Weight of Evidence Demonstration: Ozone

The purpose of this paper is to summarize a weight of evidence (WOE) demonstration to support development of state implementation plans for ozone. The following analyses were performed as part of the WOE demonstration: attainment modeling, alternative modeling, trends-based projections, observation-based methods, and source apportionment analyses.

Traditionally, ozone attainment demonstrations involved a "bright line" test in which a single modeled value (based on modeling performed in accordance with USEPA guidance) was compared to the ambient standard. To provide a more robust assessment of expected future year air quality, other information should also be considered. This information can be used to help address the following questions:

- Are existing control programs sufficient to provide for attainment?
- If not, then what type of additional controls are needed (e.g., pollutants, source sectors, and source regions)?
- How effective will these additional controls be in improving air quality?

Introduction

According to USEPA's ozone modeling guidance, if the future year modeled design values are "close" to the standard (i.e., 82 – 87 ppb), then a WOE demonstration should be conducted to determine if aggregate supplemental information support the modeling result (see "Guideline on the Use of Models and Other Analyses in Attainment Demonstrations for the 8-hour Ozone NAAQS", October 2005).

Based on LADCO's attainment modeling with existing controls ("on the books" controls, including the Clean Air Interstate Rule), the future year modeled design values for seven major urban areas in the 5-state region are as follows[1]:

Area	2009 OTB/CAIR	2012 OTB/CAIR
Lake Michigan	**92.0**	**90.3**
Cleveland	**88.8**	**86.2**
Indianapolis	83.8	82.1
St. Louis	**85.2**	84.0
Detroit	**85.3**	83.5
Cincinnati	84.7	82.9
Columbus	82.6	80.2

[1] "Base K/Round 4 Modeling: Summary", August 31, 2006

If the modeled design values are above the WOE threshold (i.e., equal to or greater than 88 ppb), as is the case for the Lake Michigan area and Cleveland, then according to USEPA's guidance "it is far less likely that the more qualitative arguments made in a weight of evidence determination can be sufficiently convincing to conclude that the NAAQS will be attained." Assuming, then, that additional controls will be needed in these two areas (and, possibly, other areas with high modeled design values), the supplemental modeling and trends-based information will be developed for these areas to help assess the effectiveness and adequacy of existing and possible additional controls.

Attainment Modeling

The attainment modeling was performed consistent with USEPA modeling guidance. This modeling reflects the following:

Model:	CAMx
Base Year:	2002
Base Year Design Value Calculation:	Average of three 3-year periods including 2002 ('00-'02, '01-'03, '02-'04)
RRF Calculation:	For each monitoring site, use all days with a base year modeled value > 85 ppb. Use lower concentration days (down to 70 ppb), if necessary to get at least 10 days at a site.

The modeling results for existing controls for several high concentration sites in the seven major urban areas are presented in Table 1. Several comments on these results should be noted:

- Existing controls are expected to produce significant improvement in ozone air quality by 2009 and 2012.

- Despite this improvement, several sites in the Lake Michigan area and in northeastern Ohio are projected to still be nonattainment in 2009 and 2012. One site in the Detroit area and one in the St. Louis area are also projected to be above the standard in 2009, but below the standard in 2012.

- The modeling also indicates a few monitors in the Indianapolis, Cincinnati, and Columbus areas to be "close" to (but just below) the standard in 2009 (i.e., within 2-3 ppb).

- A screening run (using mostly interpolated emissions) for 2008 showed that all basic ozone nonattainment areas are projected to be in attainment by their attainment date, with the exception of Indianapolis and Cincinnati.

Alternative Modeling

Alternative modeling analyses were performed with the following different model assumptions:

(1) Different Base Year Design Value Calculation: Three other approaches were used to calculate the monitoring-based base year design value (2002 base year)
    - 3-year period centered on base year ('01-'03)
    - 3-year period centered on base year with met-adjusted concentrations ('01-'03)
    - 5-year period centered on base year ('00-'04)

(2) Different RRF Calculation: Two other approaches were used to calculate the relative reduction factors:
   - Use all days with a base year modeled value > 70 ppb
   - Use all days with a base year modeled value > 85 ppb, with at least 10 days and "acceptable" model performance

(3) Different Base Year: A more recent base year (2003) was used to reflect more current air quality data[2].

The results for several high concentration sites in the seven major urban areas are also presented in Table 1. Several comments on these results should be noted:

- The different modeling assumptions produce 13 new estimates of future year ozone concentrations. The highest estimates are associated with base year design values representing the 3-year average for 2001-2003, whereas the lowest estimates are associated with base year design values representing the 5-year average of 2000-2004. The different RRF approaches produce little change in future year ozone concentrations. This suggests that future year concentration estimates are most sensitive to methodology used to derive the base year design values.

- The 2003 base year results are qualitatively similar to the 2002 base year results, but tend to be slightly lower (e.g., Chiwaukee 2009 ozone value = 91.9 ppb (2002) v. 89.1 ppb (2003)). This is due to slightly lower base year design values (e.g., Chiwaukee base year design value = 98.3 v. 93.7 ppb).

Trends-Based Projections

USEPA's modeling guidance notes that while air quality models are generally the most appropriate tools for assessing the expected impacts of a change in emissions, it may also be possible to extrapolate future trends based on measured historical trends of air quality and emissions. To do so, USEPA's guidance suggests that ambient trends should be normalized to account for year-to-year variations in meteorological conditions, actual VOC and NOx emissions should be known for the given area and the relevant surrounding area, and a conceptual model of ozone formation is needed (e.g., VOC- v. NOx-limited conditions)[3].

Meterologically-adjusted 4th high 8-hour ozone concentrations were derived using an air quality – meteorological statistical model developed by USEPA (i.e., Cox method)[4]. This method uses

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[2] Work is underway for a 2005 base year. The results of this additional base year analysis will be available later this year.

[3] Further discussion of the use of ambient trends is provided in "Recommended Approach for Performing Mid-Course Review of SIPs to Meet the 1-Hour NAAQS for Ozone" (January 2002).

[4] Another technique for examining the relationship between ozone levels and meteorology is a Classification and Regression Tree (CART) analysis. In a CART analysis, days are grouped (binned) by similar meteorological conditions. Although this method can be used to assess the change in average ozone concentrations over time for each bin (thereby, reflecting the met-adjusted trends), it does not provide a 4th high ozone concentration which is needed to represent an ozone design value.

a statistical model to "remove" the annual effect of meteorology on ozone and allows for a non-linear trend over a multi-year period. A generalized linear model is prepared to relate daily peak ozone levels to four meteorological variables: daily peak 1-hour temperature, midday average relative humidity, morning and afternoon wind speed and wind direction, and morning mixing heights.

The historical trend in these met-adjusted ozone concentrations can be extrapolated to estimate future year ozone concentrations. Four extrapolation approaches were used: straight-line or emissions-weighted with either a 1995 or 1998 start year. The emissions-weighted trend is referred to as proportional extrapolation in USEPA's guidance. This approach accounts for differences in historical and future emissions changes. Both VOC and NOx emissions affect ozone concentrations. Given that observation-based methods (see below) show that urban areas in the region are generally VOC-limited and rural areas in the region are NOx-limited, urban VOC emissions and regional (i.e., statewide) NOx emissions are considered important.

The VOC and NOx emissions, and ozone concentrations for the areas of interest are provided in Appendix I. The resulting extrapolated future year ozone concentrations are presented in Table 2. Several comments on these results should be noted:

- Trends-based values are generally higher than the modeled-based values.
- Assuming a more recent start year (1998) generally results in lower future year values than those based on the earlier start year (1995).
- Emissions-weighted trends values are higher than straight-line trends values, as expected given that future year emissions trends are generally flatter than historical emissions trends.

Figures 1a and 1b summarize the modeled and trends-based future year ozone concentrations for "on the books" controls for several sites in the Lake Michigan, Detroit, Indianapolis, and Cleveland areas. The modeled EPA guideline value is represented by a large red diamond, the alternative modeled values by small black circles, and the trends-based values by small green squares.

Observation-Based Methods

Ambient measurements of ozone and ozone precursor concentrations were analyzed to characterize where and when ozone formation is VOC- or NOx-limited. This analysis used the Smog Production algorithm (see "VOC and NOx Limitation of Ozone Formation at Monitoring Sites in Illinois, Indiana, Michigan, Missouri, Ohio, and Wisconsin, 1998-2002", February 24, 2003, and "Corroborative Evidence for Pursuing Effective Ozone Precursor Emission Reductions in the U.S.", October 6, 1999). The results indicate a pattern of VOC-limited conditions within most urban areas and NOx-limited conditions in rural areas.

Source Apportionment

Ozone culpability analyses were performed to provide information on source sector and source region contributions (see "Ozone Culpability Analyses", August 31, 2006). Key findings from these analyses are as follows:

- On-road and nonroad NOx emissions generally have the largest contribution at most of the key monitor locations (i.e., > 15% each). EGU and non-EGU NOx emissions are also important contributors (i.e., > 10% each). The source group contributions vary by area due to emissions inventory differences.

- In the two ozone residual nonattainment areas (i.e., Lake Michigan area and northeastern Ohio), the geographic regions with the highest impacts are the Chicago nonattainment counties (25 – 40% contribution in Lake Michigan area), and Cleveland nonattainment counties and other Ohio counties (20-30% and about 15% contribution, respectively, in northeastern Ohio).

- The results at 36 km and 12 km are similar, although the local area contribution is somewhat greater in the 12 km modeling.

Summary

Air quality modeling and other supplemental analyses were performed to estimate future year ozone concentrations. These analyses include modeling performed in accordance with USEPA guidance, modeling performed using alternative assumptions, and monitoring trends-based analyses. Based on this information, several findings should be noted:

- Are existing control programs sufficient to provide for attainment?

  Existing controls are expected to produce significant improvement in ozone air quality, but will not be enough to provide for attainment at all monitoring sites in the Lake Michigan and northeastern Ohio moderate nonattainment areas by their attainment date of 2010. All marginal nonattainment areas and all basic nonattainment areas are expected to attain by their attainment dates, except, possibly, ……..(??????????)

- If not, then what type of additional controls are needed (e.g., pollutants, source sectors, and source regions)?

- How effective will these additional controls be in improving air quality?

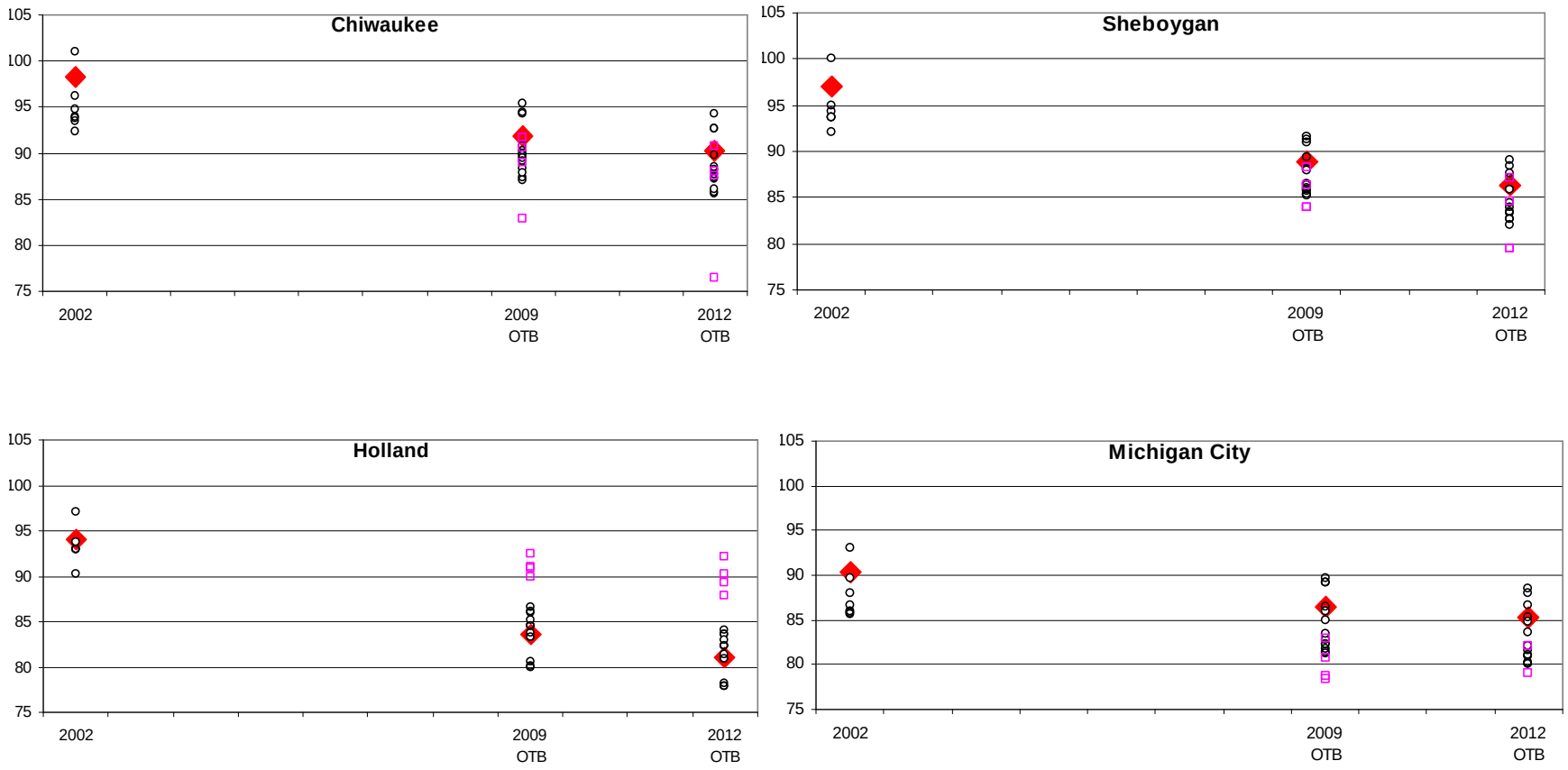

Figure 1a. Modeling and Trends-Based Estimates of Future Year Ozone Concentrations – Lake Michigan Area

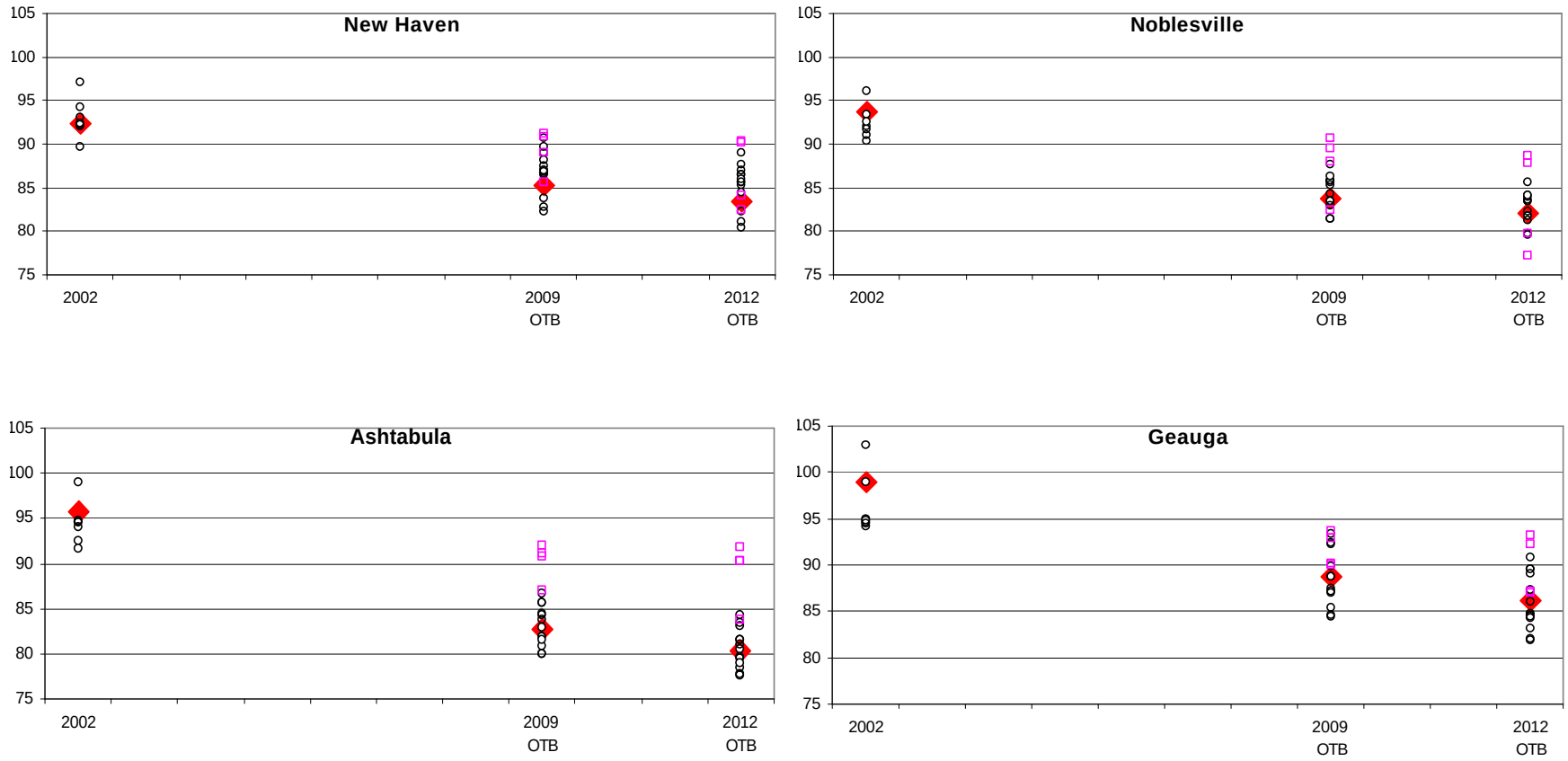

Figure 1b. Modeling and Trends-Based Estimates of Future Year Ozone Concentrations – Detroit (upper left hand plot), Indianapolis (upper right hand plot), and Cleveland (lower two plots)

2009 Modeling Results	Lake Michigan Area										Cleveland Area				
	Chiwaukee	Kenosha	Racine	S. Milwaukee	Milw-Bayside	Harr.Beach	Sheboygan	Holland	Hammond	MichiganCity	Ashtabula	Geauga	Eastlake	Portage	Summit
	550590019	550590002	551010017	550791025	550790085	550890009	551170006	260050003	180892008	180910005	390071001	390550004	390850003	391331001	391530020
Attainment Test (based on EPA guidance-2002 baseyear)															
Base Year Design Value (average of three 3-year periods)	*98.3*	*96.0*	*91.7*	*91.0*	*91.0*	*93.0*	*97.0*	*94.0*	*88.3*	*90.3*	*95.7*	*99.0*	*92.7*	*91.0*	*93.3*
RRF (all days > 85 ppb, or at least 10 days)	0.935	0.935	0.926	0.933	0.925	0.918	0.916	0.888	0.980	0.958	0.865	0.897	0.894	0.873	0.872
Future Year Design Value	**91.9**	**89.8**	84.9	84.9	84.2	**85.4**	**88.9**	83.5	**86.5**	**86.5**	82.8	**88.8**	82.9	79.4	81.4
Weight of Evidence (alternative approaches-2002baseyear)															
Alt 1 - Base Year Des. Value (3-year period centered on 2002)	*101.0*	*97.0*	*95.0*	*94.0*	*94.0*	*98.0*	*100.0*	*97.0*	*90.0*	*93.0*	*99.0*	*103.0*	*95.0*	*93.0*	*96.0*
Alt 2 - Base Year Des. Value (3-year period centered on 2002 w/ met adj.)	*96.1*	*92.7*	*89.0*	*90.1*	*91.3*	*89.3*	*94.3*	*93.8*	*92.4*	*89.7*	*94.6*	*99*	*98.2*	*95.9*	*95.9*
Alt 3 - Base Year Des. Value (5-year period centered on 2002)	*93.4*	*93.0*	*86.4*	*88.7*	*88.0*	*90.6*	*93.6*	*90.2*	*85.0*	*85.8*	*92.4*	*94.2*	*89.4*	*89.4*	*90.2*
RRF (2002 baseyear) (all days > 85 ppb, or at least 10 days)	0.935	0.935	0.926	0.933	0.925	0.918	0.916	0.888	0.980	0.958	0.865	0.897	0.894	0.873	0.872
Alt 1 - Future Year Projected Value	**94.4**	**90.7**	**88.0**	**87.7**	**87.0**	**90.0**	**91.6**	**86.1**	**88.2**	**89.1**	**85.6**	**92.4**	84.9	81.2	83.7
Alt 2 - Future Year Projected Value	**89.9**	**86.7**	82.4	84.1	84.5	82.0	**86.4**	83.3	**90.6**	**85.9**	81.8	**88.8**	**87.8**	83.7	83.6
Alt 3 - Future Year Projected Value	**87.3**	**87.0**	80.0	82.8	81.4	83.2	**85.7**	80.1	83.3	82.2	79.9	84.5	79.9	78.0	78.7
Alt 1 - RRF (all days > 70 ppb)	0.933	0.933	0.920	0.945	0.932	0.918	0.912	0.893	0.969	0.947	0.876	0.907	0.900	0.884	0.882
Alt 1 - Future Year Projected Value	**94.2**	**90.5**	**87.4**	**88.8**	**87.6**	**90.0**	**91.2**	**86.6**	**87.2**	**88.1**	**86.7**	**93.4**	**85.5**	82.2	84.7
Alt 2 - Future Year Projected Value	**89.7**	**86.5**	81.9	***85.1***	***85.1***	82.0	**86.0**	83.8	**89.5**	84.9	82.9	**89.8**	**88.4**	84.8	84.6
Alt 3 - Future Year Projected Value	**87.1**	**86.8**	79.5	83.8	82.0	83.2	**85.4**	80.5	82.4	81.3	80.9	**85.4**	80.5	79.0	79.6
Alt 2 - RRF (all days > 85 ppb, or at least 10 days; with acceptable model performance)	0.945	0.949	0.926	0.935	0.911	0.904	0.910	0.887	0.976	0.964	0.866	0.896	0.894	0.870	0.871
Alt 1 - Future Year Projected Value	**95.4**	**92.1**	**88.0**	**87.9**	**85.6**	**88.6**	**91.0**	**86.0**	**87.8**	**89.7**	**85.7**	**92.3**	84.9	80.9	83.6
Alt 2 - Future Year Projected Value	**90.8**	**88.0**	82.4	84.2	83.2	80.7	***85.8***	83.2	**90.2**	**86.5**	81.9	**88.7**	**87.8**	83.4	83.5
Alt 3 - Future Year Projected Value	**88.3**	**88.3**	80.0	82.9	80.2	81.9	**85.2**	80.0	83.0	82.7	80.0	84.4	79.9	77.8	78.6
Weight of Evidence (alternative approaches-2003baseyear)															
Alt 0 - Base Year Des. Value (average of three 3-year periods centered on 2003)	*93.7*	*discontinued after 2003*	*88.0*	*discontinued after 2003*	*89.3*	*91.3*	*93.7*	*93.0*	*83.7*	*85.7*	*94.7*	*94.7*	*91.7*	*90.0*	*90.0*
Alt 1 - Base Year Des. Value (3-year period centered on 2003)	*94.0*	*discontinued after 2003*	*87.0*	*discontinued after 2003*	*88.0*	*88.0*	*92.0*	*93.0*	*83.0*	*86.0*	*94.0*	*95.0*	*91.0*	*89.0*	*89.0*
Alt 2 - Base Year Des. Value (3-year period centered on 2003 w/ met adj.)	*92.3*	*discontinued after 2003*	*86.9*	*discontinued after 2003*	*89.2*	*84.6*	*93.6*	*93.7*	*88.8*	*87.9*	*91.6*	*94.6*	*95.9*	*96.0*	*91.2*
Alt 3 - Base Year Des. Value (5-year period centered on 2003)	*94.8*	*discontinued after 2003*	*89.8*	*discontinued after 2003*	*90.0*	*92.2*	*95.0*	*93.0*	*85.2*	*86.6*	*94.6*	*94.4*	*92.2*	*90.8*	*91.2*
RRF (2003 base year) (all days > 85 ppb, or at least 10 days)	0.951		0.949		0.953	0.950	0.940	0.909	0.961	0.950	0.891	0.921	0.915	0.881	0.904
Alt 0 - Future Year Projected Value	**89.1**		83.5		**85.1**	**86.7**	**88.1**	84.5	80.4	81.4	84.4	**87.2**	83.9	79.3	81.4
Alt 1 - Future Year Projected Value	**89.4**		82.6		83.9	83.6	**86.5**	84.5	79.8	81.7	83.8	**87.5**	83.3	78.4	80.5
Alt 2 - Future Year Projected Value	**87.8**		82.5		85.0	80.4	88.0	85.2	**85.3**	83.5	81.6	87.1	**87.7**	84.6	82.4
Alt 3 - Future Year Projected Value	**90.2**		**85.2**		**85.8**	**87.6**	**89.3**	84.5	81.9	82.3	84.3	**86.9**	84.4	80.0	82.4

2012 Modeling Results	Lake Michigan Area										Cleveland Area				
	Chiwaukee	Kenosha	Racine	S. Milwaukee	Milw-Bayside	Harr.Beach	Sheboygan	Holland	Hammond	MichiganCity	Ashtabula	Geauga	Eastlake	Portage	Summit
	550590019	550590002	551010017	550791025	550790085	550890009	551170006	260050003	180892008	180910005	390071001	390550004	390850003	391331001	391530020
Attainment Test (based on EPA guidance-2002 baseyear)															
Base Year Design Value (average of three 3-year periods)	*98.3*	*96.0*	*91.7*	*91.0*	*91.0*	*93.0*	*97.0*	*94.0*	*88.3*	*90.3*	*95.7*	*99.0*	*92.7*	*91.0*	*93.3*
RRF (all days > 85 ppb, or at least 10 days)	0.918	0.918	0.905	0.906	0.904	0.892	0.890	0.862	0.977	0.945	0.839	0.87	0.87	0.84	0.842
Future Year Design Value	**90.2**	**88.1**	83.0	82.4	82.3	83.0	**86.3**	81.0	**86.3**	**85.3**	80.3	**86.1**	80.6	76.4	78.6
Weight of Evidence (alternative approaches-2002baseyear)															
Alt 1 - Base Year Des. Value (3-year period centered on 2002)	*101.0*	*97.0*	*95.0*	*94.0*	*94.0*	*98.0*	*100.0*	*97.0*	*90.0*	*93.0*	*99.0*	*103.0*	*95.0*	*93.0*	*96.0*
Alt 2 - Base Year Des. Value (3-year period centered on 2002 w/ met adj.)	*96.1*	*92.7*	*89.0*	*90.1*	*91.3*	*89.3*	*94.3*	*93.8*	*92.4*	*89.7*	*94.6*	*99*	*98.2*	*95.9*	*95.9*
Alt 3 - Base Year Des. Value (5-year period centered on 2002)	*93.4*	*93.0*	*86.4*	*88.7*	*88.0*	*90.6*	*93.6*	*90.2*	*85.0*	*85.8*	*92.4*	*94.2*	*89.4*	*89.4*	*90.2*
RRF (2002 baseyear) (all days > 85 ppb, or at least 10 days)	0.918	0.918	0.905	0.906	0.904	0.892	0.890	0.862	0.977	0.945	0.839	0.87	0.87	0.84	0.842
Alt 1 - Future Year Projected Value	**92.7**	**89.0**	**86.0**	**85.2**	**85.0**	**87.4**	**89.0**	83.6	**87.9**	**87.9**	83.1	**89.6**	82.7	78.1	80.8
Alt 2 - Future Year Projected Value	**88.2**	**85.1**	80.5	81.6	82.5	79.7	83.9	80.9	***90.3***	84.8	79.4	**86.1**	**85.4**	80.6	80.7
Alt 3 - Future Year Projected Value	**85.7**	**85.4**	78.2	80.4	79.6	80.8	83.3	77.8	83.0	81.1	77.5	82.0	77.8	75.1	75.9
Alt 1 - RRF (all days > 70 ppb)	0.917	0.917	0.896	0.920	0.909	0.888	0.876	0.867	0.964	0.932	0.850	0.882	0.876	0.853	0.852
Alt 1 - Future Year Projected Value	**92.6**	**88.9**	**85.1**	**86.5**	**85.4**	**87.0**	**87.6**	84.1	**86.8**	**86.7**	84.2	**90.8**	83.2	79.3	81.8
Alt 2 - Future Year Projected Value	**88.1**	85.0	79.7	82.9	83.0	79.3	82.6	81.3	**89.1**	83.6	80.4	**87.3**	**86.0**	81.8	81.7
Alt 3 - Future Year Projected Value	**85.6**	**85.3**	77.4	81.6	80.0	80.5	82.0	78.2	81.9	80.0	78.5	83.1	78.3	76.3	76.9
Alt 2 - RRF (all days > 85 ppb, or at least 10 days; with acceptable model performance)	0.934	0.930	0.902	0.907	0.884	0.870	0.884	0.862	0.970	0.950	0.842	0.869	0.871	0.838	0.841
Alt 1 - Future Year Projected Value	**94.3**	**90.2**	**85.7**	**85.3**	83.1	**85.3**	**88.4**	83.6	**87.3**	**88.4**	83.4	**89.5**	82.7	77.9	80.7
Alt 2 - Future Year Projected Value	**89.8**	**86.2**	80.3	81.7	80.7	77.7	83.4	80.9	**89.6**	**85.2**	79.7	**86.0**	**85.5**	80.4	80.7
Alt 3 - Future Year Projected Value	**87.2**	**86.5**	77.9	80.5	77.8	78.8	82.7	77.8	82.5	81.5	77.8	81.9	77.9	74.9	75.9
Weight of Evidence (alternative approaches-2003baseyear)															
Alt 0 - Base Year Des. Value (average of three 3-year periods centered on 2003)	*93.7*	*discontinued after 2003*	*88.0*	*discontinued after 2003*	*89.3*	*91.3*	*93.7*	*93.0*	*83.7*	*85.7*	*94.7*	*94.7*	*91.7*	*90.0*	*90.0*
Alt 1 - Base Year Des. Value (3-year period centered on 2003)	*94.0*	*discontinued after 2003*	*87.0*	*discontinued after 2003*	*88.0*	*88.0*	*92.0*	*93.0*	*83.0*	*86.0*	*94.0*	*95.0*	*91.0*	*89.0*	*89.0*
Alt 2 - Base Year Des. Value (3-year period centered on 2003 w/ met adj.)	*92.3*	*discontinued after 2003*	*86.9*	*discontinued after 2003*	*89.2*	*84.6*	*93.6*	*93.7*	*88.8*	*87.9*	*91.6*	*94.6*	*95.9*	*96.0*	*91.2*
Alt 3 - Base Year Des. Value (5-year period centered on 2003)	*94.8*	*discontinued after 2003*	*89.8*	*discontinued after 2003*	*90.0*	*92.2*	*95.0*	*93.0*	*85.2*	*86.6*	*94.6*	*94.4*	*92.2*	*90.8*	*91.2*
RRF (2003 base year) (all days > 85 ppb, or at least 10 days)	0.932		0.926		0.934	0.926	0.917	0.885	0.947	0.934	0.862	0.892	0.888	0.841	0.870
Alt 0 - Future Year Projected Value	**87.3**		81.5		83.4	84.5	**85.9**	82.3	79.3	80.0	81.6	84.5	81.4	75.7	78.3
Alt 1 - Future Year Projected Value	**87.6**		80.6		82.2	81.5	84.4	82.3	78.6	80.3	81.0	84.7	80.8	74.8	77.4
Alt 2 - Future Year Projected Value	**86.0**		80.5		83.3	78.3	**85.8**	82.9	84.1	82.1	79.0	84.4	**85.2**	80.7	79.3
Alt 3 - Future Year Projected Value	**88.4**		83.2		84.1	**85.4**	**87.1**	82.3	80.7	80.9	81.5	84.2	81.9	76.4	79.3

2009 Modeling Results	Indianapolis Area				Detroit Area		Cincinnati Area			Columbus	St. Louis Area	
	Noblesville	Fortville	Indy-Harrison	Fairland	New Haven	Warren	Hamlton	Wilmington	Sycamore	New Albany	W. Alton	OrchardFarm
	180571001	18059003	180970050	181450001	260990009	260991003	390172004	390271002	390610006	390490029	291831002	291831004
Attainment Test (based on EPA guidance-2002 baseyear)												
Base Year Design Value (average of three 3-year periods)	*93.7*	*91.3*	*90.0*	*91.3*	*92.3*	*90.0*	*89.7*	*94.3*	*90.3*	*93.0*	*90.0*	*90.0*
RRF (all days > 85 ppb, or at least 10 days)	0.894	0.918	0.930	0.907	0.924	0.926	0.919	0.885	0.938	0.888	0.947	0.914
Future Year Design Value	83.8	83.8	83.7	82.8	**85.3**	83.3	82.4	83.5	84.7	82.6	**85.2**	82.3
Weight of Evidence (alternative approaches-2002baseyear)												
Alt 1 - Base Year Des. Value (3-year period centered on 2002)	*96.0*	*94.0*	*92.0*	*94.0*	*97.0*	*95.0*	*92.0*	*96.0*	*93.0*	*95.0*	*91.0*	*92.0*
Alt 2 - Base Year Des. Value (3-year period centered on 2002 w/ met adj.)	*93.4*	*93.7*	*90.5*		*94.2*	*95.6*			*91.9*			
Alt 3 - Base Year Des. Value (5-year period centered on 2002)	*91.0*	*88.0*	*86.8*	*88.2*	*89.6*	*86.2*	*86.8*	*92.6*	*87.6*	*91.2*	*88*	*87.6*
RRF (2002 baseyear) (all days > 85 ppb, or at least 10 days)	0.894	0.918	0.930	0.907	0.924	0.926	0.929	0.885	0.938	0.888	0.947	0.914
Alt 1 - Future Year Projected Value	**85.8**	**86.3**	**85.6**	**85.3**	**89.6**	**88.0**	**85.5**	**85.0**	**87.2**	84.4	**86.2**	84.1
Alt 2 - Future Year Projected Value	83.5	**86.0**	84.2		**87.0**	**88.5**			**86.2**			
Alt 3 - Future Year Projected Value	81.4	80.8	80.7	80.0	82.8	79.8	80.6	82.0	82.2	81.0	83.3	80.1
Alt 1 - RRF (all days > 70 ppb)	0.912	0.907	0.926	0.905	0.918	0.927	0.918	0.885	0.940	0.901	0.945	0.911
Alt 1 - Future Year Projected Value	**87.6**	**85.3**	**85.2**	**85.1**	**89.0**	**88.1**	84.5	**85.0**	**87.4**	**85.6**	**86.0**	83.8
Alt 2 - Future Year Projected Value	**85.2**	**85.0**	83.8		**86.5**	**88.6**			**86.4**			
Alt 3 - Future Year Projected Value	83.0	79.8	80.4	79.8	82.3	79.9	79.7	82.0	82.3	82.2	83.2	79.8
Alt 2 - RRF (all days > 85 ppb, or at least 10 days; with acceptable model performance)	0.894	0.916	0.932	0.910	0.935	0.930	0.921	0.880	0.940	0.886	0.951	0.913
Alt 1 - Future Year Projected Value	**85.8**	**86.1**	**85.7**	**85.5**	**90.7**	**88.4**	84.7	84.5	**87.4**	84.2	**86.5**	84.0
Alt 2 - Future Year Projected Value	83.5	**85.8**	84.3		**88.1**	**88.9**			**86.4**			
Alt 3 - Future Year Projected Value	81.4	80.6	80.9	80.3	83.8	80.2	79.9	81.5	82.3	80.8	83.7	80.0
Weight of Evidence (alternative approaches-2003baseyear)												
Alt 0 - Base Year Des. Value (average of three 3-year periods centered on 2003)	*91.7*	*87.7*	*87.0*	*87.0*	*93.0*	*90.0*	*88.7*	*90.7*	*89.3*	*91.3*	*88.3*	*88.6*
Alt 1 - Base Year Des. Value (3-year period centered on 2003)	*92.0*	*88.0*	*88.0*	*87.0*	*92.0*	*88.0*	*89.0*	*91.0*	*89.0*	*91.0*	*89.0*	*88.0*
Alt 2 - Base Year Des. Value (3-year period centered on 2003 w/ met adj.)	*92.5*	*91.5*	*89.1*		*92.4*	*93.0*			*91.7*			
Alt 3 - Base Year Des. Value (5-year period centered on 2003)	*90.4*	*86.8*	*86.2*	*86.8*	*92.2*	*89.4*	*87.6*	*89.8*	*89.2*	*91.4*	*88.2*	*88.8*
												0.9
RRF (2003 base year) (all days > 85 ppb, or at least 10 days)	0.933	0.944	0.945	0.931	0.941	0.971	0.921	0.892	0.933	0.901	0.953	0.941
Alt 0 - Future Year Projected Value	**85.6**	82.8	82.2	81.0	**87.5**	**87.4**	81.7	80.9	83.3	82.3	84.1	83.4
Alt 1 - Future Year Projected Value	**85.8**	83.1	83.2	81.0	**86.6**	**85.4**	82.0	81.2	83.0	82.0	84.8	82.8
Alt 2 - Future Year Projected Value	**86.3**	**86.4**	84.2		**86.9**	**90.3**			**85.6**			
Alt 3 - Future Year Projected Value	84.3	81.9	81.5	80.8	**86.8**	**86.8**	80.7	80.1	83.2	82.4	84.1	83.6

2012 Modeling Results	Indianapolis Area				Detroit Area		Cincinnati Area			Columbus	St. Louis Area	
	Noblesville	Fortville	Indy-Harrison	Fairland	New Haven	Warren	Hamlton	Wilmington	Sycamore	New Albany	W. Alton	OrchardFarm
	180571001	18059003	180970050	181450001	260990009	260991003	390170004	390271002	390610006	390490029	291831002	291831004
Attainment Test (based on EPA guidance-2002 baseyear)												
Base Year Design Value (average of three 3-year periods)	*93.7*	*91.3*	*90.0*	*91.3*	*92.3*	*90.0*	*89.7*	*94.3*	*90.3*	*93.0*	*90.0*	*90.0*
RRF (all days > 85 ppb, or at least 10 days)	0.876	0.899	0.915	0.887	0.904	0.910	0.895	0.859	0.918	0.863	0.934	0.893
Future Year Design Value	82.1	82.1	82.4	81.0	83.4	81.9	80.3	81.0	82.9	80.3	84.1	80.4
Weight of Evidence (alternative approaches-2002baseyear)												
Alt 1 - Base Year Des. Value (3-year period centered on 2002)	*96.0*	*94.0*	*92.0*	*94.0*	*97.0*	*95.0*	*92.0*	*96.0*	*93.0*	*95.0*	*91.0*	*92.0*
Alt 2 - Base Year Des. Value (3-year period centered on 2002 w/ met adj.)	*93.4*	*93.7*	*90.5*		*94.2*	*95.6*			*91.9*			
Alt 3 - Base Year Des. Value (5-year period centered on 2002)	*91.0*	*88.0*	*86.8*	*88.2*	*89.6*	*86.2*	*86.8*	*92.6*	*87.6*	*91.2*	*88*	*87.6*
RRF (2002 baseyear) (all days > 85 ppb, or at least 10 days)	0.876	0.899	0.915	0.887	0.904	0.910	0.895	0.859	0.918	0.863	0.934	0.893
Alt 1 - Future Year Projected Value	84.1	84.5	84.2	83.4	**87.7**	**86.5**	82.3	82.5	**85.4**	82.0	**85.0**	82.2
Alt 2 - Future Year Projected Value	81.8	84.2	82.8		**85.2**	**87.0**			84.4			
Alt 3 - Future Year Projected Value	79.7	79.1	79.4	78.2	81.0	78.4	77.7	79.5	80.4	78.7	82.2	78.2
Alt 1 - RRF (all days > 70 ppb)	0.893	0.888	0.914	0.888	0.897	0.914	0.900	0.861	0.926	0.878	0.932	0.891
Alt 1 - Future Year Projected Value	**85.7**	83.5	84.1	83.5	**87.0**	**86.8**	82.8	82.7	**86.1**	83.4	84.8	82.0
Alt 2 - Future Year Projected Value	**83.4**	83.2	82.7		**84.5**	**87.4**			**85.1**			
Alt 3 - Future Year Projected Value	81.3	78.1	79.3	78.3	80.4	78.8	78.1	79.7	81.1	80.1	82.0	78.1
Alt 2 - RRF (all days > 85 ppb, or at least 10 days; with acceptable model performance)	0.875	0.897	0.916	0.888	0.918	0.913	0.900	0.855	0.921	0.862	0.937	0.893
Alt 1 - Future Year Projected Value	84.0	84.3	84.3	83.5	**89.0**	**86.7**	82.8	82.1	**85.7**	81.9	**85.3**	82.2
Alt 2 - Future Year Projected Value	81.7	84.0	82.9		**86.5**	**87.3**			84.6			
Alt 3 - Future Year Projected Value	79.6	78.9	79.5	78.3	82.3	78.7	78.1	79.2	80.7	78.6	82.5	78.2
Weight of Evidence (alternative approaches-2003baseyear)												
Alt 0 - Base Year Des. Value (average of three 3-year periods centered on 2003)	*91.7*	*87.7*	*87.0*	*87.0*	*93.0*	*90.0*	*88.7*	*90.7*	*89.3*	*91.3*	*88.3*	*88.6*
Alt 1 - Base Year Des. Value (3-year period centered on 2003)	*92.0*	*88.0*	*88.0*	*87.0*	*92.0*	*88.0*	*89.0*	*91.0*	*89.0*	*91.0*	*89.0*	*88.0*
Alt 2 - Base Year Des. Value (3-year period centered on 2003 w/ met adj.)	*92.5*	*91.5*	*89.1*		*92.4*	*93.0*			*91.7*			
Alt 3 - Base Year Des. Value (5-year period centered on 2003)	*90.4*	*86.8*	*86.2*	*86.8*	*92.2*	*89.4*	*87.6*	*89.8*	*89.2*	*91.4*	*88.2*	*88.8*
RRF (2003 base year) (all days > 85 ppb, or at least 10 days)	0.909	0.923	0.927	0.909	0.930	0.968	0.896	0.862	0.911	0.873	0.940	0.918
Alt 0 - Future Year Projected Value	83.4	80.9	80.6	79.1	**86.5**	**87.1**	79.5	78.2	81.4	79.7	83.0	81.3
Alt 1 - Future Year Projected Value	83.6	81.2	81.6	79.1	**85.6**	**85.2**	79.7	78.4	81.1	79.4	83.7	80.8
Alt 2 - Future Year Projected Value	84.1	84.5	82.6		**85.9**	**90.0**			83.5			
Alt 3 - Future Year Projected Value	82.2	80.1	79.9	78.9	**85.7**	**86.5**	78.5	77.4	81.3	79.8	82.9	81.5

1998Start Year										
4thHigh	1999	2004	2009	2012		D.V.	1999	2004	2009	2012
	1	6	11	14			1	6	11	14
Chiwaukee	104.2	93.6	82.9	76.5		Chiwaukee	101.1	90.9	80.6	74.4
Sheboygan	99.2	91.6	84.0	79.4		Sheboygan	97.4	92.0	86.5	83.3
MichCity	93.9	86.3	78.7	74.2		MichCity	90.3	85.3	80.3	77.3
Holland	96.4	93.7	90.9	89.3		Holland	94.3	92.7	91.1	90.2
E-wtd						E-wtd				
Chiwaukee			88.9	87.5		Chiwaukee			86.4	85.0
Sheboygan			88.3	87.2		Sheboygan			89.6	88.9
MichCity			83.0	82.0		MichCity			83.1	82.5
Holland			92.5	92.1		Holland			92.0	91.8
1995Start Year										
4thHigh	1996	2004	2009	2012		D.V.	1996	2004	2009	2012
	1	9	14	17			1	9	14	17
Chiwaukee	101.1	94.6	90.5	88.0		Chiwaukee	102.0	92.8	87.1	83.6
Sheboygan	103.8	91.6	84.0	79.4		Sheboygan	100.0	90.9	85.1	81.7
MichCity	99.6	86.5	78.3	73.4		MichCity	99.1	83.6	74.0	68.2
Holland	99.4	93.6	90.0	87.8		Holland	98.5	91.7	87.5	84.9
E-wtd						E-wtd				
Chiwaukee			91.7	90.8		Chiwaukee			88.8	87.6
Sheboygan			86.3	84.6		Sheboygan			86.9	85.6
MichCity			80.8	79.0		MichCity			76.9	74.8
Holland			91.1	90.3		Holland			88.7	87.8

1998Start Year										
4thHigh	1999	2004	2009	2012		D.V.	1999	2004	2009	2012
	1	6	11	14			1	6	11	14
Ashtabula	97.5	92.2	87.0	83.8		Ashtabula	96.4	90.6	84.7	81.2
Geauga	100.2	95.1	90.0	86.9		Geauga	100.4	93.6	86.7	82.6
Eastlake	99.4	97.5	95.7	94.6		Eastlake	99.0	96.0	93.0	91.2
Summit	105.0	94.2	83.3	76.8		Summit	103.6	90.0	76.5	68.3
E-wtd						E-wtd				
Ashtabula			90.7	90.3		Ashtabula			88.9	88.4
Geauga			93.6	93.2		Geauga			91.6	91.1
Eastlake			97.0	96.9		Eastlake			95.1	94.9
Summit			91.0	90.2		Summit			86.1	85.1
1995Start Year										
4thHigh	1996	2004	2009	2012		D.V.	1996	2004	2009	2012
	1	9	14	17			1	9	14	17
Ashtabula	95.2	92.7	91.1	90.2		Ashtabula	95.2	92.1	90.2	89.1
Geauga	103.1	95.1	90.1	87.1		Geauga	100.3	94.8	91.4	89.4
Eastlake	99.2	97.9	97.0	96.5		Eastlake	101.3	96.9	94.2	92.5
Summit	98.7	95.5	93.5	92.3		Summit	101.6	93.6	88.6	85.6
E-wtd						E-wtd				
Ashtabula			92.0	91.8		Ashtabula			91.2	91.0
Geauga			92.8	92.2		Geauga			93.2	92.8
Eastlake			97.5	97.4		Eastlake			95.6	95.3
Summit			94.6	94.3		Summit			91.2	90.6

1998Start Year										
4thHigh	1999	2004	2009	2012		D.V.	1999	2004	2009	2012
	1	6	11	14			1	6	11	14
Noblesville	100.1	91.3	82.5	77.2		Noblesville	96.4	90.0	83.5	79.7
NewHaven	96.6	91.1	85.7	82.4		NewHaven	92.3	91.7	91.2	90.9
E-wtd						E-wtd				
Noblesville			88.0	79.7		Noblesville			87.5	81.5
NewHaven			89.0	84.1		NewHaven			91.5	91.0
1995Start Year										
4thHigh	1996	2004	2009	2012		D.V.	1996	2004	2009	2012
	1	9	14	17			1	9	14	17
Noblesville	96.6	92.2	89.5	87.8		Noblesville	97.8	91.0	86.8	84.2
NewHaven	93.8	91.9	90.8	90.1		NewHaven	95.2	91.2	88.7	87.2
E-wtd						E-wtd				
Noblesville			90.6	88.6		Noblesville			88.5	85.4
NewHaven			91.2	90.4		NewHaven			89.7	88.0