

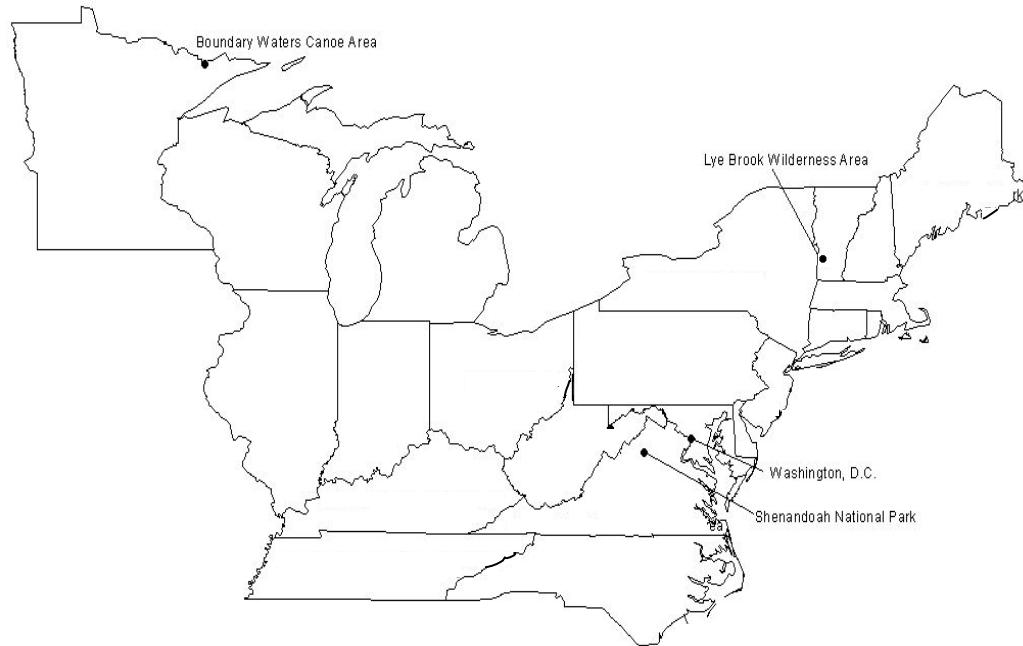
# **MANE-VU**

Mid-Atlantic/Northeast Visibility Union

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## Source Apportionment Analysis of Air Quality Monitoring Data: Phase II



*Final Report*

**APPENDIX 6.4**

UNMIX Receptor Modeling

*Prepared by*

Desert Research Institute

**March 2005**

*for the*

Mid-Atlantic/Northeast Visibility Union

and

Midwest Regional Planning Organization

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and to the United States Environmental Protection Agency, Region V under EPA Agreement A-97522601-1.

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## TABLE OF CONTENTS

	<u>Page</u>
<b>6. RECEPTOR MODELING .....</b>	<b>1</b>
6.4 UNMIX – Receptor Modeling .....	1
6.4.1 Boundary Waters Canoe Area .....	1
6.4.2 Lye Brook Wilderness Area .....	13
6.4.3 Shenandoah National Park .....	25
6.4.4 Washington DC .....	37
<b>9. REFERENCES:.....</b>	<b>49</b>

## **TABLE OF FIGURES**

Figure 6.4-1	UNMIX modeled source profiles for Boundary Waters Canoe Area annual.....	4
Figure 6.4-2	UNMIX modeled source profiles for Boundary Waters Canoe Area, winter.....	6
Figure 6.4-3	UNMIX modeled source profiles for Boundary Waters Canoe Area, spring.....	8
Figure 6.4-4	UNMIX modeled source profiles for Boundary Waters Canoe Area, summer.....	10
Figure 6.4-5	UNMIX modeled source profiles for Boundary Waters Canoe Area, fall.....	12
Figure 6.4-6	UNMIX modeled source profiles for Lye Brook Wilderness Are, annual.....	16
Figure 6.4-7	UNMIX modeled source profiles for Lye Brook Wilderness Area, winter.....	18
Figure 6.4-8	UNMIX modeled source profiles for Lye Brook Wilderness Area, spring.....	20
Figure 6.4-9	UNMIX modeled source profiles for Lye Brook Wilderness Area, summer.....	22
Figure 6.4-10	UNMIX modeled source profiles for Lye Brook Wilderness Area, fall.....	24
Figure 6.4-11	UNMIX modeled source profiles for Shenandoah National Park, annual.....	28
Figure 6.4-12	UNMIX modeled source profiles for Shenandoah National Park, winter.....	30
Figure 6.4-13	UNMIX modeled source profiles for Shenandoah National Park, spring.....	32
Figure 6.4-14	UNMIX modeled source profiles for Shenandoah National Park, summer.....	34
Figure 6.4-15	UNMIX modeled source profiles for Shenandoah National Park, fall.....	36
Figure 6.4-16	UNMIX modeled source profiles for Washington DC, annual.....	40
Figure 6.4-17	UNMIX modeled source profiles for Washington DC, winter.....	42
Figure 6.4-18	UNMIX modeled source profiles for Washington DC, spring.....	44
Figure 6.4-19	UNMIX modeled source profiles for Washington DC, summer.....	46
Figure 6.4-20	UNMIX modeled source profiles for Washington DC – fall.....	48

## LIST OF TABLES

Table 6.4-1	UNMIX modeled source profiles for Boundary Waters Canoe Area, annual.....	3
Table 6.4-2	UNMIX modeled source types with species abundances and relative mass percentages for Boundary Waters Canoe Area. annual .....	4
Table 6.4-3	UNMIX modeled source profiles for Boundary Waters Canoe Area , winter.....	6
Table 6.4-4	UNMIX modeled source types with species abundances and relative mass percentages for Boundary Waters Canoe Area, winter.....	7
Table 6.4-5	UNMIX modeled source profiles for Boundary Waters Canoe Area , spring.....	8
Table 6.4-6	UNMIX modeled source types with species abundances and relative mass percentages for Boundary Waters Canoe Area, spring.....	9
Table 6.4-7	UNMIX modeled source profiles for Boundary Waters Canoe Area , summer.....	10
Table 6.4-8	UNMIX modeled source types with species abundances and relative mass percentages for Boundary Waters Canoe Area, summer.....	11
Table 6.4-9	UNMIX modeled source profiles for Boundary Waters Canoe Area, fall.....	12
Table 6.4-10	UNMIX modeled source types with species abundances and relative mass percentages for Boundary Waters Canoe Area, fall.....	13
Table 6.4-11	UNMIX modeled source profiles for Lye Brook Wilderness Area, annual.....	14
Table 6.4-12	UNMIX modeled source types with species abundances and relative mass percentages for Lye Brook Wilderness Area ,annual.....	16
Table 6.4-13	UNMIX modeled source profiles for Lye Brook Wilderness Area, winter.....	18
Table 6.4-14	UNMIX modeled source types with species abundances and relative mass percentages for Lye Brook Wilderness Area, winter.....	19
Table 6.4-15	UNMIX modeled source profiles for Lye Brook Wilderness Area, spring.....	20
Table 6.4-16	UNMIX modeled source types with species abundances and relative mass percentages for Lye Brook Wilderness Area, spring.....	21
Table 6.4-17	UNMIX modeled source profiles for Lye Brook Wilderness Area, summer.....	22
Table 6.4-18	UNMIX modeled source types with species abundances and relative mass percentages for Lye Brook Wilderness Area, summer.....	23
Table 6.4-19	UNMIX modeled source profiles for Lye Brook Wilderness Area, fall.....	24
Table 6.4-20	UNMIX modeled source types with species abundances and relative mass percentages for Lye Brook Wilderness Area, fall.....	25
Table 6.4-21	UNMIX modeled source profiles for Shenandoah National Park, annual.....	26
Table 6.4-22	UNMIX modeled source types with species abundances and relative mass percentages for Shenandoah National Park, annual.....	28
Table 6.4-23	UNMIX modeled source profiles for Shenandoah National Park, winter.....	30
Table 6.4-24	UNMIX modeled source types with species abundances and relative mass percentages for Shenandoah National Park, winter.....	31
Table 6.4-25	UNMIX modeled source profiles for Shenandoah National Park ,spring.....	32

## LIST OF TABLES

Table 6.4-26	UNMIX modeled source types with species abundances and relative mass percentages for Shenandoah National Park, spring.....	33
Table 6.4-27	UNMIX modeled source profiles for Shenandoah National Park, summer.....	34
Table 6.4-28	UNMIX modeled source types with species abundances and relative mass percentages for Shenandoah National Park, summer.....	35
Table 6.4-29	UNMIX modeled source profiles for Shenandoah National Park, fall.....	36
Table 6.4-30	UNMIX modeled source types with species abundances and relative mass percentages for Shenandoah National Park, fall.....	37
Table 6.4-31	UNMIX modeled source profiles for Washington DC, annual.....	38
Table 6.4-32	UNMIX modeled source types with species abundances and relative mass percentages for Washington DC, annual.....	40
Table 6.4-33	UNMIX modeled source profiles for Washington DC, winter.....	42
Table 6.4-34	UNMIX modeled source types with species abundances and relative mass percentages for Washington DC, winter.....	43
Table 6.4-35	UNMIX modeled source profiles for Washington DC, spring.....	44
Table 6.4-36	UNMIX modeled source types with species abundances and relative mass percentages for Washington DC, spring.....	45
Table 6.4-37	UNMIX modeled source profiles for Washington DC, summer.....	46
Table 6.4-38	UNMIX modeled source types with species abundances and relative mass percentages for Washington DC, summer.....	47
Table 6.4-39	UNMIX modeled source profiles for Washington DC, fall.....	48
Table 6.4-40	UNMIX modeled source types with species abundances and relative mass percentages for Washington DC, fall.....	49

## 6. RECEPTOR MODELING

### 6.4 UNMIX – Receptor Modeling

UNMIX seeks to solve the general mixture problem where the data are assumed to be a linear combination of an unknown number of sources of unknown composition. UNMIX assumes that the data and the compositions and contributions of the sources are all strictly positive. The model further assumes that for each source there are some samples that contain little or no contribution from that source. For a given selection of species, UNMIX estimates the number of sources, the source compositions, and the source contributions to each sample. The receptor model provides a unique solution using only ambient data without an *a priori* knowledge of the sources, *i.e.* no assumptions about the number or compositions of the contributing source types are required. The success of the model lies in its ability to find edges in the ambient data from which the number of sources and the source compositions are extracted (Henry, 1997, 2002).

The EPA UNMIX 2.3 stand-alone version was first applied to the initial data analysis. In order to allow an enhancement of missing data with reconstructed estimates, Version 2.3 was replaced with Version 2.4, which runs on MATLAB® Version 6.5.

Following the PCA, the data sets for each of the four sampling sites were modeled by UNMIX. This was conducted in two ways, firstly on the complete annual sets, and then on the seasonal sample subsets, to better resolve sources that may impact the sites at different periods of the year. Chemical species initially included in the model were Mass2.5, EC, EC1, EC2, EC3, OC1, OC2, OC3, OC4, SO<sub>4</sub>, NO<sub>3</sub>- as well as Si, Fe, Ca, and Zn, because they fit the model better than some of the other species. However, other species such as Na, Al, and OPT as well as the trace species such as As, Br, Cr, Cu, K, Mn, Pb, S, Se, V and Zn were also considered. UNMIX does produce a solution with species that do not fit the model under the specified set of filter and weighting parameters. Each run produced four to five profiles from the complete data sets and three to four profiles from the monthly sampling sub-sets.

After some consultation, Dr. Henry derived four sets of preliminary UNMIX modeled profiles, one from each site, to serve as a starting point for further modeling. The four data sets were screened for species with anomalous concentrations and those, which do not stand out above the background. Assessing various scatter plots and using a Varimax routine of Factor Analysis accomplished this. Chemical species including Na, Mg, P, NH<sub>4</sub><sup>+</sup>, Mn, Mo, Se, Sr, Zr, the calculated species such as RCFM and Soil as well as non-chemical species such as DeciV and Coars PM were not included in the input files to the preliminary UNMIX model. The UNMIX model was able to calculate four to seven profiles for data sets. In the following four tables, the concentrations have been calculated as mass fractions of the total PM<sub>2.5</sub> mass.

## 6.4.1 Boundary Waters Canoe Area

### 6.4.1.1 Boundary Waters Canoe Area - Annual

**Table 6.4-1a UNMIX modeled source profiles for Boundary Waters Canoe Area, annual.**  
**Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species											
	% of UBAll S1	% of Source	% of Species	% of UBAll S2	% of Source	% of Species	% of UBAll S3	% of Source	% of Species	% of UBAll S4	% of Source	% of Species
ammNitr	0.8472	76.59	94.79	0.0082	0.93	0.92	0.0028	0.36	0.32	0.0003	0.05	0.03
ammSulf	0.1558	14.09	8.49	0.3527	39.89	19.23	0.1199	15.45	6.54			
OC1	0.0042	0.38	1.22	0.0072	0.81	2.07	0.3277	42.21	94.39	0.0033	0.54	0.94
OC2	0.0057	0.52	1.25	0.0545	6.16	11.90	0.2183	28.11	47.69	0.0784	12.90	17.13
OC3	0.0214	1.93	4.69	0.1031	11.66	22.61				0.2738	45.05	60.02
OC4	0.0264	2.38	8.78	0.0791	8.95	26.33				0.1243	20.45	41.36
EC1	0.0342	3.09	6.11	0.1062	12.00	18.98	0.0766	9.86	13.69	0.1119	18.41	20.00
EC2	0.0008	0.07	0.41	0.0183	2.07	9.59	0.0136	1.75	7.14	0.0036	0.60	1.90
EC3	0.0003	0.03	0.66	0.0028	0.32	5.99	0.0017	0.22	3.66	0.0005	0.08	1.03
Al	0.0008	0.07	1.32	0.0081	0.91	14.00	0.0029	0.37	5.04			
As				0.0048	0.54	94.69						
Br*												
Ca	0.0028	0.25	6.59	0.0014	0.16	3.33	0.0004	0.05	0.86	0.0013	0.21	3.00
Cr				0.0005	0.06	14.20						
Fe	0.0023	0.21	1.58	0.1111	12.56	76.17	0.0058	0.75	4.00			
K	0.0037	0.33	6.79	0.0062	0.70	11.30				0.0101	1.66	18.50
Pb*												
Se*												
Si				0.0181	2.04	13.54	0.0067	0.86	4.99			
V				0.0009	0.10	18.16	0.0001	0.01	1.00			
Zn	0.0007	0.06	16.71	0.0013	0.15	33.16				0.0004	0.06	9.51
Total Modeled Species Mass	1.1062	100.00%	19.98	0.8843	100.00	15.97	0.7764	100.00	14.02	0.6076	100.00	10.97
Modeled Mass	0.7316			0.1902			0.2356			0.9714		
% of Total	14.29%			3.72%			4.60%			18.98%		

**Table 6.4-1b**

**UNMIX modeled source profiles for Boundary Waters Canoe Area, annual  
Sources 5 to 7 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species								
	% of UBAll S5	% of Source	% of Species	% of UBAll S6	% of Source	% of Species	% of UBAll S7	% of Source	% of Species
ammNitr	0.0007	0.09	0.08				0.0345	5.70	3.86
ammSulf	0.6732	86.46	36.69	0.2967	38.13	16.17	0.2363	39.02	12.88
OC1	0.0015	0.19	0.42	0.0033	0.43	0.96			
OC2	0.0206	2.64	4.49	0.0723	9.29	15.79	0.0080	1.33	1.76
OC3				0.0142	1.82	3.10	0.0437	7.21	9.57
OC4	0.0208	2.68	6.94				0.0498	8.23	16.59
EC1	0.0483	6.20	8.63	0.1630	20.95	29.15	0.0192	3.17	3.43
EC2	0.0060	0.77	3.13	0.1375	17.67	72.20	0.0107	1.77	5.62
EC3	0.0002	0.02	0.36	0.0412	5.29	88.06	0.0001	0.02	0.24
Al	0.0015	0.19	2.56	0.0113	1.46	19.65	0.0332	5.47	57.43
As	0.0001	0.01	1.18	0.0002	0.03	4.13			
Br*									
Ca	0.0009	0.12	2.23	0.0026	0.34	6.31	0.0324	5.35	77.67
Cr	0.0001	0.01	2.27	0.0026	0.33	73.30	0.0004	0.06	10.23
Fe							0.0266	4.39	18.25
K	0.0013	0.16	2.31	0.0119	1.53	21.82	0.0214	3.53	39.27
Pb*									
Se*									
Si	0.0028	0.36	2.11	0.0180	2.31	13.46	0.0879	14.52	65.91
V	0.0001	0.02	2.79	0.0033	0.42	65.87	0.0006	0.10	12.18
Zn	0.0007	0.09	18.25	0.0001	0.01	2.83	0.0008	0.13	19.54
Total Modeled Relative Mass	0.7787	100.00	14.06	0.7781	100.00	14.05	0.6055	100.00	10.94
Modeled Mass	2.1958			0.2736			0.5207		5.1188
% of Total	42.90%			5.34%			10.17%		100.00%

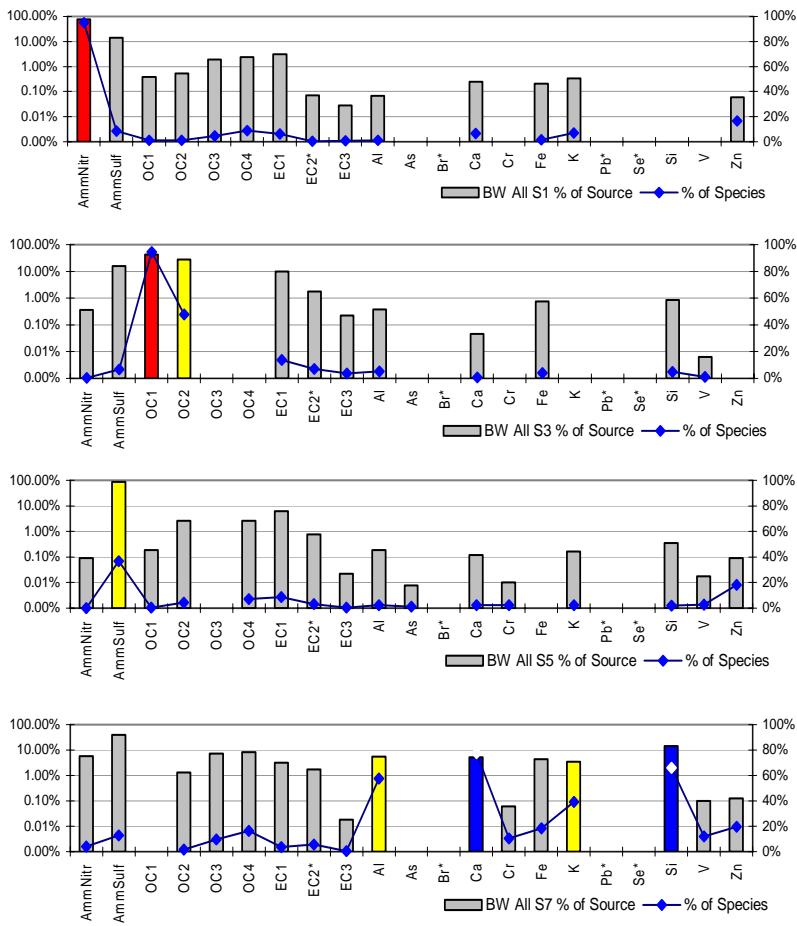
\*Not modeled Br, Pb, Se,

\*\*Blank cells represent deleted negative and zero values

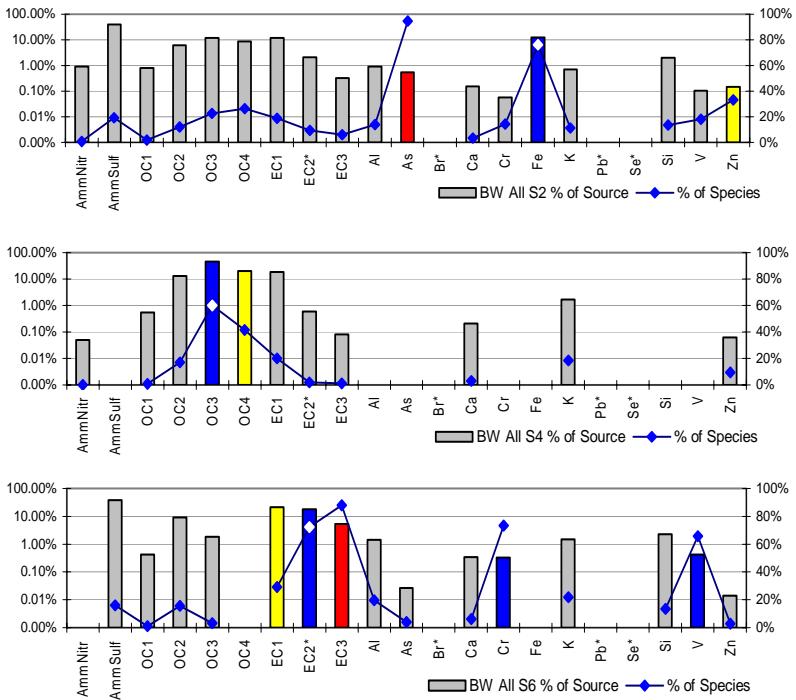
**Table 6.4-2. UNMIX modeled source types with species abundances and relative mass percentages Boundary Waters Canoe Area. annual**

Source Identification		Source Type			Species Abundances by Percent of Factor				Modeled source	
Source ID	Profile ID	Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:	Relative Mass	Mass %
MBUAL1	UBAll S1	Sec. amm. nitrate/sulfate	Vegetative burning		<b>ammNO3,</b> ammSO4,	EC1, OC4, OC3	OC2, OC1, K, Ca, Fe,	EC2, Al, Zn, EC3	1.10616	19.98
MBUAL2	UBAll S2	Sec.amm. sulfate	Iron, zinc smelter (As)	Vegetative burning	ammSO4, <b>Fe,</b> EC1, OC3,	OC4, OC2, EC2, Si	ammNO3, Al, OC1, K, <b>As,</b> EC3, Ca, Zn, V	Cr	0.88427	15.97
MBUAL3	UBAll S3	Biogenic emissions	Sec.amm. sulfate	Geological dust	<b>OC1, OC2,</b> ammSO4,	EC1, EC2	Si, Fe, Al, ammNO3, EC3,	Ca, V	0.7764	14.02
MBUAL4	UBAll S4	Vegetative burning		Sec. amm. nitrate	<b>OC3, OC4,</b> EC1, OC2,	K	EC2, OC1, Ca,	Zn, ammNO3	0.60764	10.97
MBUAL5	UBAll S5	Sec.amm. sulfate		Geological dust	<b>ammSO4</b>	EC1, OC4, OC2,	EC2, Si, Al, OC1, K, Ca,	Zn, ammNO3, EC3, V, Cr, As	0.77865	14.06
MBUAL6	UBAll S6	Oil combustion	Geological dust		ammSO4, <b>EC1, EC2</b>	OC2, <b>EC3</b> , Si, OC3, K, Al	OC1, <b>V</b> , Ca, <b>Cr,</b>	As, Zn	0.7781	14.05
MBUAL7	UBAll S7	Geological dust	Sec.amm. sulfate	Secondary organics	ammSO4, <b>Si,</b>	OC4, OC3, ammNO3, Al, <b>Ca,</b> Fe, <b>K,</b> EC1, OC2, OC2	Zn, V,	Cr, EC3	0.60551	10.94
										5.5367 100.0

Percentage of Source Contributed by Species



Percentage of Species Contributed by Source



#### Color Key

1. Highest concentration for specific species      Yellow
2. 60 – 80% of species      Blue
3. >80% of species      Red

Figure 6.4-1a. UNMIX modeled source profiles for Boundary Waters Canoe Area, annual

### 6.4.1.2 Boundary Waters Canoe Area - Winter

**Table 6.4-3 UNMIX modeled source profiles for Boundary Waters Canoe Area, winter Sources 1 to 5 (Modeled Species Relative PM2.5 Mass)**

Color Key: Yellow indicates the source with highest concentration for a specific species

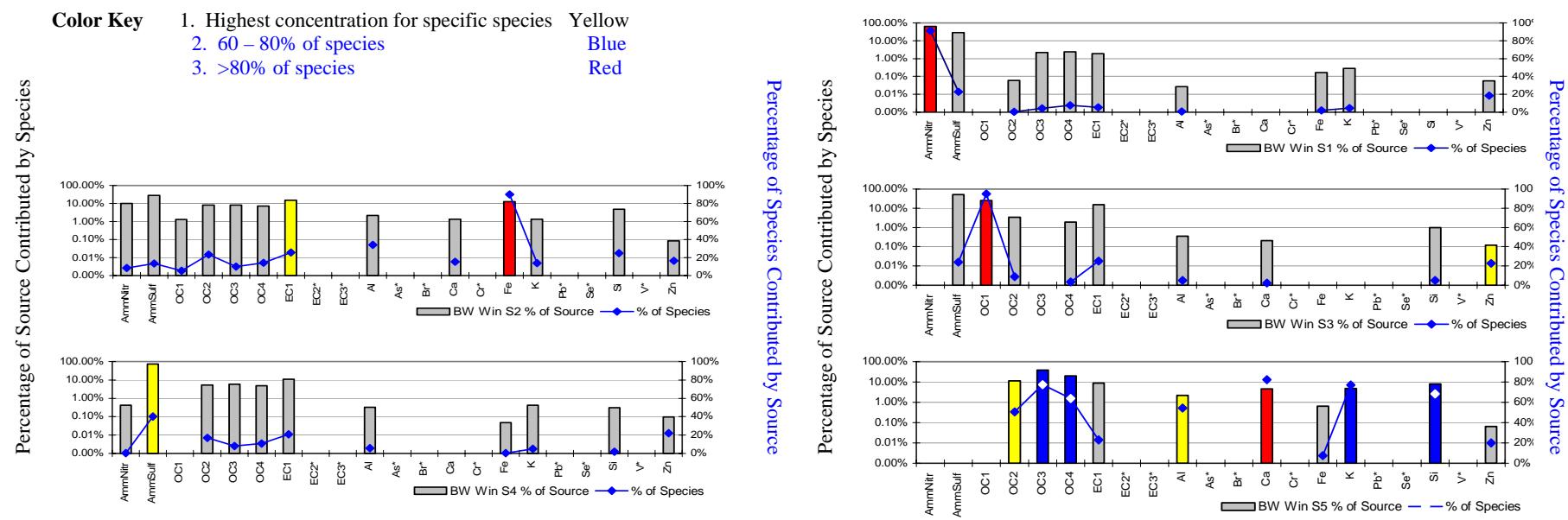
Species	% of UBWinS1	% of Source	% of Species	% of UBWinS2	% of Source	% of Species	% of UBWinS3	% of Source	% of Species	% of UBWinS4	% of Source	% of Species	% of UBWinS5	% of Source	% of Species
ammNitr	0.6857	64.39	91.02	0.0645	10.06	8.56				0.0032	0.43	0.42			
ammSulf	0.3046	28.60	22.87	0.1771	27.62	13.29	0.3178	52.36	23.86	0.5326	71.67	39.98			
OC1				0.0083	1.29	5.20	0.1512	24.91	94.80						
OC2	0.0006	0.06	0.28	0.0528	8.24	23.09	0.0203	3.35	8.89	0.0393	5.28	17.17	0.1156	11.31	50.57
OC3	0.0229	2.15	4.42	0.0515	8.04	9.95				0.0429	5.77	8.28	0.4007	39.19	77.36
OC4	0.0254	2.39	7.73	0.0463	7.23	14.09	0.0119	1.95	3.60	0.0361	4.86	10.98	0.2092	20.46	63.60
EC1	0.0201	1.89	5.24	0.0985	15.36	25.72	0.0957	15.76	24.99	0.0802	10.80	20.95	0.0885	8.65	23.10
EC2*															
EC3*															
Al	0.0003	0.03	0.68	0.0140	2.19	34.03	0.0021	0.35	5.10	0.0024	0.32	5.70	0.0225	2.20	54.49
As*															
Br*															
Ca				0.0087	1.36	15.44	0.0012	0.20	2.20				0.0465	4.55	82.36
Cr*															
Fe	0.0017	0.16	1.96	0.0796	12.42	90.19				0.0004	0.05	0.41	0.0066	0.64	7.44
K	0.0030	0.28	4.65	0.0086	1.34	13.58				0.0031	0.41	4.84	0.0488	4.78	76.94
Pb*															
Se*															
Si				0.0305	4.76	24.95	0.0061	1.00	4.95	0.0023	0.31	1.90	0.0834	8.16	68.20
V*															
Zn	0.0006	0.06	18.60	0.0005	0.08	16.46	0.0008	0.12	22.87	0.0007	0.10	21.95	0.0007	0.06	20.12
Total Modeled Relative Mass				26.11	0.6410	15.72	0.6070		14.88	0.7431		18.22	1.0224		25.07
Modeled Mass %	0.7399 17.22			0.3852 8.97			0.5282 12.29			2.1472 49.97			0.4962 11.55		

\*Not modeled EC2, EC3, As, Br, Cr, Pb, Se, V

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-4 UNMIX source types with species abundances and relative mass percentages for Boundary Waters Canoe Area, winter**

Source Identification Source ID	Profile ID	Major	Source Type Minor	Trace	> 10%:	Species Abundances by Percent of Factor	1 - 10%:	0.1 - 1.0%:	0.01 - 0.1%:	Modeled source Relative Mass Mass %
MBUWI1	UBWinS1	Sec. ammonium sulfate/nitrate			<b>ammNO3,</b> ammSO4	OC4, OC3, EC1	K, Fe,		Zn, Al	1.06485 26.11
MBUWI2	UBWinS2	Secondary organics	Sec. ammonium sulfate/nitrate	Geological dust - iron rich	ammSO4, <b>EC1,</b> <b>Fe</b> , ammNO3	OC2, OC3, <b>OC4</b> , Si, <b>K</b> , OC1	Zn, Al			0.64097 15.72
MBUWI3	UBWinS3	Biogenic emissions	Sec. ammonium sulfate		ammSO4, <b>OC1</b> , EC1,	OC2, OC4, Si,	Al, Ca, <b>Zn</b>			0.60704 14.88
MBUWI4	UBWinS4	Sec. ammonium sulfate	Secondary organics	Geological dust	<b>ammSO4</b> , EC1,	OC3, OC2, OC4,	ammNO3, K, Al, Si, Si, Zn,	Fe		0.74307 18.22
MBUWI5	UBWinS5	Vegetative burning	Geological dust		<b>OC3</b> , OC4, <b>OC2</b> ,	EC1, <b>Si</b> , <b>K</b> , <b>Ca</b> , <b>Al</b> ,	Fe	Zn		1.02242 25.07
										4.07835 100.0



**Figure 6.4-2. UNMIX modeled source profiles for Boundary Waters Canoe Area, winter**

### 6.4.1.3 Boundary Waters Canoe Area - Spring

**Table 6.4-5 UNMIX modeled source profiles for Boundary Waters Canoe Area, spring  
Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

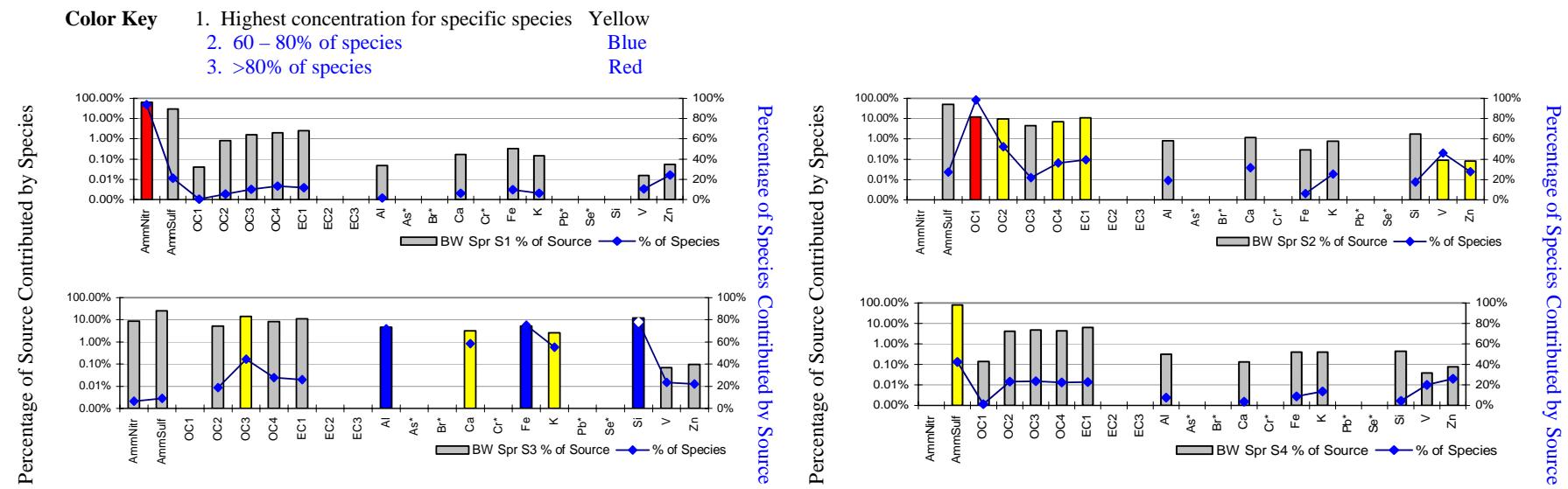
Species	Color Key: Yellow indicates the source with highest concentration for a specific species											
	UBSpr S1	% of Source	% of Species	UBSpr S2	% of Source	% of Species	UBSpr S3	% of Source	% of Species	UBSpr S4	% of Source	% of Species
ammNitr	0.6489	62.46	93.62				0.0442	8.46	6.38			
ammSulf	0.3100	29.85	21.07	0.4030	50.54	27.39	0.1324	25.33	9.00	0.6259	78.19	42.54
OC1	0.0004	0.04	0.42	0.0975	12.23	98.47				0.0011	0.14	1.10
OC2	0.0083	0.80	5.64	0.0768	9.63	52.45	0.0274	5.24	18.72	0.0339	4.24	23.18
OC3	0.0168	1.62	10.12	0.0365	4.58	21.99	0.0736	14.08	44.33	0.0391	4.89	23.56
OC4	0.0205	1.97	13.33	0.0555	6.96	36.19	0.0428	8.20	27.92	0.0346	4.32	22.56
EC1	0.0260	2.51	11.59	0.0889	11.15	39.57	0.0583	11.15	25.94	0.0515	6.43	22.90
EC2*												
EC3*												
Al	0.0005	0.05	1.49	0.0065	0.81	19.26	0.0241	4.61	71.78	0.0025	0.31	7.47
As*												
Br*												
Ca	0.0018	0.17	6.18	0.0091	1.15	31.75	0.0168	3.22	58.39	0.0011	0.13	3.68
Cr*												
Fe	0.0035	0.33	9.60	0.0023	0.29	6.37	0.0273	5.22	75.22	0.0032	0.40	8.80
K	0.0015	0.14	6.21	0.0061	0.77	25.27	0.0133	2.54	55.10	0.0032	0.40	13.42
Pb*												
Se*												
Si				0.0138	1.74	17.53	0.0616	11.79	78.00	0.0035	0.44	4.47
V	0.0002	0.02	10.39	0.0007	0.09	46.10	0.0004	0.07	23.38	0.0003	0.04	20.13
Zn	0.00056	0.05	24.24	0.00064	0.08	27.71	0.0005	0.10	22.08	0.0006	0.07	25.97
Total Modeled Relative Mass	1.0388	100.00%	32.88	0.7974	100.00	25.24	0.5226	100.00	16.54	0.8005	100.00	25.34
Modeled Mass	0.742			0.688			1.0421			2.3054		
% of Total	15.53%			14.40%			21.81%			48.25%		

\* Not modeled EC2, EC3, As, Br, Cr, Pb, Se

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-6 UNMIX source types with species abundances and relative mass percentages for Boundary Waters Canoe Area, spring**

Source Identification Source ID	Profile ID	Source Type			Species Abundances by Percent of Factor					Modeled source Relative Mass Mass %	
		Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:			
MBUSP1	UBSpr S1	Sec. ammonium nitrate/sulfate	Vegetative burning		ammSO4, <b>ammNO3,</b>	EC1, OC4, OC3	OC2, Fe, Ca, K,	Zn, Al, V	1.0388	32.88	
MBUSP2	UBSpr S2	Sec.ammonium sulfate	Oil combustion		ammSO4, <b>OC1, EC1,</b>	<b>OC2, OC4,</b> OC3, Si, Ca	Al, K, Fe	<b>V, Zn</b>	0.79735	25.24	
MBUSP3	UBSpr S3	Sec. ammonium sulfate/nitrate	Geological dust	Vegetative burning	ammSO4, <b>OC3, Si, EC1</b>	ammNO3, OC4, OC2, <b>Fe, Al, Ca, K</b>	Zn,	<b>V</b>	0.5226	16.54	
MBUSP4	UBSpr S4	Sec.ammonium sulfate	Oil combustion	Geological dust	<b>ammSO4,</b>	EC1, OC3, OC4, OC2,	Si, K, Fe, Al, OC1, Ca,	Zn, V	0.80051	25.34	
									3.1593	100.0	



**Figure 6.4-3. UNMIX modeled source profiles for Boundary Waters Canoe Area, spring**

#### 6.4.1.4 Boundary Waters Canoe Area - Summer

**Table 6.4-7 UNMIX modeled source profiles for Boundary Waters Canoe Area, summer Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Color Key: Yellow indicates the source with highest concentration for a specific species

Species	UBSum S1	% of Source	% of Species	UBSum S2	% of Source	% of Species	UBSum S3	% of Source	% of Species	UBSum S4	% of Source	% of Species
ammNitr				0.0497	5.71	53.41	0.0169	3.53	18.13	0.0265	3.71	28.46
ammSulf	0.3308	24.21	33.40	0.0806	9.25	8.14				0.5789	81.00	58.46
OC1	0.5102	37.35	97.12	0.0118	1.36	2.25	0.0033	0.69	0.63			
OC2	0.3442	25.19	67.89	0.0724	8.31	14.28	0.0659	13.78	13.00	0.0245	3.43	4.83
OC3	0.0555	4.06	11.06	0.2485	28.52	49.55	0.1975	41.31	39.39			
OC4	0.0080	0.58	3.18	0.1398	16.05	55.93	0.0854	17.85	34.14	0.0169	2.36	6.75
EC1	0.1161	8.50	38.64	0.0323	3.71	10.75	0.1010	21.12	33.60	0.0511	7.15	17.00
EC2*												
EC3*												
Al	0.0014	0.11	3.96	0.0310	3.56	85.19	0.0004	0.08	1.07	0.0036	0.50	9.78
As*												
Br*												
Ca*												
Cr*												
Fe				0.1008	11.56	99.73				0.0003	0.04	0.27
K				0.0139	1.59	58.59	0.0075	1.56	31.60	0.0023	0.32	9.81
Pb*												
Se*												
Si				0.0900	10.33	89.87				0.0101	1.42	10.13
V*												
Zn				0.0005	0.05	32.87	0.0004	0.09	29.37	0.0005	0.08	37.76
Total Modeled Species Mass	1.3661	100.00%	39.83	0.8712	100.00	25.40	0.4782	100.00	13.94	0.7147	100.00	20.83
Modeled Mass % of Total	0.3028 4.76%			0.35 5.50%			2.5449 39.98%			3.1675 49.76%		6.3651 100.00%

\*Not modeled EC2, EC3, As, Br, Ca, Cr, Se, V

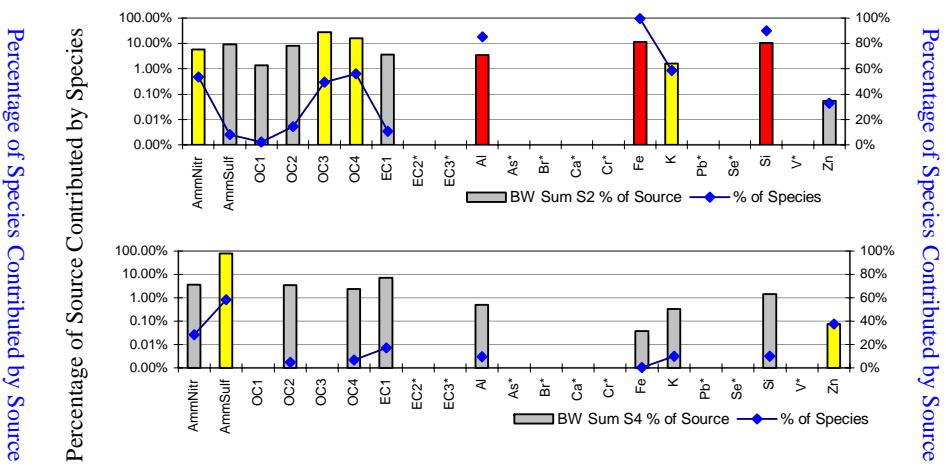
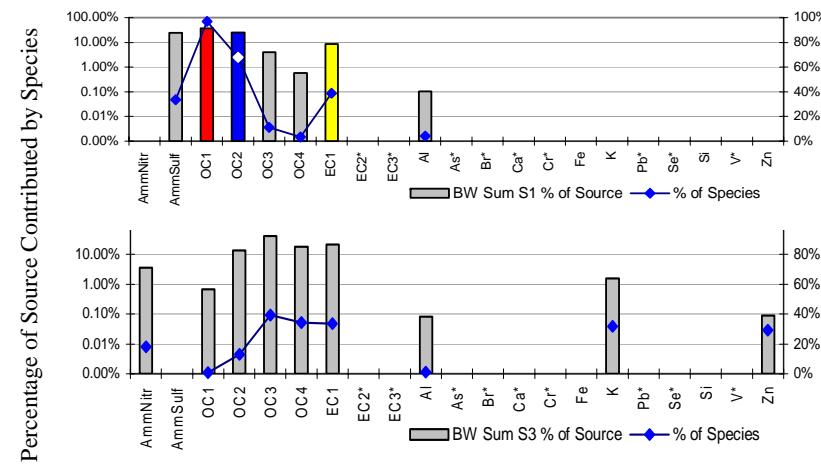
\*\*Blank cells represent deleted negative and zero values

**Table 6.4-8 UNMIX source types with species abundances and relative mass percentages for Boundary Waters Canoe Area, summer**

Source Identification		Source Type			Species Abundances by Percent of Factor				Modeled source	
Source ID	Profile ID	Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:	Relative Mass	Mass %
MBUSU1	UBSum S1	Biogenic emissions	Sec. ammonium nitrate	Secondary organics	<b>OC1, OC2,</b> ammSO4	<b>EC1, OC3,</b>		OC4, Al	1.36613	39.83
MBUSU2	UBSum S2	Geological dust	Vegetative burning	Sec. ammonium nitrate/sulfate	<b>OC3, OC4,</b> <b>Fe, Si,</b>	ammSO4, OC2, <b>ammNO3,</b> EC1, <b>Al, K, OC1</b>		Zn	0.87121	25.40
MBUSU3	UBSum S3	Vegetative burning	Sec. ammonium nitrate		OC3, EC1, OC4, OC2	ammNO3, K, OC1,	OC1	Zn, Al	0.47822	13.94
MBUSU4	UBSum S4	Sec. ammonium sulfate	Zinc smelter	Secondary organics	<b>ammSO4,</b>	EC1, ammNO3, OC2, OC4, Si,	Al, K,	<b>Zn, Fe</b>	0.71465	20.83
									3.4302	100.0

**Color Key**

- 1. Highest concentration for specific species      Yellow
- 2. 60 – 80% of species      Blue
- 3. >80% of species      Red



**Figure 6.4-4. UNMIX modeled source profiles for Boundary Waters Canoe Area, summer**

### 6.4.1.5 Boundary Waters Canoe Area - Fall

**Table 6.4-9 UNMIX modeled source profiles for Boundary Waters Canoe Area - fall Sources 1 to 5 (Modeled Species Relative PM2.5 Mass)**

Color Key: Yellow indicates the source with highest concentration for a specific species

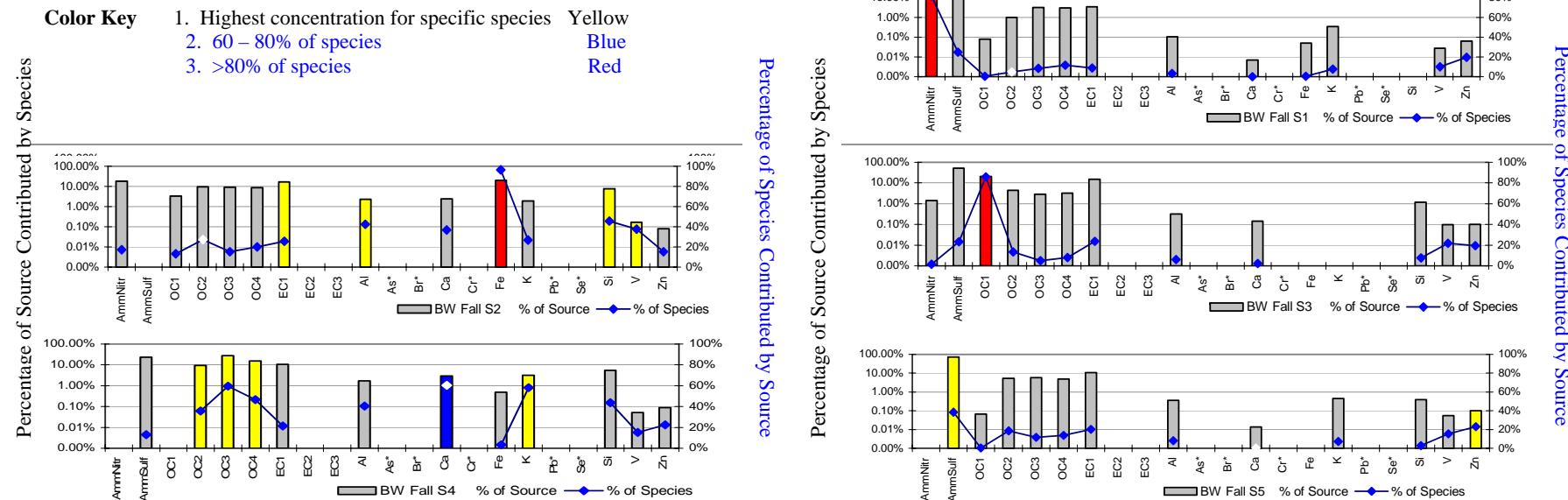
Species	UBFall S1	% of Source	% of Species	UBFall S2	% of Source	% of Species	UBFall S3	% of Source	% of Species	UBFall S4	% of Source	% of Species	UBFall S5	% of Source	% of Species
ammNitr	0.5317	53.67	81.48	0.1118	18.40	17.12	0.0091	1.432	1.390						
ammSulf	0.3468	35.00	24.96				0.3236	51.09	23.29	0.1829	23.03	13.16	0.5360	71.77	38.58
OC1	0.0008	0.078	0.518	0.0197	3.249	13.27	0.1277	20.15	85.88				0.0005	0.066	0.330
OC2	0.0099	0.995	4.678	0.0576	9.481	27.31	0.0280	4.421	13.28	0.0757	9.536	35.91	0.0396	5.308	18.80
OC3	0.0313	3.164	8.561	0.0559	9.211	15.28	0.0180	2.837	4.90	0.2177	27.42	59.46	0.0432	5.780	11.78
OC4	0.0298	3.009	11.44	0.0523	8.603	20.06	0.0207	3.262	7.93	0.1215	15.30	46.63	0.0363	4.858	13.92
EC1	0.0345	3.479	8.666	0.1023	16.83	25.71	0.0949	14.97	23.84	0.0851	10.72	21.40	0.0810	10.85	20.37
EC2*															
EC3*															
Al	0.0010	0.104	3.124	0.0139	2.292	42.22	0.0020	0.317	6.096	0.0133	1.679	40.43	0.0027	0.359	8.129
As*															
Br*															
Ca	0.0001	0.007	0.179	0.0144	2.364	36.78	0.0009	0.144	2.331	0.0236	2.973	60.45	0.0001	0.013	0.256
Cr*															
Fe	0.0005	0.049	0.391	0.1209	19.90	96.49				0.0039	0.491	3.113			
K	0.0034	0.342	7.715	0.0117	1.933	26.7				0.0255	3.216	58.10	0.0033	0.439	7.465
Pb*															
Se*															
Si				0.0454	7.475	45.79	0.0074	1.167	7.453	0.0434	5.470	43.79	0.0029	0.394	2.965
V	0.0003	0.027	9.854	0.0010	0.170	37.59	0.0006	0.095	21.9	0.0004	0.053	15.33	0.0004	0.056	15.33
Zn	0.0006	0.064	19.63	0.0005	0.081	15.27	0.0006	0.099	19.63	0.0007	0.091	22.43	0.0007	0.099	23.05
Total Modeled Relative Mass	0.9907	26.26	0.6073	16.10	0.6333		16.79	0.7938		21.04	0.7467		19.80		
Modeled Mass	0.9109		0.2465		0.5283		0.874		1.6011						
% of Total	21.89%		5.93%		12.70%		21.01%		38.48%						

\*Not modeled EC2, EC3, As, Br, Cr, Pb, Se

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-10 UNMIX source types with species abundances and relative mass percentages for Boundary Waters Canoe Area, fall**

Source Identification Source ID	Profile ID	Source Type			Species Abundances by Percent of Factor					Modeled source	
		Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:	Relative Mass	Mass %	
MBUFA1	UBFall S1	Sec. ammonium nitrate/sulfate	Vegetative burning		<b>ammNO3,</b> ammSO4,	EC1, OC3, OC4, OC2	K, Al,	Zn, Fe, V, Ca	0.9907	26.26	
MBUFA2	UBFall S2	Iron ore	Sec. ammon. nitrate	Secondary organics	<b>Fe,</b> ammNO3, <b>EC1,</b>	OC2, OC3, OC4, Si, OC1, Ca, Al, K	V	Zn,	0.6073	16.10	
MBUFA3	UBFall S3	Sec. ammonium sulfate	Biogenic emissions	Secondary organics	ammSO4, <b>OC1</b> , EC1	OC2, OC4, OC3, ammNO3, Si,	Al, Ca, Zn,	V	0.6333	16.79	
MBUFA4	UBFall S4	Sec. ammonium sulfate	Vegetative burning	Geological dust - Ca rich	OC3, ammSO4, <b>OC4</b> , EC1,	<b>OC2</b> , Si, K, <b>Ca</b> , Al	Fe, ammNO3, EC1,	Zn V	0.7938	21.04	
MBUFA5	UBFall S5	Sec. ammonium sulfate	Secondary organics	Zinc smelter	<b>ammSO4</b> , EC1,	OC3, OC2, OC4,	K, Si, Al, <b>Zn</b>	V, Ca	0.7467	19.80	
							3.7718	100.0			



**Figure 6.4-5. UNMIX modeled source profiles for Boundary Waters Canoe Area, fall**

## 6.4.2 Lye Brook Wilderness Area

### 6.4.2.1 Lye Brook Wilderness Area - Annual

**Table 6.4-11a UNMIX modeled source profiles for Lye Brook Wilderness Area, annual Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species											
	% of ULAll S1	% of Source	% of Species	% of ULAll S2	% of Source	% of Species	% of ULAll S3	% of Source	% of Species	% of ULAll S4	% of Source	% of Species
ammNitr	0.0443	6.43	6.30	0.6201	49.51	88.23	0.0045	0.54	0.64	0.0149	2.35	2.11%
ammSulf	0.0000	0.00	0.00	0.4547	36.31	28.00	0.7394	89.98	45.53	0.3082	48.69	18.98%
OC1	0.3232	46.93	92.96	0.0034	0.27	0.97	0.0005	0.06	0.14	0.0114	1.80	3.28%
OC2	0.1078	15.64	41.93	0.0055	0.44	2.14	0.0180	2.19	6.99	0.0172	2.72	6.71%
OC3	0.0500	7.26	16.90	0.0170	1.35	5.73	0.0027	0.33	0.91	0.0611	9.65	20.64%
OC4	0.0296	4.30	12.39	0.0552	4.41	23.10	0.0179	2.18	7.49	0.0300	4.74	12.56%
EC1	0.1117	16.22	23.38	0.0771	6.15	16.13	0.0326	3.97	6.83	0.0056	0.88	1.16%
EC2*	0.0041	0.59	8.25	0.0000	0.00	0.02	0.0001	0.01	0.14	0.0013	0.20	2.63%
EC3												
Al	0.0040	0.57	6.53	0.0025	0.20	4.10	0.0010	0.12	1.60	0.0454	7.17	75.10%
As	0.0002	0.02	12.59	0.0001	0.01	7.41	0.0000	0.00	0.74	0.0002	0.02	11.11%
Br*												
Ca*												
Cr*												
Fe	0.0000	0.00	0.03	0.0050	0.40	14.37	0.0010	0.13	2.97	0.0265	4.18	76.25%
K	0.0059	0.86	12.75	0.0060	0.48	12.90	0.0003	0.04	0.62	0.0143	2.26	30.86%
Pb*												
Se	0.0066	0.96	5.29	0.0034	0.27	2.73	0.0034	0.41	2.68	0.0959	15.15	76.61%
Si	0.0014	0.20	19.91	0.0003	0.02	3.69	0.0001	0.01	1.77	0.0008	0.13	11.95%
V*												
Zn	0.0001	0.02	2.26	0.0023	0.18	43.23	0.0003	0.04	6.20	0.0003	0.05	5.83%
Total Modeled Species Mass	0.6888	100.00%	16.12	1.2524	100.00	29.30	0.8218	100.00	19.23	0.6331	100.00	14.81
Modeled Mass	0.2789			0.7701			3.9786			0.4044		
% of Total	4.05%			11.18%			57.75%			5.87%		

\*Not modeled EC2, EC3, Br, CA, Cr, Pb, V

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-11b UNMIX modeled source profiles for Lye Brook Wilderness Area, annual**  
 Sources 5 to 6 (Modeled Species Relative PM2.5 Mass)

Color Key: Yellow indicates the source with highest concentration for a specific species

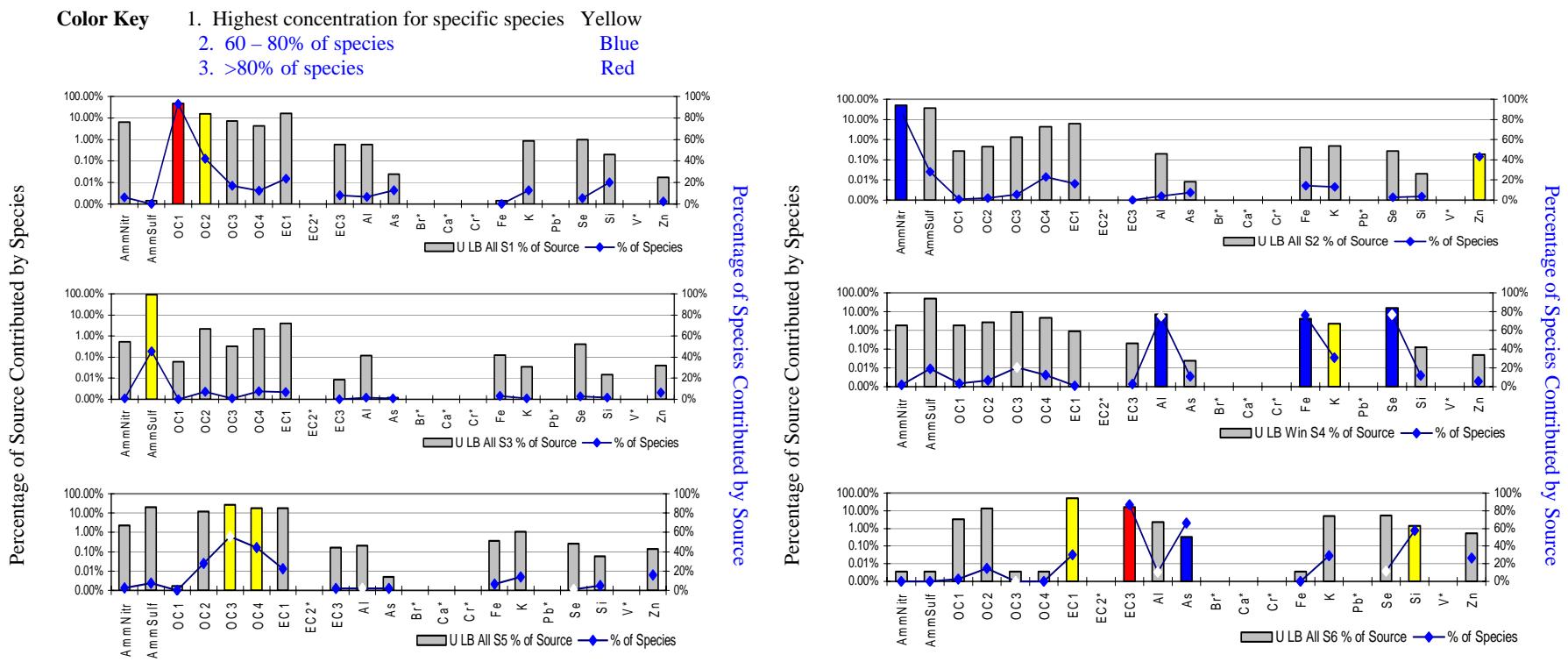
Species	% of ULAll S5	% of Source	% of Species	% of ULAll S6	% of Source	% of Species
ammNitr	0.0191	2.33	2.72	0.0000	0.004	0.00%
ammSulf	0.1217	20.121	7.49	0.0000	0.004	0.00%
OC1	0.0000	0.002	0.00	0.0092	3.376	2.65%
OC2	0.0711	11.752	27.66	0.0375	13.718	14.58%
OC3	0.1653	27.325	55.83	0.0000	0.004	0.00%
OC4	0.1063	17.568	44.47	0.0000	0.004	0.00%
EC1	0.1078	17.816	22.54	0.1433	52.446	29.97%
EC2*						
EC3	0.0010	0.167	2.06	0.0427	15.626	86.91%
Al	0.0013	0.207	2.07	0.0064	2.343	10.59%
As	0.0000	0.005	2.22	0.0009	0.326	65.93%
Br*						
Ca*						
Cr*						
Fe	0.0022	0.365	6.36	0.0000	0.004	0.03%
K	0.0064	1.053	13.72	0.0135	4.954	29.14%
Pb*						
Se	0.0016	0.256	1.24	0.0143	5.250	11.45%
Si	0.0004	0.058	5.16	0.0039	1.428	57.52%
V*						
Zn	0.0009	0.141	15.98	0.0014	0.516	26.50%
Total Modeled Relative Mass	0.60484	100.00%	14.15	0.2731	100.00	6.39
Modeled Mass	1.14679			0.31005		6.8888
% of Total	16.65%			4.50%		100%

\*Not modeled EC2, EC3, Br, Ca, Cr, Pb, V

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-12 UNMIX source types with species abundances and relative mass percentages for Lye Brook Wilderness Area, annual**

Source Identification Source ID	Profile ID	Source Type			Species Abundances by Percent of Factor				Modeled source Relative Mass Mass %	
		Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:		
MLUAL1	ULAll S1	Biogenic emissions	Coal fired power plant	Sec. ammonium nitrate	<b>OC1</b> , EC1, <b>OC2</b>	OC3, ammNO3, OC4	Se, K, Al, Si	As, Zn	0.68879	16.12
MLUAL2	ULAll S2	Sec. ammonium nitrate/sulfate	Coal fired power plant	Zinc smelter	<b>ammNO3</b> , ammSO4	EC1, OC4, OC3	K, OC2, Fe, Se, OC1, Al, Zn	Si	1.25244	29.30
MLUAL3	ULAll S3	Sec. ammonium sulfate	Coal fired power plant		<b>ammSO4</b>	EC1, OC2, OC4	ammNO3, Se, OC3, Fe, Al	OC1, Zn, K, Si, As	0.82175	19.23
MLUAL4	ULAll S4	Coal fired power plant	Sec. ammonium sulfate		ammSO4, <b>Se</b>	OC3, <b>Al</b> , OC4, <b>Fe</b> , OC2, <b>K</b> , OC2	EC1, Si	Zn	0.63306	14.81
MLUAL5	ULAll S5	Vegetative burning	Sec. ammonium sulfate		<b>OC3</b> , ammSO4, EC1, <b>OC4</b> , OC2	K		Si	0.60484	14.15
MLUAL6	ULAll S6	Secondary organics	Geological dust		<b>EC1</b> , <b>EC3</b> , OC2	Se, K, OC1, Al	<b>Si</b> , Zn, <b>As</b>		0.27314	6.39
										4.27402 100.0



**Figure 6.4-6** UNMIX modeled source profiles for Lye Brook Wilderness Area, annual

## Lye Brook Wilderness Area - Winter

**Table 6.4-13 UNMIX modeled source profiles for Lye Brook Wilderness Area, winter  
Sources 1 to 3 (Modeled Species Relative PM2.5 Mass)**

Modeled Species Relative PM2.5 Mass	Color Key: Yellow indicates the source with highest concentration for a specific species											
	Species	ULWin S1	% of Source	% of Species	ULWin S2	% of Source	% of Species	ULWin S3	% of Source	% of Species	ULWin S4	% of Source
ammNitr	0.0238	2.62	3.86	0.4844	47.97	78.72	0.1072	13.72	17.42	0.5612	73.13	31.43%
ammSulf	0.4080	44.97	22.85	0.2945	29.16	16.49	0.5219	66.77	29.23	0.0001	0.01	0.04%
OC1	0.1987	21.90	96.22	0.0010	0.10	0.49	0.0067	0.86	3.24	0.0248	3.23	15.61%
OC2	0.0882	9.72	55.50	0.0241	2.38	15.13	0.0219	2.80	13.76	0.0340	4.43	20.25%
OC3	0.0552	6.09	32.88	0.0622	6.16	37.01	0.0166	2.12	9.85	0.0452	5.88	24.77%
OC4	0.0467	5.15	25.63	0.0642	6.36	35.20	0.0263	3.36	14.40	0.0778	8.58	27.99
EC1	0.0579	5.73	20.81	0.0573	7.34	20.62	0.0850	11.08	30.58%			
EC2*												
EC3*												
Al	0.0007	0.08	6.00	0.0040	0.40	32.60	0.0048	0.61	38.61	0.0028	0.37	22.79%
As	0.0001	0.01	10.14				0.0006	0.08	89.86			
Br*												
Ca*												
Cr*												
Fe	0.0014	0.16	12.79	0.0043	0.43	38.74	0.0024	0.30	21.44	0.0030	0.39	27.03%
K	0.0036	0.40	20.36	0.0044	0.43	24.62	0.0057	0.72	31.74	0.0042	0.54	23.28%
Pb*												
Se	0.0000	0.00	3.92	0.0002	0.02	37.25	0.0001	0.02	25.49	0.0002	0.02	33.33%
Si	0.0022	0.24	8.90	0.0073	0.73	29.70	0.0093	1.19	37.56	0.0059	0.77	23.84%
V*												
Zn	0.0007	0.08	16.79	0.0014	0.14	33.82	0.0009	0.12	22.63	0.0011	0.14	26.76%
Total Modeled Relative Mass	0.9073	100.00%	26.18	1.0098	100.00	29.13	0.7816	100.00	22.55	0.7674	100.0	22.14
Modeled Mass	0.3808			1.44335			1.1322			1.76261		
% of Total	8.07%			30.59%			23.99%			37.35%		

\*Not modeled EC2, EC3, Br, Ca, Cr, Pb, V

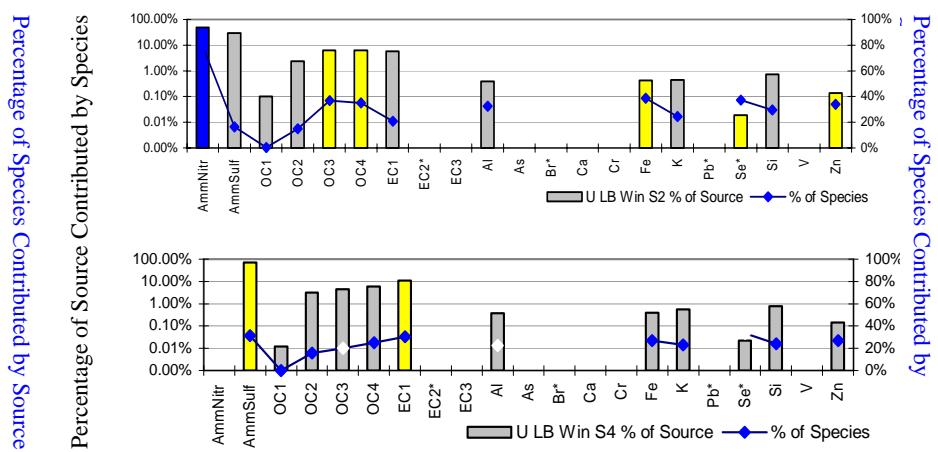
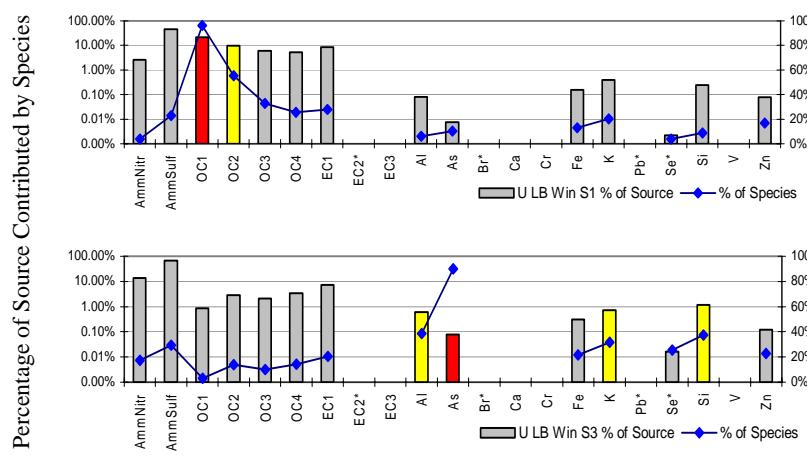
\*\*Blank cells represent deleted negative and zero values

**Table 6.4-14 UNMIX source types with species abundances and relative mass percentages for Lye Brook Wilderness Area, winter**

Source Identification		Source Type			Species Abundances by Percent of Factor				Modeled source	
Source ID	Profile ID	Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:	Relative Mass	Mass %
MLUWI1	ULWinS1	Sec. ammonium sulfate	Secondary organics	Geological dust	ammSO4, OC1	OC2, EC1, OC3, OC4, ammNO3,	K, Si, Fe,	Al, Zn, As,	0.9073	26.18
MLUWI1	ULWinS2	Sec. ammonium nitrate/sulfate	Coal fired power plant	Iron, zinc smelter	ammNO3, ammSO4,	OC4, OC3, EC1, OC2	Si, K, Fe, Al, Zn, OC1	Se	1.00981	29.13
MLUWI1	ULWinS3	Sec. ammonium sulfate/nitrate	Arsenic source	Geological dust	ammSO4, ammNO3	EC1, OC4, OC2, OC3, Si,	OC1, K, Al, Fe, Zn,	As, Se	0.78162	22.55
MLUWI1	ULWinS4	Sec. ammonium sulfate	Secondary organics	Geological dust	ammSO4, EC1,	OC4, OC3, OC2	Si, K, Fe, Al, Zn, OC1	Se,	0.76744	22.14
									3.4662	100.00

**Color Key**

- 1. Highest concentration for specific species Yellow
- 2. 60 – 80% of species Blue
- 3. >80% of species Red



**Figure 6.4-7 UNMIX modeled source profiles for Lye Brook Wilderness Area, winter**

### 6.4.2.2 Lye Brook Wilderness Area - Spring

**Table 6.4-15 UNMIX modeled source profiles for Lye Brook Wilderness Area, spring  
Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Color Key: Yellow indicates the source with highest concentration for a specific species

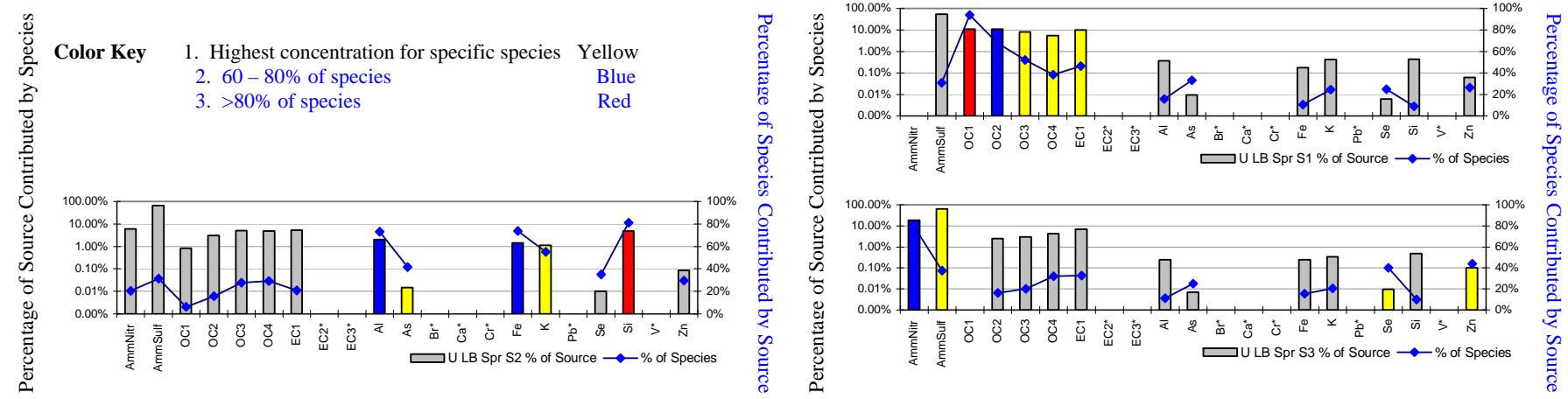
Modeled Species Relative PM2.5 Mass	Species	% of Source	% of Species	% of Source	% of Species	% of Source	% of Species
		ULSpr S1	ULSpr S2	ULSpr S3	ULSpr S4	ULSpr S5	ULSpr S6
ammNitr				0.0411	5.97	20.58	0.1586
ammSulf	0.4431	53.77	31.03	0.4497	65.36	31.50	0.5351
OC1	0.0880	10.68	93.82	0.0058	0.84	6.18	
OC2	0.0887	10.76	68.08	0.0206	3.00	15.85	0.0209
OC3	0.0663	8.04	52.21	0.0352	5.11	27.71	0.0255
OC4	0.0441	5.35	38.63	0.0334	4.85	29.26	0.0367
EC1	0.0818	9.93	46.31	0.0367	5.33	20.76	0.0582
EC2*							
EC*3							
Al	0.0030	0.37	15.93	0.0138	2.00	72.95	0.0021
As	0.0001	0.01	33.33	0.0001	0.01	41.67	0.0001
Br*							
Ca*							
Cr*							
Fe	0.0014	0.17	10.72	0.0099	1.44	73.86	0.0021
K	0.0034	0.41	24.41	0.0077	1.11	55.15	0.0028
Pb*							
Se	0.0001	0.01	25.00	0.0001	0.01	35.00	0.0001
Si	0.0037	0.45	8.91	0.0334	4.86	81.17	0.0041
V*							
Zn	0.0005	0.06	26.53	0.0006	0.08	29.59	0.0009
Total Modeled Relative Mass		0.8240	34.93	0.6881	29.17	0.8471	35.91
Modeled Mass		0.79746		1.98357		3.18137	5.9624
%		13.37%		33.27%		53.36%	100%

\* Not modeled EC2, EC3, Br, Ca, Cr, Pb, V

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-16 UNMIX source types with species abundances and relative mass percentages for Lye Brook Wilderness Area, spring**

Source Identification		Source Type			Species Abundances by Percent of Factor				Modeled source	
Source ID	Profile ID	Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:	Relative Mass	Mass %
MLUSP1	ULSpr S1	Secondary organics	Sec. ammonium sulfate		ammSO4, <b>OC2, OC1,</b>	<b>EC1, OC3, OC4,</b>	Si, K, Al, Fe,	Zn, As, Se	0.82403	34.93
MLUSP2	ULSpr S2	Sec. ammonium sulfate	Geological dust	Vegetative burning	ammSO4,	ammNO3, EC1, OC3, <b>Si, OC4, OC2, Al, Fe, K,</b>	OC1	Zn, As	0.68805	29.17
MLUSP3	ULSpr S3	Sec. ammonium sulfate/nitrate	Coal fired power plant	Iron, zinc smelter	<b>ammSO4, ammNO3,</b>	EC1, OC4, OC3, OC2,	Si, K, Al, Fe, <b>Zn</b>	<b>Se, As</b>	0.84708	35.91
									2.35916	100.00



**Figure 6.4-8 UNMIX modeled source profiles for Lye Brook Wilderness Area, spring**

### 6.4.2.3 Lye Brook Wilderness Area - Summer

**Table 6.4-17 UNMIX modeled source profiles for Lye Brook Wilderness Area, summer  
Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Color Key: Yellow indicates the source with highest concentration for a specific species

Modeled Species Relative PM2.5 Mass	Species	ULSum	% of Source	% of Species	ULSum	% of Source	% of Species	ULSum	% of Source	% of Species	ULSum	% of Source	% of Species
		S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
	ammNitr	0.00322	0.71	0.90	0.00461	1.01	1.29	0.32329	39.63	90.43	0.02638	4.83	7.38
	ammSulf	0.05271	11.57	4.82	0.74372	92.13	68.05	0.20870	25.58	19.10	0.08773	16.08	8.03
	OC1	0.15691	34.45	94.40				0.00426	0.52	2.56	0.00504	0.92	3.03
	OC2	0.05031	11.05	27.73	0.01615	2.00	8.90	0.04180	5.12	23.04	0.07314	13.40	40.32
	OC3	0.04726	10.38	19.33	0.00010	0.01	0.04	0.02988	3.66	12.22	0.16726	30.65	68.41
	OC4	0.04482	9.84	23.41	0.01568	1.94	8.19	0.04318	5.29	22.56	0.08776	16.08	45.84
	EC1	0.09554	20.98	26.69	0.02623	3.25	7.33	0.14470	17.74	40.43	0.09147	16.76	25.55
	EC2*												
	EC3*												
	Al	0.00007	0.02	14.58	0.00001	0.00	2.08	0.00035	0.04	72.92	0.00005	0.01	10.42
	As*												
	Br*												
	Ca*												
	Cr*												
	Fe*												
	K	0.00421	0.92	15.56	0.00033	0.04	1.22	0.01627	1.99	60.13	0.00625	1.15	23.10
	Pb	0.00024	0.05	14.46	0.00010	0.01	6.02	0.00110	0.13	66.27	0.00022	0.04	13.25
	Se*												
	Si*												
	V*												
	Zn	0.00018	0.04	5.61	0.00030	0.04	9.35	0.00230	0.28	71.65	0.00043	0.08	13.40
Total Modeled Species Mass		0.4555	100.00	17.36	0.8072	100.00	30.76	0.8158	100.00	31.09	0.5457	100.00	20.80
Modeled Mass % of Total		0.87156 8.04		7.45254 68.77		0.59938 5.53		1.91267 17.65					10.8362 100.00%

\*Not modeled EC2, EC3, As, Br, Ca, Cr, Fe, Se, Si, V

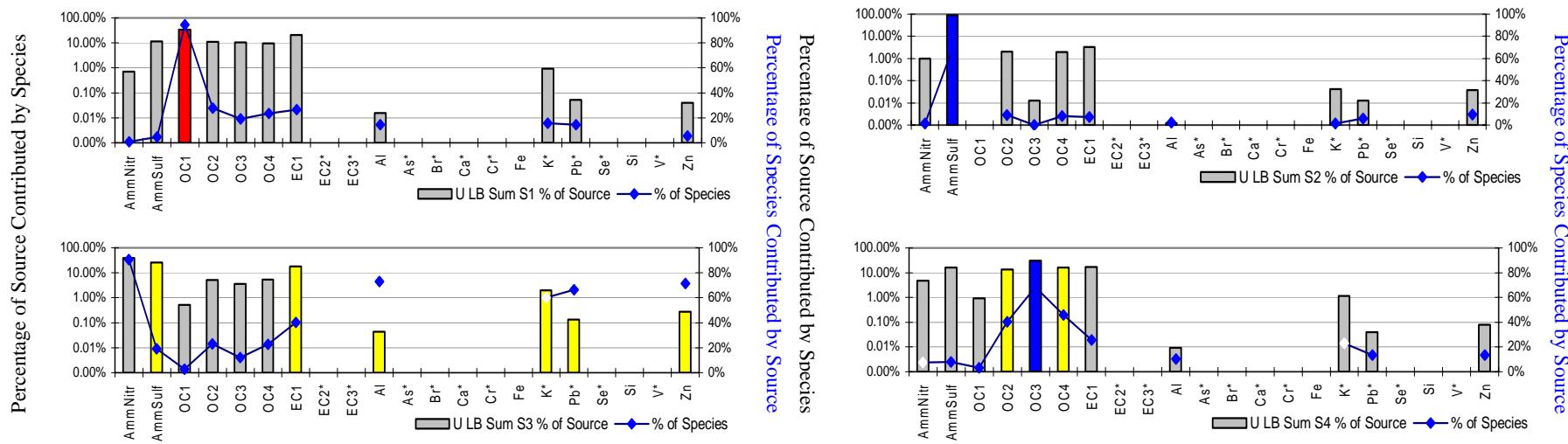
\*\*Blank cells represent deleted negative and zero values

**Table 6.4-18 UNMIX source types with species abundances and relative mass percentages for Lye Brook Wilderness Area, summer**

Source Identification		Source Type			Species Abundances by Percent of Factor				Modeled source	
Source ID	Profile ID	Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:	Relative Mass	Mass %
MLUSU1	ULSumS1	Secondary organics	Sec. ammonium sulfate		<b>OC1</b> , EC1, ammSulf, OC2, OC3,	OC4	K, ammNitr,	Pb, Zn, Al	0.9429	0.30
MLUSU1	ULSumS2	Sec. ammonium sulfate	Secondary organics		<b>ammSO4</b> ,	EC1, OC2, OC4, ammNitr		K, Zn, OC3, Pb,	0.4718	0.15
MLUSU1	ULSumS3	Sec. ammonium sulfate/nitrate	Vegetative burning	Lead, zinc smelter	ammNitr, <b>ammSO4</b>	EC1, OC4, OC2, OC3,	ammNO3, Si, Al, Fe, <b>Zn</b> , K	OC1, <b>Pb</b> , Br	0.8427	0.27
MLUSU1	ULSumS4	Sec. ammonium nitrate/sulfate	Secondary organics	Lead, zinc smelter	<b>OC3</b> , EC1, OC4, ammSulf, OC2	AmmNitr, K,	OC1	Zn, Pb, Al	0.8941	28.37
									3.1514	100.0

**Color Key**

- 1. Highest concentration for specific species      Yellow
- 2. 60 – 80% of species      Blue
- 3. >80% of species      Red



**Figure 6.4-9. UNMIX modeled source profiles for Lye Brook Wilderness Area, summer.**

#### 6.4.2.4 Lye Brook Wilderness Area - Fall

**Table 6.4-19 UNMIX modeled source profiles for Lye Brook Wilderness Area, fall  
Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species												
	ULFall S1	% of Source	% of Species	ULFall S2	% of Source	% of Species	ULFall S3	% of Source	% of Species	ULFall S4	% of Source	% of Species	
ammNitr	0.1975	20.94	38.39				0.0068	0.81	1.33	0.3100	34.67	60.28	
ammSulf	0.2672	28.33	18.95	0.1834	38.88	13.01	0.7165	85.02	50.82	0.2428	27.16	17.22	
OC1	0.2271	24.08	98.63	0.0029	0.61	1.26	0.0003	0.03	0.11				
OC2	0.0788	8.35	48.54	0.0249	5.28	15.34	0.0241	2.86	14.88	0.0345	3.86	21.24	
OC3	0.0623	6.61	27.89	0.0380	8.05	17.00	0.0178	2.11	7.97	0.1053	11.78	47.14	
OC4	0.0397	4.21	20.19	0.0344	7.30	17.52	0.0282	3.35	14.35	0.0942	10.53	47.93	
EC1	0.0670	7.10	21.45	0.1162	24.62	37.21	0.0414	4.91	13.24	0.0877	9.81	28.10	
EC2*													
EC3*													
Al				0.0193		4.10	77.40	0.0016	0.19	6.49	0.0040	0.45	16.11
As*													
Br*	0.0002	0.02	17.19	0.0003	0.05	19.53	0.0001	0.02	10.94	0.0007	0.07	52.34	
Ca*													
Cr*													
Fe				0.0117		2.47	62.27	0.0015	0.17	7.80	0.0056	0.63	29.93
K*													
Pb					0.0007	0.15	43.98	0.0002	0.02	10.24	0.0008	0.09	45.78
Se*													
Si	0.0033	0.35	6.36	0.0387	8.20	73.63	0.0038	0.45	7.24	0.0067	0.75	12.78	
V*													
Zn													
Total Modeled Species Mass	0.9429	29.92	0.4718		14.97	0.8427		26.74	0.8941		28.37	3.1514	
Modeled Mass	0.42942		0.77415		3.78765		1.28439					6.27561	
% of Total	6.84%		12.34%		60.36%		20.47%						

\*Not modeled EC2, EC3, As, Ca, Cr, K, Se, V

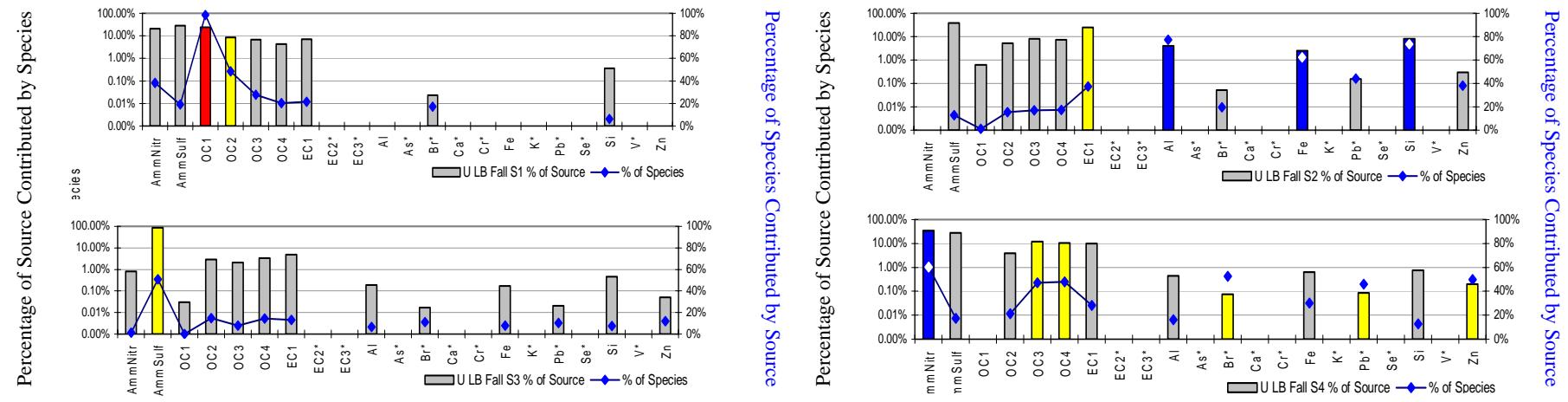
\*\*Blank cells represent deleted negative and zero values

**Table 6.4-20 UNMIX source types with species abundances and relative mass percentages for Lye Brook Wilderness Area, fall**

Source Identification Source ID	Profile ID	Source Type			Species Abundances by Percent of Factor				Modeled source Relative Mass Mass %	
		Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01 - 0.1%:		
MLUFA1	ULFallS1	Sec. ammonium sulfate/nitrate	Biogenic emissions	Secondary organics	ammSO4, OC1, ammNO3	OC2, EC1, OC3, OC4	Si	Br	0.9429	29.92
MLUFA2	ULFallS2	Sec. ammonium sulfate	Geological dust	Diesel vehicle emissions	ammSO4, EC1	Si, OC3, OC4, OC2, Al, Fe,	OC1, Zn, Pb	Br	0.4718	14.97
MLUFA3	ULFallS3	Sec. ammonium sulfate	Secondary organics	Geological dust	ammSO4	EC1, OC4, OC2, OC3	ammNO3, Si, Al, Fe, Zn	OC1, Pb, Br	0.8427	26.74
MLUFA4	ULFallS4	Sec. ammonium nitrate/sulfate	Motor vehicle emissions	Lead, zinc smelter	ammNO3, ammSO4, OC3, OC4	EC1, OC2	Si, Fe, Al, Zn	Pb, Br	0.8941	28.37
									3.1514	100.0

**Color Key**

- 1. Highest concentration for specific species Yellow
- 2. 60 – 80% of species Blue
- 3. >80% of species Red



**Figure 6.4-10. UNMIX modeled source profiles for Lye Brook Wilderness Area, fall.**

## 6.4.3 Shenandoah National Park

### 6.4.3.1 Shenandoah National Park - Annual

**Table 6.4-21a UNMIX modeled source profiles for Shenandoah National Park , annual Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species											
	% of Source	% of Species	% of Source	% of Species	% of Source	% of Species	% of Source	% of Species	% of Source	% of Species	% of Source	% of Species
ammNitr	0.0006	0.11	0.05	0.1419	13.44	11.41	0.0302	3.90	2.43			
ammSulf	0.2801	52.03	12.70	0.1586	15.03	7.19	0.3163	40.85	14.34	0.3955	59.43	17.94
OC1	0.0815	15.13	87.22				0.0031	0.40	3.32	0.0075	1.12	7.98
OC2	0.0278	5.17	12.30	0.0990	9.38	43.73	0.0700	9.05	30.96	0.0093	1.40	4.11
OC3	0.0150	2.79	7.15	0.0097	0.92	4.63	0.1339	17.30	63.69			
OC4	0.0293	5.43	13.29			0.00	0.1162	15.00	52.78			
EC1	0.0934	17.35	11.41	0.4920	46.62	60.08	0.0895	11.56	10.93			
EC2*												
EC3	0.0005	0.08	0.41	0.1088	10.31	98.95						
Al	0.0010	0.19	1.32	0.0036	0.34	4.54	0.0012	0.15	1.48	0.0672	10.10	85.23
As	0.0001	0.01	5.83	0.0007	0.06	66.02	0.0000	0.00	2.91			
Br*												
Ca	0.0012	0.22	3.15	0.0094	0.89	25.10	0.0024	0.31	6.42	0.0148	2.22	39.43
Cr	0.0002	0.03	5.45	0.0015	0.14	55.27	0.0001	0.01	4.00	0.0003	0.04	10.55
Fe	0.0012	0.21	2.69	0.0001	0.01	0.16	0.0013	0.17	3.08	0.0312	4.68	72.76
K	0.0024	0.44	4.94	0.0138	1.31	28.61	0.0070	0.91	14.58	0.0134	2.01	27.72
Pb	0.0003	0.05	7.58	0.0012	0.11	36.67	0.0000	0.00	0.61	0.0000	0.00	0.61
Se	0.0000	0.01	2.91	0.0003	0.03	26.21	0.0001	0.01	6.80	0.0000	0.00	0.97
Si	0.0034	0.62	2.17	0.0118	1.12	7.63	0.0022	0.28	1.42	0.1259	18.91	81.29
V	0.0001	0.02	3.62	0.0016	0.15	45.40	0.0002	0.03	6.69	0.0006	0.09	16.16
Zn	0.0005	0.09	7.08	0.0014	0.14	21.69	0.0005	0.06	6.93	0.0001	0.02	1.51
Total Modeled Relative Mass	0.5383	9.77	1.0554		19.16	0.7743		14.06	0.6656		12.09	
Modeled Mass	1.71881		0.15576		1.98702		0.5177					
% of Total	14.70%		1.33%		17.00%		4.43%					

\*Not modeled EC2, Br,

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-21b UNMIX modeled source profiles for Shenandoah National Park, annual Sources 5 to 6 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species					
	% of USAll S5	% of Source	% of Species	% of USAll S6	% of Source	% of Species
ammNitr	1.0704	65.78	86.11			
ammSulf	0.2754	16.92	12.49	0.7790	92.03	35.33
OC1				0.0014	0.16	1.48
OC2	0.0013	0.08	0.59	0.0188	2.22	8.31
OC3	0.0503	3.09	23.94	0.0012	0.15	0.59
OC4	0.0607	3.73	27.55	0.0140	1.657	6.374
EC1	0.1175	7.22	14.35	0.0265	3.14	3.24
EC2*						
EC3	0.0007	0.04	0.59	0.0001	0.01	0.05
Al	0.0047	0.29	6.01	0.0011	0.13	1.41
As	0.0003	0.02	25.24			
Br*						
Ca*	0.0094	0.58	25.18	0.0003	0.03	0.72
Cr*	0.0006	0.04	22.91	0.0001	0.01	1.82
Fe	0.0085	0.52	19.88	0.0006	0.072	1.42
K	0.0115	0.71	23.84	0.0002	0.02	0.31
Pb*	0.0017	0.10	51.52	0.0001	0.01	3.03
Se	0.0006	0.04	56.31	0.0001	0.01	6.80
Si	0.0089	0.55	5.73	0.0027	0.32	1.76
V*	0.0009	0.06	25.63	0.0001	0.01	2.51
Zn	0.0040	0.24	59.49	0.0002	0.03	3.31
Total Modeled Relative Mass	1.6273	29.55	0.8465	15.37	5.5073	
Modeled Mass	0.70416		6.60516		11.6886	
% of Total	6.02%		56.51%		100.00%	

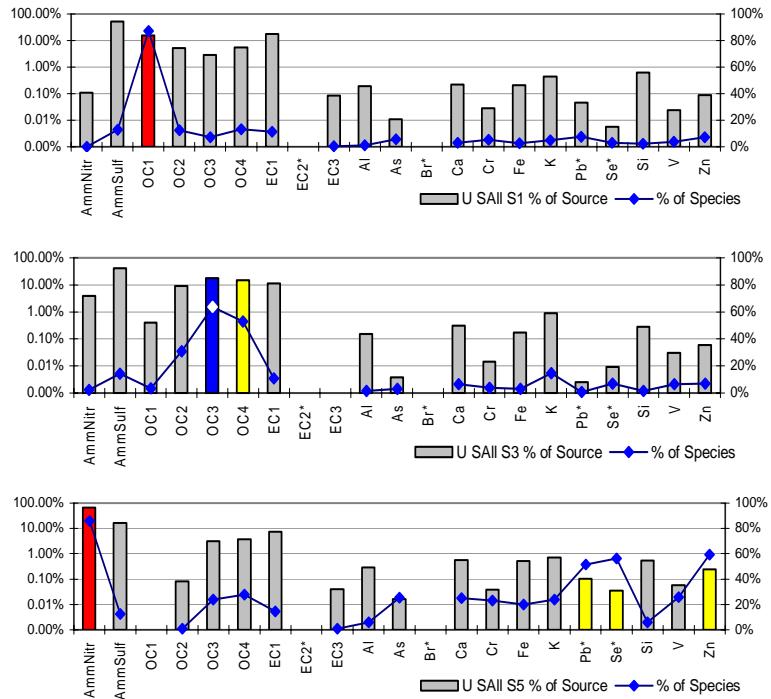
\*Not modeled EC2, Br

\*\*Blank cells represent deleted negative and zero values

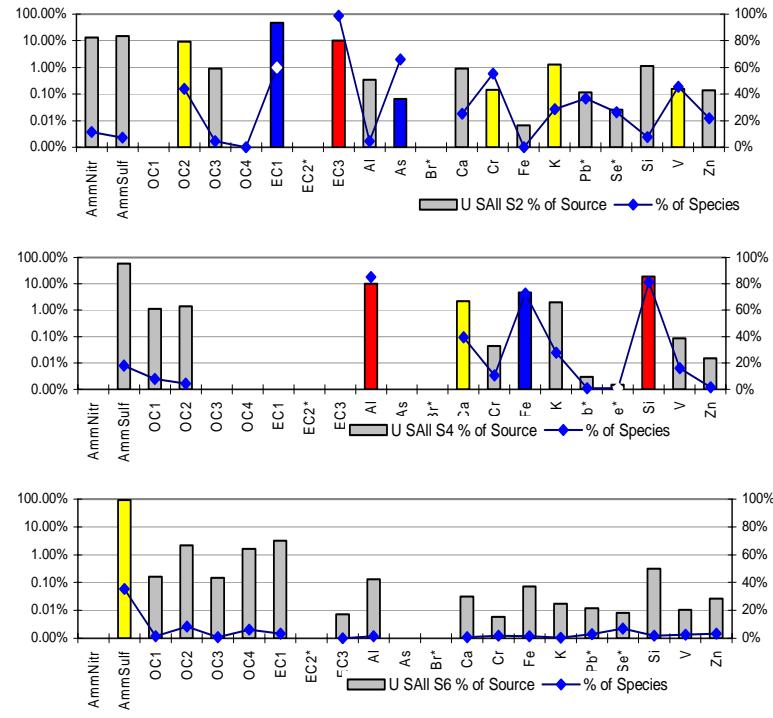
**Table 6.4-22 UNMIX source types with species abundances and relative mass percentages for Shenandoah National Park, annual**

Source Identification Source ID	Profile ID	Source Type			Species Abundances by Percent of Factor				Modeled source Relative Mass Mass %	
		Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:		
MSUAL1	USA1s1	Sec. ammonium sulfate	Biogenic emissions	Geological dust	ammSO4, <b>EC1, OC1</b>	OC4, OC2, OC3	Si, K, Ca, Fe, Al, ammNO3	Zn, EC3, Pb, Cr, V, As, Se	0.5383	9.77
MSUAL2	USA1s2	Diesel vehicle emissions	Sec. ammonium sulfate/nitrate	Geological dust	<b>EC1</b> , ammSO4, ammNO3, <b>EC3</b>	<b>OC2, K, Si</b>	OC3, Ca, Al, <b>V, Cr, Zn, Pb</b>	<b>As, Se, Fe, OC1</b>	1.0554	19.16
MSUAL3	USA1s3	Vegetative burning	Sec. ammonium sulfate	Geological dust	AmmSO4, <b>OC3, OC4</b> , EC1	OC2, ammNO3	K, OC1, Ca, Si, Fe, Al	Zn, V, Cr, Se,	0.7743	14.06
MSUAL4	USA1s4	Geological dust - Al, Ca, Fe	Sec. ammonium sulfate		ammSO4, <b>Si, Al</b>	<b>Fe, Ca, K,</b> OC2, OC1		V, Cr, Zn,	0.6656	12.09
MSUAL5	USA1s5	Sec. ammonium nitrate	Coal fired power plant	Lead, zinc smelter	<b>ammNO3</b> , ammSO4	EC1, OC4, OC3	K, Ca, Si, Fe, Al, <b>Zn, Pb</b>	OC2, V, EC3, Cr, <b>Se, As</b>	1.6273	29.55
MSUAL6	USA1s6	Sec. ammonium sulfate	Secondary organics	Geological dust	<b>ammSO4</b>	EC1, OC2, OC4	Si, OC1, OC3, Al	Fe, Ca, Zn, K, Pb, V, Se, EC3, Cr,	0.8465	15.37
		5.5073 100.0								

Percentage of Source Contributed by Species



Percentage of Species Contributed by Source



#### Color Key

1. Highest concentration for specific species Yellow
2. 60 – 80% of species Blue
3. >80% of species Red

Figure 6.4-11. UNMIX modeled source profiles for Lye Brook Wilderness Area, fall.

### 6.4.3.2 Shenandoah National Park - Winter

**Table 6.4-23 UNMIX modeled source profiles for Shenandoah National Park, winter  
Sources 1 to 5 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species														
	USWin S1	% of Source	% of Species	USWin S2	% of Source	% of Species	USWin S3	% of Source	% of Species	USWin S4	% of Source	% of Species	USWin S5	% of Source	% of Species
ammNitr	1.0517	65.49	36.96	0.5758	79.20	20.23	0.5467	47.64	88.72	0.0410	6.90	6.66	0.0285	3.19	4.62
ammSulf	0.2560	15.94	98.13				0.4645	40.47	16.32	0.0237	3.99	0.83	0.7300	81.70	25.65
OC1	0.0734	4.57	40.04	0.0195	2.68	10.64	0.0011	0.09	0.41				0.0038	0.43	1.47
OC2	0.0451	2.81	19.08				0.0129	1.13	7.05	0.0564	9.49	30.79	0.0210	2.35	11.47
OC3	0.0385	2.40	15.36				0.0209	1.82	8.83	0.1658	27.90	70.12	0.0047	0.52	1.98
OC4	0.1024	6.38	24.11	0.0882	12.13	20.76	0.0245	2.13	9.78	0.1673	28.15	66.79	0.0202	2.26	8.06
EC1							0.0497	4.33	11.70	0.1176	19.78	27.67	0.0669	7.49	15.76
EC2*							0.0287	3.95	100.0						
EC3*															
Al	0.0032	0.20	17.06	0.0053	0.72	27.75	0.0054	0.47	28.44	0.0023	0.38	11.90	0.0028	0.32	14.85
As*	0.0002	0.01	41.67	0.0001	0.01	18.75	0.0001	0.01	20.83	0.0000	0.00	4.17	0.0001	0.01	14.58
Br*															
Ca*	0.0072	0.45	47.98	0.0005	0.07	3.52	0.0033	0.29	21.83	0.0022	0.37	14.66	0.0018	0.20	12.01
Cr*															
Fe	0.0083	0.52	48.51				0.0042	0.36	24.46	0.0020	0.34	11.94	0.0026	0.29	15.10
K	0.0083	0.51	29.63	0.0041	0.56	14.55	0.0039	0.34	13.79	0.0083	1.40	29.77	0.0034	0.38	12.25
Pb*															
Se															
Si	0.0085	0.53	23.26	0.0049	0.67	13.35	0.0094	0.82	25.75	0.0069	1.15	18.74	0.0069	0.77	18.91
V*															
Zn	0.0032	0.20	53.79				0.0012	0.10	19.90	0.0008	0.13	13.49	0.0008	0.09	12.82
Total Modeled Relative Mass				1.6060	32.32	0.7270	14.63	1.1477	23.10	0.5943	11.96	0.8935	17.98		
Modeled Mass % of Total	0.33374 5.24%		0.52651 8.27%		1.86709 29.31%		1.20243 18.88%		2.43949 38.30%						

\*Not modeled EC2, EC3, Br, Cr, Pb, Se, V

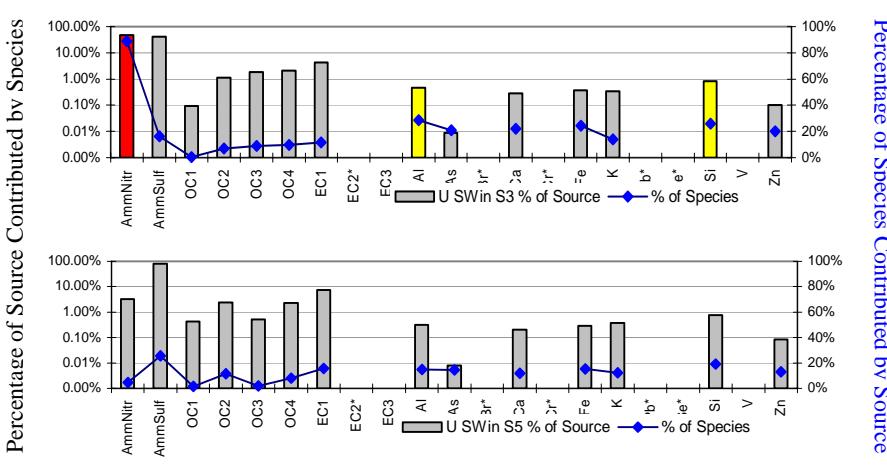
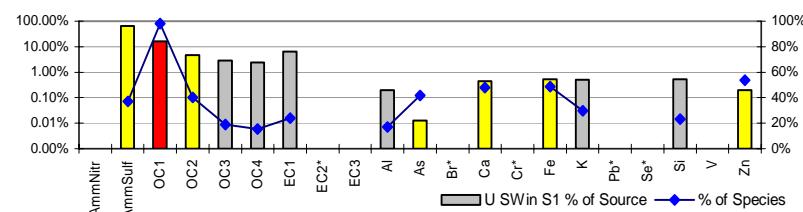
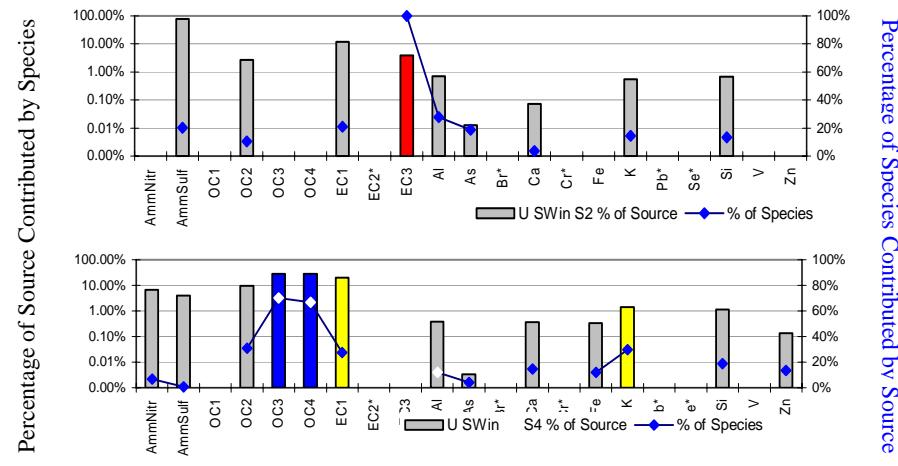
\*\*Blank cells represent deleted negative and zero values

**Table 6.4-24 UNMIX source types with species abundances and relative mass percentages for Shenandoah National Park, winter**

Source Identification		Source Type			Species Abundances by Percent of Factor				Modeled source	
Source ID	Profile ID	Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01 - 0.1%:	Relative Mass	Mass %
MSUWI1	USWinS1	Sec. ammonium sulfate	Secondary organics	Geological dust	ammSO4, OC1	EC1, OC2, OC3, OC4	Si, Fe, K, Ca, Al, Zn	As	1.60597	32.32
MSUWI1	USWinS2	Secondary organics (>EC2)	Sec. ammonium sulfate	Geological dust	ammSO4, EC1	EC3, OC2	Al, Si, K	Ca, As	0.72702	14.63
MSUWI1	USWinS3	Sec. ammonium nitrate/sulfate	Vegetative burning	Geological dust + Zn?	ammNO3, ammSO4	EC1, OC4, OC3, OC2	Si, Al, Fe, K, Ca, Zn	OC1, As	1.14769	23.10
MSUWI1	USWinS4	Vegetative burning	Sec. ammonium sulfate/nitrate	Geological dust + Zn?	OC4, OC3, EC1	OC2, ammNO3, ammSO4, K, Si	Al, Ca, Fe, Zn	As	0.59432	11.96
MSUWI1	USWinS5	Sec. ammonium sulfate	Secondary organics	Geological dust + Zn?	ammSO4	EC1, ammNO3, OC2, OC4	Si, OC3, OC1, K, Al, Fe, Ca	Zn, As	0.89349	17.98
									4.9685	100.0

**Color Key**

- 1. Highest concentration for specific species      Yellow
- 2. 60 – 80% of species      Blue
- 3. >80% of species      Red



**Figure 6.4-12. UNMIX modeled source profiles for Shenandoah National Park, winter**

### 6.4.3.3 Shenandoah National Park - Spring

**Table 6.4-25 UNMIX modeled source profiles for Shenandoah National Park, spring  
Sources 1 to 5 (Modeled Species Relative PM2.5 Mass)**

Color Key: Yellow indicates the source with highest concentration for a specific species															
Species	USSpr S1	% of Source	% of Species	USSpr S2	% of Source	% of Species	USSpr S3	% of Source	% of Species	USSpr S4	% of Source	% of Species	USSpr S5	% of Source	% of Species
ammNitr				1.29516	66.37	98.18	0.0086	1.32	0.65	0.01537	2.00	1.17			
ammSulf	0.3521	56.56	14.58	0.4033	20.67	16.70	0.4393	67.16	18.19	0.4886	63.57	20.23	0.7318	88.65	30.30
OC1	0.1290	20.72	91.40				0.0086	1.31	6.08	0.0017	0.23	1.23	0.0018	0.22	1.29
OC2	0.0293	4.71	24.44	0.0157	0.80	13.08	0.0082	1.25	6.81	0.0483	6.29	40.30	0.0184	2.23	15.37
OC3				0.0350	1.79	27.93	0.0124	1.89	9.87	0.0780	10.15	62.20			
OC4	0.0180	2.89	10.53	0.0609	3.12	35.70	0.0067	1.02	3.90	0.0684	8.89	40.07	0.0167	2.02	9.79
EC1	0.0873	14.02	26.26	0.1265	6.48	38.06	0.0150	2.30	4.52	0.0583	7.58	17.52	0.0454	5.49	13.64
EC2*															
EC3*															
Al	0.0024	0.39	5.74	0.0001	0.00	0.14	0.0357	5.45	84.90	0.0016	0.21	3.81	0.0023	0.27	5.40
As	0.0001	0.02	19.61	0.0002	0.01	43.14	0.0001	0.02	23.53				0.0001	0.01	13.73
Br*															
Ca	0.0004	0.07	1.72	0.0039	0.20	15.63	0.0183	2.79	73.01	0.0015	0.19	5.96	0.0009	0.11	3.68
Cr*															
Fe	0.0004	0.07	1.41	0.0052	0.27	17.63	0.0205	3.13	68.95	0.0018	0.23	5.92	0.0018	0.22	6.09
K*															
Pb*	0.0003	0.04	12.07	0.0013	0.07	56.03	0.0004	0.06	17.24				0.0003	0.04	14.66
Se*				0.0003	0.01	52.73	0.0001	0.01	14.55	0.0001	0.01	10.91	0.0001	0.01	21.82
Si	0.0028	0.44	3.00				0.0793	12.13	86.48	0.0046	0.60	5.04	0.0050	0.61	5.48
V*	0.0004	0.07	26.99	0.0006	0.03	36.20	0.0003	0.04	17.18	0.0001	0.01	6.75	0.0002	0.03	12.88
Zn	0.0001	0.01	0.98	0.0033	0.17	65.42	0.0008	0.12	14.93	0.0003	0.04	6.68	0.0006	0.07	11.98
Total Modeled Relative Mass	0.6226	100.00%	12.91	1.9515	100.00	40.47	0.6542	100.00	13.57	0.7686	100.00	15.94	0.8255	100.00	17.12
Modeled Mass %	0.84954			0.69258			1.00374			3.58355			4.02707		
	8.36%			6.82%			9.88%			35.28%			39.65%		

\* Not modeled EC2, EC3, Br, Cr, K,

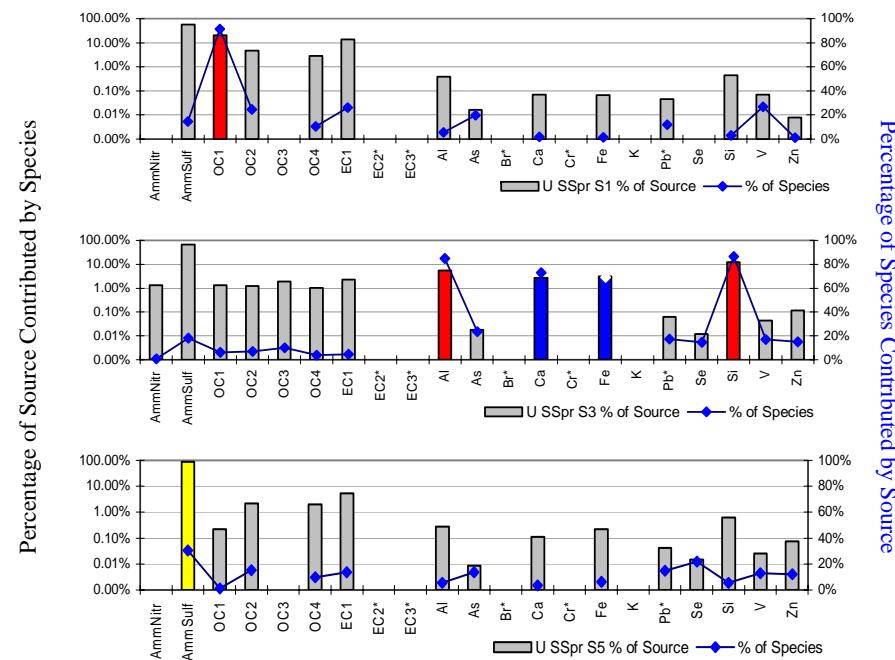
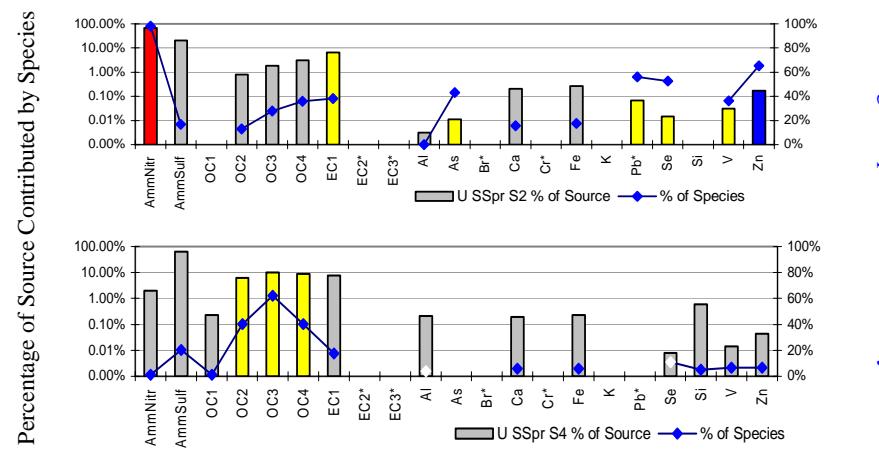
\*\*Blank cells represent deleted negative and zero values

**Table 6.4-26 UNMIX source types with species abundances and relative mass percentages for Shenandoah National Park, spring**

Source Identification		Source Type			Species Abundances by Percent of Factor				Modeled source	
Source ID	Profile ID	Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:	Relative Mass	Mass %
MSUSP1	USSprS1	Sec. ammonium sulfate	Biogenic emissions	Geological dust (Al rich)	ammSO4, OC1, EC1	OC2, OC4,	Si, Al, OC1, Fe, Ca	V, Ca, Fe, Pb, As, Zn	0.62255	12.91
MSUSP1	USSprS2	Sec. ammonium nitrate/sulfate	Coal fired power plant	Lead/zinc smelter	ammNO3, ammSO4	EC1, OC4, OC3	OC2, Fe, Ca, Zn,	Pb, V, Se, As	1.95151	40.47
MSUSP1	USSprS3	Sec. ammonium sulfate	Geological dust	Secondary organics	ammSO4, Si,	Al, Fe, Ca, EC1, OC3, ammNO3, OC1, OC2, OC4	Zn	Pb, V, As, Se	0.6542	13.57
MSUSP1	USSprS4	Secondary organics	Sec. ammonium sulfate	Geological dust	ammSO4, OC3	OC4, EC1, OC2, ammNO3,	Si, Fe, OC1, Al, Ca	Zn, V, Se	0.76859	15.94
MSUSP1	USSprS5	Sec. ammonium sulfate	Secondary organics	Lead/zinc smelter	ammSO4	EC1, OC2, OC4,	Si, Al, OC1, Fe, Ca	Zn, Pb, V, Se, As	0.82552	17.12
										4.8223 100.0

**Color Key**

- 1. Highest concentration for specific species Yellow
- 2. 60 – 80% of species Blue
- 3. >80% of species Red



**Figure 6.4-13. UNMIX modeled source profiles for Shenandoah National Park, spring**

#### 6.4.3.4 Shenandoah National Park - Summer

**Table 6.4-27 UNMIX modeled source profiles for Shenandoah National Park, summer Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species											
	USSum S1	% of Source	% of Species	USSum S2	% of Source	% of Species	USSum S3	% of Source	% of Species	USSum S4	% of Source	% of Species
ammNitr	0.7663	49.82	98.81	0.0073	0.94	0.94				0.0019	0.23	0.25
ammSulf				0.5971	77.45	37.00	0.2870	53.33	17.79	0.7296	88.19	45.21
OC1				0.0129	1.68	19.90	0.0494	9.17	75.95	0.0027	0.33	4.16
OC2	0.1604	10.43	67.60	0.0224	2.90	9.43	0.0331	6.16	13.96	0.0214	2.58	9.00
OC3	0.2541	16.52	83.58	0.0102	1.32	3.34	0.0280	5.21	9.22	0.0117	1.42	3.85
OC4	0.1479	9.62	68.37	0.0069	0.89	3.17	0.0385	7.16	17.80	0.0231	2.79	10.66
EC1	0.1580	10.27	55.20	0.0040	0.52	1.39	0.0920	17.10	32.16	0.0322	3.89	11.25
EC2*												
EC3*												
Al	0.0024	0.16	7.36	0.0293	3.80	88.29	0.0009	0.17	2.78	0.0005	0.06	1.57
As*	0.0003	0.02	78.95	0.0000	0.00	5.26	0.0000	0.01	10.53	0.0000	0.00	5.26
Br*												
Ca*	0.0112	0.73	61.32	0.0055	0.71	30.03	0.0011	0.20	5.97	0.0005	0.06	2.68
Cr*	0.0019	0.13	89.40	0.0001	0.02	5.53	0.0001	0.01	3.23	0.00004	0.00	1.84
Fe*	0.0050	0.33	24.64	0.0137	1.78	67.07	0.0012	0.22	5.68	0.0005	0.06	2.60
K												
Pb*	0.0244	1.59	73.81	0.0055	0.71	16.67	0.0026	0.49	7.92	0.0005	0.06	1.60
Se*	0.0004	0.02	71.15	0.0000	0.01	7.69	0.0000	0.01	7.69	0.0001	0.01	13.46
Si*				0.0560	7.26	90.39	0.0037	0.68	5.93	0.0023	0.28	3.68
V*	0.0023	0.15	86.79	0.0002	0.03	7.55	0.0001	0.02	3.77	0.0001	0.01	1.89
Zn	0.0036	0.23	84.74	0.0000	0.00	0.70	0.0004	0.07	9.15	0.0002	0.03	5.40
Total Modeled Relative Mass	1.5383	100.00%	41.86	0.7710	100.00	20.98	0.5382	100.00	14.65	0.8273	100.00	22.51
Modeled Mass %	0.45807 2.36%			1.73686 8.95%			4.59053 23.65%			12.6222 65.04%		19.4077 100.00%

\*Not modeled EC2, EC3, Br, K, Si,

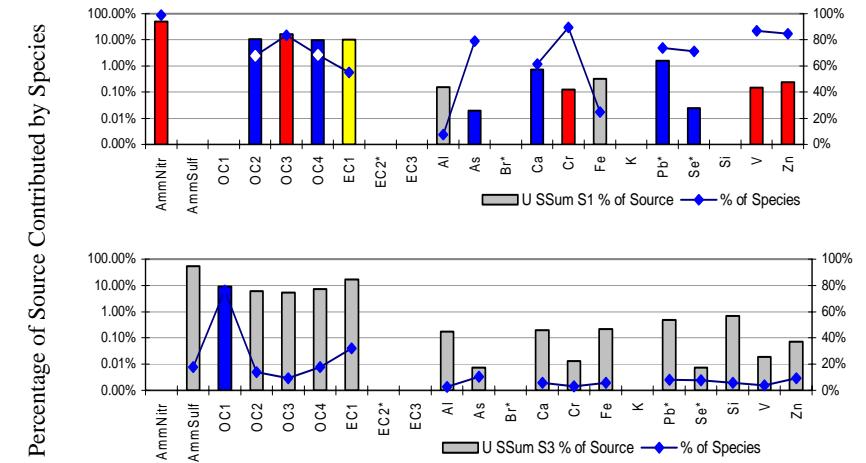
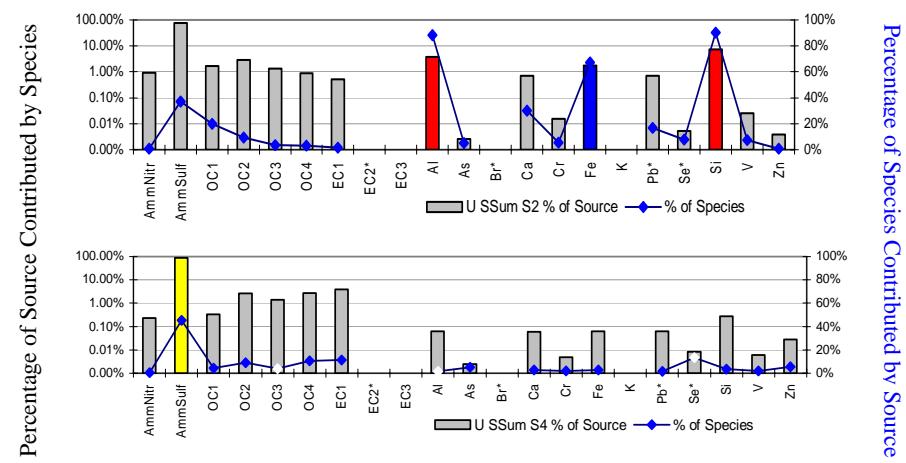
\*\*Blank cells represent deleted negative and zero values

**Table 6.4-28 UNMIX source types with species abundances and relative mass percentages for Shenandoah National Park, summer**

Source Identification Source ID	Profile ID	Source Type			Species Abundances by Percent of Factor				Modeled source Relative Mass Mass %	
		Major	Minor	Trace	> 10%	1 - 10%	0.1 - 1.0%	0.01- 0.1%		
MSUSU1	USSumS1	Sec. ammonium nitrate	Secondary organics (oil combustion/coal fired power plant)	Iron/lead/zinc smelter	ammNO3, OC3, OC2, EC1, OC4,	Pb, Ca	Fe, Zn, Al, V, Cr	Se, As	1.53829	41.86
MSUSU2	USSumS2	Sec. ammonium sulfate	Geological dust	Gasoline vehicle emissions	ammSO4	Si, Al, OC2, Fe, OC1, OC3	ammNO3, OC4, Pb, Ca, EC1,	V, Cr, Se	0.77096	20.98
MSUSU3	USSumS3	Secondary organics	Sec. ammonium sulfate		ammSO4, EC1	OC1, OC4, OC2, OC3,	Si, Pb, Fe, Ca, Al,	Zn, V, Cr, As, Se	0.5382	14.65
MSUSU4	USSumS4	Sec. ammonium sulfate	Secondary organics	Geological dust	ammSO4	EC1, OC4, OC2, OC3	OC1, ammNO3,	Fe, Pb, Al, Ca, Zn, Se, V	0.82729	22.51
									3.6747	100.0

**Color Key**

- 1. Highest concentration for specific species Yellow
- 2. 60 – 80% of species Blue
- 3. >80% of species Red



**Figure 6.4-14. UNMIX modeled source profiles for Shenandoah National Park, summer**

### 6.4.3.5 Shenandoah National Park - Fall

**Table 6.4-29 UNMIX modeled source profiles for Shenandoah National Park, fall  
Sources 1 to 5 (Modeled Species Relative PM2.5 Mass)**

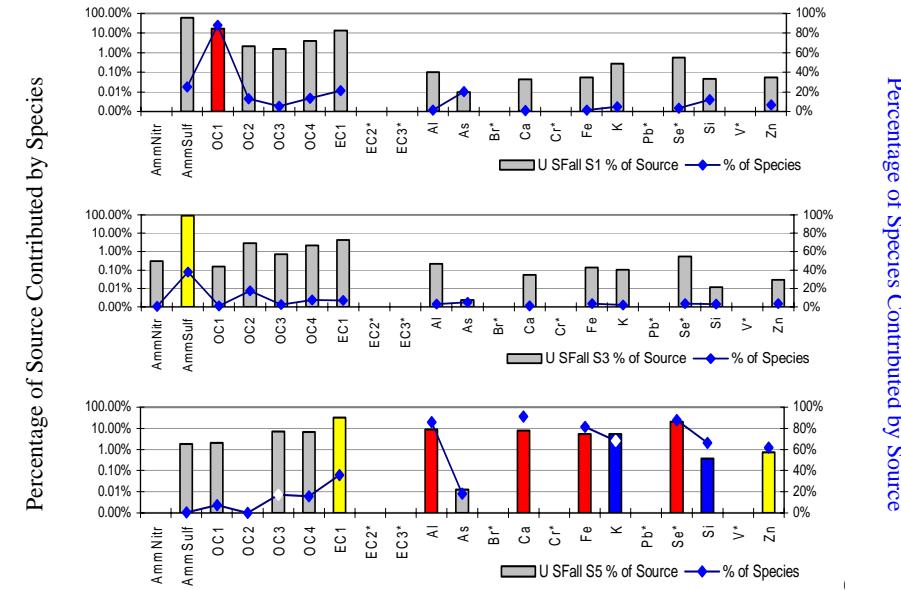
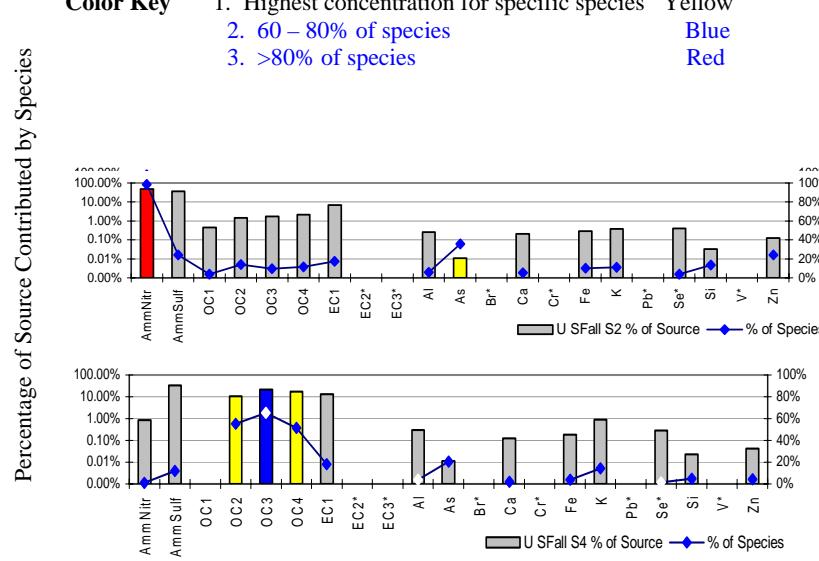
Species	Color Key:			Yellow indicates the source with highest concentration for a specific species											
	USFall S1	% of Source	% of Species	USFall S2	% of Source	% of Species	USFall S3	% of Source	% of Species	USFall S4	% of Source	% of Species	USFall S5	% of Source	% of Species
ammNitr	0.4985	60.67	25.26	0.6476	49.42	98.70	0.0026	0.30	0.39	0.0060	0.85	0.91			
ammSulf				0.4752	36.27	24.08	0.7509	88.46	38.05	0.2383	34.03	12.08	0.0105	1.85	0.53
OC1	0.1401	17.05	88.09	0.0059	0.45	3.70	0.0013	0.16	0.84				0.0117	2.07	7.36
OC2	0.0178	2.16	13.13	0.0188	1.43	13.85	0.0238	2.81	17.59	0.0751	10.72	55.44			0.00
OC3	0.0125	1.53	5.48	0.0222	1.70	9.70	0.0061	0.72	2.68	0.1493	21.32	65.19	0.0389	6.88	16.96
OC4	0.0329	4.00	13.57	0.0279	2.13	11.51	0.0186	2.19	7.66	0.1244	17.76	51.40	0.0384	6.80	15.85
EC1	0.1104	13.44	21.44	0.0905	6.90	17.57	0.0363	4.28	7.05	0.0941	13.44	18.27	0.1837	32.55	35.67
EC2*															
EC3															
Al	0.0008	0.10	1.39	0.0035	0.26	5.83	0.0019	0.22	3.14	0.0022	0.31	3.61	0.0512	9.07	86.02
As	0.0001	0.01	20.51	0.0001	0.01	35.90	0.0000	0.00	5.13	0.0001	0.01	20.51	0.0001	0.01	17.95
Br*															
Ca*	0.0004	0.05	0.75	0.0027	0.21	5.45	0.0005	0.06	0.95	0.0009	0.12	1.72	0.0452	8.00	91.14
Cr*															
Fe	0.0004	0.05	1.22	0.0037	0.28	10.29	0.0012	0.14	3.26	0.0013	0.19	3.62	0.0295	5.23	81.60
K	0.0022	0.27	4.91	0.0050	0.38	11.04	0.0009	0.10	1.90	0.0064	0.91	14.07	0.0308	5.45	68.07
Pb*															
Se	0.0047	0.57	3.46	0.0052	0.40	3.86	0.0045	0.53	3.36	0.0020	0.29	1.49	0.1182	20.94	87.83
Si	0.0004	0.05	12.04	0.0004	0.03	13.58	0.0001	0.01	3.09	0.0002	0.02	4.94	0.0022	0.38	66.36
V*															
Zn	0.0005	0.06	6.62	0.0017	0.13	24.03	0.0003	0.03	3.60	0.0003	0.04	4.17	0.0043	0.76	61.58
Total Modeled Relative Mass	0.8216	100.0%	19.35	1.3102	100.0	30.86	0.8489	100.0	19.99	0.7004	100.0	22.51	0.5644	100.0	13.29
Modeled Mass % of Total	0.86041 8.14%			1.12119 10.60%			6.26847 59.28%			1.95541 18.49%			0.36924 3.49%		

\*Not modeled EC2, EC3, Br, Cr, V

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-30 UNMIX modeled source types with species abundances and relative mass percentages for Shenandoah National Park, fall**

Source Identification Source ID	Profile ID	Source Type			> 10%:	Species Abundances by Percent of Source				Modeled source	
		Major	Minor	Trace		1 - 10%:	0.1 - 1.0%:	0.01 - 0.1%:	Relative Mass	Mass %	
MSUFA1	USFallS1	Sec. ammonium sulfate	Secondary organics	Coal fired power plant	ammSO4, OC1, EC1	OC4, OC2, OC3	Se, K, Al,	Zn, Fe, Si, Ca, As	0.82162	19.35	
MSUFA2	USFallS2	Sec. ammonium nitrate/sulfate	Coal fired power plant	Geological dust Zn?	ammNO3, ammSO4	EC1, OC4, OC3, OC2	OC1, Se, K, Fe, Al, Ca, Zn	Si, As	1.31024	30.86	
MSUFA3	USFallS3	Sec. ammonium sulfate	Coal fired power plant	Geological dust Zn?	ammSO4, OC1, EC1	EC1, OC2, OC4,	OC3, Se, ammNO3, Al, OC1, Fe, K	Ca, Zn, Si	0.84888	19.99	
MSUFA4	USFallS4	Secondary organics	Sec. amm. sulfate	Geological dust Zn?	ammSO4, OC3, OC4, EC1, OC2		K, ammNO3, Al, Se, Fe, Ca	Zn, Si, As	0.70039	16.50	
MSUFA5	USFallS5	Coal fired power plant	Iron, zinc smelter	Secondary organics	EC1, Se,	Al, Ca, OC3, OC4, K, Fe, OC1, ammSO4	Zn, Si, Fe	As	0.56436	13.29	
									4.2455	100.0	



**Figure 6.4-15. UNMIX modeled source profiles for Shenandoah National Park, fall**

## 6.4.4 Washington DC

### 6.4.4.1 Washington DC - Annual

**Table 6.4-31a UNMIX modeled source profiles for Washington DC, annual.  
Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species											
	UWAll S1	% of Source	% of Species	UWAll S2	% of Source	% of Species	UWAll S3	% of Source	% of Species	UWAll S4	% of Source	% of Species
ammNitr	0.0741	9.57	8.92	0.2705	24.13	32.57	0.4505	48.23	54.25	0.0202	2.27	2.44
ammSulf	0.3857	49.81	17.86	0.4922	43.91	22.78	0.2479	26.54	11.48	0.3313	37.21	15.34
OC1	0.0219	2.83	14.30	0.0132	1.18	8.61	0.0081	0.87	5.31			
OC2	0.0491	6.34	25.19	0.0261	2.33	13.41	0.0234	2.50	12.01	0.0016	0.18	0.80
OC3	0.0032	0.41	1.28				0.0650	6.95	26.49	0.0199	2.24	8.13
OC4	0.0245	3.17	9.71				0.0685	7.33	27.10	0.0231	2.60	9.14
EC1	0.1936	24.99	25.68	0.2777	24.78	36.85	0.0591	6.33	7.84			
EC2*							0.0003	0.03	2.13			
EC3	0.0132	1.70	96.69									
Al				0.0037	0.33	2.87	0.0015	0.16	1.19	0.1203	13.51	93.24
As	0.0001	0.01	10.00	0.0002	0.01	26.67	0.0001	0.01	8.33	0.0002	0.03	38.33
Br	0.0004	0.05	20.21	0.0004	0.03	20.74	0.0005	0.05	26.06	0.0001	0.02	7.45
Ca	0.0023	0.30	3.44	0.0083	0.74	12.41	0.0011	0.12	1.67	0.0514	5.78	76.53
Cr*												
Fe	0.0058	0.75	4.37	0.0148	1.32	11.09	0.0056	0.60	4.20	0.0949	10.66	71.06
K*												
Pb	0.0003	0.03	2.30	0.0103	0.92	94.85	0.0002	0.02	1.84			
Se*												
Si				0.0028	0.25	1.18	0.0016	0.17	0.66	0.2266	25.44	94.92
V	0.0004	0.05	12.95	0.0007	0.06	23.74	0.0006	0.07	23.02	0.0007	0.08	25.90
Zn*												
Total Modeled Relative Mass	0.7744	100.00%	14.92	1.1209	100.00	21.60	0.9341	100.00	18.00	0.8905	100.00	17.16
Modeled Mass	1.1925			0.4436			3.8149			0.32851		
% of Total	6.99%			2.60%			22.36%			1.93%		

**Table 6.4-31b****UNMIX modeled source profiles for Washington DC, annual.**

Sources 5 to 6 (Modeled Species Relative PM2.5 Mass)

Species	Color Key: Yellow indicates the source with highest concentration for a specific species					
	UWAll S5	% of Source	% of Species	UWAll S6	% of Source	% of Species
ammNitr	0.0095	1.40	1.14	0.0056	0.71	0.68%
ammSulf	0.0740	10.94	3.43	0.6291	79.37	29.12%
OC1	0.1049	15.50	68.37	0.0052	0.66	3.42%
OC2	0.0610	9.02	31.32	0.0337	4.25	17.28%
OC3	0.1300	19.22	53.02	0.0272	3.43	11.08%
OC4	0.1037	15.33	41.00	0.0330	4.163	13.050%
EC1	0.1750	25.87	23.22	0.0483	6.09	6.41%
EC2*						
EC3	0.0001	0.01	0.44	0.0001	0.01	0.73%
Al	0.0008	0.11	0.60	0.0027	0.34	2.11%
As	0.0001	0.01	10.00	0.0000	0.01	6.67%
Br	0.0004	0.05	18.62	0.0001	0.02	6.91%
Ca	0.0034	0.50	5.01	0.0006	0.08	0.94%
Cr*						
Fe	0.0108	1.59	8.06	0.0016	0.206	1.22%
K*						
Pb	0.0000	0.00	0.28	0.0001	0.01	0.74%
Se*						
Si	0.0028	0.42	1.18	0.0049	0.62	2.06%
V	0.0002	0.02	5.76	0.0002	0.03	8.63%
Zn*						
Total Modeled Relative Mass	0.6764	100.00	13.04	0.7926	100.00	15.27
Modeled Mass	2.7999		8.4834		17.06288	
% of Total	16.41%		49.72%		100.00%	

\*Not modeled EC2, Cr, K, Se, Zn

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-32 UNMIX modeled source types with species abundances and relative mass percentages for Washington DC, annual**

Source Identification		Source Type			Species Abundances by Percent of Factor				Modeled source	
Source ID	Profile ID	Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:	Relative Mass	Mass %
MWUAL1	UWALLS1	Sec. ammonium sulfate	Secondary organics EC3>	Diesel vehicle emissions	ammSO4, EC1	ammNO3, OC2, OC4, OC1, <b>EC3</b>	Fe, OC3, Ca	Br, V, Pb, As	0.7744	14.92
MWUAL2	UWALLS2	Sec. ammonium sulfate/nitrate	Iron, lead smelter	Secondary organics	ammSO4, <b>EC1</b> , ammNO3	OC2, Fe, OC1,	<b>Pb</b> , Ca, Al, Si	V, Br, As	1.1209	21.60
MWUAL3	UWALLS3	Sec. ammonium nitrate/sulfate	Motor vehicle emissions	Geological dust	<b>ammNO3</b> , ammSO4	OC4, OC3, EC1, OC2	OC1, Fe, Si, Al, Ca	V, <b>Br</b> , EC3, Pb, As	0.9341	18.00
MWUAL4	UWALLS4	Geological dust Al, Fe, Ca>	Sec. ammonium sulfate	Secondary organics	ammSO4, <b>Si</b> , <b>Al</b> , <b>Fe</b>	<b>Ca</b> , OC4, AmmNO3, OC3	OC2	V, As, Br	0.8905	17.16
MWUAL5	UWALLS5	Motor vehicle emissions	Sec. ammonium sulfate	Geological dust	<b>EC1</b> , <b>OC3</b> , <b>OC1</b> , <b>OC4</b>	ammSO4, <b>OC2</b> , Fe, ammNO3	Ca, Si, Al	V, EC3, As, Pb	0.6764	13.04
MWUAL6	UWALLS6	Sec. ammonium sulfate	Motor vehicle emissions	Geological dust	<b>ammSO4</b>	EC1, OC2, OC4, OC3	ammNO3, OC1, Si, Al, Fe	Ca, V, Br, EC3, Pb, As	0.7926	15.27
										5.1889 100.0

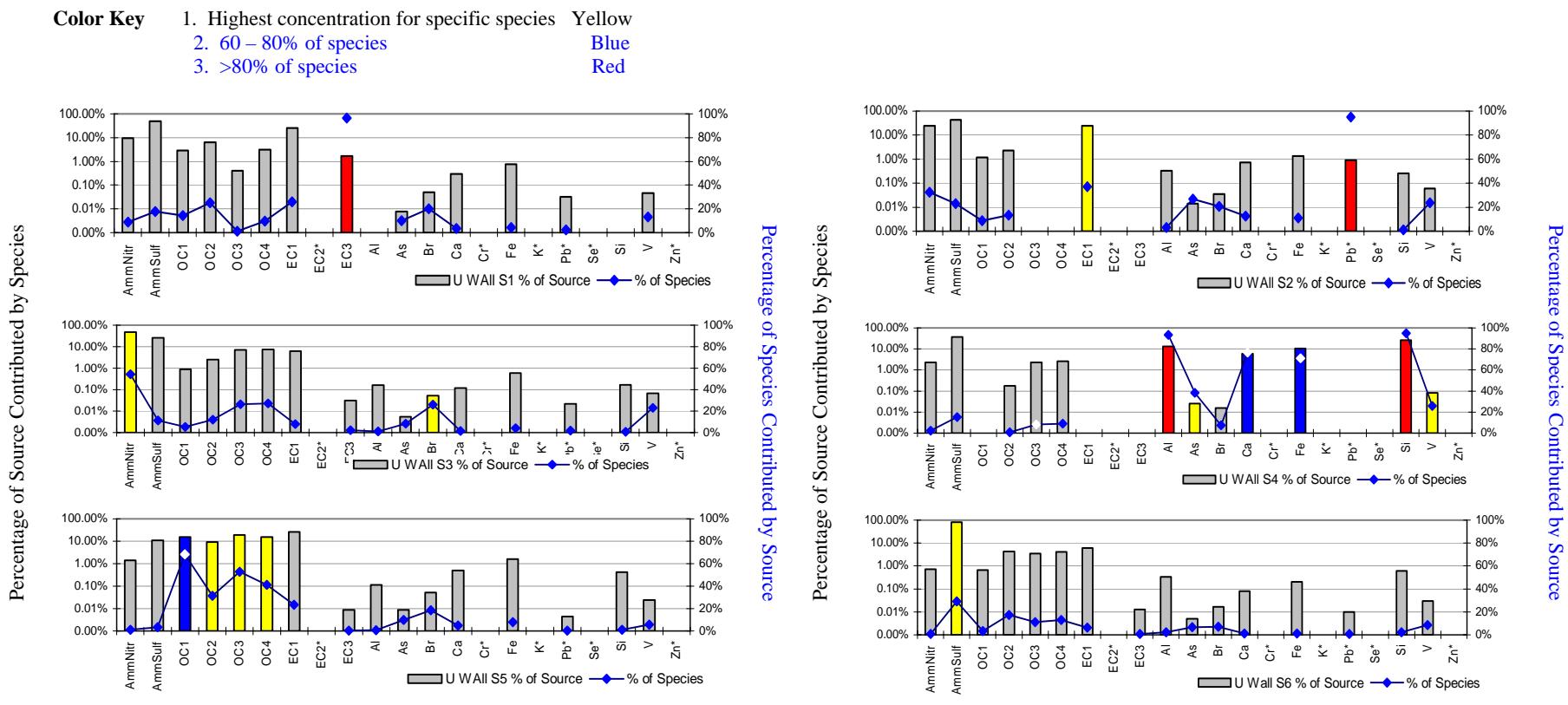


Figure 6.4-16. UNMIX modeled source profiles for Washington DC, annual

## 6.4.4.2 Washington DC - Winter

**Table 6.4-33 UNMIX modeled source profiles for Washington DC, winter.**  
**Sources 1 to 5 (Modeled Species Relative PM2.5 Mass)**

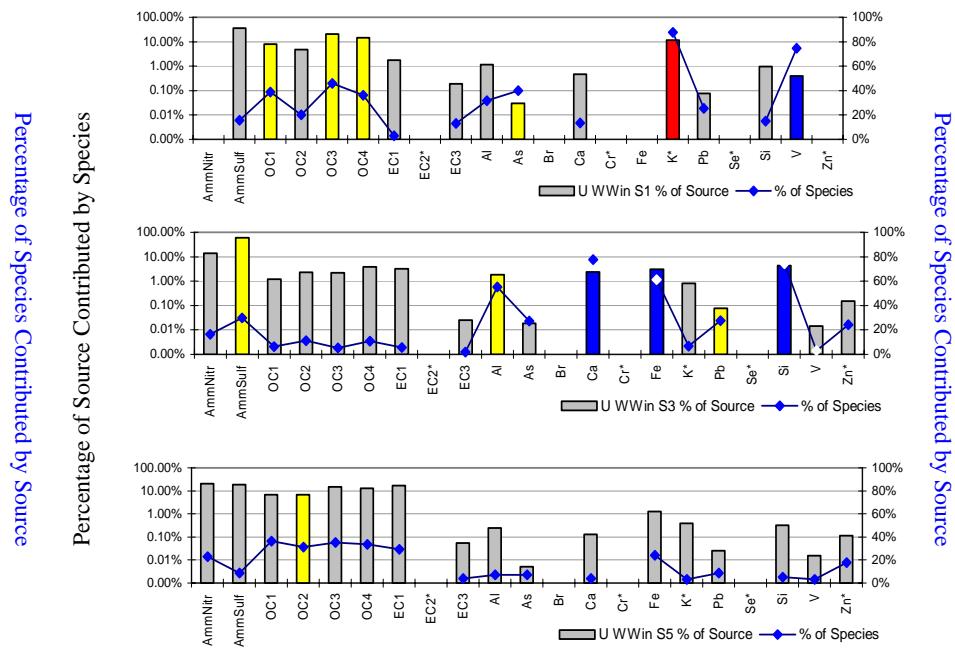
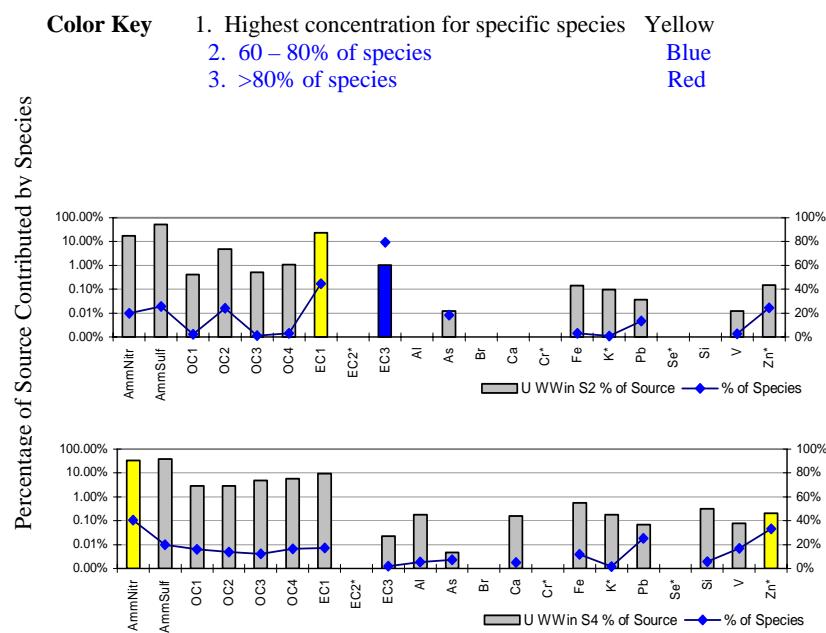
Color Key: Yellow indicates the source with highest concentration for a specific species															
Species	UWWin S1	% of Source	% of Species	UWWin S2	% of Source	% of Species	UWWin S3	% of Source	% of Species	UWWin S4	% of Source	% of Species	UWWin S5	% of Source	% of Species
ammNitr	0.26198	35.48	15.81	0.14089	16.93	19.96	0.11581	14.10	16.40	0.28659	33.89	40.59	0.16272	20.67	23.05
ammSulf	0.05881	7.96	38.84	0.42207	50.71	25.47	0.49722	60.53	30.01	0.32868	38.87	19.84	0.14708	18.68	8.88
OC1	0.03423	4.64	20.03	0.00344	0.41	2.27	0.00983	1.20	6.49	0.02450	2.90	16.18	0.05482	6.96	36.21
OC2	0.15368	20.81	45.99	0.04080	4.90	23.87	0.01909	2.32	11.17	0.02358	2.79	13.80	0.05323	6.76	31.14
OC3	0.10828	14.66	36.30	0.00912	1.10	3.06	0.03190	3.88	10.69	0.04847	5.73	16.25	0.10054	12.77	33.70
OC4	0.01275	1.73	2.85	0.19956	23.97	44.60	0.02588	3.15	5.78	0.07768	9.19	17.36	0.13161	16.71	29.41
EC1	0.00139	0.19	12.93	0.00852	1.02	79.26	0.00021	0.03	1.95	0.00019	0.02	1.77	0.00044	0.06	4.09
EC2*	0.00858	1.16	31.81				0.01493	1.82	55.36	0.00149	0.18	5.52	0.00197	0.25	7.30
EC3	0.00022	0.03	40.00	0.00010	0.01	18.18	0.00015	0.02	27.27	0.00004	0.00	7.27	0.00004	0.01	7.27
Al							0.01981	2.41	77.47	0.00130	0.15	5.08	0.00103	0.13	4.03
As															
Br*															
Ca	0.00343	0.46	13.41												
Cr*															
Fe				0.00117	0.14	2.87	0.02493	3.03	61.16	0.00477	0.56	11.70	0.00989	1.26	24.26
K	0.08443	11.43	87.60	0.00079	0.09	0.82	0.00664	0.81	6.89	0.00153	0.18	1.59	0.00299	0.38	3.10
Pb	0.00057	0.08	25.22	0.00030	0.04	13.27	0.00062	0.08	27.43	0.00057	0.07	25.22	0.00020	0.03	8.85
Se*															
Si	0.00721	0.98	15.05				0.03550	4.32	74.11	0.00270	0.32	5.64	0.00249	0.32	5.20
V	0.00291	0.39	74.62	0.00010	0.01	2.56	0.00012	0.01	3.08	0.00065	0.08	16.67	0.00012	0.02	3.08
Zn				0.00124	0.15	24.41	0.00124	0.15	24.41	0.00169	0.20	33.27	0.00091	0.12	17.91
Total Modeled Relative Mass	0.7385	100.0%	18.35	0.8324	100.	20.68	0.8215	100.0	20.41	0.8457	100.0	21.01	0.78740	100.0	19.56
Modeled Mass %	0.4083 2.61%		1.4159 9.04%			1.3097 8.36%				7.2696 46.42%			5.2553 33.56%		

\*Not modeled EC2, Br, Cr, Se

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-34 UNMIX modeled source types with species abundances and relative mass percentages for Washington DC, winter**

Source Identification		Source Type			Species Abundances by Percent of Factor					Modeled source	
Source ID	Profile ID	Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01 - 0.1%:	Relative Mass	Mass %	
MWUWI1	UWWinS1	Sec. ammonium sulfate	Vegetative burning	Oil combustion	ammSO4, OC3, OC4, K	OC1, OC2, EC1, Al	Si, Ca, V, EC3	Pb, As	0.73847	18.35	
MWUWI1	UWWinS2	Sec. ammonium sulfate	Diesel vehicle emissions	Sec. ammonium nitrate	ammSO4, EC1, ammNO3,	OC2, OC4, EC3	OC3, OC1, Zn, Fe	K, Pb, As, V	0.83238	20.68	
MWUWI1	UWWinS3	Sec. ammonium sulfate	Geological dust (Al, Ca, Fe>)	Iron, lead, zinc smelter	ammSO4, ammNO3,	Si, OC4, EC1, Fe, Ca, OC2, OC3, Al, OC1	K, Zn	EC3, As, V, Pb	0.82148	20.41	
MWUWI1	UWWinS4	Sec. ammonium nitrate/sulfate	Diesel vehicle emissions	Iron, lead, zinc smelter	ammSO4, ammNO3	EC1, OC4, OC3, OC1, OC2	Fe, Si, Zn, K, Al, Ca	V, Pb, EC3, As	0.84568	21.01	
MWUWI1	UWWinS5	Diesel vehicle emissions	Sec. ammonium nitrate/sulfate	Geological dust + Zn?	ammNO3, ammSO4, EC1, OC3, OC4	OC1, OC2, Fe	K, Si, Al, Ca, Zn	EC3, Pb, V, As	0.787	19.56	
											4.0254 100.0



**Figure 6.4-17. UNMIX modeled source profiles for Washington DC, winter**

### 6.4.4.3 Washington DC - Spring

**Table 6.4-35 UNMIX modeled source profiles for Washington DC, spring  
Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species											
	UWSpr S1	% of Source	% of Species	UWSpr S2	% of Source	% of Species	UWSpr S3	% of Source	% of Species	UWSpr S4	% of Source	% of Species
ammNitr				0.02879	3.558	6.258	0.34301	36.802	74.556	0.08827	11.063	19.186
ammSulf	0.48763	56.85	26.27	0.62763	77.559	33.818	0.37939	40.706	20.443	0.36123	45.272	19.464
OC1	0.00071	0.08	0.97				0.01455	1.561	19.899	0.05786	7.251	79.130
OC2	0.04783	5.58	32.71	0.03730	4.609	25.506	0.02226	2.388	15.222	0.03885	4.869	26.566
OC3	0.08104	9.45	40.83	0.01677	2.072	8.448	0.03869	4.151	19.491	0.06200	7.770	31.234
OC4	0.06471	7.54	31.83	0.03294	4.071	16.203	0.04538	4.869	22.323	0.06026	7.552	29.642
EC1	0.07238	8.44	23.08	0.05255	6.494	16.757	0.07574	8.126	24.152	0.11293	14.153	36.011
EC2*												
EC3	0.00067	0.08	12.91	0.00437	0.540	84.200	0.00015	0.016	2.890			
Al	0.02108	2.46	83.58	0.00091	0.112	3.608	0.00150	0.161	5.948	0.00173	0.217	6.860
As	0.00010	0.01	34.48	0.00007	0.009	24.138	0.00007	0.008	24.138	0.00005	0.006	17.241
Br*	0.00041	0.05	31.78	0.00028	0.035	21.705	0.00038	0.041	29.457	0.00022	0.028	17.054
Ca*	0.01180	1.38	70.74	0.00071	0.088	4.257	0.00122	0.131	7.314	0.00295	0.370	17.686
Cr*												
Fe	0.02307	2.69	63.41	0.00254	0.314	6.982	0.00480	0.515	13.194	0.00597	0.748	16.410
K												
Pb*	0.00037	0.04	23.72	0.00010	0.012	6.410	0.00068	0.073	43.590	0.00041	0.051	26.282
Se												
Si	0.04460	5.20	82.23	0.00347	0.429	6.397	0.00190	0.204	3.503	0.00427	0.535	7.872
V*	0.00024	0.03	18.05	0.00031	0.038	23.308	0.00068	0.073	51.128	0.00010	0.013	7.519
Zn	0.00114	0.13	28.01	0.00049	0.061	12.039	0.00163	0.175	40.049	0.00081	0.102	19.902
Total Modeled Relative Mass	0.8578	25.25	0.80923		23.822	0.93203		27.437	0.79791	100.000	23.489	
Modeled Mass % of Total	0.7926 5.26%		2.764 18.33%		4.0229 26.67%		7.5023 49.74%			15.082 100.00%		

\* Not modeled EC2, Br, Cr, K

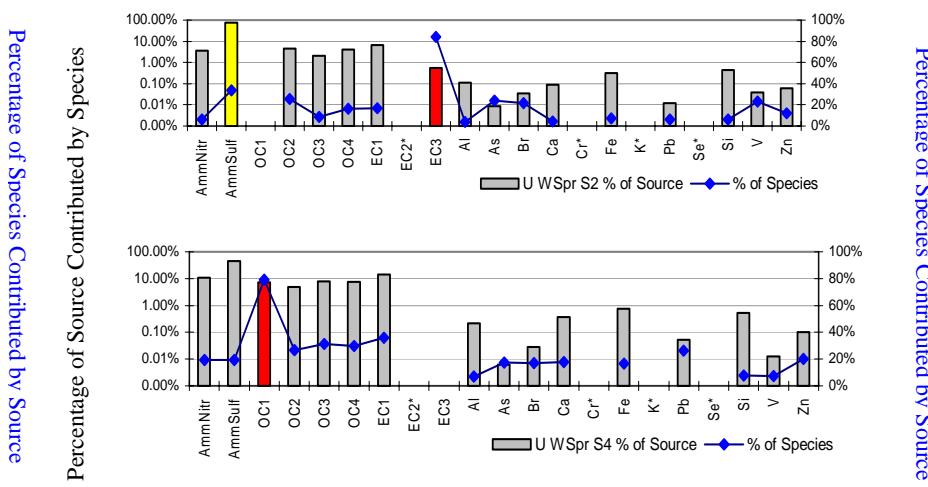
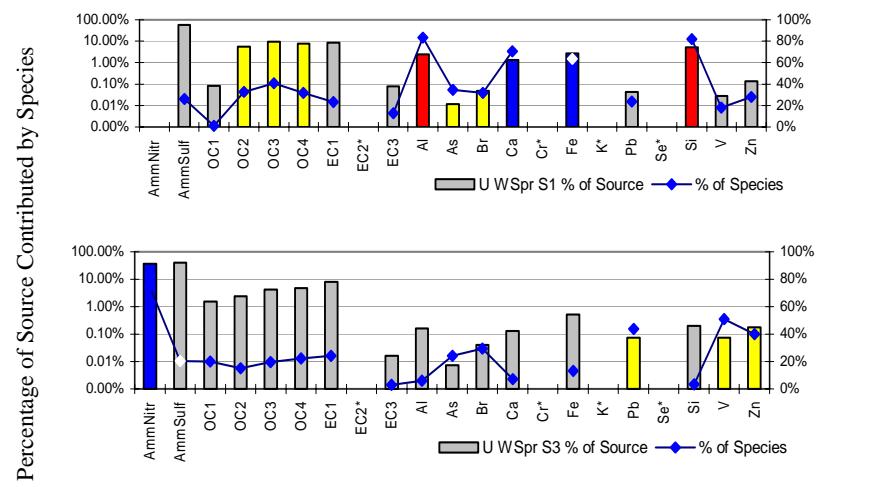
\*\*Blank cells represent deleted negative and zero values

**Table 6.4-36 UNMIX modeled source types with species abundances and relative mass percentages for Washington DC, spring**

Source Identification		Source Type			Species Abundances by Percent of Factor				Modeled source	
Source ID	Profile ID	Major	Minor	Trace	> 10%:	1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:	Relative Mass	Mass %
MWUSP1	UWSprS1	Sec ammonium sulfate	Geological dust	Secondary organics	ammSO4,	<b>OC3, EC1, OC4,</b> <b>OC2, Si, Fe, Al, Ca</b>	Zn,	OC1, EC3, <b>Br, Pb, V, As</b>	0.85778	25.25
MWUSP2	UWSprS2	Sec ammonium sulfate	Secondary organics	Geological dust	<b>ammSO4,</b>	EC1, OC2, OC4, ammNO3, OC3	<b>EC3,</b> Si, Fe, Al	Ca, Zn, V, Br, Pb, As	0.80923	23.82
MWUSP3	UWSprS3	Sec ammonium sulfate/nitrate	Secondary organics	Iron, lead, zinc smelter	ammSO4, <b>ammNO3</b>	EC1, OC4, OC3, OC2, OC1, Si, Fe, ammSO4, Al	Fe, Si, <b>Zn, Al, Ca</b>	<b>Pb, V,</b> Br, EC3, As	0.93203	27.44
MWUSP4	UWSprS4	Sec ammonium sulfate	Secondary organics	Geological dust	ammSO4, EC1 ammNO3,	OC3, OC4, <b>OC1</b> , OC2,	Fe, Si, Ca, Al, Zn	Pb, Br, V, As, EC2	0.79791	23.49
									3.39695	100.0

**Color Key**

- 1. Highest concentration for specific species Yellow
- 2. 60 – 80% of species Blue
- 3. >80% of species Red



**Figure 6.4-18. UNMIX modeled source profiles for Washington DC, spring**

**Table 6.4-37 UNMIX modeled source profiles for Washington DC, summer.  
Sources 1 to 5 (Modeled Species Relative PM2.5 Mass)**

Color Key: Yellow indicates the source with highest concentration for a specific species																
Modeled Species Relative PM2.5 Mass	UWSu m S1	% of Source	% of Species	UWSu m S2	% of Source	% of Species	UWSu m S3	% of Source	% of Species	UWSu m S4	% of Source	% of Species	UWSu m S5	% of Source	% of Species	
	ammNitr	0.33790	32.88	81.51	0.01552	2.12	3.74	0.01096	1.56	2.64	0.03756	4.44	9.06	0.01260	1.67	3.04
	ammSulf	0.42400	41.25	17.53	0.52059	71.03	21.52	0.35007	49.80	14.47	0.54847	64.89	22.68	0.57554	76.13	23.80
	OC1						0.14377	20.45	96.75	0.00483	0.57	3.25				
	OC2	0.03894	3.79	23.42	0.02790	3.81	16.78	0.02872	4.09	17.27	0.03444	4.07	20.71	0.03630	4.80	21.83
	OC3	0.04984	4.85	30.04	0.02600	3.55	15.67	0.00857	1.22	5.17	0.04346	5.14	26.19	0.03805	5.03	22.93
	OC4	0.06265	6.10	32.32	0.02634	3.59	13.59	0.03677	5.23	18.97	0.03077	3.64	15.87	0.03732	4.94	19.25
	EC1	0.10321	10.04	25.46	0.02291	3.13	5.65	0.11509	16.37	28.39	0.11789	13.95	29.08	0.04633	6.13	11.43
	EC2*															
	EC3*															
	Al	0.00203	0.20	5.81	0.02728	3.72	78.03	0.00114	0.16	3.26	0.00313	0.37	8.95	0.00138	0.18	3.95
	As	0.00005	0.00	19.23	0.00005	0.01	19.23				0.00013	0.02	50.00	0.00003	0.00	11.54
	Br	0.00023	0.02	27.38	0.00008	0.01	9.52	0.00014	0.02	16.67	0.00025	0.03	29.76	0.00014	0.02	16.67
	Ca	0.00113	0.11	8.03	0.00512	0.70	36.36	0.00094	0.13	6.68	0.00570	0.67	40.48	0.00119	0.16	8.45
	Cr*															
	Fe	0.00531	0.52	15.21	0.01362	1.86	39.00				0.01314	1.55	37.63	0.00285	0.38	8.16
	K*															
	Pb*															
	Se	0.00013	0.01	30.23	0.00006	0.01	13.95	0.00010	0.01	23.26	0.00004	0.00	9.30	0.00010	0.01	23.26
	Si	0.00132	0.13	2.19	0.04709	6.43	78.07	0.00629	0.89	10.43	0.00182	0.22	3.02	0.00380	0.50	6.30
	V	0.00013	0.01	7.22	0.00025	0.03	13.89	0.00006	0.01	3.33	0.00129	0.15	71.67	0.00007	0.01	3.89
	Zn	0.00096	0.09	23.94	0.00008	0.01	2.00	0.00036	0.05	8.98	0.00229	0.27	57.11	0.00032	0.04	7.98
Total Modeled Species Mass	1.0278	100.0%	25.29	0.7329	100.0	18.03	0.7030	100.0	17.29	0.8452	100.0	20.79	0.75602	100.0	18.60	
Modeled Mass %	2.2824 10.38%		2.0915 9.51%		2.7514 12.51%			2.31802 10.54%					12.555 57.07%			

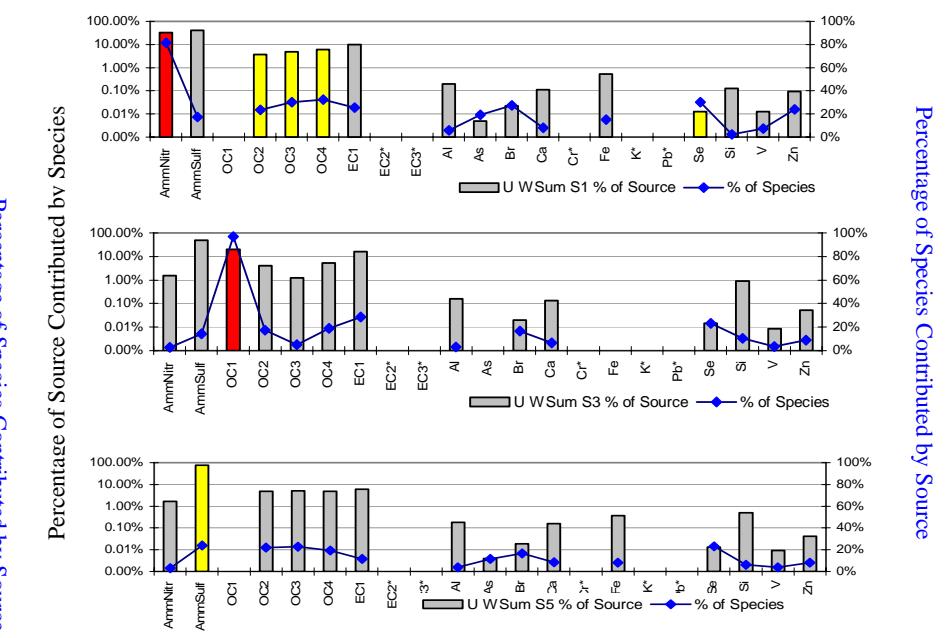
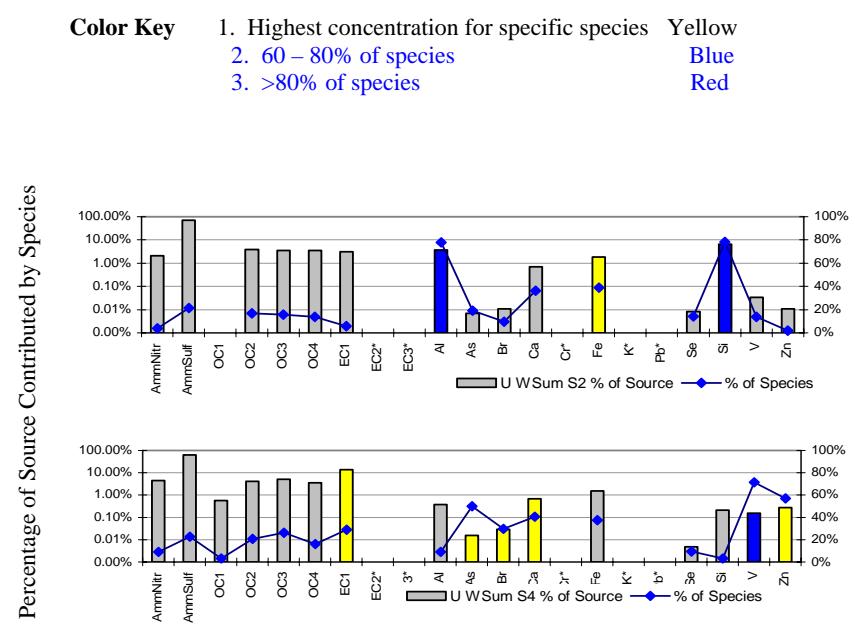
\*Not modeled EC2, EC3, Cr, K, Pb

\*\*Blank cells represent deleted negative and zero values

**Table 6.4-38 UNMIX modeled source types with species abundances and relative mass percentages for Washington DC, summer**

Source Identification		Source Type			> 10%:	Species Abundances by Percent of Factor				Modeled source	
Source ID	Profile ID	Major	Minor	Trace		1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:	Relative Mass	Mass %	
MWUSU1	UWSumS1	Sec. ammonium sulfate/nitrate	Coal fired power plant	Geological dust	ammSO4, <b>ammNO3</b> , EC1	<b>OC4, OC3, OC2</b>	Fe, Al, Si, Ca	Zn, Br, Se, V	1.02783	25.29	
MWUSU2	UWSumS2	Sec. ammonium sulfate	Geological dust aluminum rich	Secondary organics	ammSO4	<b>Si, OC2, Al, OC4, OC3, EC1, ammNO3, Fe</b>		V, Br, Zn, Se, As	0.73289	18.03	
MWUSU3	UWSumS3	Secondary organics	Sec. ammonium sulfate	Secondary organics	ammSO4, <b>OC1</b> , EC1	OC4, OC2, ammNO3, OC3	Si, Al, Ca,	Zn, Br, Se, V	0.70298	17.29	
MWUSU4	UWSumS4	Motor vehicle emissions	Sec. ammonium sulfate	Iron, zinc smelter	ammSO4, EC1	OC3, ammNO3, OC2, OC4, Fe	Ca, OC1, Al, <b>Zn, Si, V</b>	<b>Br, As</b>	0.84521	20.79	
MWUSU5	UWSumS5	Sec. ammonium sulfate	Motor vehicle emissions		ammSO4,	EC1, OC3, OC4, OC2, ammNO3	Si, Fe, Al, Ca	Zn, Br, Se, V	0.75602	18.60	

4.0649 100.0



**Figure 6.4-19. UNMIX modeled source profiles for Washington DC, summer**

#### 6.4.4.4 Washington DC - Fall

**Table 6.4-39 UNMIX modeled source profiles for Washington DC, fall.  
Sources 1 to 4 (Modeled Species Relative PM2.5 Mass)**

Species	Color Key: Yellow indicates the source with highest concentration for a specific species											
	UWFall S1	% of Source	% of Species	UWFall S2	% of Source	% of Species	UWFall S3	% of Source	% of Species	UWFall S4	% of Source	% of Species
ammNitr	0.20433	21.83	43.31	0.06247	7.20	13.24	0.01023	1.26	2.17	0.19472	22.86	41.28
ammSulf	0.36862	39.37	21.42	0.53728	61.91	31.22	0.50593	62.28	29.40	0.30925	36.31	17.97
OC1	0.01025	1.09	12.74	0.03013	3.47	37.46	0.00166	0.20	2.06	0.03839	4.51	47.73
OC2	0.04803	5.13	29.14	0.02937	3.38	17.82	0.04644	5.72	28.17	0.04100	4.81	24.87
OC3	0.05722	6.11	27.50				0.05965	7.34	28.67	0.09121	10.71	43.83
OC4	0.06359	6.79	31.33				0.05963	7.34	29.38	0.07972	9.36	39.28
EC1	0.15443	16.50	31.09	0.17614	20.30	35.46	0.08084	9.95	16.27	0.08537	10.02	17.18
EC2*				0.00546	0.63	89.07	0.00067	0.08	10.93			
EC3				0.00449	0.52	27.21	0.00895	1.10	54.24	0.00143	0.17	8.67
Al	0.00163	0.17	9.88	0.00010	0.01	40.00	0.00006	0.01	24.00	0.00004	0.00	16.00
As	0.00005	0.01	20.00									
Br*												
Ca	0.00234	0.25	17.81	0.00370	0.43	28.16	0.00600	0.74	45.66	0.00110	0.13	8.37
Cr*e												
Fe	0.01072	1.15	29.13	0.00739	0.85	20.08	0.01332	1.64	36.20	0.00537	0.63	14.59
K*												
Pb	0.00688	0.73	94.90	0.00018	0.02	2.48	0.00010	0.01	1.38	0.00009	0.01	1.24
Se	0.00015	0.02	25.86	0.00015	0.02	25.86	0.00014	0.02	24.14	0.00014	0.02	24.14
Si	0.00482	0.51	13.99	0.00943	1.09	27.37	0.01761	2.17	51.12	0.00259	0.30	7.52
V	0.00019	0.02	15.57	0.00037	0.04	30.33	0.00034	0.04	27.87	0.00032	0.04	26.23
Zn	0.00296	0.32	50.34	0.00119	0.14	20.24	0.00082	0.10	13.95	0.00091	0.11	15.48
Total Modeled Species Mass	0.9362	100.00%	26.99	0.8679	100.00	25.02	0.8124	100.00	23.42	0.8517	100.00	24.56

Modeled Mass	0.7926	2.764	4.0229	7.5023	15.082
% of Total	5.26%	18.33%	26.67%	49.74%	100.00%

\*Not modeled EC2, Br, Cr K,

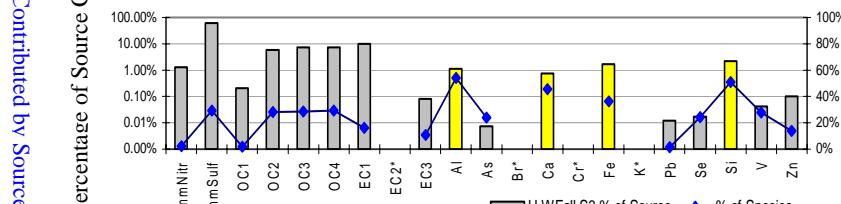
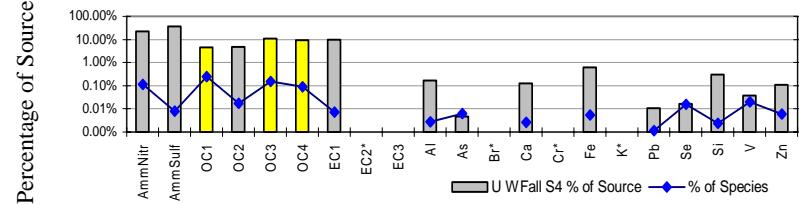
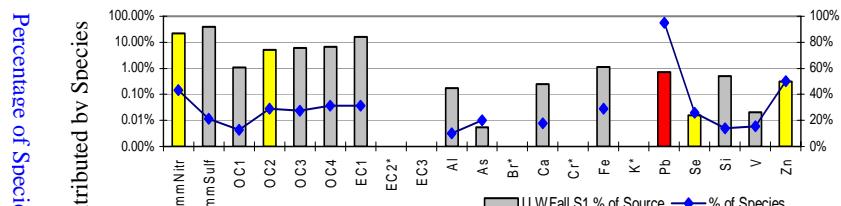
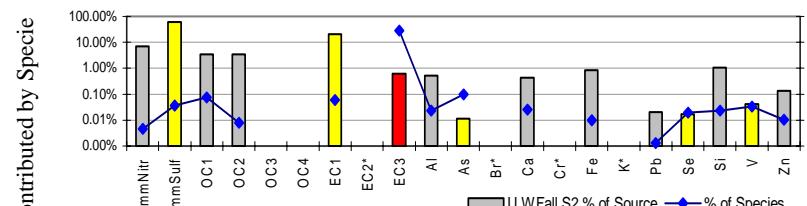
\*\*Blank cells represent deleted negative and zero values

**Table 6.4-40 UNMIX modeled source types with species abundances and relative mass percentages for Washington DC, fall**

Source Identification Source ID	Profile ID	Source Type			> 10%:	Species Abundances by Percent of Factor				Modeled source Relative Mass Mass %
		Major	Minor	Trace		1 - 10%:	0.1 - 1.0%:	0.01- 0.1%:		
MWUFA1	UWFallS1	Sec. ammonium sulfate/nitrate	Coal fired power plant	Lead zinc smelter	ammSO4, <b>ammNO3</b> , EC1	OC4, <b>OC2</b> , Fe, OC1	<b>Pb</b> , Si, Zn, Ca, Al	V, <b>Se</b> , As	0.93621	26.99
MWUFA2	UWFallS2	Sec. ammonium sulfate/nitrate	Secondary organics	Geological dust	<b>ammSO4</b> , EC1	ammNO3, OC1, OC2, Si	Fe, <b>EC3</b> , Al, Ca, Zn	V, Pb, Se, <b>As</b>	0.8679	25.02
MWUFA3	UWFallS3	Sec. ammonium sulfate	Motor vehicle emissions	Geological dust	ammSO4,	EC1, OC3, OC4, OC2, <b>Si</b> , <b>Fe</b> , ammNO3, Al	Ca, OC1, Zn,	V, Se, Pb, As	0.85165	24.56
MWUFA4	UWFallS4	Motor vehicle emissions	Sec. ammonium sulfate/nitrate	Iron, zinc smelter	ammSO4, ammNO3, <b>OC3</b> , EC1	<b>OC4</b> , OC2, <b>OC1</b> ,	Fe, Si, Al, Ca, Zn	V, Se, Pb,	0.85165	24.56
									3.4681	100.0

**Color Key**

- 1. Highest concentration for specific species      Yellow
- 2. 60 – 80% of species      Blue
- 3. >80% of species      Red



**Figure 6.4-20. UNMIX modeled source profiles for Washington DC, fall**

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