



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**  
**Office of Air Quality Planning and Standards (OAQPS)**  
**Research Triangle Park, North Carolina 27711**

December 14, 2012

**MEMORANDUM**

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**SUBJECT:** Updated comparison of 24-hour PM<sub>2.5</sub> design values and visibility index design values

**FROM:** James Kelly, Mark Schmidt, and Neil Frank, Air Quality Assessment Division, OAQPS/OAR /s/

**TO:** PM NAAQS Review Docket (EPA-HQ-OAR-2007-0492)

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This memorandum updates the original area-by-area evaluations in Kelly et al. (2012a), “Technical Analysis to Support Surrogacy Policy for Proposed Secondary PM<sub>2.5</sub> NAAQS Under NSR/PSD Program” that compared 24-hour PM<sub>2.5</sub> design values and visibility index design values.

Two updates to the original comparison of 24-hour PM<sub>2.5</sub> design values and visibility index design values are presented. First, design values based on 2008-2010 data are recalculated to reflect: (1) use of a revised multiplier of 1.6 for purposes of estimating organic mass (OM) concentration from measured organic carbon (OC) concentration in the calculation of visibility index design values, as compared to a value of 1.4 used in Kelly et al. (2012a)<sup>1</sup>; and (2) consistency with the data completeness criteria of 40 CFR Part 50, Appendix N and with removal of data approved by EPA as exceptional events for the existing 24-hour PM<sub>2.5</sub> standard and the PM<sub>2.5</sub> visibility index standard proposed by EPA (77 FR 38890, June 29, 2012).

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<sup>1</sup> With regard to the multiplier, there has been considerable debate within the research community about the appropriate multiplier for converting measured OC to OM in urban environments. As discussed in Appendix F of the Policy Assessment (U.S. EPA, 2011a) for the review of the national ambient air quality standards (NAAQS) for particulate matter (PM), the EPA used the SANDWICH mass closure approach in the Urban Focused Visibility Assessment (U.S. EPA, 2010b) for purposes of calculating maximum daylight hourly PM<sub>2.5</sub> light extinction and evaluated which multiplier would produce 24-hour results most similar to the SANDWICH approach using 24-hour PM<sub>2.5</sub> organic carbon derived from the new Chemical Speciation Network (CSN) carbon monitoring protocol established in 2007. Analyses presented in Appendix F of the Policy Assessment indicate that a multiplier of 1.6 is most appropriate for purposes of comparing the hourly PM<sub>2.5</sub> light extinction with calculated 24-hour extinction (see Appendix F, section F.6 for a full explanation). The EPA also considers this higher multiplier to be a better approach for urban CSN monitoring sites where the new measurements of organic carbon tend to be lower than those produced by the older NIOSH-type monitoring protocol (Malm, 2011). A multiplier of 1.6 is now used to calculate OM from PM<sub>2.5</sub> OC derived from the new measurement protocol at CSN sites while 1.4 is used for PM<sub>2.5</sub> OC from the older NIOSH-type monitoring.

Second, design values for the existing 24-hour PM<sub>2.5</sub> NAAQS and the proposed PM<sub>2.5</sub> visibility index standard are calculated using more recently available 2009-2011 data from CSN sites that have speciated PM<sub>2.5</sub> measurements collocated with Federal Reference Method (FRM) measurements of total PM<sub>2.5</sub>. As in Kelly et al. (2012a), we then evaluate the relationship between these updated design values for the existing 24-hour PM<sub>2.5</sub> standard and the proposed visibility index standard along with violation status under each standard.

To provide context for the discussion below, a reproduction of Figure 6 from Kelly et al. (2012a) is provided here in Figure 1. This figure depicts data from 102 sites that meet the current and/or proposed data completeness criteria of 40 CFR Part 50, Appendix N for the 24-hour PM<sub>2.5</sub> standard and the proposed visibility index standard at a level of 30 dv. As defined in Kelly et al. (2012a), the data markers are color-coded according to the U.S. regions and are shape-coded according to location in the eastern or western U.S. The four quadrants demarcated by solid grey lines identify zones of exceedance for the 24-hour PM<sub>2.5</sub> standard and the proposed visibility index standard at a level of 30 dv. Note that the quadrants in Figure 1 are based on design values of 35.5 µg/m<sup>3</sup> and 30.5 dv (rather than 35 µg/m<sup>3</sup> and 30 dv) to reflect rounding conventions.

Updated design values for the 2008-2010 period are presented in Figure 2 based on the methodology updates described above (i.e., use of an updated OC-to-OM multiplier in calculating visibility index design values, ensuring consistency with the data completeness criteria of 40 CFR Part 50, Appendix N, and exclusion of data approved by EPA as exceptional events for the existing 24-hour PM<sub>2.5</sub> standard and the proposed visibility index standard). Based on the updated data selection criteria, data from 5 additional monitoring sites are considered valid here compared with Kelly et al. (2012a). For example, the CSN site in Fairbanks, Alaska is considered valid in this analysis but was not included previously.

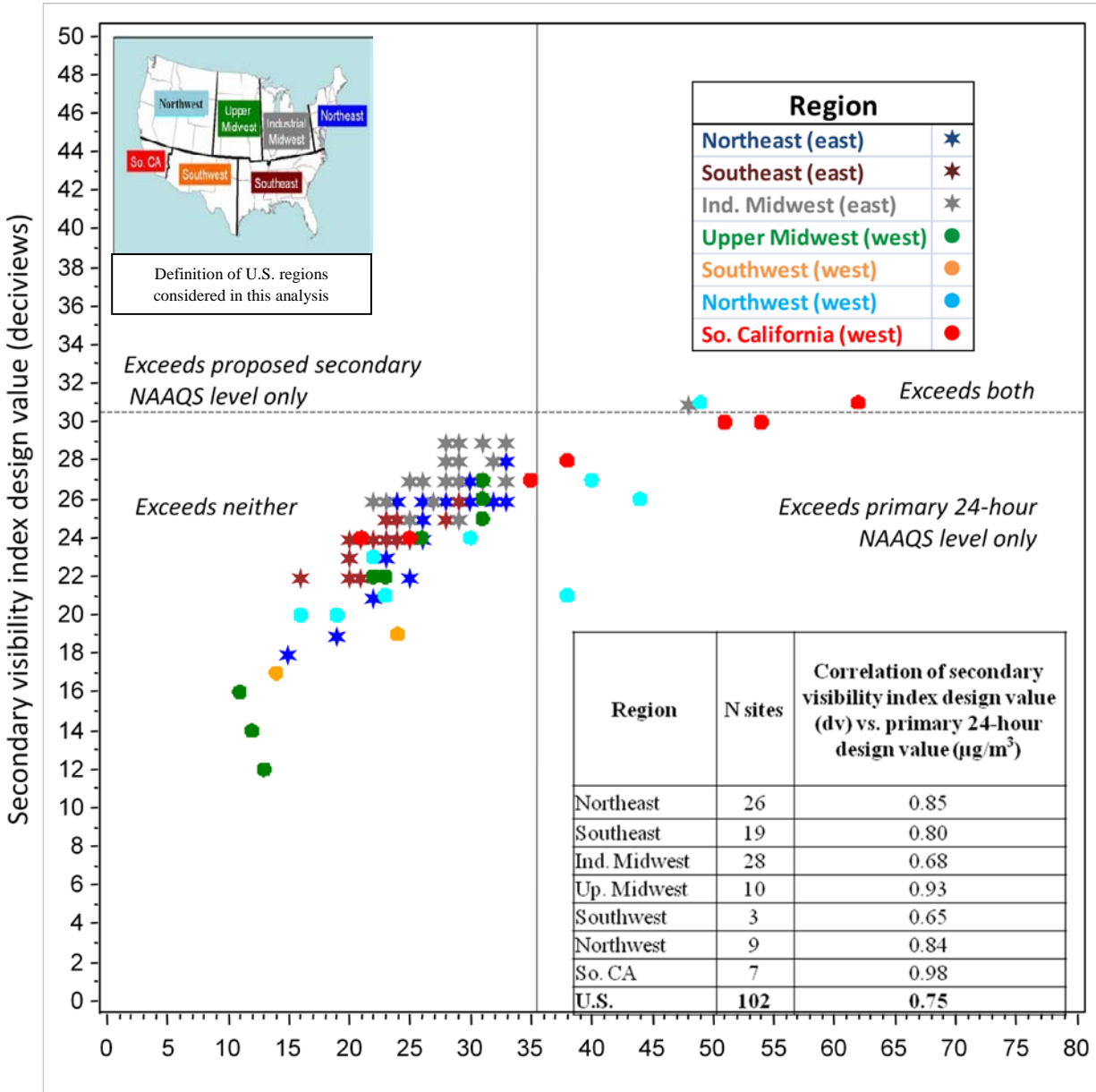
The updated 2008-2010 design values show a similar relationship between visibility index and 24-hour PM<sub>2.5</sub> design values to that shown in Kelly et al. (2012a) in terms of which quadrant each data point falls into (see Figures 1 and 2, below). The change in OC-to-OM multiplier had a minor impact on visibility index design values in part because only a subset of the OC measurements were based on CSN's newer monitoring protocol and required use of the updated multiplier. In addition, the updates to ensure consistency with data completeness criteria and treatment of exceptional events had a minor impact on both the visibility index and 24-hour PM<sub>2.5</sub> design values. As a result, the updated 2008-2010 analysis still shows that no design value falls into the upper-left quadrant where the visibility index of 30 dv is exceeded and the 24-hour PM<sub>2.5</sub> design is less than 35 µg/m<sup>3</sup>.

Updated design values for the 2009-2011 period are presented in Figure 3 for 100 CSN monitoring sites with collocated FRM measurements. Results based on the more recent 2009-2011 data reveal a similar relationship between visibility index and 24-hour PM<sub>2.5</sub> design values as those based on 2008-2010 data. As in Figures 1 and 2, no design value falls into the upper-left quadrant where the visibility index of 30 dv is exceeded and the 24-hour PM<sub>2.5</sub> design is less than 35 µg/m<sup>3</sup>. Therefore results based on the 2009-2011 data corroborate the findings based on 2008-2010 data as described in Kelly et al. (2012a) and here.

In summary, we made two updates to the original area-by-area evaluations by Kelly et al. (2012a) of the relationship between 24-hour PM<sub>2.5</sub> design values and visibility index design values. Consistent with the results of Kelly et al. (2012a), the updated analyses indicate that no area had a visibility index design value that exceeded 30 dv while meeting the existing 24-hour PM<sub>2.5</sub> standard level of 35 µg/m<sup>3</sup>. Furthermore, in light of the empirical relationship between the data points depicted in Figures 2 and 3, below, it appears that the updated analyses corroborate the conclusion of Kelly et al. (2012a) that a visibility index standard, as proposed, at a level of 30 dv would likely be attained at sites that violate both the existing 24-hour PM<sub>2.5</sub> standard and a visibility index standard at a level 30 dv if PM<sub>2.5</sub> concentrations were reduced such that the 24-hour PM<sub>2.5</sub> standard level was attained.

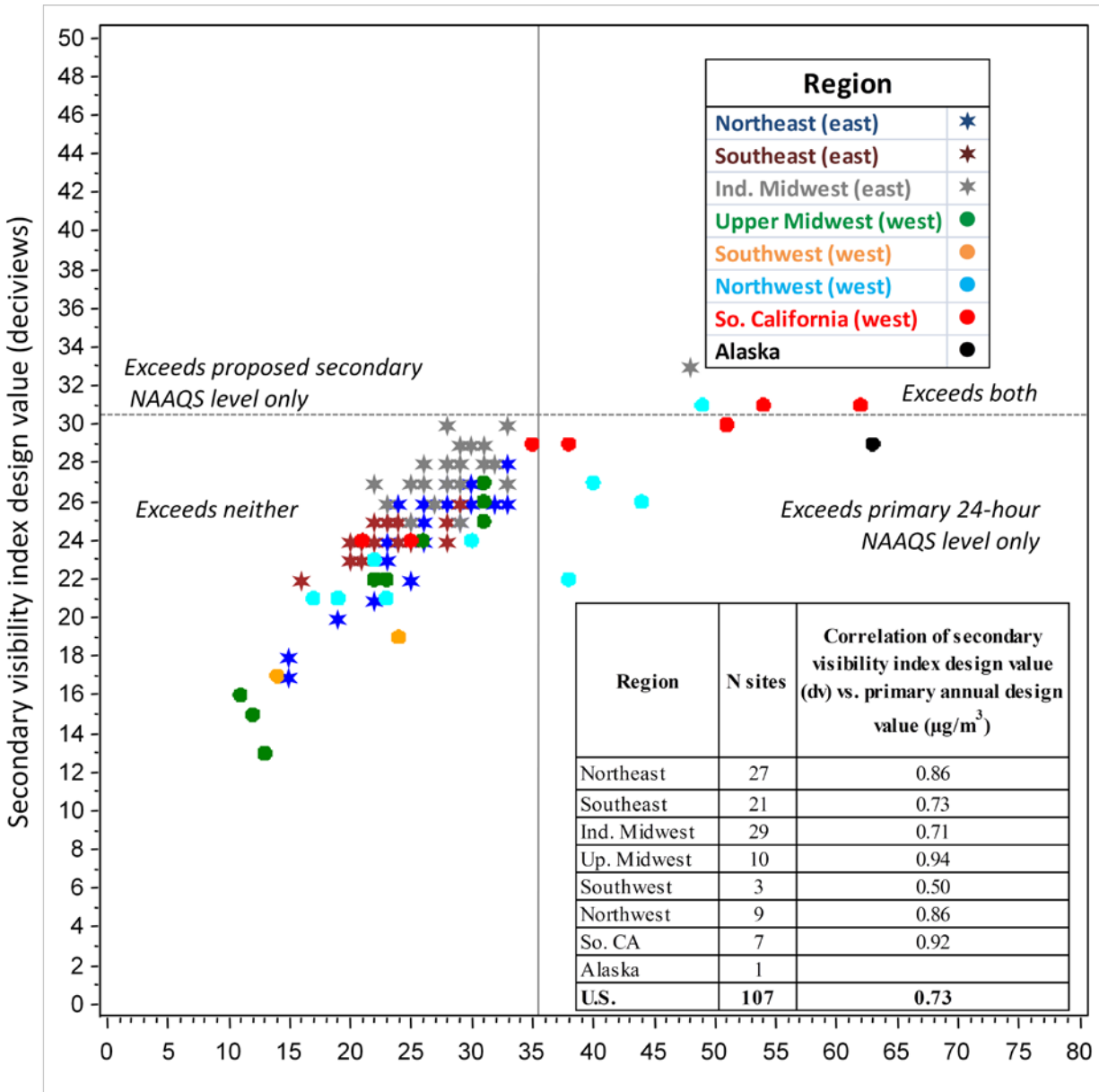
## References

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**Figure 1. Design values for 24-hour  $\text{PM}_{2.5}$  standard and proposed visibility index standard based on 24-hour average  $\text{PM}_{2.5}$  measurements from 2008 to 2010 for sites that meet the current and/or proposed data completeness criteria of 40 CFR Part 50, Appendix N, for the 24-hour  $\text{PM}_{2.5}$  standard and the proposed visibility index standard at a level of 30 dv (presented as Figure 6 in Kelly, et al., 2012a)<sup>2</sup>**

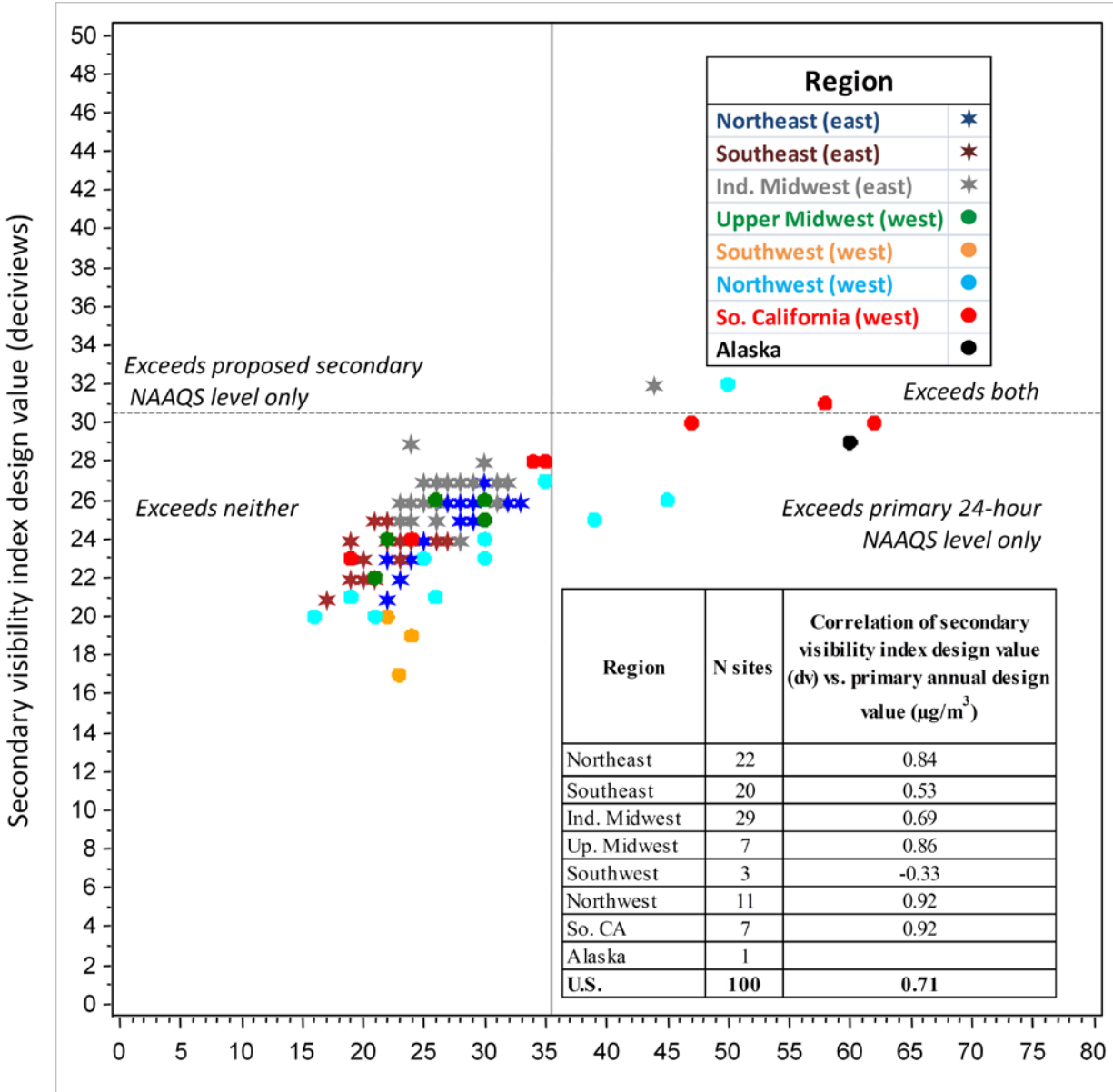
<sup>2</sup> Quadrants in the figure are based on design values of  $35.5 \mu\text{g}/\text{m}^3$  and 30.5 dv (rather than  $35 \mu\text{g}/\text{m}^3$  and 30 dv, respectively) to reflect rounding conventions.



**Figure 2. Updated<sup>3</sup> design values for 24-hour PM<sub>2.5</sub> NAAQS and secondary visibility index NAAQS based on 24-hour average PM<sub>2.5</sub> measurements from 2008 to 2010 for sites that meet the current and/or proposed data completeness criteria of 40 CFR Part 50, Appendix N, for the 24-hour PM<sub>2.5</sub> NAAQS and the 30-dv visibility index NAAQS<sup>4</sup>**

<sup>3</sup> Updated Figure 6 from Kelly et al., 2012a, based on 2008-2010 data. In this update, OM is calculated as 1.6 \* PM<sub>2.5</sub> OC when OC is measured with the CSN's revised monitoring protocol for carbon. Also, speciated PM<sub>2.5</sub> component measurements as well as PM<sub>2.5</sub> mass were excluded on days when PM<sub>2.5</sub> mass concentrations were approved by EPA as an exceptional event.

<sup>4</sup> Quadrants in the figure are based on design values of 35.5 µg/m<sup>3</sup> and 30.5 dv (rather than 35 µg/m<sup>3</sup> and 30 dv, respectively) to reflect rounding conventions.



**Figure 3. Design values for 24-hour  $\text{PM}_{2.5}$  NAAQS and secondary visibility index NAAQS based on 24-hour average  $\text{PM}_{2.5}$  measurements from 2009 to 2011 for sites that meet the current and/or proposed data completeness criteria of 40 CFR Part 50, Appendix N, for the 24-hour  $\text{PM}_{2.5}$  NAAQS and the 30-dv visibility index NAAQS<sup>5</sup>**

<sup>5</sup> Quadrants in the figure are based on design values of  $35.5 \mu\text{g}/\text{m}^3$  and 30.5 dv (rather than  $35 \mu\text{g}/\text{m}^3$  and 30 dv, respectively) to reflect rounding conventions.