Appendix C

Near Roadway Impact Analysis

Living close to roadways has been shown to result in adverse health impacts including incidence of COPD, asthma, and heart attack – health events indicative of elevated PM2.5 concentrations – as documented in the comprehensive and systematic review completed by the Health Effects Institute in 2010.[1] "Close" is most commonly defined as either within 300 or 500 meters of a major roadway.[2,3]

Data Sources

EPA's multi-pollutant near-roadway monitoring network was initiated as part of the 2010 NO2 NAAQS review. Monitoring of sites within 50 m of roadways began in 2013[4]. This evaluation examines CY2017 data for 5 locations building from the Sonoma Technology (STI) comprehensive evaluation of the 2017 results.[5] Oak Leaf Environmental utilized STI's examination of 49 near-roadway sites, which identified 20 locations with technically suitable, co-located near-roadway and background monitors that were examined for incremental near-roadway PM impacts.[6] This evaluation covered 5 of the 20 locations in greater detail – quantifying the near-roadway impact of the proposed regulation. The incremental impacts of CY2017 were extrapolated forward to the timeline of the proposed regulation using state-specific annualized inventory results.

Table C-1 summarizes the 5 evaluated co-located monitoring sites in Denver, Indianapolis, Louisville, Milwaukee and Providence. Table C-1 defines the monitors, the measurement method, measurement frequency, distance to the roadway for the near-road monitors, the distance between the monitors and the number of 24-hour measurements in 2017. "Matched" measurements are those dates with valid 24-hour readings from both monitors. Denver is presented twice in Table C-1, both with and without exceptional events identified on 9/2 and 9/4/2017.[7]

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[1] https://www.healtheffects.org/publication/traffic-related-air-pollution-critical-review-literature-emissions-exposure-and-health.
[2] https://www.lung.org/clean-air/outdoors/who-is-at-risk/highways.
[3] https://www.sciencedirect.com/science/article/pii/S1361920920306295.
[4] https://www.epa.gov/amtic/near-road-monitoring.
[5] https://environment.transportation.org/wp-content/uploads/2021/11/4-2019-Oct-STI-TPF-NR-Increments-POAQC-Insights-Final-Report-10-31-19.pdf.
[6] "Technically suitable" is defined by identical measurement instrumentation, proximity, similarity of land-use characteristics and absence of confounding factors.
[7] These were related to the influence of regional air quality impacts of historic wildfires in the Pacific northwest.

Table C-1. Paired roadway and nearest background monitors at 5 locations.

Location	Scale	Monitor AQS-POS	Method*	Frequency	Distance to Roadway (m)	24-Hr Measurements Total	24-Hr Measurements Matched	Distance Between Monitors (Miles)
Denver	Near-Roadway	0002-1	FRM	1 in 6	9	59	59	2.0
	Nearest Background	0027-1	FRM	Daily	-	359		
Denver (Exclude 9/2, 9/4)	Near-Roadway	0002-1	FRM	1 in 6	9	58	58	2.0
	Nearest Background	0027-1	FRM	Daily	-	357		
Indianapolis	Near-Roadway	0087-1	FRM	1 in 3	16	121	115	1.0
	Nearest Background	0083-1	FRM	1 in 3	-	115		
Louisville	Near-Roadway	0075-1	FRM	1 in 3	32	122	116	4.0
	Nearest Background	0067-1	FRM	1 in 3	-	123		
Milwaukee	Near-Roadway	0056-1	FRM	1 in 3	25	112	109	0.2
	Nearest Background	0058-1	FRM	1 in 3	-	123		
Providence	Near-Roadway	0030-1	FEM	Hourly	5	337	336	3.0
	Nearest Background	1010-3	FEM	Hourly	-	346		

* FRM = federal reference method; FEM = federal equivalent method.

24-Hour PM2.5 Concentrations

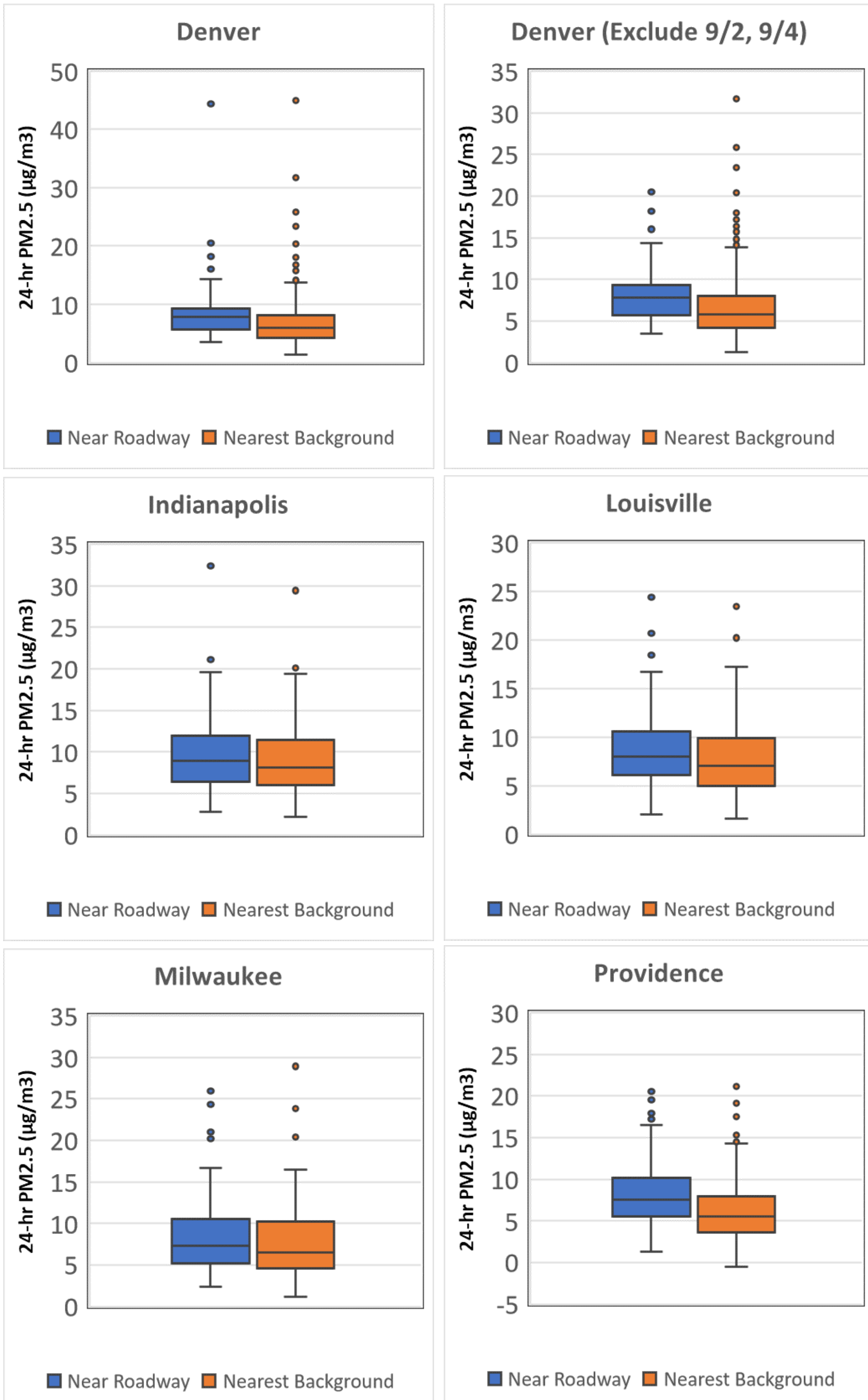
The 24-hour measurement distribution from 2017 at both monitors in each location is summarized in Figure C-1 and Table C-2. These statistics represent the total measurements at each monitor in 2017 (not matched). Expectedly, the near-roadway monitor measures higher PM2.5 as defined by the annual mean and each percentile. Notably, EPA applies two metrics of PM2.5 NAAQS compliance: a short-term (daily) standard of 35 µg/m^3 for the 98th percentile (over 3 years) and a long-term (annual) standard of 12 µg/m^3 (averaged over 3 years). EPA is reviewing these standards and has published proposed revisions.[8]

Table C-2. Distribution of 24-hr PM2.5 measurements in 2017 at 5 pairs of near-roadway and nearest background monitors (µg/m^3).

Location	Scale	Mean	Percentile 25%	50%	75%	90%	98%
Denver	Near-Roadway	8.9	5.8	7.9	9.3	13.8	20.1
	Nearest Background	6.9	4.2	5.9	8.1	11.9	20.0
Denver (Exclude 9/2, 9/4)	Near-Roadway	8.3	5.8	7.9	9.3	12.7	18.0
	Nearest Background	6.8	4.2	5.8	8.0	11.8	17.2
Indianapolis	Near-Roadway	9.6	6.4	8.9	11.9	15.8	19.3
	Nearest Background	9.2	6.0	8.1	11.4	15.6	19.2
Louisville	Near-Roadway	8.9	6.1	8.0	10.6	14.6	19.8
	Nearest Background	7.9	4.9	7.1	9.9	13.7	17.0
Milwaukee	Near-Roadway	8.4	5.2	7.3	10.5	13.9	22.9
	Nearest Background	7.8	4.6	6.5	10.2	14.0	20.8
Providence	Near-Roadway	8.2	5.6	7.6	10.1	13.4	17.4
	Nearest Background	6.2	3.6	5.5	7.9	11.2	15.1

[8] In January 2023, EPA proposed lowering the annual standard to the 9 to 10 µg/m^3 range; EPA did not propose modifying the daily standard, but it is soliciting input on lowering this to 25 µg/m^3. See https://www.epa.gov/newsreleases/epa-proposes-strengthen-air-quality-standards-protect-public-harmful-effects-soot#:~:text=The%20Agency%20is%20proposing%20to,25%20micrograms%20per%20cubic%20meter..

Figure C-1. Distribution of 24-hr PM2.5 measurements in 2017 at 5 pairs of near-roadway and nearest background monitors.



Near-Roadway Incremental PM2.5 Impacts

For each location, directly comparing the two technically suitable, co-located monitors on matched dates was applied to estimate the incremental near-roadway air quality impacts. The distribution of incremental impacts is summarized in Table C-3 and Figure C-2. Maximum impacts measured in 2017 range from 3 to 10 µg/m^3.

Table C-4 presents the monthly distribution of the highest 10 percent incremental PM2.5 impacts for each location. Common to all 5 locations is that high incremental PM2.5 events most frequently occur in the late-fall/winter and least frequently in the summer. STI completed a detailed analysis the highest incremental events at two of the near-roadway locations (Denver and Indianapolis) and found that these events were associated with distinct meteorological conditions.[9] Key seasonal factors are that re-entrained road dust varies with precipitation (which varies by season), gasoline PM exhaust emissions go up significantly with colder temperatures and meteorological conditions vary by season.

Table C-3. Distribution of near-roadway incremental PM2.5 µg/m^3 (2017).

Location	Maximum	Mean	Percentile		
			50%	75%	90%
Denver	9.8	1.8	1.5	2.2	3.7
Indianapolis	4.5	0.5	0.5	0.9	1.4
Louisville	3.5	0.9	0.9	1.3	1.9
Milwaukee	3.7	0.4	0.5	1.0	1.4
Providence	9.6	2.1	2.1	3.2	4.4

Table C-4. Monthly distribution of highest 10 percent incremental PM2.5 impacts (2017).

Month	Denver	Indianapolis	Louisville	Milwaukee	Providence
JAN	75%	9%	18%	-	9%
FEB	-	9%	27%	-	6%
MAR	-	9%	9%	27%	-
APR	-	-	9%	-	-
MAY	-	27%	-	-	6%
JUN	-	-	-	-	3%
JUL	-	-	-	-	-
AUG	-	-	-	-	9%
SEP	-	-	-	-	3%
OCT	-	9%	-	27%	18%
NOV	-	-	18%	18%	15%
DEC	25%	36%	18%	27%	32%

[9] Slightly off parallel, light wind conditions were found to result in the highest near-roadway PM2.5 measurements at both locations; see https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6539787/.

Figure C-2. Distribution of near roadway incremental PM2.5 in 2017

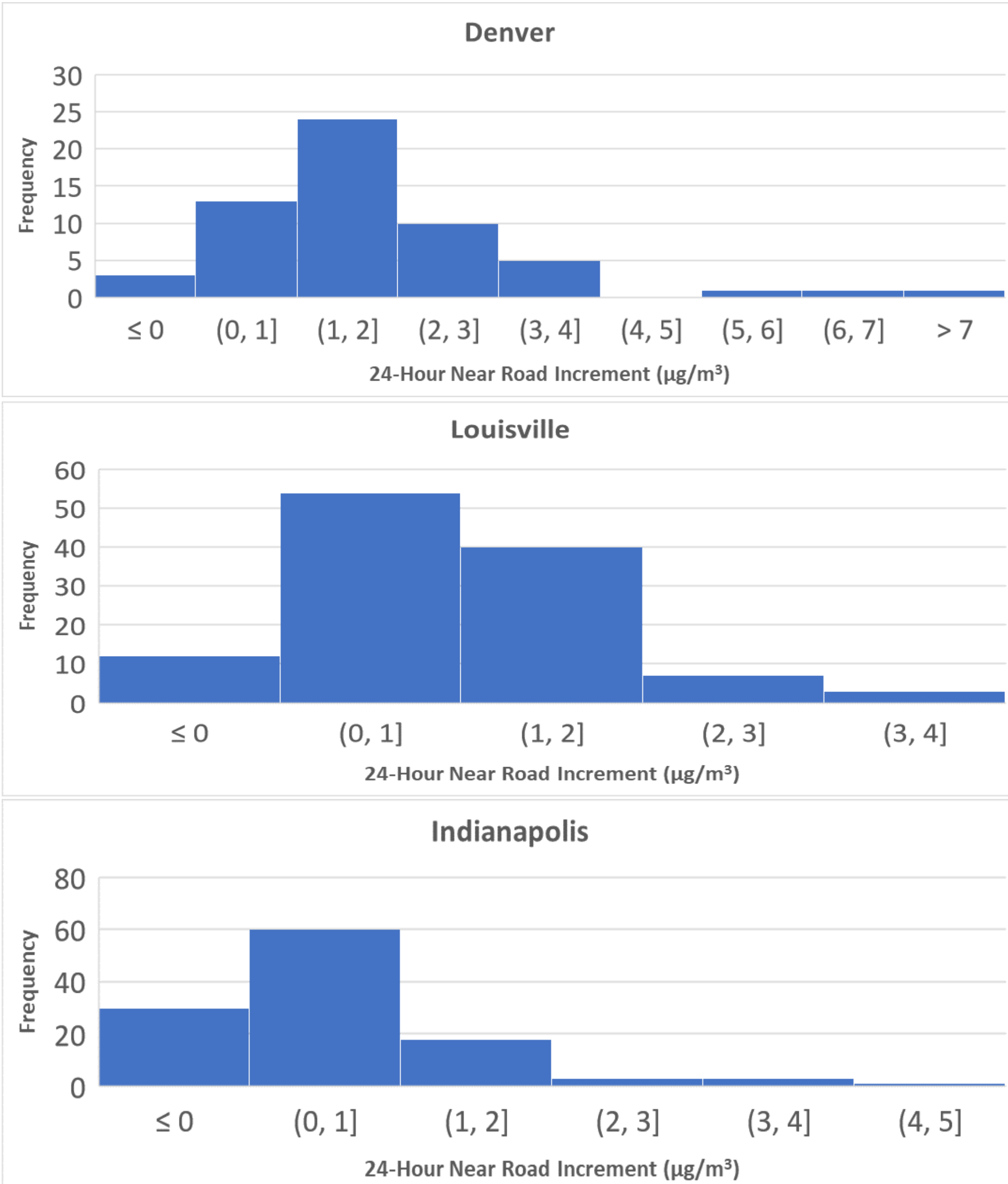
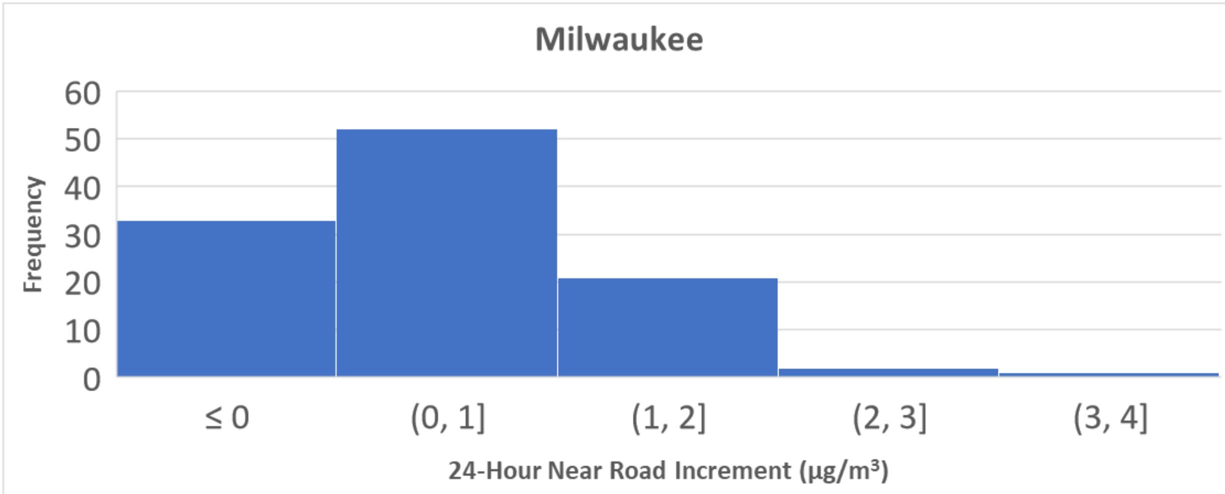
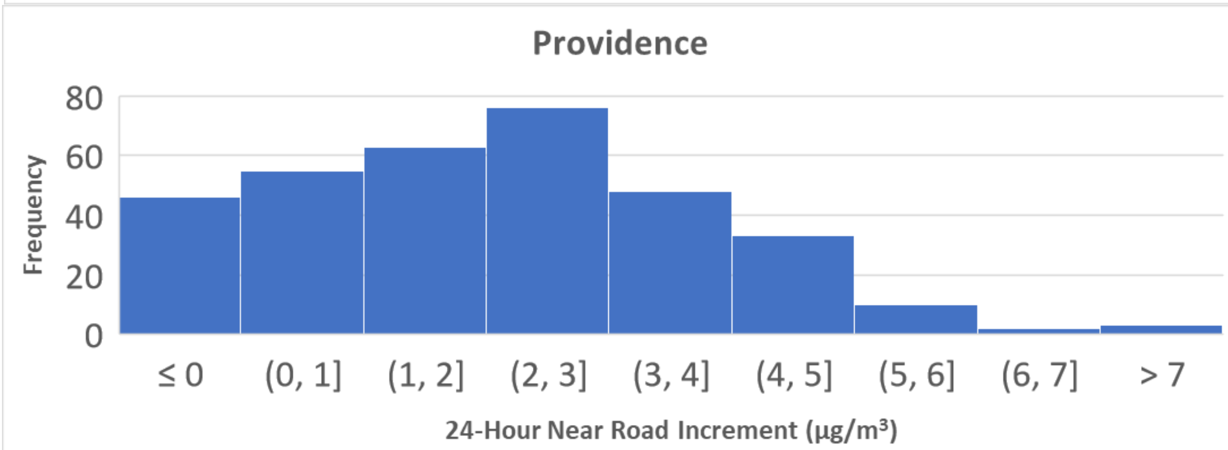


Figure C-2 (continued). Distribution of Near Roadway Incremental PM2.5 in 2017





Regulatory Impact Analysis on Near-Roadway Air Quality

The estimated incremental PM2.5 impacts for 2017 were extrapolated forward to the period of 2030 to 2050 using MOVES3 statewide, annual modeling – under the assumption of no growth in AADT of each roadway. The forward extrapolation included the bounding impacts of the bounding low-range and high-range electrification scenarios along with the roadway specific mix of light-duty (LD) and heavy-duty (HD) traffic as observed in 2017. The national average HD VMT fraction on urban interstates in 2017 was 11 percent,[10] which compares to the observations of the individual roadways of the 5 locations as shown below.

- Denver = 1% HD VMT
- Indianapolis = 10% HD VMT
- Louisville = 6% HD VMT
- Milwaukee = 0% HD VMT
- Providence = 14% HD VMT

Tables C-5 and C-6 present the forecasted mean incremental PM2.5 impact of the base and control cases, respectively. Table C-7 presents the percent reduction in incremental PM impact achieved by the proposed regulation. Within these locations both Denver and Providence are California ZEV mandate states, whereas the other 3 locations meet federal LD regulatory requirements. The reduction in incremental PM2.5 is larger for the low electrification case as a greater number of vehicles would meet the prosed LD PM standards.

Table C-5. Base case forecast of mean near-roadway incremental PM2.5.

Location	Electrification Scenario	Mean Near-Roadway Incremental PM2.5 ($\mu g/m^3$) 2030	2035	2040	2045	2050
Denver	Low-Range	1.53	1.39	1.25	1.12	1.07
	High-Range	1.49	1.28	1.09	0.91	0.85
Indianapolis	Low-Range	0.46	0.42	0.41	0.39	0.39
	High-Range	0.45	0.39	0.35	0.31	0.29
Louisville	Low-Range	0.75	0.69	0.67	0.65	0.64
	High-Range	0.74	0.64	0.57	0.51	0.47
Milwaukee	Low-Range	2.00	1.88	1.83	1.78	1.76
	High-Range	1.95	1.73	1.54	1.36	1.24
Providence	Low-Range	0.31	0.27	0.25	0.23	0.22
	High-Range	0.30	0.25	0.21	0.18	0.17

[10] *Highway Statistics 2017*, Federal Highway Administration: https://www.fhwa.dot.gov/policyinformation/statistics/2017/.

Table C-6. Control case forecast of mean near-roadway incremental PM2.5.

Location	Electrification Scenario	Mean Near-Roadway Incremental PM2.5 ($\mu g/m^3$) 2030	2035	2040	2045	2050
Denver	Low-Range	1.48	1.25	1.06	0.89	0.83
	High-Range	1.46	1.22	1.01	0.83	0.77
Indianapolis	Low-Range	0.44	0.36	0.32	0.28	0.26
	High-Range	0.44	0.35	0.30	0.25	0.23
Louisville	Low-Range	0.72	0.59	0.51	0.44	0.41
	High-Range	0.71	0.58	0.49	0.40	0.38
Milwaukee	Low-Range	1.87	1.51	1.26	1.02	0.95
	High-Range	1.86	1.49	1.22	0.98	0.90
Providence	Low-Range	0.30	0.25	0.22	0.20	0.19
	High-Range	0.30	0.24	0.20	0.17	0.16

Table C-7. Reduction in near-roadway incremental PM2.5 achieved by the proposed regulatory case.

Location	Electrification Scenario	Reduction in Near-Roadway PM2.5 Increment 2030	2035	2040	2045	2050
Denver	Low-Range	3%	10%	15%	21%	23%
	High-Range	2%	5%	7%	9%	9%
Indianapolis	Low-Range	4%	13%	22%	30%	32%
	High-Range	3%	10%	14%	19%	19%
Louisville	Low-Range	4%	15%	23%	32%	35%
	High-Range	3%	10%	15%	21%	20%
Milwaukee	Low-Range	6%	20%	31%	43%	46%
	High-Range	5%	14%	20%	28%	27%
Providence	Low-Range	2%	7%	10%	14%	15%
	High-Range	1%	3%	5%	6%	7%

Analysis Limitations and Other Final Comments

Data, tools and guidance to support near-roadway concentration estimates are new and relatively limited – when compared to the multiple generations of analysis tools to support NAAQS-scale PM impact assessments. The near-roadways results herein are useful to indicate that near roadway impacts of the proposed regulatory change would be meaningful – though the ability to get reliable, numerical localized impacts is challenging. Assumptions regarding future year AADT and non-exhaust PM components are approximate.

Another key observation is that the preponderance of high near roadway incremental PM concentrations has a strong seasonal pattern towards late fall and winter for all 5 locations. This implies that meteorology, seasonal and episodic conditions may be more important in evaluating elevated near-roadway concentration events. This analysis is largely based on annualized inventory extrapolations and key variables held as constants that could vary under seasonal or episodic conditions.