

TECHNICAL MEMORANDUM



TO: Jim Homolya / OAQPS
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DATE: July 01, 2003
SUBJECT: Nylon® Filter Extraction Study #2

Executive Summary

More experiments have been performed at the National Air and Radiation Environmental Laboratory (NAREL) to measure the extraction efficiency of ions from Nylon® filters collected for the PM_{2.5} speciation networks. A similar study conducted at NAREL in 2002 used ambient air samples collected during the late fall months of October and November.¹ Although results of the first study demonstrated good extraction efficiencies for filters collected in the late fall, questions were raised concerning the extraction efficiency of samples collected in different seasons. The aerosol composition of ambient air can be different for different seasons and therefore extraction efficiencies may also be different. All of the samples used in this study were collected during the summer months of July and August, with many of the samples obtained from the same locations as the first study. This study determines Nylon® filter extraction efficiencies for summer season samples and compares the results to the extraction efficiencies of Nylon® filters collected in late fall.

Currently most of the Nylon® filters used for collection of PM_{2.5} speciation samples are extracted with deionized water although some laboratories use an aqueous buffer as the extraction solvent. Deionized water is the extraction solvent used when both anions and cations are analyzed from the same filter. Nitrate is known to be the most difficult ion to extract with deionized water because of the affinity of the nitrate for the Nylon® filter. Although a buffer is more efficient in removing anions from a Nylon® filter, it can present problems when used for cations analysis. For example, sodium carbonate/bicarbonate solution interferes with the analysis of sodium and ammonium. This study has examined the two most frequently used extraction methods which are routinely applied to Nylon® filters collected by the Speciation Trends Network (STN) and the Interagency Monitoring of Protected Visual Environments (IMPROVE) network.

The experiments were designed to extract an ambient air filter more than once and measure the amount of analyte recovered by each extraction. Each filter was extracted twice with deionized water, and then each filter was extracted a third time with a carbonate/bicarbonate buffer. Some filters required a fourth extraction, using the buffer, before target ions were no longer observed in the extract. The efficiency of the original extraction was calculated from NAREL's analysis results as follows.

$$\text{efficiency} = \frac{\text{amount of ion from first extraction}}{\text{total amount of ion from all extractions}} \quad \text{Eq. 1}$$

This study utilized seventy-one carefully selected ambient air filters which were originally extracted and analyzed by the prime contractor, Research Triangle Institute (RTI). Filters and original extracts were removed from RTI's refrigerated archive and shipped to NAREL for this study. Samples were selected from fifty-five locations across the nation to include a variety of ambient air compositions. Since nitrate was the analyte of greatest concern, special attention was given to selecting only those samples with a significant level of captured nitrate (greater than twenty micrograms per filter) as revealed by RTI's original sample analysis. Thirty-three samples meeting the selection criteria were from the same sampling locations used in the previous study.

The two extraction methods evaluated in this study shall be referred to as the STN method and the IMPROVE method. The STN method was applied to routine 47-mm filters loaded by a variety of sampler devices located at mostly urban sites. The IMPROVE method was used to extract 37-mm filters loaded by only one type of sampler, the IMPROVE sampler, located at mostly rural sites. All sampling events were in the summer season during July or August of 2002.

Analytical results from this study demonstrate good efficiencies for both extraction methods as shown in Table 1.

Table 1		Summary of Extraction Efficiencies			
Method	Analyte	Mean	Std. Dev.	Range	Pool of Values (n)
STN	nitrate	99%	2%	89-100%	37
STN	sulfate	100%	<1%	99-100%	37
STN	ammonium	100%	<1%	98-100%	37
STN	sodium	98%	-----	-----	1
STN	potassium	99%	-----	-----	1
IMPROVE	nitrate	98%	2%	95-100%	34
IMPROVE	sulfate	99%	<1%	98-100%	34
IMPROVE	chloride	98%	<1%	96-99%	31
IMPROVE	nitrite	-----	-----	-----	0
IMPROVE	ammonium	100%	<1%	100-100%	29
IMPROVE	sodium	98%	2%	94-100%	25
IMPROVE	potassium	99%	<1%	99-100%	12

The lowest recovery of the study was 89% for nitrate observed for the STN sample collected at the Army Reserve Center in Iowa. Overall, ions that were present at a significant level showed excellent extraction efficiencies. The most significant change for this study compared to the previous study is seen in the nitrate efficiency. The overall mean extraction efficiency for nitrate is 98% for this study compared to 92% for the previous study.

History and Background

The IMPROVE network and the STN have been expanded to include approximately three hundred air monitoring stations across the nation. These two networks are similar in design and function although the older IMPROVE network was optimized for visibility issues at rural locations, and the STN was optimized for trend analysis at urban locations. Both networks capture fine particulate matter (PM_{2.5}) from the ambient air which is routinely analyzed for the presence of several ions. IMPROVE samples are normally submitted for the analysis of four anions (chloride, nitrite, nitrate, and sulfate), and recently some IMPROVE samples are also submitted for the analysis of the ammonium ion. STN samples are normally analyzed for two anions (nitrate and sulfate) and three cations (ammonium, potassium, and sodium). All of these ions are captured as deposits onto the surface of a Nylon® membrane filter. During the 24-hour collection event, sampled air must pass through a denuder which should remove acid vapors before the air approaches the Nylon® filter. After the sampling event is complete, the loaded filter must be shipped to the laboratory where it is extracted using an appropriate solvent to dissolve the captured ions. A small volume of the filter extract must be injected into a calibrated Ion Chromatograph (IC) to complete the analysis. The IC instrument provides results expressed as micrograms of ion per milliliter of extract injected. The instrument results may be converted to ambient air concentration using Equation 2.

$$\text{ambient air concentration} = \frac{\mu\text{g}}{\text{mL}} \times \frac{\text{volume of filter extract}}{\text{volume of air sampled}} \quad \text{Eq. 2}$$

Two separate IC instruments are required to determine the anions and the cations. One instrument is optimized for the analysis of anions, and the other IC is optimized for analysis of cations.

There are four critical steps in the overall analytical method for determining ions present in the ambient air: (1) capturing the sample, (2) preserving the sample, (3) extracting the sample, and (4) analyzing the extract. This study has examined the extraction methods which are currently used for STN and IMPROVE samples.

There are at least three approaches to testing an extraction method.

1. Extract each ambient air filter more than once and measure the amount of analyte recovered from each extraction.
2. Collect ambient air filter replicates and extract each replicate using a different method to compare the efficiency of each method.
3. Cut the ambient air filter into equal pieces and extract each piece using a different method to compare the efficiency of each method. This approach assumes a homogeneous filter deposit.

This study utilized approach #1. This study assumes that multiple extractions of the same filter will eventually recover all of the target ions so that accurate efficiencies may be calculated with Equation 1 which appears earlier in this report.

RTI has within their refrigerated archive many STN and IMPROVE ambient air samples which have already been analyzed for selected anions and cations. Each filter has been stored in the original 50-mL extraction tube along with remaining extract. Thirty-seven STN samples and thirty-four IMPROVE samples were taken from the archive which satisfy the following conditions:

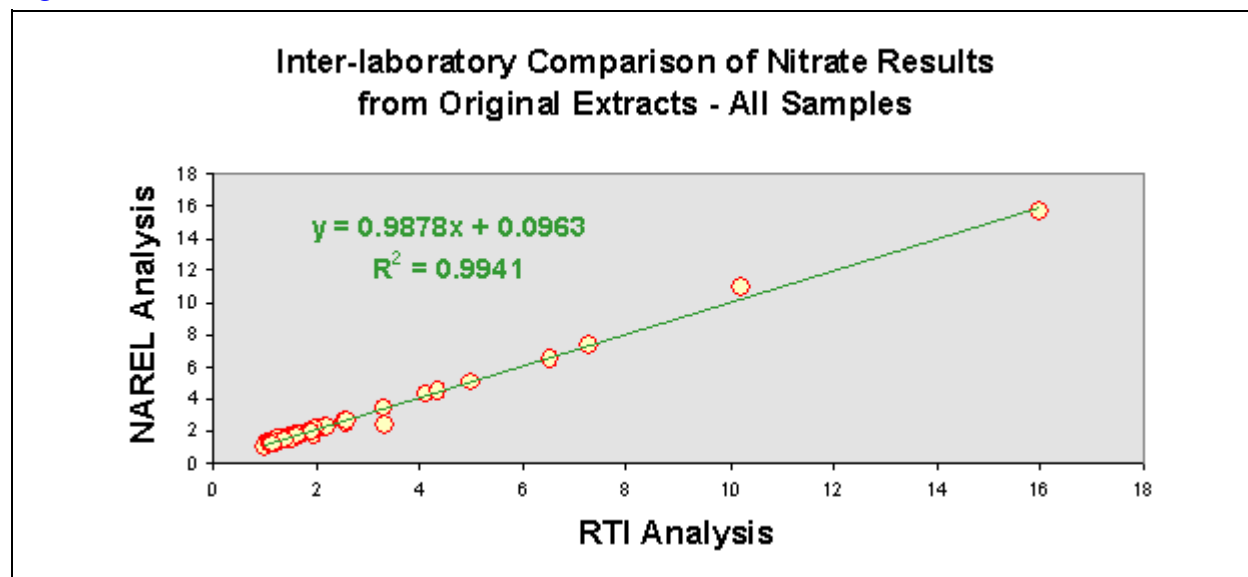
- Nitrate level was reported at 20 micrograms per filter or higher.
- No flags were assigned to the ion analysis during data validation at RTI which might compromise the integrity of this study.
- Samples were taken from several locations that included California, middle America, and the east coast.
- All filters had collected ambient air during the summer season.

Efforts were made to obtain samples from locations that matched the locations of the previous study. A total of thirty-three samples were available that matched sampling locations of the previous study.

Experimental

All of the filters and original extracts were removed from RTI's refrigerated archive and shipped to NAREL in a cooler by express mail. Extracts were immediately re-analyzed at NAREL, and good inter-laboratory agreement was observed for all ions. The nitrate results from both laboratories are presented in Figure 1.

Figure 1



The instrumentation and the analytical method used at NAREL^{2,3} for this study were essentially the same as those used at the RTI.^{4,5} The novelty was extracting each filter more than once. The second extraction began by carefully removing each filter from the original extraction tube and placing it into a new clean extraction tube. Care was taken to transfer a minimum of the original extract into the second tube.

A crude experiment was performed to estimate the percentage of ion crossover of the original extract to the second extraction tube. A clean Nylon® filter was placed into an extraction tube with twenty five mL of deionized water spiked with anion and cation standards. The filter was extracted following the standard STN procedure. The filter was removed from the extraction tube and placed into a second tube, taking care to transfer a minimum of liquid. The filter was extracted a second time in deionized water. The first and second extracts were analyzed for ions and the percent crossover was estimated. Results of the crossover experiment are presented in table 2.

Table 2		% Crossover		
Analyte	Spike Concentration (µg/mL)	1 st Extraction (µg/mL)	2 nd Extraction (µg/mL)	% Crossover
Nitrate	200	198	1.48	0.74%
Sulfate	200	200	0.949	0.47%
Sodium	74	75	0.349	0.47%
Potassium	163	164	0.772	0.47%

Results of this experiment indicate that nitrate has the greatest crossover, possibly due to the affinity of nitrate to the Nylon® filter.

The second extraction of each filter was performed using the same procedure that RTI used for the original extraction. The method for STN samples and for IMPROVE samples are slightly different as described here.

For STN samples, a 25-mL aliquot of deionized water was added to each tube to cover the 47-mm filter, and the tubes were placed into an ultrasonic bath for 60 minutes. Ice was added to the bath as needed to prevent the temperature from exceeding 27 °C. After the sonication period was complete, the tubes were moved into a cold room maintained at 4 °C and placed on a horizontal shaker table set to run overnight at 60 cycle per minute. Extracts were ready for analysis of anions and cations the following day.

For IMPROVE samples, a 20-mL aliquot of deionized water was added to each tube to cover the 37-mm filter, and the tubes were placed into an ultrasonic bath for 30 minutes. Ice was added to the bath as needed to prevent the temperature from exceeding 27 °C. After the sonication period was complete, the tubes were allowed to stand at room temperature overnight. Extracts were ready for analysis of anions and cations the following day.

A third extraction of each filter was performed exactly as described for the second extraction with one exception: a buffer composed of 0.3 mM sodium bicarbonate / 2.7 mM sodium carbonate was used as the extraction solvent instead of deionized water. The carbonate buffer has a pH of approximately 10. Because of the extremely high level of sodium ion present in the buffer, the third and fourth extracts were analyzed for anions only. The extreme level of sodium in the buffer obviously prohibits a useful analysis of sodium in the sample, but the buffer also produced chromatographic interference for the ammonium ion.

A small number of STN filters were extracted a fourth time exactly as described for the third extraction. A fourth extraction was not performed for the IMPROVE samples because none of the third extracts contained a significant level of the target ions.

Results for all of the analyses are presented in Table 3 through Table 9 at the end of this report. Within each table, the STN samples are listed first, and the IMPROVE samples are listed together at the end of the table. Samples are also listed in order of decreasing nitrate capture. The nitrate extraction efficiencies were calculated for all seventy-one samples. The extraction efficiency was also calculated for other ions if the concentration present in the sample was sufficiently high. Efficiencies were not calculated for those ions present in the original extract at a concentration lower than 0.5 µg/mL, as reflected by the “low capture” message which does appear in some of the data tables. The lowest calibration standard routinely analyzed at NAREL offers an ion concentration of 0.04 µg/mL, and this concentration is considered the lowest limit for accurate quantification. Lower concentration values have not been censured and are presented in Table 3 through Table 9 since they were above the instrument detection limit.

Some efficiencies have been plotted for easy viewing. The nitrate, sulfate, and ammonium efficiencies observed from the STN samples are plotted in Figure 2. The nitrate, sulfate, chloride, and ammonium efficiencies observed from IMPROVE samples are plotted in Figure 3. Within Figure 2 and Figure 3, the samples are plotted from left to right in order of decreasing nitrate capture.

Figure 2

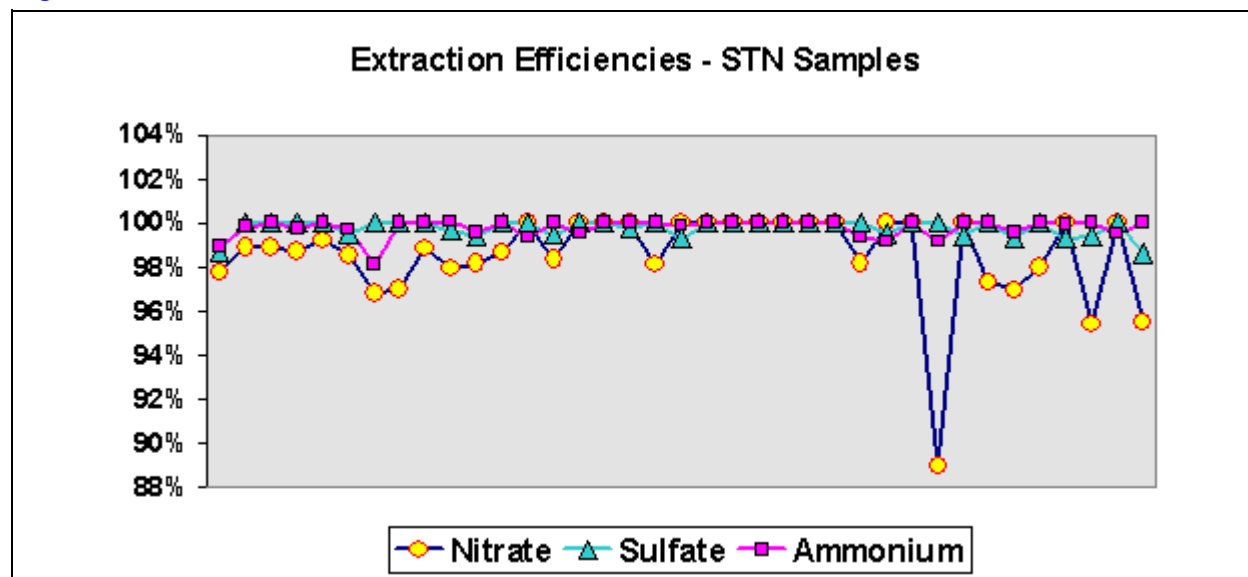
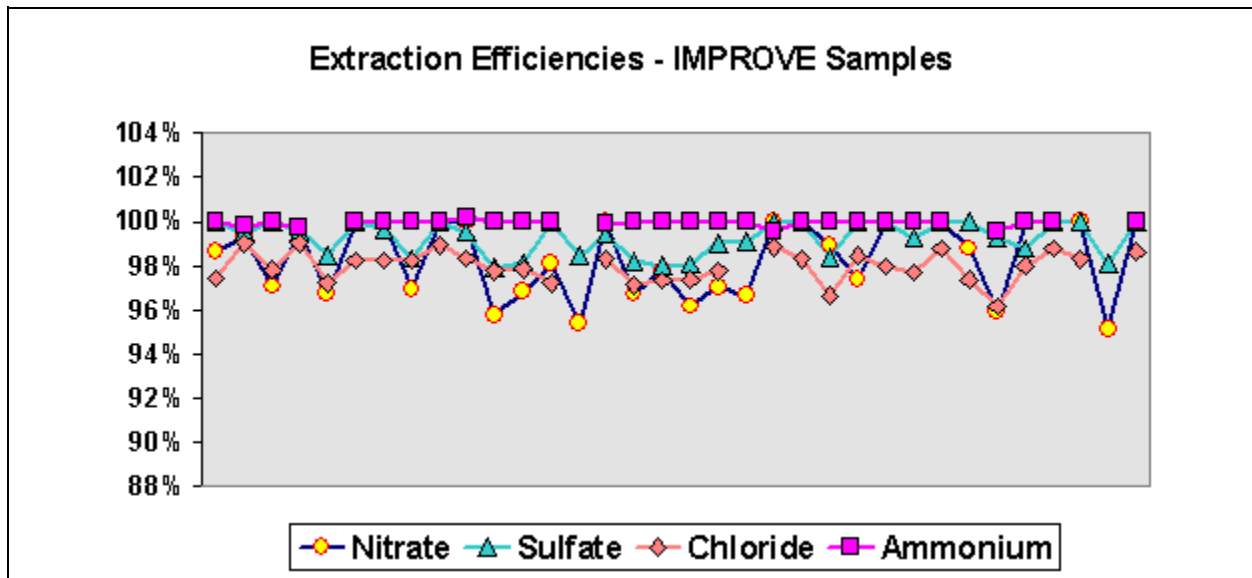
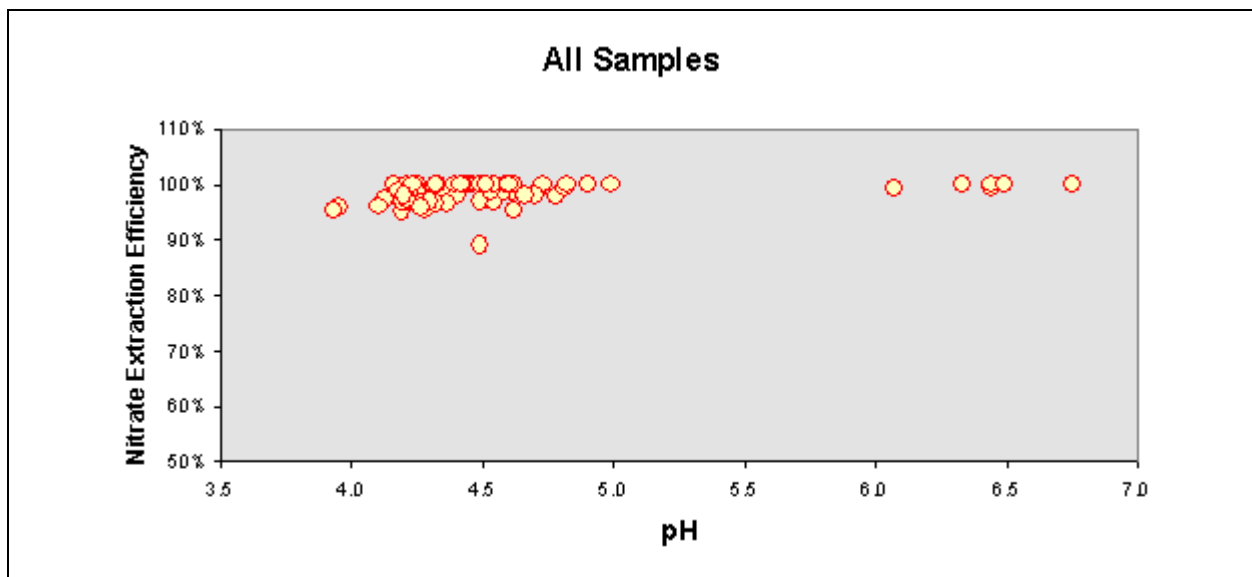


Figure 3



A suggestion was made to measure the pH of the original [first] extracts. In response to this suggestion, a 3-mL aliquot of each original extract was used to properly submerge the electrodes of the pH meter. The values of pH so determined are displayed as a scatter plot in Figure 4 and are also included in the tables at the end of this report. No significant correlation was observed between pH and extraction efficiency.

Figure 4



Conclusions

Results of this study of summer season samples have shown that good extraction efficiencies can be obtained using deionized water as the extraction solvent. No significant difference was found between the STN and IMPROVE methods of extraction. Extraction efficiencies produced by this summer season study are comparable to the efficiencies found in the previous study of samples collected during the late fall season. Nitrate extraction efficiency showed the largest change from the previous study. The overall mean extraction efficiency for nitrate improved from 92% to 98%. Ideally, all samples for this study would have come from the same sampling locations used in the previous study. Thirty-three archived samples were available that met selection criteria and that were from locations that matched those used in the previous study. Figures 5 and 6 present a comparison summary of mean extraction efficiencies and mean ion concentrations for the thirty-three site pairs.

Figure 5

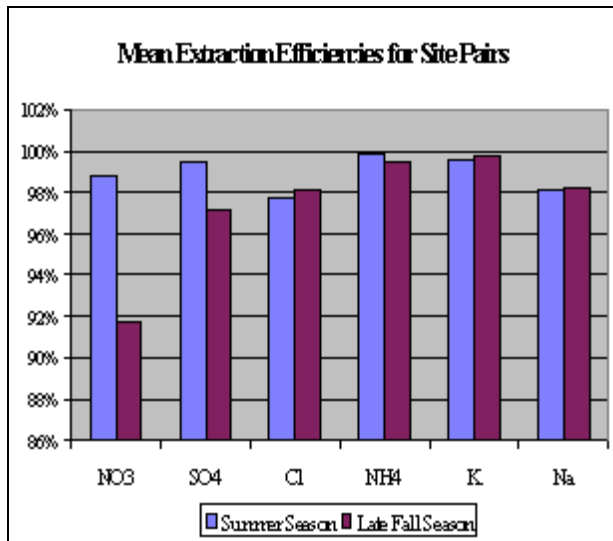
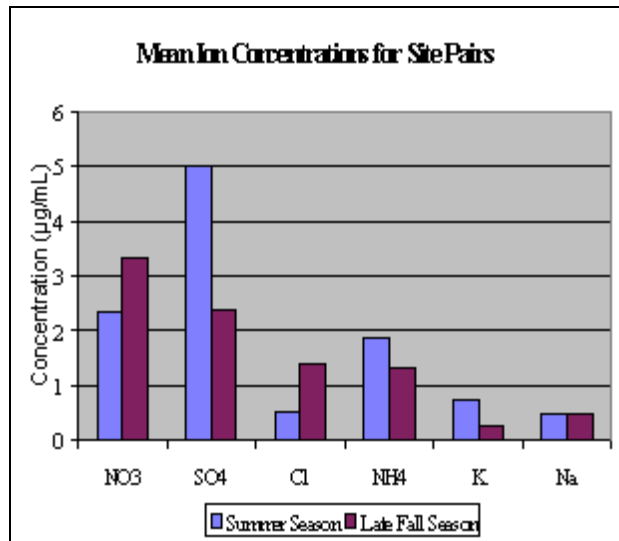


Figure 6



The values displayed in Figure 6 are results from NAREL's re-analysis of the original archived extracts. Table 10 through table 15 contain the site-pair data.

This study utilized actual routine samples which were collected onto a Nylon® filter positioned downstream of a denuder designed to remove acid vapors. Nylon® filters which are loaded without using an effective denuder may be more difficult to extract.

References

1. EPA/NAREL 2002. Technical Memorandum: “Nylon® Filter Extraction Study”. U.S. Environmental Protection Agency. National Air and Radiation Environmental Laboratory, Montgomery, AL.
2. EPA/NAREL. 2000. “Standard Operating Procedure - Anion Analysis for the PM_{2.5} Chemical Speciation QA Program”. U.S. Environmental Protection Agency. National Air and Radiation Environmental Laboratory, Montgomery, AL.
3. EPA/NAREL. 2000. “Standard Operating Procedure - Cation Analysis for the PM_{2.5} Chemical Speciation QA Program”. U.S. Environmental Protection Agency. National Air and Radiation Environmental Laboratory, Montgomery, AL.
4. RTI. 2002. “Standard Operating Procedure for PM_{2.5} Anion Analysis”. Research Triangle Institute, Research Triangle Park, NC.
5. RTI. 2002. “Standard Operating Procedure for PM_{2.5} Cation Analysis”. Research Triangle Institute, Research Triangle Park, NC.
6. EPA/NAREL 2001. Technical Memorandum: “PM_{2.5} Speciation Trends Network Special Study”. U.S. Environmental Protection Agency. National Air and Radiation Environmental Laboratory, Montgomery, AL.

Table 3

Location Name	State	Sampler	Sample Id	pH of Original Extract	Nitrate Concentration (µg/mL)					Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	Third Extraction (Buffer)	Fourth Extraction (Buffer)	
Riverside-Rubidoux	CA	SASS	A193863S	4.78	10.227	10.894	0.253	not detected	-----	98%
Riverside-Rubidoux	CA	SASS	A174934K	4.52	7.281	7.345	0.083	not detected	-----	99%
Riverside-Rubidoux	CA	SASS	A185503A	4.32	4.125	4.304	0.046	not detected	-----	99%
North Los Angeles	CA	SASS	A1655223	4.61	3.315	3.482	0.044	not detected	-----	99%
Riverside-Rubidoux	CA	SASS	A178142C	4.81	2.185	2.286	0.018	not detected	-----	99%
IS 52	NY	RPSPEC	A178253I	4.71	1.957	2.050	0.030	not detected	-----	99%
Simi Valley	CA	SASS	A146019N	4.54	1.935	2.043	0.067	not detected	-----	97%
Springfield Pumping Station	IL	RAAS	A1458233	4.49	1.855	1.928	0.059	not detected	-----	97%
Riverside-Rubidoux	CA	SASS	A189471Z	4.58	1.695	1.715	0.020	not detected	-----	99%
Manitowoc, Woodland Dunes site	WI	SASS	A185952V	4.35	1.683	1.738	0.036	not detected	-----	98%
Camden	NJ	SASS	A188429T	4.28	1.608	1.799	0.034	not detected	-----	98%
Luna Pier	MI	SASS	A193550E	4.53	1.588	1.604	0.022	not detected	-----	99%
El Cajon	CA	SASS	A175881S	4.59	1.492	1.666	not detected	not detected	-----	100%
Jefferson Elementary (10th and Vine)	IA	RPSPEC	A1854219	4.29	1.363	1.481	0.024	not detected	-----	98%
Head Start	OH	SASS	A176603C	4.54	1.310	1.349	not detected	not detected	-----	100%
Mayville Hubbard Township site	WI	SASS	A186409H	4.46	1.307	1.394	not detected	not detected	-----	100%
Queens College	NY	RPSPEC	A1894833	4.44	1.302	1.408	not detected	not detected	-----	100%
Simi Valley	CA	SASS	A186093H	4.40	1.297	1.408	0.027	not detected	-----	98%
Blair Street	MO	RAAS	A187171I	4.55	1.267	1.411	not detected	not detected	-----	100%
Bakersfield-California Ave (Collocated)	CA	SASS	A182681F	4.60	1.230	1.353	not detected	not detected	-----	100%
Washington Park	IN	SASS	A1853012	4.62	1.212	1.239	not detected	not detected	-----	100%
Harrisburg	PA	SASS	A174546C	4.43	1.206	1.245	not detected	not detected	-----	100%
Fresno - First Street	CA	SASS	A185486Q	4.54	1.199	1.315	not detected	not detected	-----	100%
Bakersfield-California Ave	CA	SASS	A1811996	4.73	1.183	1.292	not detected	not detected	-----	100%
SER-DNR Headquarters	WI	SASS	A1976574	4.60	1.183	1.222	not detected	not detected	-----	100%
Dearborn	MI	SASS	A189552Z	4.70	1.154	1.259	0.024	not detected	-----	98%
NY Botanical Gardens	NY	SASS	A186564R	4.90	1.138	1.209	not detected	not detected	-----	100%

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					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	Third Extraction (Buffer)	Fourth Extraction (Buffer)	
Bakersfield-California Ave	CA	SASS	A187449T	4.49	1.114	1.316	not detected	not detected	-----	100%
Army Reserve Center	IA	RPSPEC	A187310B	4.49	1.111	1.188	0.068	0.053	0.026	89%
New Garden	PA	SASS	A174690J	4.49	1.071	1.182	not detected	not detected	-----	100%
Shenandoah High School	IN	SASS	A175281A	4.13	1.059	1.142	0.031	not detected	-----	97%
PHILA - AMS Laboratory	PA	SASS	A185903M	4.22	1.054	1.149	0.036	not detected	-----	97%
Bakersfield-California Ave (Collocated)	CA	SASS	A1935106	4.66	1.053	1.221	0.025	not detected	-----	98%
Allen Park	MI	SASS	A1822493	4.43	1.041	1.147	not detected	not detected	-----	100%
Wilbur Wright Middle School	OH	SASS	A1754225	4.28	1.024	1.133	0.055	not detected	-----	95%
G.T. Craig	OH	SASS	A188525S	4.99	1.015	1.090	not detected	not detected	-----	100%
Maple Canyon	OH	SASS	A189066Q	4.62	1.010	1.041	0.049	not detected	-----	95%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10709	4.22	16.008	15.632	0.214	not detected	-----	99%
[BOND1] Bondville	IL	IMPROVE	N03-10710	6.07	6.527	6.443	0.041	not detected	-----	99%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10711	4.30	4.998	5.007	0.150	not detected	-----	97%
[GRRI1] Great River Bluffs	WI	IMPROVE	N03-10712	6.44	4.355	4.437	0.023	not detected	-----	99%
[CRES1] Crescent Lake	NE	IMPROVE	N03-10713	6.75	3.350	2.314	not detected	not detected	-----	100%
[SAGA1] San Gabriel	CA	IMPROVE	N03-10714	4.23	2.592	2.598	not detected	not detected	-----	100%
[PINN1] Pinnacles, Ventana	CA	IMPROVE	N03-10715	4.25	2.569	2.587	not detected	not detected	-----	100%
[RAFA1] San Rafael	CA	IMPROVE	N03-10716	4.27	2.566	2.536	0.080	not detected	-----	97%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10717	4.21	2.540	2.625	0.089	not detected	-----	97%
[PUSO1] Puget Sound	WA	IMPROVE	N03-10718	4.39	2.218	2.274	not detected	not detected	-----	100%
[BLMO1] Blue Mounds	IA	IMPROVE	N03-10720	4.19	2.012	2.071	0.068	not detected	-----	97%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10721	4.26	1.964	2.088	0.092	not detected	-----	96%
[PORE1] Point Reyes National Seashore	CA	IMPROVE	N03-10722	4.19	1.943	1.734	0.053	not detected	-----	97%
[DENA1] Denali National Park	AK	IMPROVE	N03-10723	4.20	1.921	1.976	0.039	not detected	-----	98%
[MKGO1] M.K. Goddard	PA	IMPROVE	N03-10724	3.93	1.821	1.952	0.095	not detected	-----	95%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10725	4.32	1.664	1.774	0.061	not detected	-----	97%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10726	4.28	1.653	1.765	0.040	not detected	-----	98%

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Location Name	State	Sampler	Sample Id	pH of Original Extract	Nitrate Concentration (µg/mL)					Efficiency of Original Extraction
					Original Extract at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	Third Extraction (Buffer)	Fourth Extraction (Buffer)	
[CABA1] Casco Bay	ME	IMPROVE	N03-10727	4.10	1.642	1.737	0.070	not detected	-----	96%
[JOSH1] Joshua Tree	CA	IMPROVE	N03-10728	4.32	1.639	1.677	not detected	not detected	-----	100%
[VILA1] Viking Lake	IA	IMPROVE	N03-10729	4.51	1.601	1.782	not detected	not detected	-----	100%
[WASH1] Washington DC	---	IMPROVE	N03-10730	4.36	1.548	1.707	0.060	not detected	-----	97%
[THRO1] Theodore Roosevelt	ND	IMPROVE	N03-10731	4.33	1.543	1.591	not detected	not detected	-----	100%
[REDW1] Redwood National Park	CA	IMPROVE	N03-10732	4.21	1.543	1.554	0.042	not detected	-----	97%
[PHOE1] Phoenix	AZ	IMPROVE	N03-10733	4.42	1.490	1.538	not detected	not detected	-----	100%
[NEBR1] Nebraska National Forest	NE	IMPROVE	N03-10734	6.33	1.451	1.510	not detected	not detected	-----	100%
[LIVO1] Livonia	IN	IMPROVE	N03-10735	4.21	1.427	1.528	not detected	not detected	not detected	100%
[SNPA1] Snoqualamie Pass, N.F.	WA	IMPROVE	N03-10736	4.25	1.426	1.509	not detected	0.018	not detected	99%
[THBA1] Thunder Basin	WY	IMPROVE	N03-10737	6.44	1.381	1.400	not detected	not detected	-----	100%
[LIVO1] Livonia	IN	IMPROVE	N03-10738	3.95	1.305	1.461	0.048	not detected	0.014	96%
[AREN1] Arendtsville	PA	IMPROVE	N03-10739	4.16	1.283	1.422	not detected	not detected	-----	100%
[AREN1] Arendtsville	PA	IMPROVE	N03-10740	4.18	1.272	1.580	not detected	0.017	not detected	99%
[COGO1] Columbia Gorge	WA	IMPROVE	N03-10741	4.82	1.258	1.379	not detected	not detected	-----	100%
[THBA1] Thunder Basin	WY	IMPROVE	N03-10742	6.49	1.155	1.143	not detected	not detected	-----	100%
[WASH1] Washington DC	---	IMPROVE	N03-10743	4.19	1.115	1.218	0.063	not detected	-----	95%
			Mean	4.58	2.16	2.23	0.06	0.03	0.02	98%
			Max	6.75	16.008	15.632	0.253	0.053	0.026	100%
			Min	3.93	1.010	1.041	0.018	0.017	0.014	89%
			n	71	71	71	39	3	2	71

Table 4

Location Name	State	Sampler	Sample Id	pH of Original Extract	Sulfate Concentration (µg/mL)					Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	Third Extraction (Buffer)	Fourth Extraction (Buffer)	
Riverside-Rubidoux	CA	SASS	A193863S	4.78	1.833	1.918	0.026	not detected	-----	99%
Riverside-Rubidoux	CA	SASS	A174934K	4.52	3.019	2.997	not detected	not detected	-----	100%
Riverside-Rubidoux	CA	SASS	A185503A	4.32	1.762	1.730	not detected	not detected	-----	100%
North Los Angeles	CA	SASS	A1655223	4.61	3.232	3.243	not detected	not detected	-----	100%
Riverside-Rubidoux	CA	SASS	A178142C	4.81	1.196	1.261	not detected	not detected	-----	100%
IS 52	NY	RPSPEC	A178253I	4.71	8.749	8.639	0.040	not detected	-----	100%
Simi Valley	CA	SASS	A146019N	4.54	1.596	1.590	not detected	not detected	-----	100%
Springfield Pumping Station	IL	RAAS	A1458233	4.49	3.491	3.376	not detected	not detected	-----	100%
Riverside-Rubidoux	CA	SASS	A189471Z	4.58	1.396	1.350	not detected	not detected	-----	100%
Manitowoc, Woodland Dunes site	WI	SASS	A185952V	4.35	3.564	3.462	0.012	not detected	-----	100%
Camden	NJ	SASS	A188429T	4.28	12.230	12.496	0.078	not detected	-----	99%
Luna Pier	MI	SASS	A193550E	4.53	2.058	1.994	not detected	not detected	-----	100%
El Cajon	CA	SASS	A175881S	4.59	1.715	1.740	not detected	not detected	-----	100%
Jefferson Elementary (10th and Vine)	IA	RPSPEC	A1854219	4.29	3.654	3.629	0.020	not detected	-----	99%
Head Start	OH	SASS	A176603C	4.54	5.916	5.729	not detected	not detected	-----	100%
Mayville Hubbard Township site	WI	SASS	A186409H	4.46	2.204	2.234	not detected	not detected	-----	100%
Queens College	NY	RPSPEC	A1894833	4.44	9.416	9.122	0.019	not detected	-----	100%
Simi Valley	CA	SASS	A186093H	4.40	2.086	2.084	not detected	not detected	-----	100%
Blair Street	MO	RAAS	A187171I	4.55	7.755	7.834	0.057	not detected	-----	99%
Bakersfield-California Ave (Collocated)	CA	SASS	A182681F	4.60	1.264	1.327	not detected	not detected	-----	100%
Washington Park	IN	SASS	A1853012	4.62	1.919	1.889	not detected	not detected	-----	100%
Harrisburg	PA	SASS	A174546C	4.43	1.530	1.453	not detected	not detected	-----	100%
Fresno - First Street	CA	SASS	A185486Q	4.54	1.177	1.176	not detected	not detected	-----	100%
Bakersfield-California Ave	CA	SASS	A1811996	4.73	1.161	1.193	not detected	not detected	-----	100%
SER-DNR Headquarters	WI	SASS	A1976574	4.60	2.378	2.332	not detected	not detected	-----	100%
Dearborn	MI	SASS	A189552Z	4.70	2.955	3.015	not detected	not detected	-----	100%
NY Botanical Gardens	NY	SASS	A186564R	4.90	5.621	5.482	0.026	not detected	-----	100%

Table 4

Location Name	State	Sampler	Sample Id	pH of Original Extract	Sulfate Concentration (µg/mL)					Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	Third Extraction (Buffer)	Fourth Extraction (Buffer)	
Bakersfield-California Ave	CA	SASS	A187449T	4.49	0.852	0.964	not detected	not detected	-----	100%
Army Reserve Center	IA	RPSPEC	A187310B	4.49	5.622	5.327	not detected	not detected	not detected	100%
New Garden	PA	SASS	A174690J	4.49	2.611	2.732	0.017	not detected	-----	99%
Shenandoah High School	IN	SASS	A175281A	4.13	4.820	4.523	not detected	not detected	-----	100%
PHILA - AMS Laboratory	PA	SASS	A185903M	4.22	11.819	11.381	0.076	not detected	-----	99%
Bakersfield-California Ave (Collocated)	CA	SASS	A1935106	4.66	0.809	0.882	not detected	not detected	-----	100%
Allen Park	MI	SASS	A1822493	4.43	4.077	4.076	0.029	not detected	-----	99%
Wilbur Wright Middle School	OH	SASS	A1754225	4.28	4.832	4.770	0.028	not detected	-----	99%
G.T. Craig	OH	SASS	A188525S	4.99	2.943	2.937	not detected	not detected	-----	100%
Maple Canyon	OH	SASS	A189066Q	4.62	1.718	1.724	0.024	not detected	-----	99%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10709	4.22	2.755	2.646	not detected	not detected	-----	100%
[BOND1] Bondville	IL	IMPROVE	N03-10710	6.07	16.876	15.928	0.079	not detected	-----	100%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10711	4.30	1.296	1.236	not detected	not detected	-----	100%
[GRR1] Great River Bluffs	WI	IMPROVE	N03-10712	6.44	9.586	9.350	0.042	not detected	-----	100%
[CRES1] Crescent Lake	NE	IMPROVE	N03-10713	6.75	2.493	2.180	not detected	not detected	-----	100%
[SAGA1] San Gabriel	CA	IMPROVE	N03-10714	4.23	1.864	1.798	not detected	not detected	-----	100%
[PINN1] Pinnacles, Ventana	CA	IMPROVE	N03-10715	4.25	4.143	3.923	0.013	not detected	-----	100%
[RAFA1] San Rafael	CA	IMPROVE	N03-10716	4.27	2.347	2.280	0.039	not detected	-----	98%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10717	4.21	7.618	7.315	0.113	not detected	-----	98%
[PUSO1] Puget Sound	WA	IMPROVE	N03-10718	4.39	3.922	3.846	0.020	not detected	-----	99%
[BLMO1] Blue Mounds	IA	IMPROVE	N03-10720	4.19	7.555	7.277	0.136	not detected	-----	98%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10721	4.26	1.264	1.260	0.027	not detected	-----	98%
[PORE1] Point Reyes National Seashore	CA	IMPROVE	N03-10722	4.19	6.150	5.611	0.055	not detected	-----	99%
[DENA1] Denali National Park	AK	IMPROVE	N03-10723	4.20	0.708	0.672	not detected	not detected	-----	100%
[MKGO1] M.K. Goddard	PA	IMPROVE	N03-10724	3.93	17.845	16.937	0.269	not detected	-----	98%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10725	4.32	2.317	2.281	0.042	not detected	-----	98%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10726	4.28	3.379	3.314	0.067	not detected	-----	98%

Table 4

Location Name	State	Sampler	Sample Id	pH of Original Extract	Sulfate Concentration (µg/mL)					Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	Third Extraction (Buffer)	Fourth Extraction (Buffer)	
[CABA1] Casco Bay	ME	IMPROVE	N03-10727	4.10	4.976	4.766	0.094	not detected	-----	98%
[JOSH1] Joshua Tree	CA	IMPROVE	N03-10728	4.32	1.713	1.682	not detected	not detected	-----	100%
[VILA1] Viking Lake	IA	IMPROVE	N03-10729	4.51	10.497	10.679	0.065	not detected	-----	99%
[WASH1] Washington DC	---	IMPROVE	N03-10730	4.36	16.643	16.066	0.151	not detected	-----	99%
[THRO1] Theodore Roosevelt	ND	IMPROVE	N03-10731	4.33	3.998	3.860	not detected	not detected	-----	100%
[REDW1] Redwood National Park	CA	IMPROVE	N03-10732	4.21	1.985	1.862	not detected	not detected	-----	100%
[PHOE1] Phoenix	AZ	IMPROVE	N03-10733	4.42	3.683	3.589	not detected	not detected	-----	100%
[NEBR1] Nebraska National Forest	NE	IMPROVE	N03-10734	6.33	2.400	2.278	not detected	not detected	-----	100%
[LIVO1] Livonia	IN	IMPROVE	N03-10735	4.21	8.178	7.878	0.056	not detected	not detected	99%
[SNPA1] Snoqualamie Pass, N.F.	WA	IMPROVE	N03-10736	4.25	2.809	2.789	not detected	not detected	not detected	100%
[THBA1] Thunder Basin	WY	IMPROVE	N03-10737	6.44	1.479	1.505	not detected	not detected	-----	100%
[LIVO1] Livonia	IN	IMPROVE	N03-10738	3.95	18.377	17.557	0.141	not detected	not detected	99%
[AREN1] Arendtsville	PA	IMPROVE	N03-10739	4.16	11.617	11.123	0.136	not detected	-----	99%
[AREN1] Arendtsville	PA	IMPROVE	N03-10740	4.18	7.012	6.769	0.110	not detected	not detected	98%
[COGO1] Columbia Gorge	WA	IMPROVE	N03-10741	4.82	2.299	2.339	not detected	not detected	-----	100%
[THBA1] Thunder Basin	WY	IMPROVE	N03-10742	6.49	1.419	1.401	not detected	not detected	-----	100%
[WASH1] Washington DC	---	IMPROVE	N03-10743	4.19	10.763	10.311	0.201	not detected	-----	98%
			Mean	4.58	4.75	4.62	0.07	-----	-----	100%
			Max	6.75	18.377	17.557	0.269	0.000	0.000	100%
			Min	3.93	0.708	0.672	0.012	0.000	0.000	98%
			n	71	71	71	33	0	0	71

Table 5

Location Name	State	Sampler	Sample Id	pH of Original Extract	Original Extract Analyzed at RTI	Chloride Concentration ($\mu\text{g/mL}$)				Efficiency of Original Extraction
						Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	Third Extraction (Buffer)	Fourth Extraction (Buffer)	
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10709	4.22	0.755	0.766	0.016	0.004	-----	97%
[BOND1] Bondville	IL	IMPROVE	N03-10710	6.07	1.426	1.338	0.013	not	-----	99%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10711	4.30	0.763	0.763	0.014	0.003	-----	98%
[GRR11] Great River Bluffs	WI	IMPROVE	N03-10712	6.44	1.112	1.087	0.011	not	-----	99%
[CRES1] Crescent Lake	NE	IMPROVE	N03-10713	6.75	1.185	1.111	0.012	not	-----	99%
[SAGA1] San Gabriel	CA	IMPROVE	N03-10714	4.23	0.738	0.750	0.009	0.004	-----	98%
[PINN1] Pinnacles, Ventana	CA	IMPROVE	N03-10715	4.25	1.433	1.417	0.021	0.005	-----	98%
[RAFA1] San Rafael	CA	IMPROVE	N03-10716	4.27	1.649	1.673	0.025	0.005	-----	98%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10717	4.21	0.703	0.715	0.015	0.006	-----	97%
[PUSO1] Puget Sound	WA	IMPROVE	N03-10718	4.39	1.257	1.253	0.017	0.004	-----	98%
[BLMO1] Blue Mounds	IA	IMPROVE	N03-10720	4.19	0.838	0.815	0.018	not	-----	98%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10721	4.26	0.830	0.848	0.016	0.003	-----	98%
[PORE1] Point Reyes National	CA	IMPROVE	N03-10722	4.19	0.985	0.857	0.015	0.004	-----	98%
[DENA1] Denali National Park	AK	IMPROVE	N03-10723	4.20	0.980	0.952	0.018	0.009	-----	97%
[MKGO1] M.K. Goddard	PA	IMPROVE	N03-10724	3.93	0.379	0.377	0.012	0.013	-----	low capture
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10725	4.32	0.682	0.841	0.021	0.004	-----	97%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10726	4.28	0.773	0.791	0.016	0.006	-----	97%
[CABA1] Casco Bay	ME	IMPROVE	N03-10727	4.10	0.934	0.928	0.020	0.005	-----	97%
[JOSH1] Joshua Tree	CA	IMPROVE	N03-10728	4.32	0.869	0.871	0.010	not	-----	99%
[VILA1] Viking Lake	IA	IMPROVE	N03-10729	4.51	1.325	1.352	0.017	0.007	-----	98%
[WASH1] Washington DC	---	IMPROVE	N03-10730	4.36	0.503	0.490	0.009	0.008	-----	low capture
[THRO1] Theodore Roosevelt	ND	IMPROVE	N03-10731	4.33	0.886	0.880	0.010	0.005	-----	98%
[REDW1] Redwood National Park	CA	IMPROVE	N03-10732	4.21	2.396	2.335	0.031	0.006	-----	98%
[PHOE1] Phoenix	AZ	IMPROVE	N03-10733	4.42	1.205	1.211	0.021	0.004	-----	98%
[NEBR1] Nebraska National Forest	NE	IMPROVE	N03-10734	6.33	1.183	1.164	0.010	0.005	-----	99%
[LIVO1] Livonia	IN	IMPROVE	N03-10735	4.21	0.709	0.719	0.011	0.006	not	98%

Table 5

Location Name	State	Sampler	Sample Id	pH of Original Extract	Original Extract Analyzed at RTI	Chloride Concentration (µg/mL)				Efficiency of Original Extraction
						Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	Third Extraction (Buffer)	Fourth Extraction (Buffer)	
[SNPA1] Snoqualamie Pass, N.F.	WA	IMPROVE	N03-10736	4.25	1.038	1.032	0.013	0.008	0.006	97%
[THBA1] Thunder Basin	WY	IMPROVE	N03-10737	6.44	1.792	1.756	0.014	0.007	-----	99%
[LIVO1] Livonia	IN	IMPROVE	N03-10738	3.95	0.511	0.506	0.007	0.006	0.007	96%
[AREN1] Arendtsville	PA	IMPROVE	N03-10739	4.16	1.328	1.310	0.023	0.004	-----	98%
[AREN1] Arendtsville	PA	IMPROVE	N03-10740	4.18	0.629	0.649	0.016	not	0.007	97%
[COGO1] Columbia Gorge	WA	IMPROVE	N03-10741	4.82	1.256	1.262	0.015	0.007	-----	98%
[THBA1] Thunder Basin	WY	IMPROVE	N03-10742	6.49	1.612	1.583	0.014	0.008	-----	99%
[WASH1] Washington DC	---	IMPROVE	N03-10743	4.19	0.512	0.497	0.013	0.007	-----	low capture
			Mean	4.64	1.035	1.026	0.015	0.006	0.007	98%
			Max	6.75	2.396	2.335	0.031	0.013	0.007	99%
			Min	3.93	0.379	0.377	0.007	0.003	0.006	96%
			n	34	34	34	34	28	3	31

Table 6

Location Name	State	Sampler	Sample Id	pH of Original Extract	Original Extract Analyzed at RTI	Nitrite Concentration (µg/mL)				Efficiency of Original Extraction
						Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	Third Extraction (Buffer)	Fourth Extraction (Buffer)	
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10709	4.22	0.033	not detected	0.028	not detected	-----	low capture
[BOND1] Bondville	IL	IMPROVE	N03-10710	6.07	0.098	0.064	not detected	not detected	-----	low capture
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10711	4.30	0.032	not detected	not detected	0.015	-----	low capture
[GRRI1] Great River Bluffs	WI	IMPROVE	N03-10712	6.44	0.420	0.351	not detected	not detected	-----	low capture
[CRES1] Crescent Lake	NE	IMPROVE	N03-10713	6.75	0.195	0.052	not detected	0.031	-----	low capture
[SAGA1] San Gabriel	CA	IMPROVE	N03-10714	4.23	0.033	not detected	not detected	0.040	-----	low capture
[PINN1] Pinnacles, Ventana	CA	IMPROVE	N03-10715	4.25	0.029	not detected	not detected	not detected	-----	low capture
[RAFA1] San Rafael	CA	IMPROVE	N03-10716	4.27	0.026	not detected	0.020	not detected	-----	low capture
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10717	4.21	0.032	not detected	not detected	not detected	-----	low capture
[PUSO1] Puget Sound	WA	IMPROVE	N03-10718	4.39	0.028	not detected	not detected	not detected	-----	low capture
[BLMO1] Blue Mounds	IA	IMPROVE	N03-10720	4.19	0.031	not detected	not detected	not detected	-----	low capture
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10721	4.26	0.076	not detected	not detected	not detected	-----	low capture
[PORE1] Point Reyes National Seashore	CA	IMPROVE	N03-10722	4.19	0.000	not detected	not detected	not detected	-----	low capture
[DENA1] Denali National Park	AK	IMPROVE	N03-10723	4.20	0.032	0.034	not detected	0.014	-----	low capture
[MKGO1] M.K. Goddard	PA	IMPROVE	N03-10724	3.93	0.065	0.028	not detected	not detected	-----	low capture
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10725	4.32	0.030	not detected	not detected	not detected	-----	low capture
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10726	4.28	0.000	not detected	not detected	not detected	-----	low capture
[CABA1] Casco Bay	ME	IMPROVE	N03-10727	4.10	0.026	not detected	not detected	not detected	-----	low capture
[JOSH1] Joshua Tree	CA	IMPROVE	N03-10728	4.32	0.000	not detected	not detected	0.024	-----	low capture
[VILA1] Viking Lake	IA	IMPROVE	N03-10729	4.51	0.052	not detected	not detected	0.019	-----	low capture
[WASH1] Washington DC	---	IMPROVE	N03-10730	4.36	0.043	0.019	not detected	not detected	-----	low capture
[THRO1] Theodore Roosevelt	ND	IMPROVE	N03-10731	4.33	0.000	not detected	not detected	not detected	-----	low capture
[REDW1] Redwood National Park	CA	IMPROVE	N03-10732	4.21	0.029	not detected	not detected	not detected	-----	low capture
[PHOE1] Phoenix	AZ	IMPROVE	N03-10733	4.42	0.031	not detected	not detected	not detected	-----	low capture
[NEBR1] Nebraska National Forest	NE	IMPROVE	N03-10734	6.33	0.456	0.436	not detected	0.026	-----	low capture
[LIVO1] Livonia	IN	IMPROVE	N03-10735	4.21	0.032	not detected	not detected	0.140	0.014	low capture

Table 6

Location Name	State	Sampler	Sample Id	pH of Original Extract	Original Extract Analyzed at RTI	Nitrite Concentration (µg/mL)				Efficiency of Original Extraction
						Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	Third Extraction (Buffer)	Fourth Extraction (Buffer)	
[SNPA1] Snoqualmie Pass, N.F.	WA	IMPROVE	N03-10736	4.25	0.033	not detected	not detected	0.123	not detected	low capture
[THBA1] Thunder Basin	WY	IMPROVE	N03-10737	6.44	0.221	0.139	not detected	0.024	-----	low capture
[LIVO1] Livonia	IN	IMPROVE	N03-10738	3.95	0.040	0.028	not detected	0.101	0.067	low capture
[AREN1] Arendtsville	PA	IMPROVE	N03-10739	4.16	0.047	not detected	0.018	not detected	-----	low capture
[AREN1] Arendtsville	PA	IMPROVE	N03-10740	4.18	0.264	not detected	not detected	0.034	0.059	low capture
[COGO1] Columbia Gorge	WA	IMPROVE	N03-10741	4.82	0.050	0.019	not detected	not detected	-----	low capture
[THBA1] Thunder Basin	WY	IMPROVE	N03-10742	6.49	0.390	0.244	not detected	0.017	-----	low capture
[WASH1] Washington DC	---	IMPROVE	N03-10743	4.19	0.042	not detected	not detected	not detected	-----	low capture
			Mean	4.64	0.086	0.129	0.022	0.047	0.047	-----
			Max	6.75	0.456	0.436	0.028	0.140	0.067	-----
			Min	3.93	0.000	0.019	0.018	0.014	0.014	-----
			n	34	34	11	3	13	3	-----

Table 7

Location Name	State	Sampler	Sample Id	pH of Original Extract	Ammonium Concentration ($\mu\text{g/mL}$)			Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	
Riverside-Rubidoux	CA	SASS	A193863S	4.78	4.036	3.644	0.041	99%
Riverside-Rubidoux	CA	SASS	A174934K	4.52	3.492	3.120	0.004	100%
Riverside-Rubidoux	CA	SASS	A185503A	4.32	1.725	1.665	not detected	100%
North Los Angeles	CA	SASS	A1655223	4.61	2.102	2.075	0.005	100%
Riverside-Rubidoux	CA	SASS	A178142C	4.81	0.861	0.838	not detected	100%
IS 52	NY	RPSPEC	A178253I	4.71	3.994	3.702	0.011	100%
Simi Valley	CA	SASS	A146019N	4.54	0.863	0.913	0.018	98%
Springfield Pumping Station	IL	RAAS	A1458233	4.49	1.467	1.440	not detected	100%
Riverside-Rubidoux	CA	SASS	A189471Z	4.58	0.830	0.774	not detected	100%
Manitowoc, Woodland Dunes site	WI	SASS	A185952V	4.35	1.535	1.426	-0.001	100%
Camden	NJ	SASS	A188429T	4.28	4.705	4.553	0.018	100%
Luna Pier	MI	SASS	A193550E	4.53	0.993	0.963	not detected	100%
El Cajon	CA	SASS	A175881S	4.59	0.948	1.068	0.007	99%
Jefferson Elementary (10th and Vine)	IA	RPSPEC	A1854219	4.29	1.713	1.491	not detected	100%
Head Start	OH	SASS	A176603C	4.54	2.464	2.327	0.011	100%
Mayville Hubbard Township site	WI	SASS	A186409H	4.46	1.113	1.033	not detected	100%
Queens College	NY	RPSPEC	A1894833	4.44	4.110	3.725	not detected	100%
Simi Valley	CA	SASS	A186093H	4.40	1.014	0.943	not detected	100%
Blair Street	MO	RAAS	A187171I	4.55	1.813	1.845	0.002	100%
Bakersfield-California Ave (Collocated)	CA	SASS	A182681F	4.60	0.713	0.723	not detected	100%
Washington Park	IN	SASS	A1853012	4.62	0.880	0.901	not detected	100%
Harrisburg	PA	SASS	A174546C	4.43	0.974	0.856	not detected	100%
Fresno - First Street	CA	SASS	A185486Q	4.54	0.596	0.680	not detected	100%
Bakersfield-California Ave	CA	SASS	A1811996	4.73	0.722	0.798	not detected	100%
SER-DNR Headquarters	WI	SASS	A1976574	4.60	1.213	1.140	not detected	100%
Dearborn	MI	SASS	A189552Z	4.70	1.357	1.498	0.010	99%
NY Botanical Gardens	NY	SASS	A186564R	4.90	2.305	2.284	0.019	99%

Table 7

Location Name	State	Sampler	Sample Id	pH of Original Extract	Ammonium Concentration (µg/mL)			Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	
Bakersfield-California Ave	CA	SASS	A187449T	4.49	0.733	0.717	not detected	100%
Army Reserve Center	IA	RPSPEC	A187310B	4.49	2.170	2.350	0.021	99%
New Garden	PA	SASS	A174690J	4.49	1.327	1.211	not detected	100%
Shenandoah High School	IN	SASS	A175281A	4.13	1.746	1.624	not detected	100%
PHILA - AMS Laboratory	PA	SASS	A185903M	4.22	4.434	4.004	0.016	100%
Bakersfield-California Ave (Collocated)	CA	SASS	A1935106	4.66	0.608	0.582	not detected	100%
Allen Park	MI	SASS	A1822493	4.43	1.610	1.579	0.001	100%
Wilbur Wright Middle School	OH	SASS	A1754225	4.28	1.929	1.777	not detected	100%
G.T. Craig	OH	SASS	A188525S	4.99	1.220	1.321	0.007	100%
Maple Canyon	OH	SASS	A189066Q	4.62	0.750	0.738	not detected	100%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10709	4.22	-----	4.915	-0.001	100%
[BOND1] Bondville	IL	IMPROVE	N03-10710	6.07	-----	2.747	0.005	100%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10711	4.3	-----	1.461	not detected	100%
[GRR1] Great River Bluffs	WI	IMPROVE	N03-10712	6.44	-----	2.055	0.006	100%
[CRES1] Crescent Lake	NE	IMPROVE	N03-10713	6.75	-----	not detected	not detected	need data
[SAGA1] San Gabriel	CA	IMPROVE	N03-10714	4.23	-----	0.987	not detected	100%
[PINN1] Pinnacles, Ventana	CA	IMPROVE	N03-10715	4.25	-----	0.913	not detected	100%
[RAFA1] San Rafael	CA	IMPROVE	N03-10716	4.27	-----	0.587	not detected	100%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10717	4.21	-----	2.272	not detected	100%
[PUSO1] Puget Sound	WA	IMPROVE	N03-10718	4.39	-----	1.017	-0.002	100%
[BLMO1] Blue Mounds	IA	IMPROVE	N03-10720	4.19	-----	2.723	not detected	100%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10721	4.26	-----	0.804	not detected	100%
[PORE1] Point Reyes National Seashore	CA	IMPROVE	N03-10722	4.19	-----	1.873	not detected	100%
[DENA1] Denali National Park	AK	IMPROVE	N03-10723	4.2	-----	0.218	not detected	low capture
[MKGO1] M.K. Goddard	PA	IMPROVE	N03-10724	3.93	-----	5.525	0.006	100%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10725	4.32	-----	0.952	not detected	100%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10726	4.28	-----	1.113	not detected	100%

Table 7

Location Name	State	Sampler	Sample Id	pH of Original Extract	Ammonium Concentration (µg/mL)			Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	
[CABA1] Casco Bay	ME	IMPROVE	N03-10727	4.1	-----	1.124	not detected	100%
[JOSH1] Joshua Tree	CA	IMPROVE	N03-10728	4.32	-----	0.818	not detected	100%
[VILA1] Viking Lake	IA	IMPROVE	N03-10729	4.51	-----	3.276	not detected	100%
[WASH1] Washington DC	---	IMPROVE	N03-10730	4.36	-----	5.011	0.022	100%
[THRO1] Theodore Roosevelt	ND	IMPROVE	N03-10731	4.33	-----	1.498	not detected	100%
[REDW1] Redwood National Park	CA	IMPROVE	N03-10732	4.21	-----	0.907	not detected	100%
[PHOE1] Phoenix	AZ	IMPROVE	N03-10733	4.42	-----	0.855	not detected	100%
[NEBR1] Nebraska National Forest	NE	IMPROVE	N03-10734	6.33	-----	0.620	not detected	100%
[LIVO1] Livonia	IN	IMPROVE	N03-10735	4.21	-----	2.523	not detected	100%
[SNPA1] Snoqualamie Pass, N.F.	WA	IMPROVE	N03-10736	4.25	-----	0.699	not detected	100%
[THBA1] Thunder Basin	WY	IMPROVE	N03-10737	6.44	-----	not detected	not detected	need data
[LIVO1] Livonia	IN	IMPROVE	N03-10738	3.95	-----	5.213	0.023	100%
[AREN1] Arendtsville	PA	IMPROVE	N03-10739	4.16	-----	3.064	not detected	100%
[AREN1] Arendtsville	PA	IMPROVE	N03-10740	4.18	-----	2.220	not detected	100%
[COGO1] Columbia Gorge	WA	IMPROVE	N03-10741	4.82	-----	0.364	not detected	low capture
[THBA1] Thunder Basin	WY	IMPROVE	N03-10742	6.49	-----	0.006	not detected	low capture
[WASH1] Washington DC	---	IMPROVE	N03-10743	4.19	-----	2.776	not detected	100%
			Mean	4.58	1.758	1.789	0.011	100%
			Max	6.75	4.705	5.525	0.041	100%
			Min	3.93	0.596	0.006	-0.002	98%
			n	71	37	69	23	66

Table 8

Location Name	State	Sampler	Sample Id	pH of Original Extract	Potassium Concentration (µg/mL)			Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	
Riverside-Rubidoux	CA	SASS	A193863S	4.78	0.056	0.076	not detected	low capture
Riverside-Rubidoux	CA	SASS	A174934K	4.52	0.020	0.057	not detected	low capture
Riverside-Rubidoux	CA	SASS	A185503A	4.32	0.047	0.064	not detected	low capture
North Los Angeles	CA	SASS	A1655223	4.61	0.000	0.046	not detected	low capture
Riverside-Rubidoux	CA	SASS	A178142C	4.81	0.055	0.089	not detected	low capture
IS 52	NY	RPSPEC	A178253I	4.71	0.000	0.037	not detected	low capture
Simi Valley	CA	SASS	A146019N	4.54	0.000	0.030	not detected	low capture
Springfield Pumping Station	IL	RAAS	A1458233	4.49	0.000	0.041	not detected	low capture
Riverside-Rubidoux	CA	SASS	A189471Z	4.58	0.035	0.049	not detected	low capture
Manitowoc, Woodland Dunes site	WI	SASS	A185952V	4.35	0.105	0.146	not detected	low capture
Camden	NJ	SASS	A188429T	4.28	0.000	0.055	not detected	low capture
Luna Pier	MI	SASS	A193550E	4.53	0.000	0.031	not detected	low capture
El Cajon	CA	SASS	A175881S	4.59	0.037	0.044	not detected	low capture
Jefferson Elementary (10th and Head Start	IA	RPSPEC	A1854219	4.29	0.086	0.096	not detected	low capture
Mayville Hubbard Township site	OH	SASS	A176603C	4.54	0.000	0.042	not detected	low capture
Queens College	WI	SASS	A186409H	4.46	0.110	0.124	not detected	low capture
Simi Valley	NY	RPSPEC	A1894833	4.44	0.000	0.045	not detected	low capture
Blair Street	CA	SASS	A186093H	4.40	0.029	0.037	not detected	low capture
Bakersfield-California Ave	MO	RAAS	A187171I	4.55	2.353	2.296	0.017	99%
Washington Park	CA	SASS	A182681F	4.60	0.000	0.049	not detected	low capture
Harrisburg	IN	SASS	A1853012	4.62	0.000	0.026	not detected	low capture
Fresno - First Street	PA	SASS	A174546C	4.43	0.375	0.426	not detected	low capture
Bakersfield-California Ave	CA	SASS	A185486Q	4.54	0.044	0.061	not detected	low capture
SER-DNR Headquarters	CA	SASS	A1811996	4.73	0.000	0.048	not detected	low capture
Dearborn	WI	SASS	A1976574	4.60	0.000	0.028	not detected	low capture
NY Botanical Gardens	MI	SASS	A189552Z	4.70	0.000	0.039	not detected	low capture
	NY	SASS	A186564R	4.90	0.000	0.029	not detected	low capture

Table 8

Location Name	State	Sampler	Sample Id	pH of Original Extract	Potassium Concentration (µg/mL)			Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	
Bakersfield-California Ave	CA	SASS	A187449T	4.49	0.075	0.081	not detected	low capture
Army Reserve Center	IA	RPSPEC	A187310B	4.49	0.068	0.071	not detected	low capture
New Garden	PA	SASS	A174690J	4.49	0.037	0.050	not detected	low capture
Shenandoah High School	IN	SASS	A175281A	4.13	0.000	0.037	not detected	low capture
PHILA - AMS Laboratory	PA	SASS	A185903M	4.22	0.000	0.043	not detected	low capture
Bakersfield-California Ave	CA	SASS	A1935106	4.66	0.066	0.074	not detected	low capture
Allen Park	MI	SASS	A1822493	4.43	0.067	0.091	not detected	low capture
Wilbur Wright Middle School	OH	SASS	A1754225	4.28	0.042	0.059	not detected	low capture
G.T. Craig	OH	SASS	A188525S	4.99	0.052	0.066	not detected	low capture
Maple Canyon	OH	SASS	A189066Q	4.62	0.000	0.030	not detected	low capture
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10709	4.22	----	0.265	not detected	low capture
[BOND1] Bondville	IL	IMPROVE	N03-10710	6.07	----	17.610	0.178	99%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10711	4.3	----	0.169	not detected	low capture
[GRR1] Great River Bluffs	WI	IMPROVE	N03-10712	6.44	----	17.919	0.229	99%
[CRES1] Crescent Lake	NE	IMPROVE	N03-10713	6.75	----	38.520	0.571	99%
[SAGA1] San Gabriel	CA	IMPROVE	N03-10714	4.23	----	0.250	not detected	low capture
[PINN1] Pinnacles, Ventana	CA	IMPROVE	N03-10715	4.25	----	0.286	not detected	low capture
[RAFA1] San Rafael	CA	IMPROVE	N03-10716	4.27	----	0.198	not detected	low capture
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10717	4.21	----	0.190	not detected	low capture
[PUSO1] Puget Sound	WA	IMPROVE	N03-10718	4.39	----	0.243	not detected	low capture
[BLMO1] Blue Mounds	IA	IMPROVE	N03-10720	4.19	----	0.154	not detected	low capture
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10721	4.26	----	0.151	not detected	low capture
[PORE1] Point Reyes National	CA	IMPROVE	N03-10722	4.19	----	0.276	not detected	low capture
[DENA1] Denali National Park	AK	IMPROVE	N03-10723	4.2	----	0.448	not detected	low capture
[MKGO1] M.K. Goddard	PA	IMPROVE	N03-10724	3.93	----	0.314	not detected	low capture
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10725	4.32	----	0.188	not detected	low capture
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10726	4.28	----	0.163	not detected	low capture

Table 8

Location Name	State	Sampler	Sample Id	pH of Original Extract	Potassium Concentration (µg/mL)			Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	
[CABA1] Casco Bay	ME	IMPROVE	N03-10727	4.1	----	0.164	not detected	low capture
[JOSH1] Joshua Tree	CA	IMPROVE	N03-10728	4.32	----	0.240	not detected	low capture
[VILA1] Viking Lake	IA	IMPROVE	N03-10729	4.51	----	3.141	0.022	99%
[WASH1] Washington DC	---	IMPROVE	N03-10730	4.36	----	0.201	not detected	low capture
[THRO1] Theodore Roosevelt	ND	IMPROVE	N03-10731	4.33	----	0.205	not detected	low capture
[REDW1] Redwood National Park	CA	IMPROVE	N03-10732	4.21	----	0.333	not detected	low capture
[PHOE1] Phoenix	AZ	IMPROVE	N03-10733	4.42	----	0.903	not detected	100%
[NEBR1] Nebraska National Forest	NE	IMPROVE	N03-10734	6.33	----	8.862	0.123	99%
[LIVO1] Livonia	IN	IMPROVE	N03-10735	4.21	----	0.726	not detected	100%
[SNPA1] Snoqualmie Pass, N.F.	WA	IMPROVE	N03-10736	4.25	----	0.202	not detected	low capture
[THBA1] Thunder Basin	WY	IMPROVE	N03-10737	6.44	----	14.375	0.109	99%
[LIVO1] Livonia	IN	IMPROVE	N03-10738	3.95	----	0.253	not detected	low capture
[AREN1] Arendtsville	PA	IMPROVE	N03-10739	4.16	----	3.292	0.015	100%
[AREN1] Arendtsville	PA	IMPROVE	N03-10740	4.18	----	0.741	not detected	100%
[COGO1] Columbia Gorge	WA	IMPROVE	N03-10741	4.82	----	2.917	0.020	99%
[THBA1] Thunder Basin	WY	IMPROVE	N03-10742	6.49	----	15.951	0.125	99%
[WASH1] Washington DC	---	IMPROVE	N03-10743	4.19	----	0.182	not detected	low capture
			Mean	4.58	0.102	1.898	0.141	99%
			Max	6.75	2.353	38.520	0.571	100%
			Min	3.93	0.000	0.026	0.015	99%
			n	71	37	71	10	13

Table 9

Location Name	State	Sampler	Sample Id	pH of Original Extract	Sodium Concentration (µg/mL)			Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	
Riverside-Rubidoux	CA	SASS	A193863S	4.78	0.301	0.296	not detected	low capture
Riverside-Rubidoux	CA	SASS	A174934K	4.52	0.120	0.145	not detected	low capture
Riverside-Rubidoux	CA	SASS	A185503A	4.32	0.107	0.144	not detected	low capture
North Los Angeles	CA	SASS	A1655223	4.61	0.136	0.174	0.008	low capture
Riverside-Rubidoux	CA	SASS	A178142C	4.81	0.406	0.524	0.009	98%
IS 52	NY	RPSPEC	A178253I	4.71	0.098	0.098	not detected	low capture
Simi Valley	CA	SASS	A146019N	4.54	0.136	0.169	not detected	low capture
Springfield Pumping Station	IL	RAAS	A1458233	4.49	0.053	0.088	0.007	low capture
Riverside-Rubidoux	CA	SASS	A189471Z	4.58	0.260	0.274	0.006	low capture
Manitowoc, Woodland Dunes site	WI	SASS	A185952V	4.35	0.055	0.089	not detected	low capture
Camden	NJ	SASS	A188429T	4.28	0.056	0.131	not detected	low capture
Luna Pier	MI	SASS	A193550E	4.53	0.058	0.096	not detected	low capture
El Cajon	CA	SASS	A175881S	4.59	0.199	0.202	0.007	low capture
Jefferson Elementary (10th and Head Start	IA	RPSPEC	A1854219	4.29	0.049	0.043	0.007	low capture
Mayville Hubbard Township site	WI	SASS	A186409H	4.46	0.108	0.124	not detected	low capture
Queens College	NY	RPSPEC	A1894833	4.44	0.029	0.044	0.007	low capture
Simi Valley	CA	SASS	A186093H	4.40	0.155	0.165	0.007	low capture
Blair Street	MO	RAAS	A187171I	4.55	0.118	0.121	not detected	low capture
Bakersfield-California Ave	CA	SASS	A182681F	4.60	0.116	0.143	not detected	low capture
Washington Park	IN	SASS	A1853012	4.62	0.009	0.027	0.007	low capture
Harrisburg	PA	SASS	A174546C	4.43	0.051	0.074	not detected	low capture
Fresno - First Street	CA	SASS	A185486Q	4.54	0.125	0.163	0.016	low capture
Bakersfield-California Ave	CA	SASS	A1811996	4.73	0.043	0.081	not detected	low capture
SER-DNR Headquarters	WI	SASS	A1976574	4.60	0.027	0.043	0.015	low capture
Dearborn	MI	SASS	A189552Z	4.70	0.014	0.048	not detected	low capture
NY Botanical Gardens	NY	SASS	A186564R	4.90	0.037	0.046	not detected	low capture

Table 9

Location Name	State	Sampler	Sample Id	pH of Original Extract	Sodium Concentration (µg/mL)			Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	
Bakersfield-California Ave	CA	SASS	A187449T	4.49	0.084	0.137	not detected	low capture
Army Reserve Center	IA	RPSPEC	A187310B	4.49	0.083	0.093	not detected	low capture
New Garden	PA	SASS	A174690J	4.49	0.092	0.109	not detected	low capture
Shenandoah High School	IN	SASS	A175281A	4.13	0.079	0.100	not detected	low capture
PHILA - AMS Laboratory	PA	SASS	A185903M	4.22	0.034	0.047	not detected	low capture
Bakersfield-California Ave	CA	SASS	A1935106	4.66	0.056	0.066	not detected	low capture
Allen Park	MI	SASS	A1822493	4.43	0.074	0.105	not detected	low capture
Wilbur Wright Middle School	OH	SASS	A1754225	4.28	0.054	0.063	0.010	low capture
G.T. Craig	OH	SASS	A188525S	4.99	0.175	0.189	0.009	low capture
Maple Canyon	OH	SASS	A189066Q	4.62	0.026	0.053	0.006	low capture
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10709	4.22	----	0.691	0.008	99%
[BOND1] Bondville	IL	IMPROVE	N03-10710	6.07	----	0.585	0.026	96%
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10711	4.3	----	0.382	not detected	low capture
[GRR1] Great River Bluffs	WI	IMPROVE	N03-10712	6.44	----	0.667	0.013	98%
[CRES1] Crescent Lake	NE	IMPROVE	N03-10713	6.75	----	0.651	0.014	98%
[SAGA1] San Gabriel	CA	IMPROVE	N03-10714	4.23	----	0.795	0.012	98%
[PINN1] Pinnacles, Ventana	CA	IMPROVE	N03-10715	4.25	----	2.191	0.015	99%
[RAFA1] San Rafael	CA	IMPROVE	N03-10716	4.27	----	1.743	0.013	99%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10717	4.21	----	1.147	0.032	97%
[PUSO1] Puget Sound	WA	IMPROVE	N03-10718	4.39	----	1.635	0.012	99%
[BLMO1] Blue Mounds	IA	IMPROVE	N03-10720	4.19	----	0.298	0.017	low capture
[SAGO1] San Gorgonio Wilderness	CA	IMPROVE	N03-10721	4.26	----	0.301	0.030	low capture
[PORE1] Point Reyes National	CA	IMPROVE	N03-10722	4.19	----	0.871	0.034	96%
[DENA1] Denali National Park	AK	IMPROVE	N03-10723	4.2	----	0.258	0.037	low capture
[MKGO1] M.K. Goddard	PA	IMPROVE	N03-10724	3.93	----	0.279	0.042	low capture
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10725	4.32	----	0.538	0.025	96%
[AGTI1] Agua Tibia	CA	IMPROVE	N03-10726	4.28	----	0.614	0.043	94%

Table 9

Location Name	State	Sampler	Sample Id	pH of Original Extract	Sodium Concentration ($\mu\text{g/mL}$)			Efficiency of Original Extraction
					Original Extract Analyzed at RTI	Original Extract Re-analyzed at NAREL	Second Extraction (DI Water)	
[CABA1] Casco Bay	ME	IMPROVE	N03-10727	4.1	-----	1.092	0.009	99%
[JOSH1] Joshua Tree	CA	IMPROVE	N03-10728	4.32	-----	0.727	not detected	100%
[VILA1] Viking Lake	IA	IMPROVE	N03-10729	4.51	-----	0.384	0.026	low capture
[WASH1] Washington DC	---	IMPROVE	N03-10730	4.36	-----	0.823	0.006	99%
[THRO1] Theodore Roosevelt	ND	IMPROVE	N03-10731	4.33	-----	0.636	0.007	99%
[REDW1] Redwood National Park	CA	IMPROVE	N03-10732	4.21	-----	1.182	0.009	99%
[PHOE1] Phoenix	AZ	IMPROVE	N03-10733	4.42	-----	0.693	not detected	100%
[NEBR1] Nebraska National Forest	NE	IMPROVE	N03-10734	6.33	-----	0.653	0.045	94%
[LIVO1] Livonia	IN	IMPROVE	N03-10735	4.21	-----	0.619	not detected	100%
[SNPA1] Snoqualmie Pass, N.F.	WA	IMPROVE	N03-10736	4.25	-----	1.162	0.008	99%
[THBA1] Thunder Basin	WY	IMPROVE	N03-10737	6.44	-----	0.940	0.034	96%
[LIVO1] Livonia	IN	IMPROVE	N03-10738	3.95	-----	0.577	0.006	99%
[AREN1] Arendtsville	PA	IMPROVE	N03-10739	4.16	-----	0.292	0.006	low capture
[AREN1] Arendtsville	PA	IMPROVE	N03-10740	4.18	-----	0.448	0.025	low capture
[COGO1] Columbia Gorge	WA	IMPROVE	N03-10741	4.82	-----	0.592	0.006	99%
[THBA1] Thunder Basin	WY	IMPROVE	N03-10742	6.49	-----	0.473	0.005	low capture
[WASH1] Washington DC	---	IMPROVE	N03-10743	4.19	-----	0.547	0.006	99%
			Mean	4.584	0.099	0.424	0.016	98%
			Max	6.750	0.406	2.191	0.045	100%
			Min	3.930	0.009	0.027	0.005	94%
			n	71	37	71	44	26

Table 10

Nitrate Site-Pair Data

Site-Pair	Location Name	State	Sampler	Nitrate Site-Pair Data			
				Summer Nitrate (µg/mL)	Late Fall Nitrate (µg/mL)	Summer Nitrate Efficiency	Late Fall Nitrate Efficiency
1	Bakersfield-California Ave	CA	SASS	1.353	16.256	100%	92%
2	Riverside-Rubidoux	CA	SASS	10.894	9.342	98%	91%
3	Riverside-Rubidoux	CA	SASS	7.345	6.315	99%	91%
4	El Cajon	CA	SASS	1.666	6.075	100%	87%
5	Riverside-Rubidoux	CA	SASS	4.304	3.144	99%	91%
6	Riverside-Rubidoux	CA	SASS	2.286	2.184	99%	84%
7	SER-DNR Headquarters	WI	SASS	1.222	2.051	100%	99%
8	Bakersfield-California Ave	CA	SASS	1.221	2.061	98%	98%
9	Riverside-Rubidoux	CA	SASS	1.715	1.985	99%	99%
10	Jefferson Elementary (10th and Vine)	IA	RPSPEC	1.481	1.947	98%	99%
11	IS 52	NY	RPSPEC	2.050	1.937	99%	98%
12	Bakersfield-California Ave	CA	SASS	1.316	1.886	100%	88%
13	Queens College	NY	RPSPEC	1.408	1.743	100%	78%
14	G.T. Craig	OH	SASS	1.090	1.580	100%	85%
15	Camden	NJ	SASS	1.799	1.494	98%	86%
16	Bakersfield-California Ave	CA	SASS	1.292	1.459	100%	85%
17	Washington Park	IN	SASS	1.239	1.320	100%	96%
18	Blair Street	MO	RAAS	1.411	1.257	100%	91%
19	Springfield Pumping Station	IL	RAAS	1.928	1.044	97%	81%
20	Allen Park	MI	SASS	1.147	1.058	100%	86%
21	[BOND1] Bondville	IL	IMPROVE	6.443	13.631	99%	98%
22	[AGTI1] Agua Tibia	CA	IMPROVE	2.625	8.628	97%	98%
23	[LIVO1] Livonia	IN	IMPROVE	1.528	3.554	100%	98%
24	[AGTI1] Agua Tibia	CA	IMPROVE	1.774	2.689	97%	94%
25	[PUSO1] Puget Sound	WA	IMPROVE	2.274	2.410	100%	95%
26	[LIVO1] Livonia	IN	IMPROVE	1.461	2.232	96%	94%
27	[MKGO1] M.K. Goddard	PA	IMPROVE	1.952	2.059	95%	95%
28	[PHOE1] Phoenix	AZ	IMPROVE	1.538	2.003	100%	95%
29	[RAFA1] San Rafael	CA	IMPROVE	2.536	1.399	97%	90%
30	[THRO1] Theodore Roosevelt	ND	IMPROVE	1.591	1.269	100%	92%
31	[AGTI1] Agua Tibia	CA	IMPROVE	1.765	1.203	98%	92%
32	[PINN1] Pinnacles, Ventana	CA	IMPROVE	2.587	1.132	100%	88%
33	[CABA1] Casco Bay	ME	IMPROVE	1.737	1.371	96%	93%
			Mean	2.363	3.325	99%	92%
			Max	10.894	16.256	100%	99%
			Min	1.090	1.044	95%	78%
			n	33	33	33	33

Table 11

Site-Pair	Location Name	State	Sampler	Sulfate Site-Pair Data			
				Summer Sulfate (µg/mL)	Late Fall Sulfate (µg/mL)	Summer Sulfate Efficiency	Late Fall Sulfate Efficiency
1	Bakersfield-California Ave	CA	SASS	1.327	1.102	100%	98%
2	Riverside-Rubidoux	CA	SASS	1.918	0.732	99%	100%
3	Riverside-Rubidoux	CA	SASS	2.997	1.964	100%	97%
4	El Cajon	CA	SASS	1.740	2.685	100%	95%
5	Riverside-Rubidoux	CA	SASS	1.730	0.251	100%	low capture
6	Riverside-Rubidoux	CA	SASS	1.261	0.746	100%	92%
7	SER-DNR Headquarters	WI	SASS	2.332	1.049	100%	100%
8	Bakersfield-California Ave	CA	SASS	0.882	0.869	100%	100%
9	Riverside-Rubidoux	CA	SASS	1.350	0.613	100%	100%
10	Jefferson Elementary (10th and Vine)	IA	RPSPEC	3.629	1.892	99%	100%
11	IS 52	NY	RPSPEC	8.639	2.768	100%	99%
12	Bakersfield-California Ave	CA	SASS	0.964	0.776	100%	100%
13	Queens College	NY	RPSPEC	9.122	2.281	100%	85%
14	G.T. Craig	OH	SASS	2.937	2.700	100%	94%
15	Camden	NJ	SASS	12.496	3.269	99%	96%
16	Bakersfield-California Ave	CA	SASS	1.193	0.355	100%	low capture
17	Washington Park	IN	SASS	1.889	1.176	100%	100%
18	Blair Street	MO	RAAS	7.834	1.129	99%	97%
19	Springfield Pumping Station	IL	RAAS	3.376	0.469	100%	low capture
20	Allen Park	MI	SASS	4.076	0.629	99%	94%
21	[BOND1] Bondville	IL	IMPROVE	15.928	14.958	100%	99%
22	[AGTI1] Agua Tibia	CA	IMPROVE	7.315	7.218	98%	99%
23	[LIVO1] Livonia	IN	IMPROVE	7.878	2.503	99%	99%
24	[AGTI1] Agua Tibia	CA	IMPROVE	2.281	1.556	98%	96%
25	[PUSO1] Puget Sound	WA	IMPROVE	3.846	2.083	99%	97%
26	[LIVO1] Livonia	IN	IMPROVE	17.557	3.193	99%	97%
27	[MKGO1] M.K. Goddard	PA	IMPROVE	16.937	2.840	98%	98%
28	[PHOE1] Phoenix	AZ	IMPROVE	3.589	0.941	100%	97%
29	[RAFA1] San Rafael	CA	IMPROVE	2.280	1.828	98%	96%
30	[THRO1] Theodore Roosevelt	ND	IMPROVE	3.860	4.050	100%	97%
31	[AGTI1] Agua Tibia	CA	IMPROVE	3.314	4.920	98%	97%
32	[PINN1] Pinnacles, Ventana	CA	IMPROVE	3.923	0.753	100%	94%
33	[CABA1] Casco Bay	ME	IMPROVE	4.766	3.975	98%	99%
			Mean	5.005	2.372	99%	97%
			Max	17.557	14.958	100%	100%
			Min	0.882	0.251	98%	85%
			n	33	33	33	30

Table 12

Chloride Site-Pair Data

Site-Pair	Location Name	State	Sampler	Summer Chloride (µg/mL)	Late Fall Chloride (µg/mL)	Summer Chloride Efficiency	Late Fall Chloride Efficiency
1	Bakersfield-California Ave	CA	SASS	1.327	1.102	100%	98%
1	Bakersfield-California Ave	CA	SASS	0.078	----	low capture	low capture
2	Riverside-Rubidoux	CA	SASS	0.326	----	low capture	low capture
3	Riverside-Rubidoux	CA	SASS	0.378	----	low capture	low capture
4	El Cajon	CA	SASS	0.225	----	low capture	low capture
5	Riverside-Rubidoux	CA	SASS	0.172	----	low capture	low capture
6	Riverside-Rubidoux	CA	SASS	0.477	----	low capture	low capture
7	SER-DNR Headquarters	WI	SASS	0.054	----	low capture	low capture
8	Bakersfield-California Ave	CA	SASS	0.064	----	low capture	low capture
9	Riverside-Rubidoux	CA	SASS	0.214	----	low capture	low capture
10	Jefferson Elementary (10th and Vine)	IA	RPSPEC	0.070	----	low capture	low capture
11	IS 52	NY	RPSPEC	0.148	----	low capture	low capture
12	Bakersfield-California Ave	CA	SASS	0.095	----	low capture	low capture
13	Queens College	NY	RPSPEC	0.052	----	low capture	low capture
14	G.T. Craig	OH	SASS	0.155	----	low capture	low capture
15	Camden	NJ	SASS	0.114	----	low capture	low capture
16	Bakersfield-California Ave	CA	SASS	0.059	----	low capture	low capture
17	Washington Park	IN	SASS	0.043	----	low capture	low capture
18	Blair Street	MO	RAAS	0.666	----	98%	low capture
19	Springfield Pumping Station	IL	RAAS	0.111	----	low capture	low capture
20	Allen Park	MI	SASS	0.111	----	low capture	low capture
21	[BOND1] Bondville	IL	IMPROVE	1.338	1.643	99%	99%
22	[AGTI1] Agua Tibia	CA	IMPROVE	0.715	1.635	97%	99%
23	[LIVO1] Livonia	IN	IMPROVE	0.719	0.779	98%	99%
24	[AGTI1] Agua Tibia	CA	IMPROVE	0.841	1.472	97%	97%
25	[PUSO1] Puget Sound	WA	IMPROVE	1.253	1.677	98%	98%
26	[LIVO1] Livonia	IN	IMPROVE	0.506	1.056	96%	96%
27	[MKGO1] M.K. Goddard	PA	IMPROVE	0.377	1.153	low capture	98%
28	[PHOE1] Phoenix	AZ	IMPROVE	1.211	1.190	98%	98%
29	[RAFA1] San Rafael	CA	IMPROVE	1.673	1.698	98%	98%
30	[THRO1] Theodore Roosevelt	ND	IMPROVE	0.880	1.059	98%	98%
31	[AGTI1] Agua Tibia	CA	IMPROVE	0.791	0.998	97%	98%
32	[PINN1] Pinnacles, Ventana	CA	IMPROVE	1.417	1.461	98%	98%
33	[CABA1] Casco Bay	ME	IMPROVE	0.928	2.327	97%	99%
			Mean	0.493	1.396	98%	98%
			Max	1.673	2.327	99%	99%
			Min	0.043	0.779	96%	96%
			n	33	13	13	13

Table 13

Site-Pair	Location Name	State	Sampler	Ammonium Site-Pair			
				Summer Ammonium (µg/mL)	Late Fall Ammonium (µg/mL)	Summer Ammonium Efficiency	Late Fall Ammonium Efficiency
1	Bakersfield-California Ave	CA	SASS	0.723	4.496	100%	99%
2	Riverside-Rubidoux	CA	SASS	3.644	2.455	99%	99%
3	Riverside-Rubidoux	CA	SASS	3.120	2.211	100%	99%
4	El Cajon	CA	SASS	1.068	2.196	99%	99%
5	Riverside-Rubidoux	CA	SASS	1.665	0.616	100%	100%
6	Riverside-Rubidoux	CA	SASS	0.838	0.473	100%	low capture
7	SER-DNR Headquarters	WI	SASS	1.140	0.569	100%	100%
8	Bakersfield-California Ave	CA	SASS	0.582	0.410	100%	low capture
9	Riverside-Rubidoux	CA	SASS	0.774	0.276	100%	low capture
10	Jefferson Elementary (10th and Vine)	IA	RPSPEC	1.491	0.679	100%	99%
11	IS 52	NY	RPSPEC	3.702	1.296	100%	99%
12	Bakersfield-California Ave	CA	SASS	0.717	0.422	100%	low capture
13	Queens College	NY	RPSPEC	3.725	0.576	100%	99%
14	G.T. Craig	OH	SASS	1.321	1.025	100%	99%
15	Camden	NJ	SASS	4.553	1.246	100%	99%
16	Bakersfield-California Ave	CA	SASS	0.798	0.211	100%	low capture
17	Washington Park	IN	SASS	0.901	0.528	100%	100%
18	Blair Street	MO	RAAS	1.845	0.441	100%	low capture
19	Springfield Pumping Station	IL	RAAS	1.440	0.288	100%	low capture
20	Allen Park	MI	SASS	1.579	0.189	100%	low capture
21	[BOND1] Bondville	IL	IMPROVE	2.747	9.127	100%	99%
22	[AGTI1] Agua Tibia	CA	IMPROVE	2.272	3.637	100%	99%
23	[LIVO1] Livonia	IN	IMPROVE	2.523	1.278	100%	100%
24	[AGTI1] Agua Tibia	CA	IMPROVE	0.952	0.529	100%	98%
25	[PUSO1] Puget Sound	WA	IMPROVE	1.017	1.072	100%	99%
26	[LIVO1] Livonia	IN	IMPROVE	5.213	1.347	100%	100%
27	[MKGO1] M.K. Goddard	PA	IMPROVE	5.525	1.333	100%	99%
28	[PHOE1] Phoenix	AZ	IMPROVE	0.855	0.472	100%	low capture
29	[RAFA1] San Rafael	CA	IMPROVE	0.587	0.442	100%	low capture
30	[THRO1] Theodore Roosevelt	ND	IMPROVE	1.498	1.408	100%	100%
31	[AGTI1] Agua Tibia	CA	IMPROVE	1.113	1.408	100%	100%
32	[PINN1] Pinnacles, Ventana	CA	IMPROVE	0.913	0.095	100%	low capture
33	[CABA1] Casco Bay	ME	IMPROVE	1.124	0.893	100%	100%
			Mean	1.878	1.323	100%	99%
			Max	5.525	9.127	100%	100%
			Min	0.582	0.095	99%	98%
			n	33	33	33	22

Table 14

Potassium Site-Pair Data

Site-Pair	Location Name	State	Sampler	Summer Potassium (µg/mL)	Late Fall Potassium (µg/mL)	Summer Potassium Efficiency	Late Fall Potassium Efficiency
1	Bakersfield-California Ave	CA	SASS	0.049	0.086	low capture	low capture
2	Riverside-Rubidoux	CA	SASS	0.076	0.079	low capture	low capture
3	Riverside-Rubidoux	CA	SASS	0.057	0.039	low capture	low capture
4	El Cajon	CA	SASS	0.044	0.034	low capture	low capture
5	Riverside-Rubidoux	CA	SASS	0.064	0.030	low capture	low capture
6	Riverside-Rubidoux	CA	SASS	0.089	0.026	low capture	low capture
7	SER-DNR Headquarters	WI	SASS	0.028	0.032	low capture	low capture
8	Bakersfield-California Ave	CA	SASS	0.074	0.077	low capture	low capture
9	Riverside-Rubidoux	CA	SASS	0.049	0.050	low capture	low capture
10	Jefferson Elementary (10th and Vine)	IA	RPSPEC	0.096	0.024	low capture	low capture
11	IS 52	NY	RPSPEC	0.037	0.038	low capture	low capture
12	Bakersfield-California Ave	CA	SASS	0.081	0.071	low capture	low capture
13	Queens College	NY	RPSPEC	0.045	0.022	low capture	low capture
14	G.T. Craig	OH	SASS	0.066	0.067	low capture	low capture
15	Camden	NJ	SASS	0.055	0.040	low capture	low capture
16	Bakersfield-California Ave	CA	SASS	0.048	0.040	low capture	low capture
17	Washington Park	IN	SASS	0.026	0.033	low capture	low capture
18	Blair Street	MO	RAAS	2.296	0.040	99%	low capture
19	Springfield Pumping Station	IL	RAAS	0.041	0.122	low capture	low capture
20	Allen Park	MI	SASS	0.091	0.035	low capture	low capture
21	[BOND1] Bondville	IL	IMPROVE	17.610	0.449	99%	low capture
22	[AGTI1] Agua Tibia	CA	IMPROVE	0.190	3.948	low capture	99%
23	[LIVO1] Livonia	IN	IMPROVE	0.726	1.442	100%	100%
24	[AGTI1] Agua Tibia	CA	IMPROVE	0.188	0.123	low capture	low capture
25	[PUSO1] Puget Sound	WA	IMPROVE	0.243	0.255	low capture	low capture
26	[LIVO1] Livonia	IN	IMPROVE	0.253	0.147	low capture	low capture
27	[MKGO1] M.K. Goddard	PA	IMPROVE	0.314	0.363	low capture	low capture
28	[PHOE1] Phoenix	AZ	IMPROVE	0.903	0.163	100%	low capture
29	[RAFA1] San Rafael	CA	IMPROVE	0.198	0.159	low capture	low capture
30	[THRO1] Theodore Roosevelt	ND	IMPROVE	0.205	0.130	low capture	low capture
31	[AGTI1] Agua Tibia	CA	IMPROVE	0.163	0.264	low capture	low capture
32	[PINN1] Pinnacles, Ventana	CA	IMPROVE	0.286	0.124	low capture	low capture
33	[CABA1] Casco Bay	ME	IMPROVE	0.164	0.505	low capture	100%
			Mean	0.753	0.274	100%	100%
			Max	17.610	3.948	100%	100%
			Min	0.026	0.022	99%	99%
			n	33	33	4	3

Table 15

Sodium Site-Pair Data

Site-Pair	Location Name	State	Sampler	Summer Sodium (µg/mL)	Late Fall Sodium (µg/mL)	Summer Sodium Efficiency	Late Fall Sodium Efficiency
1	Bakersfield-California Ave	CA	SASS	0.143	0.347	low capture	low capture
2	Riverside-Rubidoux	CA	SASS	0.296	0.170	low capture	low capture
3	Riverside-Rubidoux	CA	SASS	0.145	0.186	low capture	low capture
4	El Cajon	CA	SASS	0.202	0.323	low capture	low capture
5	Riverside-Rubidoux	CA	SASS	0.144	0.224	low capture	low capture
6	Riverside-Rubidoux	CA	SASS	0.524	0.130	98%	low capture
7	SER-DNR Headquarters	WI	SASS	0.043	0.661	low capture	98%
8	Bakersfield-California Ave	CA	SASS	0.066	0.596	low capture	99%
9	Riverside-Rubidoux	CA	SASS	0.274	0.794	low capture	99%
10	Jefferson Elementary (10th and Vine)	IA	RPSPEC	0.043	0.727	low capture	98%
11	IS 52	NY	RPSPEC	0.098	0.674	low capture	98%
12	Bakersfield-California Ave	CA	SASS	0.137	0.253	low capture	low capture
13	Queens College	NY	RPSPEC	0.044	0.341	low capture	low capture
14	G.T. Craig	OH	SASS	0.189	0.193	low capture	low capture
15	Camden	NJ	SASS	0.131	0.129	low capture	low capture
16	Bakersfield-California Ave	CA	SASS	0.081	0.181	low capture	low capture
17	Washington Park	IN	SASS	0.027	0.631	low capture	98%
18	Blair Street	MO	RAAS	0.121	0.455	low capture	low capture
19	Springfield Pumping Station	IL	RAAS	0.088	0.305	low capture	low capture
20	Allen Park	MI	SASS	0.105	0.337	low capture	low capture
21	[BOND1] Bondville	IL	IMPROVE	0.585	0.414	96%	low capture
22	[AGTI1] Agua Tibia	CA	IMPROVE	1.147	0.532	97%	98%
23	[LIVO1] Livonia	IN	IMPROVE	0.619	0.303	100%	low capture
24	[AGTI1] Agua Tibia	CA	IMPROVE	0.538	0.999	96%	98%
25	[PUSO1] Puget Sound	WA	IMPROVE	1.635	0.405	99%	low capture
26	[LIVO1] Livonia	IN	IMPROVE	0.577	0.240	99%	low capture
27	[MKGO1] M.K. Goddard	PA	IMPROVE	0.279	0.254	low capture	low capture
28	[PHOE1] Phoenix	AZ	IMPROVE	0.693	0.329	100%	low capture
29	[RAFA1] San Rafael	CA	IMPROVE	1.743	0.971	99%	98%
30	[THRO1] Theodore Roosevelt	ND	IMPROVE	0.636	0.272	99%	low capture
31	[AGTI1] Agua Tibia	CA	IMPROVE	0.614	0.516	94%	98%
32	[PINN1] Pinnacles, Ventana	CA	IMPROVE	2.191	0.799	99%	98%
33	[CABA1] Casco Bay	ME	IMPROVE	1.092	1.551	99%	99%
			Mean	0.462	0.462	98%	98%
			Max	2.191	1.551	100%	99%
			Min	0.027	0.129	94%	98%
			n	33	33	13	12