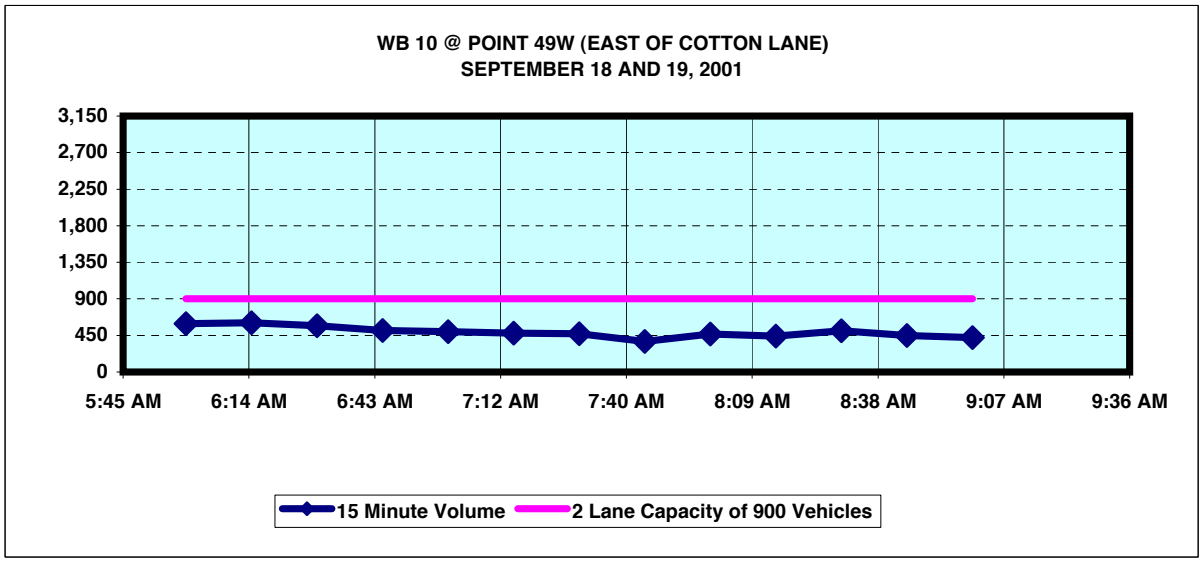

WB I-10 @ POINT 16B (EAST OF 35TH AVENUE)
OCTOBER 18, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
1:12 AM
2:24 AM
3:36 AM
4:48 AM
6:00 AM
7:12 AM
8:24 AM
9:36 AM
15 Minute Volume
6 Lane Capacity of 2,700 Vehicles

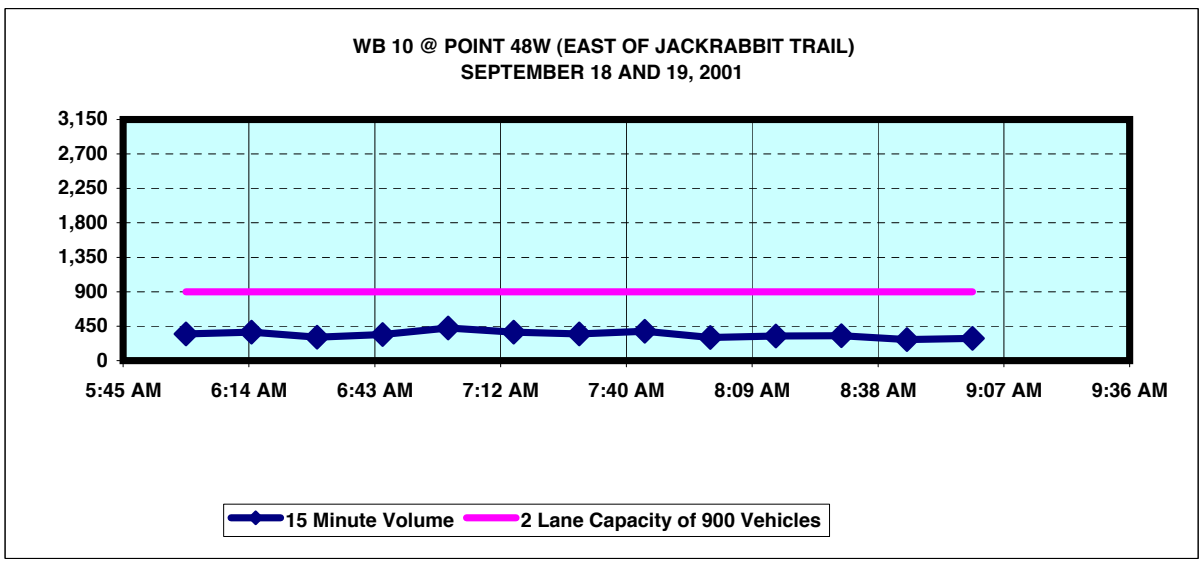

WB I-10 @ POINT 17B (EAST OF 59TH AVENUE)
SEPTEMBER 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
1:12 AM
2:24 AM
3:36 AM
4:48 AM
6:00 AM
7:12 AM
8:24 AM
9:36 AM
15 Minute Volume
5 Lane Capacity of 2,250 Vehicles

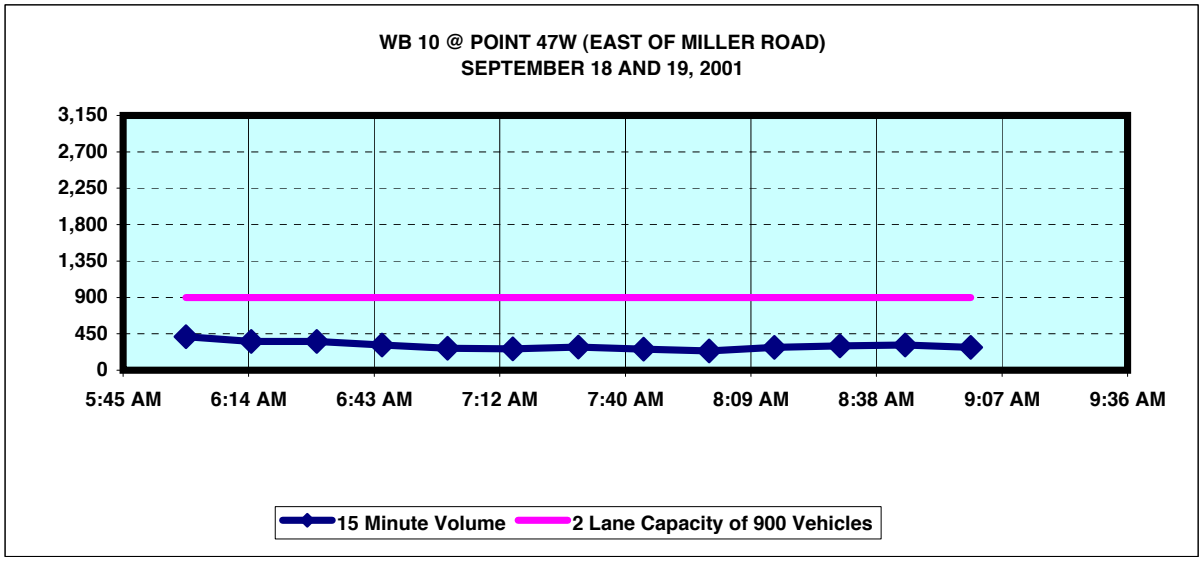

WB I-10 @ POINT 18B (EAST OF 83RD AVENUE)
SEPTEMBER 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
1:12 AM
2:24 AM
3:36 AM
4:48 AM
6:00 AM
7:12 AM
8:24 AM
9:36 AM
15 Minute Volume
4 Lane Capacity of 1,800 Vehicles

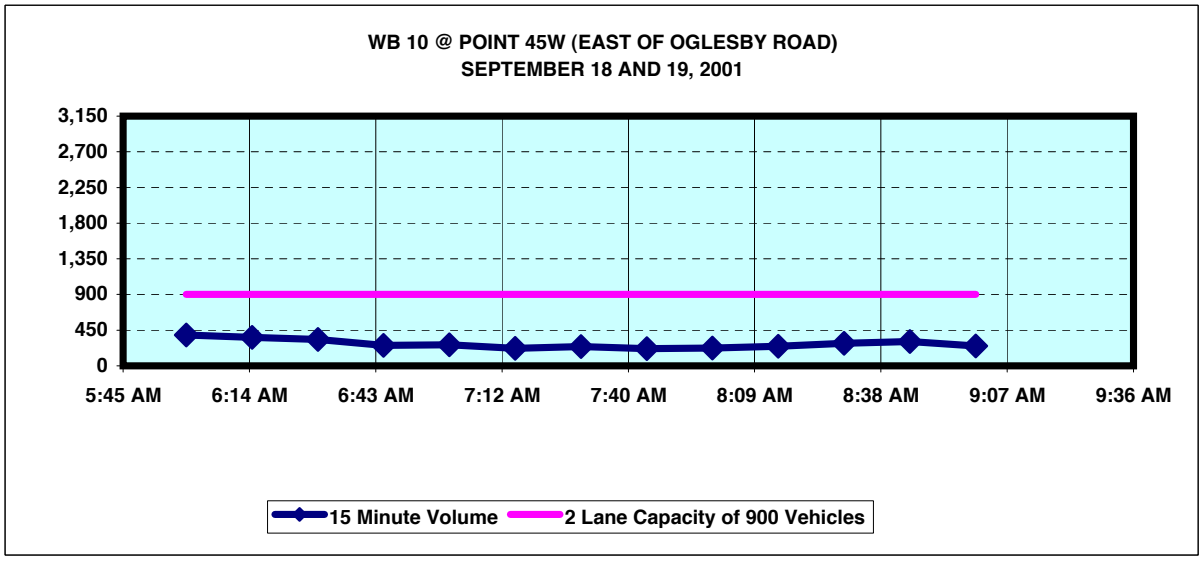

WB 10 @ POINT 51W (EAST OF 115TH AVENUE)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
5:45 AM
6:14 AM
6:43 AM
7:12 AM
7:40 AM
8:09 AM
8:38 AM
9:07 AM
9:36 AM
15 Minute Volume
3 Lane Capacity of 1,350 Vehicles


WB 10 @ POINT 50W (EAST OF LITCHFIELD ROAD)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
5:45 AM
6:14 AM
6:43 AM
7:12 AM
7:40 AM
8:09 AM
8:38 AM
9:07 AM
9:36 AM
15 Minute Volume
2 Lane Capacity of 900 Vehicles


WB 10 @ POINT 49W (EAST OF COTTON LANE)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
5:45 AM
6:14 AM
6:43 AM
7:12 AM
7:40 AM
8:09 AM
8:38 AM
9:07 AM
9:36 AM
15 Minute Volume
2 Lane Capacity of 900 Vehicles


WB 10 @ POINT 48W (EAST OF JACKRABBIT TRAIL)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
5:45 AM
6:14 AM
6:43 AM
7:12 AM
7:40 AM
8:09 AM
8:38 AM
9:07 AM
9:36 AM
15 Minute Volume
2 Lane Capacity of 900 Vehicles

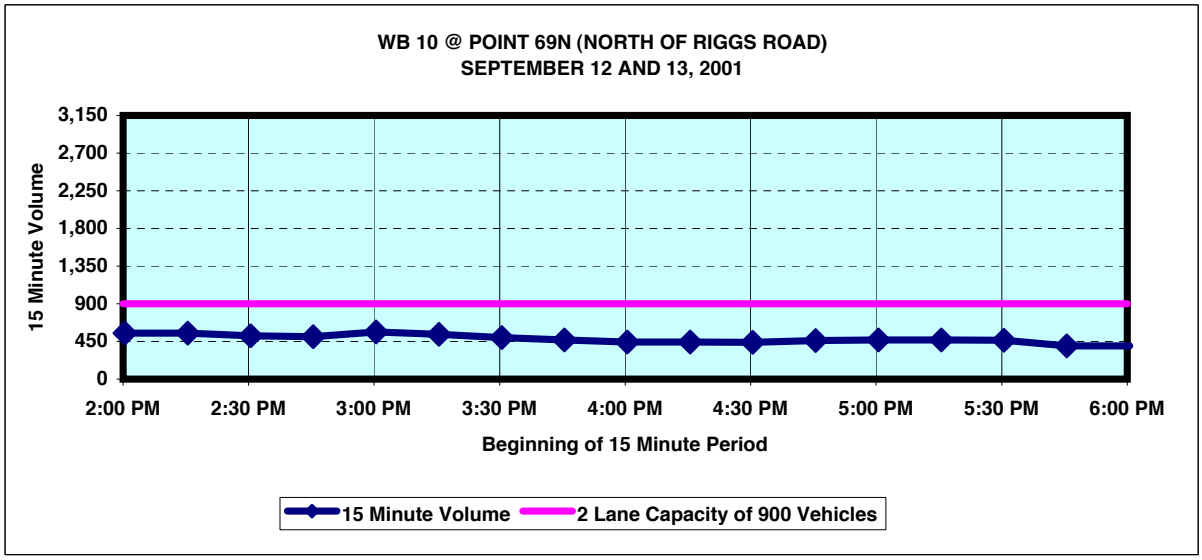

WB 10 @ POINT 47W (EAST OF MILLER ROAD)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
5:45 AM
6:14 AM
6:43 AM
7:12 AM
7:40 AM
8:09 AM
8:38 AM
9:07 AM
9:36 AM
15 Minute Volume
2 Lane Capacity of 900 Vehicles

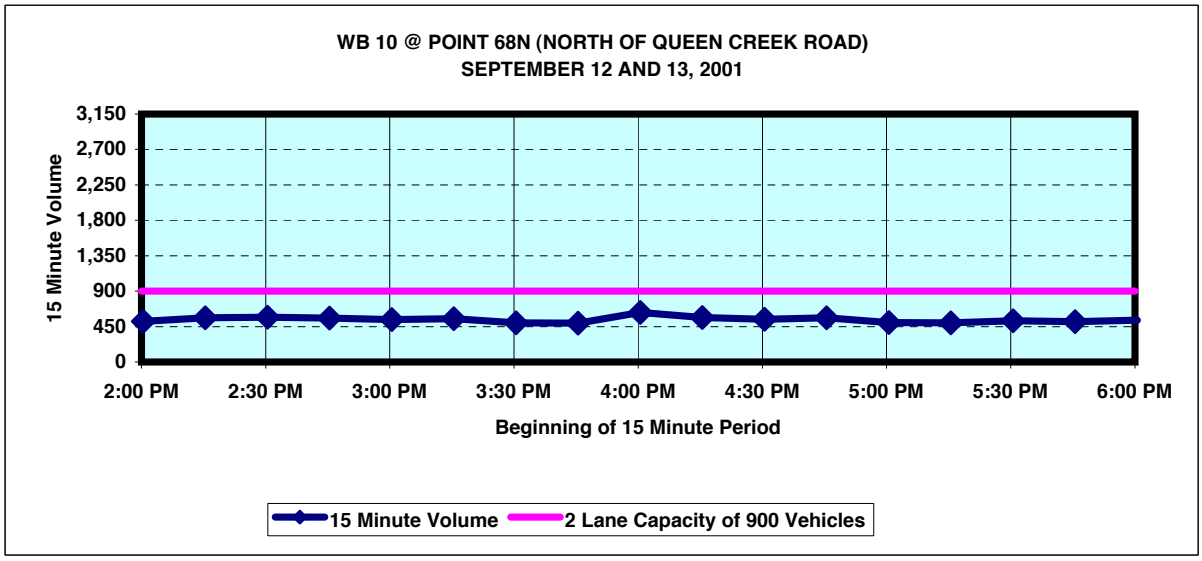

WB 10 @ POINT 45W (EAST OF OGLESBY ROAD)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
5:45 AM
6:14 AM
6:43 AM
7:12 AM
7:40 AM
8:09 AM
8:38 AM
9:07 AM
9:36 AM
15 Minute Volume
2 Lane Capacity of 900 Vehicles

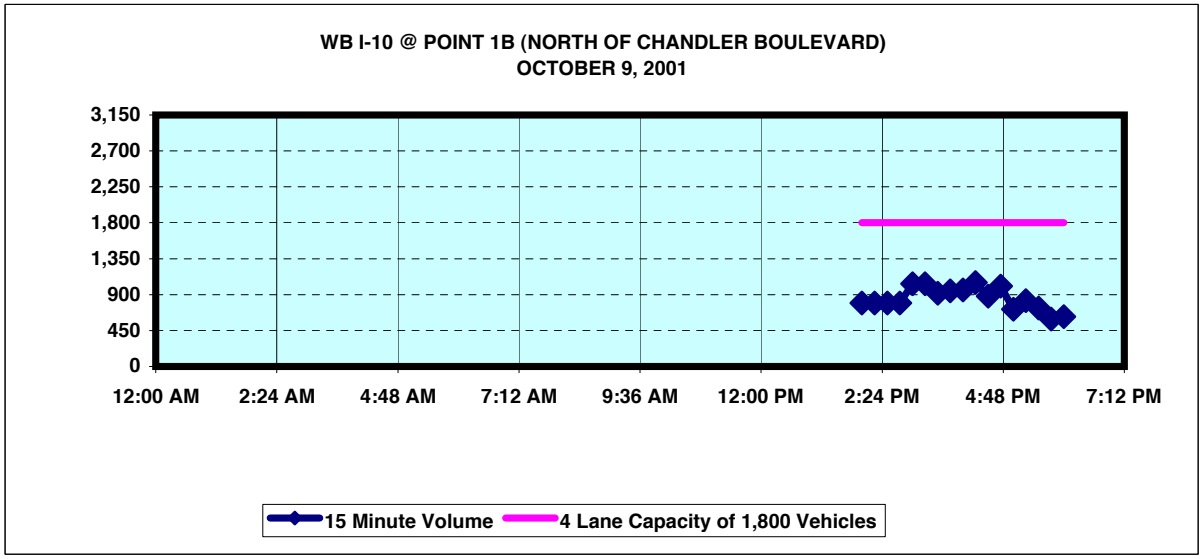
APPENDIX F

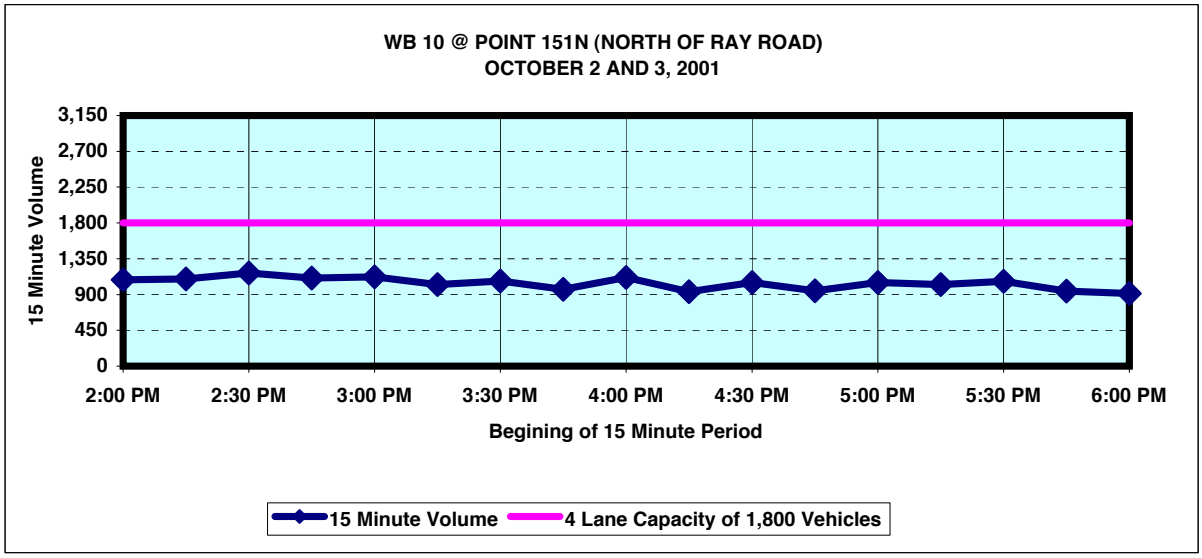
I-10 WESTBOUND
PM PEAK TRAFFIC VOLUMES

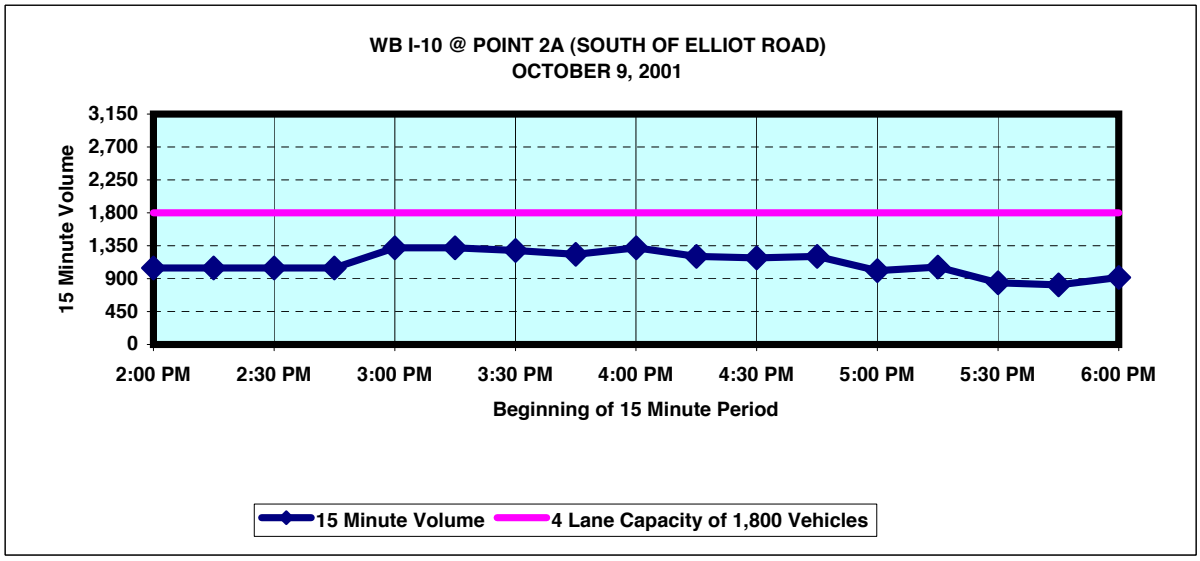
A

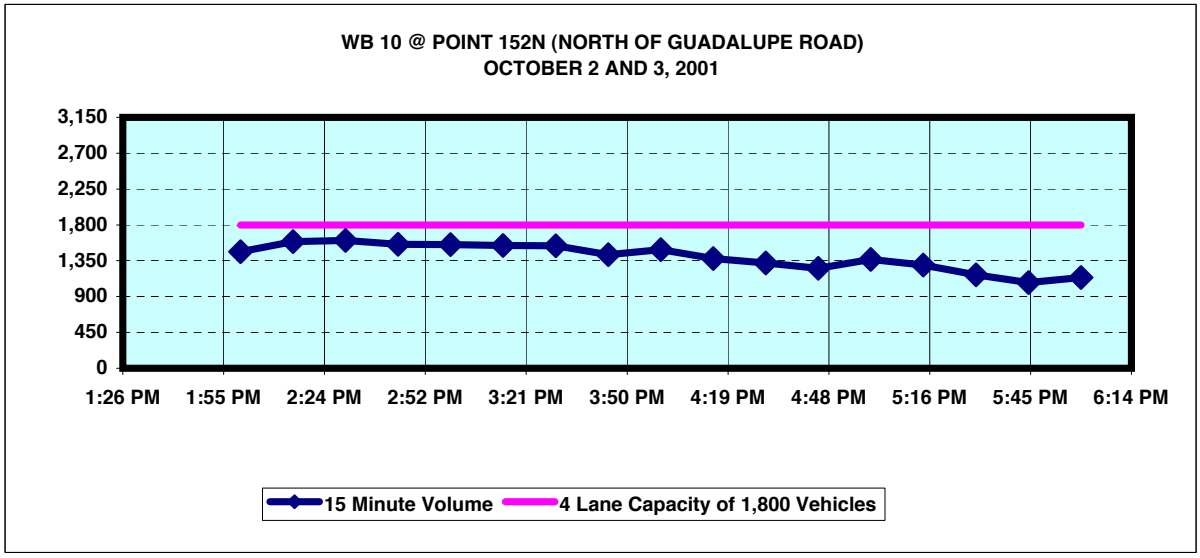

WB 10 @ POINT 69N (NORTH OF RIGGS ROAD)
SEPTEMBER 12 AND 13, 2001
15 Minute Volume
3,150
2,700
2,250
1,800
1,350
900
450
0
2:00 PM
2:30 PM
3:00 PM
3:30 PM
4:00 PM
4:30 PM
5:00 PM
5:30 PM
6:00 PM
Beginning of 15 Minute Period
15 Minute Volume
2 Lane Capacity of 900 Vehicles

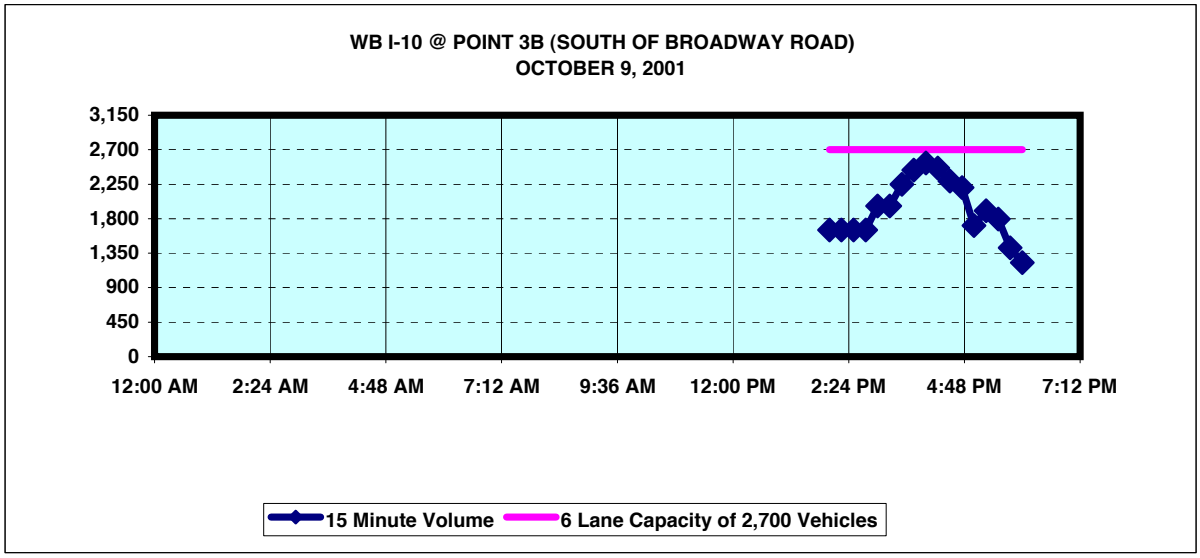

WB 10 @ POINT 68N (NORTH OF QUEEN CREEK ROAD)
SEPTEMBER 12 AND 13, 2001
15 Minute Volume
3,150
2,700
2,250
1,800
1,350
900
450
0
2:00 PM
2:30 PM
3:00 PM
3:30 PM
4:00 PM
4:30 PM
5:00 PM
5:30 PM
6:00 PM
Beginning of 15 Minute Period
15 Minute Volume
2 Lane Capacity of 900 Vehicles

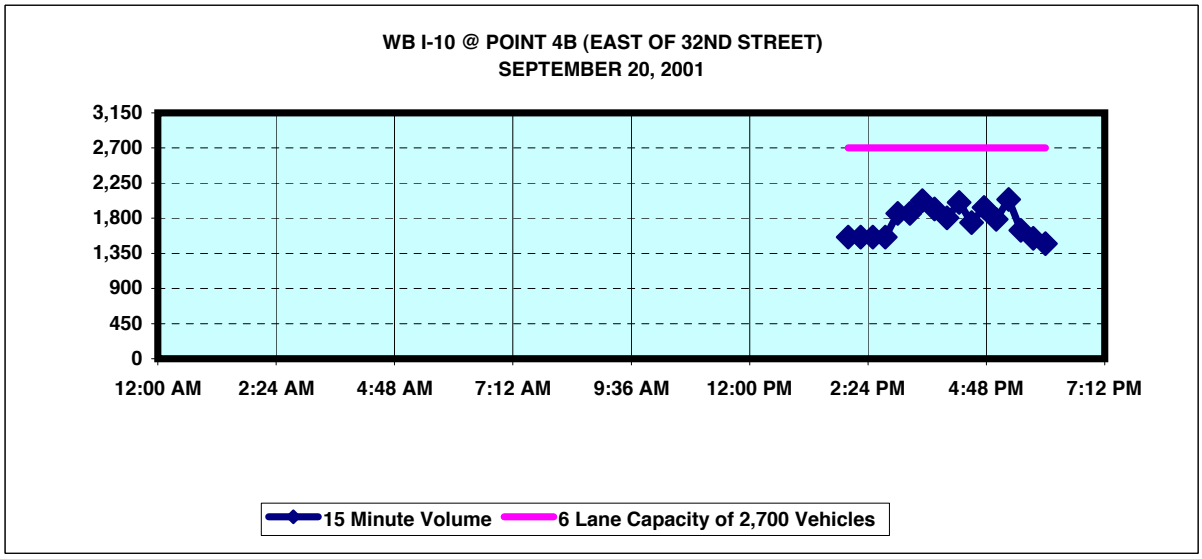

WB I-10 @ POINT 1B (NORTH OF CHANDLER BOULEVARD)
OCTOBER 9, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
2:24 AM
4:48 AM
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
15 Minute Volume
4 Lane Capacity of 1,800 Vehicles

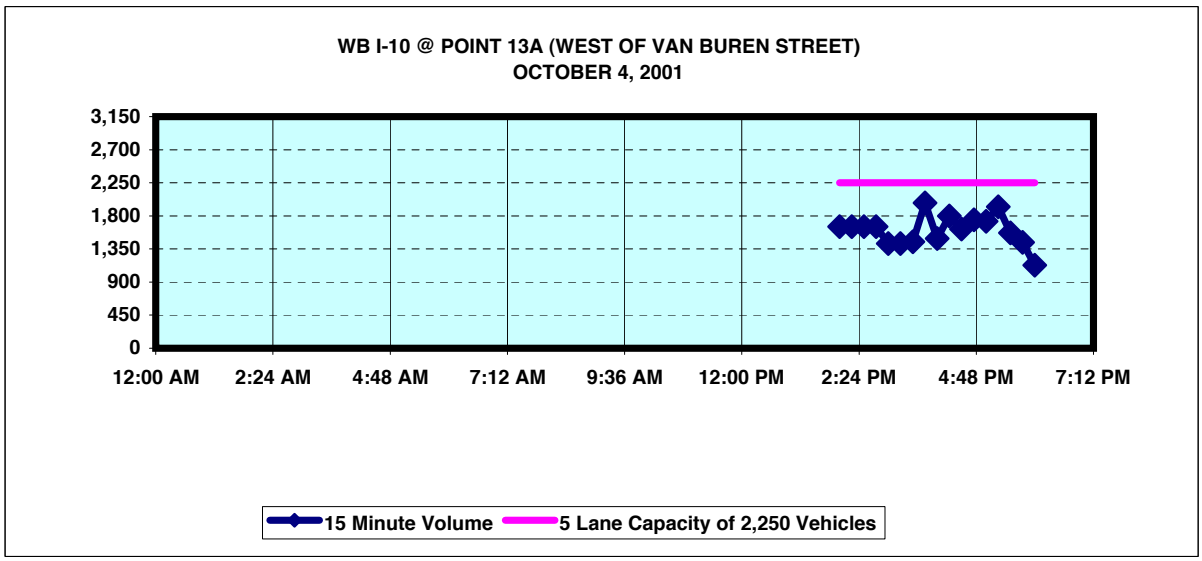

WB 10 @ POINT 151N (NORTH OF RAY ROAD)
OCTOBER 2 AND 3, 2001
15 Minute Volume
3,150
2,700
2,250
1,800
1,350
900
450
0
2:00 PM
2:30 PM
3:00 PM
3:30 PM
4:00 PM
4:30 PM
5:00 PM
5:30 PM
6:00 PM
Begining of 15 Minute Period
15 Minute Volume
4 Lane Capacity of 1,800 Vehicles

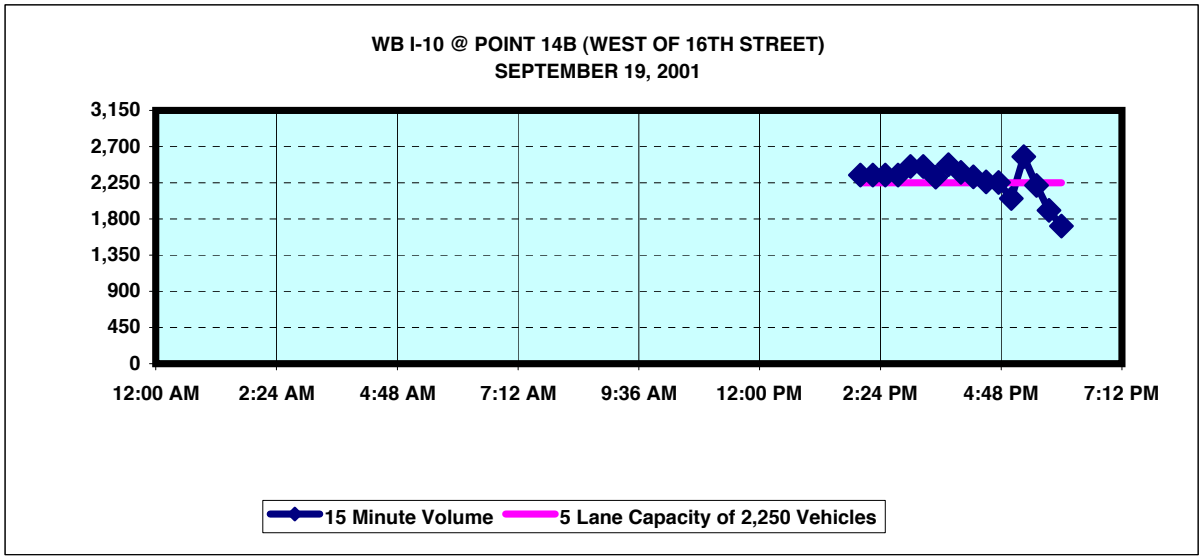

WB I-10 @ POINT 2A (SOUTH OF ELLIOT ROAD)
OCTOBER 9, 2001
15 Minute Volume
3,150
2,700
2,250
1,800
1,350
900
450
0
2:00 PM
2:30 PM
3:00 PM
3:30 PM
4:00 PM
4:30 PM
5:00 PM
5:30 PM
6:00 PM
Beginning of 15 Minute Period
15 Minute Volume
4 Lane Capacity of 1,800 Vehicles

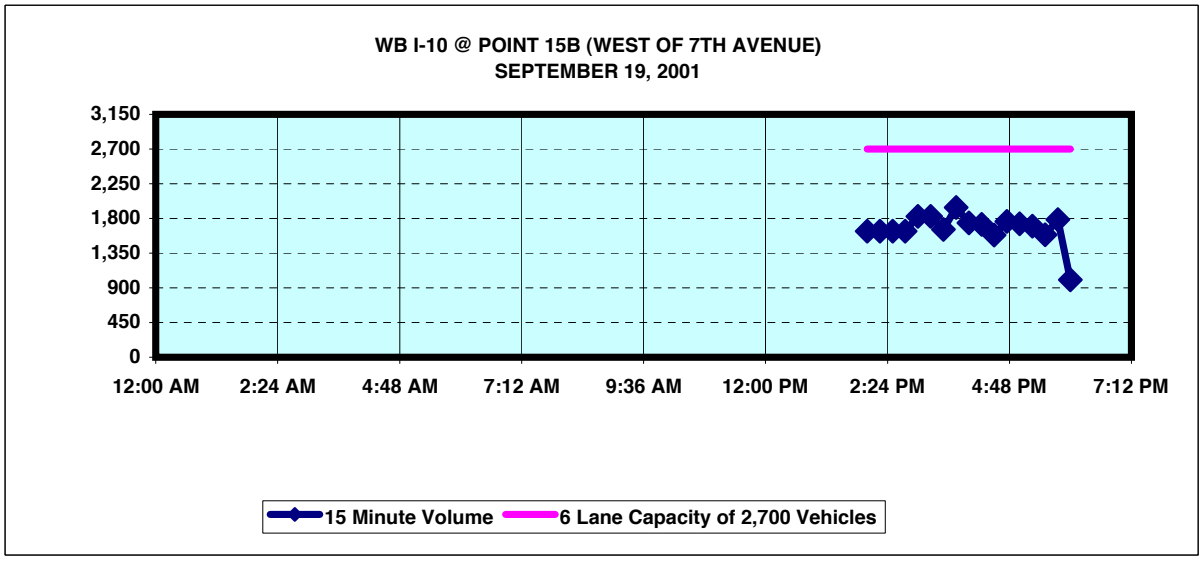

WB 10 @ POINT 152N (NORTH OF GUADALUPE ROAD)
OCTOBER 2 AND 3, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
1:26 PM
1:55 PM
2:24 PM
2:52 PM
3:21 PM
3:50 PM
4:19 PM
4:48 PM
5:16 PM
5:45 PM
6:14 PM
15 Minute Volume
4 Lane Capacity of 1,800 Vehicles

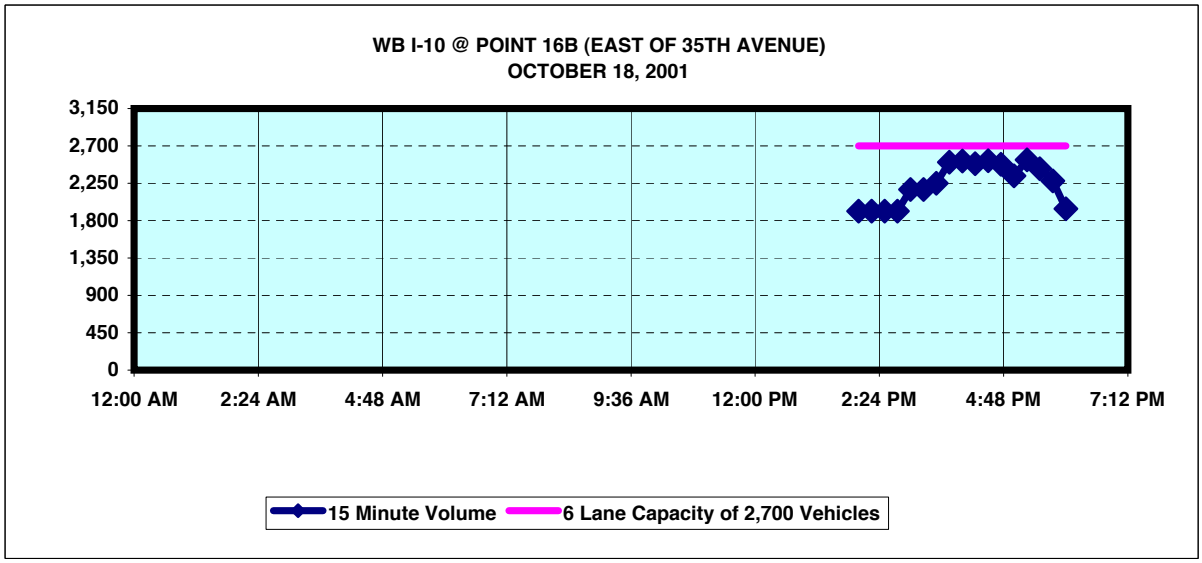

WB I-10 @ POINT 3B (SOUTH OF BROADWAY ROAD)
OCTOBER 9, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
2:24 AM
4:48 AM
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
15 Minute Volume
6 Lane Capacity of 2,700 Vehicles

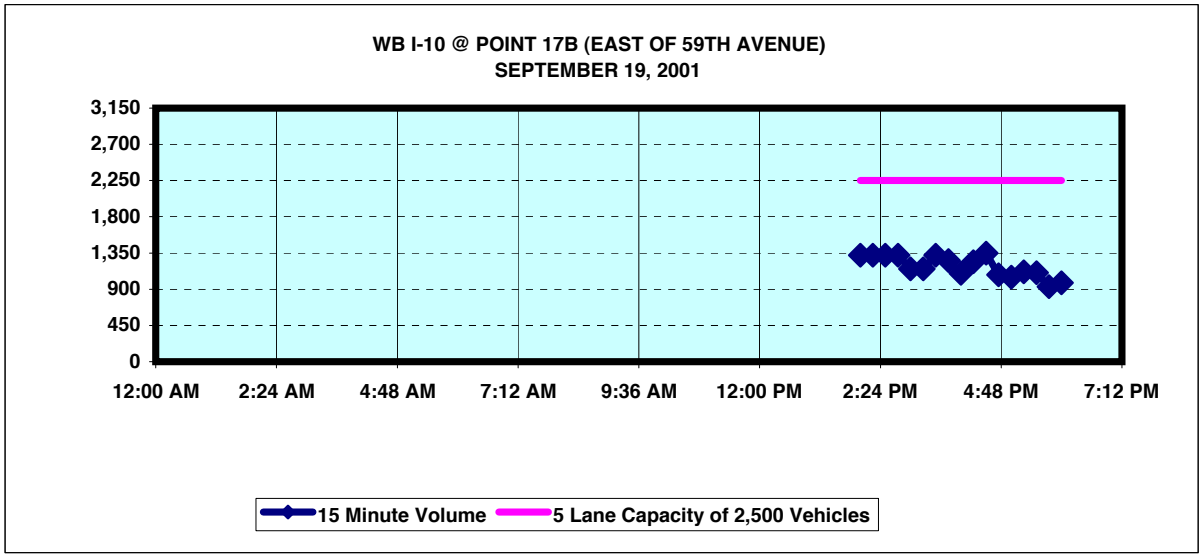

WB I-10 @ POINT 4B (EAST OF 32ND STREET)
SEPTEMBER 20, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
2:24 AM
4:48 AM
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
15 Minute Volume
6 Lane Capacity of 2,700 Vehicles

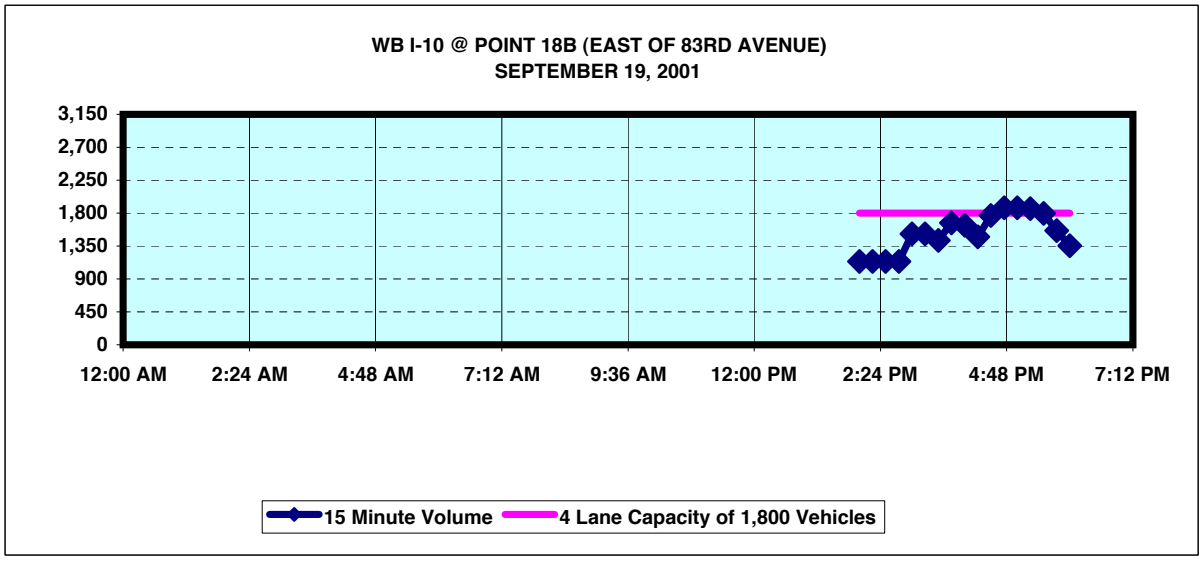

WB I-10 @ POINT 13A (WEST OF VAN BUREN STREET)
OCTOBER 4, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
2:24 AM
4:48 AM
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
15 Minute Volume
5 Lane Capacity of 2,250 Vehicles

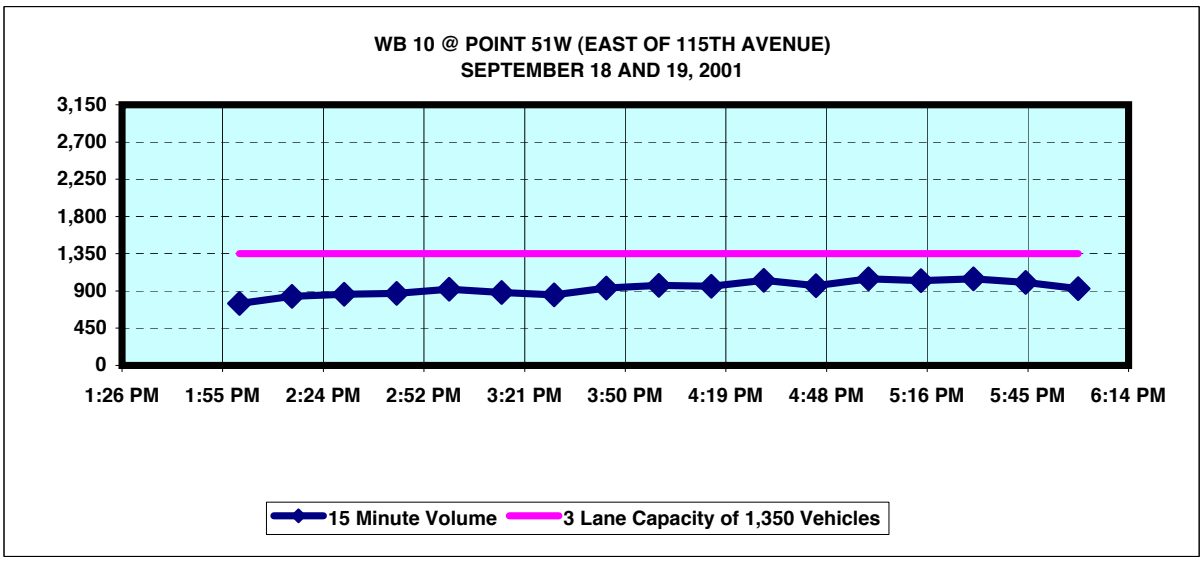

WB I-10 @ POINT 14B (WEST OF 16TH STREET)
SEPTEMBER 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
2:24 AM
4:48 AM
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
15 Minute Volume
5 Lane Capacity of 2,250 Vehicles

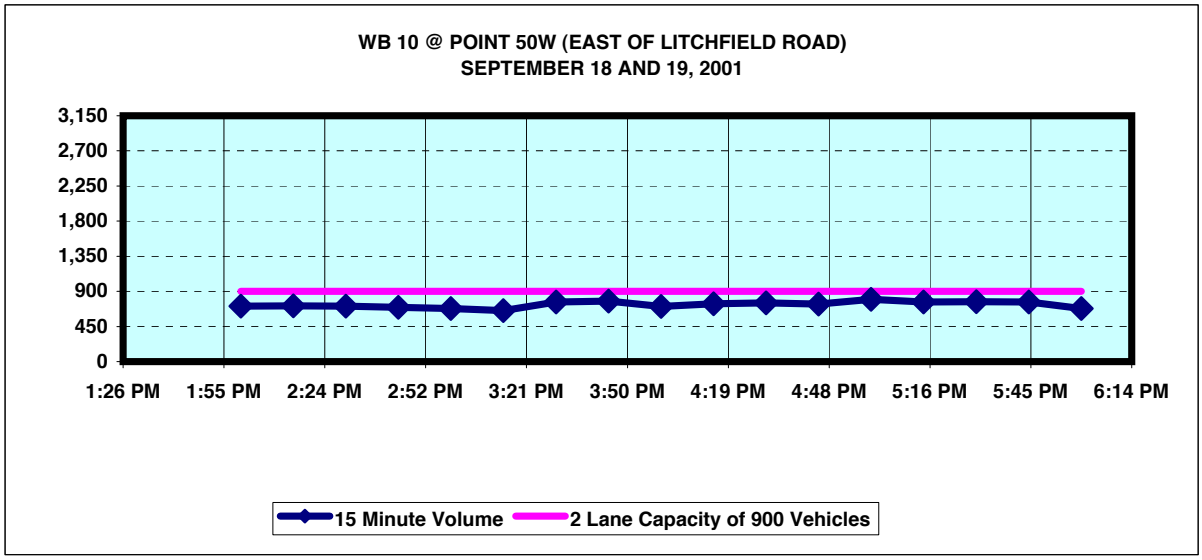

WB I-10 @ POINT 15B (WEST OF 7TH AVENUE)
SEPTEMBER 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
2:24 AM
4:48 AM
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
15 Minute Volume
6 Lane Capacity of 2,700 Vehicles

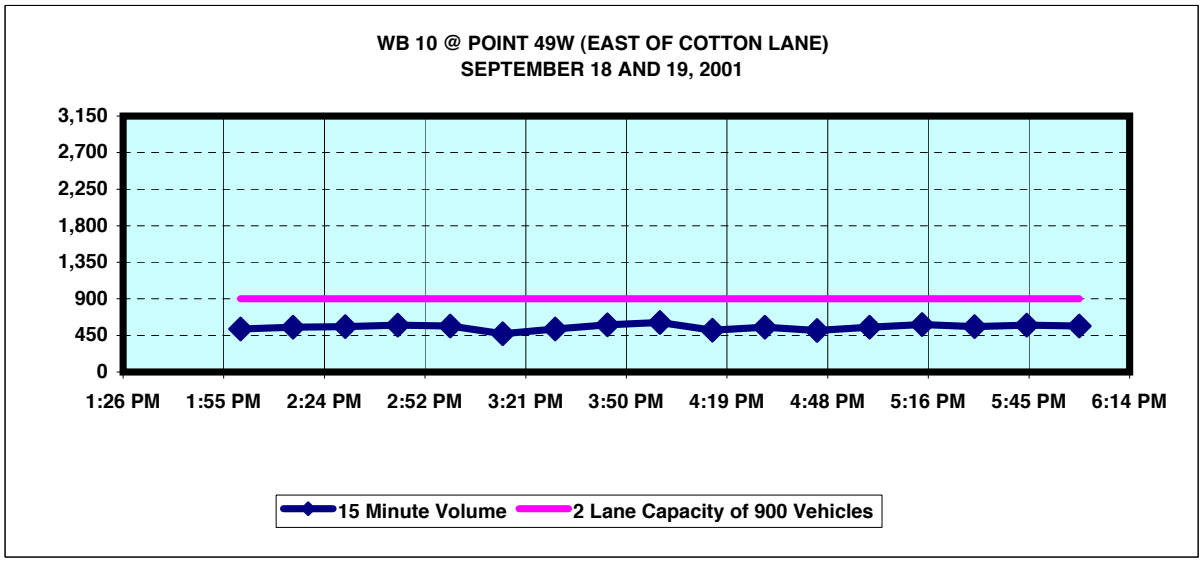

WB I-10 @ POINT 16B (EAST OF 35TH AVENUE)
OCTOBER 18, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
2:24 AM
4:48 AM
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
15 Minute Volume
6 Lane Capacity of 2,700 Vehicles

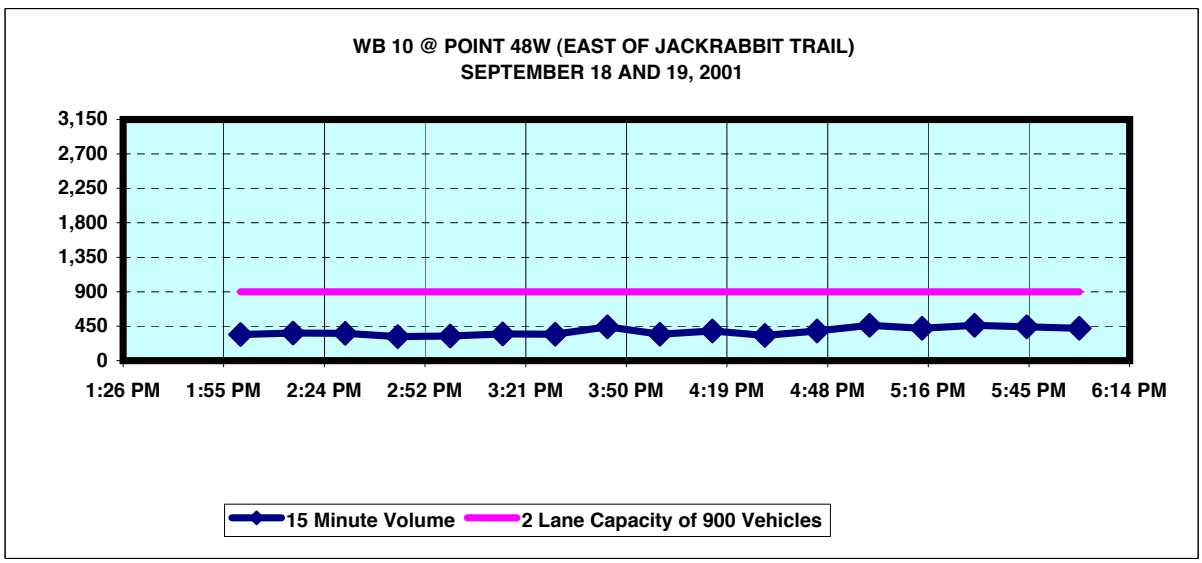

WB I-10 @ POINT 17B (EAST OF 59TH AVENUE)
SEPTEMBER 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
2:24 AM
4:48 AM
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
15 Minute Volume
5 Lane Capacity of 2,500 Vehicles

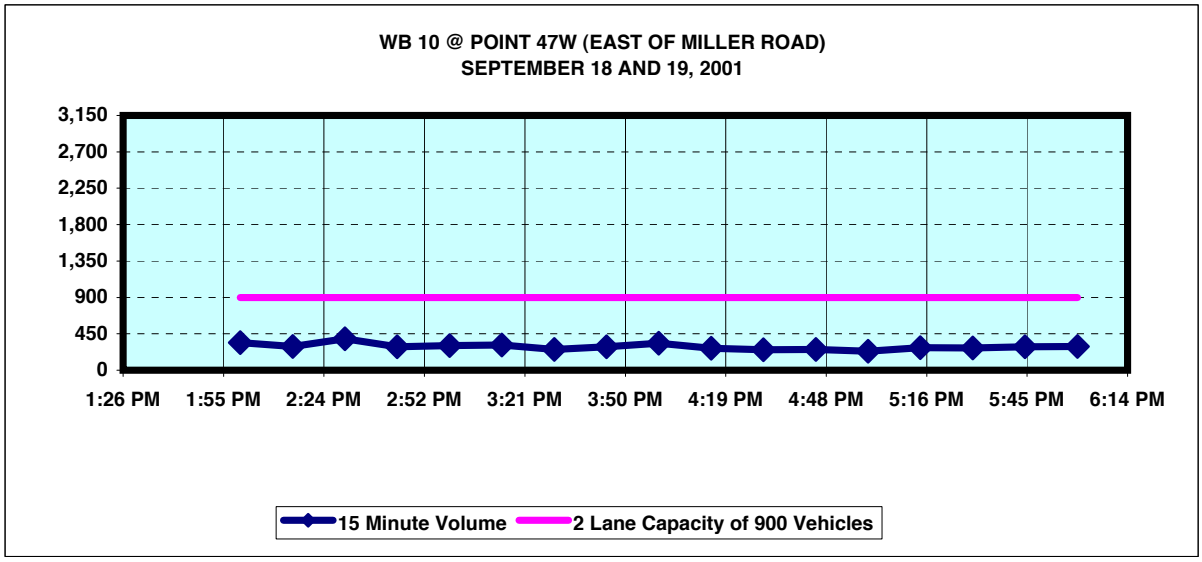

WB I-10 @ POINT 18B (EAST OF 83RD AVENUE)
SEPTEMBER 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
12:00 AM
2:24 AM
4:48 AM
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
15 Minute Volume
4 Lane Capacity of 1,800 Vehicles

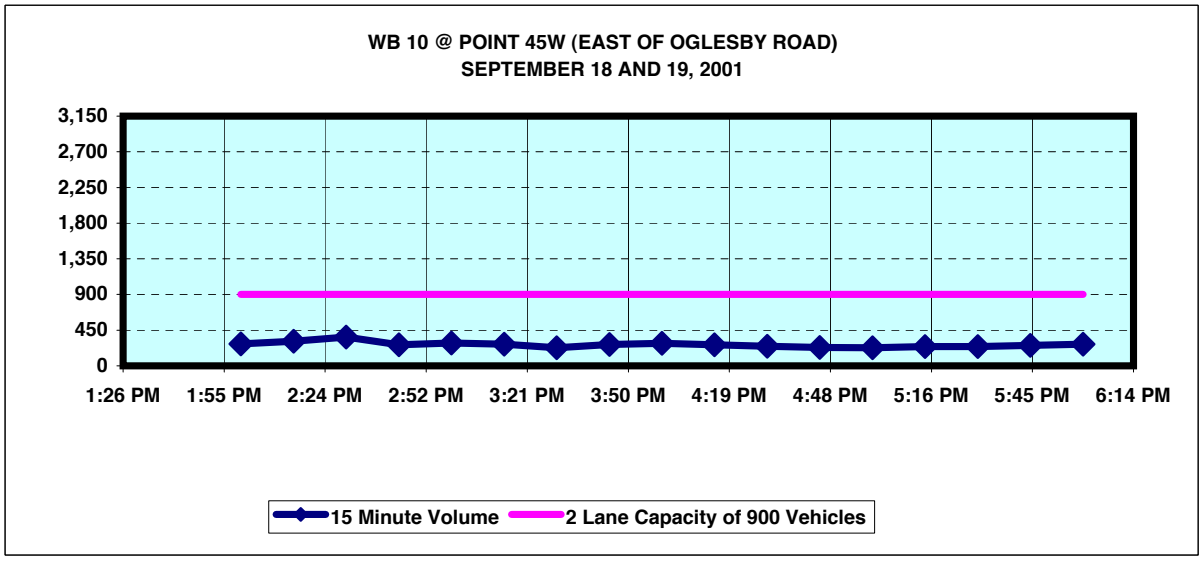

WB 10 @ POINT 51W (EAST OF 115TH AVENUE)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
1:26 PM
1:55 PM
2:24 PM
2:52 PM
3:21 PM
3:50 PM
4:19 PM
4:48 PM
5:16 PM
5:45 PM
6:14 PM
15 Minute Volume
3 Lane Capacity of 1,350 Vehicles


WB 10 @ POINT 50W (EAST OF LITCHFIELD ROAD)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
1:26 PM
1:55 PM
2:24 PM
2:52 PM
3:21 PM
3:50 PM
4:19 PM
4:48 PM
5:16 PM
5:45 PM
6:14 PM
15 Minute Volume
2 Lane Capacity of 900 Vehicles


WB 10 @ POINT 49W (EAST OF COTTON LANE)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
1:26 PM
1:55 PM
2:24 PM
2:52 PM
3:21 PM
3:50 PM
4:19 PM
4:48 PM
5:16 PM
5:45 PM
6:14 PM
15 Minute Volume
2 Lane Capacity of 900 Vehicles


WB 10 @ POINT 48W (EAST OF JACKRABBIT TRAIL)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
1:26 PM
1:55 PM
2:24 PM
2:52 PM
3:21 PM
3:50 PM
4:19 PM
4:48 PM
5:16 PM
5:45 PM
6:14 PM
15 Minute Volume
2 Lane Capacity of 900 Vehicles


WB 10 @ POINT 47W (EAST OF MILLER ROAD)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
1:26 PM
1:55 PM
2:24 PM
2:52 PM
3:21 PM
3:50 PM
4:19 PM
4:48 PM
5:16 PM
5:45 PM
6:14 PM
15 Minute Volume
2 Lane Capacity of 900 Vehicles


WB 10 @ POINT 45W (EAST OF OGLESBY ROAD)
SEPTEMBER 18 AND 19, 2001
3,150
2,700
2,250
1,800
1,350
900
450
0
1:26 PM
1:55 PM
2:24 PM
2:52 PM
3:21 PM
3:50 PM
4:19 PM
4:48 PM
5:16 PM
5:45 PM
6:14 PM
15 Minute Volume
2 Lane Capacity of 900 Vehicles