Chapter 8 Source Apportionment of Washington's Mandatory Class I Areas and Washington's Impacts on Out-of-State Mandatory Class I Areas

This chapter discusses the following:

- Significant in-state and regional sources of haze affecting Washington's mandatory Class I Areas and projected to affect visibility in 2018 and
- Mandatory Class I Areas in states significantly impacted by Washington emissions.

The contributions from each of the Western Regional Air Partnership (WRAP) designated regions and source categories were determined using Particulate Matter Source Apportionment Technology (PSAT) or Weighted Emissions Potential (WEP) which were described in Chapter 7.

This chapter looks at the most important visibility impairing pollutants as defined by Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring data. Data are organized by each mandatory Class I Area. Where two mandatory Class I Areas share an IMPROVE monitor the areas are discussed together. Data are presented in the following order:

- Olympic National Park
- North Cascades National Park and Glacier Peak Wilderness
- Alpine Lakes Wilderness
- Mount Rainer National Park
- Goat Rocks Wilderness and Mount Adams Wilderness
- Pasayten Wilderness

Within each mandatory Class I Area, or group of areas, sulfate data for the Most Impaired and Least Impaired Days are presented using PSAT analysis. Next, nitrate data are presented for the Most Impaired Days and Least Impaired Days using PSAT analysis. Organic Mass Carbon (OMC) data are presented using WEP analysis. Data are also presented for the Pasayten Wilderness for Elemental Carbon (EC) which is important at this site.

8.1 Olympic National Park

Visibility at Olympic National Park is represented by the OLYM1 IMPROVE monitoring site. The baseline conditions in Chapter 5 show that sulfates (39%), Organic Carbon (OC) (28%), and nitrates (19%) together contribute to 86% of the light extinction on the Most Impaired Days. On the Least Impaired Days sulfates (36%), OC (26%), and nitrates (17%) contributed to 79% of the light extinction at OLYM1.

8.1.1 Sulfates

Monitoring data show that sulfates were the highest contributor to haze on both the Most Impaired and Least Impaired Days in 2002.

Most Impaired Days

The PSAT tracer analysis shows that on the Most Impaired Days in 2002 sulfate emissions come primarily from outside the modeling domain (37%), Canada (21%) and Pacific offshore (15%). All of these source areas are beyond Washington's control. Washington sources emitted 25% of the sulfates responsible for haze at this monitoring site.

In comparison, the projected sulfate concentration in 2018 is the same and the relative contribution from the various source regions is almost identical. Additional detail is shown in Figure 8-1.

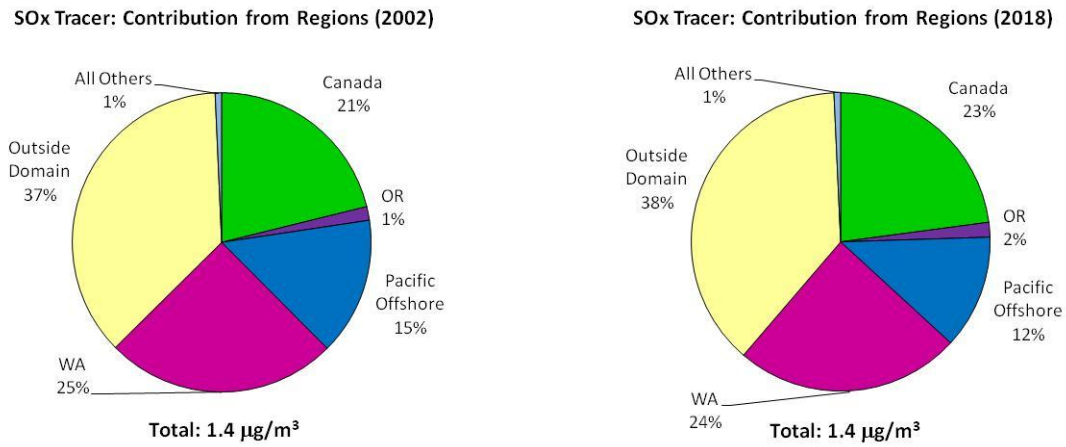

Figure 8-1 Sulfate Contributions by Source Regions for Most Impaired Days at OLYM1

Figure 8-2 shows the source regions and source categories that contribute sulfate at the OLYM1 monitoring site on the Most Impaired Days. In 2002, Washington point sources contributed to 15% of the total contribution to light extinction by sulfates, followed by mobile sources (7%) and area sources (3%). In 2018, Washington point sources are expected to contribute to 19% of the total light extinction by sulfates, followed by area sources (4%) and mobile sources (1%).

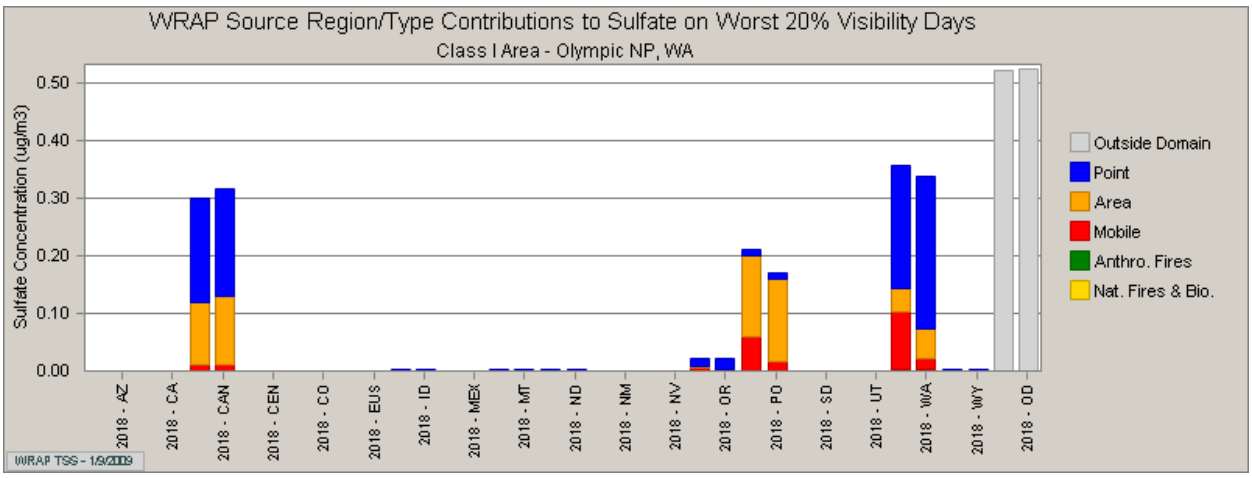

Figure 8-2 Sulfate Source Regions for 2002 and 2018 Most Impaired Days at OLYM1 Least Impaired Days

The PSAT tracer analysis sulfate emissions on the Least Impaired Days in 2002 came primarily from sources outside modeling domain (39%) and within Washington (34%). Compared with the most impaired days in 2002, contributions from Canada diminished while contributions from Oregon increased. Point, area and mobile sources are still the three major source categories which contribute to light extinction by sulfates.

In comparison to the Least Impaired Days in 2002, the projected sulfate concentration in 2018 decreases by 0.1 $\mu g/m^3$ and the relative contributions from the source regions change. The most significant change is a 5% reduction in relative contribution from Washington sources while the relative contributions from sources outside the modeling domain increase by 4%. Additional details are shown in Figure 8-3.

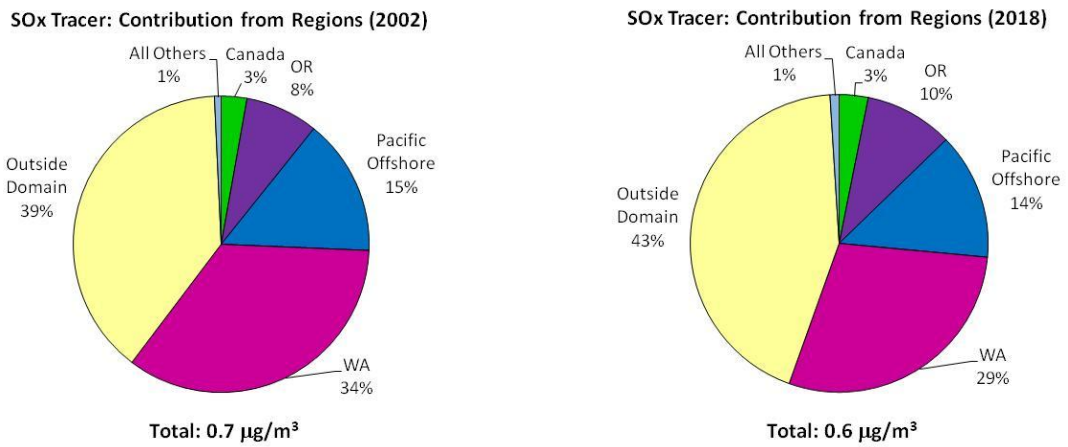

Figure 8-3 Sulfate Contributions by Source Regions for Least Impaired Days at OLYM1

Figure 8-4 shows the source regions and source categories that contribute sulfate at the OLYM1 monitoring site on the Least Impaired Days. In 2002, Washington point sources contributed to 18% of the total contribution to light extinction by sulfates, followed by mobile sources (10%) and area sources (6%). In 2018, Washington point sources are expected to contribute to 18% of the total light extinction by sulfates, followed by area sources (8%) and mobile sources (2%).

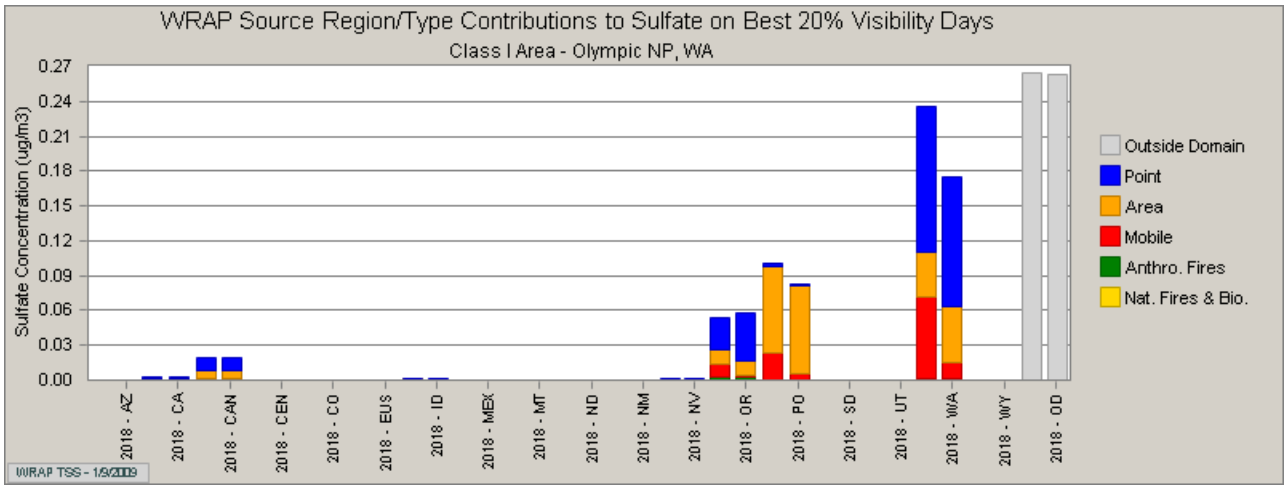

Figure 8-4 Sulfate Source Regions for 2002 and 2018 Least Impaired Days at OLYM1

8.1.2 Nitrates

Monitoring data indicate that nitrates were the third highest contributor to haze in 2002 on both the Most Impaired and Least Impaired Days at the OLYM1 site.

Most Impaired Days

Washington sources are responsible for 53% of the nitrates on the Most Impaired Days in 2002, followed by Canada (21%) and Pacific offshore (15%).

In comparison to the Least Impaired Days in 2002, on the Most Impaired Days the projected nitrate concentration in 2018 decreases 0.3 µg/m^3. The most significant change is an 11% reduction in contributions from Washington sources while the contributions from Canada, outside the modeling domain, and Pacific offshore sources increase. Additional detail is shown in Figure 8-5.

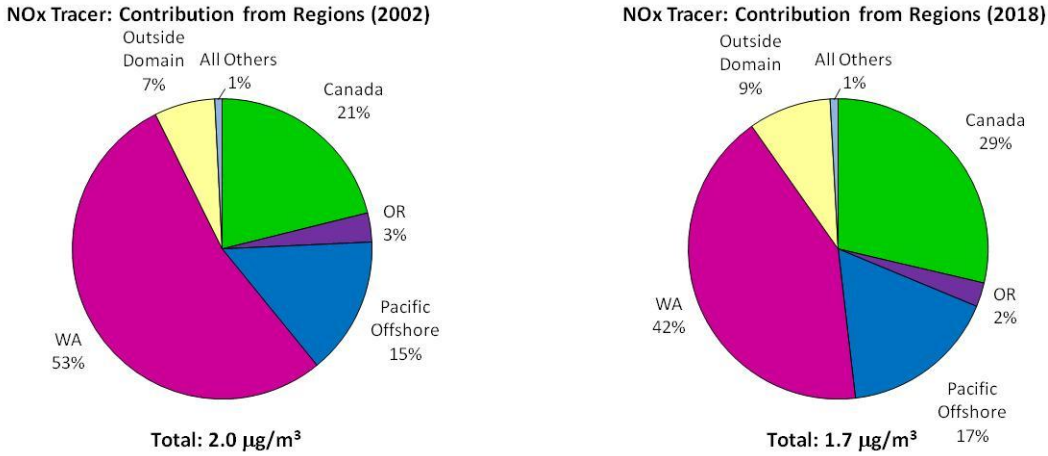

Figure 8-5 Nitrate Contributions by Source Regions for Most Impaired Days at OLYM1

Figure 8-6 shows the source regions and source categories that contribute nitrate at the OLYM1 monitoring site on the Most Impaired Days. Washington mobile sources contributed to 40% of the total contribution to light extinction by nitrates on the Most Impaired Days in 2002, followed by point sources (9%), area sources (3%), and natural fires and biogenic sources (1%). In 2018, Washington mobile sources are expected to contribute to 19% of the total light extinction by nitrates, followed by point sources (15%), area sources (6%), and natural fires and biogenic sources (1%).

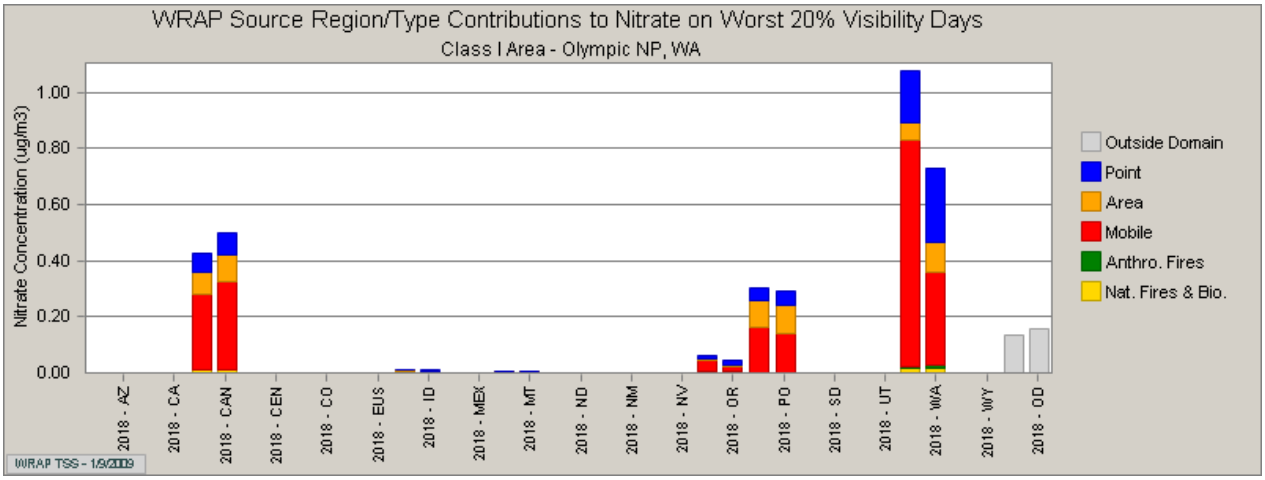

Figure 8-6 Nitrate Source Regions for 2002 and 2018 Most Impaired Days at OLYM1

Least Impaired Days

Compared to the worst days in 2002, on the Least Impaired Days the percentage contribution to visibility impairment from Canada decreased while Oregon's contribution increased. No other major changes from Most Impaired Days have been observed on the Least Impaired Days for 2002.

In comparison to the Least Impaired Days in 2002, the projected nitrate concentration in 2018 decreases 0.4 $\mu g/m^3$. The relative contributions from Washington sources decrease by 7% while contributions from outside the modeling domain, Canada, and Pacific offshore increase by 8%. Additional detail is shown in Figure 8-7.

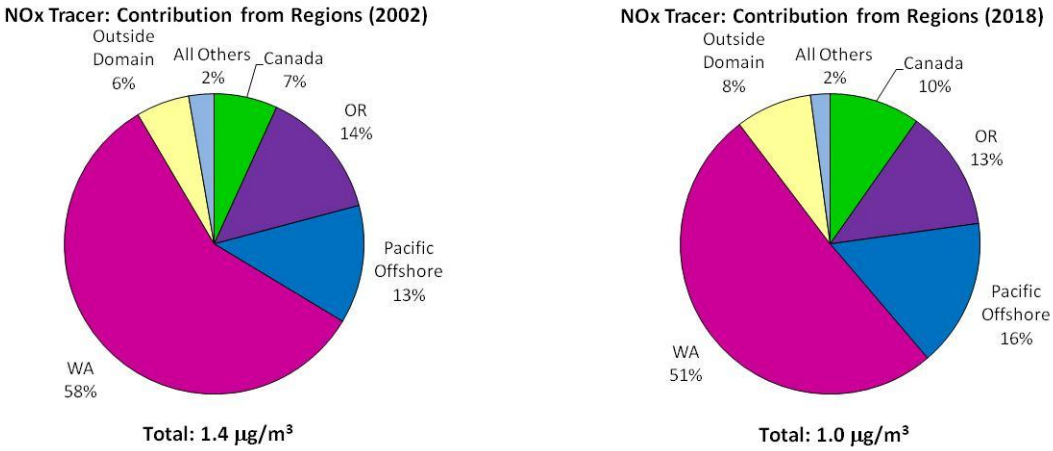

Figure 8-7 Nitrate Contributions by Source Regions for Least Impaired Days at OLYM1

Figure 8-8 shows the source regions and source categories that contribute nitrate at the OLYM1 monitoring site on the Least Impaired Days. In 2002, Washington mobile sources contributed to 45% of the total contribution to light extinction by nitrates, followed by point sources (8%), area sources (4%), and natural fire and biogenic sources (1%). The source categories contribute differently in 2018. In 2018, Washington mobile sources are expected to contribute to 26% of the total light extinction by nitrates on the Least Impaired Days, followed by point sources (15%), area sources (9%), and natural fire and biogenic sources (1%).

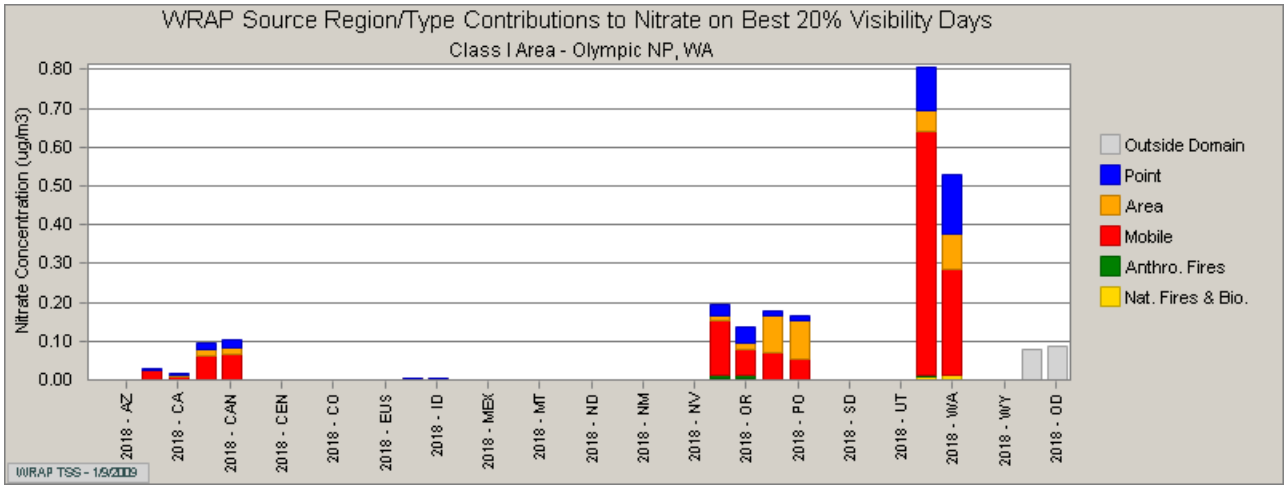

Figure 8-8 Nitrate Source Regions for 2002 and 2018 Least Impaired Days at OLYM1

8.1.3 Organic Mass Carbon

Monitoring indicates that after sulfates, OMC is the second highest cause of light extinction on both the Most Impaired and Least Impaired Days at the OLYM1 site in 2002.

As described in Chapter 7, the WEP tool helps identify source regions of OMC. WEP combines emission inventories, wind patterns, and the residence time of the air mass over each area where emissions occur to estimate the percent contribution from each source area.

While OMC is calculated from the amount of OC measured by the IMPROVE filter, neither OMC nor OC are directly represented in emission inventories. OMC consists of primary organic aerosol emissions and secondary OMC compounds. The primary compounds are emitted directly as particulates; the secondary compounds condense from emitted volatile organic compounds.

WEP uses primary organic aerosol emissions to estimate the contribution from source areas within WRAP states and from Canada and Pacific offshore. WEP does not provide an estimate of the background contribution from outside the domain.

As WEP indicates, most of the OMC emissions come from the Puget Sound areas. Additional detail is shown in Figure 8-9.

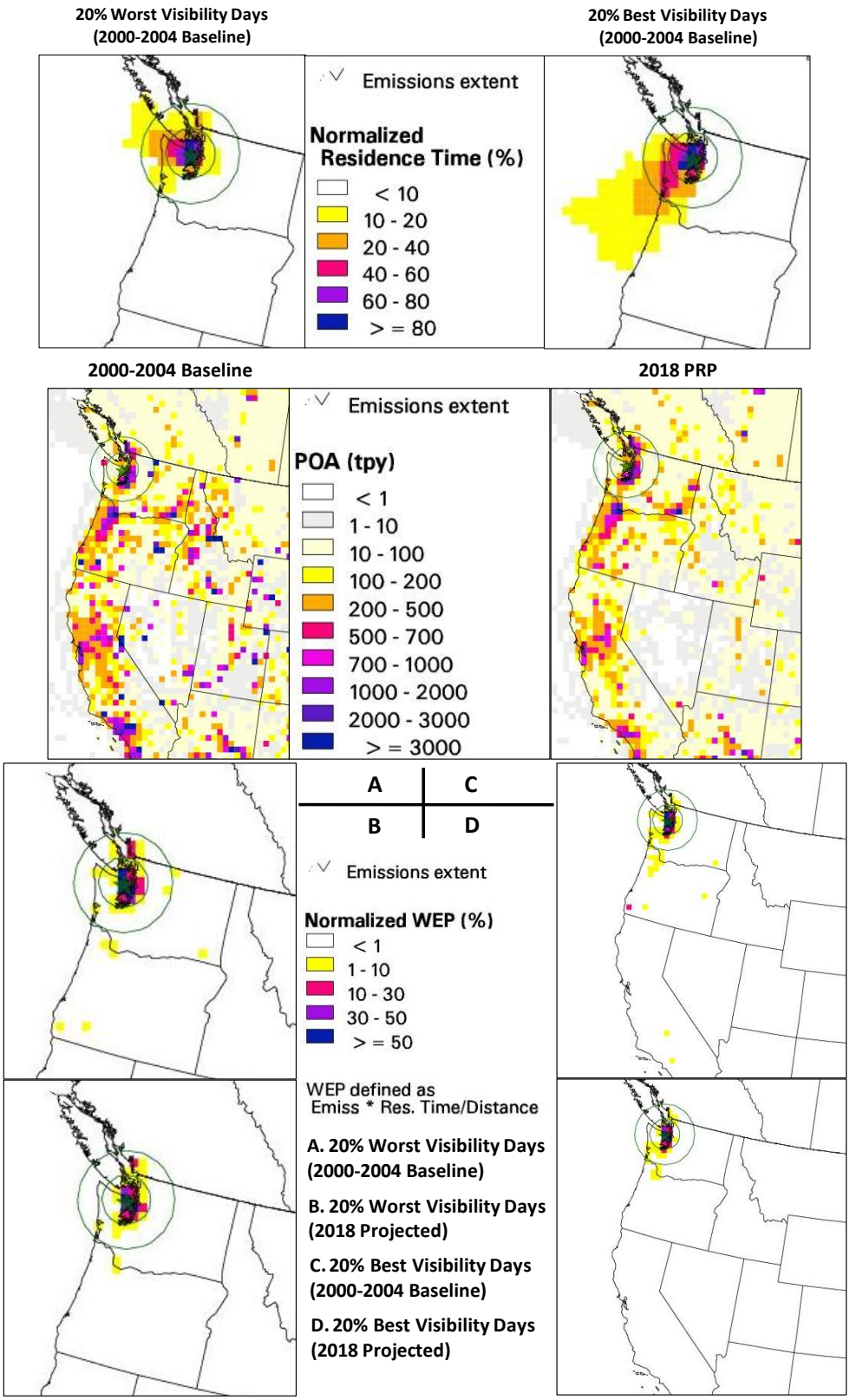

Figure 8-9 Primary Organic Aerosols Residence Time, Mapped Emissions, and Weighted Emission Potentials for Most Impaired and Least Impaired Days in 2002 and 2018 at OLYM1

For both the Most Impaired and Least Impaired Days in 2002 and 2018, area sources are the predominant sources. The emissions from this source are projected to increase 19% on the Most Impaired Days and 21% on the Least Impaired Days during the first planning period. The relative contributions from other sources are also shown in Figures 8-10 and 8-11.

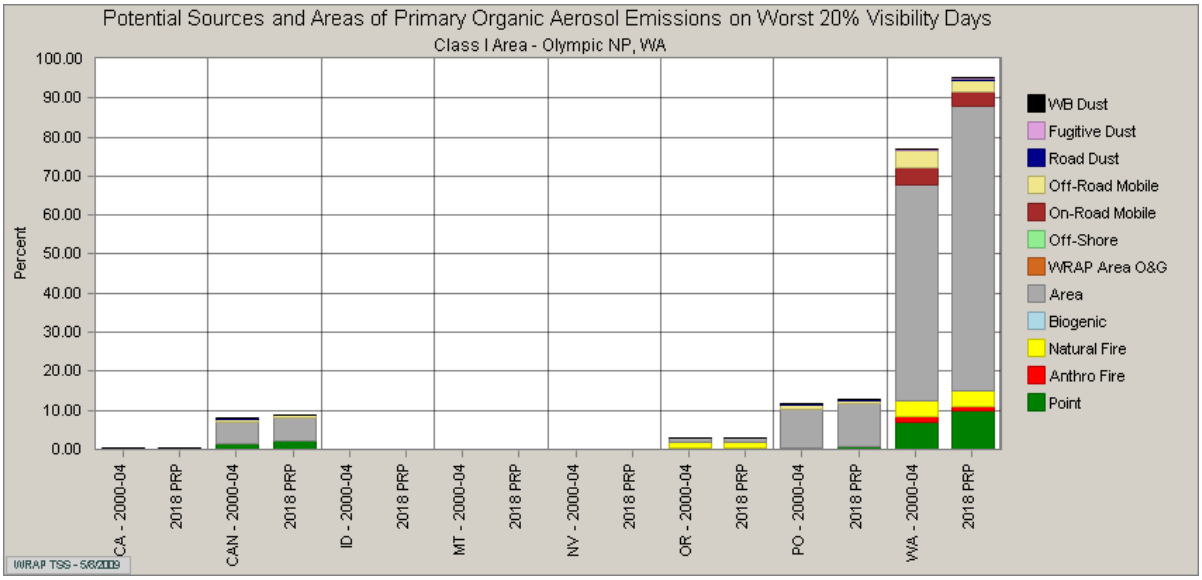

Figure 8-10 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 Most Impaired Days at OLYM1

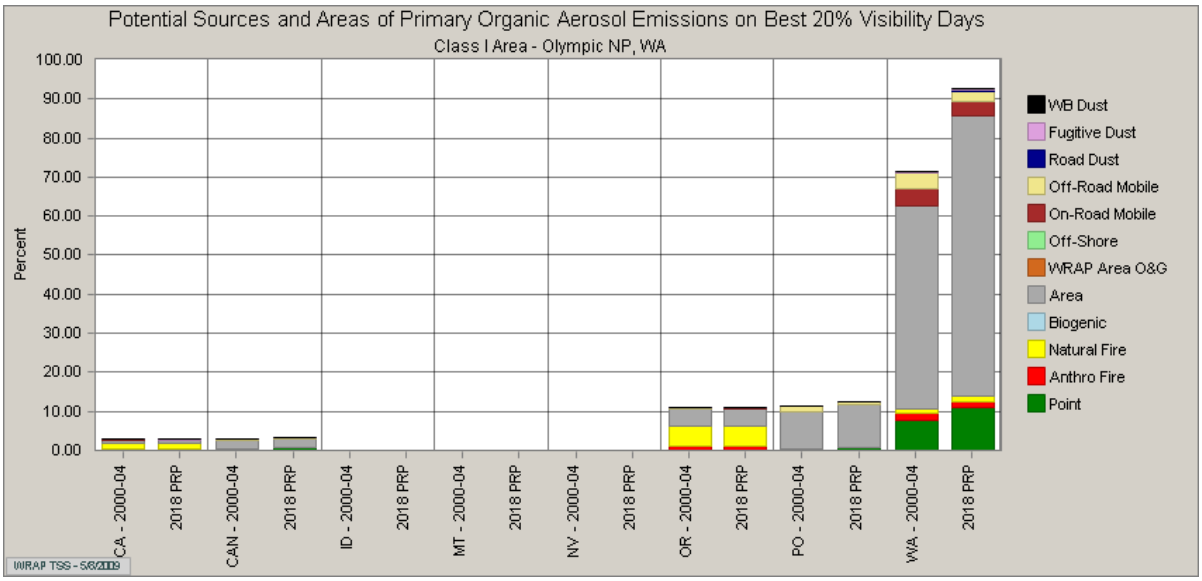

Figure 8-11 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 Least Impaired Days at OLYM1

8.2 North Cascades National Park and Glacier Peak Wilderness

The North Cascades National Park and Glacier Peak Wilderness areas are represented by the NOCA1 IMPROVE monitoring site. The baseline conditions in Chapter 5 show that together

OC (58%), sulfates (26%), and nitrates (5%) contributed to 89% of the light extinction on the Most Impaired Days at this monitoring site. On the Least Impaired Days sulfates (45%), OC (21%), and nitrates (14%) contributed to 80% of the light extinction at this monitoring site.

In 2003 there were many wildfires in or near North Cascades National Park and Glacier Peak Wilderness. The 2003 data from this high wildfire year was included in the source apportionment analysis below. The baseline conditions in Chapter 5 were presented with and without the 2003 monitoring data. The time and resources were not available to re-run the source apportionment analysis without the 2003 data to show wildfire impacts on visibility impairment.

8.2.1 Sulfates

Monitoring data show that sulfates were the second highest contributor to haze on the Most Impaired Days and the highest contributor to haze on the Least Impaired Days at this site.

Most Impaired Days

The PSAT tracer analysis shows that on the Most Impaired Days for 2002 sulfate emissions came primarily from outside the modeling domain (32%), Washington (29%), and Canada (28%). Sulfate sources outside of the modeling domain and Canada are beyond state or local control.

In comparison, the projected sulfate concentration in 2018 decreases 0.1 $\mu g/m^3$ and the relative contribution from the various source categories is almost identical. For Washington sulfate emissions, the relative contribution is the same in 2002 and 2018. Additional detail is shown in Figure 8-12.

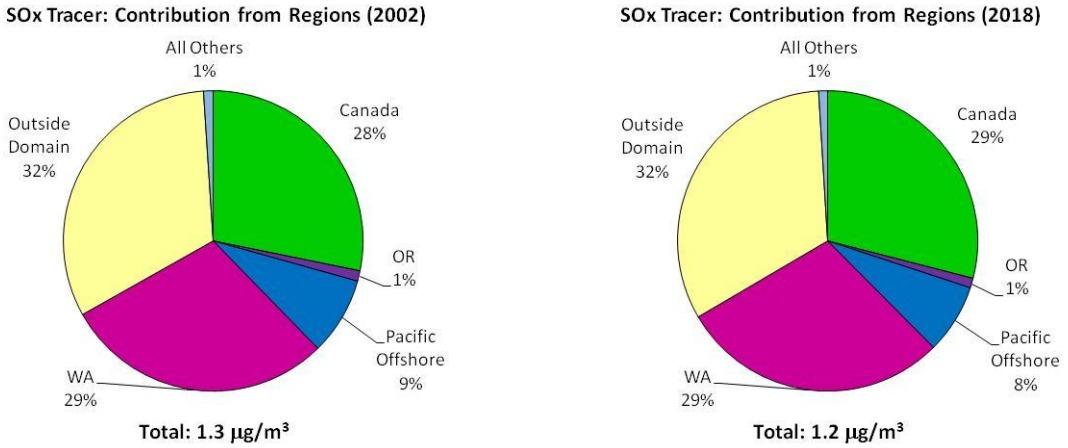

Figure 8-12 Sulfate Contributions by Source Regions for Most Impaired Days at NOCA1

Figure 8-13 shows the source regions and source categories that contribute sulfate at the NOCA1 monitoring site on the Most Impaired Days. In 2002, Washington point sources contributed to 20% of total contribution to light extinction by sulfates, followed by mobile sources (5%), area sources (3%), and natural fire and biogenic sources (1%). In 2018, Washington point sources are

expected to contribute to 24% of the total light extinction by sulfates, followed by area sources (3%), mobile sources (1%), and natural fire and biogenic sources (1%).

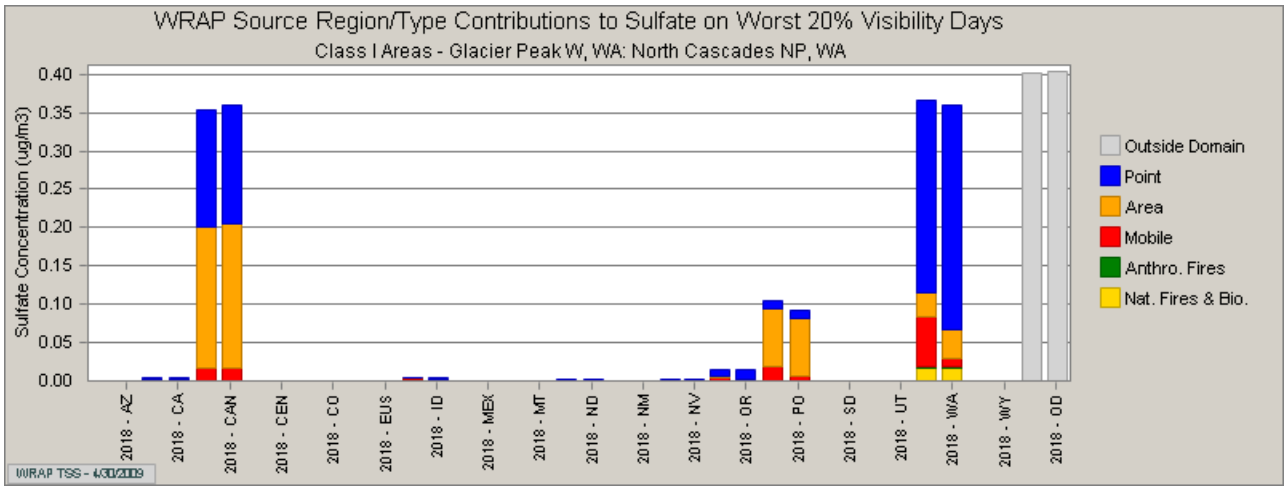

Figure 8-13 Sulfate Source Regions for 2002 and 2018 Most Impaired Days at NOCA1

Least Impaired Days

The PSAT tracer analysis shows that on the Least Impaired Days in 2002 sulfate emissions come primarily from outside the modeling domain (40%) and Washington (39%). Compared to the Most Impaired Days, on the Least Impaired Days Canada contributes far less while Oregon's contribution slightly increases.

In comparison to the Least Impaired Days in 2002, the projected sulfate concentration in 2018 is the same. The most significant change is a 6% reduction in contribution from Washington sources while the contributions from sources outside the modeling domain, Oregon, and Canada increase by the same amount. Additional detail is shown in Figure 8-14.

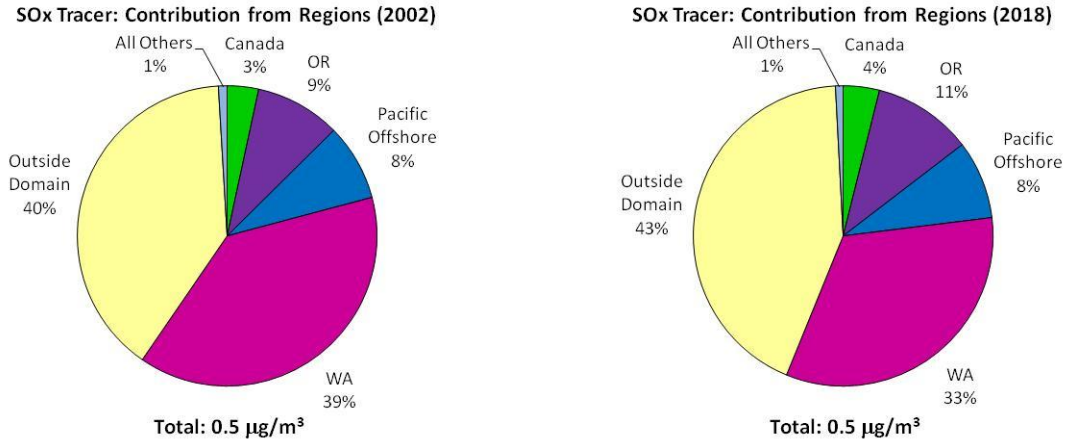

Figure 8-14 Sulfate Contributions by Source Regions for Least Impaired Days at NOCA1

Figure 8-15 shows the source regions and source categories that contribute sulfate at the NOCA1 monitoring site on the Least Impaired Days. In 2002, Washington point sources contributed to

23% of the total contribution to light extinction by sulfates, followed by mobile sources (10%), area sources (5%), and natural fire and biogenic sources (2%). In 2018, Washington point sources are expected to contribute to 24% of the total light extinction by sulfates, followed by area sources (8%), natural fire and biogenic sources (4%), and mobile sources (1%).

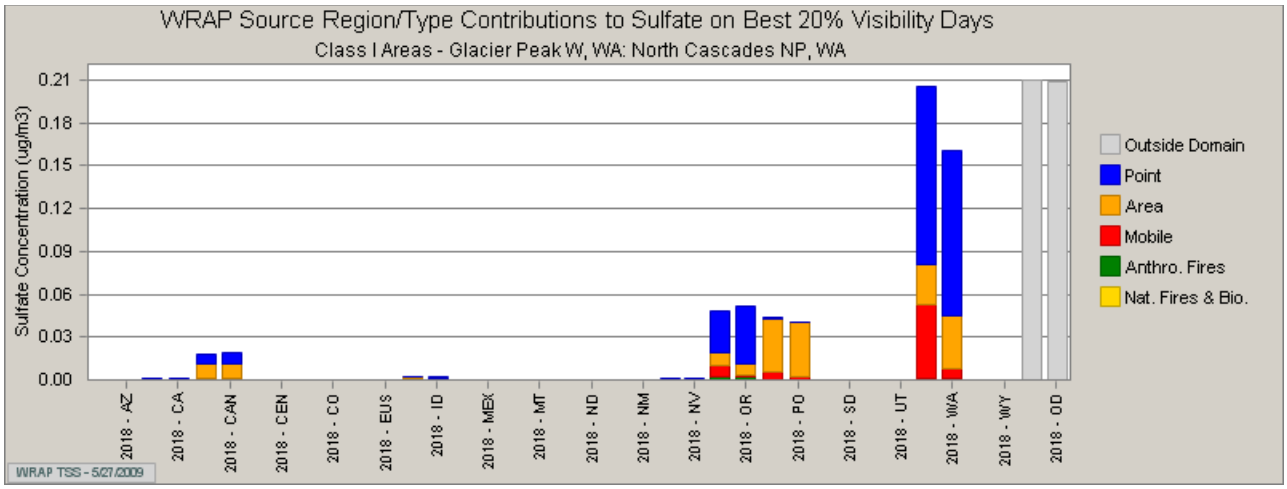

Figure 8-15 Sulfate Source Regions for 2002 and 2018 Least Impaired Days at NOCA1

8.2.2 Nitrates

Monitoring data indicate that nitrates are the third highest contributor to haze in 2002 on both the Most Impaired and Least Impaired Days.

Most Impaired Days

Washington sources are responsible for 46% of the nitrates, followed by Canada (27%), outside the modeling domain (16%) and Pacific offshore (7%) sources.

In comparison to the Most Impaired Days in 2002, the projected sulfate concentration in 2018 decreases 0.1 $\mu g/m^3$. The most significant change is a 15% reduction in relative contribution from Washington sources. The relative contributions from sources in Canada and outside the modeling domain increase by 14%. Additional detail is shown in Figure 8-16.

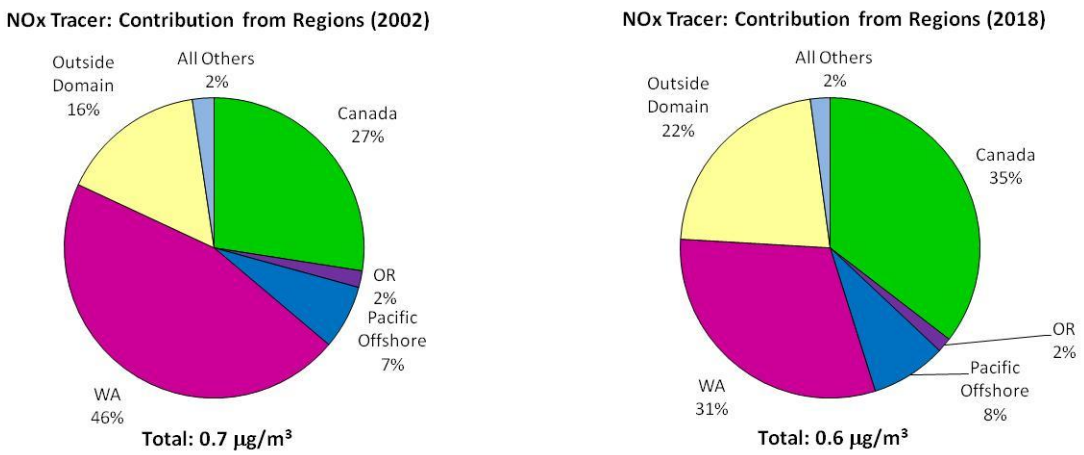

Figure 8-16 Nitrate Contributions by Source Regions for Most Impaired Days at NOCA1

Figure 8-17 shows the source regions and source categories that contribute nitrate at the NOCA1 monitoring site on the Most Impaired Days. Washington mobile sources contributed to 34% of the total contribution to light extinction by nitrates on the Most Impaired Days in 2002, followed by point sources (6%), natural fire and biogenic sources (3%), and area sources (2%). In 2018, Washington mobile sources are expected to contribute to 14% of the total light extinction by nitrates, followed by point sources (9%), natural and biogenic sources (4%) and area sources (4%).

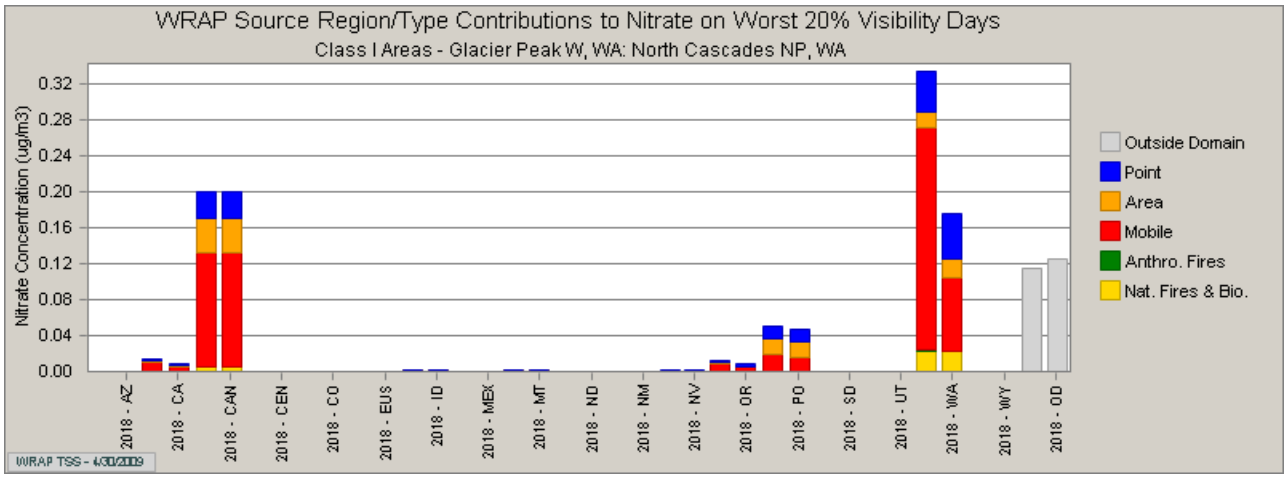

Figure 8-17 Nitrate Source Regions for 2002 and 2018 Most Impaired Days at NOCA1

Least Impaired Days

On the Least Impaired Days in 2002 Washington nitrate sources become even more dominant, contributing to 63% of the light extinction, followed by Oregon (13%) and outside the modeling domain (10%).

In comparison to the Least Impaired Days in 2002, the projected nitrate concentration in 2018 decreases 0.4 µg/m^3. The relative contributions from Washington sources decrease by 12%

while contributions from outside the modeling domain, Canada, and Pacific offshore increase by 12%. Additional detail is shown in Figure 8-18.

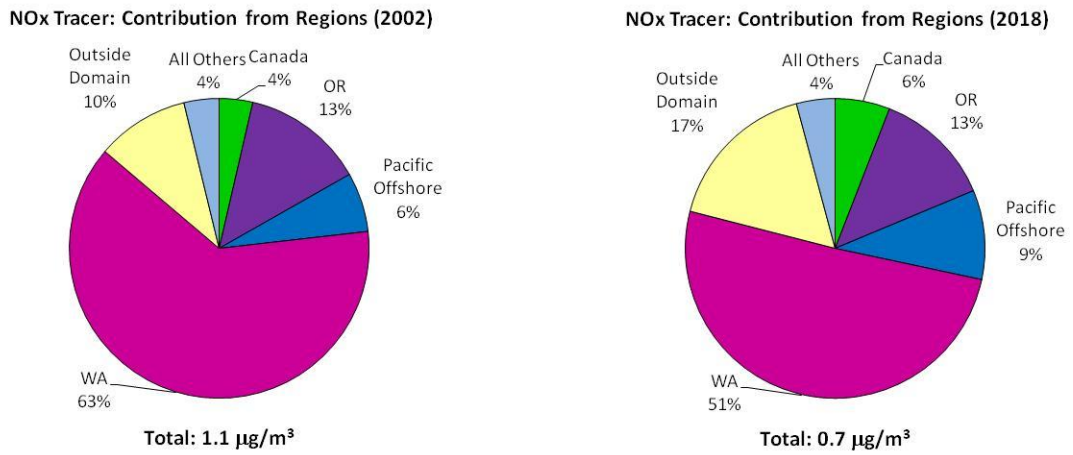

Figure 8-18 Nitrate Contributions by Source Regions for Least Impaired Days at NOCA1

Figure 8-19 shows the source regions and source categories that contribute nitrate at the NOCA1 monitoring site on the Least Impaired Days. Washington mobile sources contributed to 51% of the total contribution to light extinction by nitrates on the Least Impaired Days in 2002, followed by point sources (6%), areas sources (3%), and natural fire and biogenic sources (2%).
In 2018, Washington mobile sources are expected to contribute to 29% of the total light extinction by nitrates, followed by point sources (11%), area sources (7%), and natural and biogenic sources (4%).

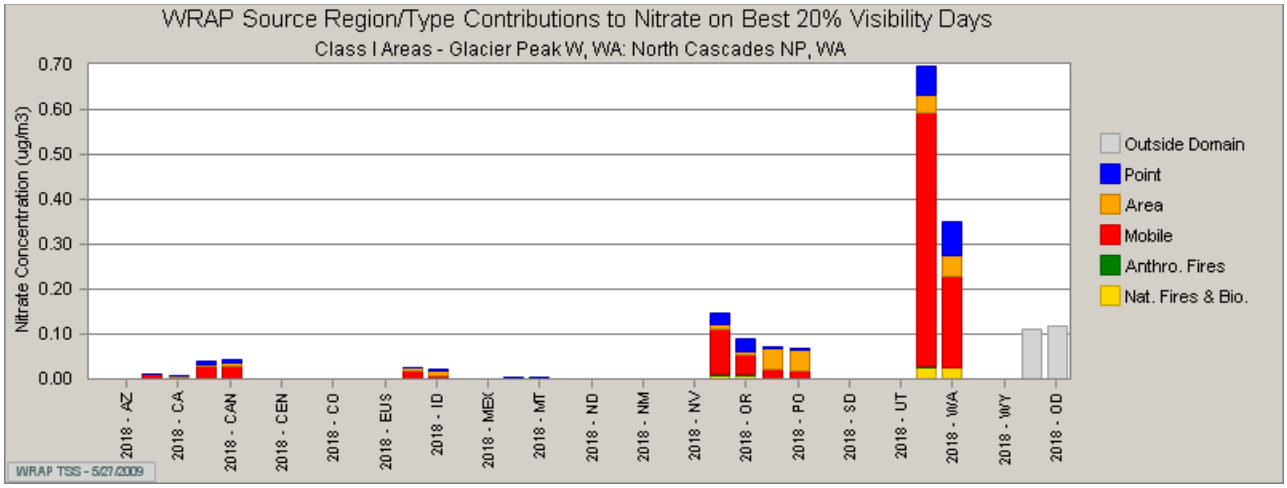

Figure 8-19 Nitrate Source Regions for 2002 and 2018 Least Impaired Days at NOCA1

8.2.3 Organic Mass Carbon

Monitoring data indicate that OMC is the highest cause of light extinction on the Most Impaired Days and second highest cause of light extinction on the Least Impaired Days at the NOCA1 site.

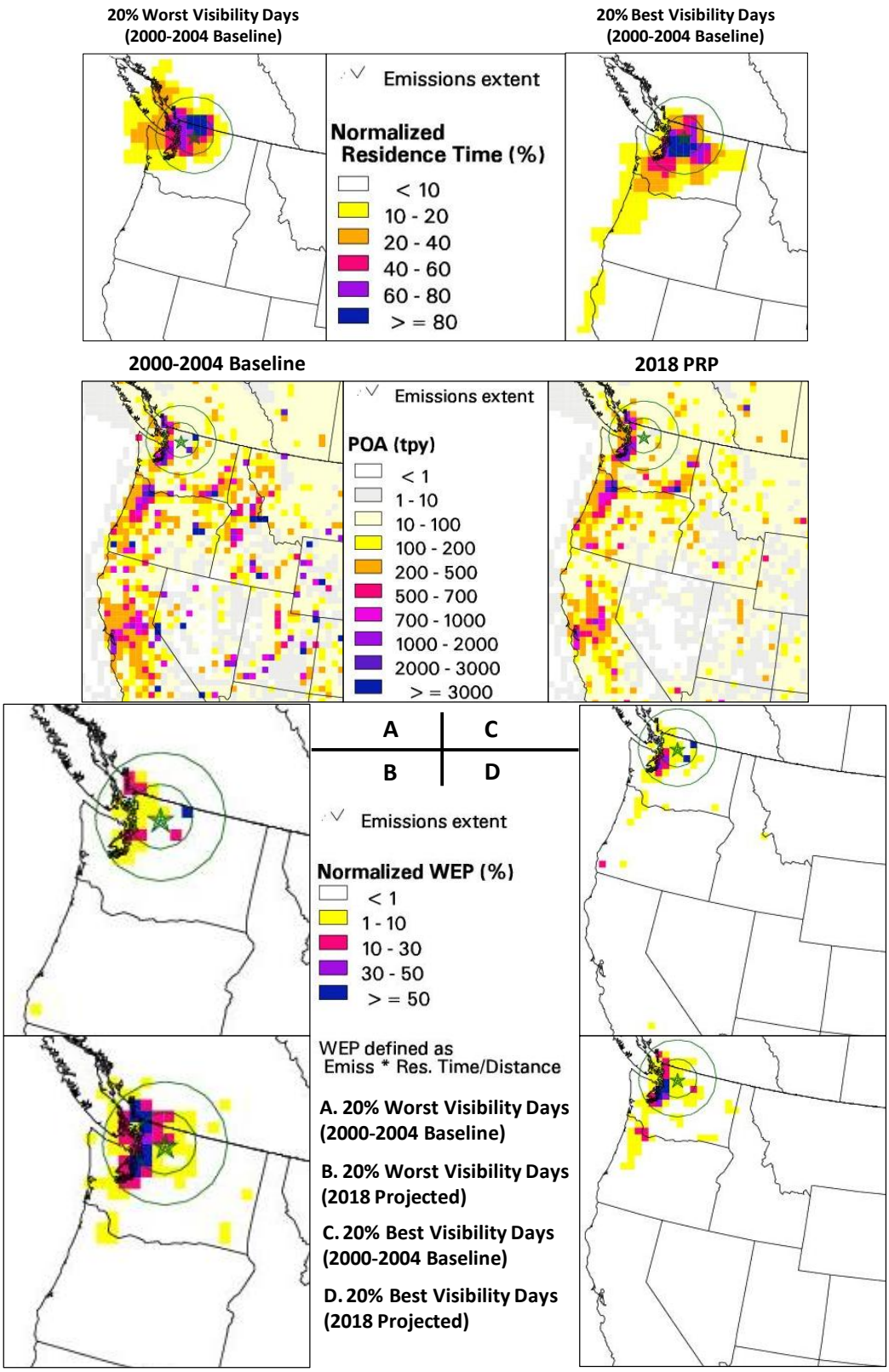

Figure 8-20 Primary Organic Aerosols Residence Time, Mapped Emissions, and Weighted Emission Potentials for Most Impaired and Least Impaired Days in 2002 and 2018 at NOCA1

WEP indicates that most of the OMC emissions come from within Washington. Additional detail is shown in Figure 8-20.

For both Most Impaired and Least Impaired Days in 2002 and 2018 natural fire and area sources are the predominant sources of OMC. The emissions from natural fire were held constant in the modeling. Area sources are projected to increase slightly during the first planning period. The relative contributions from other sources are also shown in Figures 8-21 and 8-22.

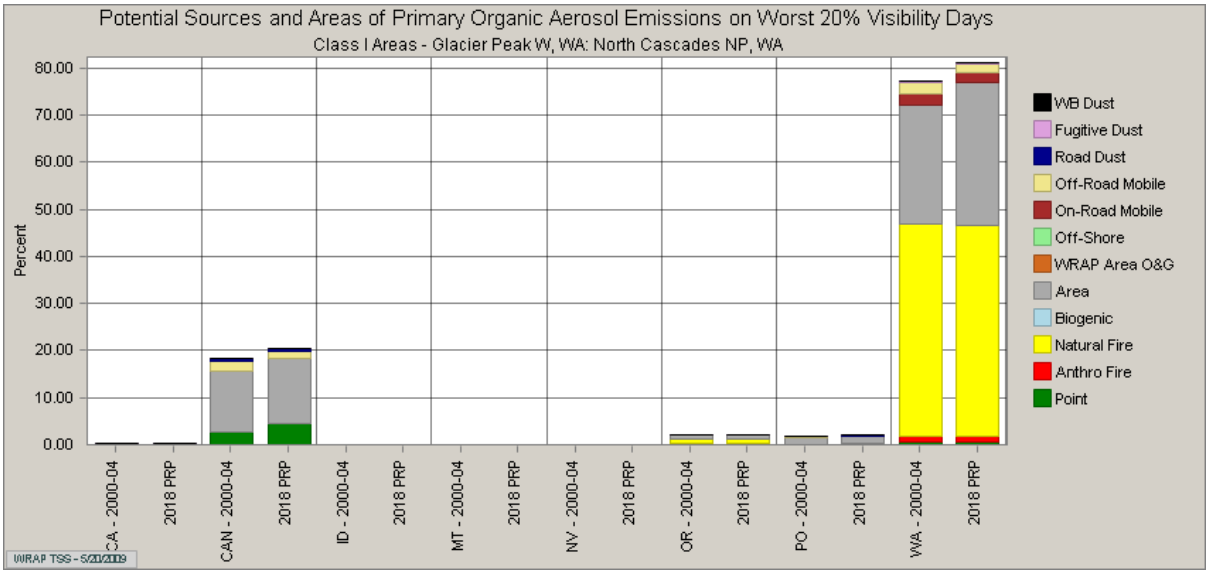

Figure 8-21 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 Most Impaired Days at NOCA1

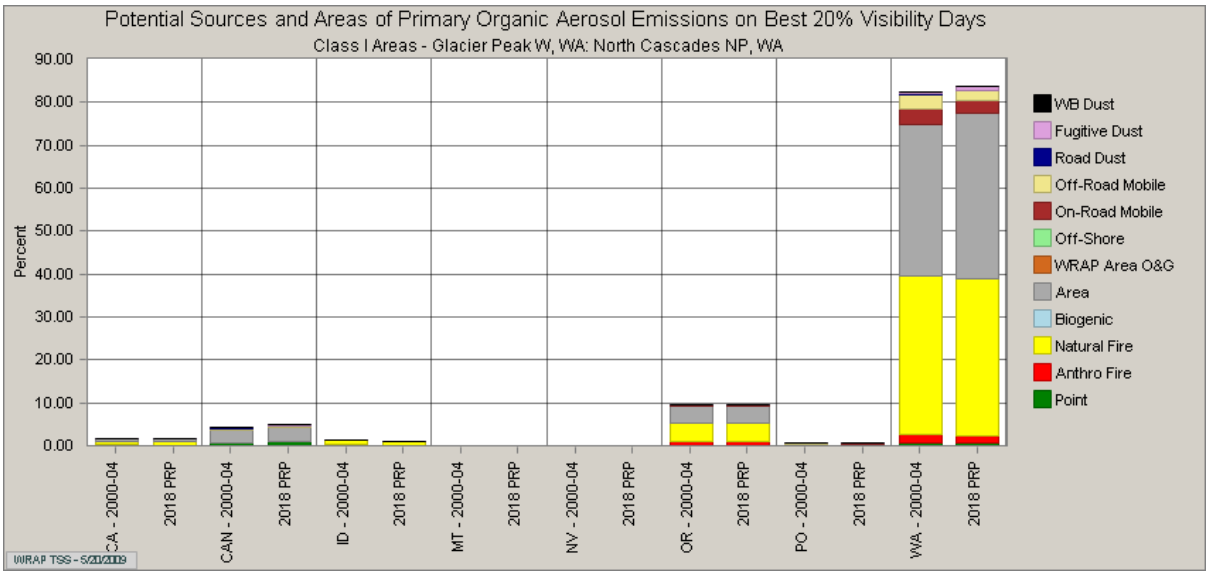

Figure 8-22 Organic Aerosol Contributions by Source Regions for 2002 and 2018 Least Impaired Days at NOCA1

8.3 Alpine Lakes Wilderness

Alpine Lakes Wilderness is represented by the SNPA1 IMPROVE monitoring site. The baseline conditions in presented in Chapter 5 show that sulfates (34%), OC (30%), and nitrates (23%) together contribute to 87% of the light extinction on the Most Impaired Days at this site. On the Least Impaired Days sulfates (40%), nitrates (18%), and OC (16%) contribute to 74% of the light extinction at this monitoring site.

8.3.1 Sulfates

Monitoring data show that sulfates were the highest contributor to haze on both the Most Impaired and Least Impaired Days in 2002 at the SNPA1 site.

Most Impaired Days

The PSAT tracer analysis shows that on the Most Impaired Days for 2002 sulfate emissions come primarily from outside the modeling domain (38%), closely followed by from Washington's own sources (32%). In addition, a small portion is from Canada (17%) and Pacific offshore (8%) sources. Sulfate sources outside of the modeling domain, in Canada and from Pacific offshore are beyond state or local control.

In comparison, the projected sulfate concentration in 2018 is the same. There is some change in the contributions between source regions. Washington sources decrease their contributions by 4% while sources outside the modeling domain and Canada increase by 4%.

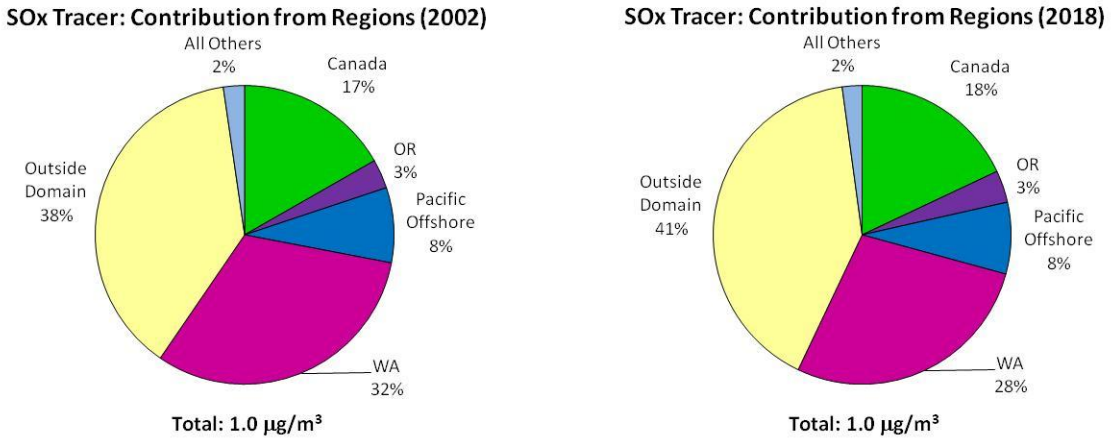

Figure 8-23 Sulfate Contributions by Source Regions for Most Impaired Days at SNPA1

Figure 8-24 shows the source regions and source categories that contribute sulfate at the SNPA1 monitoring site on the Most Impaired Days. In 2002, Washington point sources contributed to 16% of the total contribution to light extinction by sulfates, followed by mobile sources (10%) and area sources (5%). In 2018, Washington point sources are expected to contribute to 19% of the total light extinction by sulfates, followed by area sources (6%), and mobile sources (3%).

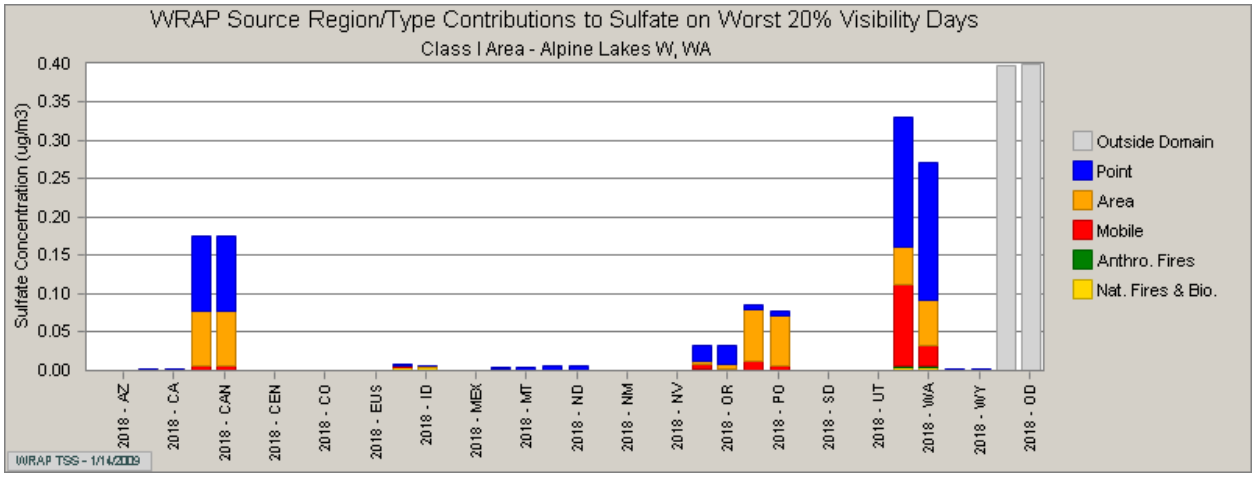

Figure 8-24 Sulfate Source Regions for 2002 and 2018 Most Impaired Days at SNPA1

Least Impaired Days

The PSAT tracer analysis for the Least Impaired Days in 2002 shows that while Washington and Oregon contributed a greater percentage of sulfates than on the Most Impaired Days. Sulfate emissions from outside the modeling domain are the dominant contributor on the Least Impaired Days.

In comparison to the Least Impaired Days in 2002, the projected sulfate concentration in 2018 is the same. There is some change in the contributions between source regions. Washington sources decrease their contributions by 7% while sources from outside the modeling domain, Pacific offshore and Oregon increase by 7%.

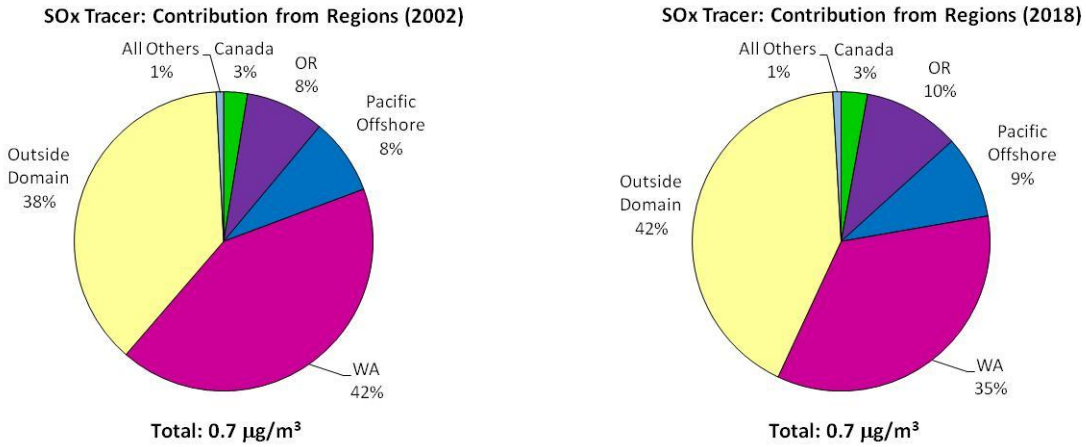

Figure 8-25 Sulfate Contributions by Source Regions for Least Impaired Days at SNPA1

Figure 8-26 shows the source regions and source categories that contribute sulfate at the SNPA1 monitoring site on the Least Impaired Days. In 2002, Washington point sources contributed to 26% of the total contribution to light extinction by sulfates, followed by mobile sources (11%), and area sources (5%). In 2018, Washington point sources are expected to contribute to 25% of the total light extinction by sulfates, followed by area sources (7%), and mobile sources (2%).

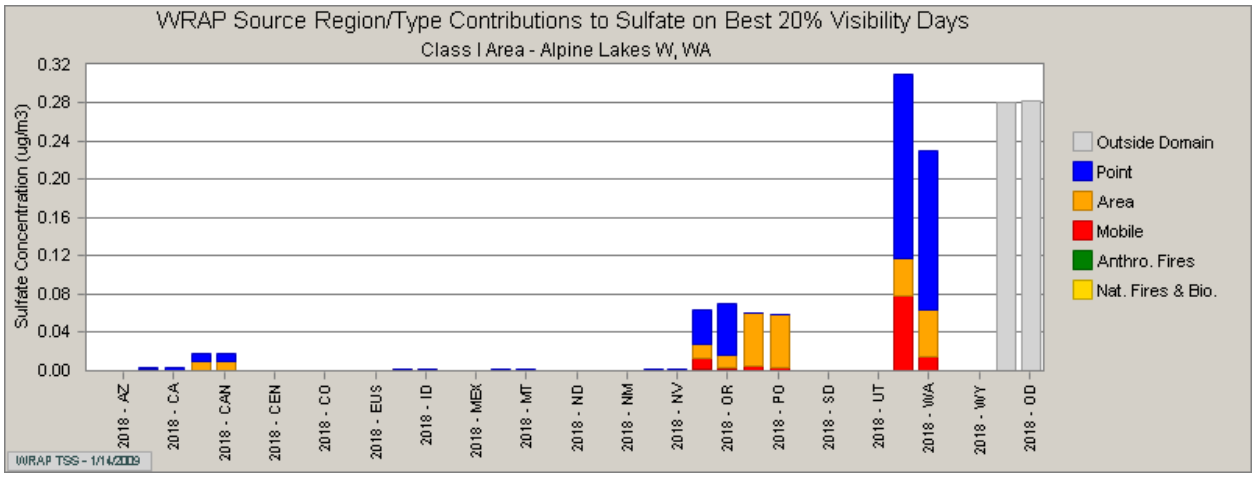

Figure 8-26 Sulfate Source Regions for 2002 and 2018 Least Impaired Days at SNPA1

8.3.2 Nitrates

Monitoring data indicate that nitrates are the third highest contributor to haze on the Most Impaired Days and the second highest contributor on the Least Impaired Days in 2002 at the SNPA1 site.

Most Impaired Days

On the Most Impaired Days in 2002, Washington sources were responsible for about two thirds (68%) of the nitrates, followed by small contributors from outside of the modeling domain (9%), Oregon (9%), and Canada (5%) sources.

In comparison, on the Most Impaired Days the projected nitrate concentration in 2018 decreases 0.3 µg/m^3. The most significant change is a 12% reduction in relative contribution from Washington sources. Additional detail is shown in Figure 8-27.

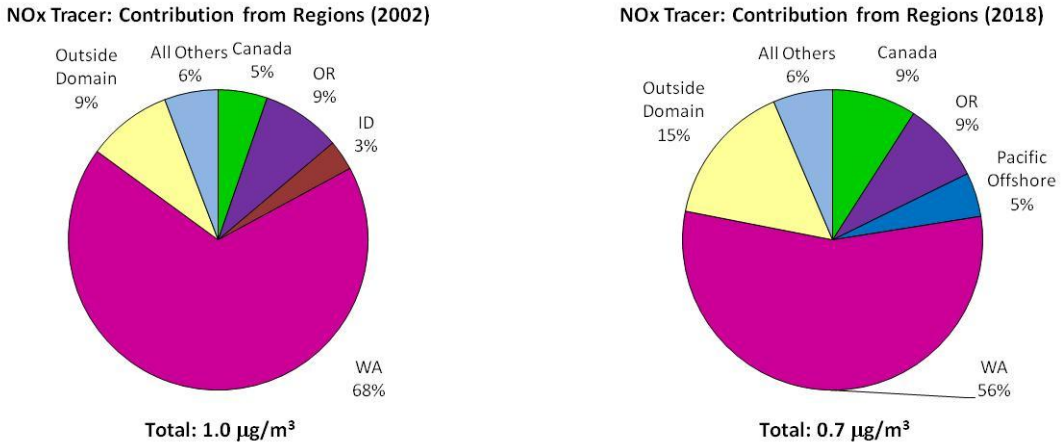

Figure 8-27 Nitrate Contributions by Source Regions for Most Impaired Days at SNPA1

Figure 8-28 shows the source regions and source categories that contribute nitrate at the SNPA1 monitoring site on the Most Impaired Days. Washington mobile sources contributed to 56% of the total contribution to light extinction by nitrates on the Most Impaired Days in 2002, followed by point sources (5%), natural fire and biogenic sources (3%), and area sources (3%). In 2018, Washington mobile sources are expected to contribute to 34% of the total light extinction by nitrates, followed by point sources (10%), areas sources (7%), and natural fire and biogenic sources (4%).

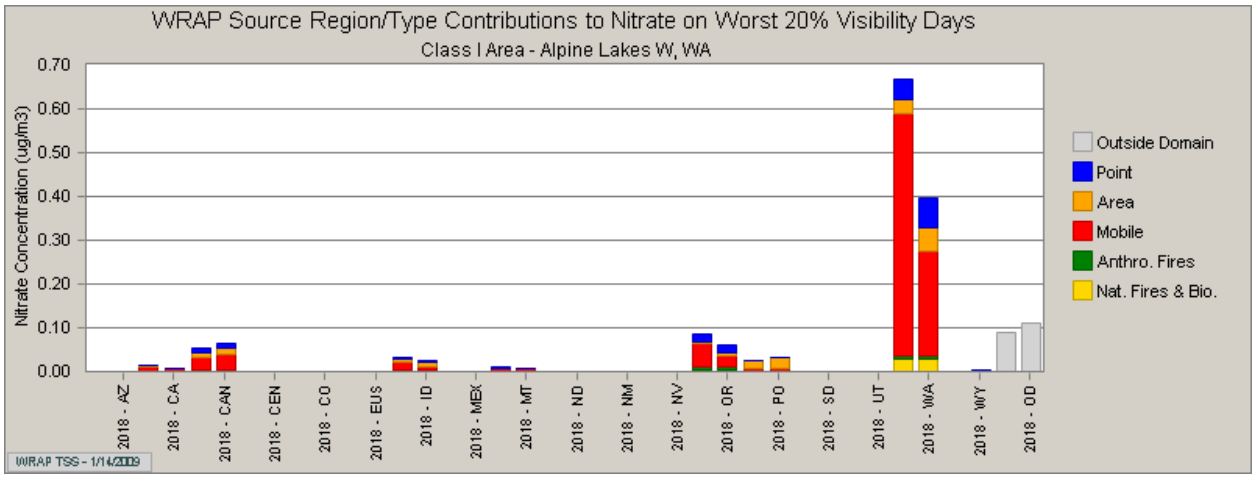

Figure 8-28 Nitrate Source Regions for 2002 and 2018 Most Impaired Days at SNPA1

Least Impaired Days

On the Least Impaired Days in 2002, Canada's percent contribution decreases when compared to their share on the Most Impaired Days. When compared to the Most Impaired Days, the relative contributions from Oregon and Pacific offshore sources increased.

In comparison to the Least Impaired Days in 2002, on the Least Impaired Days in 2018 the projected nitrate concentration decreases 0.4 µg/m^3. The relative contributions from Washington sources decrease by 10%. Additional detail is shown in Figure 8-29.

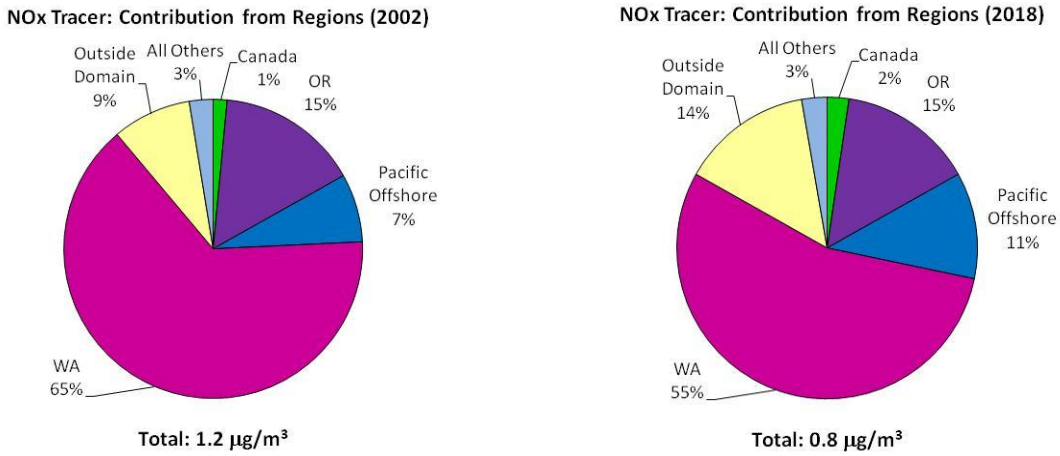

Figure 8-29 Nitrate Contributions by Source Regions for Least Impaired Days at SNPA1

Figure 8-30 shows the source regions and source categories that contribute nitrate at the SNPA1 monitoring site on the Least Impaired Days. Washington mobile sources contributed to 52% of the total contribution to light extinction by nitrates on the Least Impaired Days in 2002, followed by point sources (7%), area sources (3%), and natural fire and biogenic sources (1%). In 2018, Washington mobile sources are expected to contribute to 31% of the total light extinction by nitrates, followed by point sources (14%), area sources (8%), and natural fire and biogenic sources (2%).

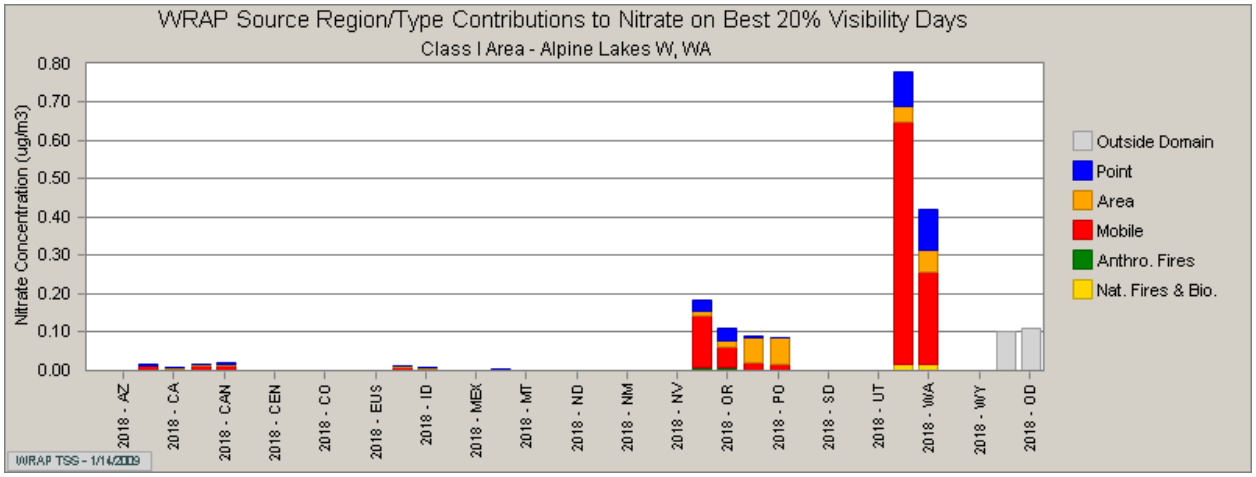

Figure 8-30 Nitrate Source Regions for 2002 and 2018 Least Impaired Days at SNPA1

8.2.3 Organic Mass Carbon

Monitoring data indicate that OMC is the second highest cause of light extinction on the most impaired days at the SNPA1 site. On the least impaired days, OC is the third highest cause of light extinction.

As WEP indicates, most of the OMC emissions come from Washington. Additional detail is shown in Figure 8-31.

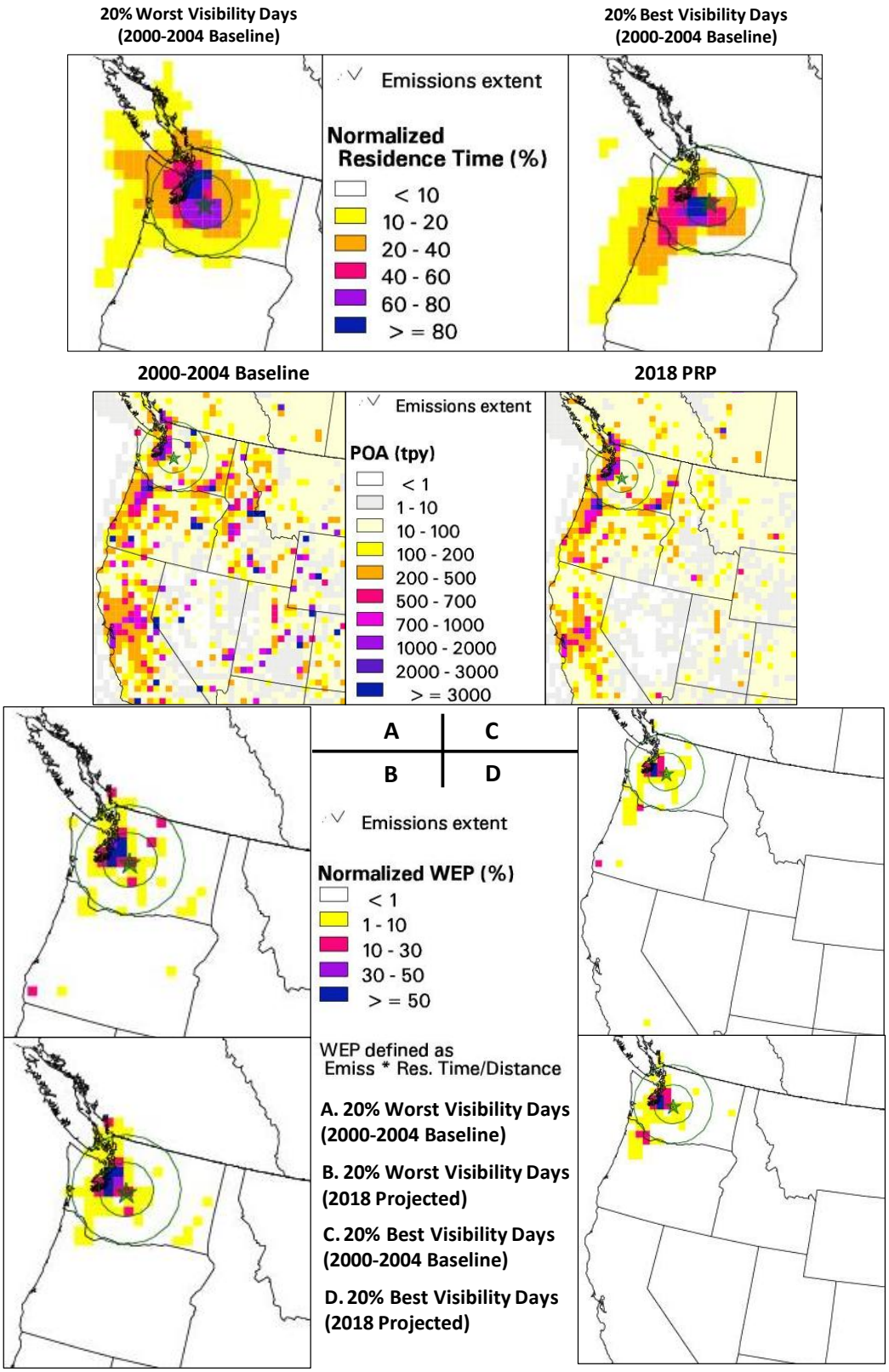

Figure 8-31 Primary Organic Aerosols Residence Time, Mapped Emissions, and Weighted Emission Potentials for Most Impaired and Least Impaired Days in 2002 and 2018 at SNPA1

For both the Most Impaired and Least Impaired in 2002 and 2018 area sources are the predominant sources of OMC. Area sources are projected to hold constant during the first planning period for both the Most Impaired and Least Impaired Days. The emissions from natural fire were also held constant in the modeling. Overall, there was 3% decrease in projected year 2018. The relative contributions from other sources are also shown in Figures 8-32 and 8-33.

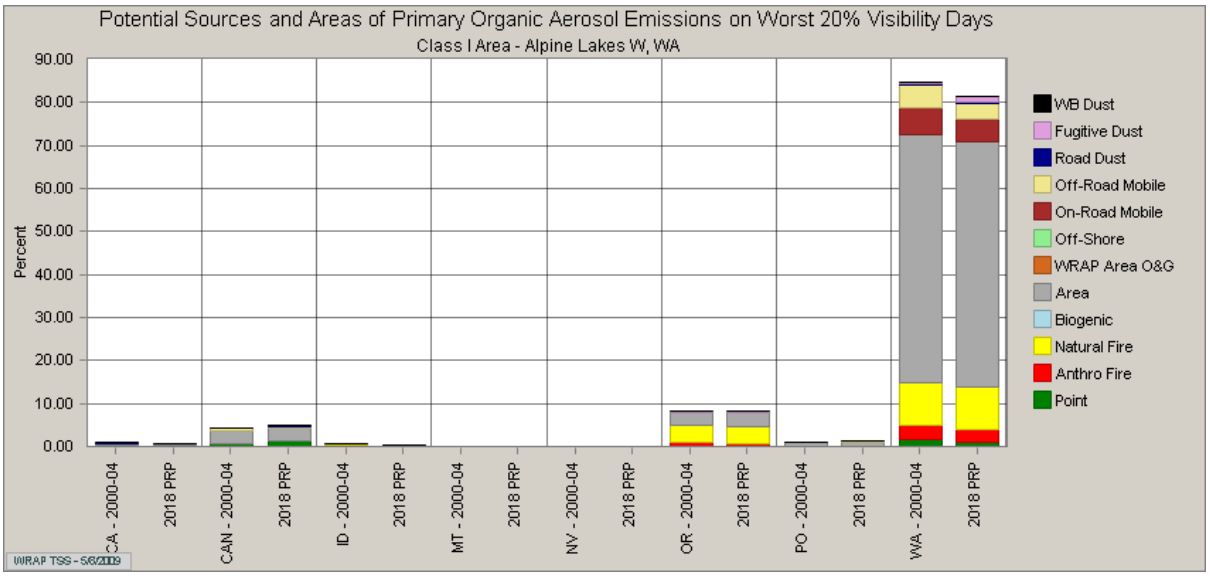

Figure 8-32 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 most impaired days at SNPA1

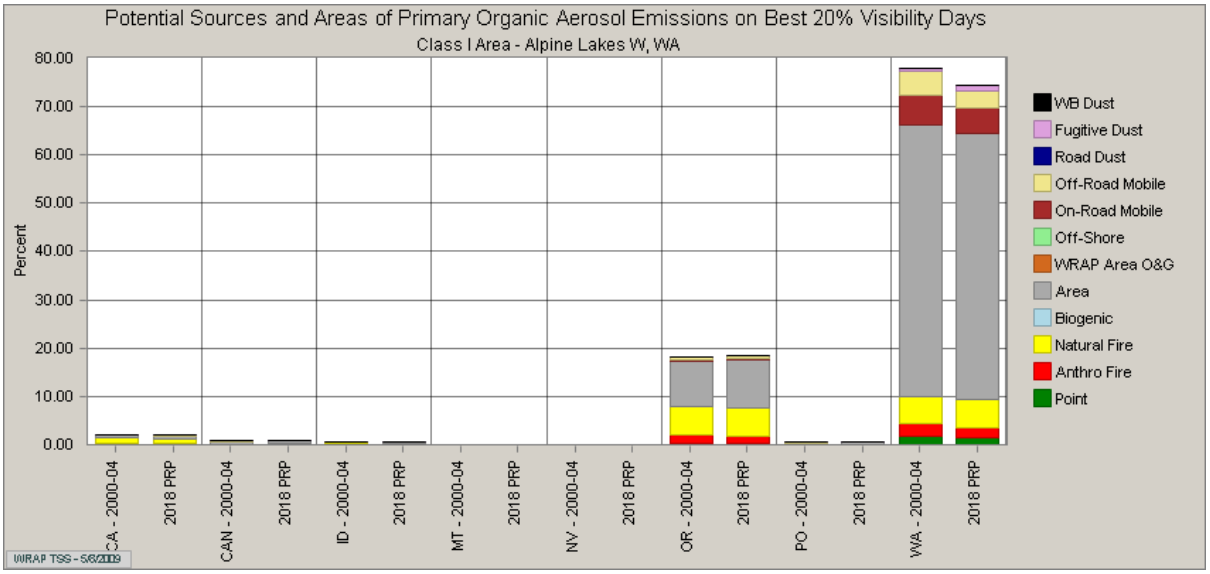

Figure 8-33 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 least impaired days at SNPA1

8.4 Mount Rainier National Park

Mount Rainier National Park is represented by the MORA1 IMPROVE monitoring site. The baseline conditions in Chapter 5 show that sulfates (46%) and OC (29%) make up 75% of the light extinction on the Most Impaired Days at this monitoring site. Nitrates (10%) and elemental carbon (10%) contribute to another 20% of the light extinction on the Most Impaired Days at this monitoring site. On the Least Impaired Days sulfates (40%) and OC (23%) make up 63% of the light extinction at this monitoring site. Nitrates (10%) and EC (10%) contribute to another 20% of the light extinction on the Least Impaired Days at this monitoring site.

8.4.1 Sulfates

Monitoring data show that sulfates were the highest contributor to haze on both the Most Impaired and Least Impaired Days in 2002.

Most Impaired Days

The PSAT tracer analysis shows that on the Most Impaired Days for 2002 sulfate emissions come primarily from primary from Washington sources (42%). Other significant regional contributors include emissions from outside the modeling domain (31%), Canada (12%) and Pacific offshore (12%). Sulfate sources from outside of the modeling domain, Canada and Pacific offshore are beyond state or local control.

In comparison to the Most Impaired Days in 2002, the projected sulfate concentration in 2018 decreases by 0.1 $\mu g/m^3$. There is some change in the relative contributions between source regions. Washington sources decrease their contributions by 8% while sources from outside the modeling domain, Canada, and Pacific offshore increase their contributions by 8%. Additional detail is shown in Figure 8-34.

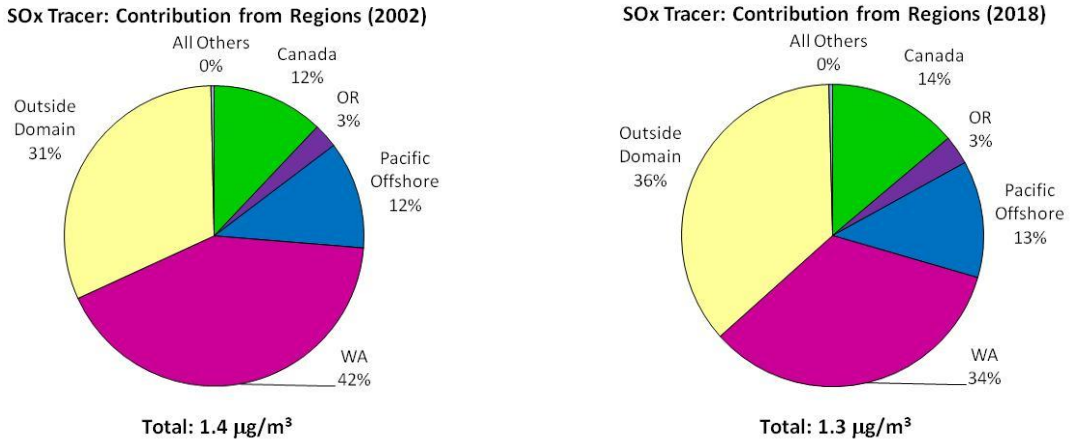

Figure 8-34 Sulfate Contributions by Source Regions for Most Impaired Days at MORA1

Figure 8-35 shows the source regions and source categories that contribute sulfate at the MORA1 monitoring site on the Most Impaired Days. In 2002, Washington point sources contributed to

25% of the total contribution to light extinction by sulfates, followed by mobile (11%) and area (6%) sources. In 2018, Washington point sources are expected to contribute to 22% of the total light extinction by sulfates, followed by area sources (8%), and mobile sources (3%).

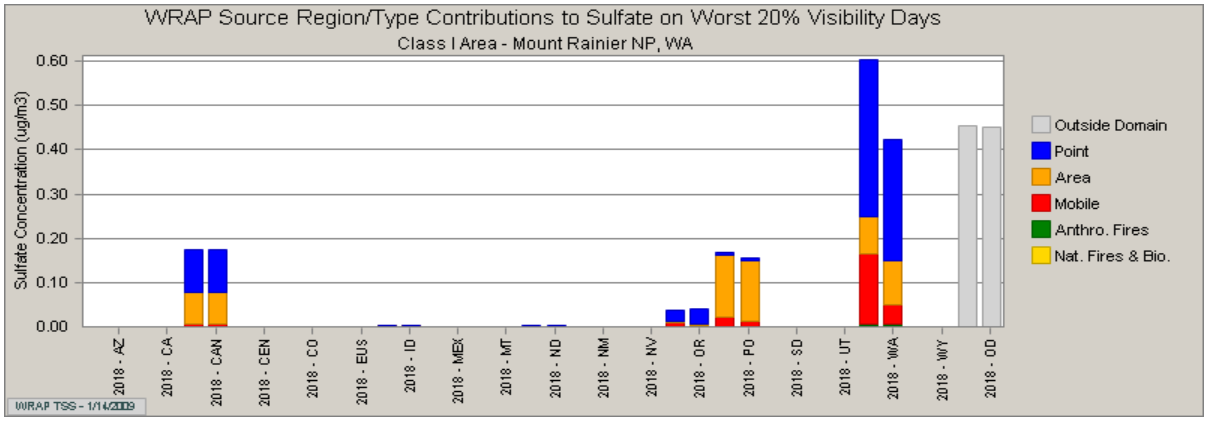

Figure 8-35 Sulfate Source Regions for 2002 and 2018 Most Impaired Days at MORA1

Least Impaired Days

The PSAT tracer analysis shows that for the Least Impaired Days in 2002, sulfate emissions come primarily from outside modeling domain and Washington's own sources. Contributions from Canada decreased on the Least Impaired Days when compared to the Most Impaired Days. Contributions from Oregon sources increased on the Least Impaired Days when compared to the Most Impaired Days.

In comparison to the Least Impaired Days in 2002, the projected sulfate concentration in 2018 decreases 0.1 µg/m^3 and the relative contributions from the source regions change. The relative contributions from Washington sources decrease by 11% while contributions from outside the modeling domain and Oregon increase by 9%. Additional detail is shown in Figure 8-36.

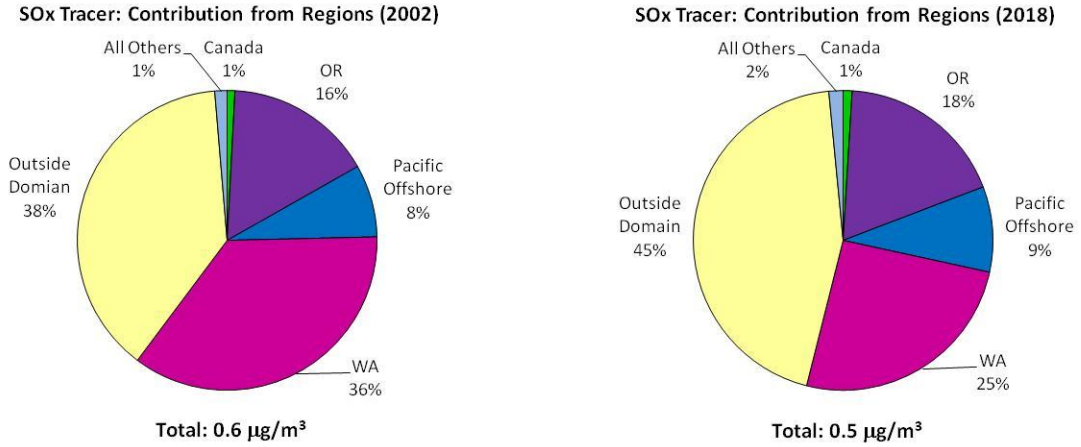

Figure 8-36 Sulfate Contributions by Source Regions for Least Impaired Days at MORA1

Figure 8-37 shows the source regions and source categories that contribute sulfate at the MORA1 monitoring site on the Least Impaired Days. In 2002, Washington point sources contributed to 25% of the total contribution to light extinction by sulfates, followed by mobile sources (7%), and area sources (3%). In 2018, Washington point sources are expected to contribute to 19% of the total light extinction by sulfates, followed by area sources (4%), and mobile sources (2%).

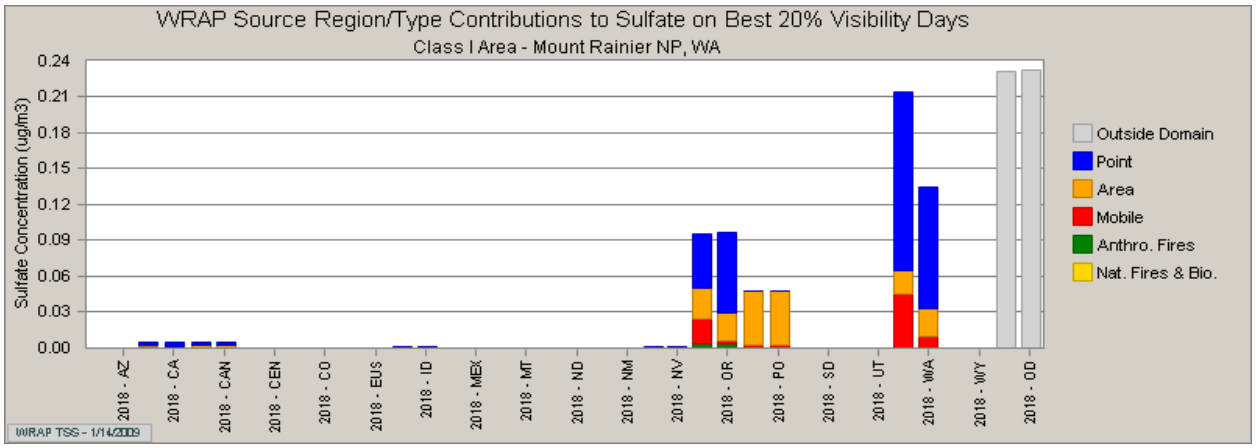

Figure 8-37 Sulfate Source Regions for 2002 and 2018 Least Impaired Days at MORA1

8.4.2 Nitrates

Monitoring data show that nitrates contributed to 10% of the haze on both the Most Impaired and Least Impaired Days in 2002 at the MORA1site.

Most Impaired Days

Washington sources are responsible for the majority (78%) of the nitrates on the Most Impaired Days in 2002, followed by other small sources (< 10% each).

In comparison to 2002, on the Most Impaired Days the projected nitrate concentration in 2018 decreases 0.3 $\mu g/m^3$. The relative contributions from Washington sources decrease by 9% while contributions from sources outside the modeling domain, Pacific offshore, and Canada increase by 7%. The relative contributions from Oregon and all other sources also increase slightly. Additional detail is shown in Figure 8-38.

Figure 8-39 shows the source regions and source categories that contribute nitrate at the MORA1 monitoring site on the Most Impaired Days. Washington mobile sources contributed to 62% of the total contribution to light extinction by nitrates on the Most Impaired Days in 2002, followed by point sources (9%), area sources (5%), and natural fire and biogenic sources (1%). In 2018, Washington mobile sources are expected to contribute to 37% of the total light extinction by nitrates, followed by point sources (18%), area sources (11%), natural and biogenic sources (2%).

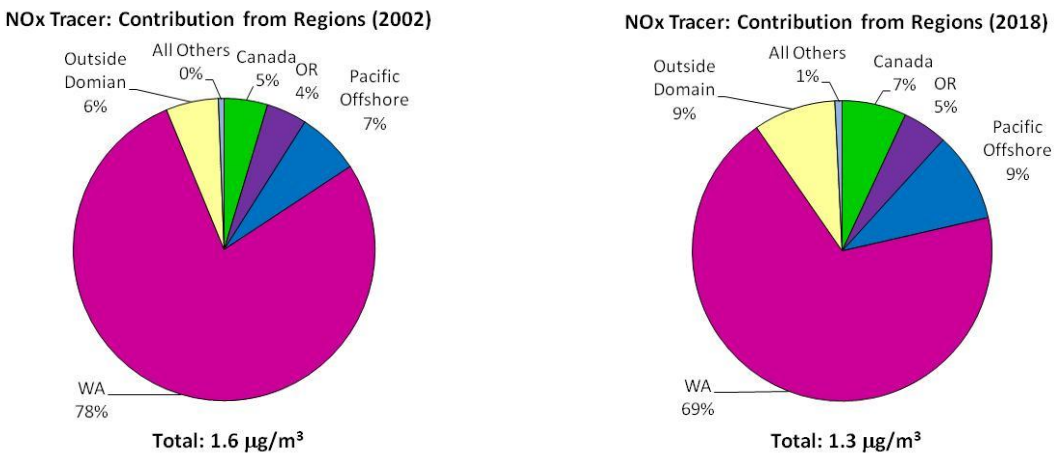

Figure 8-38 Nitrate Contributions by Source Regions for Most Impaired Days at MORA1

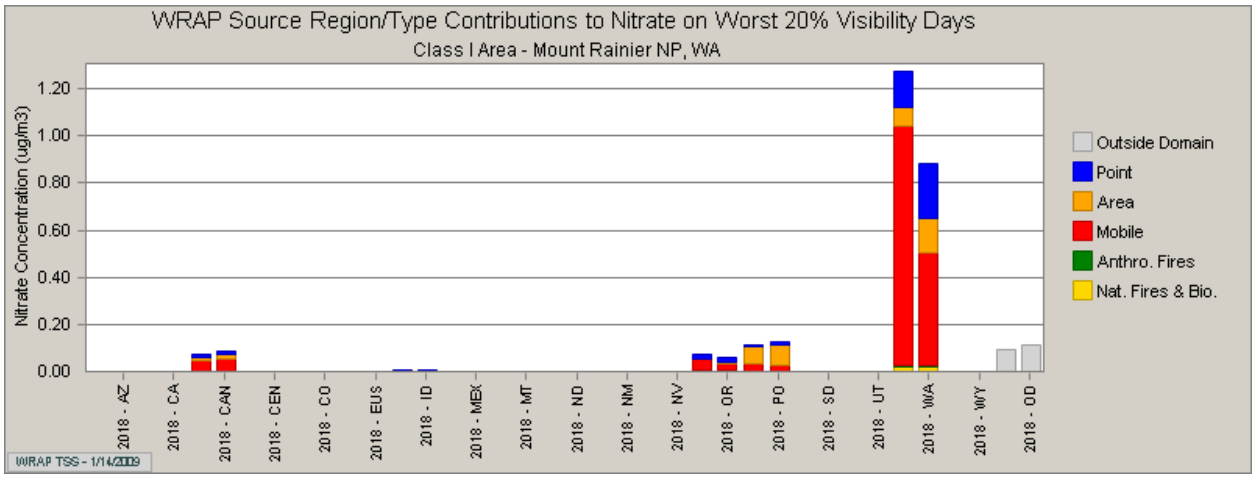

Figure 8-39 Nitrate Source Regions for 2002 and 2018 Most Impaired Days at MORA1

Least Impaired Days

On the least impaired days in 2002 Washington (42%) and Oregon (35%) account for 77% of the nitrate impacts at MORA1.

In comparison to 2002, on the Least Impaired Days the projected nitrate concentration in 2018 decreases 0.4 µg/m^3. The relative contributions from Washington sources decrease by 6%. Relative contributions from California (1%) and Oregon (3%) sources decrease by 4%. The relative contributions of nitrates from outside the modeling domain and Pacific offshore increase by 10%. Additional detail is shown in Figure 8-40.

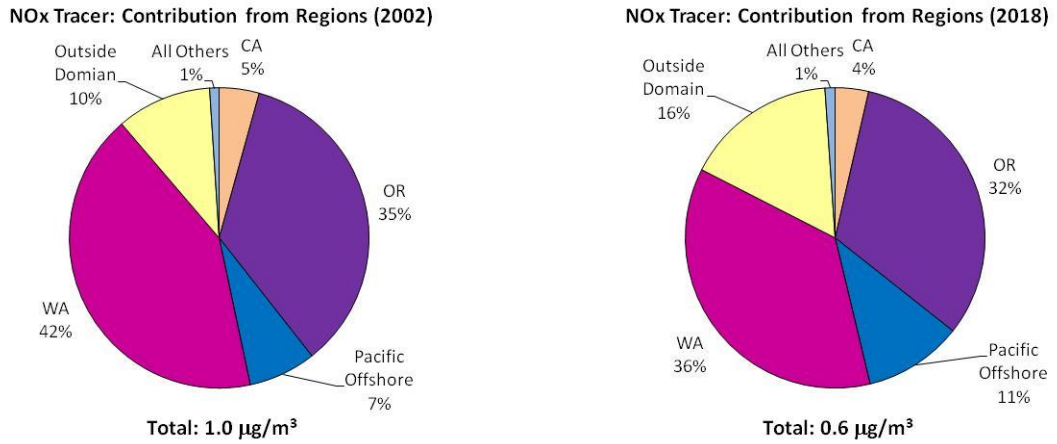

Figure 8-40 Nitrate Contributions by Source Regions for Least Impaired Days at MORA1

Figure 8-41 shows the source regions and source categories that contribute nitrate at the MORA1 monitoring site on the Least Impaired Days. Washington mobile sources contributed to 32% of the total contribution to light extinction by nitrates on the Least Impaired Days in 2002, followed by point sources (7%), areas sources (2%), and natural fire and biogenic sources (1%). In 2018, Washington mobile sources are expected to contribute to 19% of the total light extinction by nitrates, followed by point sources (11%), area sources (4%), and natural and biogenic sources (2%).

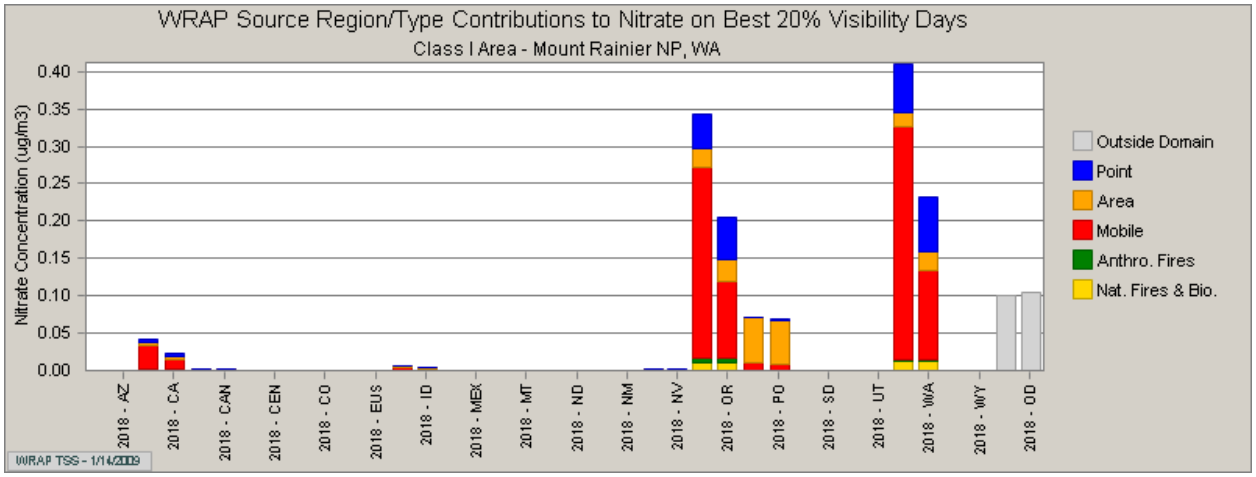

Figure 8-41 Nitrate Source Regions for 2002 and 2018 Least Impaired Days at MORA1

8.4.3 Organic Mass Carbon

Monitoring data indicate that after sulfates, OMC is the second highest cause of light extinction on both the Most Impaired and Least Impaired Days at the MORA1 site.

WEP source apportionment shows that Washington's own sources contribute most of the OMC on the Most Impaired Days at the MORA1 site. Additional detail is shown in Figure 8-42.

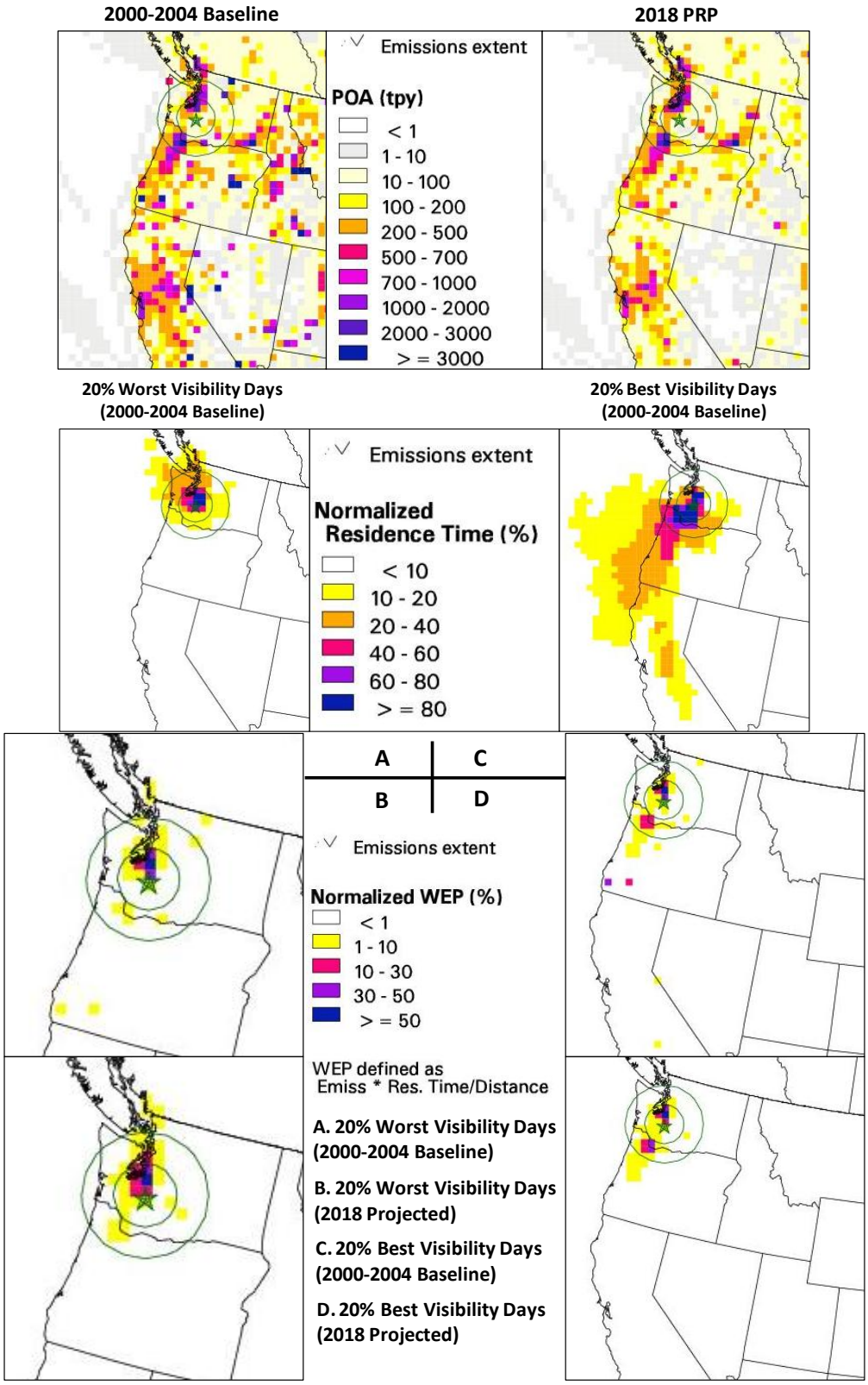

Figure 8-42 Primary Organic Aerosols Residence Time, Mapped Emissions, and Weighted Emission Potentials for Most Impaired and Least Impaired Days in 2002 and 2018 at MORA1

For both Most Impaired and Least Impaired Days in 2002 and 2018 area sources are the predominant sources. The emissions from this source are projected to decrease slightly during the first planning period. The relative contributions from other sources are also shown in Figures 8-43 and 8-44.

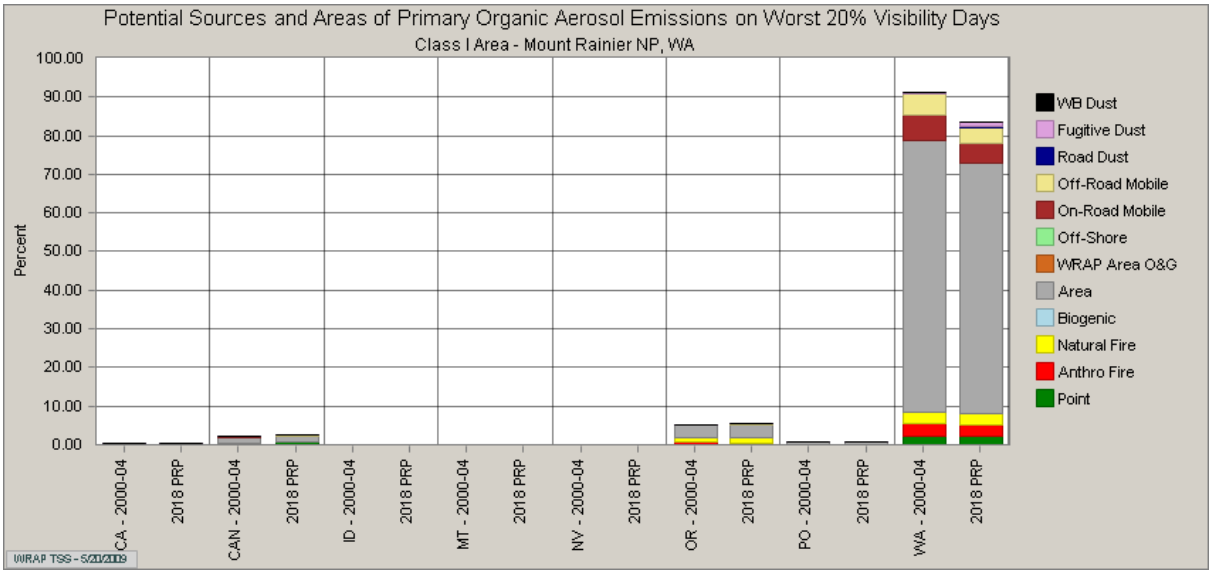

Figure 8-43 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 Most Impaired Days at MORA1

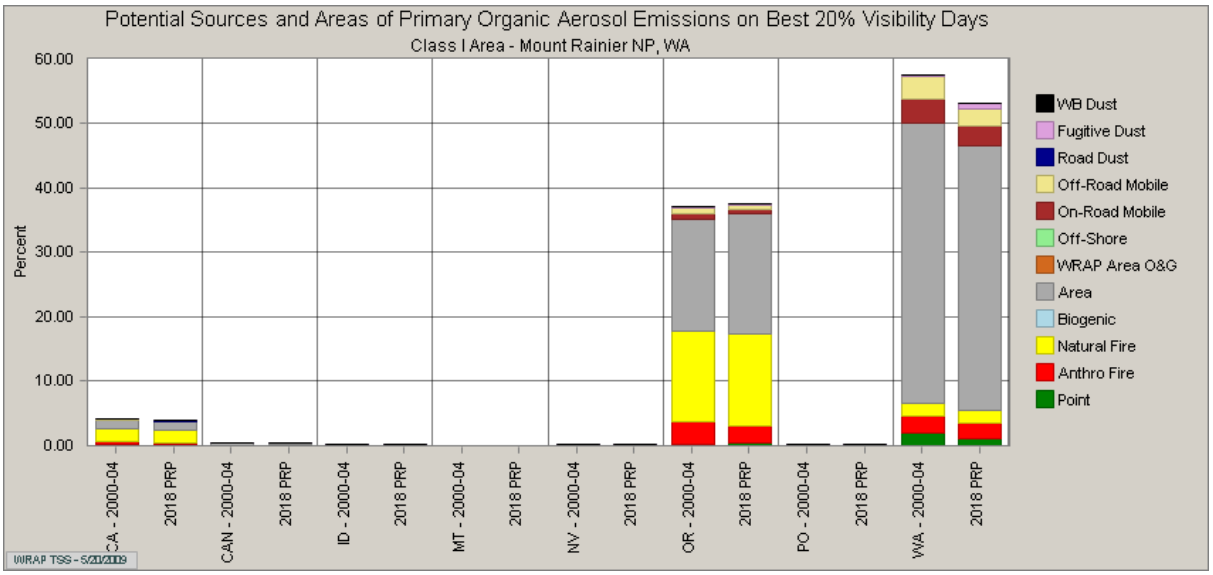

Figure 8-44 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 Least Impaired Days at MORA1

8.5 Goat Rocks Wilderness and Mount Adams Wilderness

Goat Rocks Wilderness and Mount Adams Wilderness are represented by the WHPA1 IMPROVE monitoring site. The baseline conditions in Chapter 5 show that sulfates (37%), OC

(36%), and nitrates (11%) together contribute to 84% of the light extinction on the Most Impaired Days at this monitoring site. On the Least Impaired Days sulfates (49%), OC (14%), and nitrates (13%) contribute to 76% of the light extinction at this monitoring site.

8.5.1 Sulfates

Monitoring data show that sulfates were the highest contributor to haze on both the Most Impaired and Least Impaired Days in 2002.

Most Impaired Days

The PSAT tracer analysis shows that on the Most Impaired Days in 2002 sulfate emissions come primarily from sources outside the modeling domain (39%), Washington (29%) and Canada (18%). Sulfate sources outside of the modeling domain and Canada are beyond state or local control.

In comparison to 2002, the projected sulfate concentration in 2018 decreases 0.1 $\mu g/m^3$. There is some change in the relative contributions among source regions. Washington sources decrease their contributions by 6% while sources from outside the modeling domain, Canada, and Oregon increase by 6%. Additional details are shown in Figure 8-45.

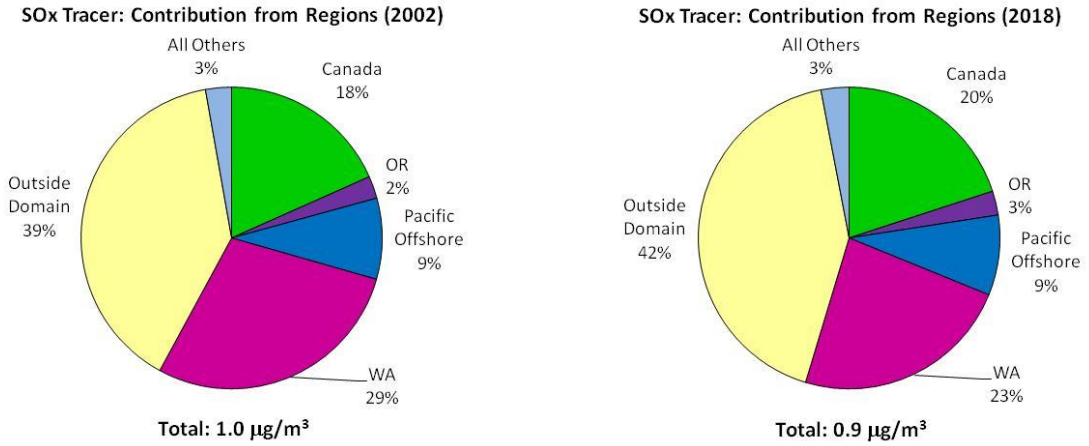

Figure 8-45 Sulfate Contributions by Source Regions for Most Impaired Days at WHPA1

Figure 8-46 shows the source regions and source categories that contribute sulfate at the WHPA1 monitoring site on the Most Impaired Days. In 2002 Washington point sources contribute to 16% of the total contributions to light extinction by sulfates, followed by mobile (8%) and area (4%) sources. In 2018, Washington point sources are expected to contribute to 16% of the total light extinction by sulfates, followed by area sources (5%), and mobile sources (2%).

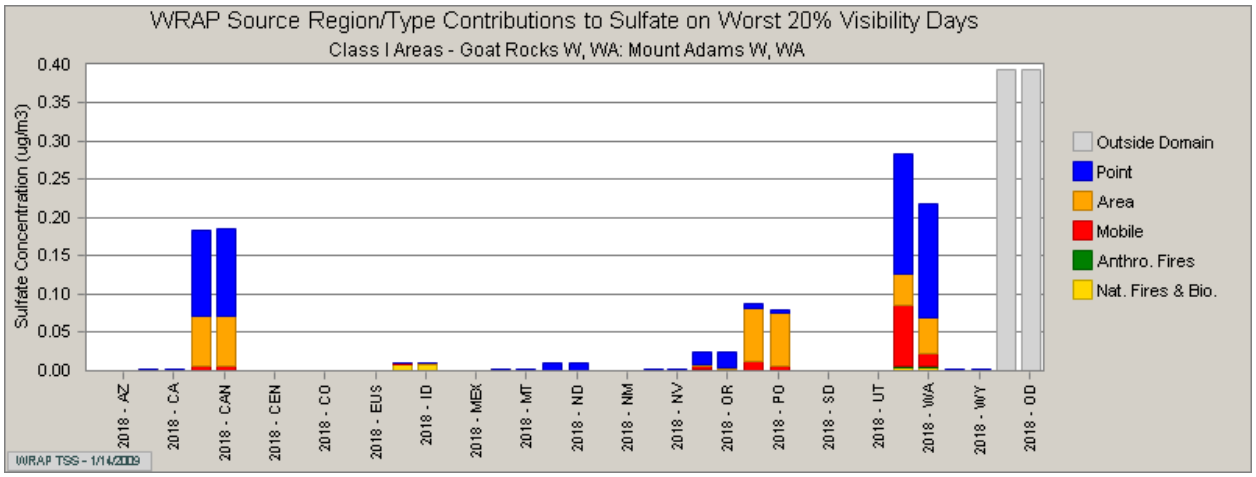

Figure 8-46 Sulfate Source Regions for 2002 and 2018 Most Impaired Days at WHPA1

Least Impaired Days

The PSAT tracer analysis shows that for the Least Impaired Days in 2002, sulfate emissions come mostly from Washington sources. Compared to the Most Impaired Days in 2002, on the Least Impaired Days in 2002 the sources from Canada and outside the modeling domain contribute far less while Oregon's contribution increases.

In comparison to the Least Impaired Days in 2018, the projected sulfate concentration decreases by 0.2 µg/m^3 and the relative contributions from the source regions change. The most significant change is a reduction in contribution from Washington sources by 13%. Other changes in relative contributions are shown in Figure 8-47.

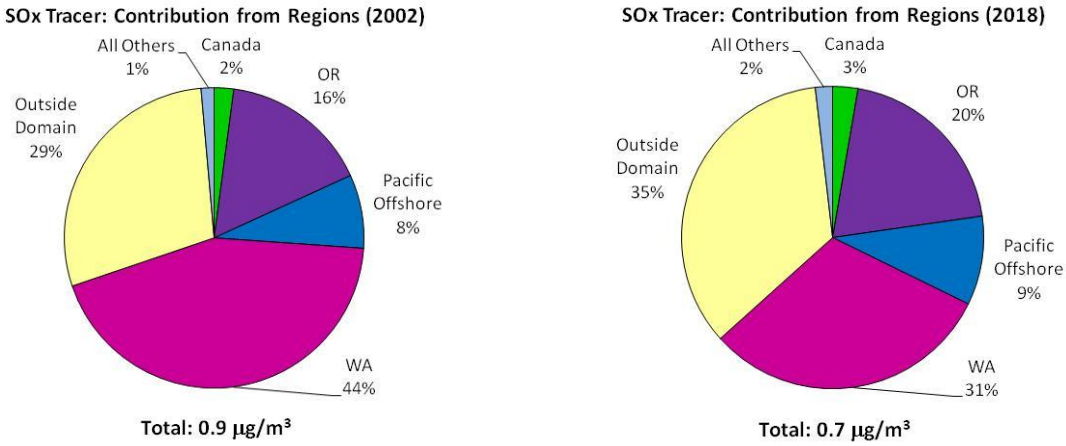

Figure 8-47 Sulfate Contributions by Source Regions for Least Impaired Days at WHPA1

Figure 8-48 shows the source regions and source categories that contribute sulfate at the WHPA1 monitoring site on the Least Impaired Days. In 2002, Washington point sources contributed to 30% of the total contribution to light extinction by sulfates, followed by mobile sources (9%),

and area sources (4%). In 2018, Washington point sources are expected to contribute to 23% of the total light extinction by sulfates, followed by area sources (6%), and mobile sources (2%).

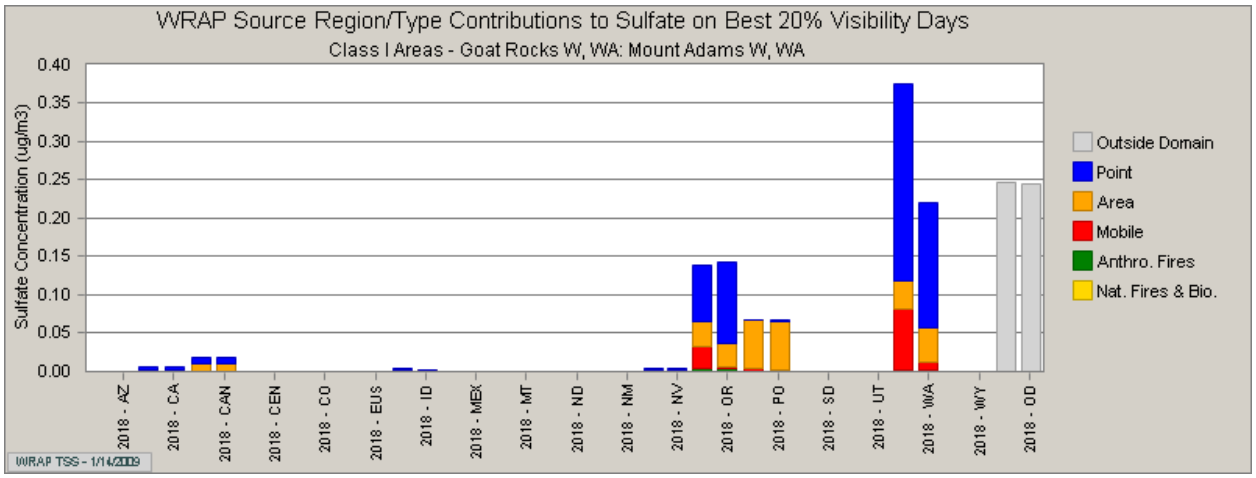

Figure 8-48 Sulfate Source Regions for 2002 and 2018 Least Impaired Days at WHPA1

8.5.2 Nitrates

Monitoring data indicate that nitrates are the third highest contributor to haze in 2002 on both the Most Impaired and Least Impaired at the WHPA1 site.

Most Impaired Days

Washington sources are responsible for 64% of the nitrates on the Most Impaired Days. Sources from outside of the modeling domain (13%), Canada (9%), Pacific offshore (5%) and Oregon (4%) contribute to another 31% of the haze impairment from nitrates.

In comparison, on the Most Impaired Days the projected nitrate concentration in 2018 decreases by 0.3 µg/m^3. The most significant change is a 14% reduction in relative contribution from Washington sources. Additional details are shown in Figure 8-49.

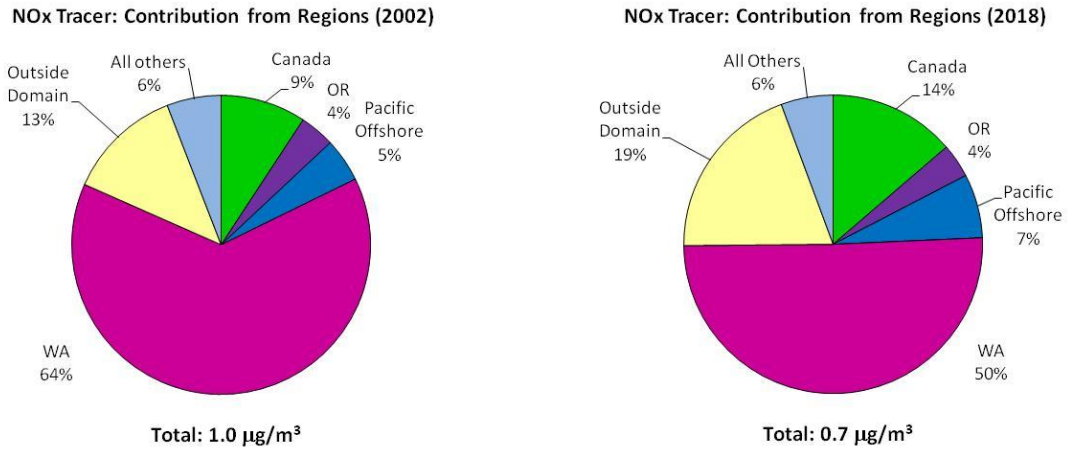

Figure 8-49 Nitrate Contributions by Source Regions for Most Impaired Days at WHPA1

Figure 8-50 shows the source regions and source categories that contribute nitrate at the WHPA1 monitoring site on the Least Impaired Days. Washington mobile sources contributed to 52% of the total contribution to light extinction by nitrates on the Most Impaired Days in 2002, followed by point sources (6%), and area sources (4%) and natural fire and biogenic sources (2%). In 2018, Washington mobile sources are expected to contribute 29% of the total light extinction by nitrates, followed by point sources (12%), areas sources (8%), and natural and biogenic sources (1%).

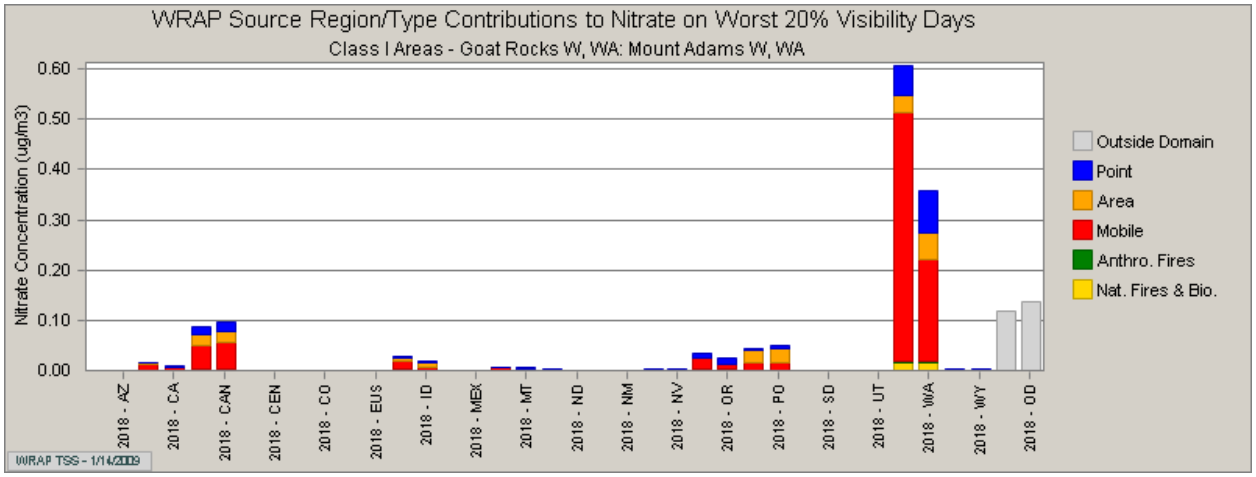

Figure 8-50 Nitrate Source Regions for 2002 and 2018 Most Impaired Days at WHPA1

Least Impaired Days

On the Least Impaired Days in 2002 Washington (48%) and Oregon (29%) sources account for 77% of the nitrate impacts at WHPA1.

In comparison to 2002, the projected nitrate concentration in 2018 decreases 0.3 µg/m^3. The relative contributions from Washington sources decrease by 5%. Contributions from Oregon decrease by 4% and California by 1%. Additional detail on the relative contributions of other regions is shown in Figure 8-51.

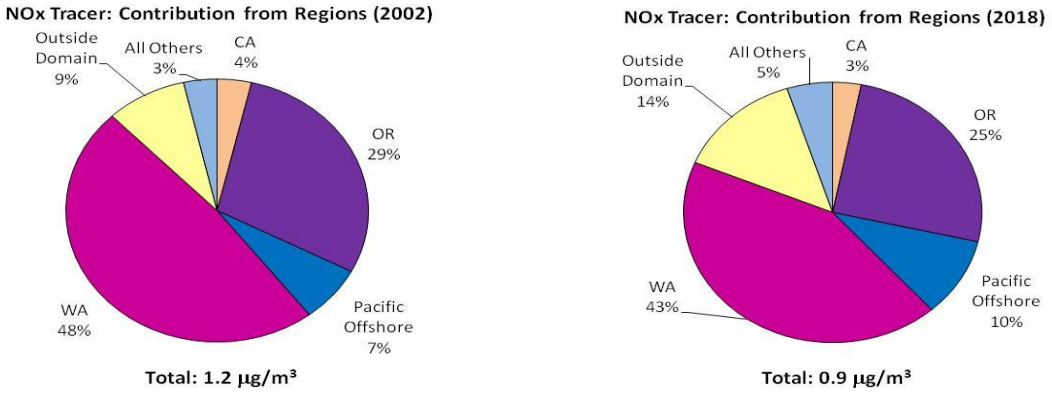

Figure 8-51 Nitrate Contributions by Source Regions for Least Impaired Days at WHPA1

Figure 8-52 shows the source regions and source categories that contribute nitrate at the WHPA1 monitoring site on the Least Impaired Days. Washington mobile sources contributed to 38% of the total contribution to light extinction by nitrates on the Least Impaired Days in 2002, followed by point sources (7%), area sources (2%), and natural fire and biogenic sources (1%). In 2018, Washington mobile sources are expected to contribute to 23% of the total light extinction by nitrates, followed by point sources (12%), area sources (5%), and natural and biogenic sources (2%).

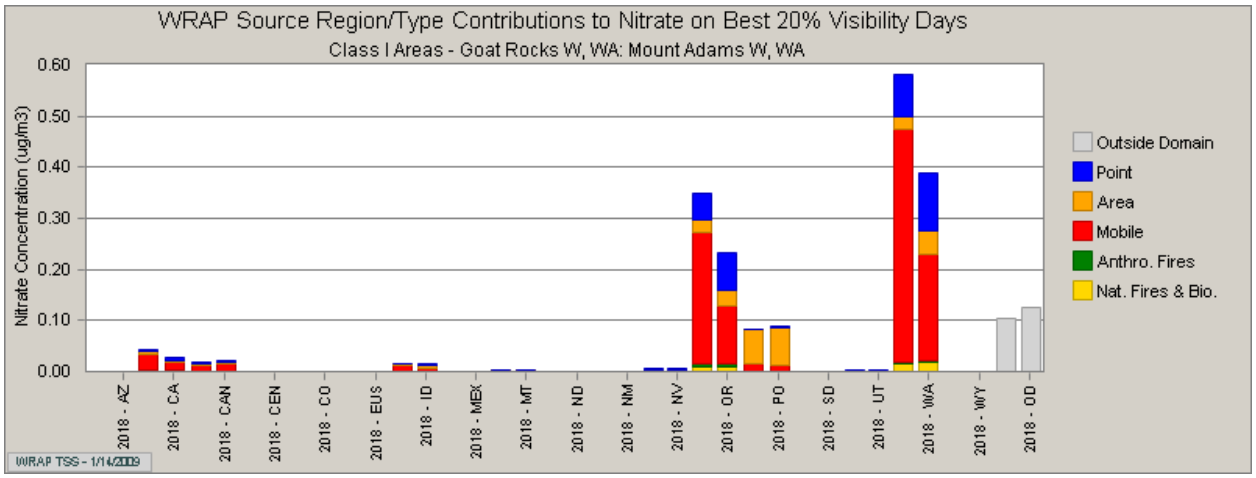

Figure 8-52 Nitrate Source Regions for 2002 and 2018 Least Impaired Days at WHPA1

8.5.3 Organic Mass Carbon

Monitoring data indicate that after sulfates, OMC is the second highest cause of light extinction on both the Most Impaired and Least Impaired Days at the WHPA1 site.
As WEP indicates, most of the OMC emissions come from Washington. Additional detail is shown in Figure 8-53.

For both Most Impaired and Least Impaired Days in 2002 and 2018 area sources are the predominant sources of OMC. Area sources are projected to increase slightly during the first planning period. The relative contributions from other sources are also shown in Figures 8-54 and 8-55.

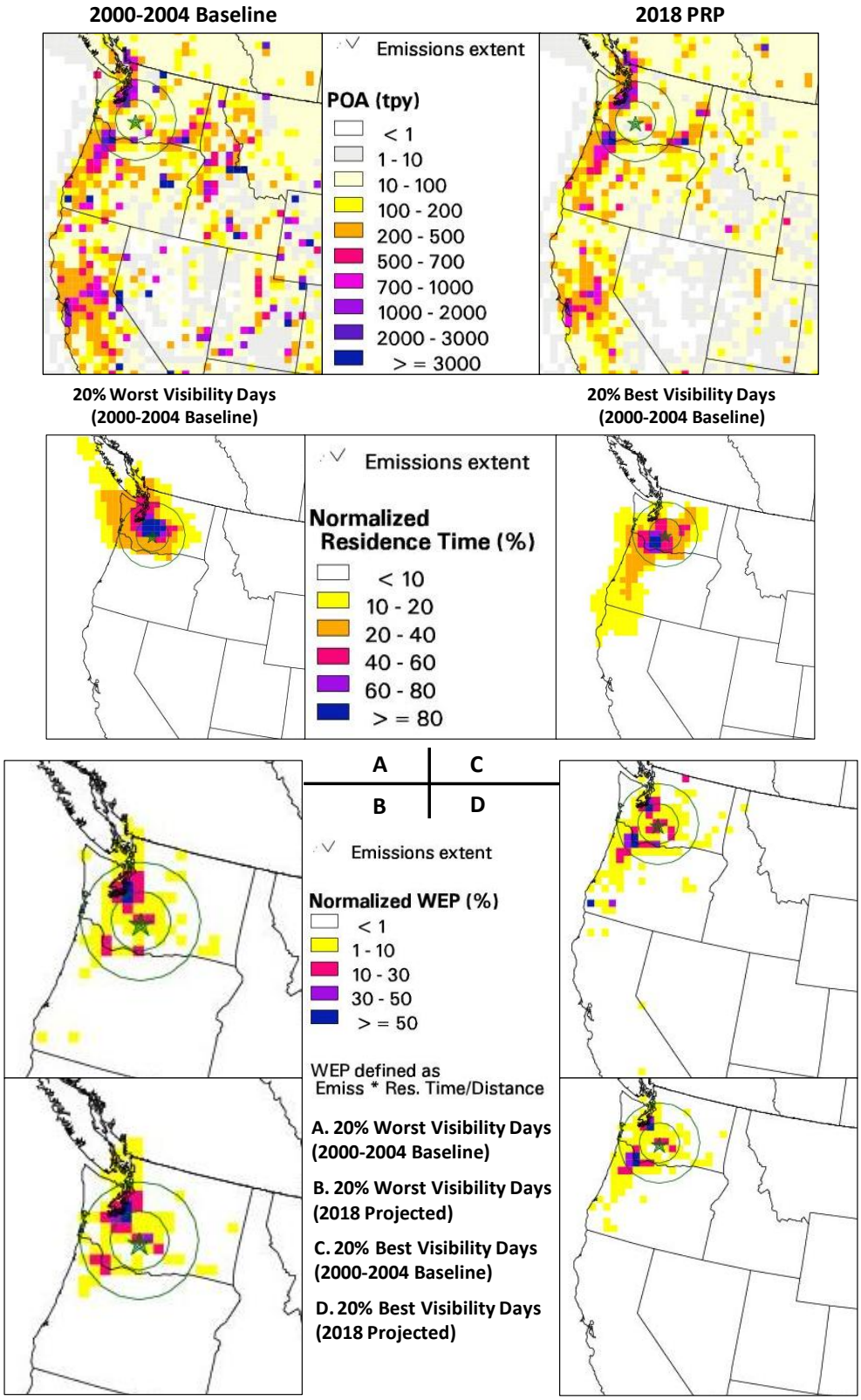

Figure 8-53 Primary Organic Aerosols Residence Time, Mapped Emissions, and Weighted Emission Potentials for Most Impaired and Least Impaired Days in 2002 and 2018 at WHPA1

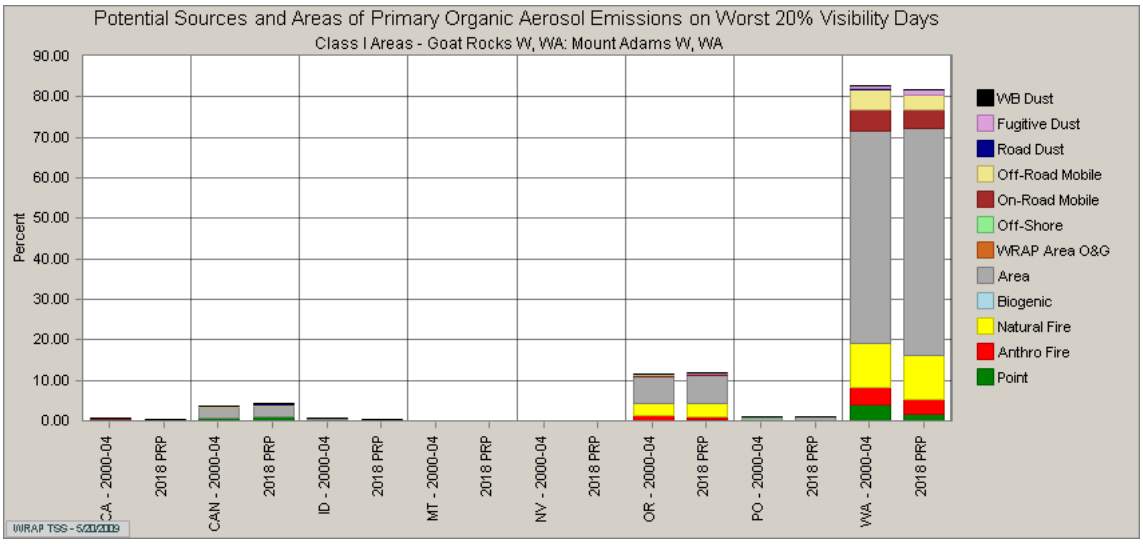

Figure 8-54 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 Most Impaired Days at WHPA1

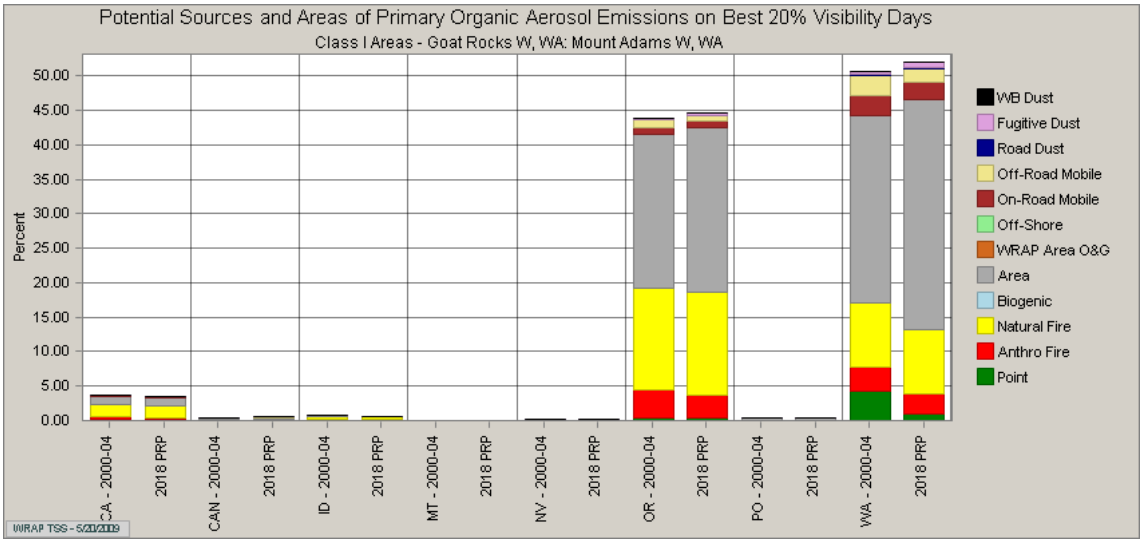

Figure 8-55 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 Least Impaired Days at WHPA1

8.6 Pasayten Wilderness

Pasayten Wilderness is represented by the PASA1 IMPROVE monitoring site. The baseline conditions in Chapter 5 show that OC (56%) and sulfates (20%) make up 76% of the light extinction on the Most Impaired Days at this monitoring site. Elemental carbon (9%) and nitrates (8%) contribute to another 17% of the light extinction on the Most Impaired Days at this monitoring site. On the Least Impaired Days, sulfates make up 48% of the light extinction at this monitoring site. OC (17%), nitrates (17%) and elemental carbon (7%) and make up another 41% of the light extinction on the Least Impaired Days at this monitoring site.

8.6.1 Sulfate

Monitoring data show sulfates are the second highest cause of light extinction on the Most Impaired Days and highest cause of light extinction on the Least Impaired Days at this site.

Most Impaired Days

The PSAT tracer analysis shows that on the Most Impaired Days for 2002 most sulfate emissions came from sources outside the modeling domain (50%) and in Canada (22%) which are beyond state or local control.

In comparison to 2002, the projected sulfate concentration in 2018 is about the same. There is some change in the contributions between sources. Washington sources decrease their contributions by 2% while sources outside the modeling domain and Canada increase by 2%. Additional detail is shown in Figure 8-56.

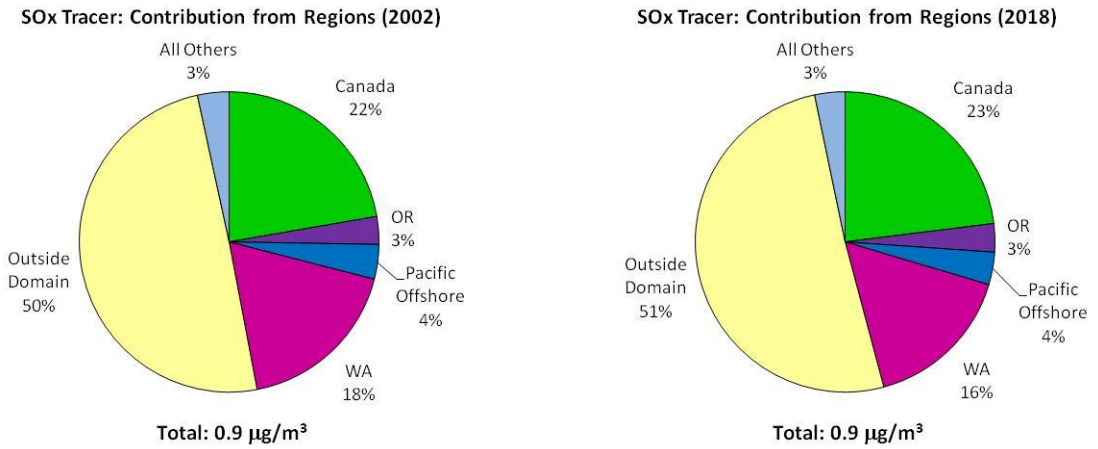

Figure 8-56 Sulfate Contributions by Source Regions for Most Impaired Days at PASA1

Figure 8-57 shows the source regions and source categories that contribute sulfate at the PASA1 monitoring site on the Most Impaired Days. In 2002, Washington point sources contributed to 8% of the total contribution to light extinction by sulfates, followed by mobile sources (4%), natural fire and biogenic sources (4%), and area sources (2%). In 2018, Washington point sources are expected to contribute to 9% of the total light extinction by sulfates, followed by natural fire and biogenic sources (4%), area sources (2%), and mobile sources (1%).

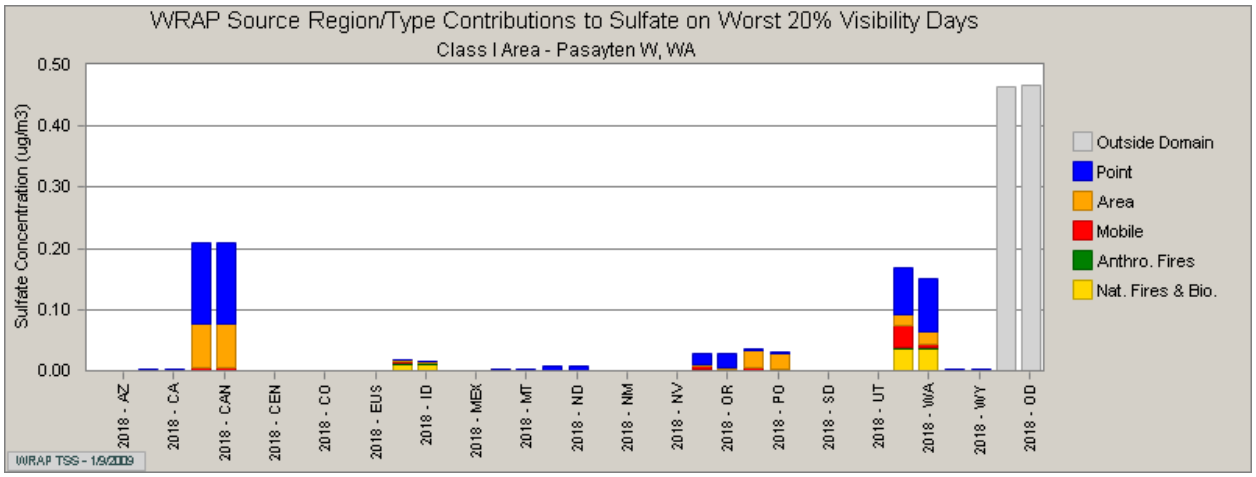

Figure 8-57 Sulfate Source Regions for 2002 and 2018 Most Impaired Days at PASA1

Least Impaired Days

On the Least Impaired Days in 2002 sulfate emissions come primarily from outside the modeling domain (40%) and Washington (36%).

In comparison to the Least Impaired Days in 2002, the projected sulfate concentration in 2018 decreases 0.1 µg/m^3. The most significant change is a 7% reduction in relative contribution from Washington sources. Changes in the relative contributions from other source regions are shown in Figure 8-58.

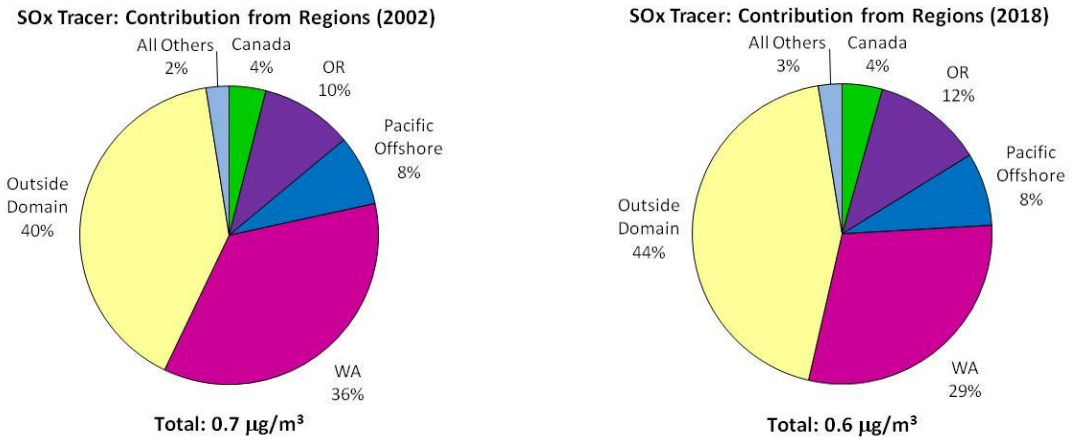

Figure 8-58 Sulfate Contributions by Source Regions for Least Impaired Days at PASA1

Figure 8-59 shows the source regions and source categories that contribute sulfate at the PASA1 monitoring site on the Least Impaired Days. In 2002, Washington point sources contributed to 21% of the total contribution to light extinction by sulfates, followed by mobile sources (10%), and area sources (5%). In 2018, Washington point sources are expected to contribute to 21% of the total light extinction by sulfates, followed by area sources (7%), and mobile sources (2%).

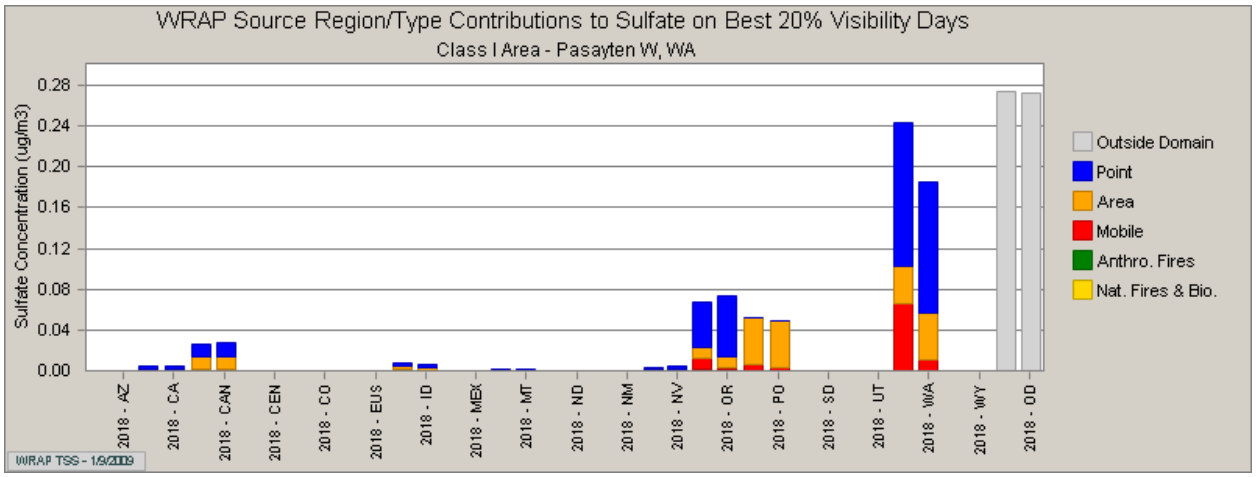

Figure 8-59 Sulfate Source Regions for 2002 and 2018 Least Impaired Days at PASA1

8.6.2 Nitrates

Monitoring data indicate that nitrates are the fourth highest contributor to haze in 2002 on the Most Impaired Days and tied with OMC as second highest on the Least Impaired Days.

Most Impaired Days

Washington sources are responsible for 48% of the nitrates, followed by sources from outside of the modeling domain (17%) and in Canada (13%).

In comparison to 2002, the projected nitrate concentration in 2018 decreases 0.2 µg/m^3. The most significant change is an 11% reduction in relative contribution from Washington sources. The changes in relative contributions from other source regions are shown in Figure 8-60.

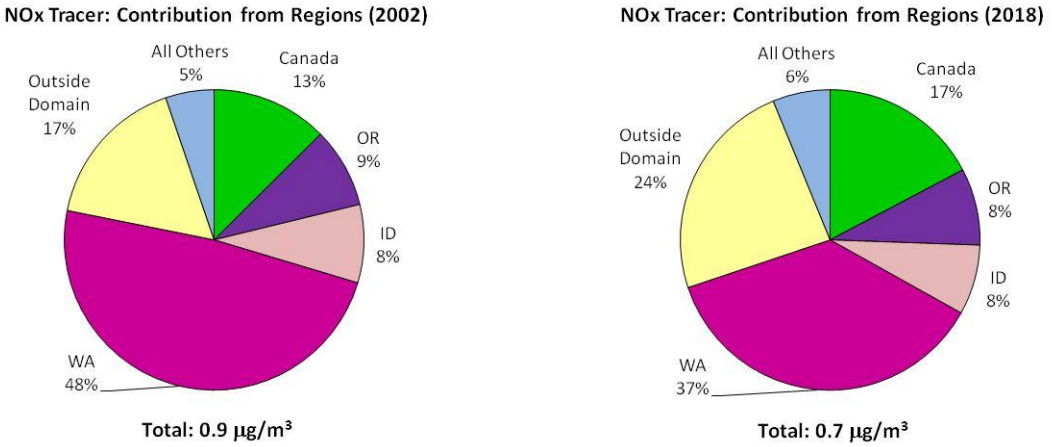

Figure 8-60 Nitrate Contributions by Source Regions for Most Impaired Days at PASA1

Figure 8-61 shows the source regions and source categories that contribute nitrate at the PASA1 monitoring site on the Most Impaired Days. Washington mobile sources contributed to 36% of the total contribution to light extinction by nitrates on the Most Impaired Days in 2002, followed

by natural fire and biogenic sources (6%), point sources (3%), and area sources (2%). In 2018, Washington mobile sources are expected to contribute to 19% of the total light extinction by nitrates, followed by natural fire and biogenic sources (8%), point sources (5%), and areas sources (3%).

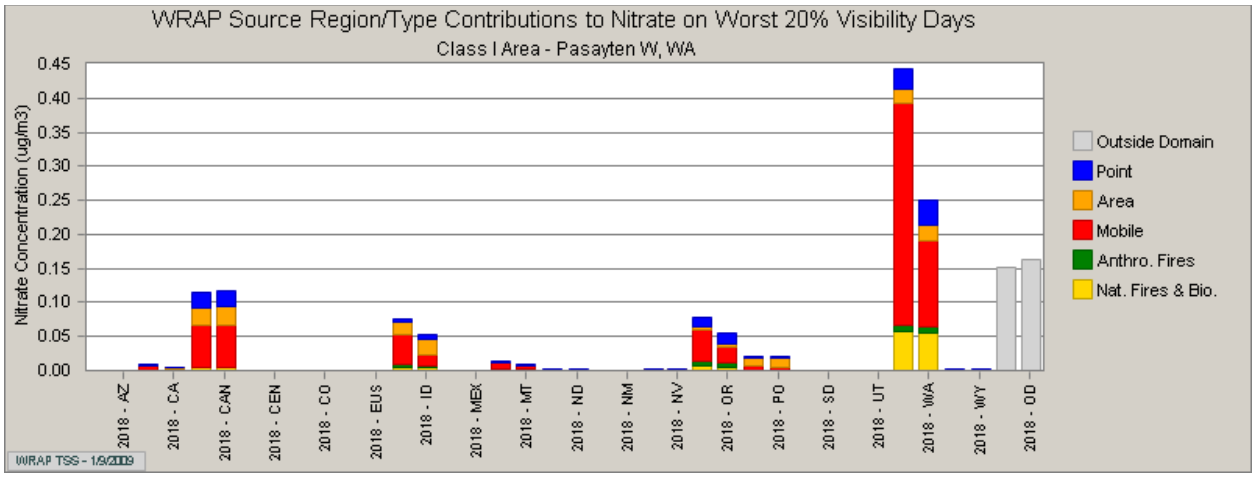

Figure 8-61 Nitrate Source Regions for 2002 and 2018 Most Impaired Days at PASA1

Least Impaired Days

On the Least Impaired Days in 2002, sources from Washington (62%), Oregon (15%) and outside of the modeling domain (8%) make up 85% of the light extinction caused by nitrates.

In comparison to the Least Impaired Days in 2002, the projected nitrate concentration in 2018 decreases 0.6 µg/m^3. The relative contributions from Washington sources decrease by 12% while contributions from outside the modeling domain, Canada, and Pacific offshore increase by 12%. Additional details are shown in Figure 8-62.

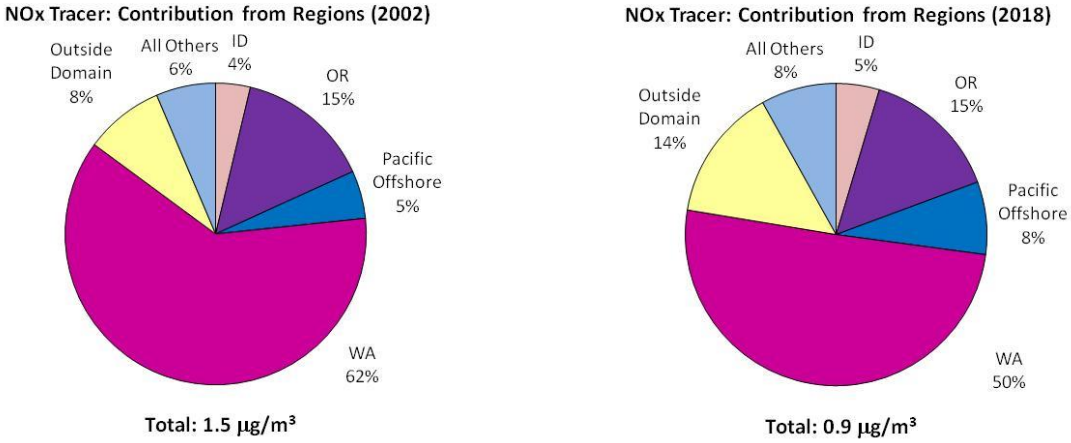

Figure 8-62 Nitrate Contributions by Source Regions for Least Impaired Days at PASA1

Figure 8-63 shows the source regions and source categories that contribute nitrate at the PASA1 monitoring site on the Least Impaired Days. Washington mobile sources contributed to 49% of

the total contribution to light extinction by nitrates on the Least Impaired Days in 2002, followed by point sources (6%), natural fire and biogenic sources (4%), and area sources (3%). In 2018, Washington mobile sources are expected to contribute to 28% of the total light extinction by nitrates, followed by point sources (10%), area sources (6%), and natural fire and biogenic sources (5%).

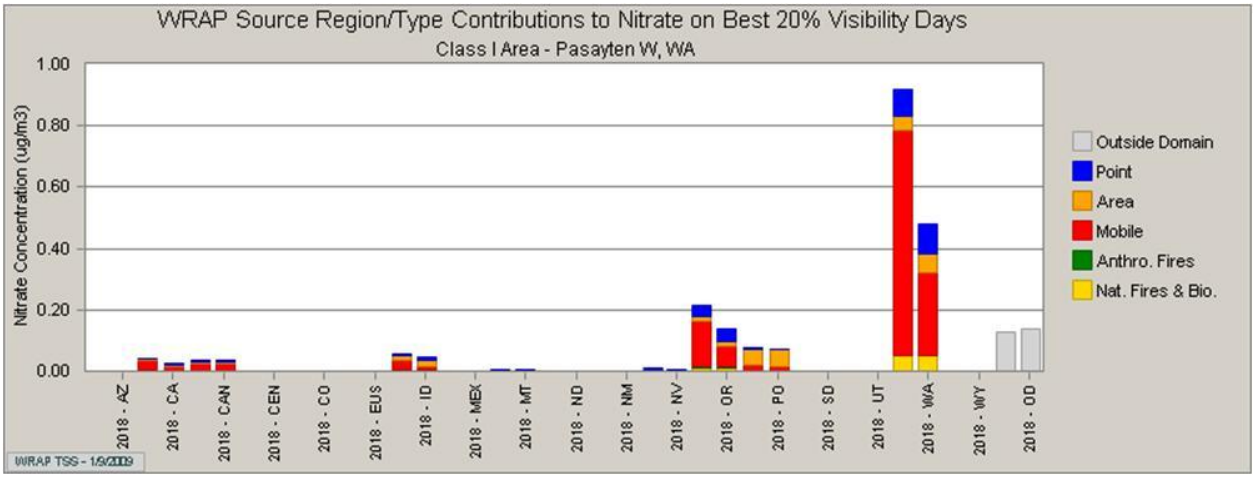

Figure 8-63 Nitrate Source Regions for 2002 and 2018 Least Impaired Days at PASA1

8.6.3 Organic Mass Carbon

Monitoring data indicate that OMC is the highest cause of light extinction on the Most Impaired Days and tied with nitrates as the second highest cause on the Least Impaired Days at the PASA1 site.

As WEP indicates, most of the OMC emissions come from Washington. Additional detail is shown in Figure 8-64.

For both Most Impaired and Least Impaired Days in 2002 and 2018 natural fire is the predominant source of OMC. The emissions from natural fire were held constant from 2002 and 2018. The relative contributions from other sources are also shown in Figures 8-65 and 8-66.

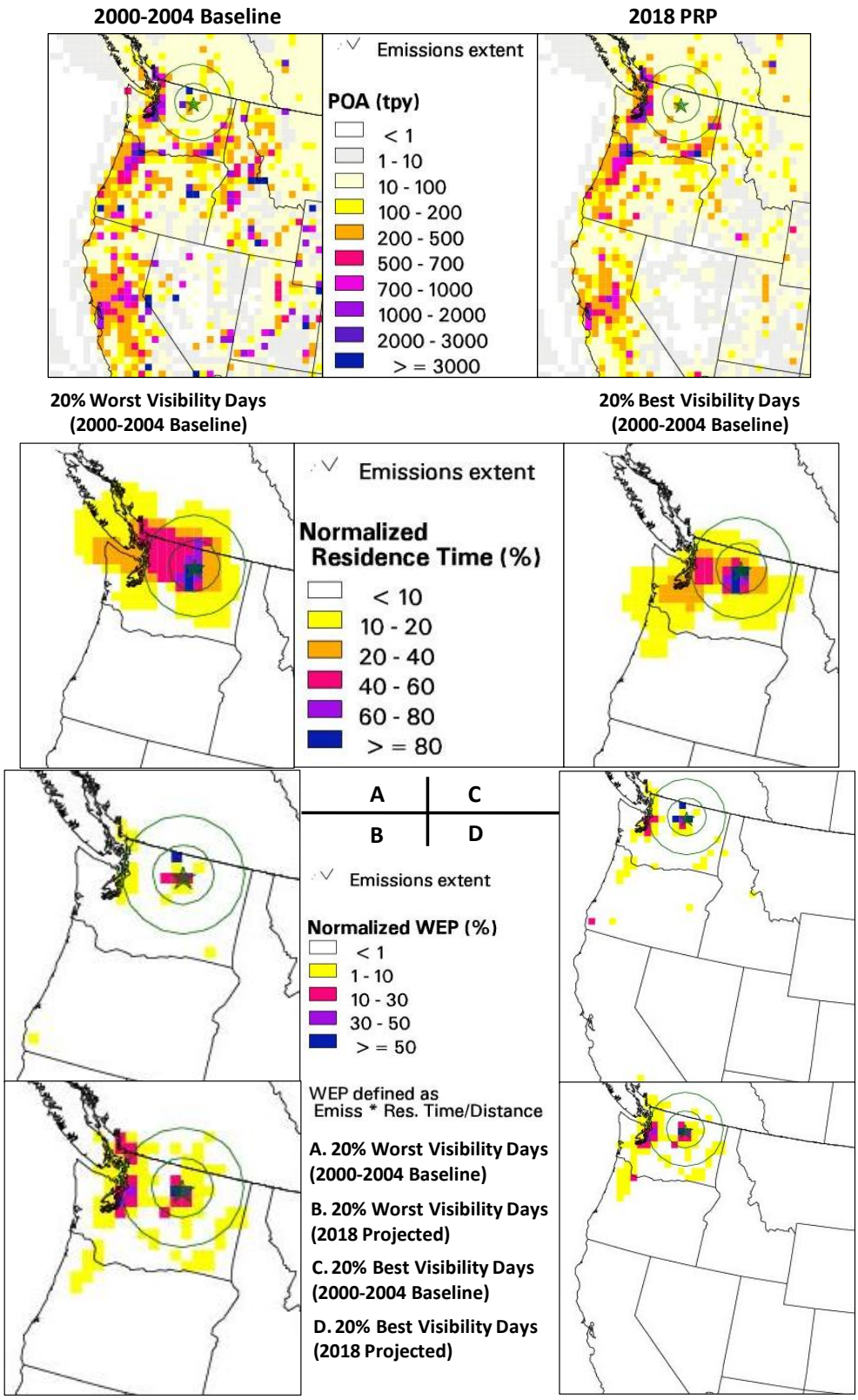

Figure 8-64 Primary Organic Aerosols Residence Time, Mapped Emissions, and Weighted Emission Potentials for Most Impaired and Least Impaired Days in 2002 and 2018 at PASA1

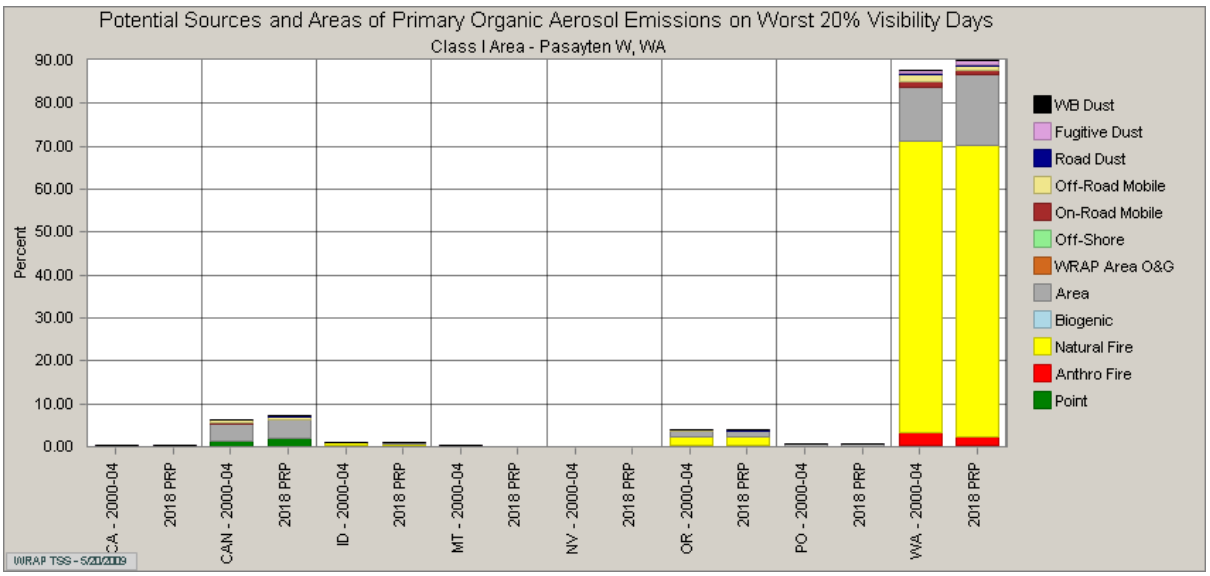

Figure 8-65 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 Most Impaired Days at PASA1

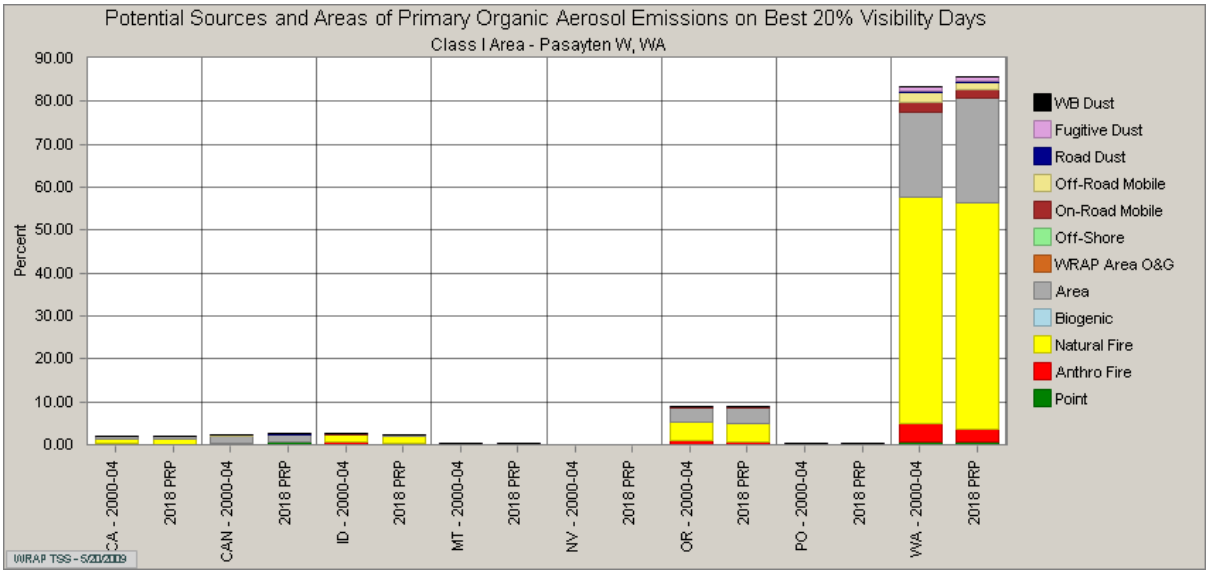

Figure 8-66 Primary Organic Aerosol Contributions by Source Regions for 2002 and 2018 Least Impaired Days at PASA1

8.6.4 Elemental Carbon

Monitoring data indicate that elemental carbon is the third highest cause of light extinction on the Most Impaired Days and fourth highest cause on the Least Impaired Days at the PASA1 site in 2002.

WEP is the screening tool used to help identify source regions for elemental carbon. As WEP indicates, most of the elemental carbon emissions come from Washington sources. Additional detail is shown in Figure 8-67.

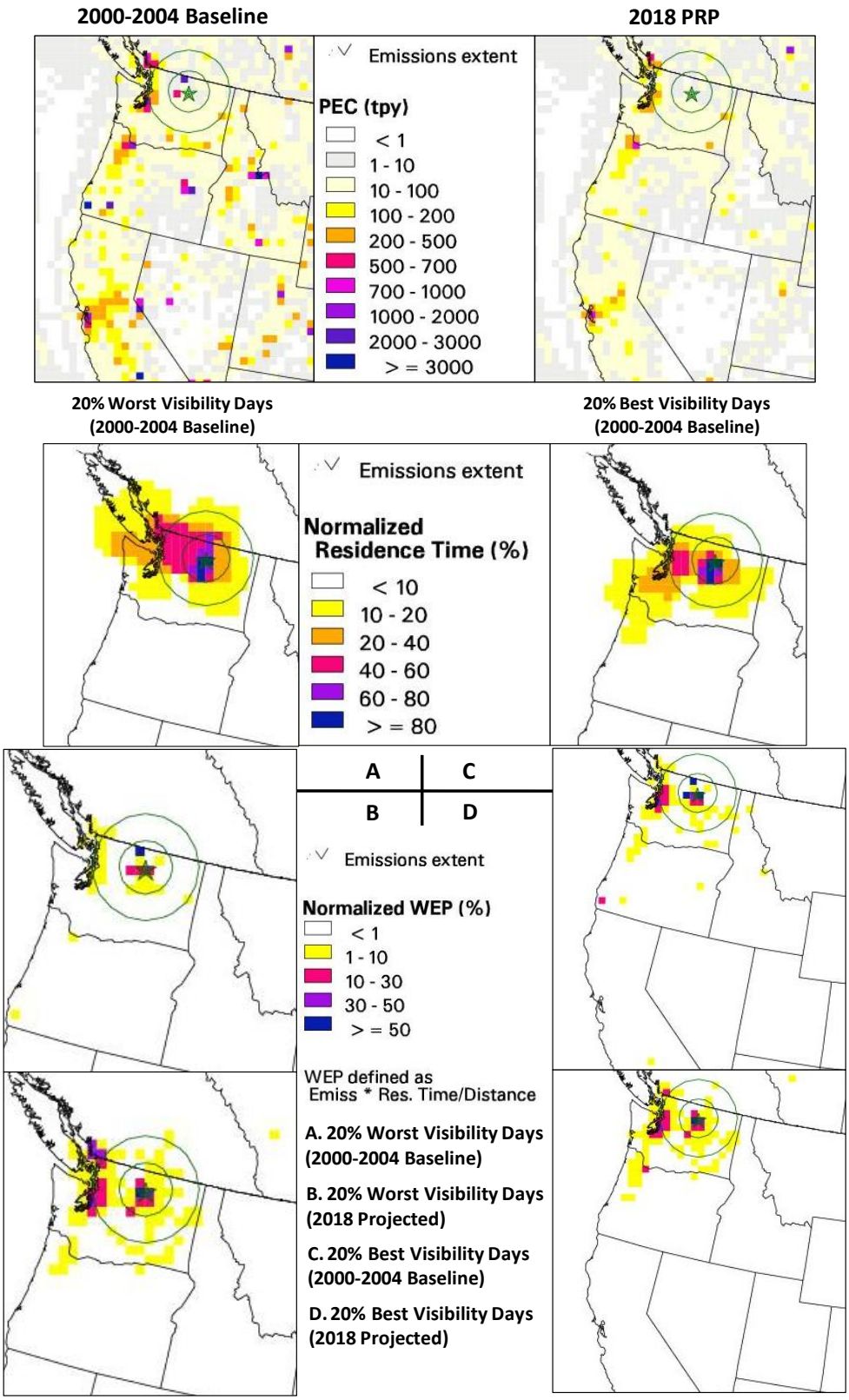

Figure 8-67 Elemental Carbon Mapped Emissions, Residence Time, and Weighted Emission Potentials for Most Impaired and Least Impaired Days in 2002 and 2018 at PASA1

For both Most Impaired and Least Impaired Days in 2002 and 2018 natural fire is the predominant source of elemental carbon. The emissions from natural fire were held constant from 2002 and 2018. The relative contributions from other sources are also shown in Figures 8-68 and 8-69.

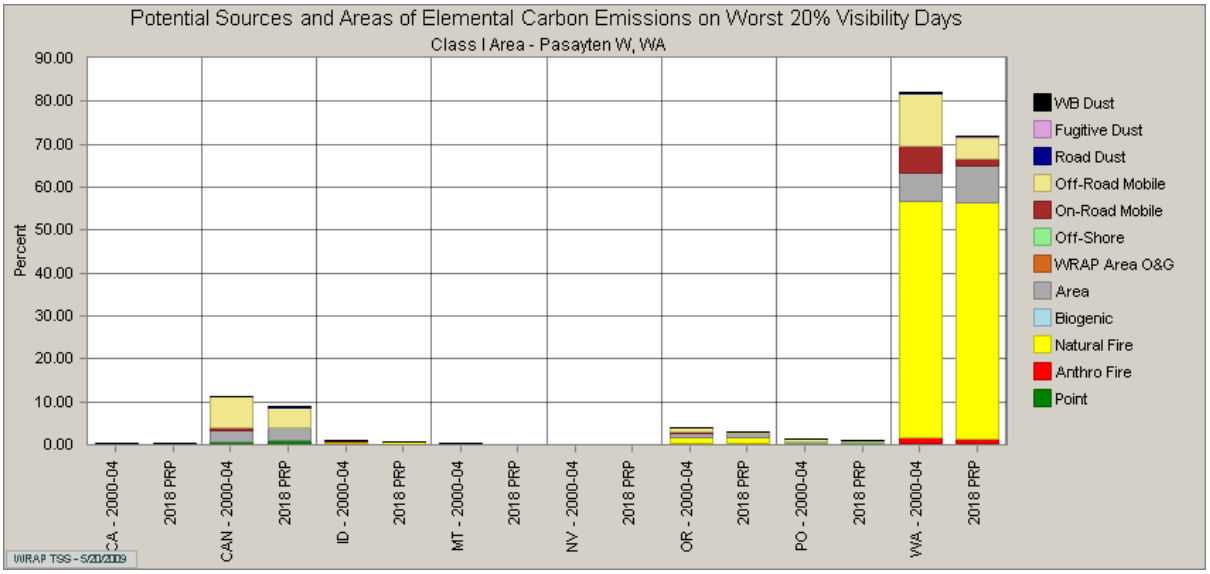

Figure 8-68 Elemental Carbon Contributions by Source Regions for 2002 and 2018 Most Impaired Days at PASA1

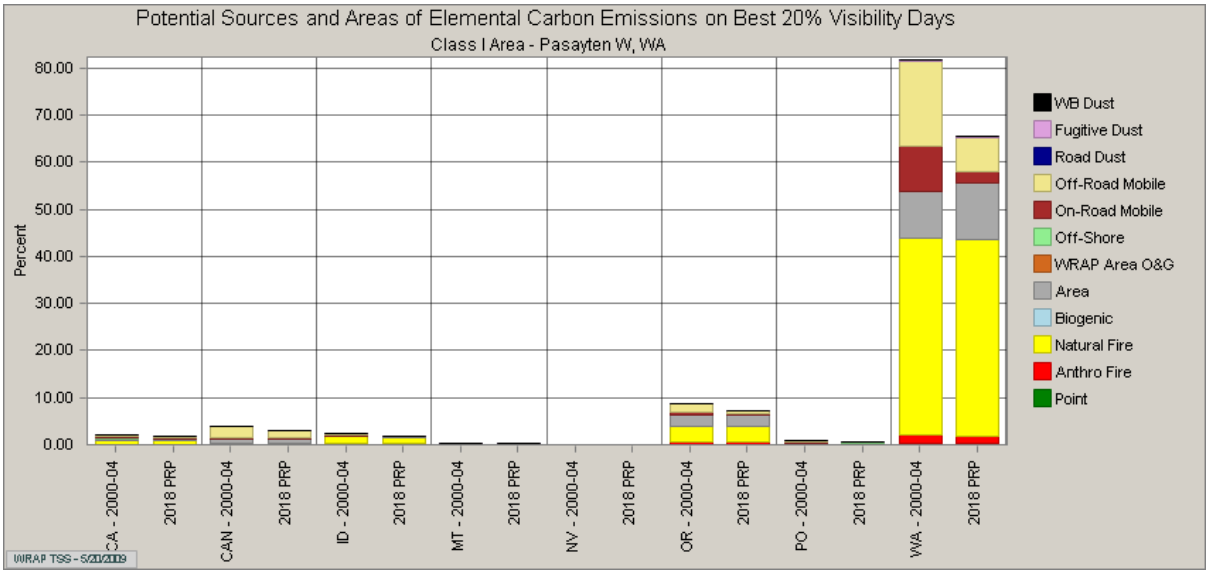

Figure 8-69 Elemental Carbon Contributions by Source Regions for 2002 and 2018 Least Impaired Days at PASA1

8.7 Summary of In State Source Contributions of Nitrates and Sulfates

Table 8-1 summarizes the in-state sources of sulfates for the four major source categories at each of the mandatory Class I Areas in Washington for both the Most Impaired and Least Impaired Days.

Table 8-2 summarizes the in-state sources of nitrates for the four major source categories at each of the mandatory Class I Areas in Washington for both the Most Impaired and Least Impaired Days.

Table 8-1 Sulfate Contributions by Major Source Category for Washington's Mandatory Class I Areas

IMPROVE Site	Most Impaired Days										Least Impaired Days									
	2002					2018					2002					2018				
	WA	Major Source Categories				WA	Major Source Categories				WA	Major Source Categories				WA	Major Source Categories			
		Point	Area	Mobile	Nat. Fires & Bio.		Point	Area	Mobile	Nat. Fires & Bio.		Point	Area	Mobile	Nat. Fires & Bio.		Point	Area	Mobile	Nat. Fires & Bio.
OLYM1	**25%**	15%	3%	7%	0%	**24%**	19%	4%	1%	0%	**34%**	18%	6%	10%	0%	**29%**	18%	8%	2%	0%
NOCA1	**29%**	20%	3%	5%	1%	**29%**	24%	3%	1%	1%	**39%**	23%	5%	10%	2%	**33%**	24%	8%	1%	4%
SNPA1	**32%**	16%	5%	10%	0%	**28%**	19%	6%	3%	0%	**42%**	26%	5%	11%	0%	**35%**	25%	7%	2%	0%
MORA1	**42%**	25%	6%	11%	0%	**34%**	22%	8%	3%	0%	**36%**	25%	3%	7%	0%	**25%**	19%	4%	2%	0%
WHPA1	**29%**	16%	4%	8%	0%	**23%**	16%	5%	2%	0%	**44%**	30%	4%	9%	0%	**31%**	23%	6%	2%	0%
PASA1	**18%**	8%	2%	4%	4%	**16%**	9%	2%	1%	4%	**36%**	21%	5%	10%	0%	**29%***	21%	7%	2%	0%

Table 8-2 Nitrate Contributions by Major Source Category for Washington's Mandatory Class I Areas

IMPROVE Site	Most Impaired Days										Least Impaired Days									
	2002					2018					2002					2018				
	WA	Major Source Categories				WA	Major Source Categories				WA	Major Source Categories				WA	Major Source Categories			
		Point	Area	Mobile	Nat. Fires & Bio.		Point	Area	Mobile	Nat. Fires & Bio.		Point	Area	Mobile	Nat. Fires & Bio.		Point	Area	Mobile	Nat. Fires & Bio.
OLYM1	**53%**	9%	3%	40%	1%	**42%**	15%	6%	19%	1%	**58%**	8%	4%	45%	1%	**51%**	15%	9%	26%	1%
NOCA1	**46%**	6%	2%	34%	3%	**31%**	9%	4%	14%	4%	**63%**	6%	3%	51%	2%	**51%**	11%	7%	29%	4%
SNPA1	**68%**	5%	3%	56%	3%	**56%**	10%	7%	34%	4%	**65%**	7%	3%	52%	1%	**55%**	14%	8%	31%	2%
MORA1	**78%**	9%	5%	62%	1%	**69%**	18%	11%	37%	2%	**42%**	7%	2%	32%	1%	**36%**	11%	4%	19%	2%
WHPA1	**64%**	6%	4%	52%	2%	**50%***	12%	8%	29%	2%	**48%**	7%	2%	38%	1%	**43%**	12%	5%	23%	2%
PASA1	**48%**	3%	2%	36%	6%	**37%**	5%	3%	19%	8%	**62%**	6%	3%	49%	4%	**50%**	10%	6%	28%	5%

*Difference due to rounding.

8.8 Summary of In-State Dominant Source Contributions of Organic Mass Carbon

Table 8-3 summarizes the dominant in-state source categories that contribute to OMC on the Most Impaired and Least Impaired Days at each of the mandatory Class I Areas in Washington.

Table 8-3 Summary of In-State Dominant Source Contributions of Organic Mass Carbon

IMPROVE SITE	Most Impaired Days		Least Impaired Days	
	2002	2018	2002	2018
OLYM1	Area	Area	Area	Area
NOCA1	Natural Fire & Area	Natural Fire & Area	Natural Fire & Area	Natural Fire & Area
SNPA1	Area	Area	Area	Area
MORA1	Area	Area	Area	Area
WHPA1	Area	Area	Area	Area
PASA1	Natural Fire	Natural Fire	Natural Fire	Natural Fire

8.9 Other Mandatory Class I Areas Impacted by Washington Emissions

The PSAT source apportionment modeling results were evaluated to determine which mandatory Class I Areas in adjacent states might be affected by emissions from Washington sources.

Table 8-4 presents the results of this evaluation for sulfates. The table identifies the rank and percentage of the total modeled concentration due to SO_2 emissions from sources within Washington to the IMPROVE monitors representing mandatory Class I Areas in California, Oregon, Idaho, Nevada, Montana, and Wyoming. The rank and percentage contribution is based on contributions from all modeled source areas. The red values indicate sulfate contributions from Washington sources equal to or greater than 10% at particular IMPROVE monitoring sites.

Table 8-4 Washington's Sulfate Extinction Contribution to Mandatory Class I Areas in Areas Outside of Washington

IMPROVE Site Code	IMPROVE Site Name	Sulfate Extinction Contribution due to Washington Emissions							
		Most Impaired Days				Least Impaired Days			
		2002		2018		2002		2018	
		Impact	Rank	Impact	Rank	Impact	Rank	Impact	Rank
California									
AGTI1	Agua Tibia W	1.0%	7	0.7%	7	0.3%	10	0.2%	12
BLIS1	Desolation W, Mokelumne W	3.3%	6	2.0%	7	0.3%	6	0.3%	6
DOME1	Dome Lands	2.9%	5	1.8%	7	0.6%	7	0.3%	9
HOOV1	Hoover W	3.6%	5	2.5%	6	0.4%	5	0.4%	5
KAIS1	Ansel Adams W, John Muir W, Kaiser W	3.1%	6	2.0%	7	0.4%	5	0.0%	9
LABE1	Lava Beds NM, South Warner W	7.1%	4	5.1%	5	2.8%	6	2.0%	6
LAVO1	Caribou W, Lassen Volcanic NP, Thousand Lakes W	5.5%	5	3.7%	5	0.6%	7	0.5%	6
PINN1	Pinnacles NM, Ventana W	3.6%	5	2.3%	5	0.8%	4	0.5%	4
PORE1	Point Reyes NS	4.5%	5	2.7%	6	5.9%	4	3.9%	5
RAFA1	San Rafael W	2.9%	5	1.9%	5	0.5%	6	0.4%	8
REDW1	Redwood NP	2.6%	4	1.7%	5	4.2%	5	2.7%	5
SAGA1	Cucamonga W, San Gabriel W	1.5%	6	0.9%	6	0.4%	8	0.3%	10
SAGO1	San Gorgonio W, San Jacinto W	1.2%	7	0.8%	7	0.4%	9	0.2%	12
SEQUI	Kings Canyon NP, Sequoia NP	1.9%	6	1.2%	7	1.4%	6	0.8%	7
TRIN1	Marble Mountain W, Yolla Bolly-Middle Eel W,	6.6%	5	4.3%	5	2.6%	5	1.7%	5
YOSE1	Emigrant W, Yosemite NP	3.7%	5	2.3%	7	0.3%	6	0.3%	6
Oregon									
CRLA1	Crater Lake NP, Diamond Peak W, Gearhart Mountain W, Mountain Lakes W	8.5%	4	5.5%	6	2.9%	5	2.1%	5
KALM1	Kalmiopsis W	6.2%	4	3.7%	4	0.6%	6	0.2%	6
MOHO1	Mount Hood W	**21.6%**	2	**17.5%**	2	7.1%	4	5.7%	4
STAR1	Eagle Cap W, Strawberry Mountain W	**14.4%**	3	**12.9%**	3	**10.6%**	3	9.3%	3
THSI1	Mount Jefferson W, Mount Washington W, Three Sisters W	**14.8%**	3	**11.0%**	4	3.3%	5	2.4%	5
Idaho									
CRMO1	Craters of the Moon NM	4.1%	5	3.1%	6	6.7%	4	5.7%	5
HECA1	Hells Canyon W	5.8%	5	4.5%	5	**10.4%**	3	8.4%	3
SAWT1	Sawtooth W	8.9%	4	6.9%	4	5.1%	6	3.6%	7

Nevada									
JARB1	Jarbidge W	8.6%	3	6.0%	5	2.2%	7	1.3%	8
Montana									
CABI1	Cabinet Mountains W	**13.8%**	3	**10.7%**	3	**16.8%**	2	**14.7%**	3
GAMO1	Gates of the Mountains W	5.8%	4	4.4%	4	7.3%	4	5.8%	6
GLAC1	Glacier NP	6.0%	4	4.8%	4	**17.2%**	3	**13.7%**	3
MELA1	Medicine Lake NWRW	2.1%	6	1.7%	6	2.1%	4	1.7%	4
MONT1	Bob Marshall W, Mission Mountains W, Scapegoat W	6.9%	3	4.8%	4	**13.3%**	3	**10.8%**	3
SULA1	Anaconda-Pintler W, Selway-Bitterroot W	9.6%	4	7.3%	4	4.9%	4	3.3%	6
ULBE1	UL Bend NWRW	2.3%	7	1.7%	7	7.7%	3	6.6%	4
Wyoming									
BRID1	Bridger W, Fitzpatrick W	1.9%	13	1.1%	15	0.9%	10	0.5%	10
NOAB1	North Absaroka W, Washakie W	3.3%	6	2.1%	8	2.4%	8	1.7%	9
YELL2	Grand Teton NP, Red Rock Lakes NWRW, Teton W, Yellowstone NP	4.3%	6	2.9%	9	3.8%	5	2.5%	9

Table 8-5 presents the results of the PSAT source apportionment modeling for nitrate extinction at the mandatory Class I Areas in California, Oregon, Idaho, Nevada, Montana, and Wyoming. The rank and percentage contribution is based on contributions from all modeled source areas. The red values indicate sulfate contributions from Washington sources equal to or greater than 10% at particular IMPROVE monitoring sites.

Table 8-5 Washington's Nitrate Extinction Contribution to Mandatory Class I Areas in Areas Outside of Washington

IMPROVE Site Code	IMPROVE Site Name	Nitrate Extinction Contribution due to Washington Emissions							
		Most Impaired Days				Least Impaired Days			
		2002		2018		2002		2018	
		Impact	Rank	Impact	Rank	Impact	Rank	Impact	Rank
California									
AGTI1	Agua Tibia W	0.2%	7	0.2%	8	0.2%	8	0.2%	9
BLIS1	Desolation W, Mokelumne W	1.0%	6	0.4%	7	0.5%	6	0.3%	7
DOME1	Dome Lands	0.9%	6	0.8%	6	0.6%	7	0.4%	9
HOOV1	Hoover W	4.2%	5	4.5%	4	0.9%	5	0.5%	5
KAIS1	Ansel Adams W, John Muir W, Kaiser W	2.7%	4	1.9%	6	0.4%	6	0.2%	6
LABE1	Lava Beds NM,South Warner W	6.6%	4	4.9%	5	3.7%	6	2.8%	6
LAVO1	Caribou W, Lassen Volcanic NP, Thousand Lakes W	2.9%	5	3.0%	5	0.7%	6	0.5%	7
PINN1	Pinnacles NM, Ventana W	1.1%	5	1.0%	6	0.4%	6	0.4%	6
PORE1	Point Reyes NS	2.1%	5	1.5%	6	4.3%	5	3.7%	5
RAFA1	San Rafael W	1.4%	5	1.2%	5	0.4%	5	0.3%	5
REDW1	Redwood NP	7.9%	5	4.9%	5	1.6%	5	1.3%	5
SAGA1	Cucamonga W, San Gabriel W	0.5%	5	0.3%	6	0.3%	6	0.2%	8
SAGO1	San Gorgonio W, San Jacinto W	0.3%	7	0.2%	7	0.5%	8	0.3%	9
SEQUI	Kings Canyon NP, Sequoia NP	0.5%	6	0.4%	6	1.1%	6	0.8%	8
TRIN1	Marble Mountain W, Yolla Bolly-Middle Eel W	5.1%	4	4.5%	5	2.8%	5	2.2%	5
YOSE1	Emigrant W, Yosemite NP	1.6%	6	1.9%	6	0.3%	5	0.2%	6
Oregon									
CRLA1	Crater Lake NP, Diamond Peak W, Gearhart Mountain W, Mountain Lakes W	**11.8%**	4	7.9%	4	3.2%	5	2.9%	5
KALM1	Kalmiopsis W	**13.2%**	4	8.3%	5	0.7%	6	0.4%	6
MOHO1	Mount Hood W	**33.5%**	2	**24.9%**	2	**10.0%**	3	8.4%	4
STAR1	Eagle Cap W, Strawberry Mountain W	**19.4%**	3	**13.7%**	4	**14.4%**	4	**10.7%**	4

THSI1	Mount Jefferson W, Mount Washington W, Three Sisters W	**21.9%**	2	**15.9%**	3	5.1%	5	4.2%	5
Idaho									
CRMO1	Craters of the Moon NM	4.9%	4	3.0%	7	7.7%	4	5.1%	8
HECA1	Hells Canyon W	7.6%	5	4.7%	6	**17.1%**	3	**11.6%**	3
SAWT1	Sawtooth W	**12.2%**	3	8.1%	4	6.7%	5	4.0%	7
Nevada									
JARB1	Jarbidge W	6.6%	6	4.6%	6	2.9%	7	1.8%	8
Montana									
CABI1	Cabinet Mountains W	**33.4%**	1	**25.0%**	1	**31.2%**	1	**23.3%**	1
GAMO1	Gates of the Mountains W	**10.2%**	4	6.4%	4	**15.1%**	3	9.6%	4
GLAC1	Glacier NP	**13.2%**	4	8.9%	4	**35.6%**	1	**25.2%**	1
MELA1	Medicine Lake NWRW	5.8%	5	3.1%	5	5.9%	4	3.2%	5
MONT1	Bob Marshall W, Mission Mountains W, Scapegoat W	**10.0%**	4	7.2%	4	**19.6%**	1	**13.6%**	4
SULA1	Anaconda-Pintler W, Selway-Bitterroot W	**16.2%**	3	**10.6%**	5	9.2%	5	5.4%	5
ULBE1	UL Bend NWRW	5.2%	5	2.8%	5	13.9%	3	8.4%	5
Wyoming									
BRID1	Bridger W, Fitzpatrick W	3.1%	8	2.9%	8	2.0%	8	1.1%	10
NOAB1	North Absaroka W, Washakie W	4.6%	6	3.0%	6	4.8%	7	2.7%	8
YELL2	Grand Teton NP, Red Rock Lakes NWRW, Teton W, Yellowstone NP	9.4%	3	6.0%	4	6.0%	5	3.6%	8