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September 30, 2016

Heather McTeer Toney
Regional Administrator
US EPA Region 4
Atlanta Federal Center
61 Forsyth Street, S.W.
Atlanta, GA 30303-8909

Re: South Carolina Recommendation for 2015 Ozone NAAQS Area Designation

Dear Ms. Toney:

I am writing this letter in response to the United States Environmental Protection Agency's (EPA's) request to submit area recommendations for the revised ozone National Ambient Air Quality Standard (NAAQS) established by the EPA in accordance with 80 *Federal Register* 65292, published on October 26, 2015.

The Clean Air Act Section 107(d)(1) provides that, "By such date as the Administrator may reasonably require, but not later than one year after promulgation of a new or revised NAAQS for any pollutant under section 109, the Governor of each state shall submit to the Administrator a list of all areas (or portions thereof) in the state that should be designated as nonattainment, attainment, or unclassifiable for the new NAAQS..." Accordingly, Governors must submit their initial ozone designations to the EPA no later than October 1, 2016 (80 FR 65292).

Attached to this letter is an analysis to address the incomplete data at two monitoring stations in South Carolina, which attained the ozone NAAQS, but did not meet the minimum data completeness requirements as outlined in Title 40, Code of Federal Regulations (CFR), Part 50, Appendix U. Appendix U requires the average data completeness to meet 90 percent. The data completeness calculations showed that the North Spartanburg (45-083-0009) and Ashton (45-029-0002) monitoring stations achieved 89 percent average data completeness for the years 2013-2015. In accordance with section 4(c) of Appendix U, this analysis shows that the missing data occurred on days that were not conducive to ozone concentrations above the level of the NAAQS. We ask that the EPA approve the attached analysis and deem the design values as valid.

Based on the attached ambient air monitoring data and data completeness analysis, I am pleased to report that South Carolina complies with the revised ozone NAAQS. On behalf of Governor Nikki R. Haley, I am recommending that each county in the State of South Carolina be separately designated as "attainment" for the revised ozone NAAQS.

Should you have any questions regarding our recommendation, please contact Rhonda B. Thompson, PE, Chief, Bureau of Air Quality, at (803) 898-4391 or by email at thompsrb@dhec.sc.gov.

Sincerely,

Catherine E. Heigel

cc: Myra C. Reece, Director, Environmental Affairs, SCDHEC
Rhonda B. Thompson, PE, Chief, Bureau of Air Quality, SCDHEC

Attachments: South Carolina Ozone Design Values – 2015
Incomplete Ozone Data Handling for the North Spartanburg Fire Station #2 and Ashton Ambient Air Monitoring Sites

South Carolina 4th highest MDA8 and Design Value for 2013-2015

Site ID	Site Name (County)	2013 4th highest MDA8 (ppm)	2014 4th highest MDA8 (ppm)	2015 4th highest MDA8 (ppm)	2013-2015 Design Value (ppm)	Meets 0.070 ppm NAAQS	Design Value Valid?
45-001-0001	Due West (Abbeville)	0.056	0.059	0.055	**0.056**	Yes	Yes
45-003-0003	Jackson (Aiken)	0.061	0.062	0.057	**0.060**	Yes	Yes
45-007-0005	Big Creek (Anderson)	0.057	0.060	0.063	**0.060**	Yes	Yes
45-015-0002	Bushy Park (Berkeley)	0.058	0.060	0.054	**0.057**	Yes	Yes
45-019-0046	Cape Romain (Charleston)	0.059	0.059	0.054	**0.057**	Yes	Yes
45-021-0002	Cowpens* (Cherokee)	0.060	0.066	0.065	**0.063**	Yes	Yes
45-025-0001	Chesterfield (Chesterfield)	0.058	0.059	0.059	**0.058**	Yes	Yes
45-029-0002	Ashton (Colleton)	0.050	0.059	0.054	**0.054**	Yes	**See Note 1**
45-031-0003	Pee Dee (Darlington)	0.059	0.063	0.061	**0.061**	Yes	Yes
45-037-0001	Trenton (Edgefield)	0.048	0.055	0.061	**0.054**	Yes	Yes
45-045-0016	Hillcrest (Greenville)	0.063	0.062	0.067	**0.064**	Yes	Yes
45-045-1003	Famoda Farm* (Greenville)	0.060	0.062	0.064	**0.062**	Yes	Yes
45-073-0001	Long Creek (Oconee)	0.053	0.064	0.060	**0.059**	Yes	Yes
45-077-0002	Clemson (Pickens)	0.060	0.062	0.064	**0.062**	Yes	Yes
45-077-0003	Wolf Creek (Pickens)	0.058	0.058	0.063	**0.059**	Yes	Yes
45-079-0007	Parklane (Richland)	0.053	0.056	0.056	**0.055**	Yes	Yes
45-079-0021	Congaree Bluff (Richland)	0.055	0.056	0.055	**0.055**	Yes	Yes
45-079-1001	Sandhill (Richland)	0.061	0.065	0.062	**0.062**	Yes	Yes
45-083-0009	N.Spartanburg Fire Sta. #2 (Spartanburg)	0.065	0.065	0.067	**0.065**	Yes	**See Note 1**
45-091-0006	York (York)	0.061	0.056	0.061	**0.059**	Yes	Yes

Notes: 1) These Design Values do not meet data completeness requirements found in 40 CFR Part 50, Appendix U and the attached data analysis addresses those design values. 2) Monitors marked with " * " were terminated at the end of the 2015 ozone monitoring season. The terminations were approved by the EPA.

Incomplete Ozone Data Handling for the North Spartanburg Fire Station #2 and Ashton Ambient Air Monitoring Sites.

Introduction

On October 1, 2015, the Administrator of the Environmental Protection Agency (EPA) signed a Final Rule setting the new primary and secondary ozone National Ambient Air Quality Standard (NAAQS) to 0.070 ppm, later published in 80 FR 65292. The previous ozone standard was 0.075 ppm. No changes to the form of the metric were promulgated, and it remains based on the maximum daily 8-hour average (MDA8). Promulgation of the NAAQS triggers Clean Air Act (CAA) Section 107(d)(1), requiring the Governor of each state (or his/her designee) to submit recommendations for the classification of each area within that state not later than one year after promulgation. If the EPA disagrees with the State's recommendations, a notification letter is sent detailing the proposed changes and inviting the State to submit further data and explanations in support of the original recommendations. This notification letter must be given no later than 120 days prior to the promulgation of the designation, and it is commonly referred to as the "120-day letter." The CAA requires area designation to be finalized by October 1, 2017, for the new NAAQS except, in a case in which there is insufficient information to make a designation, this deadline may be extended by one year at the Administrator's discretion (CAA 107(d)(1)(B)(i)).

The EPA has established criteria for air quality data collection, verification and evaluation. Appendix U to 40 CFR Part 50 was promulgated through publication on October 26, 2015 (80 FR 65458). This regulation sets forth requirements for ozone data selection, reporting, handling and comparisons to the new ozone NAAQS. Among these are requirements in Section 4(b) for data completeness for the purpose of calculating a valid 3-year ozone Design Value (see text of the section on page 2). Each annual 4^{th} highest MDA8 must be based on valid data from at least 75% of the days during the ozone monitoring season, and the 3-year Design Value must be based on valid data from at least 90% of the days during the previous three ozone monitoring seasons. If either of these criteria is not met, there are two alternatives: 1) the Administrator may defer area designation for an additional year in order to meet the criterion, or 2) the state may demonstrate, in accordance with Section 4(c) and subject to EPA approval, that "meteorological conditions on missing days were not conducive to concentrations above the NAAQS." (See text of this section on page 2)

In 2015, the South Carolina Department of Health and Environmental Control (Department) operated 20 ozone air monitoring sites throughout the state. During that year, the Ashton (45-029-0002) ozone monitor, near Orangeburg, and the North Spartanburg Fire Station #2 (NSFS) (45-083-0009) ozone monitor met the NAAQS with 0.054 and 0.065 parts per million

design values, respectively, but did not meet the data completeness requirement. During 2015, both the cited monitors produced valid data for 82% of the ozone season monitoring days, which met the minimum 75% annual requirement; however, over the 3-year averaging period (2013-2015), 89% of the total ozone monitoring season days have valid data for both monitors, which fails to meet the minimum 90% criterion.

In accordance with Appendix U to 40 CFR Part 50, Section 4(c), the following analysis is intended to demonstrate to the EPA that the missing 2013 - 2015 MDA8 data were from days when meteorological data would convince an informed observer that the 2015 Ozone NAAQS would not have been exceeded at the given site. Finally, our analysis will use a regression analysis of monitors near NSFS to predict ozone concentrations for the missing days to ensure that the three year design value meets the NAAQS. The Department is requesting concurrence from the EPA to count some of the missing days toward the minimum data completeness requirement in section 4(b). The Department is seeking concurrence with more dates than are necessary for the 2013 – 2015 period to ensure that there is sufficient data completeness available for the final designation decision based on data from 2014 – 2016. All computer programming code used to generate the analysis will be provided to the EPA Region 4 office to assist with their decision making.

Regulatory requirements for the treatment of data

The regulations in 40 CFR Part 50, Appendix U, Section 4(b) and (c) address missing data. It specifies:

> *(b) A design value greater than the level of the NAAQS is always considered to be valid. A design value less than or equal to the level of the NAAQS must meet minimum data completeness requirements in order to be considered valid. These requirements are met for a 3-year period at a site if valid daily maximum 8-hour average O_3 concentrations are available for at least 90% of the days within the O_3 monitoring season, on average, for the 3-year period, with a minimum of at least 75% of the days within the O_3 monitoring season in any one year.*
>
> *(c) When computing whether the minimum data completeness requirements have been met, meteorological or ambient data may be sufficient to demonstrate that meteorological conditions on missing days were not conducive to concentrations above the level of the NAAQS. Missing days assumed less than the level of the NAAQS are counted for the purpose of meeting the minimum data completeness requirements, subject to the approval of the appropriate Regional Administrator.*

Identification of missing days

Data for the years 2013 - 2015 were used to calculate the Ashton and NSFS's 2015 3-year ozone design values. For the Ashton ozone monitor, data completeness was 94 percent for the year 2013, 90 percent for 2014, and 82 percent for 2015. The data completeness for the 2013-2015 3-year ozone design value was 89 percent. For the NSFS ozone monitor, data completeness was 91 percent in 2013, 93 percent in 2014, and 82 percent in 2015. The data completeness for the 2013-2015 3-year ozone design value was 89 percent. Since neither Ashton nor NSFS met the 3-year ozone design value requirement of 90 percent data completeness, the Department has chosen to evaluate the meteorological conditions for the days of missing data to determine whether they can be counted for the purpose of meeting the minimum data completeness requirements.

Missing days for the Ashton ozone monitor

The first step for the identification of valid missing data which are assumed less than the NAAQS is to determine the number of missing days for the Ashton and the NSFS ozone monitors. In 2013, the Ashton monitor had 12 days not meeting the minimum data completeness requirements, with the majority of missing data occurring in April and June. For 2014, the Ashton monitor had 21 days of missing data, with the majority of the missing data occurring in July. For 2015, there were 39 days of missing data, with the majority of the missing days occurring in July and August (see Figure 1).

Figure 1: Ashton missing data by year and month

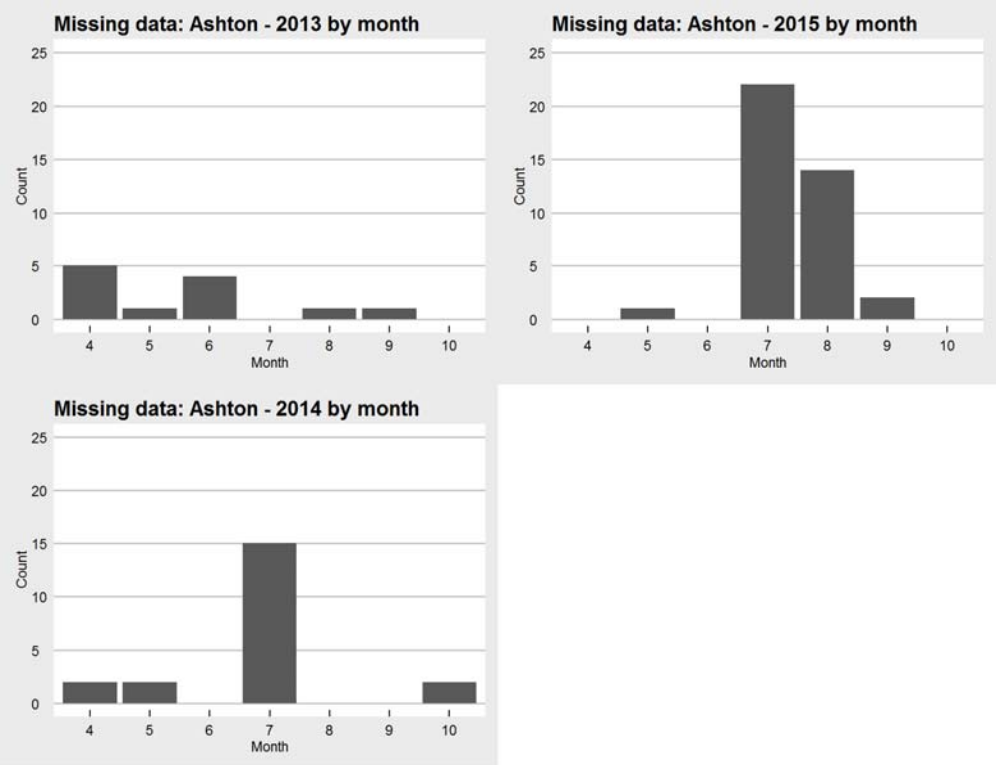
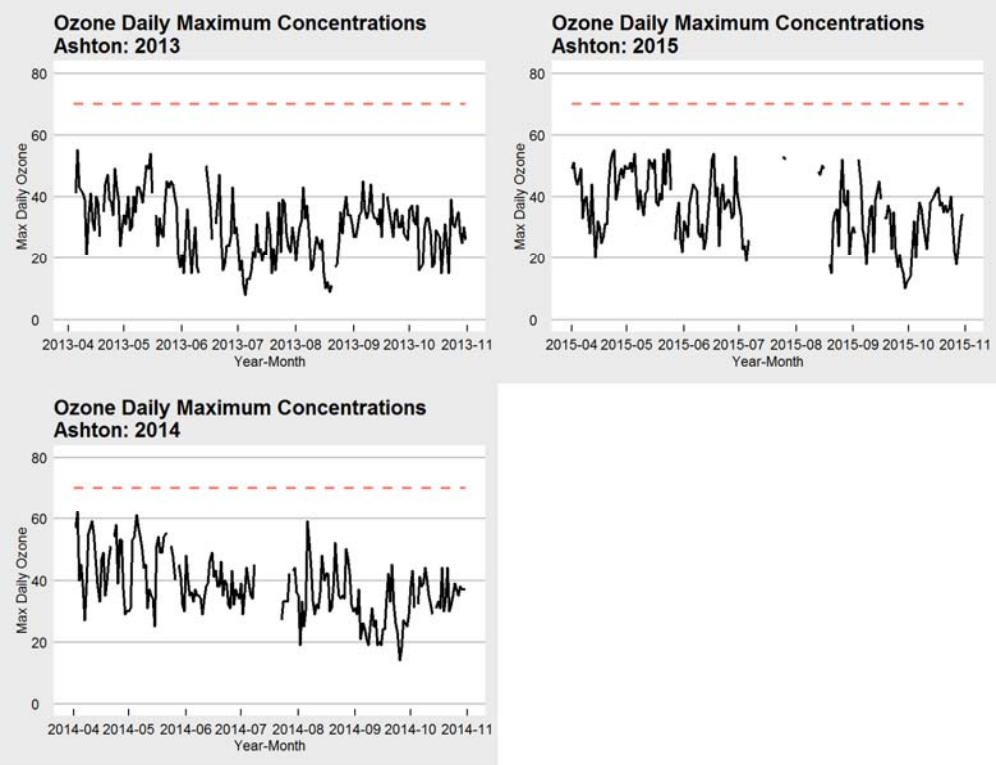


Figure 2 presents the MDA8 for 2013 - 2015 which shows that there were no values greater than 70 parts per billion (ppb). However, there is missing data during the middle of the summer in 2014 and 2015 when ozone production could potentially be at its highest.

Figure 2: Ashton MDA8 by year



Missing days for the NSFS ozone monitoring station

For the NSFS ozone monitor, Figure 3 shows that in 2013 there were 19 missing days, with the majority occurring in July. In 2014, there were 14 missing days, with most of the missing days occurring in April, May, and June. In 2015, there were 38 missing days, with the majority occurring in October. An examination of the MDA8 (Figure 4) for each year comprising the design value show that there was only one exceedance of 70 ppb in 2013.

Figure 3: NSFS missing data by year and month

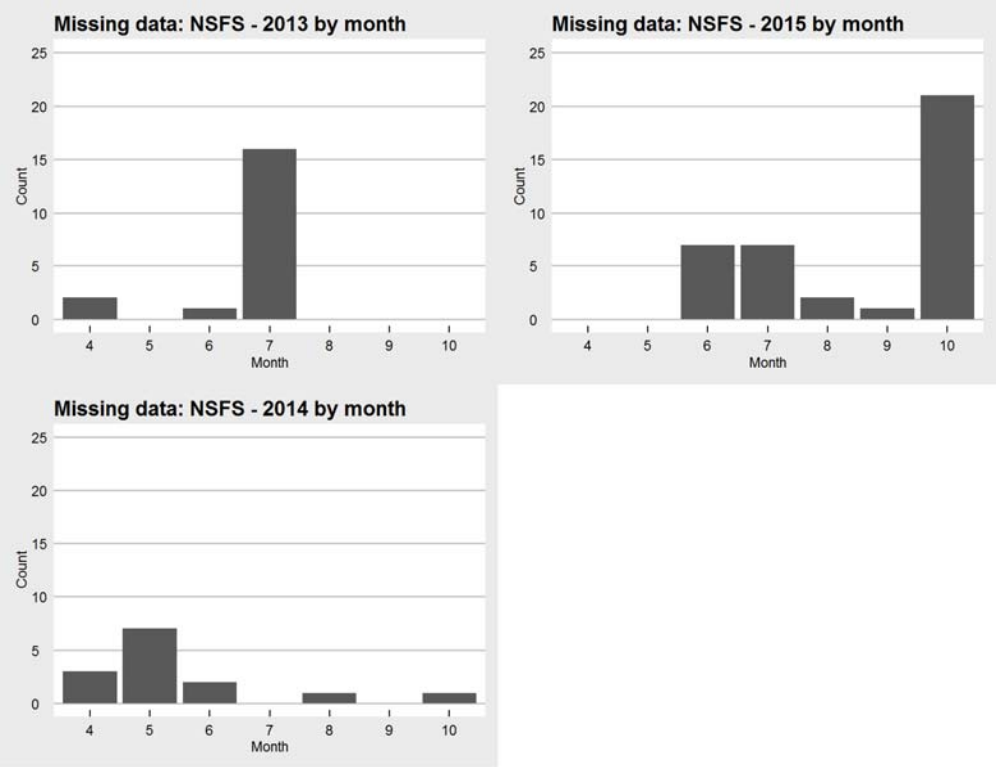
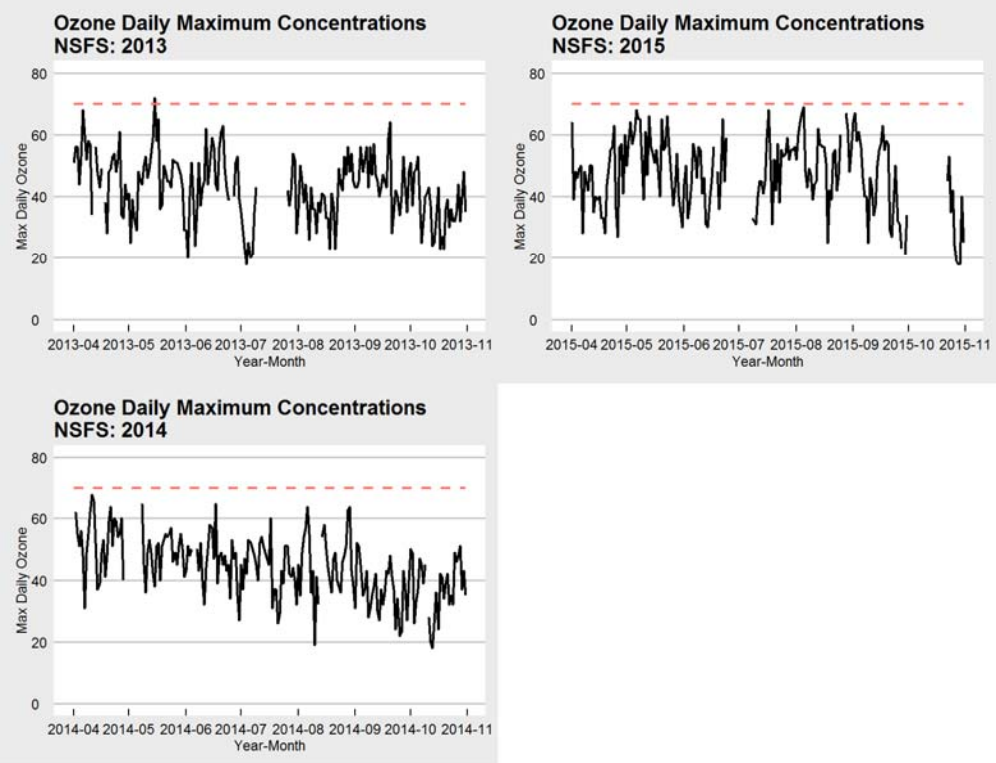


Figure 4: NSFS MDA8 by year



Selection of Days to waive

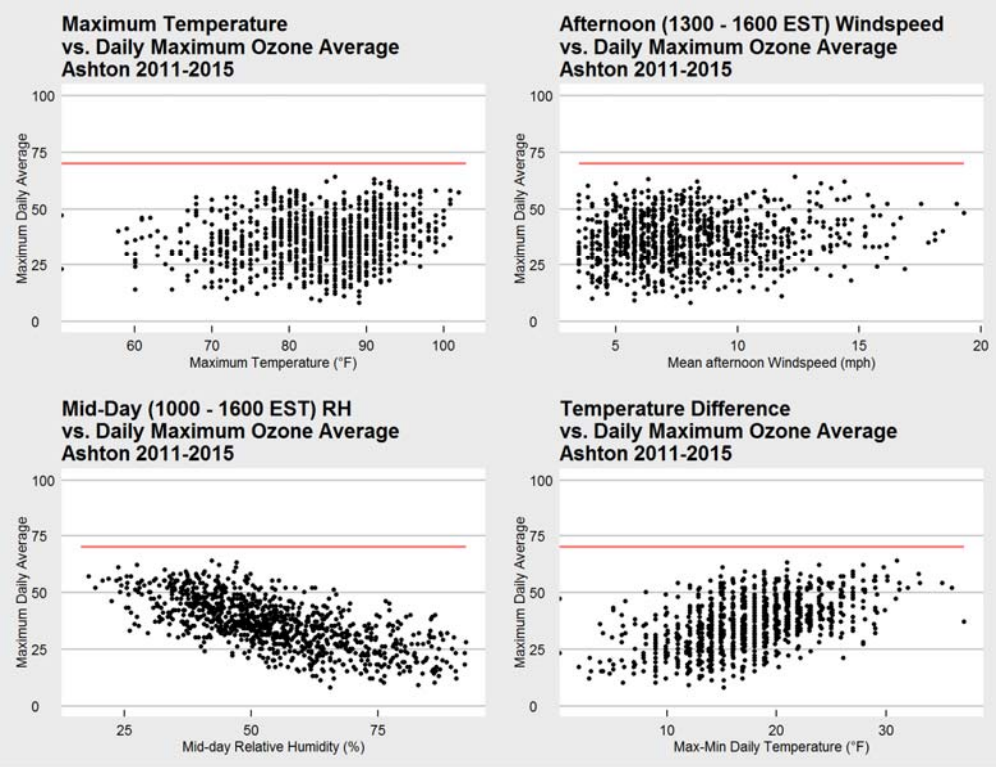
The Department first looked to see which meteorological conditions are not conducive to ozone formation to demonstrate that missing days occurred on days not conducive to ozone formation. The most important meteorological conditions to ozone formation in South Carolina are maximum daily temperature, mid-day (1000 – 1600 EST) relative humidity, temperature difference (daily maximum-daily minimum), and afternoon (1300 – 1600 EST) wind speed. These parameters were selected based on a paper (Cox & Chu, 1996) used to develop the EPA's Trends in Ozone Adjusted for Weather Conditions (US EPA, n.d.)

After identification of meteorological conditions, a prediction of the incomplete design values was conducted to further demonstrate that both monitors would continue to meet the Ozone NAAQS. Due to a lack of nearby monitors close to the Ashton site, a "brute-force" technique was used by substituting 100 percent of the missing days with the highest monthly MDA8 over the last five years and recalculating the design value. Since there were many nearby monitors near the NSFS site, a nonparametric linear regression was used to develop substituted values for 100 percent of the missing data. A bootstrap analysis was used to estimate the variability in the predictions and to ensure that the design value remained below the level of the Ozone NAAQS.

Meteorological conditions and missing data for the Ashton ozone monitor

There are no ozone monitors near the Ashton monitoring site to draw comparisons. The Department used Ashton ozone data and meteorological data from the Orangeburg Municipal Airport (KOGB) to examine meteorological conditions that were conducive to ozone formation. There were no exceedances of the ozone NAAQS from 2011 – 2015. However, some ozone is formed under similar meteorological conditions as other sites (high maximum temperatures, low afternoon wind speeds, and low mid-day relative humidity).

Figure 5: KOGB meteorological conditions vs. ozone



The Department applied a "brute-force" technique by substituting the highest daily maximum ozone concentration by month for the years 2011 - 2015 to determine the number of days for which to seek a waiver. The Department believes this is a conservative approach to demonstrate that even under a worst-case scenario, the design value at the Ashton would not have exceeded the ozone NAAQS.

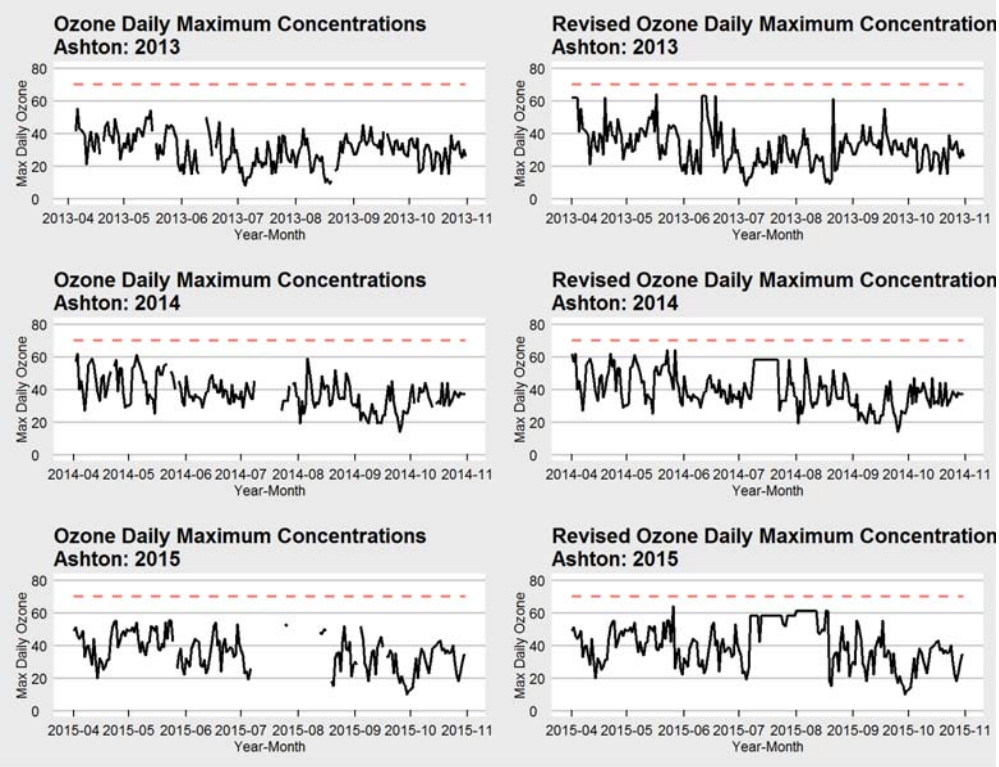
Data from 2006 – 2015 at the Ashton ozone monitor was evaluated in order to determine the highest daily maximum ozone average.

Table 1: Highest monthly MDA8 2006 - 2015

Month	Highest Daily Maximum Average (ppb)
April	62
May	64
June	63
July	58
August	61
September	55
October	47

These monthly maximums were then substituted for all missing data for 2013 – 2015. The time series graphic of the pre- and post-substitution show no exceedances of the NAAQS in 2015.

Figure 6: Ashton MDA8 pre and post data substitution



The design values were then recalculated for Ashton for all missing days. This conservative approach shows that under the worst-case scenario, Ashton design values are expected to still meet the ozone NAAQS with a recalculated design value of 62 ppb. Therefore, the Department will flag all missing ozone data for 2013 – 2015 and request concurrence from the EPA to deem the incomplete design value as being "complete".

Table 2: Pre- and post-data substitution design value calculation for Ashton

Year	Pre-substituted 4th high (ppb)	Data Completeness (%)	Post-substituted 4th high (ppb)	Data Completeness
2013	50	94	63	100
2014	59	90	62	100
2015	54	82	61	100
DV	54	89	62	100

Table 3: Ashton dates requested for waiver

Date		
4/1/2013	4/1/2014	5/26/2015
4/2/2013	4/22/2014	7/7/2015
4/3/2013	5/23/2014	7/8/2015
4/4/2013	5/27/2014	7/9/2015
4/19/2013	7/9/2014	7/10/2015
5/17/2013	7/10/2014	7/11/2015
6/11/2013	7/11/2014	7/13/2015
6/12/2013	7/12/2014	7/14/2015
6/13/2013	7/13/2014	7/15/2015
6/18/2013	7/14/2014	7/16/2015
8/21/2013	7/15/2014	7/17/2015
9/18/2013	7/16/2014	7/18/2015
	7/17/2014	7/19/2015
	7/18/2014	7/20/2015
	7/19/2014	7/21/2015
	7/20/2014	7/22/2015
	7/21/2014	7/23/2015
	7/22/2014	7/24/2015
	7/28/2014	7/27/2015
	10/4/2014	7/28/2015
	10/14/2014	7/29/2015
		7/30/2015
		7/31/2015
		8/1/2015
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		8/4/2015
		8/5/2015
		8/6/2015
		8/7/2015
		8/8/2015
		8/9/2015
		8/10/2015
		8/11/2015
		8/12/2015
		8/17/2015
		8/18/2015
		9/3/2015
		9/17/2015

Meteorological conditions and missing data for the North Spartanburg Fire Station #2 ozone monitor

To understand meteorological conditions that are conducive to ozone formation for the NSFS monitor, the Department obtained the MDA8 ozone concentrations from the close by Clemson CMS (45-077-0002), Big Creek (45-007-0005), Hillcrest (45-045-0016), and Cowpens (45-021-0002) monitoring stations. These sites were selected because they form a cluster of sites surrounding the I-85 corridor in the Upstate of South Carolina. The Department selected meteorological data from the Greenville-Spartanburg International Airport (KGSP) for 2011 – 2015.

Scatterplots between the MDA8 at the monitoring sites and selected meteorological variables show that ozone formation is conducive when maximum daily temperature is greater than 87ºF, mid-day relative humidity is less than 57.3%, afternoon wind speed is less than 14 mph, and temperature difference is greater than 20ºF. In the preceding 5 years, the ozone MDA8 exceeded the level of the ozone NAAQS under these meteorological conditions. Table 4 shows the missing days at NSFS that meet these conditions.

Figure 7: KGSP meteorological conditions vs. ozone

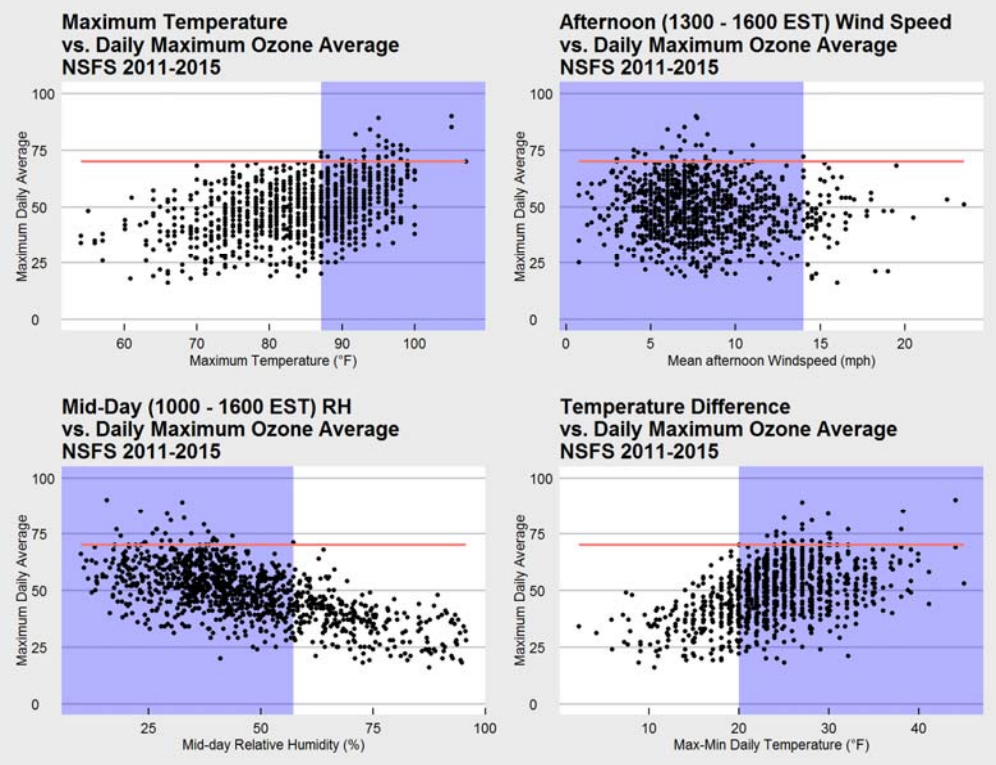


Table 4: NSFS dates requested for waiver

Date

Date		
4/12/2013	4/30/2014	7/2/2015
7/10/2013	5/1/2014	7/3/2015
7/11/2013		7/4/2015
7/14/2013		7/5/2015
7/15/2013		9/28/2015
7/20/2013		10/2/2015
		10/3/2015
		10/4/2015
		10/5/2015
		10/11/2015

Ozone regression analysis

A linear regression analysis of missing data at NSFS was conducted to serve as an additional "weight of evidence" that the site will attain the 2015 Ozone NAAQS based on data collected from 2013 – 2015. This analysis estimates the missing samples at NSFS by using a linear regression model and bootstrapping to estimate the design value for a "complete" data set in 2015. See page 12 for more information about bootstrapping.

Step 1: Organize data and perform linear regression between incomplete site and candidate sites

The Theil-Sen regression method was chosen to develop the statistical model (Team, R Core, 2016), (Maindonald & Braun, 2015), (Komsta, 2013) to predict missing ambient ozone concentrations at NSFS from monitoring conducted at other nearby candidate sites over the past five years. The Theil-Sen regression is a nonparametric linear model and is typically less likely to be influenced by outliers than a least squares linear regression (Hollander & Wolfe, 1999, pp. 415-457). Linear regressions were developed for all candidate sites which had at least 920 sample pairs (which is approximately 75% data completion over the five year period), a Spearman's Rank Correlation Coefficient of at least 0.80, and a minimum of 75% data completeness for the candidate site in 2015.

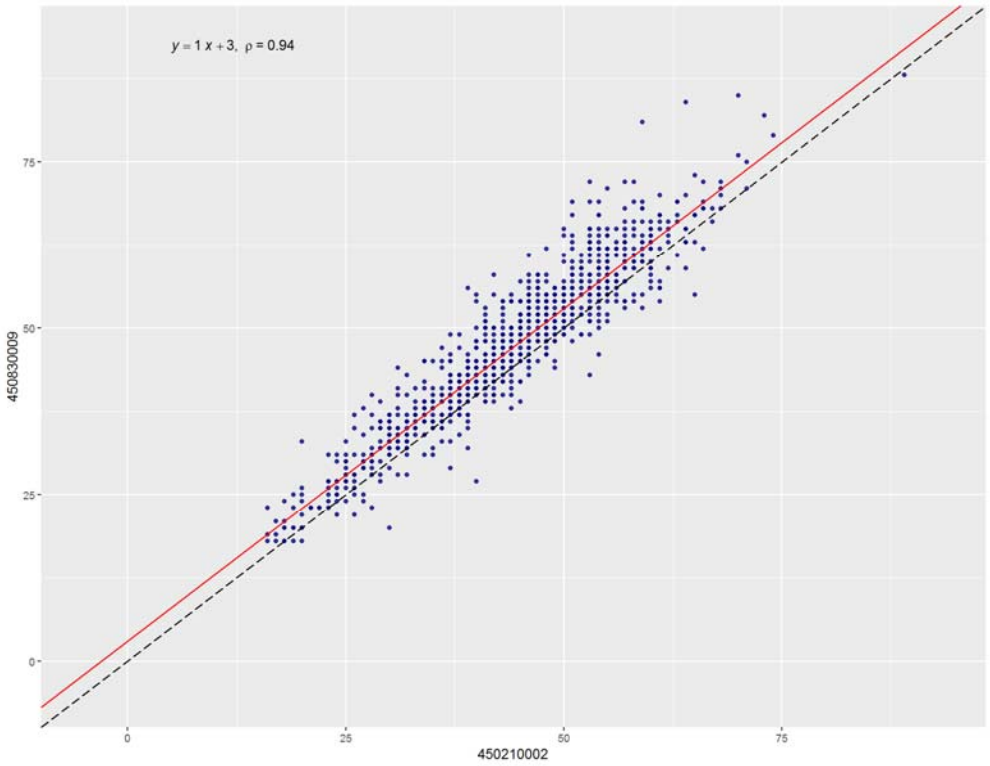
Step 2: Select the best candidate site as the predictor site

The best candidate site was selected based on an earlier analysis (EPA Region 4, 2015). Summary statistics for the models using each of the potential predictor sites are shown in Table 5, ranked by Spearman's Rank Correlation Coefficient and Root Mean Square Error (RMSE), with the best predictor site listed first in the table. Based on the criteria listed in Step 1, the correlation and RMSE results suggest that the Cowpens National Battlefield site (45-021-0002) is the best predictor site for NSFS (Spearman correlation: 0.94, RMSE=4.10 ppb). These results indicate a strong linear relationship between the two sites. A plot of the Theil-Sen regression model and paired data from both sites is in Figure 8.

Table 5: Model statistics

Incomplete Site	Predictor Site	n Sample Pairs	Minimum Pairs Met	Theil Slope	Theil Intercept	Spearman ρ	Theil RMSE (ppb)
450830009	450210002	963	Yes	1	3.00	0.94	4.10
450830009	450070005	961	Yes	1	5.00	0.91	4.90
450830009	450450016	945	Yes	1	2.00	0.89	5.27
450830009	450770002	968	Yes	1	3.22	0.89	5.47

Figure 8: Correlation plot and Theil-Sen regression between Cowpens and NSFS) sites, using ozone data (ppb) from 2011-2015



Step 3: Calculate a test design value

Next, a test 2013 – 2015 design value was calculated using the combination of collected and estimated samples. This procedure produced a design value of 69 ppb, which is below the level of the 2015 Ozone NAAQS.

Step 4: Bootstrapping Analysis

A bootstrapping analysis was conducted to determine the variance around the predicted design value to provide further evidence that the design value would have been below the level of the 2015 Ozone NAAQS if the monitor had complete data. Bootstrapping is a

statistical procedure that resamples a dataset to estimate the variance of a statistic, in this case the design value. The following procedure was used:

a. Residuals were calculated from the Theil-Sen regression model.
b. For each missing sample that was estimated in Step 2, a regression residual was randomly selected with replacement from the pool of residuals and added (or subtracted, in the case of a negative residual) to the estimated value.
c. Repeat (b) 10,000 times
d. For each of the 10,000 runs, the predicted 3-year design value was calculated as in Step 3.

The resulting 10,000 predicted design values are interpreted as an approximate probability distribution of the design values at the incomplete site, had it collected complete data. The distribution of the resulting bootstrap design values is show in Figure 9, and detailed in Table 6. None of the bootstrap runs show a design value greater than the level of the NAAQS. Based on this evidence, the Department believes that the NSFS monitor would not have exceeded the level of the NAAQS had it collected complete data from 2013 – 2015.

Figure 9: Bootstrap results for modeled 2013-2015 design values

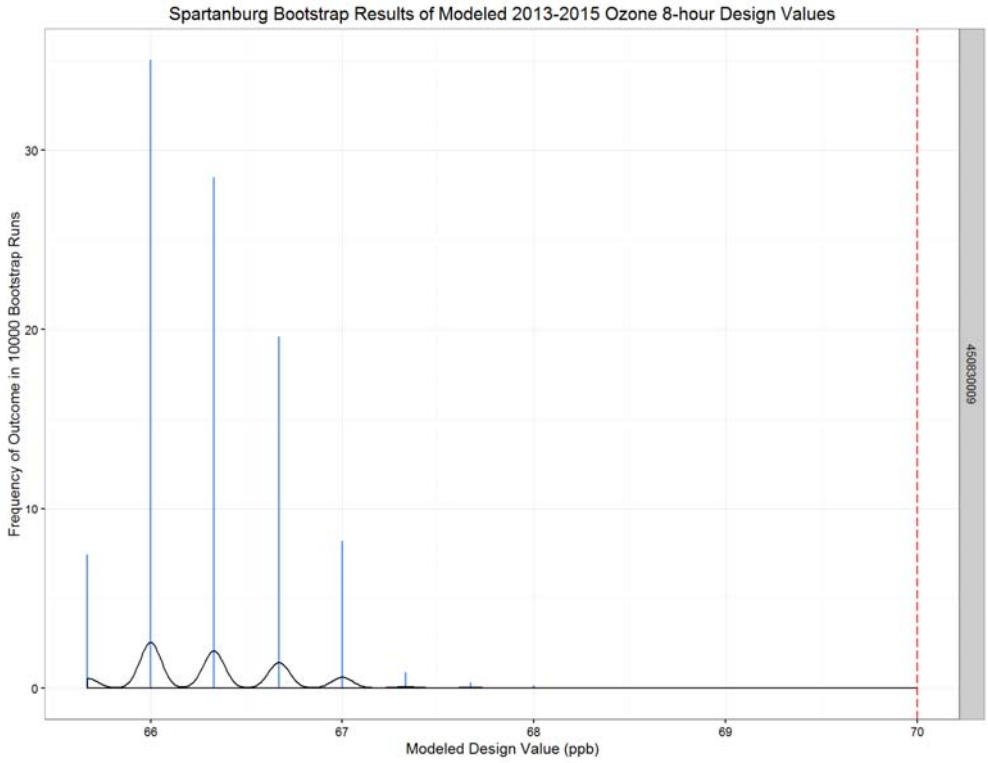


Table 6: Bootstrap results

Incomplete Site	Predictor Site	Bootstrap Runs	Predicted DV (ppb)	95% Confidence Interval (ppb)	Max Bootstrapped DV (ppb)
450830009	450210002	10,000	66	Lower: 64.34 Upper: 65.67	68.67

Conclusions and Recommendations

All monitors which operated in South Carolina between 2013 and 2015 and collected a complete data set attained the 2015 Ozone NAAQS. The Ashton and NSFS monitoring sites did not have sufficient data to have a complete design value. This analysis provides evidence that there was a minimal chance that the monitors could have exceeded the 2015 Ozone NAAQS. A "brute force" analysis at Ashton showed that under a worst-case scenario, the design value would have remained well below the level of the NAAQS. A meteorological analysis, combined with a regression analysis to predict an ozone design value, demonstrates that NSFS would have attained the Ozone NAAQS. The Department recommends that EPA approve our request to deem the design values for Ashton and NSFS ozone monitors as complete by concurring with the dates selected in Tables 3 and 4 as occurring on days not conducive to ozone concentrations above the NAAQS in accordance with Appendix U to 40 CFR Part 50.

Works Cited

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