APPENDIX III.K.13.H REGIONAL HAZE VISIBILITY PROTECTION AREA

1. OVERVIEW

The Regional Haze Rule requires Alaska to submit a 10- to 15-year long-term strategy (LTS) to address regional haze visibility impairment in each Class I area in Alaska. To assist the state's efforts in establishing the LTS and to track and control current and potential new sources that may affect visibility in the Class I areas, ADEC is proposing to establish a Regional Haze Visibility Protection Area (VPA). Emitting sources within the VPA would be subject to reporting and permit application requirements to be set by the state.

VPA is proposed for Denali National Park and Preserve and Tuxedni National Wildlife Refuge Class I areas. There is no air monitoring being conducted for the Bering Sea Wilderness Area due to its remote location and its inaccessibility. VPA is not established for the Simenof Wilderness Area due to its remoteness and large visibility contributions from natural sources and commercial marine emissions that are being addressed through different measures.

This appendix describes methodology used to establish the VPA. The fundamental considerations of establishing VPA are that VPA must 1) capture transport of pollution impacting visibility at each Class I area; 2) address existing and new potential high impacting sources; 3) align with established jurisdictional boundaries. The first two fundamentals are addressed through an Area of Influence (AOI) and Weighted Emissions Potential (WEP) analysis as described in Section K.13.G.6 *Alaska Area of Influence (AOI) and Weighted Emissions Potential (WEP) analysis*.

2. ESTABLISHMENT OF VISIBILITY PROTECTION AREA BOUNDARY

The establishment of the VPA required four main steps that are summarized here and described in more detail below:

1. Define the subset of stationary point sources that affect visibility for the Class I area.

2. Select a jurisdictional boundary over which the VPA was to be defined that includes those sources.

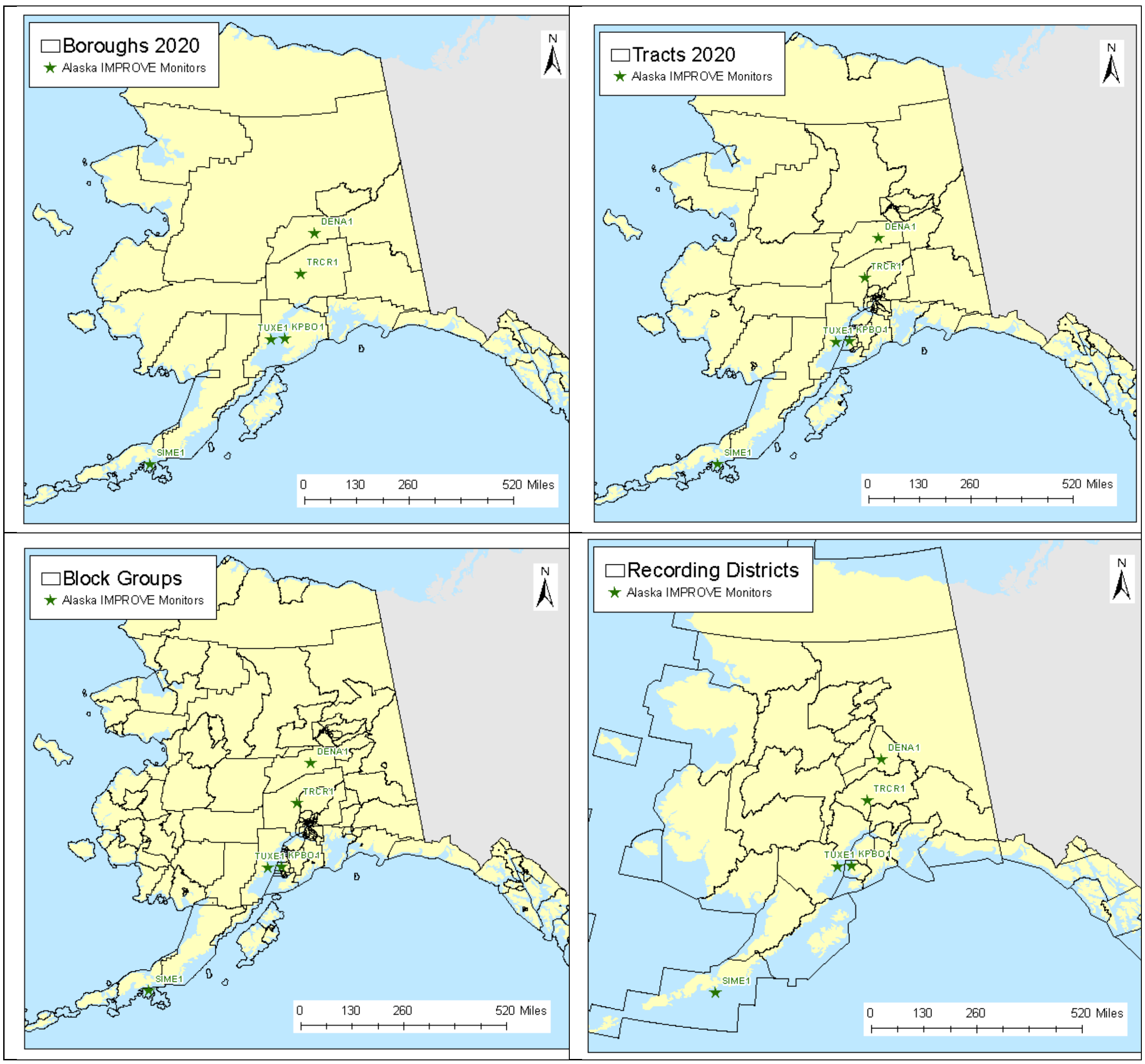
3. Determine the appropriate directionality and extent of the VPA for each Class I area. This was accomplished by analysis of the back-trajectory residence times (RT) analysis and WEP NO_x and SO_x analysis for the most impaired days (MID). NO_x and SO_x are the two main PM precursors from anthropogenic sources that contribute to visibility impairment at these locations.

4. Verify the defined VPA with respect to the current WEP for NO_x and SO_x to ensure that the VPA comprises the vast majority (e.g., more than 80 %) of current anthropogenic emissions that contribute to SO_4 and NO_3 impairment on the MID.

Jurisdiction boundaries selection

The preference for selecting the jurisdictional boundary type was to follow existing jurisdictional boundaries rather than establishing new boundaries. Four boundary types were considered as shown below in Figure 1. The top left panel displays the Alaskan boroughs which was the coarsest jurisdiction that was considered. The top right panel displays census tract boundaries that are a subdivision of the boroughs. The bottom left panel displays the block group jurisdictional boundary that is a subdivision of census tracts. The bottom right panel displays recording districts which are a different type of jurisdiction unrelated to the other three. The most refined jurisdictional boundary type is the block group which was selected as the jurisdictional boundary type for the VPA since it enables the most precise coverage of areas (i.e., the highest visibility impacting areas will be covered while simultaneously excluding areas with negligible visibility impacts).

Figure 1-. Jurisdictional boundary types in Alaska.



Residence Time and WEP Screening

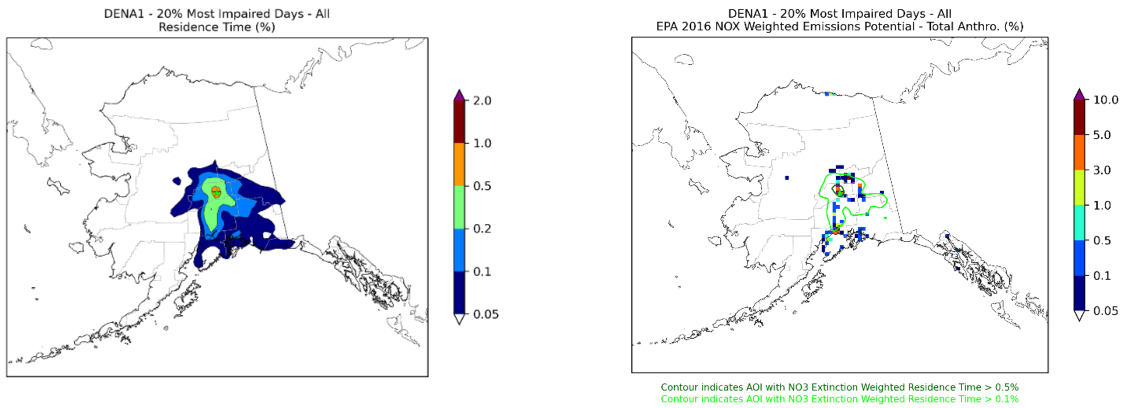
Knowledge of which geographic source regions have a high probability of contributing to anthropogenic visibility impairment at Class I areas on the MID in Alaska is critical to determine appropriate VPA coverage. The RT and WEP analyses identify, respectively, the locations and current anthropogenic sources of emissions within and nearby the state that had the potential to contribute the most to visibility impairment on the IMPROVE MID, thus are used here to form the basis of the VPA determination.

The two metrics used to determine the VPA are:

(1) **Residence Time (RT),** where the RT is the cumulative time that back trajectories reside in a specific geographical area and is normalized to display percentage of total trajectory time. An example is shown in the left panel of Figure 2. Note that the RT analysis was based on a 5-year current period (e.g., 2014-2018 for Denali) and was performed for all the MID over those 5-years to capture various meteorological conditions including those that may not occur every year. The RT analysis was based on the aggregated results for back-trajectories initiated at multiple heights above the ground (100 meter (m), 200 m, 500 m, and 1,000 m).

(2) **Weighted Emissions Potential (WEP**), where the WEP determines the potential impacts from sources by combing the extinction weighted residence time (EWRT) values with emissions (Q) from sources. Note that EWRT is the RT multiplied by the extinction coefficient attributed to the pollutant ((e.g., ammonium sulfate or ammonium nitrate) measured upon arrival at the IMPROVE site on the day that matches the day of the trajectory. To incorporate the dilution effects of dispersion, deposition and chemical transformation along the path of the trajectories, emissions were inversely weighted by the distance (*d*) between the centers of the grid cell emitting the emissions and the grid cell containing the IMPROVE site. An example of a WEP plot is shown in the right panel of Figure 0-2.

Figure 2-. Example of Residence Time (RT) analysis and weighted emissions potential (WEP) analysis for Denali.

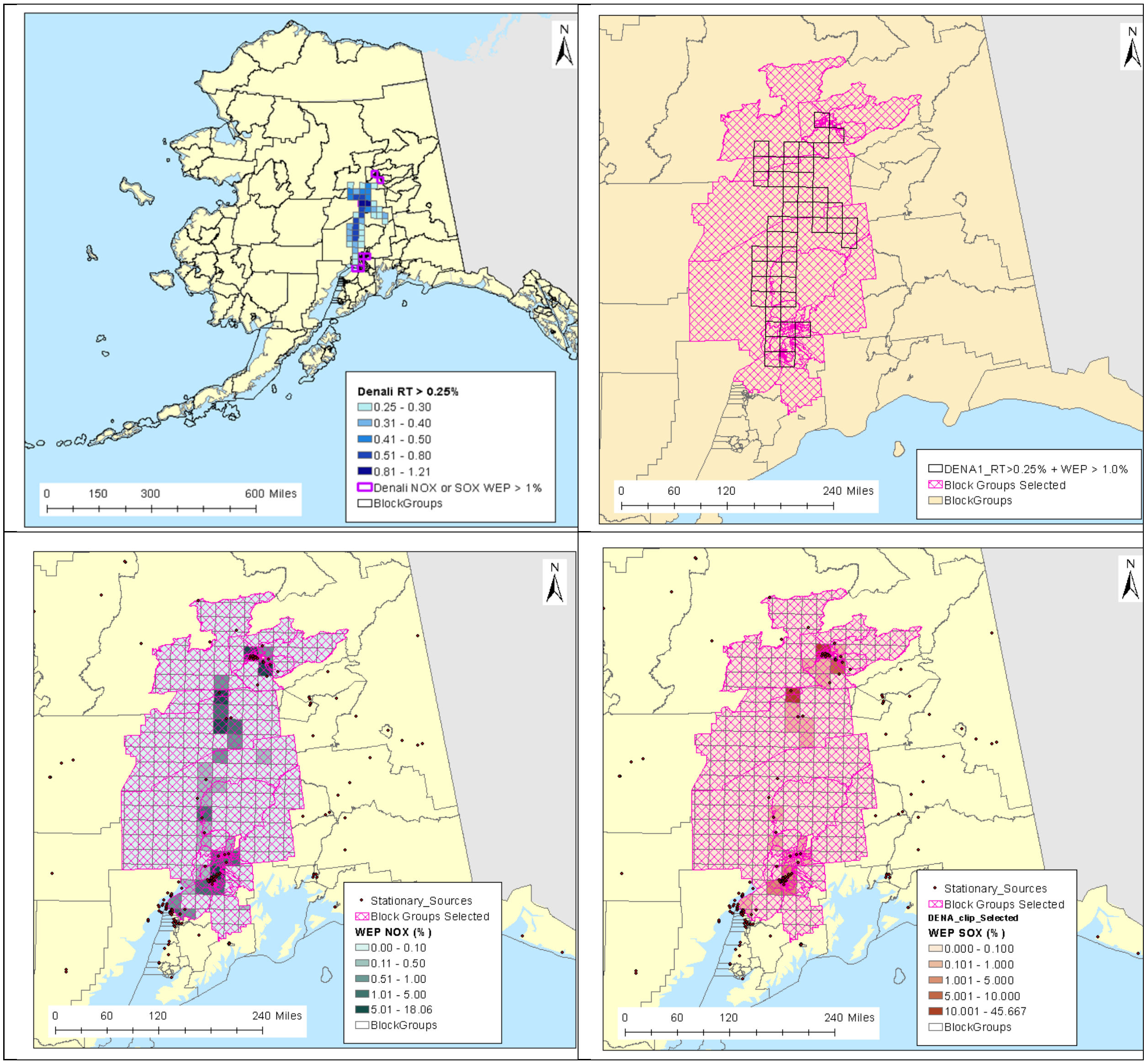


The VPA is required to satisfy a set of criteria thresholds for RT and WEP. The jurisdictional boundaries with grid cells above these thresholds are selected and included in the candidate VPA. Finally, the VPA needs to meet the minimum requirement of 80% of total WEP NO_x and SO_x. This process was performed multiple times with different RT thresholds including 0.1 %, 0.2 %, and 0.25 % and different jurisdictional boundaries. With the lower thresholds (and coarse boundaries) much of the state of Alaska was selected by this methodology including regions far from the IMPROVE monitor and with negligible contributing emissions. The 0.25 % RT threshold (with block group boundaries) captured a reasonable area coverage, and the addition of a WEP criteria threshold of WEP NO_x or SO_x of more than 1.0 % for any grid cells contiguous to the selected RT of more than 0.25 % grid cells ensured coverage of sources with high potential to contribute to visibility impairment. The final criteria were:

- Jurisdictional boundaries = Block Groups
- RT criteria threshold = 0.25 %
- WEP criteria threshold = 1.0% for WEP NOx or WEP SOx (for grid cells contiguous to the selected RT grid cells)

Figure 3 graphically presents the results of grid cell selection after applying the RT and WEP threshold (the upper left panel), the intersected jurisdictions (the upper right panel), and the resulting VPA with WEP NO_x and SO_x in the lower left and right panels, respectively, presenting Denali as an example of the methodology.

Figure 3-. Illustration of the VPA definition methodology using the Denali location as an example.



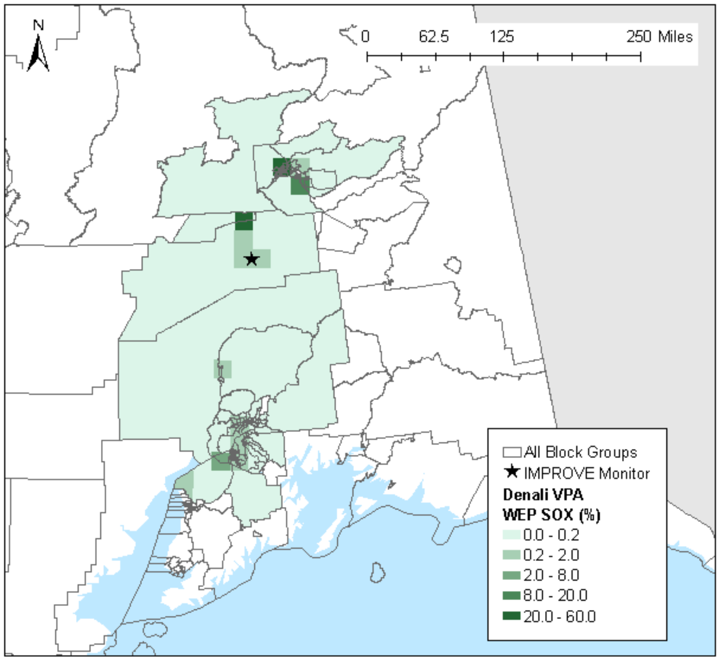
Results

Figures 4 to 7 present the VPA boundaries and NO_x and SO_x WEP emissions for the Denali Headquarters site (DENA1), the Trapper Creek Site in Denali National Park and Preserve (TRCR1), the Tuxedni National Wildlife Refuge (TUXE1) and the Simeonof Wilderness Area (SIME1), respectively. For all IMPROVE sites except SIME1, the VPA covers more than 80 % of the NO_x and SO_x WEP for that site (Table 1). The SIME1 VPA only covers 13 % of the SO_x WEP and 69% of the NO_x WEP. Most of the WEP SO_x for SIME are from emissions over the water that are not included in the emissions sum over the block group since the block jurisdictions do not extend very far into the ocean. In addition, the dominant anthropogenic emissions in this region are from Commercial Marine Vessels (CMV) that are regulated separately from this proposed effort. For these reasons, Simenonof Wilderness Area is omitted from the proposed VPA. (Figure 8)

Table 1. Summary of NO_x and SO_x WEP percentage contained the VPA defined for each IMPROVE monitor.

IMPROVE site	Sum WEP	
	NO_x (%)	SO_2 (%)
Denali Headquarters site (DENA1)	88	95
Trapper Creek Site in Denali National Park and Preserve (TRCR1)	95	84
Tuxedni National Wildlife Refuge (TUXE1)	90	87
Simeonof Wilderness Area (SIME1)	69	13

Figure 4-. SO_x and NO_x WEP within the VPA for Denali Headquarters Site (DENA1)



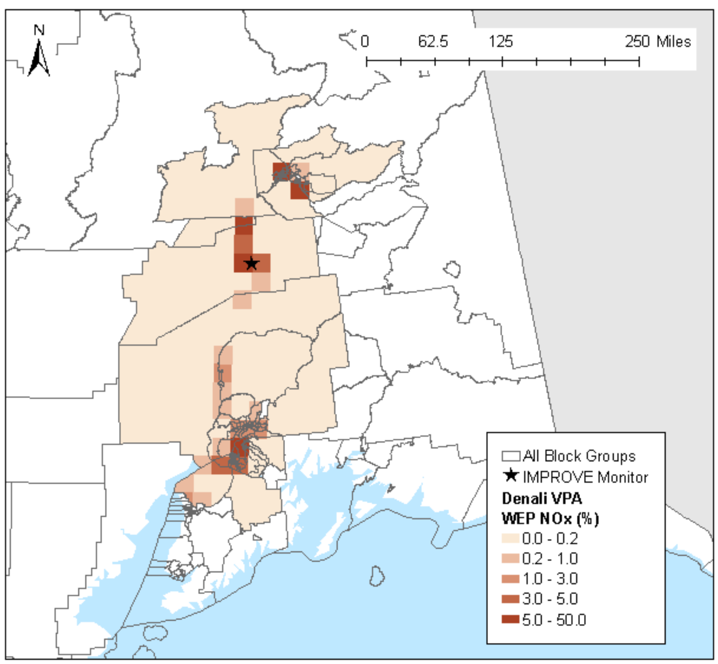
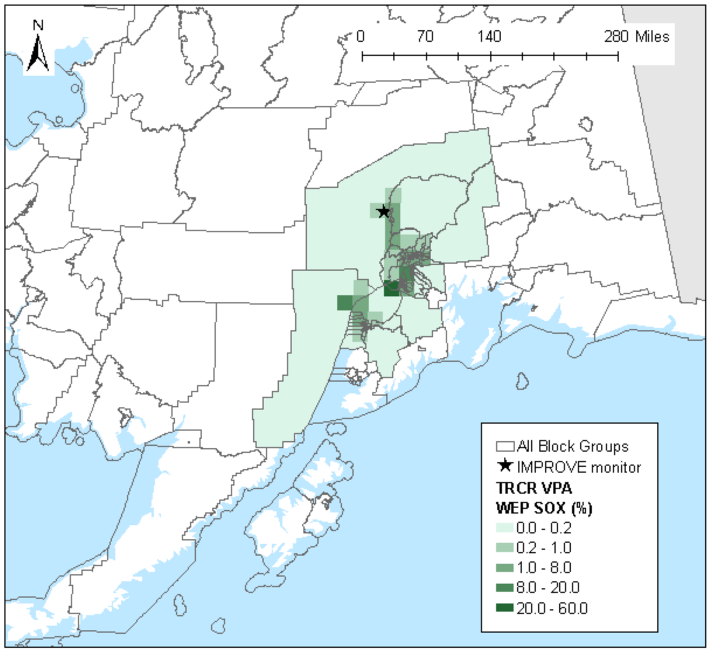


Figure 5-. SO_x and NO_x WEP within the VPA for Trapper Creek Site in Denali National Park and Preserve (TRCR1)



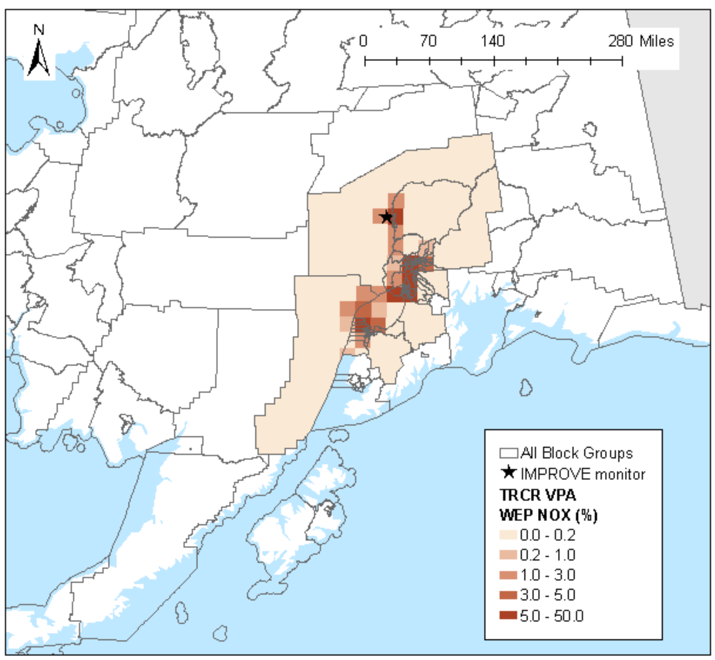
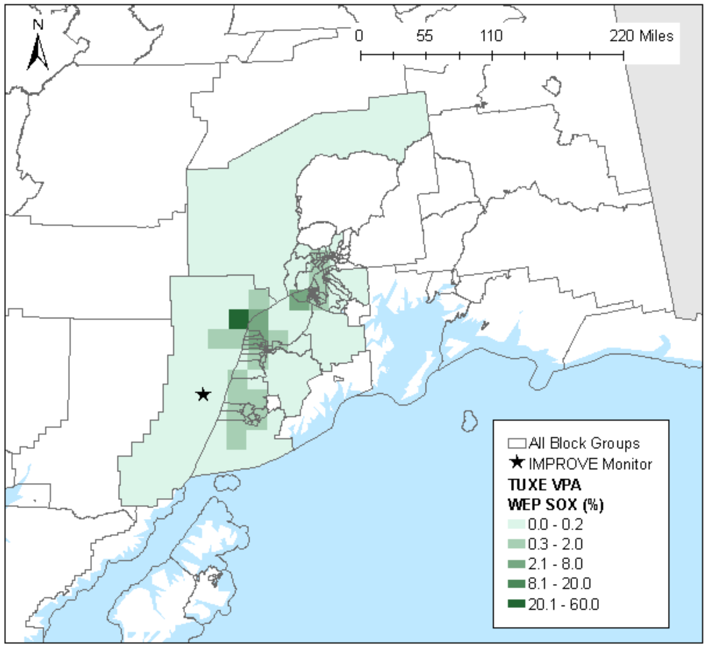


Figure 6-. SO_x and NO_x WEP within the VPA for Tuxedni National Wildlife Refuge (TUXE1)



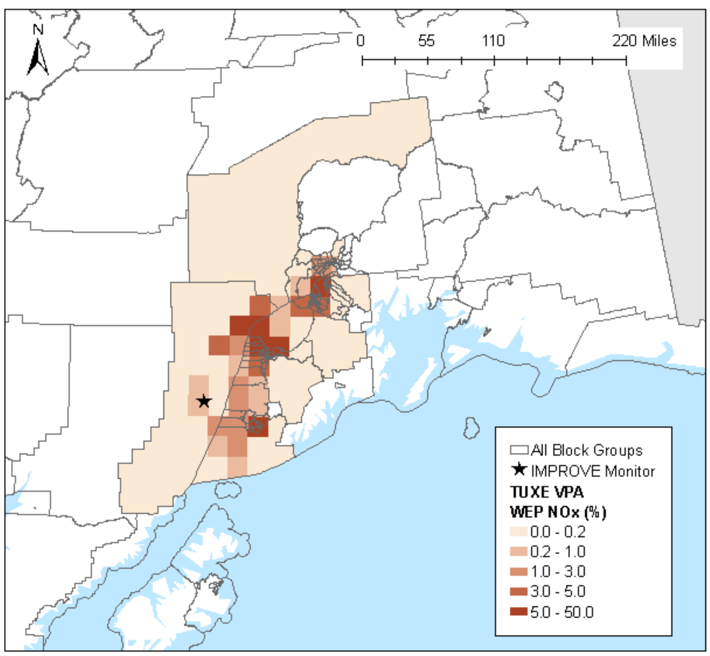
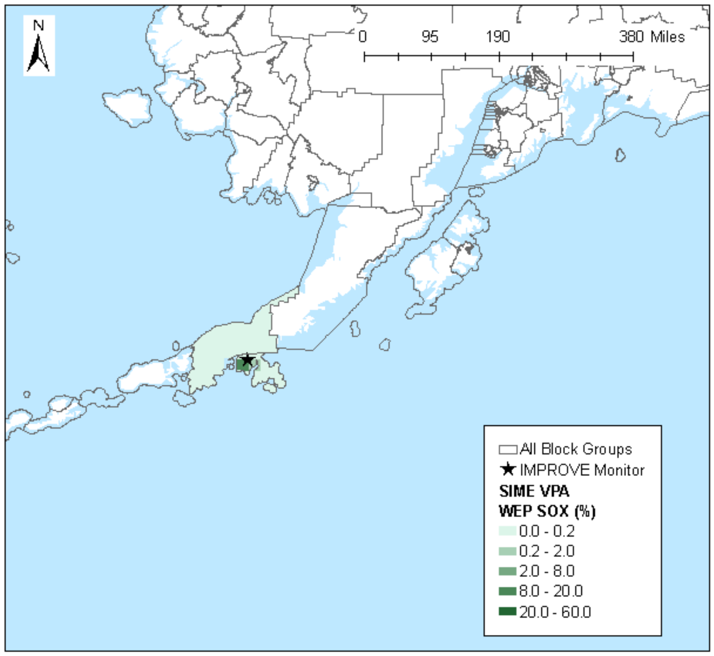


Figure 7-. SO_x and NO_x WEP within the VPA for Simeonof Wilderness Area (SIME1)



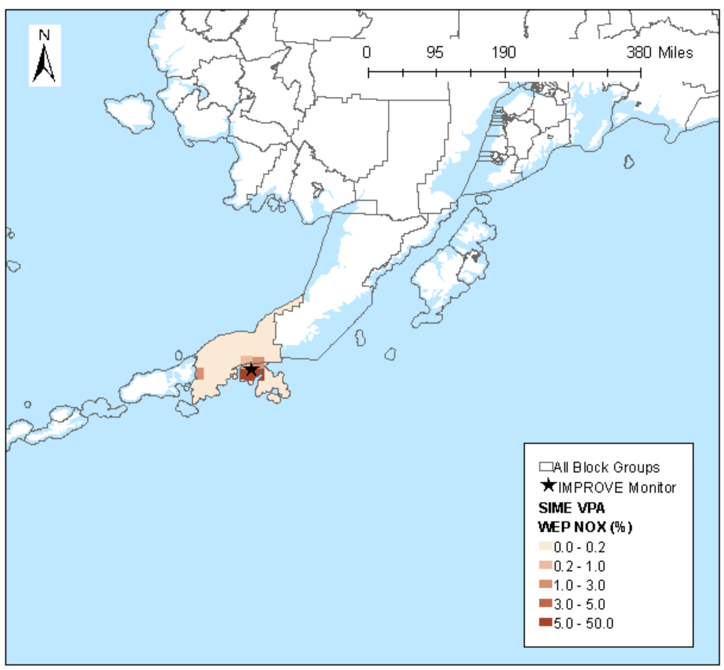
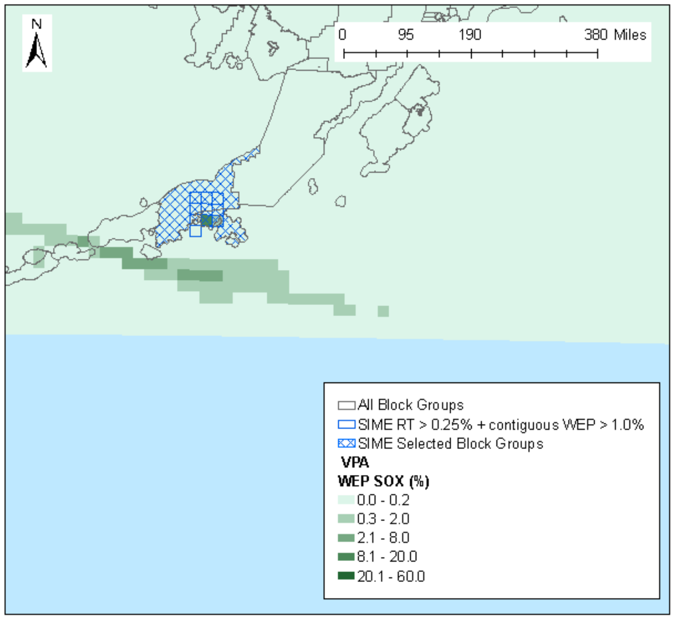


Figure 8-. Simeonof detail showing WEP SO_x emissions outside of the VPA boundary that was developed following the methodology



3. CONCLUSIONS

A visibility protection area has been defined based on prior analysis of the atmospheric transport patterns to the IMPROVE monitors in Denali National Park and Preserve and the Tuxedni National Wildlife Refuge. Figure 9 shows the extent of the combined VPA boundaries from the three IMPROVE sites at the two Class I areas. The proposed VPA covers a minimum of 84% of the current SO_x WEP and 88% of the current NO_x WEP for each individually defined VPA and the combined VPA will have even higher percentile coverage. In addition, since the method is primarily based on prevailing transport patterns irrespective of the location of current emission sources, regions that could potentially impact the IMPROVE monitors in the future due to being frequently upwind of the monitor are also included in the VPA. This method is robust at addressing both current and potential future source contributions to visibility impacts at the two Class I areas. (Figure 10)

Figure 9-. Proposed VPA boundaries

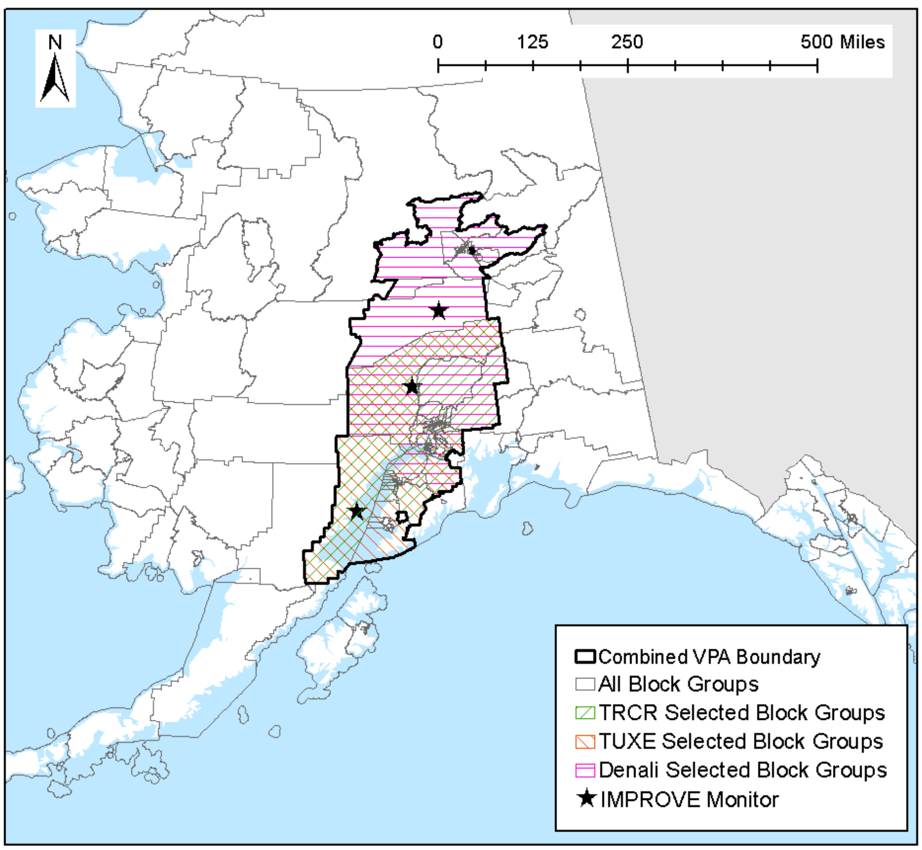


Figure 10. Proposed VPA boundaries final graphic