APPENDIX C - SENSITIVITY OF OZONE IN ATLANTA TO NOx AND VOC EMISSIONS

As part of the **S**outh**E**astern **M**odeling, **A**nalysis, and **P**lanning (SEMAP) project, Georgia Tech performed an analysis of the sensitivity of ozone concentrations in the Eastern U.S. to reductions in emissions of both nitrogen oxides (NOx) and volatile organic compounds (VOCs). This analysis was based off of the 2007 and 2018 SEMAP modeling which used CMAQ version 5.01 with updates to the vertical mixing coefficients and land-water interface. The entire "ozone season" was modeled (May 1 – September 30) using a 12-km modeling grid that covered the Eastern U.S. Details of the modeling platform set-up and the detailed modeling results can be found in Appendix E.

Sensitivities were modeled relative to 2018 emissions to evaluate the impact of NOx and VOC reductions on daily 8-hour maximum ozone concentrations. Each emission sensitivity run reduced the 2018 anthropogenic NOx or VOC emissions (point, area, mobile, NONROAD, marine/aircraft/rail) within a specific geographic region by 30%. The 14 geographic regions included Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia, Maryland, MANE-VU (minus MD), LADCO, and CENRAP. This resulted in a total of 28 model runs (2 precursors x 14 regions). The NOx and VOC sensitivities were evaluated at every ozone monitor in the domain.

GA EPD used the SEMAP NOx and VOC sensitivity modeling to examine the normalized sensitivities of NOx and VOC emissions on 8-hour daily maximum ozone concentrations (part per billion ozone/ton per day, ppt/TPD) at 10 ozone monitors in Atlanta. This analysis started with the day-by-day NOx and VOC emission sensitivities (ppb) for May 1 – September 30. Not all modeled days were used in the calculations. The criteria for selecting days to include in the calculation generally follows the approach used by EPA to select days to include in the relative response factor (RRF) calculation as described in EPA's "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze". For our analysis, the following criteria were used to select the days that would be included in the average sensitivity calculation to address the 2008 ozone NAAQS:

- An initial threshold value of 75 ppb was used.
- If the 2018 modeled 8-hour daily maximum ozone concentration was at or above the threshold, then those days were included in the calculation.
- If at least 10 modeled days were at or above the initial threshold, then an average sensitivity was calculated based on those days.
- If fewer than 10 days were available, the threshold was dropped until 10 days were available or the minimum allowable threshold value of 70 ppb was reached.
- If there were fewer than four days available when the minimum allowable threshold value was reached, the minimum allowable threshold was lowered until at least four days were available to include in the average sensitivity calculation.

The average absolute sensitivity was calculated for NOx and VOCs at each Atlanta ozone monitor location (Table 1). The average absolute NOx sensitivity across Atlanta is 6.396 ppb for a 30% reduction in NOx emissions across Georgia and the average absolute VOC sensitivity across Atlanta is 0.293 ppb for a 30% reduction in VOC emissions across Georgia.

Next, the average absolute sensitivity at each monitor was normalized by the emission reduction to give the normalized sensitivity (ppb/TPD). The SEMAP 30% emission reductions were statewide, but the ozone impacts at the Atlanta monitors will mostly results from the local NOx and VOC emission reductions in the nearby 15 ozone nonattainment counties. Therefore, it was not appropriate to normalize the local NOx and VOC sensitivity results by the statewide emission reduction. Instead, a conservative approach would be to assume the ozone impacts at the 10 Atlanta monitors resulted solely from the local

NOx and VOC emission reductions in the nearby 15 ozone nonattainment counties. Therefore, the average absolute sensitivity was normalized by the emission reductions from NOx and VOC reductions in the nearby 15 ozone nonattainment counties. The anthropogenic NOx emissions in the 15 ozone nonattainment counties are 281.5 TPD, so a 30% reduction is 84.5 TPD. The anthropogenic VOC emissions in the 15 ozone nonattainment counties are 280.0 TPD, so a 30% reduction is 84.0 TPD. The normalized sensitivity was calculated for NOx and VOCs at each Atlanta ozone monitor location (Table 2). The average normalized NOx sensitivity across Atlanta is **0.0757 ppb/TPD** and the average normalized VOC sensitivity across Atlanta is **0.0035 ppb/TPD**.

Table 1. Absolute NOx and VOC sensitivity at 10 Atlanta ozone monitors.

AIRS ID	County	Site Name	30% NOx w/ 75 ppb threshold (ppb)	30% VOC w/ 75 ppb threshold (ppb)
13-067-0003	Cobb, GA	Kennesaw	-6.272	-0.380
13-077-0002	Coweta, GA	Newnan	-6.807	-0.148
13-085-0001	Dawson, GA	Dawsonville	-5.252	-0.059
13-089-0002	DeKalb, GA	South DeKalb	-6.515	-0.487
13-097-0004	Douglas, GA	Douglasville	-6.732	-0.350
13-121-0055	Fulton, GA	Confederate Ave.	-5.167	-0.644
13-135-0002	Gwinnett, GA	Gwinnett	-6.440	-0.222
13-151-0002	Henry, GA	McDonough	-7.341	-0.282
13-223-0003	Paulding, GA	Dallas /Yorkville	-5.849	-0.096
13-247-0001	Rockdale, GA	Conyers	-7.580	-0.262
		AVERAGE (ppb)	**-6.396**	**-0.293**

Table 2. Normalized NOx and VOC sensitivity at 10 Atlanta ozone monitors.

AIRS ID	County	Site Name	30% NOx w/ 75 ppb threshold (ppb/TPD)	30% VOC w/ 75 ppb threshold (ppb/TPD)
13-067-0003	Cobb, GA	Kennesaw	-0.0743	-0.0045
13-077-0002	Coweta, GA	Newnan	-0.0806	-0.0018
13-085-0001	Dawson, GA	Dawsonville	-0.0622	-0.0007
13-089-0002	DeKalb, GA	South DeKalb	-0.0771	-0.0058
13-097-0004	Douglas, GA	Douglasville	-0.0797	-0.0042
13-121-0055	Fulton, GA	Confederate Ave.	-0.0612	-0.0077
13-135-0002	Gwinnett, GA	Gwinnett	-0.0763	-0.0026
13-151-0002	Henry, GA	McDonough	-0.0869	-0.0034
13-223-0003	Paulding, GA	Dallas /Yorkville	-0.0693	-0.0011
13-247-0001	Rockdale, GA	Conyers	-0.0898	-0.0031
		AVERAGE (ppb/TPD)	**-0.0757**	**-0.0035**

These results show that NOx emission reductions are generally 15-25 times more effective than VOC emission reductions at reducing ozone concentrations. VOC emission increases can be converted into equivalent NOx emission reductions by taking the ratio of the Atlanta average normalized sensitivity to NOx emissions divided by the Atlanta average normalized sensitivity to VOC emissions:

- (0.0757 ppb/TPD NOx)/(0.0035 ppb/TPD VOC) = **21.7 TPD VOC/TPD NOx**

In other words, a 21.7 TPD increase in VOC emissions is equivalent to a 1.0 TPD increase in NOx emissions. Hence, a 21.7 TPD increase in VOC emissions can be offset with a 1.0 TPD reduction in NOx emissions.