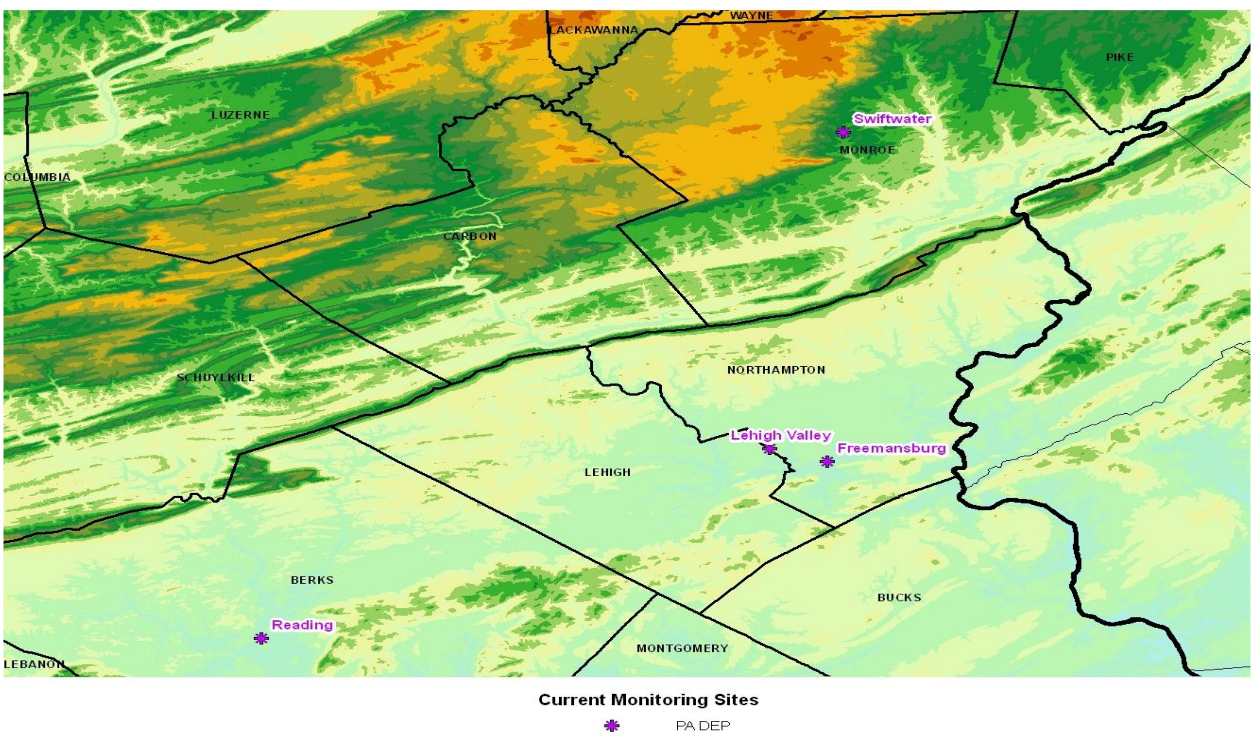
Appendix C-2
NORTHAMPTON COUNTY AREA

The Department is recommending a Northampton County annual $PM_{2.5}$ NAAQS nonattainment area consisting of Northampton County. The Department completed an analysis of the $PM_{2.5}$ ambient air quality data, which outlines the reason for recommending a smaller nonattainment area than the two-county nonattainment area EPA designated for the 1997 and 2006 $PM_{2.5}$ standards. This analysis is provided below.

Analysis of the Ambient $PM_{2.5}$ Data – A Design Value Contribution Analysis

Based on EPA-certified 2012 $PM_{2.5}$ design values, one monitor in the Allentown-Bethlehem-Easton (ABE) metropolitan statistical area (MSA) is violating the 2012 $PM_{2.5}$ annual standard of 12 $\mu g/m^3$. The monitor and its design value are Freemansburg (AIRS # 42-095-0025) (which is located near Bethlehem, in Northampton County) at 13.2 $\mu g/m^3$. The Lehigh Valley monitor (AIRS # 42-095-0027), by contrast, is monitoring attainment of the standard at 10.6 $\mu g/m^3$. The Lehigh Valley monitor is also in Northampton County, located to the northwest of the Freemansburg monitor. Figure C-2.1 is a map showing the location of these monitors, along with other monitors in attainment, in the ABE region.

Figure C-2.1: ABE Regional $PM_{2.5}$ Monitoring Map



The Department has completed a design value contribution analysis for all of the $PM_{2.5}$ monitors in the ABE region. The analysis attempts to determine the daily contribution of $PM_{2.5}$ concentrations to the annual $PM_{2.5}$ design value. Daily $PM_{2.5}$ measurements were grouped into different $PM_{2.5}$ concentration ranges. An analysis of each range's contribution was then conducted to determine which measurements are contributing to the monitor's design value. Dates of these measurements were then further analyzed to determine if there are specific meteorological conditions or sources that are adversely impacting the monitor's design value.

Results from the design value contribution analysis for the ABE region are summarized in Table C-2.1. Ultimately, the type of contribution a given monitor's daily value had on the 3-year design value (by comparing this value to 12 $\mu g/m^3$) was determined. The daily value for each day a monitor measured $PM_{2.5}$ levels was placed in one of the ten categories. For example, on January 1, 2010, the Freemansburg monitor's 24-hour $PM_{2.5}$ average was 30.2 $\mu g/m^3$. Since this value falls in the 30-36 $\mu g/m^3$ category in Table C-2.1, the calculated contribution to the design value for the monitor was placed in this category. In the first quarter of 2010 (January 1 to March 31), the Freemansburg monitor recorded 90 measurements. The Department determined that the January 1, 2010, contribution assessment to the 2012 design value was 0.016852 $\mu g/m^3$. The 0.016852 $\mu g/m^3$ was calculated by dividing the average daily value of 30.2 $\mu g/m^3$ by a factor of the number of measurements for the quarter (90) by 12 (there are a total of 12 quarters in a 3-year design value period). This type of analysis was completed for every day of measurements from January 1, 2010, through December 31, 2012. In Table C-2.1, the sum of the categorical breakdowns for the Freemansburg monitor equals 1.21 $\mu g/m^3$, which demonstrates that the design value for this monitor is 1.21 $\mu g/m^3$ above the annual standard of 12 $\mu g/m^3$.

Table C-2.1: ABE Region
2012 $PM_{2.5}$ Annual Design Value Contribution Analysis

Site Name	Site ID	Owner	0 - 6.0	6.0 - 12.0	12.0 - 18.0	18.0 - 24.0	24.0 - 30.0	30.0 - 36.0	36.0 - 42.0	42.0 - 48.0	48.0 - 54.0	54.0 - 60.0	Sum
Monitors Attaining 2012 PM 2.5 Standard													
Lehigh Valley	420950027	PA DEP	-2.2126	-1.1699	0.5775	0.6846	0.4958	0.1112	0.0242	0.0297	0.0723	0.0000	-1.3873
Reading Airport	420110011	PA DEP	-2.0603	-1.1748	0.6055	0.7689	0.4963	0.1172	0.0988	0.0000	0.0000	0.0000	-1.1485
Swiftwater	420890002	PA DEP	-3.4836	-1.0432	0.3348	0.3602	0.1083	0.0000	0.0000	0.0000	0.0000	0.0000	-3.7235
Monitors Not Attaining 2012 PM 2.5 Standard													
Freemansburg	420950025	PA DEP	-1.0979	-1.1677	0.7814	1.0820	0.7884	0.4709	0.1288	0.0555	0.0392	0.1303	1.2108
Allentown-Bethlehem-Easton Regional Average			-2.2136	-1.1389	0.5748	0.7239	0.4722	0.1748	0.0629	0.0213	0.0279	0.0326	

Table C-2.1 illustrates the differences between the monitors that are attaining the 2012 $PM_{2.5}$ annual standard and the monitor that is not attaining the standard. The Freemansburg monitor has fewer "clean" days (0-12 µg/m^3) than the monitors that are attaining the standard. For example, the Freemansburg monitor's $PM_{2.5}$ contribution to the design value in the 0-12 µg/m^3 range was 1.1 µg/m^3 lower than the regional average.

The analysis described in the remainder of this Appendix focuses on the Freemansburg monitor because it is the one monitor of concern in the ABE region. Figure C-2.2a illustrates the trend of annual averages, while Figure C-2.2b illustrates the trend of annual design values during the period in the ABE region. The Reading monitor's $PM_{2.5}$ levels have continued to decline over the last ten years while the Freemansburg monitor has seen levels remain steady. As a result, the Freemansburg monitor's 2012 design value is 2.3 µg/m^3 above the Reading monitor's 2012 design value.

Figure C-2.2a: ABE Region $PM_{2.5}$ Annual Averages

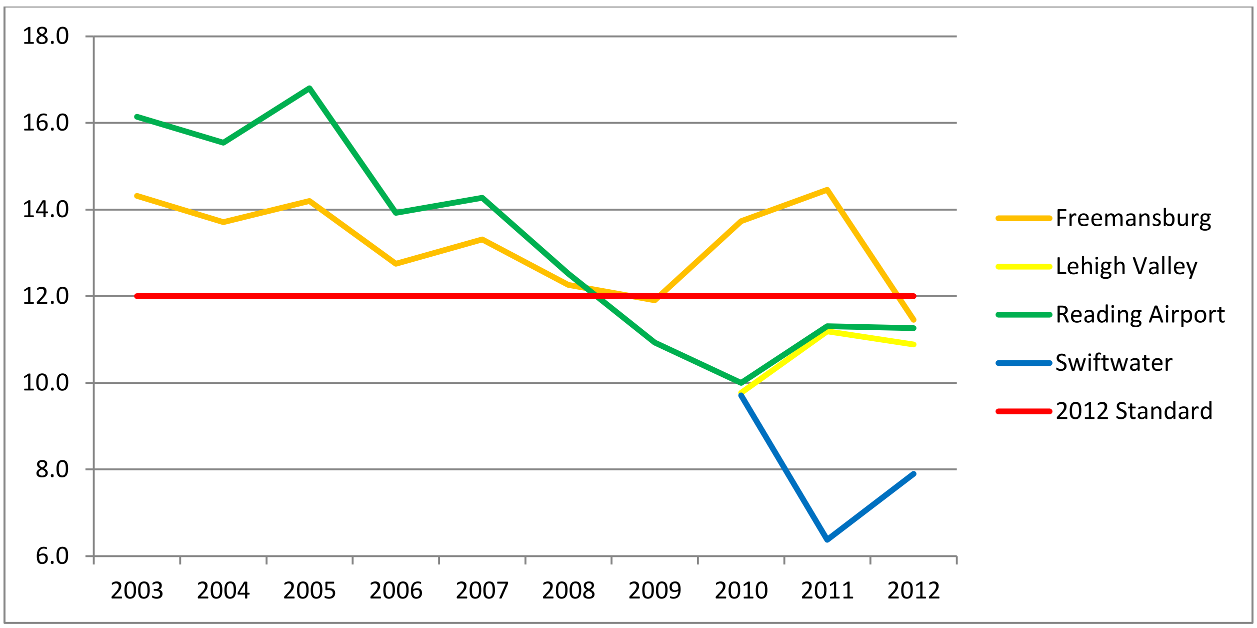


*Figure C-2.2b: ABE Region $PM_{2.5}$ Annual Design Values***

** Swiftwater does not have a full three year data set to calculate a design value.

Additional analyses were completed to determine what was contributing to the fewer number of "clean" days at the Freemansburg monitor. The Department identified days when the Freemansburg monitor's $PM_{2.5}$ concentrations were relatively high but regional monitoring concentrations in the ABE region were "clean." Between 2010 and 2012, the Department identified 344 days in which the Freemansburg monitor was at least one standard deviation above the ABE regional average while the regional average was at or below 12 µg/m^3. The most extreme events (top 25%) were further analyzed to determine why the Freemansburg monitor's concentrations were high when regional concentrations were low.

Meteorological Conditions Impacting High $PM_{2.5}$ Days at Freemansburg

The top 25% days were examined to determine the reason why the Freemansburg monitor's concentrations were high. The Freemansburg monitor has a collocated meteorological tower which monitors wind direction and wind speed. Figure C-2.3 illustrates the number of hours the wind is coming from a particular direction, while Figure C-2.4 illustrates the total $PM_{2.5}$ concentration coming from a particular direction.

Figure C-2.3: Freemansburg Wind Direction Frequency
Top 25% of Regionally "Clean" Days

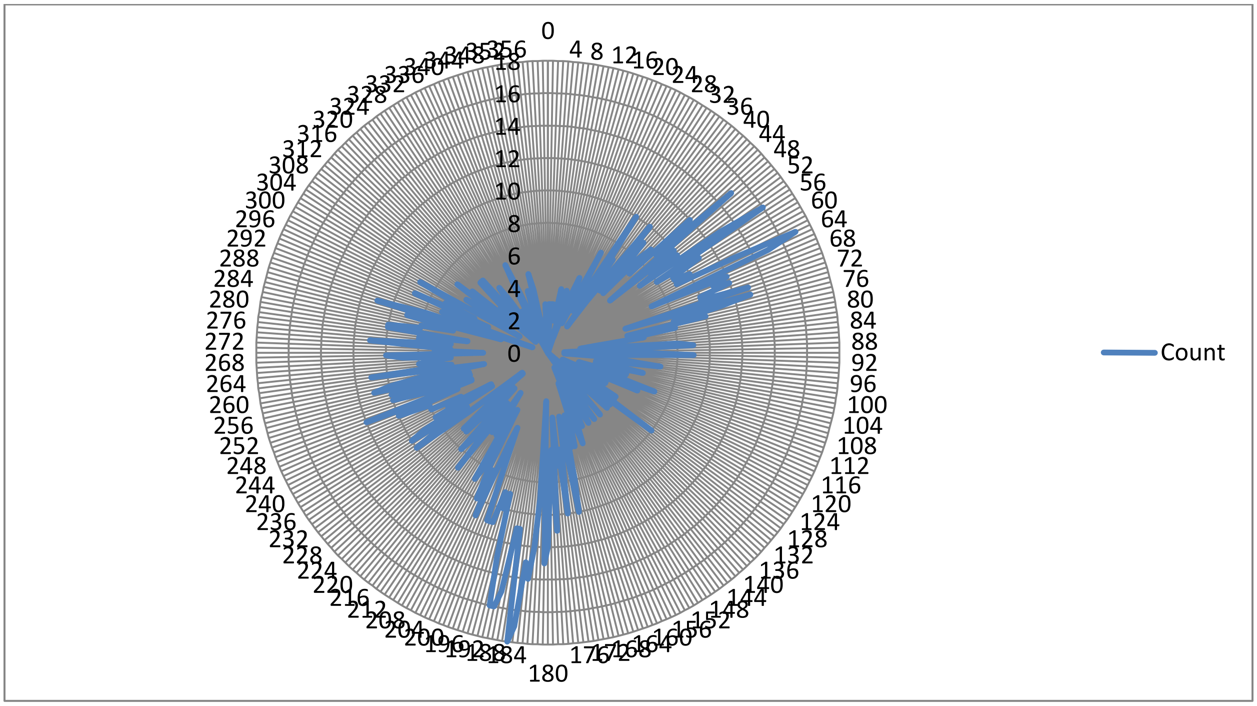


Figure C-2.4: Freemansburg $PM_{2.5}$ Concentration Distribution by Wind Direction
Top 25% of Regionally "Clean" Days

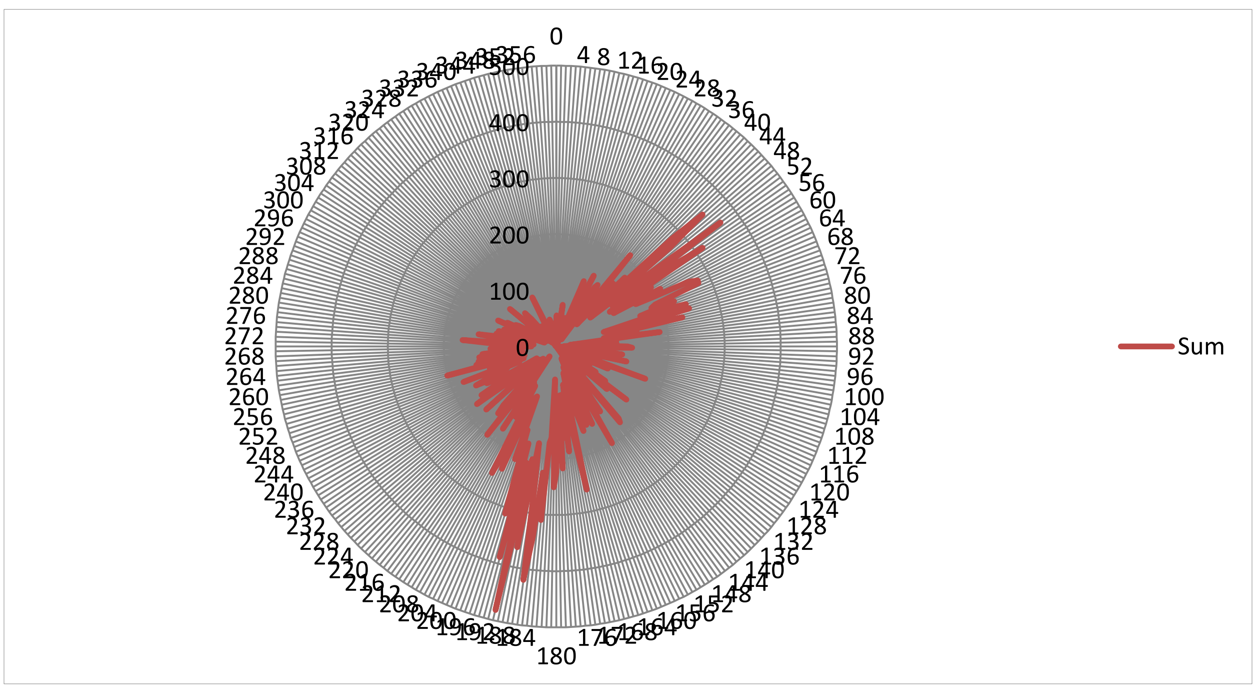


Figure C-2.3 illustrates that the highest frequency of wind distribution on the top 25% days is coming from due south. Figure C-2.4 illustrates that the highest $PM_{2.5}$ concentrations are coming from the same direction.

Analysis of Speciated $PM_{2.5}$ During Top 25% Days

The Department analyzed the days in which the Freemansburg monitor collected speciation data during the top 25% days. Of the 86 days which were in the top 25%, speciated data was collected on nine days. Figure C-2.5 displays the distribution of the speciated components of $PM_{2.5}$ during the entire 2010-12 season. Figure C-2.6 displays the distribution of the speciated components of $PM_{2.5}$ during the nine days in the top 25% of the "clean" days in the ABE region.

Figure C-2.5: Freemansburg $PM_{2.5}$ Speciation Data 2010-12

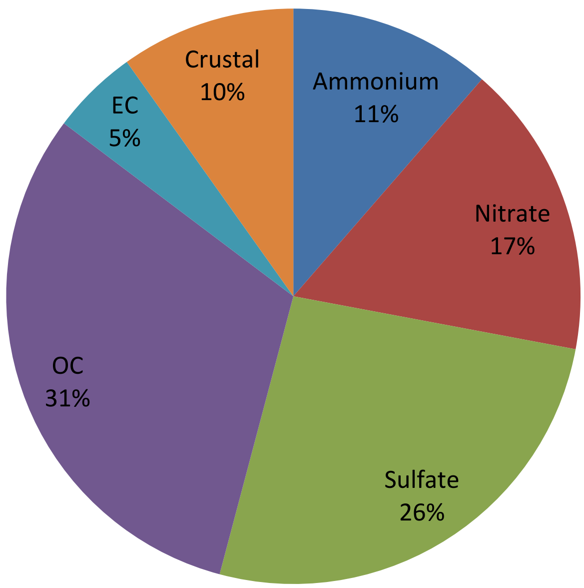
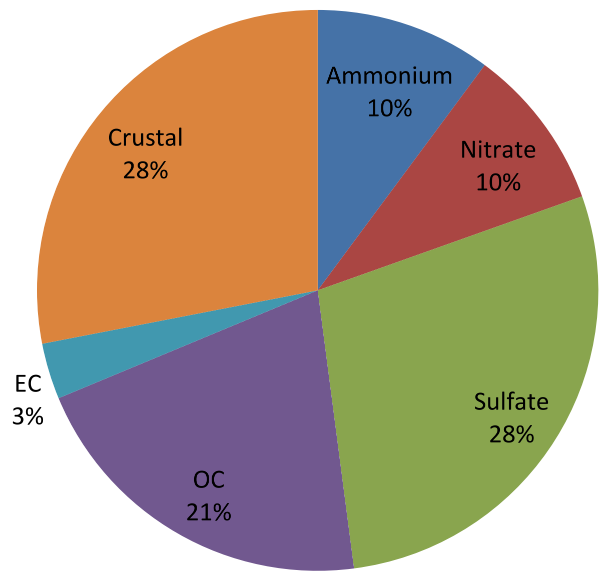
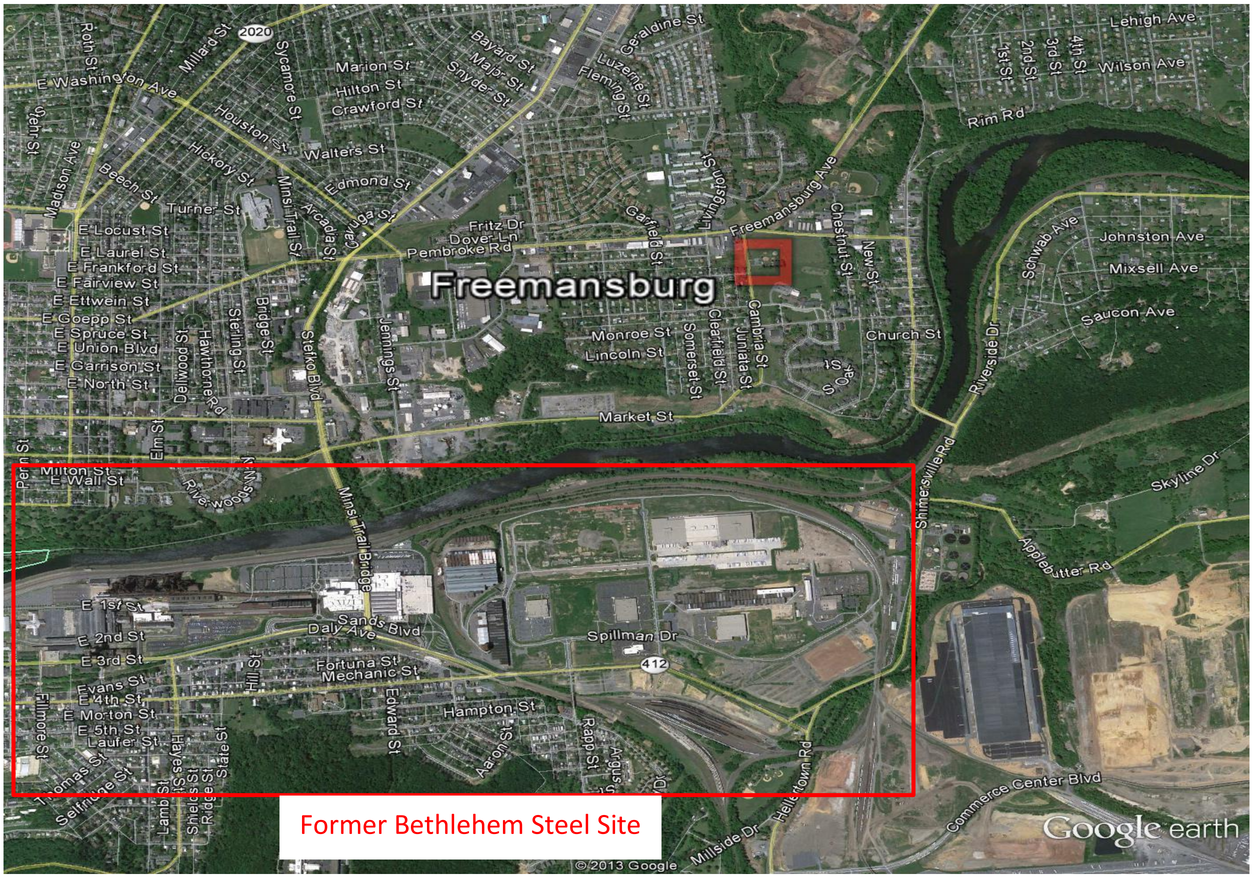


Figure C-2.6: Freemansburg $PM_{2.5}$ Speciation Data
Top 25% of Regionally "Clean" Days



The change in the $PM_{2.5}$ during the top 25% days of regionally clean days is evident. The crustal portion of the speciated $PM_{2.5}$, which was at 10% in the 2010-12 period, rises to 28% during the top 25% days. The additional crustal material illustrates the local nature of the problem at the Freemansburg monitor. Iron, which is a factor of the crustal calculation along with aluminum, calcium, silicon, and titanium, is abnormally high on several of the nine days. The iron, which can be found in dust associated with construction activities, often reached levels 10 to 20% of the total mass measured from the daily speciated sample. The high iron contribution to the $PM_{2.5}$, coupled with the strong southerly signal outlined in Figure C-2.3 and Figure C-2.4, could be attributed to the recent disturbing of soil at the former Bethlehem Steel Corporation industrial site (which lies just to the south of Freemansburg). The Bethlehem Steel site produced 2,500 to 3,000 tons of iron a day to manufacture steel. The Bethlehem Steel plant at the site closed down in 2003. The western portion of the Bethlehem Steel site, which is south-southwest of the Freemansburg monitor, has transformed into the Sands Casino, with a casino, hotel, and outlet shopping center. Also, the area just east of the Sands Casino, an area downwind of the Freemansburg monitor, appears to have been developed over the last three to four years, according to time lapse photos on Google Maps. Construction, disturbance of ground, and truck traffic on unpaved roads in this area are likely to cause dust particles to leave the premises. With a southerly wind, this explains some of the crustal portion of the speciated data recorded at the Freemansburg monitor. Figure C-2.7 illustrates the proximity of the Freemansburg monitor to the old Bethlehem Steel site.

Figure C-2.7: Freemansburg and Bethlehem Steel Site Map



The Change in the Composition of the $PM_{2.5}$

The composition of $PM_{2.5}$ has changed at the Freemansburg monitor since the height of $PM_{2.5}$ concentrations in the 2005 to 2007 time period. Table C-2.2 outlines the main speciated components of $PM_{2.5}$ during the cold season (1st quarter). Table C-2.3 outlines the main speciated components of $PM_{2.5}$ during the warm season (3rd quarter). Overall, Table C-2.2 and Table C-2.3 illustrate the decline in the main speciated components of $PM_{2.5}$ from the 2005 to 2007 period to the 2010 to 2012 period.

Table C-2.2: Freemansburg Speciated $PM_{2.5}$ Data*
Cold Season (1st Quarter) Comparison – 2005-07 Versus 2010-12

Year	Ammonium	Nitrate	Sulfate	OC	EC	Crustal
2005 – 07	2.14463696	3.30050517	3.45715107	4.47227941	0.97620399	0.43071642
2010 – 12	1.16832362	2.08211529	2.01404067	2.14272275	0.32455965	0.47814912
Difference (2005 – 07 minus 2010 – 12)	0.97631334	1.21838988	1.44311040	2.32955666	0.65164433	-0.04743270

*All concentrations are averages and have units of $\mu g/m^3$

Table C-2.3: Freemansburg Speciated $PM_{2.5}$ Data*
Warm Season (3rd Quarter) Comparison – 2005-07 Versus 2010-12

Year	Ammonium	Nitrate	Sulfate	OC	EC	Crustal
2005 – 07	2.29951810	0.78502649	6.41198050	4.41530676	0.88078346	0.51979868
2010 – 12	0.80943392	0.57709580	2.59564740	2.60585732	0.41256613	0.79557909
Difference (2005 – 07 minus 2010 – 12)	1.49008418	0.20793069	3.81633310	1.80944943	0.46821734	-0.27578041

*All concentrations are averages and have units of $\mu g/m^3$

During the cold season, there has been an equal amount of reduction in ammonium, nitrate, sulfate, and organic carbon concentrations. During the warm season, the largest reductions have occurred in ammonium, sulfate and organic carbon concentrations. However, in each quarter, there has been an increase in the amount of crustal material.

To analyze this further, we chose to compare these seasonal values with what has occurred in Arendtsville (AIRS # 42-001-0001), located in Adams County. Arendtsville is in a rural location of Pennsylvania and does not have a major nitrogen oxide or sulfur dioxide source within 50 kilometers of the monitor. For that reason, the Arendtsville monitor reflects the transport that is coming into eastern Pennsylvania from areas to the west (prevailing wind flow is from west to east across Pennsylvania).

Table C-2.4: Arendtsville Speciated $PM_{2.5}$ Data*
Cold Season (1st Quarter) Comparison – 2005-07 Versus 2010-12

Year	Ammonium	Nitrate	Sulfate	OC	EC	Crustal
2005 – 07	2.22066410	3.57683769	3.39904757	3.17044419	0.45550711	0.22843761
2010 – 12	1.23919565	2.07028981	2.18818154	1.68097944	0.16095925	0.18801487
Difference (2005 – 07 minus 2010 – 12)	0.98146846	1.50654787	1.21086602	1.48946475	0.29454786	0.04042275

*All concentrations are averages and have units of $\mu g/m^3$

Table C-2.5: Arendtsville Speciated $PM_{2.5}$ Data*
Warm Season (3rd Quarter) Comparison – 2005-07 Versus 2010-12

Year	Ammonium	Nitrate	Sulfate	OC	EC	Crustal
2005 – 07	2.43772827	0.68269750	7.29288441	3.85331667	0.37004536	0.34223237
2010 – 12	0.98470271	0.50452874	3.13218233	2.13687247	0.15489114	0.32755852
Difference (2005 – 07 minus 2010 – 12)	1.45302555	0.17816876	4.16070208	1.71644420	0.21515422	0.01467385

*All concentrations are averages and have units of $\mu g/m^3$

The reductions at Arendtsville reflected in the "difference" row of Table C-2.4 and Table C-2.5 are more representative of the reductions observed in eastern Pennsylvania due to emission control strategies of various sources (for example, the installation of flue gas desulfurization units on electric generation units across western Pennsylvania into the Ohio Valley). The data indicates that the greatest level of reduction in Freemansburg and Arendtsville occurs during the summer months (when sulfate is the primary constituent of $PM_{2.5}$). During the 2005-07 time frame, Arendtsville had a 3rd quarter total mass average of 19.08 $\mu g/m^3$, and during the 2010 – 12 time frame it had a 3rd quarter total mass average of 12.06 $\mu g/m^3$, a 7 $\mu g/m^3$ reduction.

An analysis of the 2010 – 12 differences between the Freemansburg and Arendtsville monitors indicates the nature of the problem at Freemansburg.

Figure C-2.8: Urban Excess
Freemansburg vs. Arendtsville
2010-12 – 1st Quarter

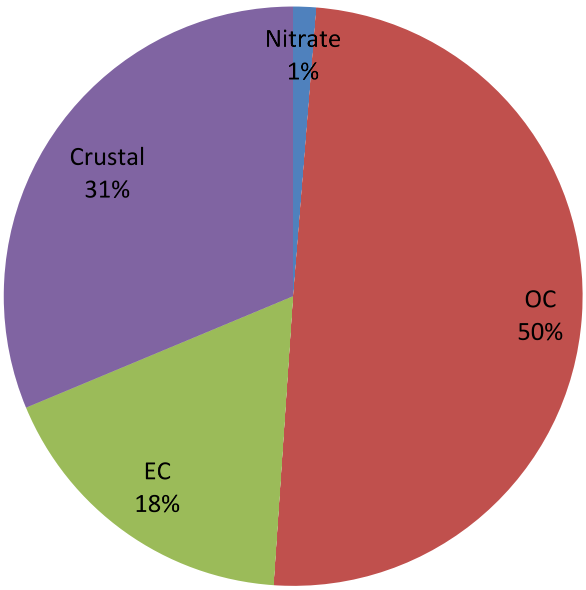
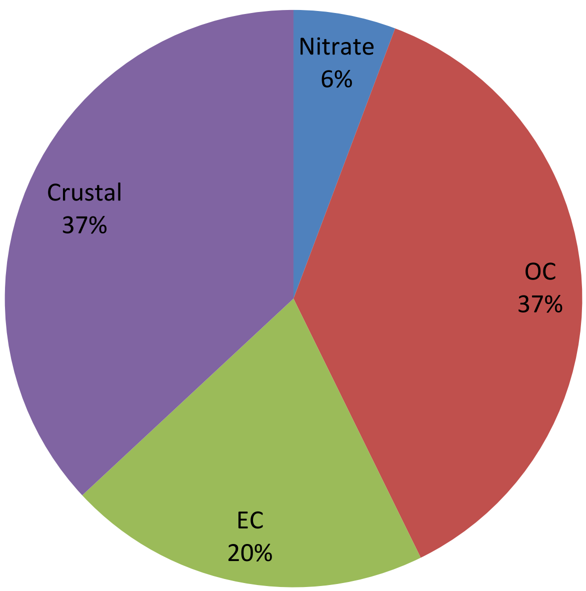


Figure C-2.9: Urban Excess
Freemansburg vs. Arendtsville
2010-12 – 3rd Quarter



In the case of Freemansburg and Arendtsville, the sulfates and ammonium portion of the speciated $PM_{2.5}$ were higher in Arendtsville than Freemansburg. This strengthens the argument that the $PM_{2.5}$ problem at Freemansburg is a local issue. The excess organic carbon, elemental carbon and crustal material (and to some extent nitrate) at the Freemansburg monitor links closely with sources of dust and secondary nitrate formation, such as traffic, suggesting that Freemansburg's emissions are local in nature.

Summary

The Department's analysis illustrates the need for a one-county nonattainment area of Northampton County in the ABE region of Pennsylvania. An analysis of the $PM_{2.5}$ data monitored at the Freemansburg monitor in Northampton County illustrates that the monitor sees concentrations in the 12-30 $\mu g/m^3$ range while the regional concentrations are in the 0-12 $\mu g/m^3$ range. A further examination into the monitoring data demonstrates that the high concentrations are coming out of two primary directions: southerly and northeasterly. The southerly wind profile is coming from an area once inhabited by the Bethlehem Steel Corporation plant and an area of apparent recent construction activity on the land of the former industrial site. An analysis of the speciated data at the Freemansburg monitor on the top 25% days illustrates the excess of crustal material on the high days. Of those species used in the calculation of the $PM_{2.5}$ crustal material, iron is the driving factor. The differences between the Freemansburg and Arendtsville monitors illustrate the excess crustal material, elemental carbon, and organic carbon (and nitrate during the summer) at the Freemansburg monitor in Northampton County. This concentration profile is indicative of dust and secondary nitrate formation, both local sources of emissions near the Freemansburg monitor. Finally, the Lehigh Valley monitor, also in Northampton County and just to the northwest of the Freemansburg monitor, is and has been monitoring attainment of the 2012 standard for several years and is not contributing to excess emissions elsewhere. Therefore, the Department is recommending the Northampton County nonattainment area encompassing Northampton County in Pennsylvania be designated nonattainment for the 2012 annual $PM_{2.5}$ NAAQS. A map of the proposed nonattainment area is provided below as Figure C-2.10.

Figure C-2.10: Recommended Northampton County $PM_{2.5}$ Nonattainment Area