Chapter 7: Screening Level Analysis of Approximated Future Near-Roadway NO_2 Ambient Concentrations

Introduction

In the main body of the RIA, we projected current area-wide monitor values to future year monitor values directly, using future year CMAQ modeling outputs that take into account expected changes in emissions from 2006 to 2020. Because a near-roadway monitoring network does not currently exist, it was not possible to do this same direct projection into the future for near-roadway peaks. This analysis therefore represents a much more uncertain screening level approximation of future year near-roadway air quality. Note in addition that this analysis cannot predict air quality in locations for which there is no current NO_2 monitor.

This analysis relies on current and future estimated air quality concentrations at area-wide monitors, making adjustments to future year projections using derived estimates of the relationship between future year area-wide air quality peaks and current near-roadway peaks.

7.1 Monitor Selection

We first select "areawide" monitors to adjust to approximate near-roadway conditions.[1] The monitors included in this analysis are those considered to be representative of "area-wide" conditions; i.e. those monitors to which it would be appropriate to apply the gradient to scale from area-wide to near-roadway conditions. Accordingly, we did not include monitors that are microscale or middle scale, source oriented, non-EPA, or those affected by a dominant source, including roadways, in this analysis.

OAQPS applied several techniques to identify NO_2 monitors that are appropriate to scale-up to simulate near-road monitor concentrations. Consistent with the NO_2 NAAQS and monitoring rulemaking proposal, we used only "area-wide" monitors to scale-up to simulate near-road concentrations. Area-wide monitors are monitors that are not significantly influenced by point, area, or mobile sources, meaning they typically do not represent the maximum concentration that may be attributable to a source or sources. Further, area-wide sites represent neighborhood, urban, and regional spatially representative scales.

To select monitors for adjustment to near-road conditions, OAQPS used (1) monitor characteristics in the AQS database, (2) visual inspection by using Google Earth geospatial

---

[1] This process excluded no monitoring sites; it merely identified those monitors relevant to adjust for a near-roadway approximation. Monitors not selected for adjustment were still included in the overall analysis.

software, and (3) the condition that only Core Based Statistical Areas (CBSAs) with populations of 350,000 or greater would be required to have at least one maximum concentration site near roadways.

Based on the monitor characteristics in the AQS database, we excluded any site that is:

- Microscale site (measurement scale)
- Middle scale site (measurement scale)
- Source oriented site (monitor objective)
- A combination of metadata: Highest Concentration, Neighborhood scale, and Point source dominated (monitor objective/measurement scale/dominant source)
- Identified as operated by industry, as these sites are usually micro or middle scale, source oriented sites.

Next, we conducted a visual inspection and geospatial analysis using Google Earth of the remaining monitors. The analysis reviewed where the site was physically located in an urban area, checked its proximity to major roads (such as interstates, freeways, and major arterial roads), and its proximity to identifiable sources such as industrial complexes and facilities, commercial facilities (such as trucking depots), or proximity to other area sources (such as airports or shipping ports).

Finally, we did not scale up any sites that were not in CBSAs with a population of 350,000 or greater to be consistent with the proposed population based thresholds that trigger minimum required near-road monitors in the NO_2 NAAQS and monitoring proposal package. Appendix 7.A contains a fuller discussion of the list of monitors included in this analysis.

Using the list of area-wide monitors relevant for near-roadway adjustment, we included only those monitors with sufficient data completeness to estimate a 2020 design value (see Chapter 3, Section 3.3.2.1 for details). One hundred seventy-three monitors were considered relevant for near-road adjustment.

7.2 Adjustment of 2020 area-wide design values to near-roadway

Because there are no NO2 near road monitors currently in existence, any effort to evaluate impacts of a short term NO2 standards requires an ‘estimation’ of future near road levels as we have determined that short term peak NO2 concentrations are likely to occur on or near roads. In an effort to create these near road monitor proxy locations, we have used two analytic approaches to attempt to adjust CMAQ results for 2020 to approximate proxies for near road levels in that same time period. Each method is described below with detailed methodology following.

7.2.1 Near road gradient adjustment

Reflecting the expected roadway gradient discussed in the proposal preamble (i.e., near road monitors can be from 30% to 100% greater than the area wide monitors), we adjust our estimated design values at area-wide locations for the future year of 2020 by 130%, 165%, and 200%. This method of adjustment will be referred to as Method 1 throughout the rest of the chapter.

The simplicity of applying the range of near road gradients to the area-wide locations for 2020 is appealing; however, one significant limitation of the method is that the range may not account for the expected future design values near roads (i.e., we believe this approach may over-estimate future design values near roads and may suggest that the future nonattainment problem is worse than it might be, and that the costs and benefits of addressing the residual nonattainment problem in the future are greater than they will actually be). This potential overestimation results from two related issues: (1) the 2020 projections are from CMAQ which estimates a volume-averaged concentration throughout a 12km grid associated with emissions reductions from all sources that occur between 2006 and 2020, and (2) the greater efficacy of the reductions in on-road mobile source emissions at near road locations that occur between 2006 and 2020. This method does not account for these two issues in projecting 2020 design values for near road locations. Any adjustments to account for these issues may result in estimated future design values at near road locations that are within the range of the gradient between near-road and area monitors.

7.2.2 Near road gradient adjustment with account for greater efficacy of future mobile source emissions reductions

This approach starts with the near road gradient adjustment described above for Method 1. In addition, as stated above, we expect that air quality peak design values near roadways will be affected more significantly by mobile source emission reductions than will air quality peak design values in area-wide locations. Therefore, we presume that future near-roadway peaks are reduced more than future area-wide peaks because (1) the near road proxy monitors are by definition located near the roadway; and (2) on-road mobile source emission reductions between 2006 and 2020 are expected to be significant due to a number of previously-cited Federal mobile source regulations. However, as mentioned above, CMAQ averages the reductions from all sources over the 12km grid which effectively smoothes the concentration changes of source-specific emissions reductions that would have a greater effect at any specific location within the grid, e.g., mobile source emissions reductions near roads. These limitations suggest we should consider an appropriate adjustment of the 2020 design values at 'near roadway' proxy monitors to account for the dilution of mobile emission reductions across entire grid squares by CMAQ. Therefore, based on available data, we calculated a relative effectiveness metric for each county with a proxy monitor reflecting the greater efficacy of mobile source emissions reductions (i.e., ppb/ton) at those locations than predicted by CMAQ for area wide monitor locations. We then applied the resulting national average metric (1.20) across all monitors calculated above to adjust the 2020 design values at the 'near roadway' proxy monitors consistently.

While we believe this approach is conceptually sound, it is a new methodology developed out of necessity to complete this assessment for near roadway monitor locations in the absence of such a monitoring network and based on limited data and modeling results, i.e., information not designed to address near road situations. Furthermore, the use of a national average adjustment as opposed to a county-specific adjustment makes the adjustment more straight forward but does result in some specific under- and over-adjustments at particular locations.

7.2.3 Methodology of concentration adjustments

Following is the methodology used to adjust the 2020 area-wide 99th percentile design values[2] to reflect near-roadway air quality levels based on area-wide concentration data for Methods 1 and 2. For Method 1, the 2020 area-wide design values were adjusted to each of the three levels of near-roadway gradient, 30%, 65%, 100% increase from area-wide to near-roadway, by multiplying the 2020 projected area-wide concentration by 1.3, 1.65, and 2.0 respectively.

For Method 2, near-roadway concentrations will be affected more significantly by on-road mobile emission reductions than locations representing area-wide concentrations as described in Section 7.2.2. The calculation of 2020 near-roadway adjusted design values is described below for both Methods 1 and 2.

1. For Method 2, calculate the 2005-2007 and 2020 onroad components of the 99th percentile area-wide design values by multiplying the area-wide design values by the ratio of county onroad to county total emissions:

---

[2] Hereafter, 2005-2007 and 2020 design values refer to 99th percentile design values.

$$DV_{on:2005-2007} = DV_{2005-2007} \times \frac{E_{onroad:2006}}{E_{total:2006}} \quad (7.1)$$

$$DV_{on:2020} = DV_{2020} \times \frac{E_{onroad:2020}}{E_{total:2020}} \quad (7.2)$$

Where DV_{on} represents on-road design values for a particular year, and E represents emissions. The county emissions for both 2006 and 2020 are the county emissions used to calculate the 2020 area-wide design values as described in Chapter 3. The 2020 emissions are the 2020 emissions used to meet the 0.075 ppm ozone standard [See Chapter 4 of the ozone RIA (EPA, 2008)].

2. After calculating the onroad components of the area-wide design values for 2005-2007 and 2020, the onroad ppb/ton estimate was calculated as:

$$ppb/ton_{onroad} = \frac{DV_{on:2020} - DV_{on:2005-2007}}{E_{on:2020} - E_{on:2006}} \quad (7.3)$$

3. Next, the ratio of onroad to total ppb/ton metric was calculated as:

$$Ratio_{ppb/ton} = \frac{ppb/ton_{onroad}}{ppb/ton_{total}} \quad (7.4)$$

Where ppb/ton_{onroad} is as defined above and ppb/ton_{total} is defined as in Equation 3.8 of Section 3.2.1 in Chapter 3.

4. To simplify the analysis, we used the average Ratio in step 4 above across all monitors in the final adjustment for the near road proxy monitors. The national average ratio was calculated as 1.2, meaning that onroad emissions reductions were approximately 20% more effective at reducing near-roadway concentrations than total emission reductions in the county.
5. After calculating the national average ratio in step 4, the final near-roadway adjusted 2020 design value for Method 1 was calculated as:

$$DV_{NR1} = DV_{2020} \times GRAD \quad (7.5)$$

and for Method 2 as:

$$DV_{NR2} = \frac{DV_{2020} \times GRAD}{1.2} \quad (7.6)$$

Where DV_{NR1} is the 2020 near-roadway adjusted concentration for each gradient with GRAD equal to 1.3, 1.65, or 2 (i.e., reflecting 30%, 65%, or 100% increase respectively),

DV_{NR2} is the 2020 near-roadway adjusted concentration for Method 2, and DV_{2020} is the 2020 area-wide design value.

6. Once the near-roadway design values were calculated for 2020 for each of the three gradient increases (30%, 65%, and 100%), residual nonattainment was calculated for four alternative standards (in ppb): 65, 80, 100, and 125. Nonattainment was calculated as:

$$NA_{X;GRAD:AS} = DV_{NR:GRAD} - AS \tag{7.7}$$

Where $NA_{XGRAD:AS}$ is the residual nonattainment (ppb) for GRAD equal to 30, 65, or 100% increase for alternative standard AS of 65, 80, 100, or 125 ppb and $DV_{NR:GRAD}$ is the 2020 near-roadway adjusted design value for the 30%, 65%, or 100% increase for either Method 1 or 2 (denoted by X). For locations exceeding a particular alternative standard AS, the mobile tons needed to reach attainment are calculated as:

$$Tons1_{GRAD:AS} = \frac{NA_{1GRAD:AS}}{ppb/ton_{total}} \tag{7.8}$$

for Method 1 and

$$Tons2_{GRAD:AS} = \frac{NA_{2GRAD:AS}}{(ppb/ton_{total} \times 1.2)} \tag{7.9}$$

for Method 2,

Where $Tons1_{GRAD:AS}$ and $Tons2_{GRAD:AS}$ are the tons needed for attainment of alternative standard for the near-roadway increase of 30%, 65%, or 100% for Methods 1 and 2 respectively, $NA_{1GRAD:AS}$ and $NA_{2GRAD:AS}$ are as defined in step 6 above, and ppb/ton_{total} is the total (all county emissions) ppb/ton as calculated in Chapter 3. The total ppb/ton is multiplied by 1.2 in Equation 7.9 to approximate the onroad ppb/ton based on the national average of onroad ppb/ton to total ppb/ton.

7.2.4 Adjusted near-roadway concentrations

After calculating the near-roadway adjusted design values for each monitor, the maximum design value was chosen for each county for each of the gradient increases. Lists of the nonattainment counties are shown in Tables 7.1 through 7.3 for each of the three gradient increases for Method 1: 130%, 165%, and 200%. Also shown in each table are the residual nonattainment and mobile tons needed for attainment for each alternative standard that is exceeded. One monitor exceeded the 125 ppb level considered, Adams County, CO for the 100% gradient increase.

Tables 7.4 through 7.6 list the nonattainment counties for Method 2 for each of the three gradient increases: 130%, 165%, and 200% respectively. No monitor exceeded either the 125 ppb level considered, or any level higher than 125 ppb for Method 2. Tables 7.7 shows the results of the calculation of the ppb/ton estimates and onroad to total ppb/ton estimates for Adams County, CO for Method 2 as well as results for Method 1 for the 200% gradient increase and comparison against a 65 ppb alternative standard.

Table 7.1. 2005-2007, 2020 30% increase near-roadway design values with residual nonattainment and mobile tons needed for attainment for 65 and 80 ppb alternative standard for Method 1.

				Alternative standards			
				65 ppb		80 ppb	
County	State	2005-07 design value (ppb)	2020 design value (ppb)	Residual nonattainment (ppb)	Mobile tons needed for attainment	Residual nonattainment (ppb)	Mobile tons needed for attainment
Adams[a]	CO	82.6	86.3	20.9	9,549	5.9	2,696
El Paso[a]	TX	72.6	79.4	14.0	8,855	-	-
Salt Lake[a]	UT	70.3	76.7	11.3	5,818	-	-

[a] These counties were also included in the area-wide analysis presented in Chapter 3. Estimates of tons needed may differ due to the approach used in projecting near roadway air quality concentrations as well as the standard being analyzed.

Table 7.2. 2005-2007, 2020 65% increase near-roadway design values with residual nonattainment and mobile tons needed for attainment for 65, 80, and 100 ppb alternative standards for Method 1.

County	State	2005-07 design value (ppb)	2020 design value (ppb)	Alternative Standards					
				65 ppb		80 ppb		100 ppb	
				Residual nonattainment (ppb)	Mobile tons needed for attainment	Residual nonattainment (ppb)	Mobile tons needed for attainment	Residual nonattainment (ppb)	Mobile tons needed for attainment
Adams[a]	CO	82.6	109.5	44.1	20,148	29.1	13,295	9.1	4,158
El Paso[a]	TX	72.6	100.8	35.4	22,390	20.4	12,903	0.4	253
Salt Lake[a]	UT	70.3	97.3	31.9	16,425	16.9	8,701	-	-
East Baton Rouge[a]	LA	65.3	90	24.6	29,859	9.6	11,652	-	-
Los Angeles[a]	CA	81.6	86.6	21.2	180,872	6.2	52,896	-	-
Charles City[a]	VA	70.0	85.9	20.5	232	5.5	62	-	-
West Baton Rouge	LA	58.6	82.9	17.5	2,863	2.5	409	-	-
Allegheny	PA	67.6	77.2	11.8	12,226	-	-	-	-
Kern	CA	73.0	72.4	7.0	13,777	-	-	-	-
Harris	TX	63.0	72.1	6.7	39,979	-	-	-	-
Union	NJ	90.6	69.3	3.9	1,324	-	-	-	-
St Louis	MO	63.0	68.1	2.7	1,015	-	-	-	-
Ascension	LA	46.0	66.9	1.5	1,164	-	-	-	-
Jefferson	LA	55.0	65.5	0.1	98	-	-	-	-
Bernalillo	NM	59.3	65.5	0.1	58	-	-	-	-

[a] These counties were also included in the area-wide analysis presented in Chapter 3. Estimates of tons needed may differ due to the approach used in projecting near roadway air quality concentrations as well as the standard being analyzed.

Table 7.3. 2005-2007, 2020 100% increase near-roadway design values with residual nonattainment and mobile tons needed for attainment for 65, 80 ppb, and 100 ppb alternative standards for Method 1.

				Alternative standards					
				65 ppb		80 ppb		100 ppb	
County	State	2005-07 design value (ppb)	2020 design value (ppb)	Residual nonattainment (ppb)	Tons needed for attainment	Residual nonattainment (ppb)	Tons needed for attainment	Residual nonattainme nt (ppb)	Tons needed for attainment
Adams[a]	CO	82.6	132.8	67.4	30,793	52.4	23,940	32.4	14,803
El Paso[a]	TX	72.6	122.2	56.8	35,925	41.8	26,438	21.8	13,788
Salt Lake[a]	UT	70.3	118.0	52.6	27,083	37.6	19,360	17.6	9,062
East Baton Rouge[a]	LA	65.3	109.2	43.8	53,163	28.8	34,957	8.8	10,681
Los Angeles[a]	CA	81.6	105.0	39.6	337,855	24.6	209,880	4.6	39,246
Charles City[a]	VA	70.0	104.2	38.8	438	23.8	269	3.8	43
West Baton Rouge	LA	58.6	100.6	35.2	5,759	20.2	3,305	0.2	33
Allegheny	PA	67.6	93.6	28.2	29,218	13.2	13,677	-	-
Kern	CA	73.0	87.8	22.4	44,087	7.4	14,565	-	-
Harris	TX	63.0	87.4	22.0	131,274	7.0	41,769	-	-
Union	NJ	90.6	84.0	18.6	6,316	3.6	1,222	-	-
St Louis	MO	63.0	82.6	17.2	6,469	2.2	827	-	-
Ascension	LA	46.0	81.2	15.8	12,264	0.8	621	-	-
Jefferson	LA	55.0	79.4	14.0	13,734	-	-	-	-
Bernalillo	NM	59.3	79.4	14.0	8,183	-	-	-	-
Davis	UT	71.0	78.8	13.4	2,767	-	-	-	-
Cuyahoga	OH	66.0	77.2	11.8	9,162	-	-	-	-
Maricopa	AZ	76.0	76.6	11.2	17,946	-	-	-	-
Jackson	MO	65.0	74.0	8.6	5,852	-	-	-	-
Richmond	VA	62.6	73.8	8.4	1,233	-	-	-	-
Iberville	LA	42.3	73.0	7.6	9,096	-	-	-	-
Santa Clara	CA	63.6	69.4	4.0	5,569	-	-	-	-
Hudson	NJ	77.6	68.2	2.8	1,727	-	-	-	-
Anoka	MN	47.6	68.0	2.6	1,085	-	-	-	-
Broward	FL	57.0	67.4	2.0	3,506	-	-	-	-
Fulton	GA	75.6	66.6	1.2	737	-	-	-	-
Dallas	TX	60.6	66.0	0.6	805	-	-	-	-
Orange	CA	78.0	65.8	0.4	510	-	-	-	-

[a] These counties were also included in the area-wide analysis presented in Chapter 3. Estimates of tons needed may differ due to the approach used in projecting near roadway air quality concentrations as well as the standard being analyzed. Adams County, CO also exceeded the 125 ppb level with nonattainment of 7.4 ppb and tons needed for attainment were 3,381 tons.

Table 7.4. 2005-2007, 2020 30% increase near-roadway design values with residual nonattainment and mobile tons needed for attainment for 65 ppb alternative standard for Method 2.

County	State	2005-07 design value (ppb)	2020 design value (ppb)	Alternative standard 65 ppb	
				Residual nonattaintment (ppb)	Mobile tons needed for attainment
Adams[a]	CO	82.6	71.9	6.5	2,475
El Paso[a]	TX	72.6	66.1	0.7	369

[a] These counties were also included in the area-wide analysis presented in Chapter 3. Estimates of tons needed may differ due to the approach used in projecting near roadway air quality concentrations.

Table 7.5. 2005-2007, 2020 65% increase near-roadway design values with residual nonattainment and mobile tons needed for attainment for 65 and 80 ppb alternative standards for Method 2.

County	State	2005-07 design value (ppb)	2020 design value (ppb)	Alternative standards			
				65 ppb		80 ppb	
				Residual nonattaintment (ppb)	Mobile tons needed for attainment	Residual nonattaintment (ppb)	Mobile tons needed for attainment
Adams[a]	CO	82.6	91.3	25.9	9,861	10.9	4,150
El Paso[a]	TX	72.6	84	18.6	9,803	3.6	1,897
Salt Lake[a]	UT	70.3	81.1	15.7	6,736	0.7	300
East Baton Rouge[a]	LA	65.3	75	9.6	9,710	-	-
Los Angeles[a]	CA	81.6	72.1	6.7	47,635	-	-
Charles City[a]	VA	70.0	71.6	6.2	58	-	-
West Baton Rouge[a]	LA	58.6	69.1	3.7	504	-	-

[a] These counties were also included in the area-wide analysis presented in Chapter 3. Estimates of tons needed may differ due to the approach used in projecting near roadway air quality concentrations as well as the standard being analyzed.

Table 7.6. 2005-2007, 2020 100% increase near-roadway design values with residual nonattainment and mobile tons needed for attainment for 65, 80 ppb, and 100 ppb alternative standards for Method 2.

County	State	2005-07 design value (ppb)	2020 design value (ppb)	Alternative standards					
				65 ppb		80 ppb		100 ppb	
				Residual nonattaintment (ppb)	Mobile tons needed for attainment	Residual nonattaintment (ppb)	Mobile tons needed for attainment	Residual nonattaintment (ppb)	Mobile tons needed for attainment
Adams[a]	CO	82.6	110.6	45.2	17,209	30.2	11,498	10.2	3,883
El Paso[a]	TZ	72.6	101.8	36.4	19,185	21.4	11,279	1.4	738
Salt Lake[a]	UT	70.3	98.3	32.9	14,116	17.9	7,680	-	-
East Baton Rouge[a]	LA	65.3	91	25.6	25,894	10.6	10,722	-	-
Los Angeles[a]	CA	81.6	87.5	22.1	157,125	7.1	50,479	-	-
Charles City[a]	VA	70.0	86.8	21.4	202	6.4	60	-	-
West Baton Rouge	LA	58.6	83.8	18.4	2,509	3.4	464	-	-
Allegheny	PA	67.6	78	12.6	10,879	-	-	-	-
Kern	CA	73.0	73.1	7.7	12,629	-	-	-	-
Harris	TX	63.0	72.8	7.4	36,797	-	-	-	-
Union	NJ	90.6	70	4.6	1,302	-	-	-	-
St Louis	MO	63.0	68.8	3.4	1,066	-	-	-	-
Ascension	LA	46.0	67.6	2.2	1,423	-	-	-	-
Jefferson	LA	55.0	66.1	0.7	572	-	-	-	-
Bernalillo	NM	59.3	66.1	0.7	341	-	-	-	-
Davis	UT	71.0	65.6	0.2	34	-	-	-	-

[a] These counties were also included in the area-wide analysis presented in Chapter 3. Estimates of tons needed may differ due to the approach used in projecting near roadway air quality concentrations as well as the standard being analyzed.

Table 7.7 Example adjustment of 2020 area-wide design value to near-roadway design value for Adams County, CO for 100% adjustment and comparison to 65 ppb standard

Variable	Description	Value
$DV_{2005\text{-}2007}$	2005-2007 area-wide 99th percentile design value concentration (ppb)	82.6
$E_{onroad:2006}$	2006 onroad county emissions (tons)	7,816
$(E_{total:2006})$	2006 total county emissions (tons)	26,368
$DV_{on:2005\text{-}2007}$ (Equation 7.1)	Onroad component of 2005-2007 area-wide design values (ppb)	24.5
DV_{2020}	2020 area-wide 99th percentile design value concentration (ppb)	66.4
$E_{onroad:2020}$	2020 onroad county emissions (tons)	2,747
$E_{total:2020}$	2020 total county emissions (tons)	18,967
$DV_{on:2020}$ (Equation 7.2)	Onroad component of 2020 area-wide design values (ppb)	9.6
ppb/ton_{onroad} (Equation 7.3)	Onroad ppb/ton estimate used in ratio calculation	2.93×10^{-3}
ppb/ton_{total}	Total ppb/ton estimate as calculated for Chapter 3	2.19×10^{-3}
Ratio (Equation 7.4)	Ratio of onroad ppb/ton to total ppb/ton used in national average ratio calculation	1.34
$DV_{1NR:100}$ (Equation 7.5)	Method1 near-roadway adjusted concentration for 2020 for 100% increase from area-wide to near-roadway	132.8
$DV_{2NR:100}$ (Equation 7.6)	Method 2 near-roadway adjusted concentration for 2020 for 100% increase from area-wide to near-roadway	110.6
$NA_{1100:65}$ (Equation 7.7)	Method 1 near-roadway design value residual nonattainment for 100% near-roadway gradient increase for 65 ppb alternative standard	67.4
$NA_{2100:65}$ (Equation 7.7)	Method 2 near-roadway design value residual nonattainment for 100% near-roadway gradient increase for 65 ppb alternative standard	45.2
$Tons1_{100:65}$ (Equation 7.8)	Onroad mobile tons needed to reach attainment of 65 ppb alternative standard for Method 1 100% near-roadway gradient increase	30,793
$Tons2_{100:65}$ (Equation 7.9)	Onroad mobile tons needed to reach attainment of 65 ppb alternative standard for Method 2 100% near-roadway gradient increase	17,209

7.3 Cost Effectiveness for Mobile Source Controls

Because this analysis examines emissions and air quality approximating near-roadway conditions, we believe it is appropriate to focus analysis of controls on mobile sources. For the purposes of this analysis we reviewed existing cost effectiveness estimates for a number of on-road and non-road regulations that have been promulgated in the last several years. These regulations include the Tier 2 regulation for light-duty motor vehicles, the 2001 and 2004 heavy duty diesel rules, the Tier 4 non-road equipment rule, the locomotive/marine rule, and the small spark ignition equipment rule. We also reviewed the cost effectiveness estimates for the mobile source controls that were applied in the area-wide monitor analysis presented in Chapter 4 of this RIA, as well as for the 2008 ozone NAAQS. That RIA included cost effectiveness estimates for mobile source controls that included retrofits for on-road vehicles and non-road equipment, elimination of long duration truck idling, continuous inspection and maintenance of light-duty vehicles, the introduction of plug-in hybrid vehicles into the national vehicle fleet, more stringent requirements for aftermarket replacement catalytic converters, commuter programs to reduce vehicle miles travelled and vehicle trips, and improved emission control systems for new vehicles.

Table 7.8 Estimated $/ton Costs of NOx Emissions Reductions from Recent RIAs

SOURCE CATEGORY[a,]	NO_X COST/TON	NOTES
C3 Marine Coordinated Strategy NPRM, 2009	510	a
Nonroad Small Spark-Ignition Engines 73 FR 59034, October 8, 2008	330-1,200[b,c]	a, b, c
Stationary Diesel (CI) Engines (71 FR 39154, July 11, 2006)	580 – 20,000	a
Locomotives and C1/C2 Marine (Both New and Retrofits) (73 FR 25097, May 6, 2008)	730 [b]	a, b
Heavy Duty Nonroad Diesel Engines (69 FR 38957, June 29, 2004)	1,100 [b]	a, b
Heavy Duty Onroad Diesel Engines (66 FR 5001, January 18, 2001)	2,200 [b]	a, b
Non-road Tier 4 (page 8-64 of the non- road tier 4 RIA)	1,010	b, d, e
Tier 2 (Page VI-18 of the Tier 2 RIA)	2,047	b, f
Continuous Light-duty Vehicle Inspection and Maintenance (2008 ozone RIA Appendix 5a pages 5a-7 – 5a-9)	0	
Eliminate Long Duration Truck Idling (2008 ozone RIA Appendix 5a pages 5a-9 – 5a-10)	0	
Plug-in Hybrid Vehicles (2008 ozone RIA Appendix 7a pages 7a-4 – 7a-96)	0	
Retrofit Class 8b Trucks (2008 ozone RIA Appendix 5a pages 5a-6 – 5a-7)	1,100-2,500	
Retrofit Class 6 & 7 Trucks (2008 ozone RIA Appendix 5a pages 5a-6 – 5a-7)	5,600-14,100	
Retrofit Non-road Equipment – SCR (2008 ozone RIA Appendix 5a pages 5a-6 – 5a-7)	2,600-10,400	
Retrofit Non-road Equipment – Rebuild/Upgrade (2008 ozone RIA Appendix 5a pages 5a-6 – 5a-7)	1,000-4,900	
Improve Aftermarket Replacement Catalytic Converters (2008 ozone RIA Appendix 7a pages 7a-6 – 7a-8)	3,700	
Commuter Programs (2008 ozone RIA Appendix 5a pages 5a-10 – 5a-11)	19,200	
Improve Catalyst Efficiency for New Light-duty Vehicles (2008 ozone RIA Appendix 7a pages 7a-3 – 7a-4)	17,500	

[a] Table presents aggregate program-wide cost/ton over 30 years, discounted at a 3 percent NPV, except for Stationary CI Engines and Locomotive/Marine retrofits, for which annualized costs of control for individual sources are presented. All figures are in 2006 U.S. dollars per short ton.

[b] Includes NO_X plus non-methane hydrocarbons (NMHC). NMHC are also ozone precursors, thus some rules set combined NO_X+NMHC emissions standards. NMHC are a small fraction of NO_X so aggregate cost/ton comparisons are still reasonable.

[c] Low end of range represents costs for marine engines with credit for fuel savings, high end of range represents costs for other nonroad SI engines without credit for fuel savings.

[d] 30 year NPV at a 3% discount rate in 2002 dollars. The RIA also presents a cost effectiveness of $1,160/ton at a 7% discount rate in 2002 dollars.

[e] The non-road tier 4 RIA contained to sensitivity analyses. In those analyses the resulting cost effectiveness values for NOx+NMHC for a 30-year NPV at a 3% discount rate were $1,490 and $920 per ton.

[f] Discounted aggregate cost effectiveness.

As summarized in the table above the majority of these controls have costs of between $1,000 and $5,000 per ton of NOx or NOx+non-methane hydrocarbons. There are some exceptions. Several of the measures produce fuel savings that offset the cost of the control equipment or vehicle and any operating expenses; therefore, these measures produce NOx reductions at no cost. Some non-road retrofits, particularly for agricultural equipment, are more expensive. However, this type of equipment would not be the primary focus of an attainment strategy for the NO_2 NAAQS under a near roadway monitoring scenario. Retrofits of class 6 and 7 heavy duty vehicles and commuter programs also have higher costs per ton. However, these do not provide large emissions reductions. Finally, the estimated cost per ton of NOx reductions from improvements in the emissions control systems for new motor vehicles is also higher. However, as noted in the RIA for 2008 ozone NAAQS, this is a very rough estimate of the cost of these controls. Only one method for achieving the desired level of emissions was considered. A much more detailed analysis would be required to develop a representative cost for such future controls on new vehicles. In addition, when referring back to the area-wide engineering costs presented in Chapter 6 the average cost per ton for applied mobile source controls ranges between $1,900 and $4,300 per ton (2006$).

The purpose of this analysis is to develop an estimate of the average cost per ton of NOx reductions that would be needed to bring projected nonattainment areas into compliance with the revised NO_2 NAAQS. Based on the estimates in these recent RIAs it is evident that there remain mobile source control strategies that provide emissions reductions in the range of $1,000 to $5,000 per ton of NOx. However, we also recognize that the costs of controls will likely increase as additional control measures are implemented. We anticipate that nonattainment areas would employ a mixture of controls that fall within the range the range $1,000 to $5,000 per ton and some additional controls that have higher costs per ton. Given the screening nature of this analysis we have estimated that the annualized average cost of controls to attain the NO_2 NAAQS would be in the range of $3,000 to $6,000 per ton. This estimate is based upon previous estimates, most of which are estimated, using a three percent discount rate. A discount rate of seven percent was not available for all estimates provided in Table 7.8.

To calculate the engineering costs for this screening-level near-roadway analysis we multiplied the tons needed from Section 7.2 for each alternative standard by the lower and upper ends of the range of $3,000 to $6,000/ton (2006$). Cost estimates are provided in Tables 7.9 through 7.12 below. Note that due to the screening level nature of this analysis, we did not examine local conditions for each of these areas and apply known control measures. It is possible that for areas with few mobile measures available, costs could be higher. For example, in the area-wide analysis, Los Angeles had exhausted all known controls, and extrapolated costs were estimated for the alternative standard of 50 ppb. Due to screening nature of the near roadway analysis the same cost per ton was used for all geographic areas. We will continue to develop this analysis for the final RIA, including identifying specific controls to illustrate attainment for areas projected to violate an alternative NO2 standard in 2020. This may include additional analyses for geographic areas where it is difficult to simulate attainment with known control measures.

7.4 Benefits

To calculate the near-roadway benefits, we decided to only calculated the $PM_{2.5}$ co-benefits. Without fine-scale air quality modeling data, it would be difficult to estimate the near-roadway NO_2 benefits. Furthermore, our area-wide analysis for 50 ppb showed that the monetized NO_2 benefits only accounted for 2% of the total monetized benefits, with $PM_{2.5}$ co-benefits accounting for the remainder. To calculate the $PM_{2.5}$ co-benefits, we used a benefit-per-ton approach. To be consistent with the cost analysis, we only used the benefit-per-ton estimate corresponding to NO_X emission reductions from the mobile sector. For more information about the benefit-per-ton approach, please see Chapter 5 of this RIA. These estimates reflect EPA's most current interpretation of the scientific literature on $PM_{2.5}$ and mortality, including our updated benefits methodology (i.e., a no-threshold model that calculates incremental benefits down to the lowest modeled $PM_{2.5}$ air quality levels and incorporates two technical updates) compared to the estimates in previous RIAs that did not include these changes. In Tables 7.9 through 7.12, we present the $PM_{2.5}$ co-benefits as a range from Pope et al to Laden et al, using no-threshold functions, at discount rates of 3% and 7% respectively.[3]

7.5 Comparison of Results

Tables 7.9 and 7.10 show the cost and benefit results of the near-roadway analysis at discount rates of 3% and 7% respectively for Method 1 near-roadway design values. Tables 7.11 and 7.12 show the cost and benefit results of the near-roadway analysis at discount rates of 3% and 7% respectively for Method 2 near-roadway design values. The proposed standard range of 80ppb to 100 ppb is highlighted.

---

[3] Using the threshold model at 10 $\mu g/m^3$ without the two technical updates, we estimate the monetized benefits results would be approximately 20% to 40% less than the results shown in Tables 9.7 and 9.8.

Table 7.9: Benefit Cost Comparison for Near Roadway Analysis – Method 1 (in millions of 2006$ at a 3% discount rate for Benefits only)

	Standard Level	Total Costs[a, b]			Total Benefits[c]			Net Benefits		
30% Gradient	65 ppb	$170	to	$330	$290	to	$700	-$40	to	$530
	80 ppb	$12	to	$20	$14	to	$34	-$6.0	to	$22
	100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
	125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
65% Gradient	65 ppb	$1,000	to	$2,100	$1,800	to	$4,400	-$300	to	$3,400
	80 ppb	$300	to	$600	$520	to	$1,300	-$80	to	$1,000
	100 ppb	$17	to	$30	$23	to	$56	-$7.0	to	$39
	125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
100% Gradient	65 ppb	$2,400	to	$4,800	$4,200	to	$10,000	-$600	to	$7,600
	80 ppb	$1,200	to	$2,300	$2,000	to	$5,000	-$300	to	$3,800
	100 ppb	$270	to	$530	$460	to	$1,100	-$70	to	$830
	125 ppb	$14	to	$24	$18	to	$43	-$6.0	to	$29

[a] Total Cost estimates are shown as a range of annualized costs from $3,000/ton to $6,000/ton. Results include monitoring costs of $3.6m. Costs estimates were only available for a 3% discount rate.

[b] Los Angeles and El Paso counties were also included in the area-wide analysis of extrapolated costs. In that analysis a central estimate of $15,000/ton was used to calculate the cost of emission reductions needed beyond identified controls. If that estimate was used for this analysis of 80ppb with the 65% gradient adjustment the total costs would range from $1.1 to $1.2 billion.

[c] Total Benefit estimates are actually $PM_{2.5}$ co-benefits, shown as a range from Pope et al to Laden et al, at a 3% discount rate, using no-threshold functions, assuming NOx emission reductions from the mobile sector.

Table 7.10: Benefit Cost Comparison for Near Roadway Analysis – Method 1 (in millions of 2006$ at a 7% discount rate for Benefits only)

	Standard Level	Total Costs[a, b]			Total Benefits[c]			Net Benefits		
30% Gradient	65 ppb	$170	to	$330	$230	to	$550	-$100	to	$380
	80 ppb	$12	to	$20	$11	to	$27	-$9.0	to	$15
	100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
	125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
65% Gradient	65 ppb	$1,000	to	$2,100	$1,400	to	$3,400	-$700	to	$2,400
	80 ppb	$300	to	$600	$410	to	$1,000	-$190	to	$700
	100 ppb	$17	to	$30	$18	to	$44	-$12	to	$27
	125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
100% Gradient	65 ppb	$2,400	to	$4,800	$3,300	to	$8,100	-$1,500	to	$5,700
	80 ppb	$1,200	to	$2,300	$1,600	to	$3,900	-$700	to	$2,700
	100 ppb	$270	to	$530	$360	to	$880	-$170	to	$610
	125 ppb	$14	to	$24	$14	to	$34	-$10	to	$20

[a] Total Cost estimates are shown as a range of annualized costs from $3,000/ton to $6,000/ton. Results include monitoring costs of $3.6m. Costs estimates were only available for a 3% discount rate.

[b] Los Angeles and El Paso counties were also included in the area-wide analysis of extrapolated costs. In that analysis a central estimate of $15,000/ton was used to calculate the cost of emission reductions needed beyond identified controls. If that estimate was used for this analysis of 80ppb with the 65% gradient adjustment the total costs would range from $1.1 to $1.2 billion.

[c] Total Benefit estimates are actually $PM_{2.5}$ co-benefits, shown as a range from Pope et al to Laden et al, at a 7% discount rate, using no-threshold functions, assuming NOx emission reductions from the mobile sector.

Table 7.11: Benefit Cost Comparison for Near Roadway Analysis – Method 2 (in millions of 2006$ at a 3% discount rate for Benefits only)

	Standard Level	Total Costs[a]			Total Benefits[c]			Net Benefits		
30% Gradient	65 ppb	$12	to	$21	$15	to	$36	-$6.0	to	$24
	80 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
	100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
	125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
65% Gradient	65 ppb	$260	to	$510	$440	to	$1,100	-$70	to	$840
	80 ppb	$23	to	$42	$33	to	$81	-$9.0	to	$58
	100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
	125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
100% Gradient	65 ppb	$910	to	$1,800	$1,600	to	$3,800	-$200	to	$2,900
	80 ppb	$280	to	$560	$480	to	$1,200	-$80	to	$920
	100 ppb	$17	to	$31	$24	to	$59	-$7.0	to	$42
	125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6

[a] Total Cost estimates are shown as a range of annualized costs from $3,000/ton to $6,000/ton. Results include monitoring costs of $3.6m.

[b] Los Angeles and El Paso counties were also included in the area-wide analysis of extrapolated costs. In that analysis a central estimate of $15,000/ton was used to calculate the cost of emission reductions needed beyond identified controls. If that estimate was used for this analysis of 80ppb with the 65% gradient adjustment the total costs would range from $45 to $59 million.

[c] Total Benefit estimates are actually $PM_{2.5}$ co-benefits, shown as a range from Pope et al to Laden et al, at a 3% discount rate, using no-threshold functions, assuming NOx emission reductions from the mobile sector.

Table 7.12: Benefit Cost Comparison for Near Roadway Analysis – Method 2 (in millions of 2006$ at a 7% discount rate for Benefits only)

	Standard Level	Total Costs[a, b]			Total Benefits[c]			Net Benefits		
30% Gradient	65 ppb	$12	to	$21	$12	to	$29	-$9.0	to	$17
	80 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
	100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
	125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
65% Gradient	65 ppb	$260	to	$510	$350	to	$850	-$160	to	$590
	80 ppb	$23	to	$42	$26	to	$64	-$16	to	$41
	100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
	125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
100% Gradient	65 ppb	$910	to	$1,800	$1,300	to	$3,000	-$500	to	$2,100
	80 ppb	$280	to	$560	$380	to	$930	-$180	to	$650
	100 ppb	$17	to	$31	$19	to	$46	-$12.0	to	$29
	125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6

[a] Total Cost estimates are shown as a range of annualized costs from $3,000/ton to $6,000/ton. Results include monitoring costs of $3.6m. Costs estimates were only available for a 3% discount rate.

[b] Los Angeles and El Paso counties were also included in the area-wide analysis of extrapolated costs. In that analysis a central estimate of $15,000/ton was used to calculate the cost of emission reductions needed beyond identified controls. If that estimate was used for this analysis of 80ppb with the 65% gradient adjustment the total costs would range from $45 to $59 million.

[c] Total Benefit estimates are actually $PM_{2.5}$ co-benefits, shown as a range from Pope et al to Laden et al, at a 7% discount rate, using no-threshold functions, assuming NOx emission reductions from the mobile sector.

7.6 Limitations and uncertainties

- Due to the absence of a near-roadway monitoring network, this is a screening level analysis with several simplifying assumptions. It is provided to give a rough projection of the costs and benefits of attaining a revised NO_2 standard based on a yet to be established monitoring network.

- This analysis does not take into account a large variety of localized conditions specific to individual monitors; instead, the analysis attempts to account for some local parameters by adjusting future design values based on average localized impacts near roads from onroad emissions.

- The process of adjusting from a specific 12 km CMAQ receptor to a near-road air quality estimate represents an uncertain approximation at the specific monitor level.

- This analysis is an approximation in that it derives future year (2020) **peak** air quality concentrations in specific locations by relying on CMAQ estimates that are averages over a 12 km grid square.

- This analysis cannot predict air quality in locations for which there is no current NO_2 monitor, or where current monitoring data is incomplete. There are 142 CBSAs for which we are proposing to add new near-road monitors. Of these, 73 either have no existing monitor in the CBSA, or have a monitor with data not complete enough to include in the near-roadway analysis. In these CBSAs, extrapolation to near-roadway levels is not possible.

- This analysis assumes area-wide monitors remain in the same location; however concentrations are adjusted to reflect near-roadway conditions.

- Because the emission reductions in this analysis are solely reductions from mobile sources, this analysis uses an estimated cost per ton for NOx emission reductions that is different from the estimated cost per ton for NOx emission reductions used in the main body of the RIA.

- This analysis omits certain unquantified effects due to lack of data, time and resources. These unquantified endpoints include NO_2 health effects, ozone co-benefits, ecosystem effects, and visibility.

7.7 References

U.S. Environmental Protection Agency (EPA). 1999. *Regulatory Impact Analysis – Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements.* U.S. Environmental Protection Agency, Office of Air and Radiation, December. EPA420-R-99-023.

U.S. Environmental Protection Agency (EPA). 2001. *Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, Final Rule*. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, January 18. 66 FR 5001-5194.

U.S. Environmental Protection Agency (EPA). 2004. *Final Regulatory Impact Analysis: Control of Emissions from Nonroad Diesel Engines*. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, May. EPA420-R-04-007.

U.S. Environmental Protection Agency (EPA). 2004. *Control of Emissions of Air Pollution from Non-road Diesel Engines and Fuel, Final Rule*. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, June 29. 69 FR 38957-39273.

U.S. Environmental Protection Agency (EPA). 2006. *Standards of Performance for Stationary Compression Ignition Internal Combustion Engines, Final Rule*. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, July 11. 71 FR 39154-85.

U.S. Environmental Protection Agency (EPA). 2008. *Final Ozone NAAQS Regulatory Impact Analysis*. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, March. EPA-452/R-08-003.

U.S. Environmental Protection Agency (EPA). 2008. *Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition-Engines Less Than 30 Liters per Cylinder, Final Rule*. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, May 6. 73 FR 25097-352.

U.S. Environmental Protection Agency (EPA). 2008. *Control of Emissions from Non-road Spark Ignition Engines and Equipment, Final Rule*. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, October 8. 73 FR 59034-380.

U.S. Environmental Protection Agency (EPA). 2009. *Draft Regulatory Impact Analysis: Control of Emissions of Air Pollution from Category 3 Marine Diesel Engines*. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, June. EPA-420-D-09-002. http://epa.gov/otaq/oceanvessels.htm