APPENDIX C

AERMOD/CALPUFF COMPARISON

During the early stages of this project, a review of eligible dispersion models was conducted to inform the selection of a model for use in conducting source-receptor analyses. Because Sierra anticipated modeling only directly emitted PM_{10}, the review was limited to the dispersion models that are "Preferred/Recommended" by the U.S. Environmental Protection Agency (EPA),[1] they include:

AERMOD Modeling System - A steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

CALPUFF Modeling System - A non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation, and removal. CALPUFF can be applied for long-range transport and for complex terrain.

Other Models - Other dispersion models including BLP, CALINE3, CAL3QHC/CAL3QHCR, CTDMPLUS, and OCD.

Since the Other Models category includes models designed to address unique modeling problems (e.g., industrial source plume rise and downwash, roadway intersections, complex terrain, etc.) the choice was between AERMOD and CALPUFF. The initial focus was on AERMOD as it was the choice of the Air Quality Planning Team and EPA guidance states that it is the "best state-of-the-practice Gaussian plume dispersion model." During the course of the analysis, however, it became clear that AERMOD had difficulty representing concentrations under low wind stagnant conditions, particularly during night time hours. A review of EPA guidance[2] indicated that CALPUFF has advantages over plume models like AERMOD, in dealing with calm winds and stagnant conditions. Therefore, a comparison study was conducted between CALPUFF and AERMOD. Key differences between the models are as follows:

AERMOD is a steady-state model which assumes that a plume disperses in the horizontal and vertical directions resulting in Gaussian (i.e., bell shaped) concentration distributions. It does not track the contribution or carryover of plumes from previous hours. Consequently, each hour a plume is dispersed in the direction of that hour's meteorology in a straight-line trajectory. Given the estimates of particle residence time and settling velocity developed in this study it is expected that carryover from previous hours can be a significant contributor to concentrations during low wind conditions. Since AERMOD does not account for this effect it could explain why the model performs relatively poorly under certain conditions.

CALPUFF is a multi-layer, multi-species, non steady-state Lagrangian puff dispersion model. Dispersion is simulated for discrete "puffs" of species emitted from modeled sources. The puffs are tracked until they have left the modeling domain while calculating dispersion, transformation and removal along the way. Since this process can take hours

[1] http://www.epa.gov/scram001/dispersion_prefrec.htm
[2] Joseph S. Scire, David G. Strimaitis, and Robert J. Yarmartino, 2000. A User's Guide for the CALPUFF Dispersion model.

under low wind conditions, an important effect of non steady-state dispersion is that the puff can change direction with changing winds, allowing a curved trajectory. The ability to track this change would appear to give CALPUFF an advantage relative to AERMOD in replicating concentrations under low wind conditions.

Since there are two versions of CALPUFF available, full CALPUFF and CALPUFF-Lite, a decision had to be made on which version to employ in the comparison. Because the mechanisms described above are fully utilized in both versions of the model and the meteorological data required for full CALPUFF was not directly available, a decision was made to use CALPUFF-Lite in the comparison. An additional consideration was that most of the sources in the Salt River have a low release height and the modeling domain is relatively small therefore the vertical and spatial meteorology advantages of full CALPUFF would not significantly impact the accuracy of the estimates.

The principal limitation of CALPUFF (both full and Lite) is the maximum number of volume sources that can be represented is 200. In comparison, the number of volume sources represented in AERMOD Salt River modeling domain was more than an order of magnitude higher. Since, roadway emissions were found to be in close proximity and significant contributors to each of the Durango Complex and West 43rd monitoring sites, the analysis was limited to a comparison between road source impacts. Because roughly 3,000 volume sources are needed to represent the primary road network in the Salt River modeling domain, the comparison was further limited to the Durango Complex. The full domain of primary roads was used in the inventory for AERMOD (3,168 volume sources) and the roads surrounding the Durango Complex up to the limit of 200 volume sources was represented in CALPUFF-Lite (198 volume sources).

A comparison of the predicted hourly concentrations from the two models is presented in Figure C-1 for December 5th and 6th, 2006. It shows that both models successfully predicted the rise in morning concentrations but significantly underestimated night time and early morning concentrations. Due to the lack of discernable differences between the results, the level of effort that would be required to reconfigure CALPUFF (either full or Lite) to represent additional sources and the time/resource constraints required to complete the study, a decision was made to proceed with AERMOD to complete the analysis.

Figure C-1
Comparison of AERMOD and CAPUFF-Lite Diurnal Distribution of Predicted and Measured Concentrations for Durango Complex