July 12, 2005

Round 2 Strategy Modeling: Summary

The purpose of this document is to summarize the results of the Round 2 strategy modeling, including several sensitivity runs. The Round 2 strategies are identified in Table 1. The control measures considered in these strategies reflect an initial set of stationary source measures (see "Midwest Regional Planning Organization, Identification and Evaluation of Candidate Control Measures", April 14, 2005). Further information on these measures is provided in the Appendix.

The observed base year (2002) and modeled future year (2009) design values (Strategy 2) for ozone and $PM_{2.5}$ are shown in the figure below. As can be seen, the "on the books" and "on the way" (CAIR) controls will substantially improve air quality, but will not be enough to provide for attainment everywhere.[1]

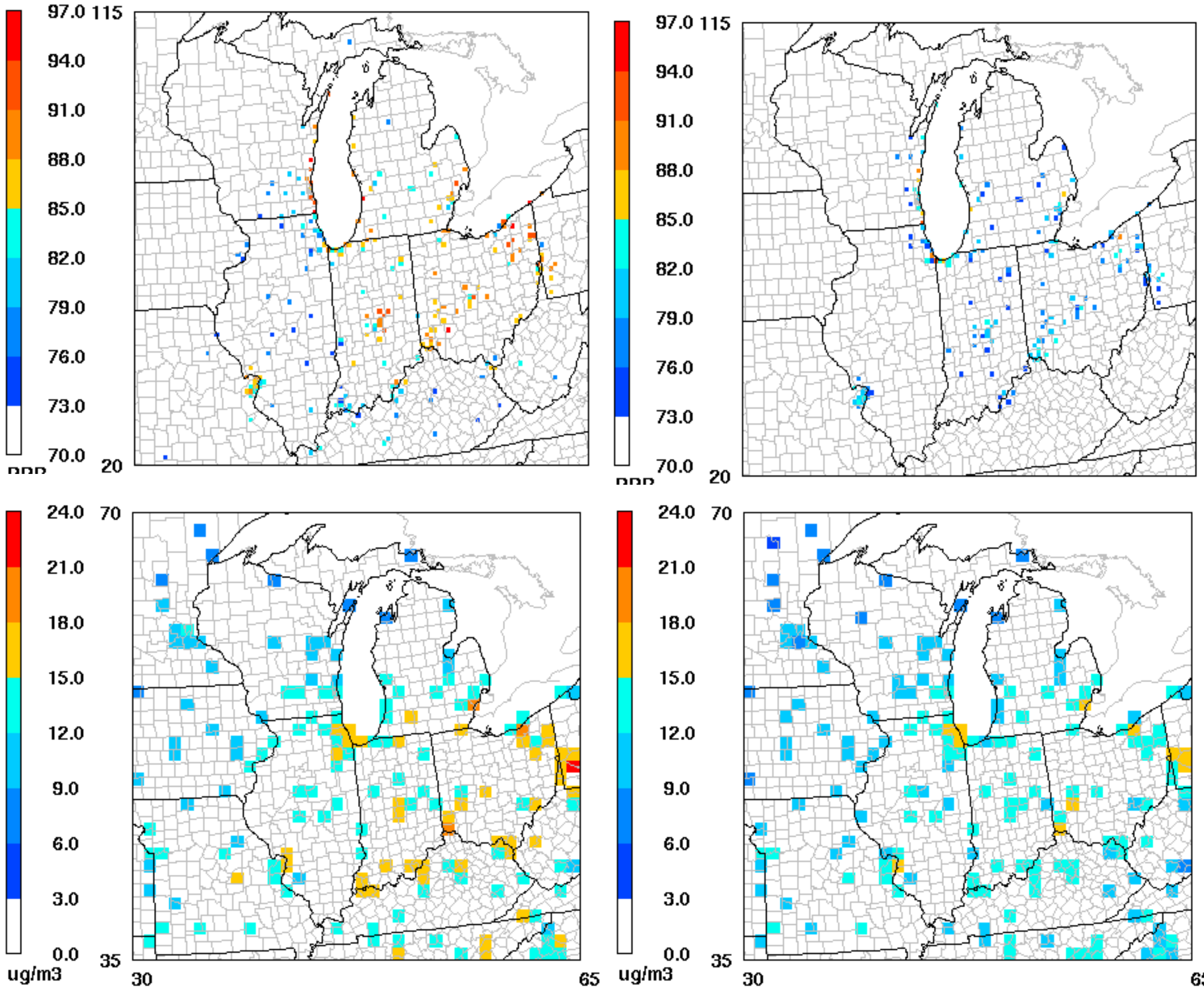


Figure 1. Observed base year (left) v. modeled future year – Strategy 2 (right) design values for ozone (top) and $PM_{2.5}$ (bottom)

[1] Even with full implementation of CAIR in 2018, there are residual nonattainment problems (i.e., for ozone, at least Kenosha, and for $PM_{2.5}$, at least Chicago and Detroit).

Table 1. Round 2 Modeling Runs

Run		Description		2009	2018
Base I+		2002 baseyear emissions inventory			
Strategy 1		"On the books" controls		x*	x
Strategy 2		"On the books" plus "on the way" controls		x*	x
Strategy 4		Strategy 2, plus EGU controls:			
		a. EGU1 in 5-state region		x*	x
		b. EGU1 in 13-state MWGA region		x	x
		c. EGU2 in 5-state region		x	x
Strategy 3		Strategy 4a, plus MACTEC VOC controls (8 point/area source categories):		x*	
		a. In all ozone nonattainment counties:			
		MACTEC point source control measures			
		MACTEC area source control measures			
		Low RVP fuel			
		b. In all ozone nonattainment counties and adjacent counties		x	
		MACTEC point source control measures			
		MACTEC area source control measures			
		Low RVP fuel			
		c. Regionwide (5-state region)		x	
		MACTEC point source control measures			
		MACTEC area source control measures			
		Low RVP fuel			
Strategy 5		Strategy 3a, Strategy 4a, plus MACTEC point and area source SOx and NOx		x*	
		controls (ICI boilers, refineries, cement kilns)			
Strategy 6		Strategy 2 plus BART for non-EGU sources (ICI boilers, refineries, cement			x
		kilns, and iron and steel plants)			
				** = additional 12 km run*	
		EGU1= 2009 - SOx:0.36 lb/MMBTU, NOx: 0.15 lb/MMBTU			
		2013 - SOx:0.15 lb/MMBTU, NOx: 0.10 lb/MMBTU			
		EGU2= 2009 - SOx:0.24 lb/MMBTU, NOx: 0.12 lb/MMBTU			
		2013 - SOx:0.10 lb/MMBTU, NOx: 0.07 lb/MMBTU			

The effect of Strategy 1 and Strategy 2 on the ozone and $PM_{2.5}$ design values for several locations in the region is shown in the figure below. Most of the benefit for ozone is provided by Strategy 1 and for $PM_{2.5}$ by Strategy 2.

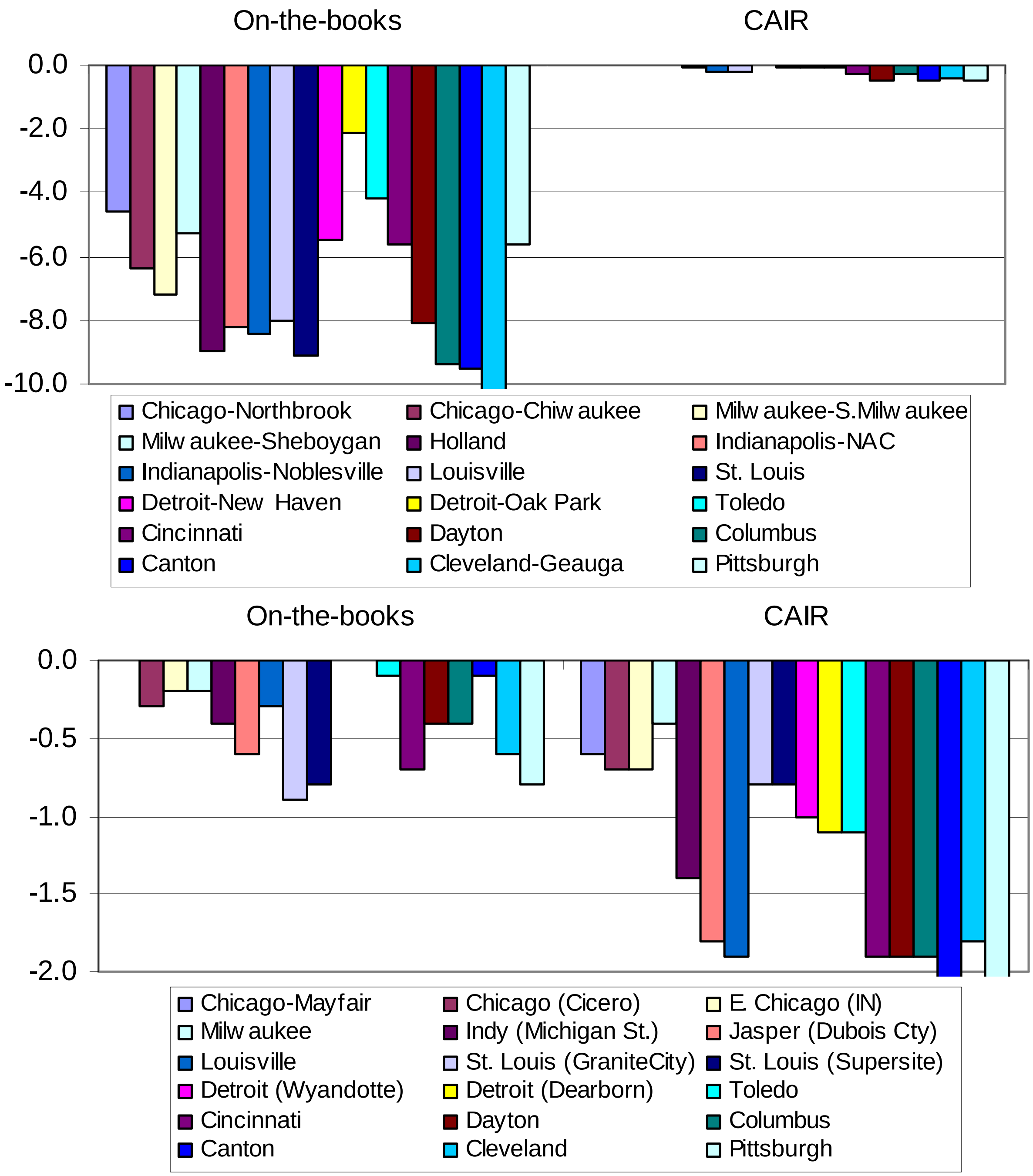


Figure 2. Change in design values for ozone (top) and $PM_{2.5}$ (bottom)

Tables 2a and 2b show the modeled future year design values above the NAAQS. For ozone, the number of nonattainment monitors decreases from 93 (2002 observed) to 11 (Strategy 1 and 2). Many of the predicted future year "nonattainment" sites are within 1 – 2 ppb of the standard (see Figure 3).

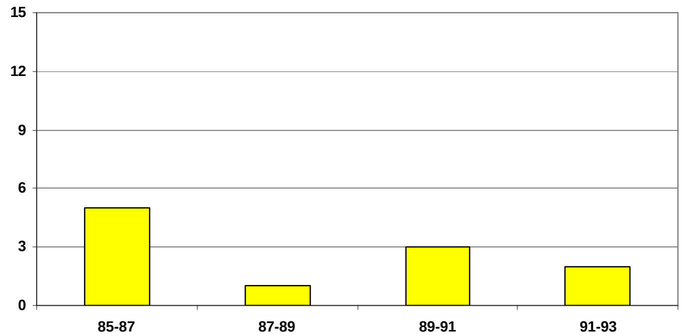


Figure 3. Ozone design values for "nonattainment" monitors (CAIR)

The more significant nonattainment problems are western Lake Michigan (Chicago/Milwaukee) and northeastern Ohio (Cleveland) – i.e., future year design values on the order of 90 ppb or more (see Figure 4).

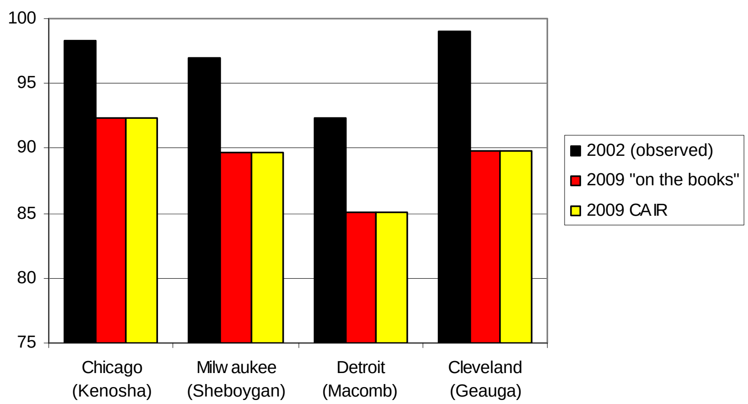


Figure 4. Sites with highest design values for ozone

For $PM_{2.5}$, the number of nonattainment monitors decreases from 65 (observed 2002) to 51 (Strategy 1) and 16 (Strategy 2). Almost all of the predicted future year "nonattainment" sites are within 1 ug/m^3 of the standard (see Figure 5).

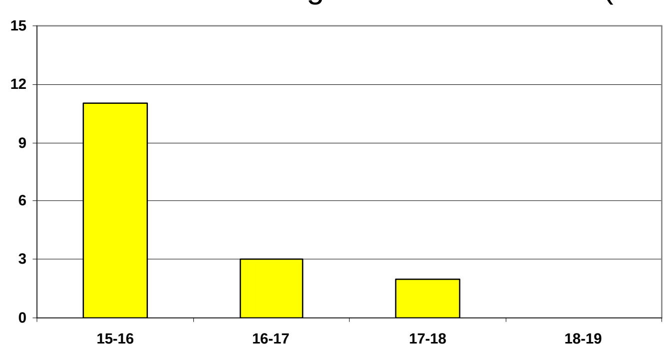


Figure 5. $PM_{2.5}$ design values for "nonattainment" monitors (CAIR)

The more significant nonattainment problems are Detroit (Dearborn), Chicago (Mayfair Pumping Station), and Cleveland (Tikhon Street) (see Figure 6).

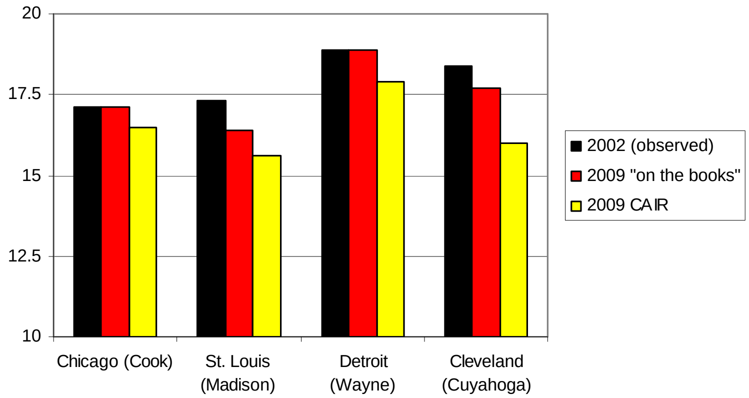


Figure 6. Sites with highest design values for $PM_{2.5}$

The chemical speciation of $PM_{2.5}$ at these sites is shown below. The major species associated with the residual nonattainment are (in order) organic carbon, nitrates, and sulfates. This suggests that to bring these sites into attainment, (local) control measures which address organic carbon, in particular, should be considered. Information on sources of organic carbon will be available later this year from the urban organics study.

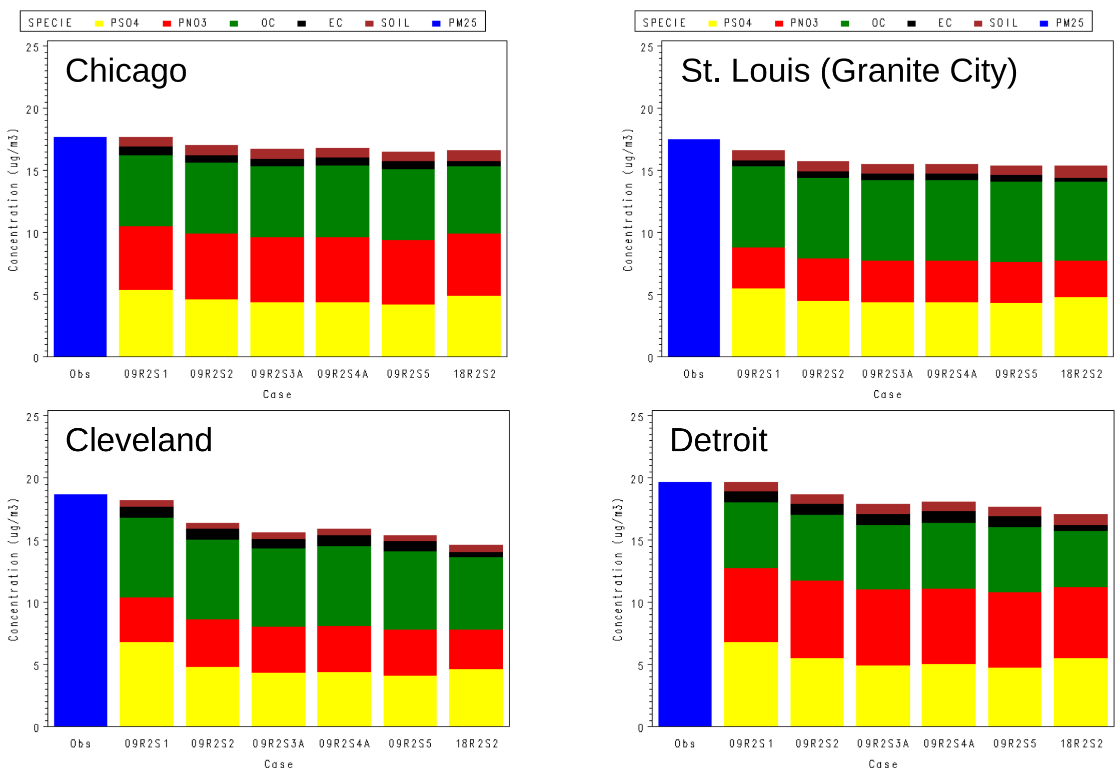


Figure 7. $PM_{2.5}$ chemical speciation for sites with highest design values

Table 2a. $PM_{2.5}$ Design Values – Strategy Runs (2009 base > NAAQS)

		Observed	2009base	2009CAIR	4a	4b	4c	5
Chicago	170310014	15.6	15.3	14.7	14.3	14.0	14.1	14.1
	170310022	15.9	15.7	15.0	14.7	14.4	14.4	14.4
	170310050	15.5	15.3	14.6	14.2	13.9	14.0	14.0
	170310052	17.1	17.1	16.5	16.2	15.9	15.9	16.0
	170310057	15.6	15.4	14.7	14.4	14.1	14.1	14.1
	170310076	15.5	15.2	14.6	14.2	13.9	14.0	14.0
	170312001	15.6	15.4	14.7	14.3	14.0	14.1	14.1
	170313103	16.0	16.3	15.7	15.4	15.1	15.2	15.2
	170313301	16.0	15.7	15.1	14.7	14.4	14.4	14.4
	170314006	15.3	15.5	15.0	14.7	14.4	14.5	14.5
	170316005	16.4	16.2	15.5	15.1	14.8	14.9	14.9
Granite City	171191007	17.3	16.4	15.6	15.3	14.9	15.1	15.2
	171630010	16.2	15.4	14.6	14.3	13.9	14.2	14.2
Clark County	180190005	16.3	16.1	14.4	14.0	13.7	13.9	13.9
Dubuis County	180372001	15.8	15.3	13.5	13.0	12.6	12.8	12.8
Indianapolis	180970078	16.2	15.8	14.5	14.1	13.8	13.9	13.9
	180970079	15.5	15.2	13.8	13.3	13.1	13.1	13.1
	180970081	16.0	15.7	14.4	14.0	13.7	13.8	13.8
	180970083	16.4	16.0	14.7	14.3	14.0	14.1	14.1
Detroit	261630001	15.9	16.1	15.1	14.0	14.4	14.4	14.4
	261630015	17.3	17.3	16.4	15.8	15.7	15.6	15.6
	261630016	15.4	15.4	14.6	14.1	13.9	13.9	13.9
	261630033	18.9	18.9	17.9	17.3	17.1	17.1	17.1
	261630036	17.8	17.9	17.0	16.4	16.2	16.2	16.2
Butler County	390170003	16.1	15.6	14.1	13.6	13.4	13.4	13.4
	390170016	15.7	15.1	13.4	12.9	12.7	12.7	12.7
Cleveland	390350013	17.3	16.7	15.0	14.5	14.4	14.3	14.2
	390350027	16.7	16.1	14.5	14.0	13.9	13.8	13.7
	390350038	18.4	17.7	16.0	15.5	15.3	15.2	15.1
	390350044	16.7	16.1	14.5	14.1	13.9	13.9	13.8
	390350060	17.5	16.9	15.2	14.7	14.5	14.5	14.4
	390350065	16.1	15.6	14.0	13.6	13.4	13.4	13.3
Columbus	390490024	16.6	16.2	14.3	13.9	13.6	13.7	13.6
	390490025	16.0	15.6	13.8	13.3	13.1	13.1	13.1
	390490081	15.9	15.5	13.8	13.3	13.1	13.1	13.1
Cincinnati	390610014	17.7	17.0	15.2	14.6	14.3	14.4	14.4
	390610040	15.6	15.0	13.3	12.9	12.6	12.7	12.6
	390610042	17.1	16.4	14.6	14.1	13.8	13.9	13.8
	390610043	15.8	15.2	13.5	13.0	12.7	12.8	12.8
	390617001	16.2	15.6	13.9	13.4	13.1	13.2	13.1

	390618001	17.1	16.5	14.7	14.2	13.9	14.0	13.9
Jefferson	390810016	17.9	15.9	13.6	12.9	13.0	13.0	13.0
	390811001	17.5	15.5	13.2	12.8	12.7	12.7	12.7
Lawrence	390870010	15.6	15.0	12.7	12.4	12.1	12.3	12.3
Dayton	391130014	17.9	17.5	15.6	15.1	14.8	14.9	14.8
	391130032	15.7	15.3	13.5	13.0	12.8	12.8	12.7
Scioto	391450013	16.5	16.5	13.7	13.3	13.0	13.1	13.1
Canton	391510017	17.3	17.1	15.0	14.2	14.0	14.0	13.9
	391510020	15.7	15.6	13.3	12.9	12.7	12.7	12.7
Summit	391530017	16.4	16.1	14.0	13.5	13.3	13.3	13.2
	391530023	15.4	15.1	13.1	12.7	12.5	12.5	12.4

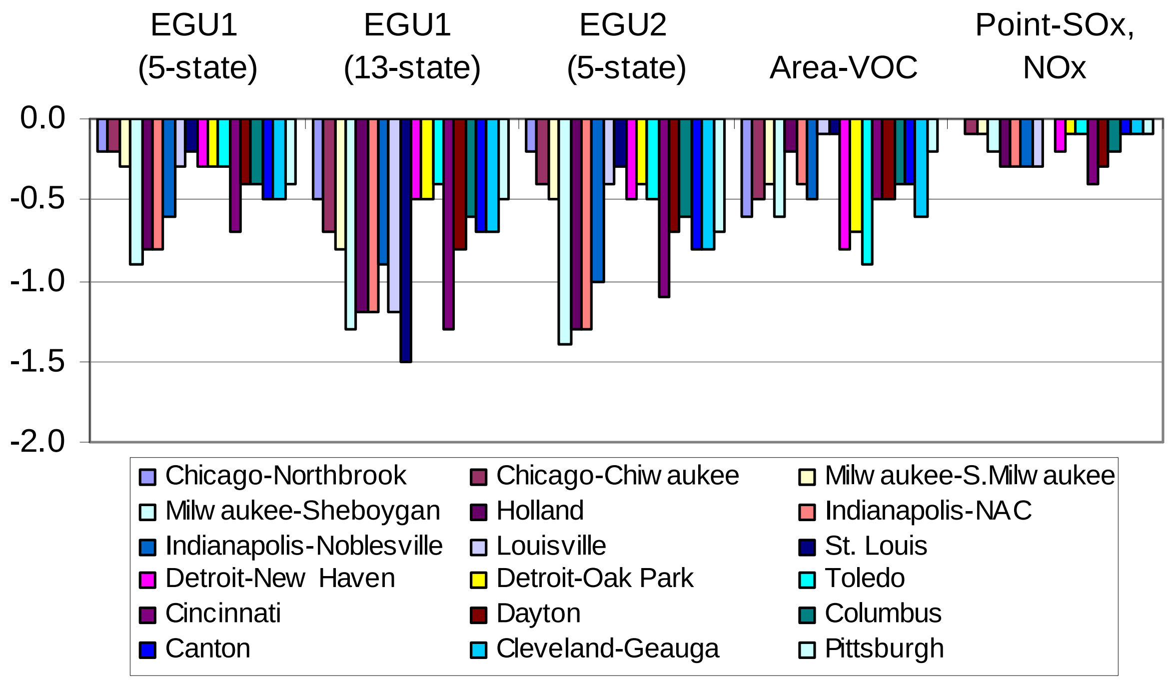
Note, the observed design values represent the average of the 2000-2002, 2001-2003, and 2002-2004 design values.

Table 2b. Ozone Design Values – Strategy Runs (2009 base > NAAQS)

			Ozone Design Values				
		Observed	**2009base**	**2009CAIR**	**4a**	**3a**	**5**
Chicago	170310032	85.3	88.1	88.0	87.8	87.0	87.2
NW Indiana	180892008	88.3	92.9	92.8	92.6	91.9	92.2
	181270024	86.3	85.4	85.3	85.2	84.9	84.7
Holland	260050003	94.0	85.7	85.8	85.0	84.6	84.4
Detroit	260990009	92.3	85.2	85.1	84.9	84.1	83.9
Cleveland	390550004	99.0	90.2	89.8	89.3	88.6	88.4
Kenosha	550590002	96.0	90.1	90.1	89.7	89.2	89.1
	550590019	98.3	92.3	92.3	91.9	91.3	91.3
Ozaukee Cty	550890009	93.0	86.5	86.5	86.0	85.4	85.2
Racine	551010017	91.7	85.2	85.2	84.8	84.3	84.2
Sheboygan	551170006	97.0	89.6	89.7	89.1	88.6	88.4

Note, the observed design values represent the average of the 2000-2002, 2001-2003, and 2002-2004 design values.

Tables 2a and 2b show the modeled design values for Strategies 3 – 5. The effect of the control measures in these strategies on the ozone and $PM_{2.5}$ design values is shown in the figure below. This information shows that these strategies will further improve air quality, but are still not enough to provide for attainment at all sites.



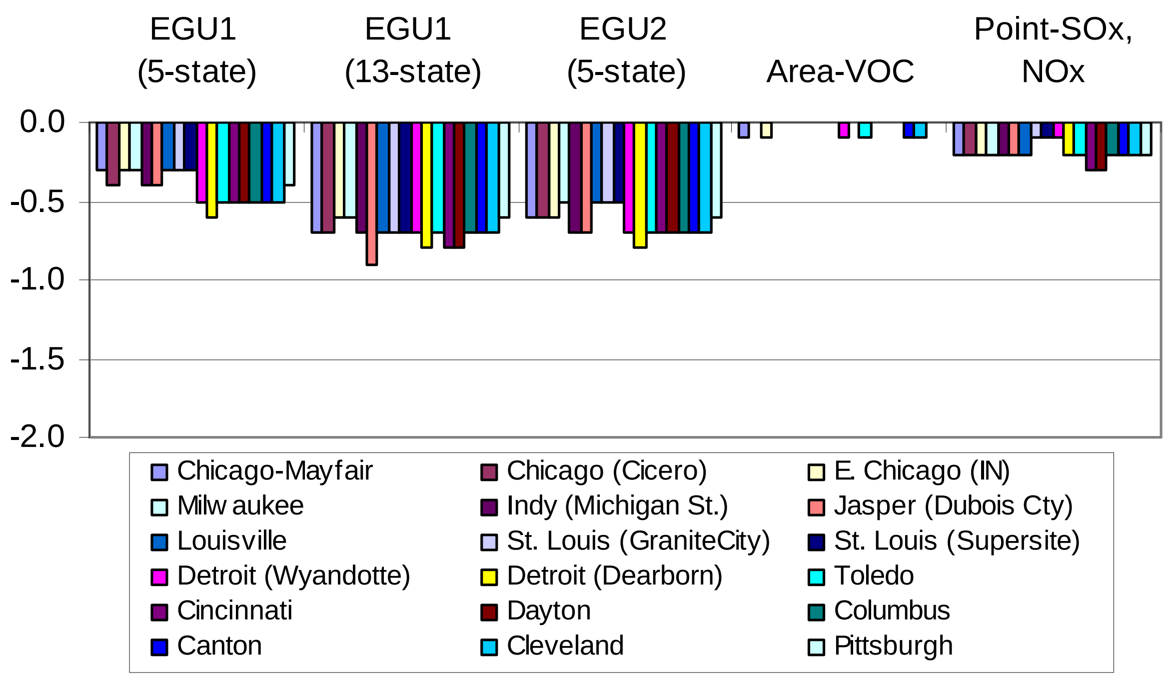


Figure 8. Change in design values for ozone (top) and $PM_{2.5}$ (bottom)

The visibility metric (deciviews) was calculated for several nearby Class I areas for both strategies and future years (see Table 3 and Figure 9). As can be seen, the 2018 calculated values for Strategy 2 (CAIR) are better than those associated with the uniform rate of progress ("2018 goal") for several Class I areas (i.e., Mammoth Cave, Dolly Sods, and Shenandoah). The 2018 calculated values for the northern Class I areas in Michigan and Minnesota, however, are slightly above those associated with the uniform rate of progress ("2018 goal"). Further analyses, including updated Integrated Planning Model (IPM) emissions estimates for electric generating units (EGUs) and consideration of additional controls (e.g., BART for northern Minnesota sources and, possibly, beyond-CAIR controls for EGUs) will be pursued to help address the 2018 reasonable progress goal for these northern Class I areas.

Table 3. Visibility Metric (deciviews) for Strategy Runs

Site	2000-2003 Baseline	2018 Goal	2018 OTB	2018 CAIR	2018 BART	2018 EGU1	2018 EGU1(MW)	2018 EGU2
BOWA1	20.1	17.8	19.6	18.9	18.8	18.3	**17.1**	18.1
VOYA2	18.7	16.7	18.3	18.0	18.0	17.7	16.8	17.7
ISLE1	21.0	18.5	20.3	19.6	19.4	18.7	**18.0**	**18.5**
SENE1	23.8	20.6	23.4	22.3	22.1	21.3	20.7	21.1
MING1	27.7	23.5	26.3	23.7	23.6	**22.4**	**21.6**	**22.1**
MACA1	30.1	25.3	28.7	**24.8**	**24.7**	**24.2**	**23.4**	**24.0**
DOSO1	27.4	23.3	26.1	**21.2**	**21.1**	**20.7**	**20.4**	**20.5**
SHEN1	27.9	23.6	26.1	**21.8**	**21.7**	**21.1**	**20.9**	**21.0**
LYBR1	23.9	20.7	23.1	21.3	21.3	21.0	20.9	21.0
BRIG1	27.9	23.6	26.9	**23.6**	**23.6**	**23.3**	**23.1**	**23.2**
BOWA1	6.4	6.4	6.4	6.4	6.4	6.3	6.2	6.3
VOYA2	6.5	6.5	6.1	6.1	6.1	6.1	6.0	6.1
ISLE1	6.2	6.2	6.3	6.2	6.2	6.1	6.1	6.1
SENE1	6.7	6.7	6.6	6.6	6.5	6.5	6.4	6.5
MING1	13.6	13.6	13.2	12.8	12.7	12.6	12.0	12.5
MACA1	16.7	16.7	17.0	16.0	16.0	15.8	15.5	15.7
DOSO1	12.9	12.9	12.9	11.9	11.9	11.8	11.8	11.8
SHEN1	11.8	11.8	11.6	10.8	10.8	10.8	10.7	10.7
LYBR1	6.1	6.1	5.9	5.8	5.8	5.8	5.7	5.7
BRIG1	13.8	13.8	13.2	12.7	12.7	12.6	12.6	12.6

(Note: values in red are below the Uniform Rate of Progress line)

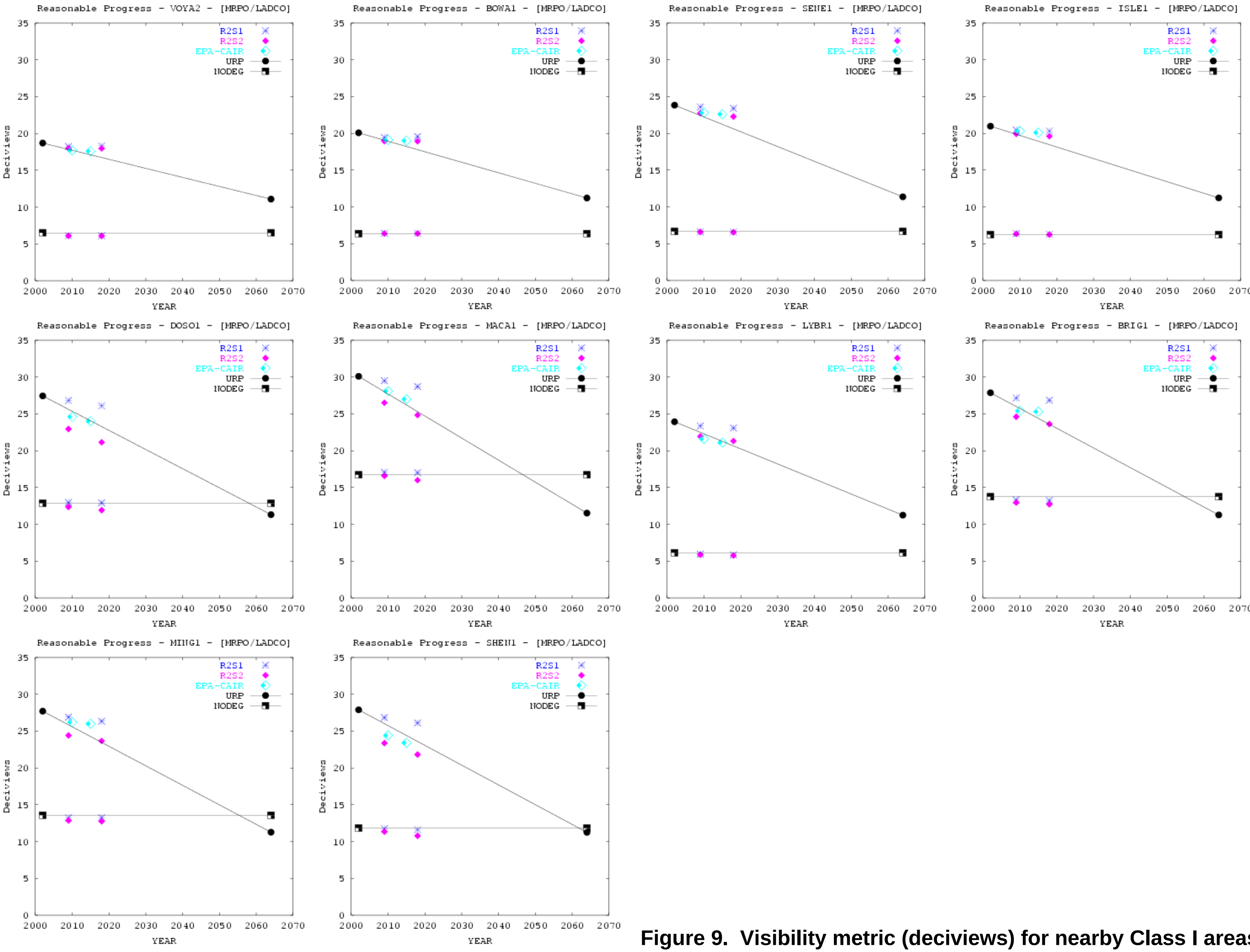


Figure 9. Visibility metric (deciviews) for nearby Class I areas

Sensitivity Modeling

To provide information on what it will take to show attainment, the following model sensitivity runs were conducted (with Strategy 2 as the base):

Run	**Change in Emissions v. Strategy 2 (v. 2002)**		
Ozone-Summer	VOC	NOx	SOx
1	-25% (-39%)	---- (-38%)	---- (-42%)
2	-50% (-64%)	---- (-38%)	---- (-42%)
3	-25% (-39%)	-25% (-63%)	---- (-42%)
4	----- (-14%)	-25% (-63%)	---- (-42%)
5	----- (-14%)	-50% (-88%)	---- (-42%)
6	-50% (-84%)	-50% (-88%)	---- (-42%)
PM2.5-Annual	OC	NOx	SOx
7	-25% (-25%)	-25% (-63%)	---- (-42%)
8	-50% (-50%)	-50% (-88%)	---- (-42%)
9	-50% (-50%)	-50% (-88%)	-50% (-92%)
10	----- (- 0%)	-25% (-63%)	---- (-42%)
11	----- (- 0%)	---- (-63%)	-25% (-77%)
12	-25% (-25%)	-25% (-63%)	-25% (-77%)
13	----- (- 0%)	---- (-63%)	-50% (-42%)

Note: VOC reductions applied in ozone nonattainment areas, and NOx and SOx reductions applied statewide in 5-state region

The emission reductions in these runs go beyond those in Strategies 3 – 5.[2] The modeled future year design values are provided in Tables 4a and 4b. The sensitivity results, along with those for Strategy 5, for the more significant ozone nonattainment monitors are shown in Figure 10.

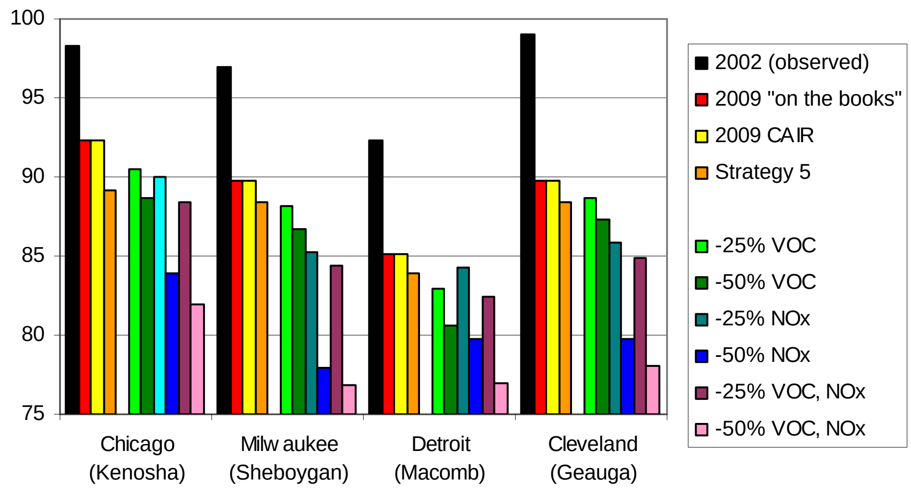


Figure 10. Highest Design Values for Ozone

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Strategy	**Change in Emissions v. Strategy 2 (v. 2002)** VOC	NOx	SOx
1	--- (-14%)	--- (-38%)	--- (+3%)
2	--- (-14%)	--- (-38%)	--- (-42%)
4a	--- (-14%)	-5%(-40%)	-26%(-57%)
4b	--- (-14%)	-5%(-40%)	-26%(-57%)
4c	--- (-14%)	-7%(-42%)	-41%(-66%)
3a	-12%(-24%)	-5%(-40%)	-26%(-57%)
3b	-16%(-28%)	-5%(-40%)	-26%(-57%)
5	-12%(-24%)	-7%(-42%)	-39%(-64%)

Table 4a. $PM_{2.5}$ Design Values – Sensitivity Runs (2009 base > NAAQS)

		Observed	2009base	2009CAIR	-25% NOx	-25% OC, NOx	-25% SO2	-25% OC, NOx, SO2	-50% OC, NOx	-50% SO2	-50% OC,NOx,SO2
Chicago	170310014	15.6	15.3	14.7	14.4	13.8	14.4	13.5	12.6	14.3	12.1
	170310022	15.9	15.7	15.0	14.8	14.1	14.8	13.8	12.9	14.6	12.4
	170310050	15.5	15.3	14.6	14.3	13.6	14.3	13.4	12.5	14.0	12.0
	170310052	17.1	17.1	16.5	16.3	15.2	16.3	15.1	14.0	16.1	13.5
	170310057	15.6	15.4	14.7	14.5	13.8	14.5	13.5	12.6	14.3	12.1
	170310076	15.5	15.2	14.6	14.3	13.6	14.3	13.4	12.5	14.1	12.0
	170312001	15.6	15.4	14.7	14.4	13.7	14.4	13.5	12.6	14.2	12.1
	170313103	16.0	16.3	15.7	15.5	14.7	15.5	14.4	13.4	15.3	12.4
	170313301	16.0	15.7	15.1	14.8	14.1	14.8	13.8	12.9	13.6	12.3
	170314006	15.3	15.5	15.0	14.8	14.0	14.8	13.8	12.8	14.6	12.3
	170316005	16.4	16.2	15.5	15.2	14.5	15.2	14.2	13.3	15.0	12.7
Granite City	171191007	17.3	16.4	15.6	15.4	14.8	15.4	14.5	13.9	15.2	13.5
	171630010	16.2	15.4	14.6	14.4	13.8	14.4	13.6	13.0	14.2	12.6
Clark County	180190005	16.3	16.1	14.4	14.3	14.1	14.2	13.8	13.7	13.9	13.2
Dubois County	180372001	15.8	15.3	13.5	13.2	13.0	13.1	12.6	12.4	12.9	11.8
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	180970081	16.0	15.7	14.4	14.0	13.4	14.1	13.2	12.3	13.9	11.9
	180970083	16.4	16.0	14.7	14.3	13.7	14.4	13.4	12.6	14.2	12.1
Detroit	261630001	15.9	16.1	15.1	14.8	14.2	14.7	13.8	13.0	14.6	12.5
	261630015	17.3	17.3	16.4	16.1	15.4	16.0	15.0	14.1	15.8	13.5
	261630016	15.4	15.4	14.6	14.3	13.7	14.2	13.3	12.6	14.6	12.0
	261630033	18.9	18.9	17.9	17.6	16.8	17.5	16.4	15.5	17.3	14.9
	261630036	17.8	17.9	17.0	16.6	15.9	16.6	15.5	14.8	16.4	14.0
Butler County	390170003	16.1	15.6	14.1	13.8	13.4	13.8	13.1	12.5	13.6	12.0
	390170016	15.7	15.1	13.4	13.2	12.9	13.1	12.6	12.2	12.9	11.7
Cleveland	390350013	17.3	16.7	15.0	14.7	14.2	14.6	13.8	13.2	14.4	12.6
	390350027	16.7	16.1	14.5	14.2	13.7	14.1	13.3	12.8	13.9	12.2
	390350038	18.4	17.7	16.0	15.7	15.1	15.5	14.7	14.1	15.3	13.4
	390350044	16.7	16.1	14.5	14.3	13.8	14.2	13.4	12.8	14.0	12.2
	390350060	17.5	16.9	15.2	14.9	14.4	14.8	14.0	13.4	14.6	12.8

	390350065	16.1	15.6	14.0	13.8	13.8	13.6	12.9	12.4	13.5	11.8
Columbus	390490024	16.6	16.2	14.3	14.1	13.7	14.0	13.3	12.9	13.8	12.3
	390490025	16.0	15.6	13.8	13.5	13.2	13.5	12.8	12.4	13.3	11.8
	390490081	15.9	15.5	13.8	13.5	13.1	13.4	12.8	12.4	14.6	11.8
Cincinnati	390610014	17.7	17.0	15.2	14.9	14.5	14.9	14.2	13.8	12.9	13.2
	390610040	15.6	15.0	13.3	13.1	12.8	13.1	12.5	12.1	12.6	11.6
	390610042	17.1	16.4	14.6	14.4	14.0	14.3	13.7	13.3	14.1	12.7
	390610043	15.8	15.2	13.5	13.3	12.9	13.2	12.6	12.2	13.0	11.7
	390617001	16.2	15.6	13.9	13.6	13.3	13.6	13.0	12.6	13.4	12.0
	390618001	17.1	16.5	14.7	14.5	14.1	14.4	13.8	13.3	14.2	12.8
Jefferson	390810016	17.9	15.9	13.6	13.4	13.2	13.2	12.8	12.8	13.0	12.2
	390811001	17.5	15.5	13.2	13.0	12.9	12.8	12.5	12.4	12.7	11.9
Lawrence	390870010	15.6	15.0	12.7	12.5	12.3	12.4	12.0	11.9	12.2	11.4
Dayton	391130014	17.9	17.5	15.6	15.3	15.0	15.3	14.6	14.1	15.1	13.5
	391130032	15.7	15.3	13.5	13.2	12.9	13.2	12.6	12.2	13.0	11.6
Scioto	391450013	16.5	16.5	13.7	13.5	13.4	13.3	13.0	13.0	13.1	12.4
Canton	391510017	17.3	17.1	15.0	14.5	14.2	14.2	13.7	13.5	14.0	12.8
	391510020	15.7	15.6	13.3	13.1	12.9	12.9	12.4	12.3	12.7	11.6
Summit	391530017	16.4	16.1	14.0	13.8	13.4	13.6	13.0	12.8	13.4	12.1
	391530023	15.4	15.1	13.1	12.9	12.6	12.7	12.2	12.0	12.5	11.4

Table 4b. Ozone Design Values – Sensitivity Runs (2009 base > NAAQS)

		Observed	2009base	2009CAIR	-25% VOC	-25% NOx	-25% VOC,NOx	-50% VOC	-50% NOx	-50% VOC,NOx
Chicago	170310032	85.3	88.1	88.0	85.3	90.3	87.8	82.6	88.1	84.5
NW Indiana	180892008	88.3	92.9	92.8	90.3	94.8	92.3	87.9	92.6	88.8
	181270024	86.3	85.4	85.3	83.6	84.9	83.2	82.0	81.4	78.7
Holland	260050003	94.0	85.7	85.8	84.6	81.9	81.1	83.4	75.1	74.0
Detroit	260990009	92.3	85.2	85.1	82.9	84.3	82.4	80.6	79.7	76.9
Cleveland	390550004	99.0	90.2	89.8	88.6	85.8	84.9	87.3	79.2	78.1
Kenosha	550590002	96.0	90.1	90.1	88.3	87.8	86.3	86.5	82.0	79.9
	550590019	98.3	92.3	92.3	90.5	90.0	88.4	88.6	83.9	81.9
Ozaukee County	550890009	93.0	86.5	86.5	85.2	82.7	81.7	83.7	75.7	74.5
Racine	551010017	91.7	85.2	85.2	83.8	82.0	80.9	82.3	75.6	74.2
Sheboygan	551170006	97.0	89.6	89.7	88.2	85.3	84.4	86.7	77.9	76.8

Several observations on this figure should be noted:

- Strategy 5 emission reductions are not enough to provide for attainment.
- For Detroit, the results for “on the books” controls are close to attainment. Some additional VOC control (<25%) is needed for attainment.
- For the other cities (Milwaukee, Cleveland, and Chicago), attainment appears to be possible through either local VOC control (albeit at a very high level), regional NOx control, or a combination of local VOC and regional NOx control, as described below.

	Option	Local VOC	Regional NOx
Milwaukee,	(1)	75%	----
Cleveland	(2)	----	30%
	(3)	25%	25%
Detroit	(1)	< 25%	----
Chicago	(1)	> 75%	----
	(2)	----	40%
	(3)	35%	35%

The results for the more significant $PM_{2.5}$ nonattainment monitors are shown in Figure 11. Also shown are the results for Strategy 5.

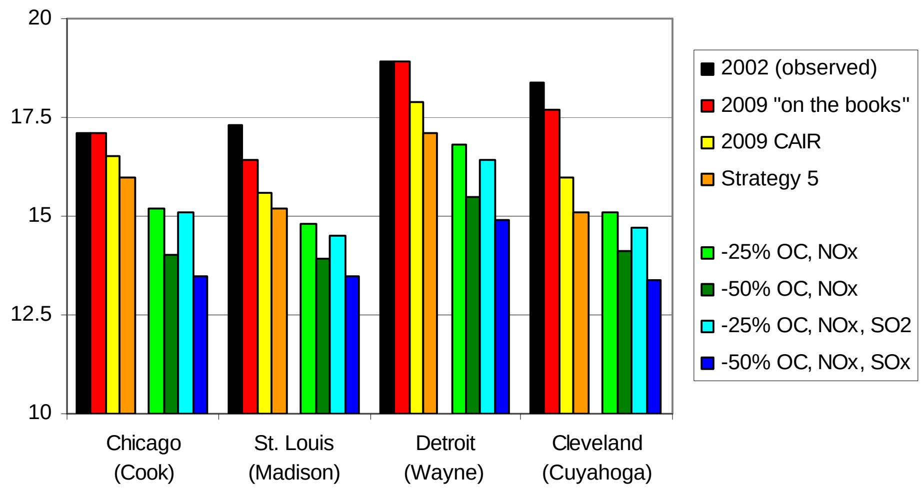

Figure 11. Highest Design Values for $PM_{2.5}$

Several observations on this figure should be noted:

- Strategy 5 emission reductions are not enough to provide for attainment.
- For St. Louis, Cleveland, and Chicago, attainment appears to be possible through local OC and regional NOx control (on the order of 25-30%). With regional SO2 control, a lesser amount of local OC and regional NOx control is needed.

- For Detroit, it appears that a lot more control is needed for attainment (e.g., model says about 50% regional NOx and SOx and local OC). Other local sources are important at the highest monitor (Dearborn) and should also be addressed

Based on these observations, several control options for $PM_{2.5}$ are identified:

	Option	Local OC	NOx	SO2
St. Louis,	(1)	25%	25%	----
Cleveland	(2)	20%	20%	20%
Detroit	(1)	50%	50%	50%
	(2)	30%	30%	30%
		plus additional local source control		
Chicago	(1)	30%	30%	----
	(2)	25%	25%	25%

In light of model performance problems (e.g., overestimation of particulate nitrate during the winter, and underestimation of organic carbon), the model may not accurately represent the amount of OC and NOx reduction needed for attainment. Thus, the estimates above should be viewed with caution.

The seasonal changes by species are shown in Figures 12 and 13. The percentage change, which is consistent with the change in design values, appears to be greatest for OC emission reductions.

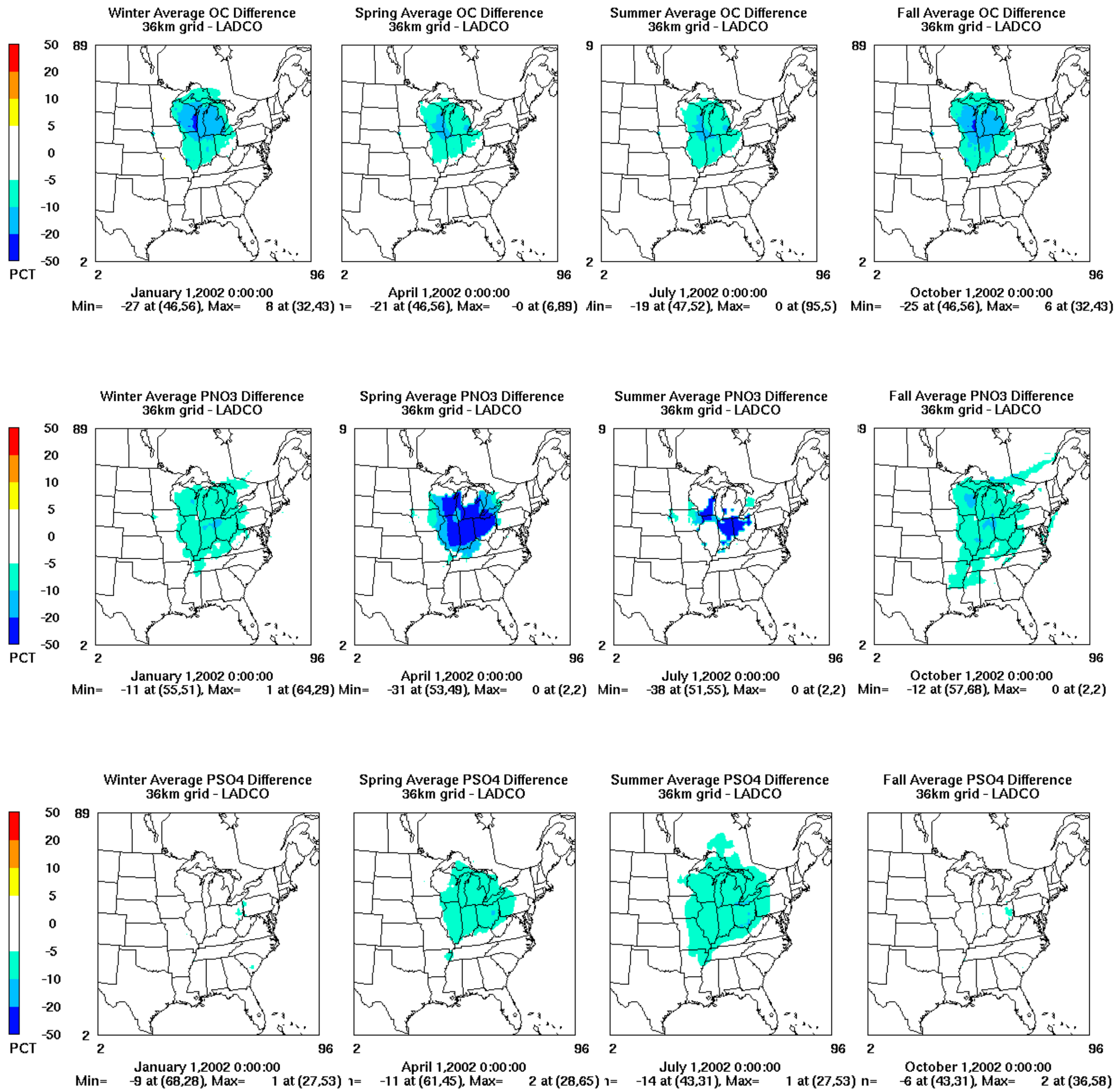

Figure 12. Percentage Change in OC due to 25% cut in primary OC emissions (top), nitrate due to 25% cut in NOx emissions (middle), and sulfate due to 25% cut in SO2 emissions (bottom)

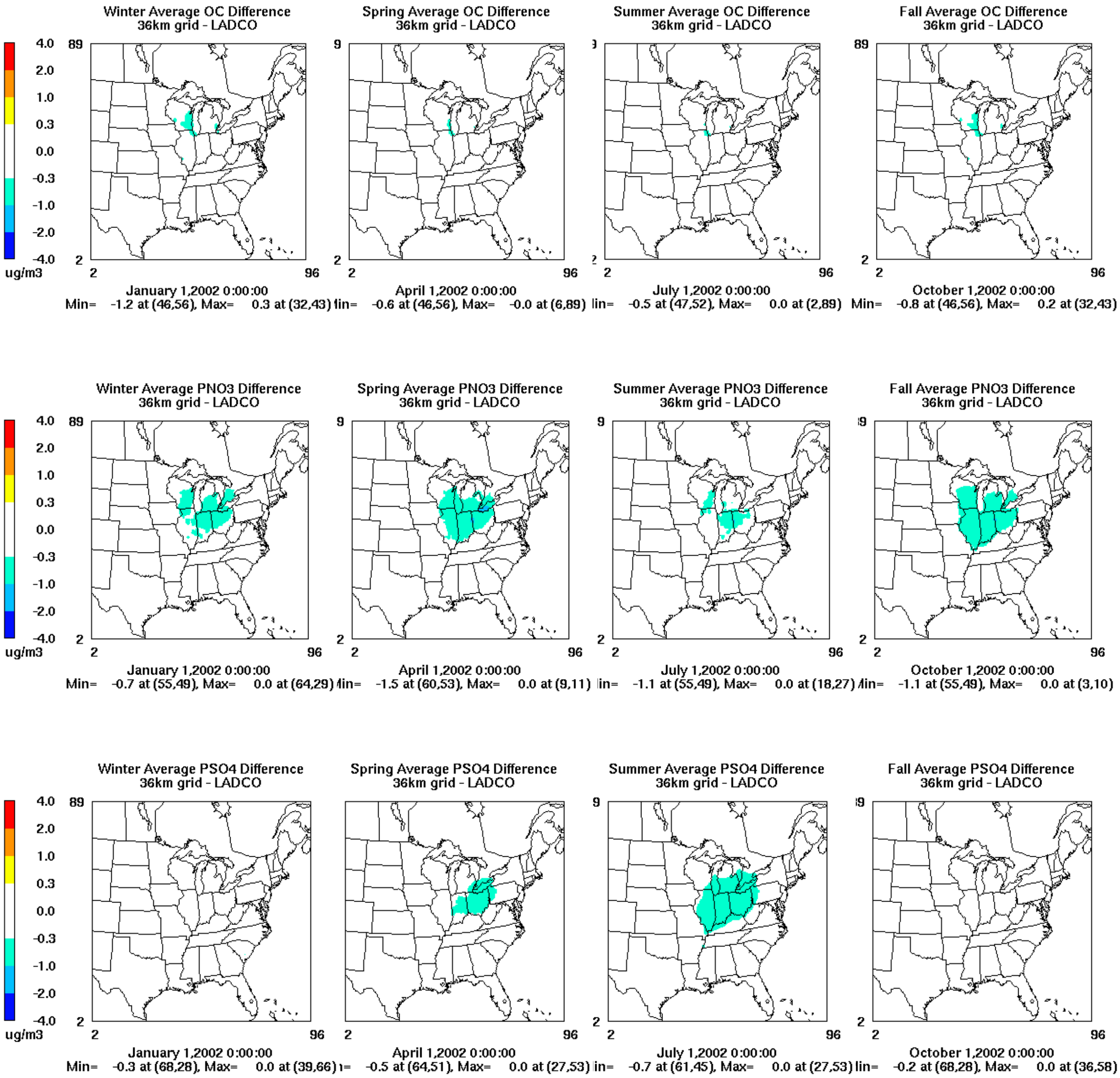

Figure 13. Absolute Change in OC due to 25% cut in primary OC emissions (top), nitrate due to 25% cut in NOx emissions (middle), and sulfate due to 25% cut in SO2 emissions (bottom

Summary
Based on the latest strategy (and sensitivity) modeling, several key findings should be noted:

- “On the books” and “on the way” (CAIR) controls will improve air quality, but are not enough to provide for attainment at all sites.

- Sensitivity analyses indicate that:
  - additional regional NOx control (on the order of 30%) plus (in certain urban areas) local VOC control are needed to attain the ozone standard, and

  - additional regional NOx (and, possibly, SOx) control (on the order of 25%) plus local OC control are needed to attain the $PM_{2.5}$ standard.

- Initial examination of candidate control measures identified several stationary source control measures. These candidate measures provide some, but not all of the necessary emission reduction. Work is on-going to identify other candidate control measures (e.g., controls for mobile sources).

APPENDIX
CANDIDATE CONTROL MEASURES

An initial set of candidate control measures for stationary sources is addressed in “Midwest Regional Planning Organization, Identification and Evaluation of Candidate Control Measures”, April 14, 2005. Based on this information, several control strategies were developed for the Round 2 strategy modeling. A summary of these strategies is provided below.

(1) Beyond-CAIR regional reductions in SO_2 and NO_x emissions for EGUs

Two beyond-CAIR scenarios were identified in “Interim White Paper: Electric Generating Units”, January 14, 2005. The SO_2 and NO_x emission limitations for CAIR and these two scenarios (EGU1 and EGU2) are as follows:

CAIR = 2009/2010	SOx: 0.53 lb/MMBTU	NOx: 0.15 lb/MMBTU
2015	SOx: 0.47 lb/MMBTU	NOx: 0.125 lb/MMBTU
EGU1= 2009	SOx:0.36 lb/MMBTU	NOx: 0.15 lb/MMBTU
2013	SOx:0.15 lb/MMBTU	NOx: 0.10 lb/MMBTU
EGU2= 2009	SOx:0.24 lb/MMBTU	NOx: 0.12 lb/MMBTU
2013	SOx:0.10 lb/MMBTU	NOx: 0.07 lb/MMBTU

The Round 2 analysis considered EGU1 in the 5-state LADCO region and the 13-state MWGA region, and EGU2 in the 5-state LADCO region. A summary of the emissions change, air quality impact, and cost effectiveness of these scenarios is provided below:

Strategy	**Emissions Decrease (TPD)**	**Change in Design Values Ozone (ppb)**	**Change in Design Values $PM_{2.5}$ (ug/m^3)**	**Cost**
EGU1 (5-state)	1445: S02 327: NOx	0.25-0.75	0.5	\$800-\$1500/T: SO2 \$700-\$1600/T: NOx
EGU1 (13-state)	2900: SO2 1164: NOx	0.50-1.50	0.7	
EGU2 (5-state)	2263: SO2 515: NOx	0.50-1.50	0.7	\$800-\$3000/T: SO2 \$700-\$2100/T: NOx

(2) Additional regional reductions in SO_2 and NO_x emissions from non-EGU point sources

Candidate controls for ICI boilers and cement kilns were identified in “Interim White Paper: Industrial, Commercial, and Institutional (ICI) Boilers”, March 29, 2005, and “Interim White Paper: Cement Kilns”, March 29, 2005. The SO_2 and NO_x controls for these source categories are as follows:

ICI1	SO2: -40%	NOx: -60%	medium and large boilers (>100 MMBTU/hr)
ICI2	SO2: -90%	NOx: -80%	boilers subject to BART
ICI3	SO2: -90%	NOx: -80%	medium and large boilers (>100 MMBTU/hr)

KILN1	SO2: -90%	NOx: -50%	all cement kilns
KILN2	SO2: -95%	NOx: -80%	cement kilns subject to BART

The Round 2 analysis considered ICI3 and KILN1. A summary of the emissions change, air quality impact, and cost effectiveness of these scenarios is provided below:

Strategy	Emissions Decrease (TPD)	Change in Design Values Ozone (ppb)	$PM_{2.5}$ (ug/m^3)	Cost
ICI3	674: S02 160: NOx	0.25	0.2	\$1622-\$5219/T: SO2 \$536-\$4493/T: NOx
KILN1	(included above)	(included above)		\$2211-\$6917/T: SO2 \$310-\$2500/T: NOx

(3) Additional local (nonattainment area) reductions in VOC emissions from area sources

Candidate controls for eight area source categories were identified in “Interim White Paper: Industrial Suface Coating”, February 15, 2005, “Interim White Paper: Industrial Solvent Cleaning”, March 14, 2005, “Interim White Paper: Architectural and Maintenance Coatings”, March 3, 2005, “Interim White Paper: Portable Fuel Containers”, February 9, 2005, “Interim White Paper: Auto Body Refinishing”, March 28, 2005, “Interim White Paper: Consumer and Commercial Solvents”, February 9, 2005, “Interim White Paper: Gasoline Distribution Facilities”, April 8, 2005, and “Interim White Paper: Asphalt Paving”, March 28, 2005. The VOC controls for these source categories are as follows:

Ind. Surface Coating	Adopt more stringent RACT (90% reduction from uncontrolled) and lower applicability threshholds
Ind. Solvent Cleaning	Adopt Chicago/Metro East cold cleaning regulations (66% reduction from uncontrolled)
AIM Coatings	Aopdt SCAQMD Phase III VOC limits, in addition to OTC model rule
Portable Fuel Containers	Adopt incentive program to accelerate phase-in of compliant PFCs
Auto Refinish.	Adopt more stringent RACT regulations (89% reduction from uncontrolled)
Cons/Comm. Solvents	Adopt CARB 2003 SIP requirements with additional products and more stringent VOC limits, in addition to OTC odel rule (25% reduction beyond federal Part 59 rule)
Gasoline Disp. Facilities	Require air pollution control devices for UST vents (90%)

Asphalt Paving Adopt SCAQMD 1108.1 VOC content limit for emulsified asphalt (50% reduction)

In addition, a regional fuels strategy was considered:

<u>RFG</u>
Maintain in mandatory areas consisting of 10-county Chicago-Gary-Lake County IL-IN and 6-county Milwaukee-Racine, WI nonattainment areas

Maintain in opt-in areas consisting of Boone, Bullitt (partial), Campbell, Jefferson, Kenton, and Oldham (partial) Counties in Kentucky, and St. Louis, Jefferson, Franklin, and St. Charles Counties in Missouri (see http://www.epa.gov/otaq/rfg/whereyoulive.htm)

Consider extending to rest of the St. Louis, MO-IL nonattainment area (i.e., Jersey, Madison, Monroe, and St. Clair Counties in Illinois)

<u>Low RVP Fuel</u>
7.0 psi in all current ozone nonattainment counties, with two exceptions: (1) do not include nonattainment counties for which states are pursuing redesignations to attainment, and (2) include adjacent attainment counties, if desired by a particular state

The Round 2 analysis considered the VOC controls in two geographic regions (all current ozone nonattainment areas and all current plus adjacent counties) and a regional fuels strategy. A summary of the emissions change, air quality impact, and cost effectiveness of these scenarios is provided below:

	Emissions	**Change in Design Values**			
Strategy	**Decrease (TPD)**	**Ozone (ppb)**	**$PM_{2.5}$ (ug/m^3)**	**Cost**	
VOC controls (NA counties)	562: VOC	0.5	0		
- Ind. Sfc. Coating				$100-$5000/T:	VOC
- Ind. Solv. Cleaning				$1400/T:	VOC
- AIM Coatings				$6400/T:	VOC
- PFCs				$4600/T:	VOC
- Auto Refinishing				$7200/T:	VOC
- Cons/Comm Solv.				$4800:	VOC
- Gasoline Disp. Fac.				$???	
- Asphalt Paving				$???	
VOC controls (NA plus adjacent counties)	822: VOC				
Low RVP fuel	140: VOC			$???: VOC	

(4) Additional local (nonattainment area) reductions in primary OC emissions: Identification of effective control measures for primary OC emissions is deferred pending the results of the urban organics study. Results from this study are expected in mid-2005.