# 6.0 WEIGHT OF EVIDENCE AND ATTAINMENT DEMONSTRATION

This section presents additional modeling analyses to the 2012 Base 5b CMAQ $PM_{2.5}$ Design Value projections, and trends in ambient and emission data as a weight of evidence (WOE) to support $PM_{2.5}$ attainment demonstration in 2012. The additional analysis includes using alternative $PM_{2.5}$ projection software and alternative 2012 control scenarios.

## 6.1 ALTERNATIVE PROJECTION TOOL

The EPA MATS tool with the annual $PM_{2.5}$ projection capability was not available until January 2008. Thus, the St. Louis modeling team developed a projection software following the EPA modeling guidance. The St. Louis $PM_{2.5}$ projection procedure used SANDWICH STN speciated $PM_{2.5}$ data that are ported into Excel spreadsheets to perform the SMAT future-year projections of FRM-derived $PM_{2.5}$ Design Values at FRM sites within the St. Louis NAA. The SANDWICH procedure was also applied to the St. Louis Super Site $PM_{2.5}$ speciation data which are not included in MATS. There are many more FRM $PM_{2.5}$ mass monitoring sites than STN/IMPROVE $PM_{2.5}$ speciation monitoring sites in the St. Louis NAA, so procedures were developed to map $PM_{2.5}$ speciation to the FRM $PM_{2.5}$ mass monitoring sites. One of the biggest differences between the $PM_{2.5}$ Design Value projection procedures using the St. Louis spreadsheet and MATS approaches is how the observed $PM_{2.5}$ speciation data are mapped to the FRM monitoring sites. The MATS tool spatially interpolates the SANDWICH $PM_{2.5}$ speciation data from the STN/IMPROVE monitoring networks to the FRM monitoring sites, whereas the St. Louis spreadsheet approach assigns SANDWICH STN/Supersite $PM_{2.5}$ speciation data to each FRM monitoring site within the St. Louis NAA. At FRM sites with co-located STN sites, the two approaches should produce nearly identical results. Table 6-1 shows how the SANDWICH STN/Supersite speciated $PM_{2.5}$ monitoring data were mapped to the FRM monitoring sites.

Table 6-1. Mapping of speciated $PM_{2.5}$ data from the STN and Supersite sites to the FRM monitoring sites for application of the SMAT in the St. Louis NAA.

| FRM Site | STN/StL-SS Site |
|---|---|
| Washington Ave.* | SuperSite |
| Granite City | SuperSite |
| Alton | Alton |
| Wood River | Alton |
| Tilden City | Arnold |
| East St. Louis | SuperSite |
| Swansea | SuperSite |
| Arnold | Arnold |
| West Alton | Alton |
| Sunset Hills | Arnold |
| Clayton | Blair St |

| FRM Site | STN/StL-SS Site |
|---|---|
| Ferguson | Blair St |
| S. Broadway | Blair St |
| Blair St. | Blair St |
| Margaretta | Blair St |
| 2nd & Mound | Blair St |

* Washington Ave. is not a compliance monitor for the annual $PM_{2.5}$ NAAQS

Table 6-2 compared the projected 2012 $PM_{2.5}$ Design Values for the CMAQ 2012 Base 5b simulation using the EPA MATS and St. Louis study Excel projection methods. The two projection methods agree that all of the monitors save Granite City are projected to achieve the annual $PM_{2.5}$ NAAQS by 2012. There are some small differences, with the Excel-based projection method producing higher 2012 $PM_{2.5}$ Design Values than MATS. For example, at Granite City the Excel 2012 $PM_{2.5}$ Design Value (15.20 µg/$m^3$) is 0.11 µg/$m^3$ higher (0.7%) than those produced by MATS (15.09 µg/$m^3$). Another difference in the two projection methods besides how the SANDWICH PM speciation data are mapped to the FRM sites is the fact that the MATS tool includes Sea Salt in its SANDWICH PM speciation but the Excel approach does not since it was not included in the EPA guidance SANDWICH documentation. Additional investigations would be needed to fully understand these differences.

Table 6-2. Projected 2012 $PM_{2.5}$ Design Values (µg/$m^3$) using the CMAQ modeling results for the 2012 Base 5b emissions scenario and the EPA MATS and St. Louis Excel-based projection methods.

| FRM Site ID | Site Name | Projection Methods | | |
|---|---|---|---|---|
| | | $PM_{2.5}$ DVC (2002) | $PM_{2.5}$ DVF (2012) | |
| | | | Excel | MATS |
| 17_119_0023 | Washington Ave. | #N/A | #N/A | #N/A |
| 17_119_1007 | Granite City | 17.27 | 15.20 | 15.09 |
| 17_119_2009 | Alton | 14.58 | 12.70 | 12.28 |
| 17_119_3007 | Wood River | 14.70 | 12.80 | 12.51 |
| 17_157_0001 | Tilden City | 12.41 | 10.64 | 10.28 |
| 17_163_0010 | East St. Louis | 16.19 | 14.23 | 13.94 |
| 17_163_4001 | Swansea | 14.68 | 12.79 | 12.38 |
| 29_099_0012 | Arnold | 14.43 | 12.57 | 12.24 |
| 29_183_1002 | West Alton | 14.08 | 12.29 | 11.92 |
| 29_189_0004 | Sunset Hills | 12.52 | 11.08 | 10.76 |
| 29_189_2003 | Clayton | 14.02 | 12.40 | 12.02 |
| 29_189_5001 | Ferguson | 13.77 | 11.96 | 11.82 |
| 29_510_0007 | S. Broadway | 14.55 | 13.01 | 12.55 |
| 29_510_0085 | Blair St. | 14.93 | 13.16 | 12.98 |
| 29_510_0086 | Margaretta | 13.93 | 12.33 | 11.93 |
| 29_510_0087 | 2nd & Mound | 15.16 | 13.33 | 12.91 |

## 6.2 ALTERNATIVE FUTURE YEARS AND FUTURE YEAR EMISSION SCENARIOS

The St. Louis modeling team has performed $PM_{2.5}$ DVF projections for two future-years (2009 and 2012) and several Base 5 emission scenarios. The differences in the future year Base 5 emission scenarios are defined in Table 6-3. The projected $PM_{2.5}$ DVFs given in Table 6-4 are based on the St. Louis Excel spreadsheet projection and MATS approaches. The second column in Table 6-4 lists the 2002 $PM_{2.5}$ Design Value, which is the average of the $PM_{2.5}$ Design Values for years ending 2002, 2003 and 2004 and is used in the $PM_{2.5}$ Design Value projections (e.g., Tables 6-2). The third column is the observed $PM_{2.5}$ Design Value from the 2004-2006 3-year period. These 2004-2006 $PM_{2.5}$ Design Values show there is significant improvement in $PM_{2.5}$ concentrations in the St. Louis area, which corroborates the modeled 2012 $PM_{2.5}$ Design Value projections. The CMAQ 2012 Base 5b $PM_{2.5}$ Design Value projections estimate that there is an approximately 0.2 µg/m$^3$ reduction per year in $PM_{2.5}$ concentrations at the Granite City monitor [(17.27 – 15.09)/10 = 0.22 µg/m$^3$]. The differences in the 2002 and 2005 PM DVs at Granite City in Table 6-4 is 0.67 µg/m$^3$, resulting in an observed trend of 0.22 µg/m$^3$ $PM_{2.5}$ reduction per year that agrees exactly with the modeled projections.

The remainders of columns in Table 6-4 display the projected $PM_{2.5}$ DVFs estimated by the CMAQ 12 km modeling results for various future-year emission scenarios given in Table 6-3. The projected 2009 $PM_{2.5}$ Design Value at the Granite City monitoring site using the CMAQ 2009 Base 5a modeling results was 15.53 µg/m$^3$, which is just at the highest value allowed for a WOE attainment demonstration. Because more time is needed to implement additional emissions reductions, the 2012 future-year was selected for further analysis.

The effects of updating the boundary conditions (BCs) that were based on the 2002 VISTAS/ASIP CMAQ 2002 Base F base case simulation for both the 2002 and 2012 years to using the VISTAS/ASIP 2002 Base G CMAQ results for the 2002 BCs and interpolated BCs from the 2009/2018 VISTAS/ASIP simulations for the St. Louis 2012 Base 5b CMAQ simulation, plus the addition of emissions due to all ethanol plants permitted by IEPA were to raise the projected $PM_{2.5}$ Design Value at Granite City from 15.06 µg/m$^3$ for 2012 Base 5a to 15.20 µg/m$^3$ for 2012 Base 5b. The remainder of the St. Louis 2012 CMAQ simulations show the incremental changes in the projected $PM_{2.5}$ Design Values due to the controls listed in Table 6-3. The 2012 Base 5c CMAQ simulation had a projected $PM_{2.5}$ Design Value at Granite City of 15.10 µg/m$^3$.

Simulations for Base 5b4 through Base 5b11 were conducted for various emissions updates and control/RACT scenarios. Base 5b4 CMAQ simulation was conducted as a result of emissions updates from IEPA. The IEPA updated emissions from three facilities as shown in Table 6-3. The effects of these updates were increases of concentrations at various monitoring sites, especially, at Granite City monitoring site where concentration increased by 1.17 µg/m$^3$ from Base 5b3. The increase was mainly due to added direct $PM_{2.5}$ (973 tpy) emissions which were not included in the old emissions inventory. Base 5b5 CMAQ simulation was conducted to examine the effect of reducing $PM_{2.5}$ emissions to 2002 level from U.S. National Steel on the future design values. As a result, the 2012 $PM_{2.5}$ emissions were reduced to 841 tpy which was a reduction of 306 tons/yr. The resulting concentration at Granite City monitoring site was 15.24 µg/m$^3$. This was a reduction of 1.09 µg/m$^3$ from base 5b4 simulation. The past two simulations showed how significantly the concentrations drop if direct $PM_{2.5}$ emissions from U.S. National

Steel were reduced. Base 5b6 CMAQ simulation was similar to base 5b5 simulation with the exception that only one ethanol plant permitted by IEPA was included. The resulting concentration at Granite City monitoring site was 15.15 $\mu g/m^3$ (14.99 for MATS). Again, this showed the significance of local sources' contributions.

The IEPA updated U.S. National Steel $PM_{2.5}$ emissions once again from 841 tpy to 1489 tpy for 2002 and from 1147 tpy to 1388 tpy for 2012. Again, the effect of these increases in $PM_{2.5}$ emissions are significant as shown in Table 6-4. Base 5b10 and 5b11 were conducted to simulate the effects reducing $PM_{2.5}$ emissions from U.S. National Steel by 36% and 20%, respectively, on the Granite City monitoring site. Table 6-4 shows that when $PM_{2.5}$ was reduced by 20%, the resulting concentration at Granite City came up to be 14.93 $\mu g/m^3$. This value is more than what is needed to attain the standard. Therefore, in order for St. Louis Area to attain the standard, local sources around Granite City monitoring site need to be considered for direct $PM_{2.5}$ controls.

Table 6-3. Definition of future-year emission scenarios.

| **Future-Year Control Scenario** | **Assumptions** |
|---|---|
| 2009 Base 5a | <u>2009 On-the-Books (OTB) Controls</u><br>CAIR/CAMR<br>$NO_x$ SIP Call<br>MACT Standards<br>Tier 2 Rule – Light Duty Vehicle Engine Standards and Lo Sulfur Gasoline<br>Heavy Duty Diesel Standards and Low Sulfur Diesel<br>Tier 4 Off Road Mobile Engine Standards<br>Vehicle Emissions Controls<br><br>IC/BC From VISTAS 2002 Base F CMAQ simulations for both current and future years (as used in ozone SIP) |
| 2012 Base 5a | <u>2009 OTB Controls, Plus:</u><br>IC/BC From VISTAS 2002 Base F CMAQ simulations for both current and future years (as used in ozone SIP)<br>Vehicle emission controls (90% program control efficiency)<br>Illinois' Mercury Rule – Phase I<br>CAIR – Phase I SO2 Controls |
| 2012 Base 5b | <u>Same as 2012 Base 5a, Plus</u><br>IC/BC interpolated from 2009 and 2018 Base G VISTAS/ASIP CMAQ runs<br>Herculaneum RACT:<br>2002 SO2 = 15,218 TPY<br>2009 SO2 = 15,218 TPY w/o growth & controls |
| 2012 Base 5b1 | <u>Same as 2012 Base 5b with</u>:<br>Herculaneum RACT:<br>2002 SO2 = 41,840 TPY<br>2012 SO2 = 55,786 TPY w/o growth and controls |
| 2012 Base 5b2 | <u>2012 Base 5b with</u>:<br>Herculaneum RACT:<br>2002 = 41,840 TPY<br>2012 = 5,579 TPY w/ growth and controls |
| 2012 Base 5b3 | <u>2012 Base5b2 (Herculaneum RACT w/ controls, plus the following additional RACT SO2 controls (TPY):</u> |

| Future-Year Control Scenario | Assumptions |
|---|---|

| Source | 2002 | 2012 w/o RACT | 2012 w/ RACT |
|---|---|---|---|
| Anheuser Busch 510-0003 B01 | 2,338.9 | 2,532.7 | 620.4 |
| Anheuser Busch 510-0003 B05 | 3,066.2 | 3,320.4 | 748.9 |
| Anheuser Busch 510-0003 B08 | 425.0 | 460.3 | 231.8 |
| Anheuser Busch 510-0003 B09 | 414.3 | 448.7 | 238.3 |
| Mallinckrodt 510-0017 - EP009 | 275.6 | 260.1 | 265.2 |
| Washington University Medical School - EP01 | 49.4 | 50.4 | 0.04 |
| McDonnell Douglas/Boeing 189-0230 - CS-005-01 | 135.7 | 127.9 | 0.05 |
| General Motors - Wentzville 183-0076 - EPN-8 | 679.8 | 641.7 | 621.1 |

| Future-Year Control Scenario | Assumptions |
|---|---|
| 2012 Base 5c | Same as 2012 Base 5b3, except:<br>No IEPA permitted ethanol plants in St. Louis NAA |
| 2012 Base 5b4 | Same as Base 5b3 but used updated U.S.STEEL CORP - GRANITE CITY WORKS, ASF-KEYSTONE INC and GATEWAY ENERGY & COKE COMPANY, LLC 2002 & 2012 Emissions provided by IEPA on 5/19/08 |

| Facility Name | VOC | | $NO_x$ | | $SO_2$ | | $PM_{10}$ | | $PM_{2.5}$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2002 | 2012 | 2002 | 2012 | 2002 | 2012 | 2002 | 2012 | 2002 | 2012 |
| ASF-KEYSTONE INC | 119 | 82 | 5 | 91 | 2 | 2 | 0 | 0 | 132 | 448 |
| U.S.STEEL CORP - GRANITE CITY WORKS | 231 | 231 | 3499 | 1169 | 4696 | 2647 | 45 | 258 | 841 | 1147 |
| GATEWAY ENERGY & COKE COMPANY, LLC | 0 | 37 | 0 | 577 | 0 | 1406 | 0 | 267 | 0 | 231 |
| Total | 350 | 350 | 3504 | 1838 | 4698 | 4056 | 45 | 526 | 973 | 1827 |

| Future-Year Control Scenario | Assumptions |
|---|---|
| 2012 Base 5b5 | Same as 2012 Base 5b4 but replaced 2012 U.S. National Steel inventory with 2002 Emissions<br>2002: 841 tpy<br>2012: 841 tpy |
| 2012 Base 5b6 | Same as Base 5b5 but included only one IL ethanol plant in the non-attainment area |
| 2012 Base 5b7 | Same as 2012 Base 5b6, except:<br>uses the updated U.S. National Steel 2002 & 2012 Emission provided by IEPA on 7/17/08<br>2002: 1489 tpy<br>2012: 1388 + (270*) tpy<br>* 270 tons of $PM_{2.5}$ were not taken out from the 2012 original emission file for U.S. National Steel facility.<br><br>reduced seven facilities emissions (RACT) for 2012 |

| Facility | $NO_x$ (tpy) | $NO_x$ (RACT) | $SO_2$ (tpy) | $SO_2$ (RACT) |
|---|---|---|---|---|
| Ford Motor | 33 | 0 | 0 | 0 |
| PQ | 181 | 0 | 74 | 0 |
| Wash. University | 3 | 0 | 50 | 0 |

<table>
<tr><th>Future-Year Control Scenario</th><th>Assumptions</th></tr>
<tr><td></td><td>
<table>
<tr><td>MSD</td><td>88</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>MEMC</td><td>62</td><td>50</td><td>0</td><td>0</td></tr>
<tr><td>Boeing</td><td>38</td><td>0</td><td>128</td><td>0</td></tr>
<tr><td>River Cement</td><td>4389</td><td>3345</td><td>554</td><td>533</td></tr>
</table>
</td></tr>
<tr><td>2012 Base 5b8</td><td>Same as 2012 Base 5b7, except:<br>Removed the seven facilities emissions from base 2002 and re-grow the new base emissions.<br>Used Herculaneum RACT 2012 $SO_2$ emissions of 55,789 tpy without control and growth.</td></tr>
<tr><td>2012 Base 5b9</td><td>Same as 2012 Base 5b8, except:<br>Corrected the U.S. National Steel $PM_{2.5}$ emission by removing the 270 tpy of $PM_{2.5}$<br>Corrected Herculaneum emissions to 5,578 tpy</td></tr>
<tr><td>2012 Base 5b10</td><td>Same as 2012 Base 5b9, except:<br>2012 $PM_{2.5}$ emissions from U.S. National Steel was reduced by 36%<br>2002: 1489 tpy<br>2012: 888 tpy<br>Anheuser-Busch new RACT
<table>
<tr><th>Emission Point</th><th>2002 $SO_2$ tpy</th><th>RACT $SO_2$ tpy</th><th>2002 $NO_x$ tpy</th><th>RACT $NO_x$ tpy</th></tr>
<tr><td>Boiler 1</td><td>2,338.9</td><td>1103.8</td><td>381.4</td><td>261.2</td></tr>
<tr><td>Boiler 5</td><td>3,066.2</td><td>1118.9</td><td>213.4</td><td>283.1</td></tr>
<tr><td>Boiler 8</td><td>425.0</td><td>439.7</td><td>103.2</td><td>118.5</td></tr>
<tr><td>Boiler 9</td><td>414.3</td><td>434.0</td><td>104.9</td><td>116.8</td></tr>
<tr><td>Facility Wide Total</td><td>6250.0</td><td>3096.0</td><td>848.4</td><td>805.0</td></tr>
</table>
</td></tr>
<tr><td>2012 Base 5b11</td><td>Same as 2012 Base 5b10, except:<br>2012 $PM_{2.5}$ emissions from U.S. National Steel was reduced by 20%<br>2002: 1489 tpy<br>2012: 1110 tpy</td></tr>
<tr><td>2012 Base 5b12</td><td>Same as 2012 Base 5b9, except:<br>Used Final RACT $SO_2$ rules for Herculaneum (25,100 tpy) and Anheuser-Busch<br>Anheuser-Busch Final RACT
<table>
<tr><th>Emission Point</th><th>2002 $SO_2$ tpy</th><th>RACT $SO_2$ tpy</th><th>2002 $NO_x$ tpy</th><th>RACT $NO_x$ tpy</th></tr>
<tr><td>Boiler 1</td><td>2,338.9</td><td>1087.2</td><td>381.4</td><td>261.2</td></tr>
<tr><td>Boiler 5</td><td>3,066.2</td><td>1102.1</td><td>213.4</td><td>283.1</td></tr>
<tr><td>Boiler 8</td><td>425.0</td><td>433.1</td><td>103.2</td><td>118.5</td></tr>
<tr><td>Boiler 9</td><td>414.3</td><td>427.5</td><td>104.9</td><td>116.8</td></tr>
<tr><td>Facility Wide Total</td><td>6250.0</td><td>3055.9</td><td>848.4</td><td>805.0</td></tr>
</table>
</td></tr>
</table>

## 6.3 DEFINITION OF FUTURE YEAR EMISSION SCENARIOS

Simulations for Base 5a through Base 5b12 (Table 6-4) were conducted for various emissions updates and control/RACT scenarios including 2009 5a scenario with On-the-Books (OTB) controls measures. The 2009 Base 5a OTB controls include:

- CAIR/CAMR;
- $NO_x$ SIP Call;
- MACT Standards;
- Tier 2 Rule – Light-Duty Vehicle Standards and Low-Sulfur Gasoline;
- Heavy-Duty Diesel Engine Standards and Low-Sulfur Diesel;
- Tier 4 Rule – Off-Road Mobile Engine Standards; and
- Vehicle Emission Controls.

With these controls, the 2009 Base 5a CMAQ simulation results show 15.53 $\mu g/m^3$ concentration value at Granite City site, which is above the annual NAAQS standard of 15.0 $\mu g/m^3$.

The next modeling scenario conducted was the 2012 base 5a. The 2009 OTB Controls were used plus the following controls:

- IC/BC From VISTAS 2002 Base F CMAQ simulations for both current and future years (as used in ozone SIP),
- Vehicle emission controls (90% program control efficiency),
- Illinois' Mercury Rule – Phase I, and
- CAIR – Phase I $SO_2$ Controls.

The CMAQ simulation result was 15.06 $\mu g/m^3$, which is a drop of 3% from the previous simulation.

Base 5b CMAQ simulation was conducted as a result of replacing the IC/BC with data interpolated from 2009 and 2018 Base G VISTAS/ASIP CMAQ runs and Herculaneum RACT without 2012 growth and controls of $SO_2$ emissions of 15,218 tons/yr. The 2012 sensitivity result was 15.09 $\mu g/m^3$.

Base 5b1 simulation was conducted because Herculaneum facility submitted a new and more accurate stack testing data, which increased the $SO_2$ emissions for 2002 and 2012 to 41,840 and 55,778 tons/yr, respectively, without control and growth. As a result, the simulation sensitivity run was 15.29 $\mu g/m^3$ which was an increase of 1.3% from the previous run.

In Base 5b2 sensitivity run, 2012 $SO_2$ emission from Herculaneum was decreased to 5,579 tons/yr and no changes to 2002 emissions was made. The simulation result was 15.21 $\mu g/m^3$. This was a reduction of only 0.5% from Base5b1 simulation. The $SO_2$ emissions decrease from Herculaneum showed a small effect on $PM_{2.5}$ concentration at Granite City monitoring site.

Additional $SO_2$ RACT controls were applied to Base 5b3 sensitivity run. The RACT facilities as shown in Table 6-3 include:

- Anheuser-Busch,
- Washington University Medical School,
- McDonnell Douglas/Boeing, and
- General Motors.

The result for the CMAQ simulation was 15.16 μg/m$^3$, which was a reduction of 0.3 % from the previous sensitivity run, and only 0.8 % reduction from Base 5b1. Again, these $SO_2$ RACT controls had a small effect on $PM_{2.5}$ concentration at Granite City monitoring site.

Base 5b4 CMAQ simulation was conducted as a result of emissions updates from the IEPA. The IEPA updated 2002 and 2012 emissions from three facilities was provided on 5/19/08. The facilities as shown in Table 6-3 are:

- GRANITE CITY WORKS,
- ASF-KEYSTONE INC, and
- GATEWAY ENERGY & COKE COMPANY, LLC.

The effect of these updates was an increase of concentration at Granite City monitoring site of 1.17 μg/m$^3$ (7.16 %) from Base 5b3. The increase was mainly due to added direct $PM_{2.5}$ (973 tons/yr) emissions which were not included in the old emissions inventory.

Base 5b5 CMAQ simulation was conducted to examine the effect of reducing $PM_{2.5}$ emissions to 2002 level from U.S. National Steel on the future design values. 2012 $PM_{2.5}$ emissions were reduced to 841 tons/yr which was a reduction of 306 tons/yr. The resulting concentration at Granite City monitoring site was 15.24 μg/m$^3$. This was a reduction of 1.09 μg/m$^3$ (7.15 %) from base 5b4 simulation. The past two simulations showed how significant the concentrations were dropping if direct $PM_{2.5}$ emissions from U.S. National Steel were controlled.

Base 5b6 CMAQ simulation was similar to base 5b5 simulation with the exception that only one ethanol plant (Center Ethanol Production, LLC facility) permitted by IEPA was included. The resulting concentration at Granite City monitoring site was 15.15 μg/m$^3$ (14.99 for MATS). Again, this showed the significance of local sources' contributions to $PM_{2.5}$ concentration at Granite City monitoring site.

Base 5b7 simulation was conducted because IEPA updated U.S. National Steel $PM_{2.5}$ emissions once again from 841 to 1489 tons/yr for 2002 and from 1147 tons/yr to 1388 tons/yr for 2012 on 7/17/08. The sensitivity result was 15.84 μg/m$^3$, which is an increase of 4.4 % from a previous simulation run. The effect of this increase in $PM_{2.5}$ emissions is significant as shown in Table 6-4.

Base 5b8 simulation was similar to base 5b7 simulation with the following changes:

- Removed the seven facilities (Ford Motor, PQ, Wash. University, MSD, MEMC, Boeing, and River Cement) emissions from base 2002 and re-grow the new base emissions; and
- Used Herculaneum RACT 2012 $SO_2$ emissions of 55,789 tons/yr without control and growth.

The result was 15.93 µg/m$^3$. The modeling result shows that by removing the $NO_x$ and $SO_2$ emission from the local sources will not have significant effects.

Base 5b9 CMAQ simulation was conducted with the following corrections:

- Corrected the U.S. National Steel $PM_{2.5}$ emission by removing the 270 tons/yr of $PM_{2.5}$
- Corrected Herculaneum emissions to 5,578 tons/yr

The result was 15.36 µg/m$^3$. A drop of 3.6% in concentration mostly is due to the reduction of direct $PM_{2.5}$ as Shown in Table 6-4.

Base 5b10 and 5b11 were conducted to simulate the effects of reducing $PM_{2.5}$ emissions from U.S. National Steel by 36% and 20%, respectively, on the Granite City monitoring site. Table 6-4 shows that when $PM_{2.5}$ was reduced by 20%, the resulting concentration at Granite City was 15.06 µg/m$^3$ (14.93 MATS results). The EPA's MATS value indicates that $PM_{2.5}$ concentration at Granite City monitoring site will attain the NAAQS. Therefore, in order for St. Louis Area to attain the standard, local sources around the Granite City monitoring site need to be considered in control scenarios similar to what is shown in Table 6-4.

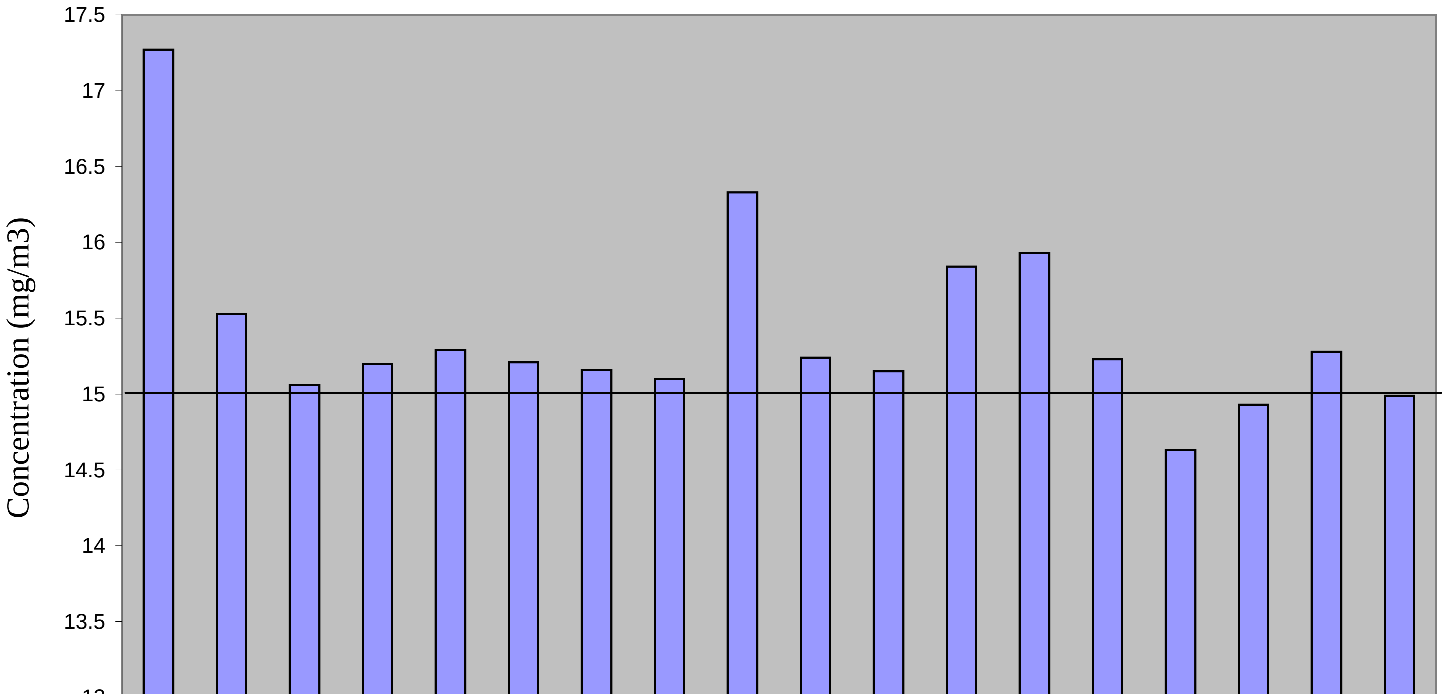
Base 5b12 was conducted to simulate the final $SO_2$ RACT rules for Doe Run Herculaneum and Anheuser Busch. The final $SO_2$ emissions from Doe Run Herculaneum and Anheuser Busch are 25,100 tons/yr and 3050 tons/yr, respectively. The result was 15.28 µg/m$^3$ at Granite City monitoring site. This is an increase of 0.05 µg/m$^3$ if compared to Base 5b9.

Base 5b13 was conducted to simulate the effects of zeroing out all 2002 & 2012 $PM_{2.5}$ emissions from U.S. National Steel Corp-Granite City Works. ASF-Keystone Inc. and Gateway Energy& Coke Company, LLC. This will assist IEPA in their modeling effort to come up with control scenarios for these facilities that will lead to the attainment of the NAAQS at the Granite City monitoring site.

In conclusion, the RACT rules have helped reduce the concentrations at the monitoring sites as shown in Table 6-4. The most significant reduction of concentrations at Granite City monitoring site occurred when direct $PM_{2.5}$ emissions was reduced from local facilities. This conclusion is supported by the Conceptual Model for $PM_{2.5}$ non-attainment in the St. Louis area (See Chapter 2) which has identified local sources as contributing a significant fraction (2-3 µg/m$^3$) of the annual $PM_{2.5}$ concentrations at the Granite City FRM monitor.

In addition, several nonattainment areas studies, including Atlanta, Birmingham, Detroit, and Pittsburg, showed significant contribution of direct $PM_{2.5}$ emissions from local sources. These areas typically have one (or two) monitor registered $PM_{2.5}$ annual concentration about 1~3 µg/m$^3$ higher than the average from other monitors in the same area. EPA modeling guidance requires a more refined analysis to evaluate the contribution form these local sources. Local area analysis can use either dispersion model or fine grid photochemical model. Several States have combined AERMOD with CMAQ (or CAMx) modeling results for attainment demonstration. As the local sources contributing to $PM_{2.5}$ at Granite City monitor are on the Illinois side of St. Louis, they are in the jurisdiction of the state of Illinois. Thus the IEPA is performing local-scale analysis using CMAQ, CAMx and AERMOD to identify the level of control needed to attain the annual $PM_{2.5}$ NAAQS.

Figure 6-1 Granite City Current-Year & Future-Year Projected PM2.5 Design Values (µg/m3) using CMAQ Model




| | DVC 2002 Annual | Base5a 2009 | Base5a 2012 | Base5b 2012 | Base5b1 2012 | Base5b2 2012 | Base5b3 2012 | Base 5c 2012 | Base5b4 2012 | Base5b5 2012 | Base5b6 2012 | Base5b7 2012 | Base5b8 2012 | Base5b9 2012 | Base5b10 2012 | Base5b11 2012 | Base5b 12 2012 | Base5b 13 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Granite City | 17.27 | 15.53 | 15.06 | 15.2 | 15.29 | 15.21 | 15.16 | 15.1 | 16.33 | 15.24 | 15.15 | 15.84 | 15.93 | 15.23 | 14.63 | 14.93 | 15.28 | 14.99 |

Table 6-4. Current-year and future-year projected $PM_{2.5}$ Design Values ($\mu g/m^3$) using the CMAQ model.

| | | 2002 Annual | 2004-2006 | CMAQ 2009 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 | CMAQ 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FRM Site ID** | **Site Name** | **DVC** | **DV** | **Base5a** | **Base5a** | **Base5b** | **Base5b 1** | **Base5b 2** | **Base5b 3** | **Base 5c** | **Base5b 4** | **Base5b 5** | **Base5b 6** | **Base5b 7** | **Base5b 8** | **Base5b 9*** | **Base5b 10*** | **Base5b 11*** | **Base5b 12*** | **Base5b 13*** |
| 17_119_1007 | Granite City | 17.27 | 16.60 | 15.53 | 15.06 | 15.20 | 15.29 | 15.21 | 15.16 | 15.10 | 16.33 | 15.24 | 15.15 | 15.84 | 15.93 | 15.23 | 14.63 | 14.93 | 15.28 | 14.99 |
| 17_119_2009 | Alton | 14.59 | 13.50 | 12.99 | 12.55 | 12.70 | 12.75 | 12.68 | 12.66 | 12.60 | 13.07 | 12.69 | 12.58 | 12.85 | 12.94 | 12.25 | 12.04 | 12.15 | 12.29 | 12.17 |
| 17_119_3007 | Wood River | 14.70 | 14.10 | 13.09 | 12.65 | 12.80 | 12.85 | 12.78 | 12.75 | 12.70 | 13.17 | 12.79 | 12.68 | 12.95 | 13.04 | 12.47 | 12.26 | 12.37 | 12.51 | 12.40 |
| 17_157_0001 | Tilden City | 12.42 | | 10.94 | 10.57 | 10.64 | 10.70 | 10.65 | 10.64 | 10.62 | 10.69 | 10.65 | 10.65 | 10.67 | 10.75 | 10.28 | 10.26 | 10.27 | 10.31 | 10.29 |
| 17_163_0010 | East St. Louis | 16.2 | 15.40 | 14.54 | 14.10 | 14.23 | 14.32 | 14.24 | 14.20 | 14.14 | 15.29 | 14.27 | 14.19 | 14.83 | 14.92 | 14.04 | 13.53 | 13.81 | 14.13 | 13.84 |
| 17_163_4001 | Swansea | 14.77 | 14.20 | 13.10 | 12.67 | 12.79 | 12.88 | 12.79 | 12.77 | 12.72 | 13.73 | 12.83 | 12.77 | 13.33 | 13.43 | 12.54 | 12.07 | 12.30 | 12.58 | 12.33 |
| 29_099_0012 | Arnold | 14.44 | 13.50 | 12.91 | 12.56 | 12.57 | 12.72 | 12.63 | 12.60 | 12.61 | 12.68 | 12.61 | 12.61 | 12.66 | 12.77 | 12.20 | 12.16 | 12.20 | 12.27 | 12.24 |
| 29_183_1002 | West Alton | 14.09 | 12.90 | 12.54 | 12.18 | 12.29 | 12.35 | 12.28 | 12.25 | 12.20 | 12.60 | 12.28 | 12.19 | 12.42 | 12.51 | 11.89 | 11.71 | 11.80 | 11.93 | 11.83 |
| 29_189_0004 | Sunset Hills | 12.61 | | 11.36 | 11.07 | 11.08 | 11.17 | 11.10 | 11.07 | 11.07 | 11.20 | 11.09 | 11.07 | 11.16 | 11.25 | 10.70 | 10.63 | 10.68 | 10.76 | 10.71 |
| 29_189_2003 | Clayton | 14.02 | 13.20 | 12.70 | 12.38 | 12.40 | 12.48 | 12.41 | 12.37 | 12.38 | 12.53 | 12.39 | 12.37 | 12.49 | 12.57 | 11.96 | 11.88 | 11.94 | 12.02 | 11.96 |
| 29_189_5001 | Ferguson | 13.57 | | 12.16 | 11.84 | 11.96 | 12.02 | 11.95 | 11.92 | 11.86 | 12.69 | 11.97 | 11.88 | 12.34 | 12.41 | 11.89 | 11.51 | 11.70 | 11.93 | 11.71 |
| 29_510_0007 | S. Broadway | 14.75 | 14.00 | 13.29 | 12.94 | 13.01 | 13.12 | 13.04 | 13.00 | 12.97 | 13.72 | 13.05 | 13.01 | 13.43 | 13.52 | 12.64 | 12.27 | 12.47 | 12.70 | 12.49 |
| 29_510_0085 | Blair St. | 14.94 | 14.20 | 13.42 | 13.01 | 13.16 | 13.24 | 13.17 | 13.13 | 13.10 | 13.66 | 13.16 | 13.11 | 13.46 | 13.54 | 13.07 | 12.63 | 12.86 | 13.12 | 12.89 |
| 29_510_0086 | Margaretta | 13.94 | 13.20 | 12.59 | 12.24 | 12.33 | 12.41 | 12.34 | 12.30 | 12.26 | 13.08 | 12.35 | 12.29 | 12.75 | 12.83 | 12.02 | 11.63 | 11.83 | 12.07 | 11.84 |
| 29_510_0087 | 2nd & Mound | 15.16 | 14.37 | 13.62 | 13.21 | 13.33 | 13.41 | 13.34 | 13.30 | 13.24 | 14.32 | 13.36 | 13.29 | 13.89 | 13.97 | 13.04 | 12.54 | 12.80 | 13.10 | 12.81 |

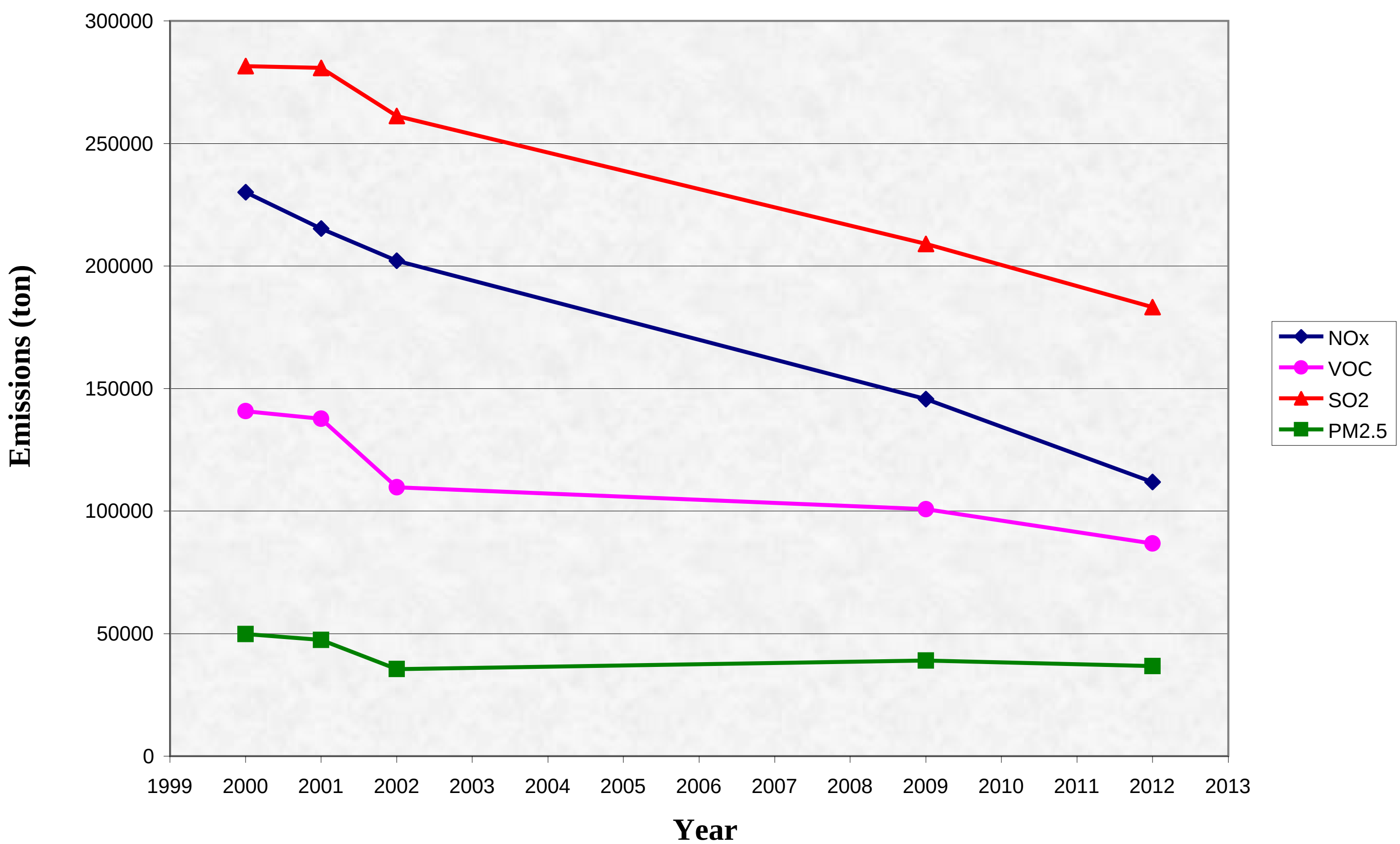
* Results from MATS

## 6.4 TRENDS IN EMISSIONS

The 2000 and 2001 emissions data pertaining to Missouri's St. Louis Nonattainment Area were obtained from EPA's Air and Radiation AirData website (http://www.epa.gov/air/data/index.html). The AirData presents annual summaries of emissions data from the National Emission Inventory (NEI) database. The NEI provides estimates of annual emissions of criteria and hazardous air pollutants from all source categories. In 2002, the NEI database replaced two separate EPA databases for emissions of criteria air pollutants (National Emission Trends, or NET) and hazardous air pollutants (National Toxics Inventory, or NTI). The annual 2002 emissions data was based on the St. Louis Base 5 data. The annual future year (2009 & 2012) were developed by growing and controlling 2002 emission data with various control programs as shown in Chapters 3 and 5.

As shown in Figure 6-2, the 2000-2012 emissions for $NO_x$, VOC, $SO_2$ and $PM_{2.5}$ in the St. Louis NAA show a downward trend between 2000 and 2012.

Figure 6-2. St. Louis NAA Emissions Trends



## 6.5 TRENDS IN AMBIENT AIR QUALITY

This section will discuss trends in average ambient air Pm2.5 values and trends in PM2.5 speciation results

### 6.5.1 Trends in Average Ambient Air PM2.5 Design Values

The trends in annual average ambient air $PM_{2.5}$ design values for the St. Louis area show a decided downward trend since 2002. This trend is demonstrated effectively in Table 6-5 and Figure 6-3.

Figure 6-3 shows a comparison of the trends of design values for Granite City, East St. Louis, and Blair St. A clear downward trend is apparent at all three sites, with the trend at Granite City a little less than the other two. These trends are consistent with other weight of evidence analysis that supports the conclusion that St. Louis will attain the annual $PM_{2.5}$ standard based on the attainment demonstration modeling.

Figure 6-3. PM2.5 Annual Design Values for the St. Louis Area

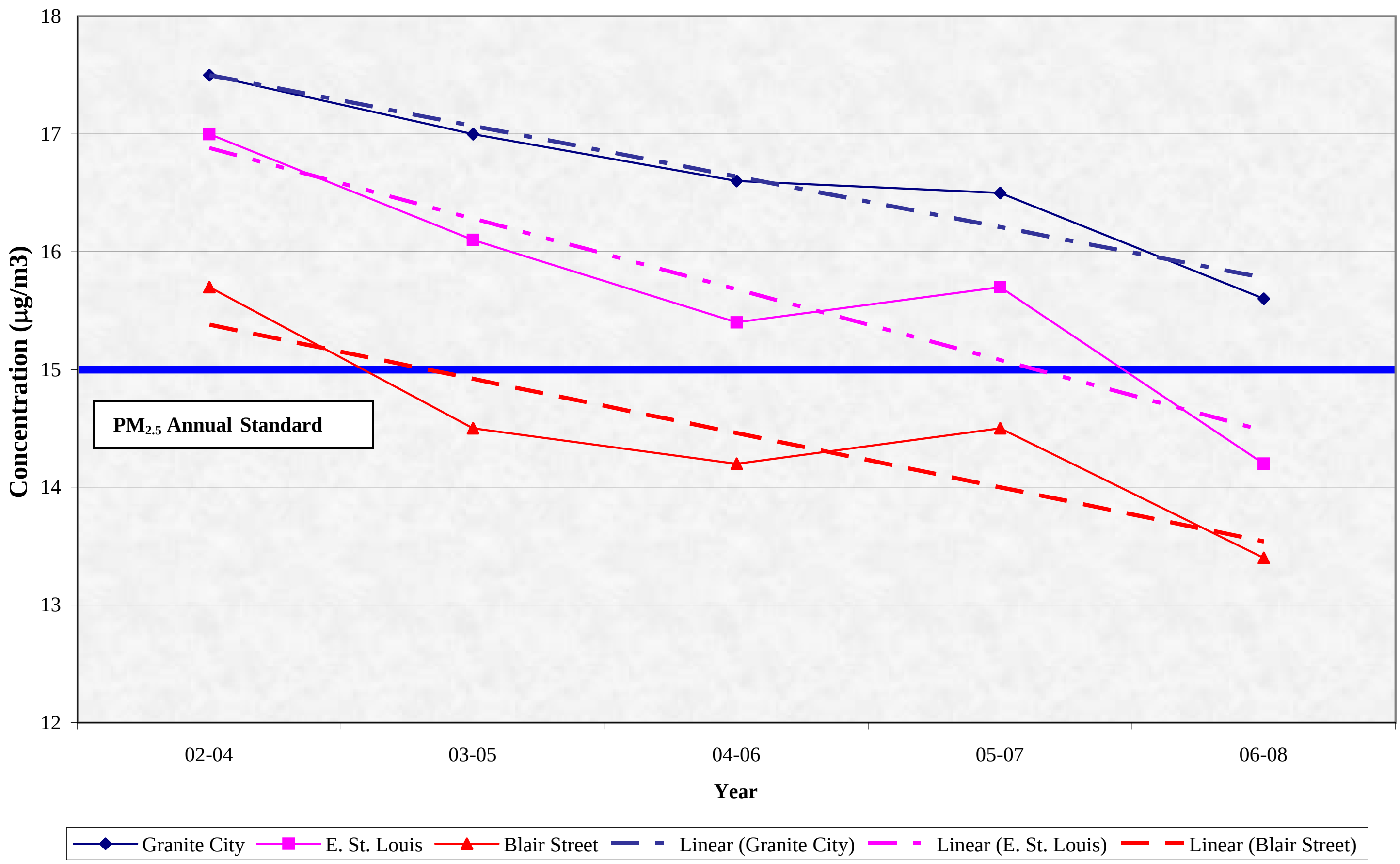



Table 6-5 shows the annual averages and design values for the St. Louis area from 2002 through 2008. The 2006-2008 design values are the lowest among the 2002-2004, 2003-2005, 2004-2006, and 2005-2007 design values.

Mound Street site attained the standard in 2005, 2006, 2007 and 2008. In addition, East St. Louis site attained the standard in 2008. Moreover, Granite City site shows a downward trend from 2005 to 2008. The downward trend is likely to continue when all new emission control measures take place.

Table 6-5. St. Louis Area $PM_{2.5}$ Annual Average Design Values

| **Monitor Site** | **$PM_{2.5}$ Annual Std = 15.0 µg/m$^3$** | | | | | | | | | **3-year average** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **00-02** | **01-03** | **02-04** | **03-05** | **04-06** | **05-07** | **06-08** |
| **Missouri** | | | | | | | | | | | | | | | | |
| West Alton | 14.8 | 15.0 | 14.0 | 14.0 | 11.9 | 15.2 | 11.6 | 13.2 | Disc | 14.6 | 14.3 | 13.3 | 13.7 | 12.9 | 13.3 | n/a |
| Margaretta | 15.2 | 14.2 | 14.3 | 13.5 | 12.1 | 15.3 | 12.5 | Disc | Disc | 14.6 | 14.0 | 13.3 | 13.6 | 13.3 | Disc | Disc |
| Blair Street | 16.4 | 15.2 | 15.4 | 14.1 | 13.2 | 16.1 | 13.4 | 13.9 | 12.9 | 15.7 | 14.9 | 14.2 | 14.5 | 14.2 | 14.5 | 13.4 |
| Mound Street | 16.0 | 15.4 | 15.8 | 14.7 | 13.6 | 15.9 | 13.7 | 14.3 | 12.7 | 15.7 | 15.2 | 14.7 | 14.7 | 14.4 | 14.6 | 13.5 |
| South Broadway | 15.3 | 14.8 | 15.3* | 14.4 | 13.1 | 15.9 | 13.1 | 14.0 | 12.5 | 15.1** | 14.8** | 14.3** | 14.5 | 14.0 | 14.3 | 13.2 |
| Clayton | 15.1 | 13.9 | 14.6 | 13.6 | 12.2 | 15.5 | 11.8 | 13.1 | 12.0 | 14.5 | 14.0 | 13.5 | 13.8 | 13.2 | 13.4 | 12.3 |
| Arnold | 15.2 | 14.5 | 15.1 | 13.9 | 12.6 | 15.4 | 12.6 | 13.8 | 11.4*** | 14.9 | 14.5 | 13.9 | 14.0 | 13.5 | 13.9 | 12.6 |
| **Illinois** | | | | | | | | | | | | | | | | |
| Alton | 16.0 | 15.8 | 14.7 | 14.0 | 11.5 | 16 | 13.1 | 14.9 | 12.5 | 15.5 | 14.8 | 13.4 | 13.8 | 13.5 | 14.7 | 13.5 |
| Wood River | 15.9 | 15.0 | 15.1 | 14.0 | 13.2 | 16 | 13.1 | 14.2 | 12.2 | 15.3 | 14.7 | 14.1 | 14.4 | 14.1 | 14.4 | 13.2 |
| Granite City | 17.4 | 17.3 | 17.7 | 17.5 | 15.4 | 18.2 | 16.3 | 15.1 | 15.7 | 17.5 | 17.5 | 16.9 | 17.0 | 16.6 | 16.5 | 15.6 |
| East St. Louis | 17.4 | 17.0 | 16.7 | 16.6 | 14.7 | 17.1 | 14.5 | 15.6 | 12.6 | 17.0 | 16.8 | 16.0 | 16.1 | 15.4 | 15.7 | 14.2 |
| Swansea | 15.0 | 15.5 | 15.1 | 14.3 | 13.2 | 16 | 13.4 | 13.3 | 12.6 | 15.2 | 15.0 | 14.2 | 14.5 | 14.2 | 14.2 | 13.1 |

*Less than four full quarters
**Less than three full years
***Sampler moved to Arnold West

Table 6-6 shows multi-year monitoring data for Granite City site. The 2005 through 2009 monitoring data shows that the third and the fourth quarters had the highest and the lowest concentrations, respectively. The data also shows that the concentrations are even lower for the fourth quarter of 2008 and first quarter of 2009. This is due to that fact that U.S. National Steel shut down some of its operations as a result of the global demand for steel was low. This is another indication of how big of influence this facility has on this monitoring site.

Table 6-6. Granite City Site Monitoring Data

| Year (Quarterly) | Quarter | Arithmetic Mean (Quarterly) | Annual Mean (Quarterly) |
|---|---|---|---|
| 2005 | Q1 | 18.4 | 18.2 |
| | Q2 | 16.5 | |
| | Q3 | 21.5 | |
| | Q4 | 16.3 | |
| | | | |
| 2006 | Q1 | 15.0 | 16.3 |
| | Q2 | 16.1 | |
| | Q3 | 20.2 | |
| | Q4 | 14.0 | |
| | | | |
| 2007 | Q1 | 14.3 | 15.1 |
| | Q2 | 15.3 | |
| | Q3 | 17.6 | |
| | Q4 | 13.2 | |
| | | | |

| | | | |
|---|---|---|---|
| 2008 | Q1 | 15.6 | 15.7 |
| | Q2 | 15.7 | |
| | Q3 | 19.7 | |
| | Q4 | 11.9 | |
| | | | |
| 2009 | Q1 | 12.7 | 15.0* |

*Average of 1st quarter of 2009 and previous three quarter averages

### 6.5.2 Trends in $PM_{2.5}$ Speciation Results

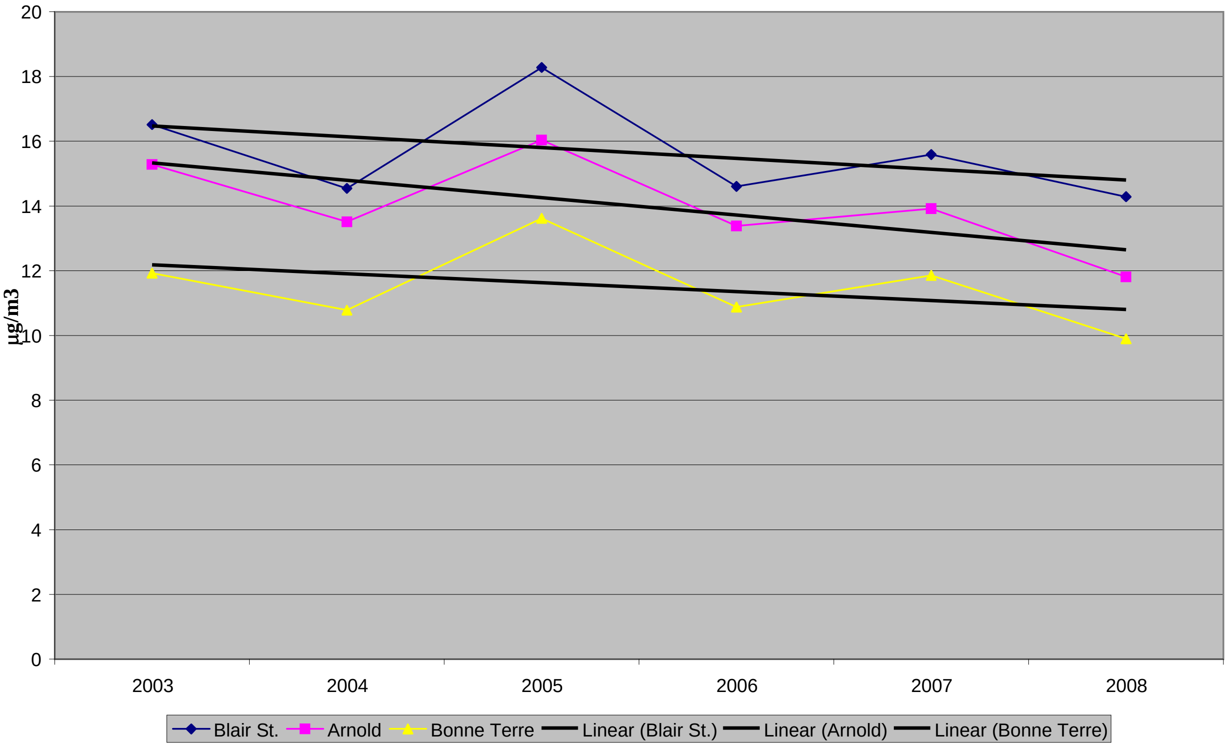
The following figures show trends for 2003 through 2008 in annual average concentrations of the major species that contribute to $PM_{2.5}$ as measured by speciation samplers at the Blair Street, Arnold, and Bonne Terre sites, an urban, suburban, and rural site respectively. Figure 6-4 shows $PM_{2.5}$ mass concentration as measured by the speciation samplers (which may be slightly different from the mass measured by the federal reference method sampler).

Figures 6-5 through 6-7 show trends in major species concentrations, grouped by site. The sum of the concentrations of these species is less than the mass concentration, for two reasons. The major species shown do not include crustal elements, other metallic elements, or the oxygen typically combined with metallic species (a relatively small part of the total mass). Also, the total carbon concentrations shown do not include the associated mass of hydrogen and other elements combined with the carbon in organic compounds (a more significant part of the mass than crustal and other components).

Total carbon is shown rather than elemental and organic carbon separately, because the sampling and analysis methodology for measuring carbon was changed during the period of interest from the NIOSH or EPA methodology to the IMPROVE methodology, and the change was made at different times for each of the three sites. The two methodologies result in different splits between organic and elemental carbon but result in similar results for total carbon. Therefore, trends in elemental or organic carbon during this period would be dominated by this artifact and so not meaningful. Speciation data from the IMPROVE sampler at Mingo are not included, because there were problems with carbon measurement at that site during part of the period of interest. However, results from the rural Bonne Terre site are presented.

Figures 6-8 through 6-10 show the same data grouped by species and including a linear trend line for each species at each site. The trend lines for each species, like the ones for total mass concentration, show a decreasing trend over time. Another notable feature is that the sulfate concentrations and trends are very similar among the three sites, suggesting that sulfate particulate matter is regional in nature, while the other species, most notably the total carbon, show differences between the sites, suggesting that there is an urban contribution to total carbon and also to nitrate.

## Figure 6-4. Total Mass Annual Average from PM2.5 Speciation Samplers




## Figure 6-5. Blair St. Species Annual Averages

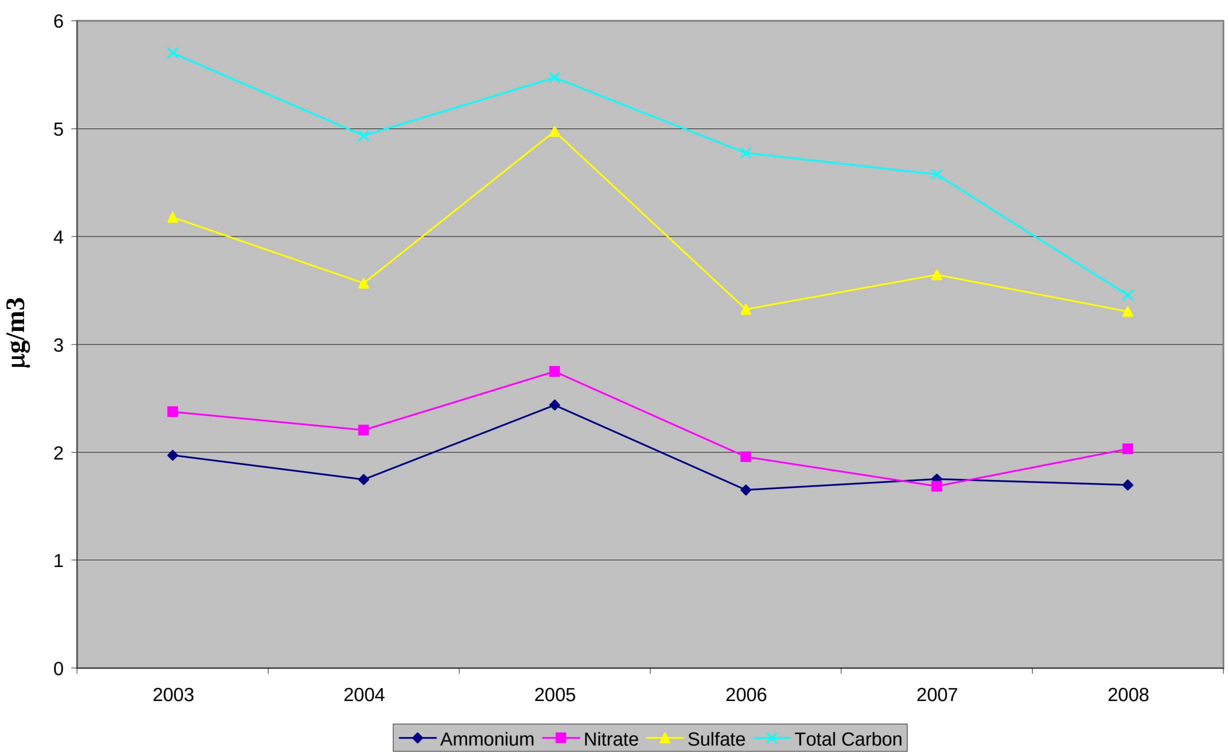


**Figure 6-6. Arnold Species Annual Averages**

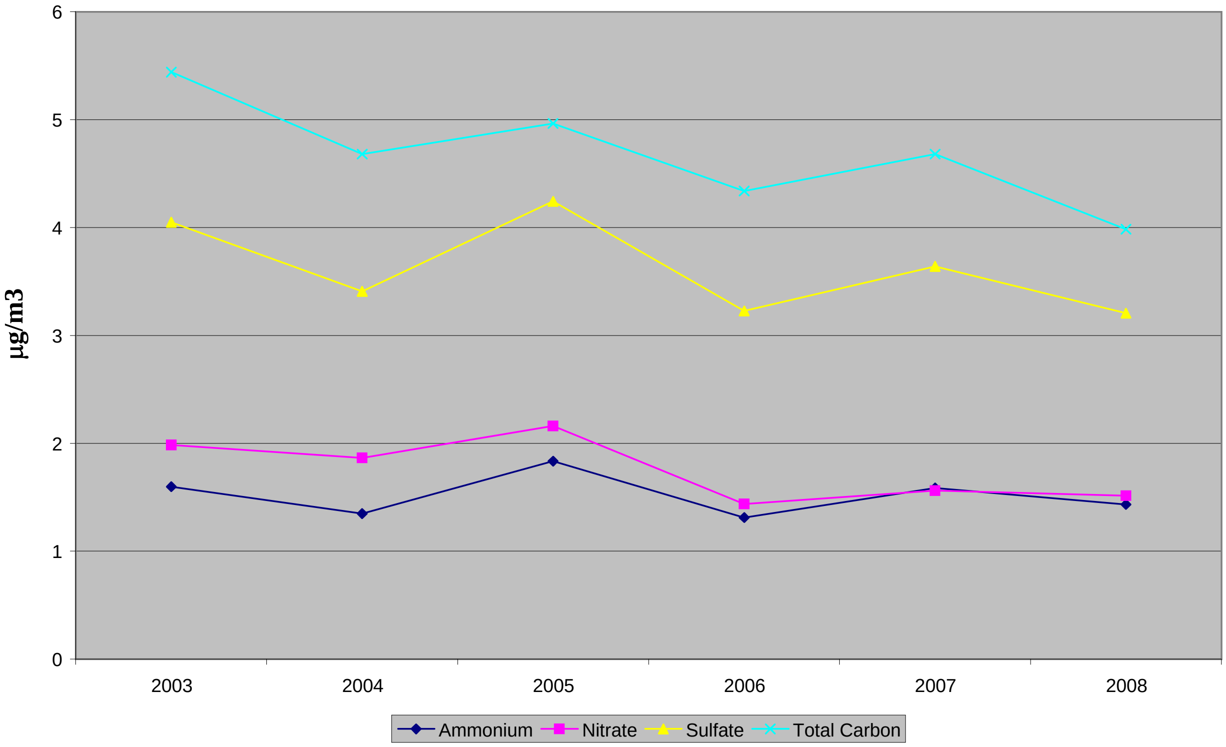
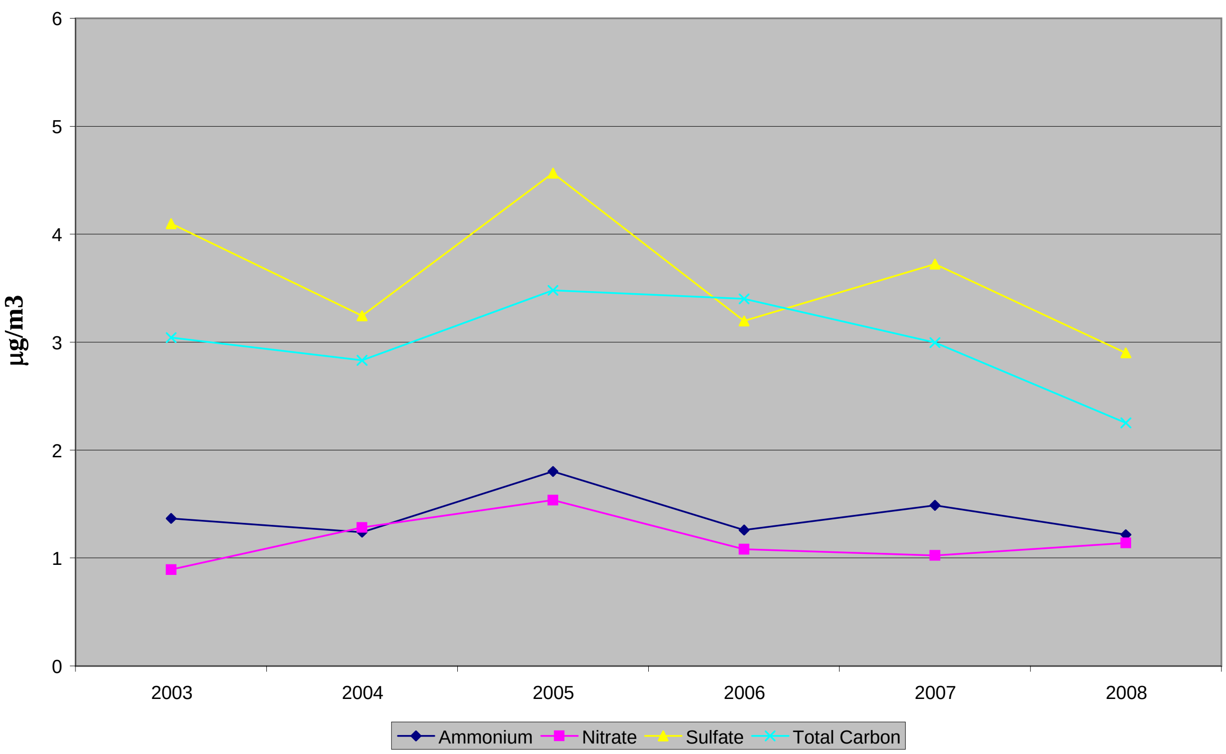
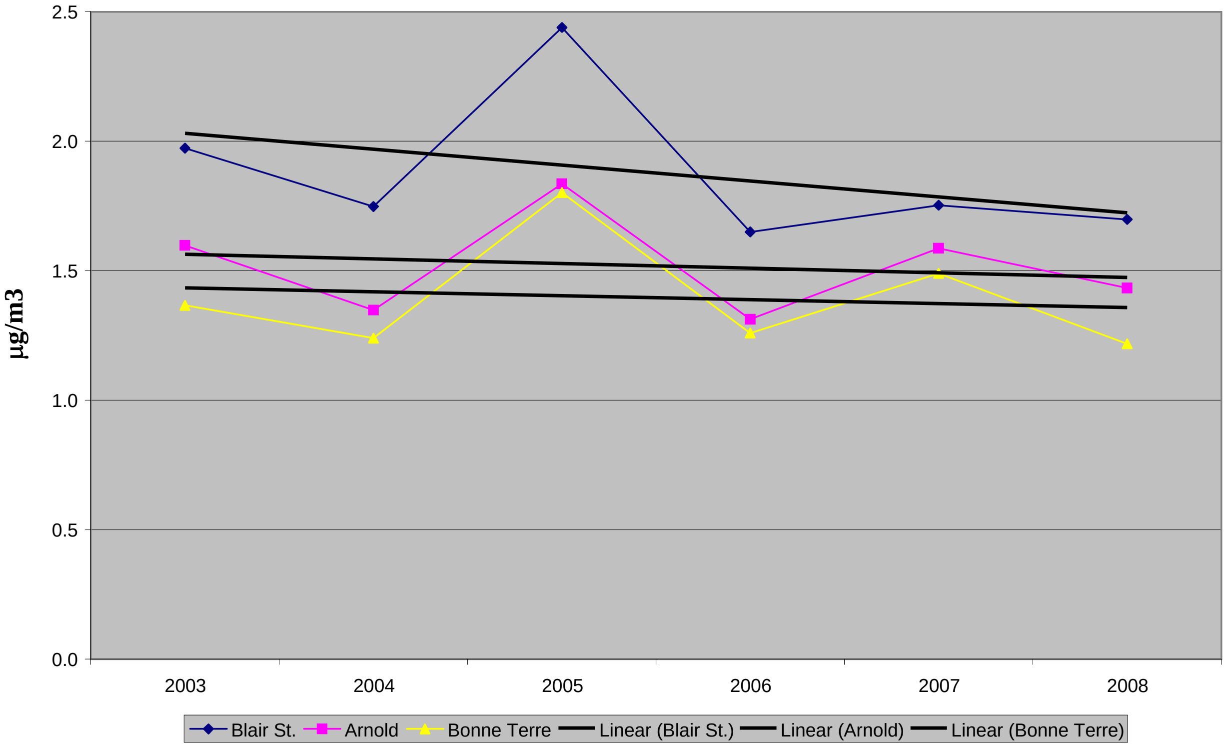



**Figure 6-7. Bonne Terre Species Annual Averages**



## Figure 6-8. Ammonium Annual Average




## Figure 6-9. Nitrate Annual Average

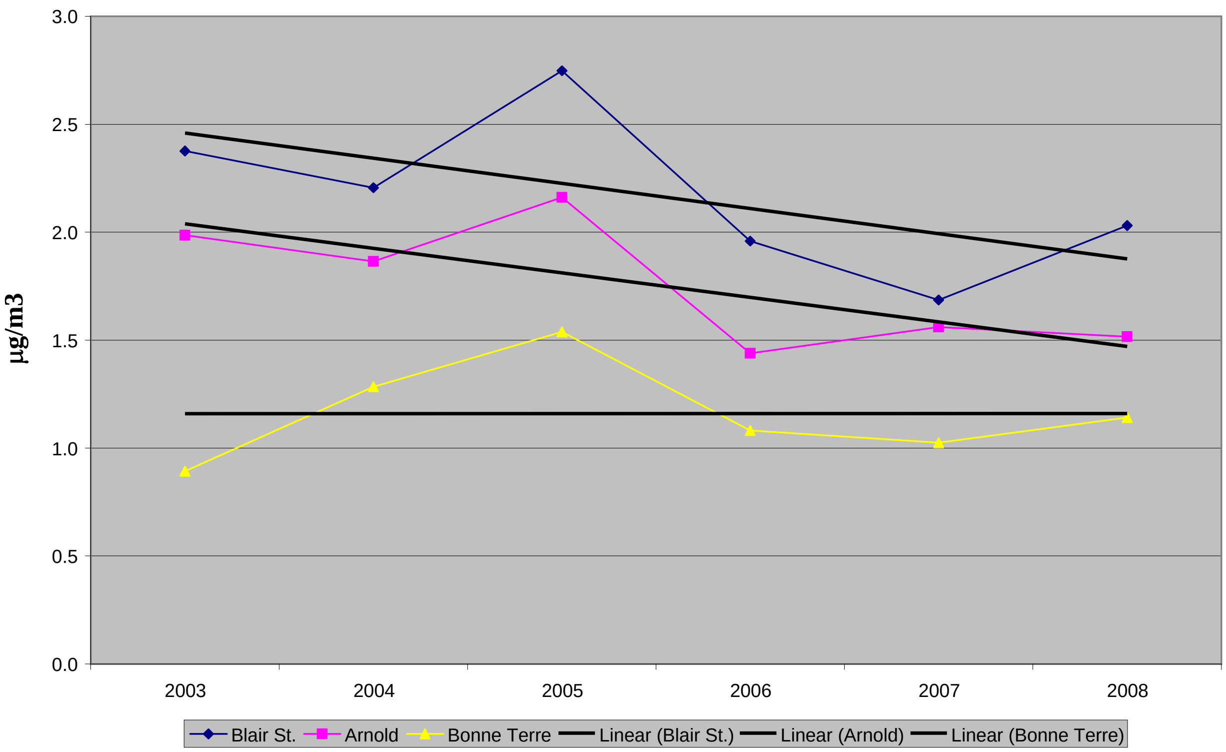
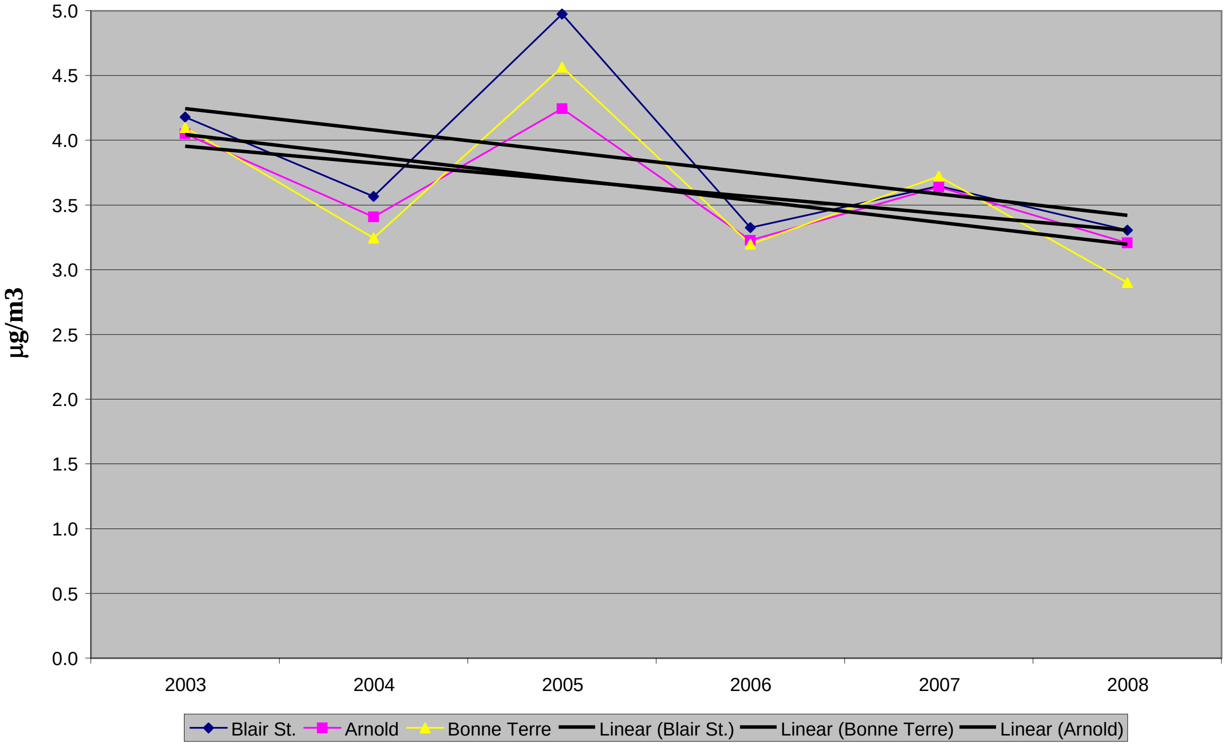


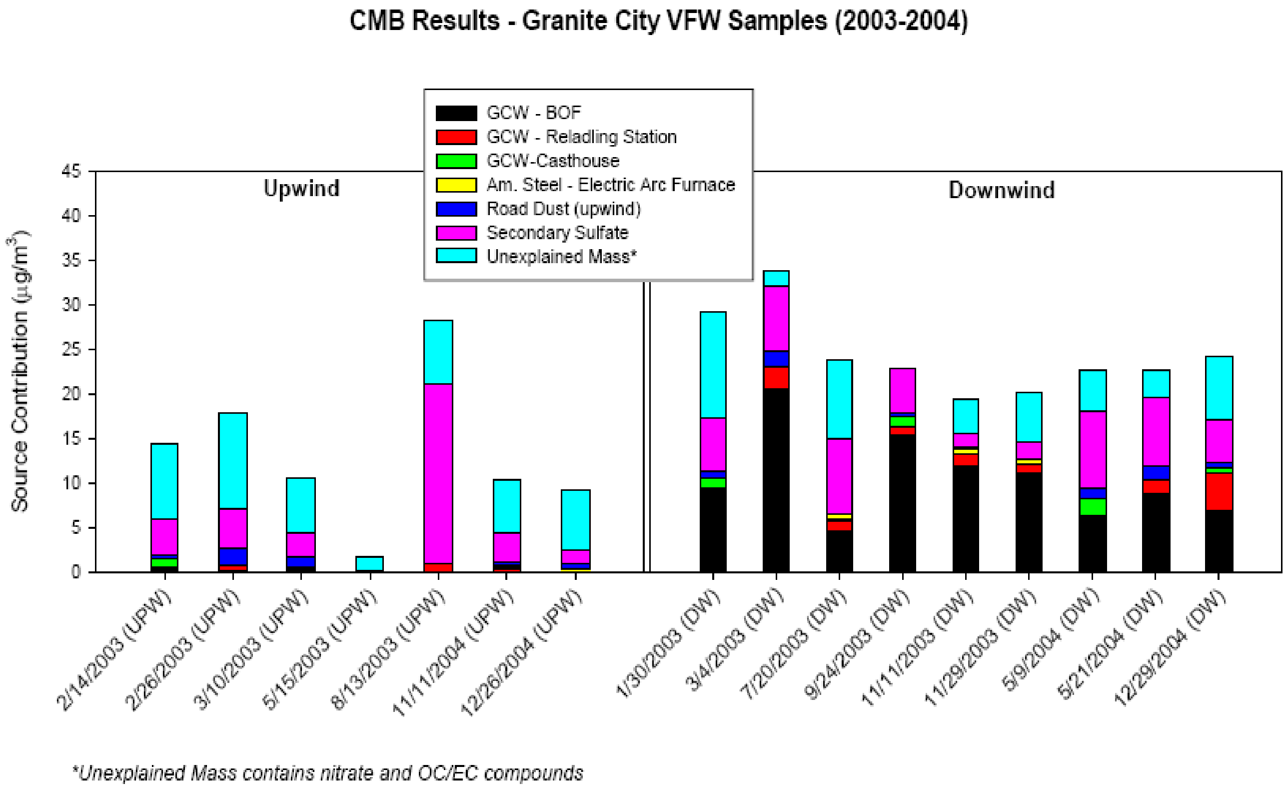
**Figure 6-10. Sulfate Annual Average**




## 6.6 CHEMICAL MASS BALANCE SOURCE APPORTIONMENT RESULTS FOR THE GRANITE CITY AREA AND URBAN EXCESS

The US EPA St. Louis Advanced Monitoring Initiative (AMI) project was initiated to assist the States of Missouri and Illinois in developing their SIPs for $PM_{2.5}$ in the St. Louis NAA. A major part of this project is the use of ambient monitoring data and advanced receptor modeling techniques to identify source contributions to $PM_{2.5}$ in the area. As a part of this project, field measurements (chemical analysis of samples from the VFW site and of source samples) conducted in the same area in 2003 and 2004 were analyzed and apportioned to sources using chemical mass balance (CMB) techniques with source signatures based on facilities in the US Steel Granite City Works complex. Figure 6-11, from a presentation of preliminary results by Rachelle Duvall of US EPA posted on the EPA Environmental Science Connector website, St. Louis AMI Project Workbench, shows source apportionment results for several days during 2003 and 2004, grouped separately for days when the sampling location was upwind or downwind of the facility.

Figure 6-11. Chemical Mass Balance Source Apportionment Results for Granite City Area and Urban Excess




As shown in the bar graphs, source attribution results clearly show significant contributions to the measured particulate species on downwind, but not on upwind days. Based on the figure, Granite City Works sources plus road dust account for, on average, only 2 of the 13 µg/m$^3$ (**15%**) on upwind days, but 14 of the 24 µg/m$^3$ (**60%**) on downwind days. Emission, wind vectors, and transport characteristics will vary from day to day, but the annual average impact of those local sources appears from this data to likely be some amount between 15% and 60% of the total. Given the tendency of southerly wind vectors and the location of monitoring primarily to the north, some fairly large amount of days when higher local source impacts occurs seems assured. This analysis leads to a conclusion that local Granite City sources are the dominant influence on air quality impacts to the VFW and also the Granite City fire station sites, confirming the need for the local controls that the Illinois EPA is working toward in its portion of the plan.

## 6.7 CONCLUSIONS

In summary, the downward trend of emissions as shown in Figure 6-3 is consistent with historic and current air quality data. This downward trend is very likely to continue when the new control measures are implemented. In 2002, there were three monitoring sites (Granite City, East St. Louis, & Mound Street) violating the annual $PM_{2.5}$ NAAQS. Recent 2009 photo chemical modeling using CMAQ with on-the-book controls showed that only one site (Granite City) was still in violation. This is consistent with the most recent air quality data which shows that both East St. Louis and Mound Street sites have attained the NAAQS.

Under section 172(a)(2)(A) of the CAA, EPA may grant an area an extension of the initial attainment date for a period of one to 5 years. Since the 2009 air quality and modeling data showed that it was impractical for the St. Louis area to attain the annual $PM_{2.5}$ standard by 2010, both Missouri DNR and Illinois EPA requested that the attainment date be extended to 2012 to take advantage of federal/state control measures taking place after 2009. MDNR proposed new RACT rules that reduced $SO_2$ and $NO_x$ emissions by 20,133 tpy and 1,067 tpy, respectively, will be implemented by 2011. These reductions showed some progress toward attainment as shown in Section 6.4. However, more reductions, particularly from sources influencing the Granite City monitoring site, were needed to get below the NAAQS of 15 $\mu g/m^3$.

The Conceptual Model (Chapter 2) concluded that Granite City monitoring site is influenced by nearby local sources which contribute a significant fraction (2-3 $\mu g/m^3$) of the annual $PM_{2.5}$ concentrations. In addition, the "Chemical Mass Balance Source Apportionment Results for the Granite City Area and Urban Excess" showed that local Granite City sources are the dominant influence on air quality impacts to the Granite City site. Moreover, Missouri DNR sensitivity modeling analyses concluded that controlling direct $PM_{2.5}$ emissions from local sources near Granite City monitoring site was far more effective than $SO_2$ and $NO_x$ RACT rules. The IEPA is performing local-scale analysis using CMAQ, CAMx and AERMOD to identify the level of control needed to attain the annual $PM_{2.5}$ NAAQS. It is believed that when the new local controls measures are implemented near the Granite City monitoring site, the annual NAAQS will be attained.