APPENDIX I

MAG Responses to Comments on the Draft Modeling Protocol in Support of an Eight-Hour Ozone Redesignation Request and Maintenance Plan for the Maricopa Nonattainment Area, March 2008

Comments received from the Arizona Department of Environmental Quality in a letter from Nancy Wrona dated April 24, 2008

1. **Comment:** *Page 2, Section 1.3: Conceptual Description*: Diurnal ozone variation should be described in this section. Information relating to when the peak hourly ozone concentration was observed and if there is spatial variation in the diurnal pattern of ozone concentrations should be discussed.

   Response: The modeling protocol was updated to include the following text:

   "The peak hourly ozone concentration occurs between 3 pm and 7 pm, and the minimum is usually reached at approximately 6 am. The diurnal cycle is stronger at sites located closer to central Phoenix. The diurnal variation is less prominent at sites farther away from central Phoenix, such as the Cave Creek site."

2. **Comment:** *Page 2, Section 1.3: Conceptual Description*: The second item in the description discussed the general weather patterns during the high ozone days: a low pressure system resides over southwestern Arizona and a high pressure system occurs over northeastern Arizona. This weather pattern could indicate that the high ozone episode may bear some significant synoptic influence. This conclusion is somewhat inconsistent with the conclusion in Attachment I, item 6, which stated that "synoptic scale forcings are weak in the area." Further examination of the synoptic air flow pattern may help to reveal possible contributions to those high ozone episodes.

   Response: Examination of meteorological observations in the Maricopa Nonattainment Area (MNA) indicate that surface winds follow a very consistent diurnal pattern that is most likely influenced by the topography of the basin. This pattern consists of northeast to east winds in the early morning and southwest to west winds in the later afternoon. Such a wind pattern indicates that large scale forcings are weak, and that the surface air is vertically decoupled from flow aloft.

   Further examination of surface weather maps reveals that the pattern of a high pressure system occurring over northeastern Arizona and a low pressure system occurring over the southwestern Arizona also prevails on low ozone days. Thus, a clear relationship between the synoptic flow pattern and high ozone events can not be determined from the available data.

3a. Comment: *Page 2, Section 1.3: Conceptual Description:* The third item discussed regional transport versus local ozone generation and concluded that the local factors are primary cause of high ozone in the MNA. Other than a back-trajectory, do you intend to employ any other approach to quantify ozone transport? Later the Protocol states that the June episode was highly sensitive to boundary conditions. MAG concluded that transport played an important role in that episode. What are the back-trajectory analysis results for this episode? Can ozone transport be ruled out, since aloft measurements of ozone are not available?

Response: The contribution of transported ozone and ozone precursors was quantified in the MAG 2007 Eight-Hour Ozone Plan by zeroing out the lateral boundary conditions. The back-trajectory analysis of the June episode revealed that the origin of the air mass at lower levels (up to 100 meters) was transported a long distance (further than 100 miles) from the southwest. This result is consistent with the sensitivity study which zeroed out the lateral boundary conditions. The sensitivity study indicated that ozone and ozone precursors that were transported from outside of the MNA contributed from 48 to 63% to the high ozone levels in the June 2002 episode. This analysis has been documented in the Eight-Hour Ozone Plan (Appendices, Volume I, TSD, Pages IV-85~87).

3b. Comment: *Page 2, Section 1.3: Conceptual Description*: The fourth item in the description states that "... in 2008 the nonattainment area exhibits a NOx-disbenefit." This is an important finding, because it indicates that further reduction of NOx would not bring any benefits in ozone reduction, but instead increase ozone production. That conclusion is contrary to real world experience in this planning area after Cleaner Burning Gasoline was implemented and contrary to MAG's reliance on fleet turnover, with improved NOx controls on newer vehicles, to continue to improve air quality. The Modeling Protocol and Maintenance Plan must provide more information about the basis for this finding, including how this conclusion was reached; monitoring and modeling results that support it; whether the NOx-disbenefit was observed across the entire MNA; and the temporal characteristics of the NOx-disbenefit. We would also recommend a more in-depth analysis to identify the controlling factors for ozone production and fate within MNA. That analysis will inform the next round of planning for the 0.075 ppm 8-Hour Ozone NAAQS.

Response: The weight of the evidence analysis in the Eight-Hour Ozone Plan (Appendices, Volume II, TSD, Pages V-14~27) addresses the NOx disbenefit finding for the attainment year of 2008. The analysis identifies (1) How this conclusion was reached, (2) Monitoring and modeling results that support it, (3) Whether the NOx-disbenefit was observed across the entire MNA, and (4) Temporal characteristics of the NOx-disbenefit. It is important to note that the modeling for 2008 indicated that the NOx disbenefit occurred only in the NOx-rich urbanized area of the modeling domain. In areas of the modeling domain outside the urbanized area, NOx reductions decreased ozone concentrations. MAG will

conduct a similar analysis for the Maintenance Plan to determine whether the NOx disbenefit is still evident in any part of the MNA in the year 2025. In the real world, monitored ozone concentrations have declined in the Maricopa nonattainment area, because VOC emissions have declined more rapidly than NOx emissions (due to cleaner burning gasoline and fleet turnover, as well as other VOC controls). The Maintenance Plan will include an in-depth analysis to identify the controlling factors for ozone production and fate within the MNA.

4. **Comments:** *Page 15, Section 2.3.2 Meteorological Data*: It is noted in the Protocol that the AZMET stations "are not traditional weather stations: the main purpose of these stations is to provide meteorological data for agricultural and horticultural interests in southern and central Arizona." Please clarify that AZMET data were or were not used in FDDA for MM5; what parameters of the AZMET and NWS data sets were used for model nudging; what type of nudging was conducted; analysis nudging and/or observational nudging. Also clarify whether FDDA was applied to the 12km grid run. It will be helpful for EPA and ADEQ to understand the MM5 simulation if MAG could provide a summary table showing all scientific options and control parameters used in MM5 simulation.

   Response: AZMET meteorological data were used in the observational nudging of the 12-km and 4-km domains. Analysis nudging was applied to all three domains. More specifically, the 3-D analysis nudging included wind, temperature, and humidity above the boundary layer, while the 2-D surface analysis nudging was applied to wind alone. Observational nudging was applied to wind.

   Summary tables showing scientific options and nudging parameters were included in the Eight-Hour Ozone Plan (Appendices, Volume Two, App. III-i, Table 2-2 and 2-3). These tables may be included in the Eight-Hour Ozone Maintenance plan as well.

5. **Comment:** *Page 16:* Provide a brief description of how CAMx would process cloud cover and UV data. These parameters are vitally important since they control the photochemical formation and destruction of ozone and its precursors.

   Response: Cloud cover data obtained from MM5 is processed through the CAMx preprocessor called MM5CAMx and stored in the CAMx cloud/rain file. Since the CAMx cloud treatment is based on the RADM approach, which requires information on cloud optical depth for each cell, MM5 cloud cover data are used to provide gridded cloud optical depth fields. This gridded cloud optical depth is used to scale down photolysis rates for layers within or below clouds to account for UV attenuation, or to scale up the rates for layers above clouds to account for UV reflection. Thus, cloud cover significantly affects photolysis rates. TUV is used to calculate the photolysis rates for each grid cell. Finally, for each grid cell, CAMx incorporates cloud cover data to adjust photolysis rates calculated from TUV and applies these adjusted photolysis rates to photochemical reactions.

6. **Comment:** *Page 17:* MAG is proposing to evaluate the model performance using WRF output as an alternative to MM5 output. WRF is the model replacing MM5. Such a comparison will reveal important factors that would affect future air quality modeling practices. This is a great opportunity for the modeling community in Arizona to see how the improvement in meteorological modeling could affect the air quality assessment. It shows great commitment and dedicated by MAG to do scientifically sound and complete work.

   Response: Thank you.

7. **Comment***: Page 24, Section 2.7 Emission Inventories*: MAG should provide more information about how the emission inventory data will be prepared, such as the sources of the raw data and the emission sectors that are included in point and area categories. The 12 km modeling domain covers a large portion of south California, south Nevada, Utah, Colorado and the majority of New Mexico. How will the emission inventories for these states be obtained. How will the emission inventories for the border provinces of Mexico be obtained? Is there any refinement of the emission inventory in terms of source –specific activities?

   Response: As of May 8, 2008, the Maricopa County Air Quality Department (MCAQD) has not drafted a summary document for their 2005 Periodic Emissions Inventory for ozone. This summary document describes the methodologies, assumptions, sources of data, categories of emission sources used to develop MCAQD's emissions inventory. If the MCAQD document becomes available in time, MAG will include it in the Technical Support Document (TSD) for the Maintenance Plan.

   The emissions data for the 12 km modeling domain will be provided by ENVIRON. ENVIRON will extract the 2002 and 2018 emission inventories for the 12 km modeling domain from the Western Regional Air Partnership (WRAP) emissions database. This database contains emissions data for California, Utah, Colorado, New Mexico, and the border provinces of Mexico. Nevada is not a member of WRAP. ENVIRON will either contact Clark County, Nevada's Department of Air Quality and Environmental Management, and Nevada's Division of Environmental Protection for Nevada emissions data and/or investigate other data sources. The 2025 emissions data will be extrapolated using source-category rates of change from WRAP 2002 to 2018. ENVIRON will also investigate possible refinements of source-specific activities as it relates to the emissions inventory.

8. **Comment:** How will the pollutants be speciated? How sensitive will the model results be to the uncertainties in the speciation?

Response: MAG will use the Carbon Bond mechanism IV (CB-IV) for this study. The Carbon Bond mechanism classifies each carbon atom in organic molecules according to its bond type. VOC emissions will be disaggregated into carbon-bond classes according to VOC source-specific speciation profiles and NOx emissions will be distributed as NO and NO_2. CB-IV includes 117 chemical reactions and 30 chemical species. Carbon Bond mechanism - 2005 (CB05) was released in 2005. MAG evaluated both CB-IV and CB05 for the 8-hour ozone attainment modeling demonstration. MAG found that the CB-IV provided slightly better model performance with CAMx than CB05 for the Maricopa Nonattainment Area. In addition, VOC speciation was checked against ambient samples collected at two Photochemical Assessment Monitoring System (PAMS) sites in the Eight-Hour Ozone Plan (Appendices, Volume Two, Appendix V, Page 13-15). The analysis shows that the modeled VOC is accurately reproducing the compounds observed in central Phoenix.

9. **Comment:** *Page 25:* Will non-Arizona emission inventories be projected to 2025 or simply use the same number as in the baseline year? In other words, will the boundary and initial conditions for the inner modeling domain remain the same for baseline year and 2025? Ideally, the emission inventories in surrounding states should also be adjusted according to projected conditions for 2025.

   Response: As indicated in MAG's response to Comment #7, ENVIRON will develop 2025 emission inventories for the 12 km modeling domain based on the WRAP emissions data. The 2025 emissions will be extrapolated using the WRAP 2002 and 2018 emissions data. Since the boundary and initial conditions for the inner modeling domain (4 km) are extracted from the modeling results of the outer modeling domain (12 km), the conditions for the inner modeling domain reflect the projected conditions for 2025.

10. **Comment:** *Page 30, Section 2.7.6 Spatial Allocation of Emissions*: How will emissions be mapped for spatial surrogates? It would be very helpful if MAG could provide a summary table showing the mapping between emission categories and the spatial surrogates.

    Response: Year 2025 area and nonroad mobile source emissions will be spatially allocated to grid cells using spatial surrogates. Since the 2025 emissions inventories and spatial surrogates are currently being developed, a summary table showing the mapping between emission categories and spatial surrogates may not be available in time for inclusion in the modeling protocol. However, this table will be included in the Technical Support Document (TSD) for the Eight-Hour Ozone Maintenance Plan. In the meantime, the spatial surrogate mapping table for 2001, 2002, and 2008 emissions can be referenced from the Eight-Hour Ozone Plan for the Maricopa Nonattainment Area (Appendices, Volume Two, Page No. App. II-37, Table 2) to review the spatial surrogates that were previously used.

11. Comment: *Page 30, Section 2.7.6*: The Protocol mentioned that the "MAG transportation model" will assign travel demand data to 2025 highway networks which will be used to spatially distribute onroad mobile source emissions." What types of roads are included in onroad emission calculations other than the highways?

Response: The MAG transportation model provides data for approximately 20,000 highway network links for five time periods: am-peak, midday, pm-peak, night time, and 24-hour periods. The data include link length, travel time, the number of lanes, ten road types, five area types, traffic volume, and geographic location of link. On-road mobile source emissions by facility type and by area type for each grid cell are calculated using MOBILE6.2 and M6Link models. The types of roads include: (1) Freeway, (2) Expressway, (3) Collector, (4) 6-Legged Arterial, (5) Centroid/Local, (6) Arterial, (7) Freeway Ramp, (8) Freeway Metered Ramp, (9) Freeway Collector/Distributor (CD) Road, and (10) Freeway HOV Lane. All regionally-significant roads are coded into the highway networks.

12. Comment: *Page 37, Section 5.1.1 Unmonitored Area Analysis*: What methodology is proposed for interpolating monitored ozone design value? EPA does not have a specific recommendation in its guidance.

Response: EPA recommends using a software package called Modeled Attainment Test Software (MATS) to do unmonitored area analysis in their *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze* (EPA, April 2007). MATS supports three interpolation methods, which are Equal Weighting of Monitors, Inverse Distance Weights, and Inverse Distance Squared Weights. MAG will select one of these methods to interpolate the monitored ozone design values.

13. Comment: *Page 38, Section 5.1.3 Indicator Species*: The Chemical Process Analysis would be the most suitable tool for understanding the NOx-disbenefit on ozone control observed in MNA. It might also be helpful in understanding the observed temporal and spatial ozone distribution.

Response: Chemical Process Analysis (CPA) is a good tool for understanding the NOx-disbenefit on ozone control observed in the MNA, as well as for understanding the observed temporal and spatial ozone distribution. MAG will apply CPA during the development of the maintenance plan to increase understanding of ozone production and distribution.

14. **Comment:** What were the updated MEGAN emission factors MAG used to estimate the biogenic emissions?

Response: MEGAN was developed by Dr. Alex Guenther at the National Center for Atmospheric Research (NCAR), who is also developing the next generation of biogenic emissions models for EPA. The MEGAN emission factors are based on the results of a field study to identify prevalent plant species and their emission rates in Maricopa County as part of the MAG Biogenics Study (Maricopa Association of Governments 2006 Biogenics Study, Final Report, September 11, 2006). As part of the MAG Biogenics Study, MEGAN was provided to MAG as a state-of-the-art biogenic model with updated emission factors.

The MEGAN model provides emission factors (ug/m^2-hr) for 135 chemical species for approximately 1,400 trees and vegetation, which were used in the development of the 2005 Ozone Periodic Emissions Inventory and the Eight-Hour Ozone Plan. Because of the massive size of the MEGAN emission factor file (i.e., several hundred pages), MAG prefers to provide the emission factors on request rather than include them in the protocol.

15. **Comment:** What is the distribution of emissions outside of the Maricopa non-attainment area, but within the 4km nested domain?

Response: Emission density plots in the Eight-Hour Ozone Plan indicate that less than 29% of total VOC emissions and 7% of total NOx emissions in the 4-km CAMx inner modeling domain are distributed outside of the MNA. More detailed emission distributions for 2001, 2002, and 2008 can be found in the emission density plots in the Eight-Hour Ozone Plan (Figure III-3 through 10 and V-4a through V-4l). Emission distributions for the 2005 emission inventory will be provided in the TSD of the Eight-Hour Ozone Maintenance Plan.

Comments received from the Pinal County Air Quality Department in an email from Scott Dibiase dated April 8, 2008

1. **Comment:** *Pg. 2, Section 1.3 Conceptual Description:* High ozone concentrations are generally observed…. Covered by clouds? This is counterintuitive to ozone formation. Perhaps some background information/data can be included in the document to back this statement up?

   Response: As described in Attachment II (Review of Eight-Hour Ozone Episodes) of the Eight-hour Ozone Attainment Plan (Appendices, Volume II), high ozone exceedances were likely to occur when the sky was partially covered by clouds. For example, 57.4% (81 out of 141 days) of the high ozone days and 88.9% (8 out of 9 days) of the top 3-ranked exceedance days from within each of the three meteorological regimes were days that had 25% or more of the sky covered by clouds (scattered clouds). The relatively high cloud cover on high ozone days might be related to high relative humidity levels since most of the top 3-ranked ozone exceedance days occurred when dew point temperatures were higher than the average.

2. **Comment:** *Pg. 16 – last sentence of paragraph two:* The word "the" is missing from between "from" and "National Center for Atmospheric Research NCAR" in the following sentence. "All of the needed datasets listed above were procured directly from National Center for Atmospheric Research (NCAR)."

   Response: The word "the" has been inserted in the updated protocol.

3. **Comment:** *Pg. 19. Figure 2-4 Ozone Monitoring Sites*: The Maricopa (MRCP) monitoring site is erroneously located east of Florence on the map. It should be located west of I-10 in the northwest corner of Pinal County. See Figure 2-5 for the correct location of the Maricopa monitoring site.

   Response: MAG obtained the geo-coordinates of the monitoring sites from the EPA's AQS website. At that time, the location data listed on EPA's AQS website for the MRCP monitor (04-021-3010) were incorrect. After Pinal County updated the MRCP site information in EPA's AQS, MAG used the correct site location in the updated protocol.

4. **Comment:** *Attachment I: Pg. 1. fourth paragraph:* The word "lists" does not need the last s on the word.

   Response: The letter "s" has been removed.

5. **Comment:** *Attachment I: Pg. 4. Figure 3.2:* North Phoenix value of 85 ppb should be in red text. Also, a suggestion, you may want to add the units "ppb" to each of these figures.

   Response: Red text was used to indicate maximum values rather than high ozone value greater than 85 ppb, thus the 85 ppb value for North Phoenix will not be in red text. Per your suggestion, the "ppb" text was added to the figure description in the updated protocol.

6. **Comment:** *Attachment III: Pg. 3. Section 2. Model input data*: Perhaps you can include the spelled out definition of the acronym "JPROC" in paragraph 3?

   Response: The suggested revision has been made in the updated protocol. JPROC stands for "photolysis rate preprocessor".

Comments received from the Environmental Protection Agency (EPA) in an email from Scott Bohning dated May 6, 2008

1. **Comment:** *Weight of Evidence Analysis*: Since “Weight of Evidence" these days is more or less considered to be a part of the attainment demonstration, I'd like to see a commitment to definitely have a W.O.E. section, even if predicted ozone is below the 84 ppb threshold mentioned in the protocol. (And by the way, EPA guidance states an 82 ppb threshold.) This does not have to be a big effort. For WOE, you can rely on emissions trends, air quality monitor trends, and the Chemical Process Analysis (CPA) you are already planning to do per protocol section 5.1.3. I didn't say this over the phone, but the absolute model forecasts mentioned in protocol section 5.1.2 would also be good for the WOE section. (By the way, I am glad you will be looking at that, since not everyone is completely satisfied with the RRF approach to attainment demonstrations.)

   Response: The modeling protocol was updated to include the following text:

   "MAG will submit a weight of evidence analysis along with corroborative tests to EPA. The weight of evidence section will include a discussion of trends in emissions and monitored ozone design values, results of a CPA analysis, as well as evidence, viewed as a whole, supporting the conclusion that the area will maintain the eight-hour ozone standard. "

2. **Comment:** I do want to confirm that it is acceptable to base your maintenance demonstration on the same base case modeling as was used for the attainment demonstration. I checked on that with our Office of Regional Counsel, and OAQPS, and it was also discussed on a call between OAQPS and the modelers of the various EPA Regional offices. I have attached some relevant excerpts from past memoranda about ozone plans. The Clean Air Act itself and the various EPA modeling guidance documents do not address the issue. And in fact, many past maintenance plans have relied on a "carrying capacity" approach, i.e., a total emissions test. But there are some advantages to performing modeling as opposed to relying on an emissions "carrying capacity" approach. Ozone formation is nonlinear, and is affected by the spatial and temporal distribution of emissions, not just total emissions; therefore, modeling provides additional assurance of NAAQS maintenance. Since NOx reductions increased ozone for some modeled Maricopa episodes, modeling would help assure that this phenomenon does not undermine continued attainment. Finally, it may be useful to model future years to assess compliance with the recently promulgated new ozone standard.

   Response: We appreciate your confirmation that it is acceptable to use the same base case modeling that was used in the attainment demonstration. The Eight-Hour Ozone Maintenance Plan will include a comparison of the modeled values in 2025 with the recently promulgated eight-hour ozone standard. MAG will also develop a

detailed schedule for modeling attainment with the new eight-hour ozone standard after EPA has released the official modeling guidance.