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LEVELS OF TRACE ELEMENTS IN THE AMBIENT AIR AT SELECTED LOCATIONS IN THE NORTHERN GREAT PLAINS

ENVIRONMENTAL PROTECTION AGENCY
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LEVELS OF TRACE ELEMENTS IN THE AMBIENT AIR AT SELECTED LOCATIONS IN THE NORTHERN GREAT PLAINS

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Prepared for:
EPA Project Officer: Terry L. Thoem
Environmental Protection Agency
1860 Lincoln Street
Denver, Colorado 80202

Prepared by:
F. G. Mesich, Radian Corporation
H. L. Taylor, Acculabs Research

TS-4a

ABSTRACT

Trace element levels were determined by spark-source mass spectometry for five (5) locations in the Northern Great Plains area. Samples were collected using low volume membrane samplers and analyzed for some fifty (50) elements.

Quarterly composite samples were analyzed. Comparison of composite results was made with individual filter results during one quarter.

A discussion of recommended methodology for ambient trace element sampling is presented.

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1.0 INTRODUCTION AND PROGRAM RATIONALE

The development of the energy industry in the Northern Great Plains area will result in an increase in the atmospheric level of particulates. Of particular interest is the possible increase in the levels of certain potentially hazardous trace elements as a result of coal conversion facilities. However, the data base concerning existing concentrations of trace elements in the ambient air in undeveloped areas is virtually nonexistent. Therefore, this program was designed as a supplement to an ambient air monitoring project performed by PEDCo Environmental under EPA Region VIII sponsorship. The PEDCo program was to collect ambient air quality data including sulfur oxides, nitrogen oxides and particulates at representative locations in the Northern Great Plains area. The filters collected by PEDCo were to be shipped to Radian's analytical subcontractor, Accu-Labs Research, Inc. for trace element analysis by spark source mass spectrometry (SSMS). The samples were collected at the following locations shown in Figure 1-1: Ft. Peck and Glendive, Montana; Garrison, North Dakota; Belle Fourche, South Dakota; and Newcastle, Wyoming.

As initially planned, samples were to be collected at twenty-six locations by Hi-Volume (Hi-Vol) sampling techniques with the 8 x 10" filters submitted for trace element analysis by SSMS. Samples were to be taken at each site at six-day intervals for one year. These samples were to be composited and analyzed for their trace element content on a quarterly basis to determine long-term variation in composition.

During the planning for this program, it was recommended by Radian that cellulosic filter material be used for the collection of trace element samples. This would insure a low ash and low

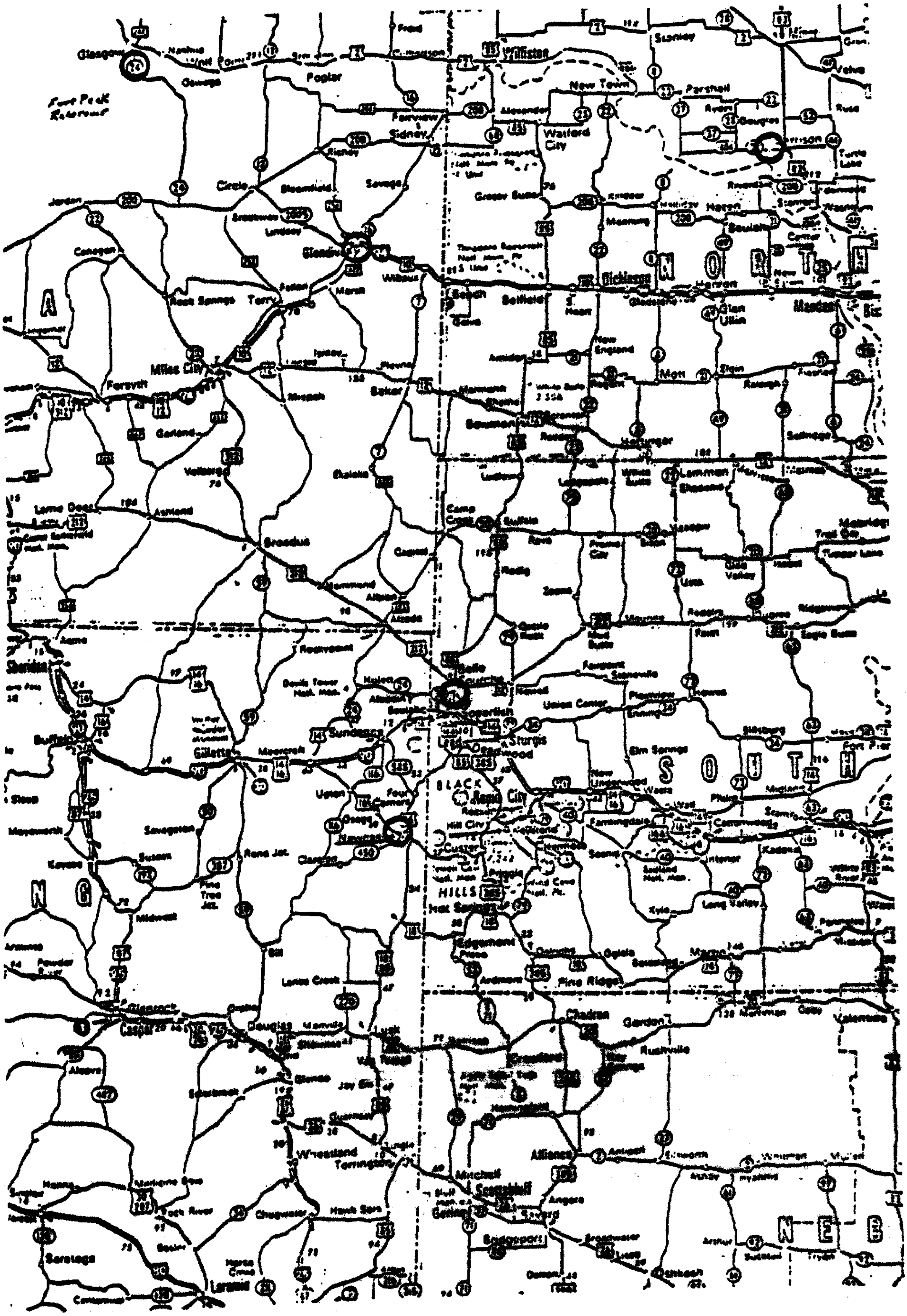

Figure 1-1 Sampling Locations

background residual of trace elements in the filter media. Also, this type of filter is highly uniform which permits suitable blank corrections to be performed. During early meetings with EPA officials, it was established that much of the sampling had already been performed utilizing fiberglass Hi-Vol filters, and that it would not be possible to change the Hi-Vol media for this project. To determine the feasibility of using the fiberglass media, a study was undertaken to establish the level of trace element impurities in selected fiberglass blank samples that had been used in the program as well as some typically loaded samples. Also the statistical variation of these impurities was established to determine how accurately blank corrections could be performed. The results of this study are outlined in Reports 1 and 2 attached as Appendix I to this report. In summary, these reports indicated that data obtained from these samples would be of little use because of the poor blank characteristics of the fiberglass filter pads used to obtain the samples.

After consultation with the project officer, it was decided to modify the scope of work to switch from the fiberglass Hi-Vol filters to the membrane back-up filters taken at each site. It was agreed that this would necessarily compromise the data to some degree but would allow the data that was acquired to be meaningful. The compromises were as follows: (1) the air volumes of the membrane filters were lower than the Hi-Vols, hence, less sample was collected; (2) no weights were obtained by the field contractor on the actual loading of the filters, thus, even though blank levels are low, an unfavorable ratio of particulate to blank can still exist; (3) due to the limited amount of sample, it would not be possible to obtain data on the element mercury, because it is determined by an alternate atomic fluorescence procedure.

To perform the analysis on the membrane filters, it was absolutely necessary to have blank membrane filters from the same lot as those used to obtain the samples. These were requested from the field contractor and received. After commencement of the analysis, it was soon realized that not only did the blank membranes not represent those used in collection of the samples, but that, definitely, several types of membranes were employed in collection of samples.

This was evidenced by attempting dissolution of the filter media. Some filters dissolved readily in acetone while others left a web of insoluble supporting material. On ashing, the materials gave ashes of varying colors, again raising suspicions that the filter substrates were of different materials. However, these problems not withstanding, the analysis of the membrane filters provides a usable data base for a number of elements. These are documented in the results section.

The analysis of filter-collected atmospheric particulate matter can be accomplished with relative ease by following a few basic procedures. It is recommended that in any ambient trace element sampling and analysis program the following key items should be considered:

- selection of a low ash/low trace element background filter material,

- careful equilibration and weighing of filters before and after particulate collection,

- collection of a sufficient amount of particulates for analysis, i.e. a 24-hr. Hi-Vol sample or a 6-7 day membrane filter sample, and

- collection of meteorological data at the sample site to permit data analysis.

2.0 EXPERIMENTAL METHODOLOGY

2.1 Filter Collection

The samples were collected at the following sites:

(1) Newcastle, Wyoming;
(2) Glendive, Montana;
(3) Garrison, North Dakota;
(4) Ft. Peck, Montana; and
(5) Belle Fourche, South Dakota.

Figure 1-1 is a map showing the collection points. The sites were selected to give a representative cross-section of background air quality conditions in the Northern Great Plains area.

2.2 Sample Preparation

The circular, 12.5 cm diameter membrane filters were prepared for spark source mass spectrographic analysis in the following manner.

(1) The sample was divided into quadrants, in such a fashion that the ink-stamped identification number was located in only one quadrant. This quadrant was not used for any of the analyses. When analyzing individual filters, one-half of the filter was carried through the remainder of the preparation steps as listed below. When compositing was performed, one-fourth of each sample to be composited was combined for subsequent preparation.

(2) 0.100 gram of ultra-high purity graphite was weighed into an acid-washed (Vycor) crucible which had been tared to constant weight by successive heatings in a muffle furnace. The portion or portions of filter(s) to be analyzed were then placed into the crucible, which was heated in a muffle furnace at 450°C for ashing.

(3) After ashing, 10 micrograms of indium were added to the graphite-ash mixture to act as an internal standard. This mixture was then thoroughly homogenized.

(4) The mixture was compressed into electrode pins, which were then ready for analysis.

2.3 Analysis

The mechanism and principles of operation of the AEI MS 702R high resolution spark source mass spectrometer have been described in many publications (1, 2, 3) and consequently will not be included in this report.

A pulsed radio frequency potential is employed to vaporize and ionize the sample. The positive ions which are formed by this process are separated by electrostatic and magnetic fields and impinged on a photographic plate. This permits not only high sensitivity to be obtained (by the integration principle of ion beams) but also high resolution.

The results appear as a series of lines with differing densities on the photoplate. The lines are measured optically with the darker lines indicating higher concentrations.

Selected isotopic spectral lines are recorded. These are then compared to values obtained for reference standards, and concentrations are calculated.

In this particular case, since the basic matrix of the samples is graphite, synthetic standards made in graphite are used for reference materials.

Figure 2-1 below shows an actual photoplate from an SSMS scan. The lines of different densities represent the various mass-to-charge ratios measured. Each line indicates a particular mass-to-charge. By selection of the appropriate isotopes, the concentrations of each element can be measured.

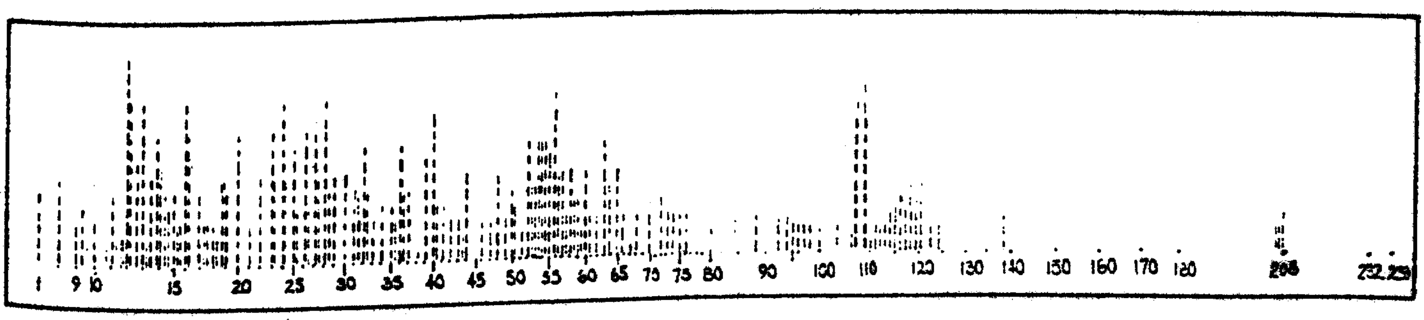

Figure 2-1 SSMS Photoplate

3.0 EXPERIMENTAL RESULTS

3.1 Major Constituents in Composites

Table I lists the mean value of the total volume of air passed through each of the composited samples from each sampling site. Table II lists the total air volume passed through each of the individual fourth-quarter samples from each site.

Tables III through VII list the major constituents in the quarterly composite samples from each of the sampling sites in micrograms per cubic meter. These values may be compared to the total particulate loading recorded using a Hi-Vol with a fiberglass filter at the same site.

The samples were generally lightly loaded. These elements represent the major constituents. The major elements varied slightly from location to location probably reflecting the mineralogy of the background dust.

3.2 Minor or Trace Elements in Composites

All samples were subjected to a semi-quantitative scan for over 50 elements. In a typical case, some 40+ were detected. The actual detection limits vary slightly from day to day and from sample to sample depending upon internal standard adjustments, sample size differences, isotope abundance and spectral background. Therefore, no uniform detection limit can be set for each element. The detection limit for elements in each sample is reflected by a less than (<) value.

Tables VIII- XII give a tabulation of the elements studied. Because of the very low levels of most elements, an exponential format is used. For example 2E-5 is equivalent to 2×10^{-5}

TABLE I

MEAN VALUES OF TOTAL AIR VOLUME FOR EACH COMPOSITED SAMPLE

Site	Quarter Composite	Mean Volume (m^3)
Newcastle	1	262
Newcastle	2	263
Newcastle	3	268
Newcastle	4	252
Glendive	1	120
Glendive	2	120
Glendive	3	123
Glendive	4	123
Garrison	1	82
Garrison	2	209
Garrison	3	198
Garrison	4	169
Ft. Peck	1	171
Ft. Peck	2	177
Ft. Peck	3	175
Ft. Peck	4	158
Belle Fourche	1	153
Belle Fourche	2	154
Belle Fourche	3	142
Belle Fourche	4	122

TABLE II

FOURTH QUARTER INDIVIDUAL TOTAL AIR VOLUMES

Site	Date	Volume (m^3)
Newcastle	6-5-75	254
	6-11-75	265
	6-17-75	257
	6-23-75	209
	6-29-75	265
	7-5-75	269
	7-11-75	261
	7-17-75	261
	7-23-75	265
	7-29-75	228
	8-4-75	254
	8-10-75	246
	8-16-75	259
	8-22-75	254
	8-28-75	239
Glendive	6-5-75	108
	6-11-75	152
	6-17-75	130
	6-23-75	152
	6-29-75	147
	7-5-75	124
	7-11-75	113
	7-17-75	119
	7-23-75	113
	7-29-75	124

TABLE II
(Continued)

Site	Date	Volume (m^3)
Garrison	6-5-75	159
	6-11-75	165
	6-17-75	159
	6-23-75	159
	6-29-75	159
	7-5-75	159
	7-11-75	159
	7-17-75	171
	7-23-75	184
	7-29-75	159
	8-4-75	223
	8-10-75	184
	8-16-75	171
	8-22-75	165
	8-28-75	159
	9-3-75	165
Belle Fourche	6-5-75	122
	6-11-75	122
	6-17-75	122
	6-23-75	122
	6-29-75	122
	7-5-75	123
	7-11-75	123
	7-17-75	123
	7-23-75	123
	7-29-75	123
	8-4-75	123
	8-10-75	123
	8-16-75	123

TABLE II
(Continued)

Site	Date	Volume (m^3)
Ft. Peck	6-5-75	157
	6-17-75	159
	6-23-75	157
	6-27-75	159
	7-5-75	160
	7-7-75	157
	7-17-75	157
	7-23-75	147
	7-29-75	153
	8-4-75	157
	8-10-75	169
	8-16-75	170
	8-22-75	170

TABLE III

MAJOR SPECIES IN NEWCASTLE QUARTERLY COMPOSITES

($\mu g/m^3$)

	Newcastle 1st Quarter Comp.	Newcastle 2nd Quarter Comp.	Newcastle 3rd Quarter Comp.	Newcastle 4th Quarter Comp.
Aluminum	1.1	0.8	0.3	0.8
Calcium	0.1	0.3	0.2	0.4
Chlorine	0.07	0.02	0.02	0.008
Fluorine	0.01	0.003	0.004	<0.02
Iron	0.4	0.1	0.09	0.4
Lead	0.05	0.01	0.02	0.01
Magnesium	0.2	0.3	0.1	0.2
Phosphorus	0.2	0.1	0.09	0.06
Potassium	0.1	0.04	0.1	0.3
Silicon	Major	Major	Major	Major
Sodium	0.3	0.2	0.2	0.4
Sulfur	0.1	0.02	0.07	0.005
Titanium	1.9	1.5	1.5	0.8
Mean High Volume Sample Loadings (ref 4)	24.9	8.3	11.3	40.3

TABLE IV

MAJOR SPECIES IN GLENDIVE QUARTERLY COMPOSITES

($\mu g/m^3$)

	Glendive 1st Quarter Comp.	Glendive 2nd Quarter Comp.	Glendive 3rd Quarter Comp.	Glendive 4th Quarter Comp.
Aluminum	2.5	0.4	0.7	1.3
Calcium	0.8	0.3	0.3	0.9
Chlorine	0.2	0.04	0.05	0.02
Fluorine	0.4	0.05	0.1	0.03
Iron	0.08	0.003	0.03	0.01
Lead	0.03	0.002	0.002	0.002
Magnesium	0.1	0.009	0.09	0.4
Phosphorus	0.02	0.07	0.02	0.02
Potassium	0.08	0.009	0.07	0.05
Silicon	Major	Major	Major	Major
Sodium	0.1	0.3	0.03	2.0
Sulfur	0.3	0.03	0.2	0.008
Titanium	1.7	3.3	2.4	1.6
Mean High Volume Sample Loadings (ref 4)	18.7	11.4	13.5	23.7

TABLE V

MAJOR SPECIES IN GARRISON QUARTERLY COMPOSITES

($\mu g/m^3$)

	Garrison 1st Quarter Comp.	Garrison 2nd Quarter Comp.	Garrison 3rd Quarter Comp.	Garrison 4th Quarter Comp.
Aluminum	2.4	0.5	1.0	3.6
Calcium	1.0	0.2	0.2	0.4
Chlorine	0.2	0.1	0.01	0.01
Fluorine	0.2	0.08	0.01	0.03
Iron	0.05	0.03	0.02	0.1
Lead	0.03	0.007	0.02	0.008
Magnesium	0.1	0.1	0.2	0.4
Phosphorus	0.1	0.04	0.1	0.05
Potassium	0.02	0.1	0.09	0.07
Silicon	Major	Major	Major	Major
Sodium	.06	0.4	0.5	2.0
Sulfur	0.06	0.1	0.1	0.03
Titanium	4.9	1.9	1.0	1.4
Mean High Volume Sample Loadings (ref 4)	31.5	40.0	18.6	34.1

TABLE VI

MAJOR SPECIES IN FT. PECK QUARTERLY COMPOSITES

($\mu g/m^3$)

	Ft. Peck 1st Quarter Comp.	Ft. Peck 2nd Quarter Comp.	Ft. Peck 3rd Quarter Comp.	Ft. Peck 4th Quarter Comp.
Aluminum	0.5	0.1	0.6	1.4
Calcium	0.1	0.4	0.3	0.1
Chlorine	0.3	0.05	0.07	0.008
Fluorine	0.06	0.03	0.09	0.03
Iron	0.01	0.006	0.06	0.06
Lead	0.003	0.009	0.01	0.003
Magnesium	0.04	0.09	0.07	0.2
Phosphorus	0.03	0.07	0.2	0.05
Potassium	0.04	0.07	0.2	0.05
Silicon	Major	Major	Major	Major
Sodium	0.6	0.2	0.5	0.9
Sulfur	0.06	0.2	0.03	0.1
Titanium	1.8	1.7	1.1	1.6
Mean High Volume Sample Loading (ref 4)	18.8	7.1	13.0	6.8

TABLE VII

MAJOR SPECIES IN BELLA FOURCHE QUARTERLY COMPOSITES

($\mu g/m^3$)

	Belle Fourche 1st Quarter Comp.	Belle Fourche 2nd Quarter Comp.	Belle Fourche 3rd Quarter Comp.	Belle Fourche 4th Quarter Comp.
Aluminum	2.6	1.3	0.7	1.8
Calcium	1.3	2.6	0.6	0.6
Chlorine	0.008	0.02	0.04	<0.02
Iron	0.4	0.3	0.07	0.06
Fluorine	0.02	0.05	0.01	<0.02
Magnesium	0.5	0.6	0.08	0.2
Lead	0.03	0.03	0.009	0.02
Phosphorus	0.2	0.3	0.06	0.04
Potassium	0.2	0.1	0.06	0.08
Silicon	Major	Major	Major	Major
Sodium	0.5	0.09	0.6	1.3
Sulfur	0.2	0.3	0.1	0.06
Titanium	3.3	0.2	2.8	1.2
Mean High Volume Sample Loading (ref 4)	19.1	8.9	14.9	39.2

TABLE VIII

DETAILED ANALYSES FOR NEWCASTLE COMPOSITES

($\mu g/m^3$)

	Newcastle 1st Quarter Composite	Newcastle 2nd Quarter Composite	Newcastle 3rd Quarter Composite	Newcastle 4th Quarter Composite
Aluminum	1E0	1E0	3E-1	8E-1
Antimony	2E-4	2E-4	2E-4	7E-5
Arsenic	4E-4	4E-4	1E-4	1E-4
Barium	8E-3	8E-3	7E-3	8E-3
Beryllium	<7E-6	<7E-6	1E-5	<4E-6
Bismuth	3E-4	5E-4	6E-4	1E-4
Cadmium	3E-5	2E-4	8E-5	8E-5
Calcium	1E-1	3E-1	2E-1	4E-1
Cerium	5E-4	2E-4	4E-4	5E-4
Chlorine	7E-2	<2E-2	<2E-2	<8E-3
Chromium	5E-3	2E-3	4E-3	5E-3
Cobalt	2E-4	3E-5	4E-5	2E-4
Copper	9E-3	6E-3	7E-3	3E-2
Fluorine	1E-2	8E-3	4E-3	<2E-2
Gallium	2E-4	9E-5	7E-5	6E-5
Germanium	7E-6	<3E-6	7E-6	4E-6
Iron	4E-1	1E-1	9E-2	4E-1
Lanthanum	3E-4	3E-4	3E-4	3E-4
Lead	5E-2	1E-2	2E-2	1E-2
Lithium	4E-4	5E-5	2E-5	4E-5
Magnesium	2E-1	3E-1	1E-1	2E-1
Manganese	6E-3	2E-3	1E-3	3E-3
Molybdenum	<2E-4	<2E-4	2E-5	2E-5
Nickel	8E-4	8E-4	1E-3	8E-4
Osmium	<2E-4	<2E-4	<2E-4	<3E-4
Palladium	<1E-4	<1E-4	<9E-5	<2E-4
Phosphorus	2E-1	1E-1	9E-2	6E-2
Platinum	<7E-6	<7E-6	<3E-6	<2E-4
Potassium	1E-1	4E-2	1E-1	3E-1
Rhenium	<2E-5	<2E-5	<3E-5	<1E-5
Rhodium	<2E-5	<2E-5	<2E-5	<4E-5
Rubidium	5E-4	2E-4	5E-4	2E-3
Ruthenium	<7E-5	<9E-5	<7E-5	<1E-4
Scandium	<1E-5	<1E-5	<1E-5	4E-5
Selenium	2E-4	7E-5	1E-4	1E-4
Silicon	<4E0	<4E0	<4E0	<3E0
Silver	3E-5	2E-6	1E-5	2E-5
Sodium	<3E-1	<2E-1	<2E-1	<4E-1
Strontium	5E-3	1E-2	8E-3	1E-3
Sulfur	1E-1	2E-2	7E-2	5E-5
Thallium	<7E-6	<7E-6	<3E-6	8E-6
Thorium	5E-5	4E-5	4E-5	8E-5
Tin	1E-3	4E-4	8E-4	1E-4
Titanium	<2E0	<2E0	<1E0	<8E-1
Uranium	2E-5	2E-5	2E-5	8E-5
Vanadium	2E-3	6E-4	9E-4	1E-6
Ytterbium	2E-5	3E-5	1E-5	[illegible]
Yttrium	9E-5	2E-4	3E-5	2E-4
Zinc	1E-2	1E-2	5E-3	1E-2
Zirconium	2E-3	7E-4	2E-4	1E-3

TABLE IX

DETAILED ANALYSES FOR GLENDIVE COMPOSITES

($\mu g/m^3$)

	Glendive 1st Quarter Composite	Glendive 2nd Quarter Composite	Glendive 3rd Quarter Composite	Glendive 4th Quarter Composite
Aluminum	2E0	4E-1	7E-1	1E0
Antimony	5E-4	2E-5	1E-4	<9E-5
Arsenic	3E-4	3E-4	2E-4	<4E-5
Barium	2E-2	1E-3	1E-2	6E-3
Beryllium	<3E-5	<3E-5	<3E-5	<8E-6
Bismuth	2E-3	4E-4	6E-4	1E-4
Cadmium	<6E-5	4E-5	5E-5	2E-5
Calcium	8E-1	3E-1	4E-1	9E-1
Cerium	7E-4	2E-4	4E-4	2E-4
Chlorine	2E-1	4E-2	5E-2	2E-2
Chromium	3E-2	2E-2	1E-2	6E-3
Cobalt	2E-4	<8E-6	<8E-6	8E-6
Copper	2E-2	7E-3	7E-3	1E-2
Fluorine	4E-1	<5E-2	1E-1	3E-2
Gallium	9E-5	6E-5	8E-5	<8E-6
Germanium	2E-5	2E-5	3E-5	<8E-6
Iron	8E-2	3E-3	3E-2	2E-2
Lanthanum	7E-4	1E-4	3E-4	1E-4
Lead	3E-2	2E-3	2E-3	8E-3
Lithium	8E-4	<2E-4	<1E-4	1E-3
Magnesium	1E-1	9E-3	9E-2	4E-1
Manganese	2E-2	<4E-3	<4E-3	<3E-3
Molybdenum	1E-4	8E-5	<4E-4	<3E-4
Nickel	2E-3	4E-4	1E-3	3E-3
Osmium	<2E-4	<1E-4	<2E-4	<6E-4
Palladium	<9E-5	<8E-5	<1E-4	<3E-4
Phosphorus	8E-2	7E-2	2E-2	2E-2
Platinum	<8E-6	<8E-6	<8E-6	<5E-4
Potassium	8E-2	9E-3	8E-2	<5E-2
Rhenium	<3E-5	<8E-5	7E-5	<3E-5
Rhodium	<3E-5	<2E-5	<3E-5	<9E-5
Rubidium	2E-3	4E-4	6E-4	6E-4
Ruthenium	<8E-5	<7E-5	<8E-5	3E-4
Scandium	<4E-5	<4E-5	<3E-5	<8E-6
Selenium	3E-5	3E-5	1E-4	2E-4
Silicon	<7E+1	[illegible]	[illegible]	[illegible]
Silver	3E-5	3E-5	3E-5	[illegible]
Sodium	1E-1	<3E-1	3E-2	[illegible]
Strontium	3E-2	7E-3	1E-2	7E-3
Sulfur	3E-5	3E-2	2E-1	8E-3
Thallium	<8E-6	<8E-6	<8E-6	<8E-6
Thorium	2E-4	7E-5	1E-4	6E-5
Tin	4E-3	6E-4	2E-3	8E-4
Titanium	2E0	<3E0	<3E0	<2E0
Uranium	1E-4	9E-5	2E-4	6E-5
Vanadium	3E-3	8E-4	2E-3	3E-4
Ytterbium	<6E-5	<5E-5	5E-5	<3E-5
Yttrium	2E-4	8E-5	8E-5	5E-5
Zinc	3E-2	1E-2	1E-2	8E-3
Zirconium	4E-3	3E-4	3E-3	5E-4

TABLE X

DETAILED ANALYSES FOR GARRISON COMPOSITES

($\mu g/m^3$)

	Garrison 1st Quarter Composite	Garrison 2nd Quarter Composite	Garrison 3rd Quarter Composite	Garrison 4th Quarter Composite
Aluminum	2E0	5E-1	1E0	4E0
Antimony	3E-4	1E-4	2E-5	9E-5
Arsenic	2E-4	2E-4	1E-4	2E-4
Barium	3E-2	2E-2	1E-2	5E-3
Beryllium	<5E-5	<2E-5	<2E-5	<5E-4
Bismuth	6E-4	2E-4	1E-4	7E-5
Cadmium	7E-5	2E-5	<4E-5	3E-5
Calcium	1E0	2E-5	2E-1	4E-1
Cerium	1E-3	5E-4	6E-4	4E-3
Chlorine	2E-1	1E-5	1E-2	<1E-2
Chromium	4E-2	6E-3	5E-3	2E-2
Cobalt	2E-4	2E-4	9E-5	1E-4
Copper	3E-2	4E-3	4E-3	2E-2
Fluorine	2E-1	8E-2	1E-2	<3E-2
Gallium	1E-4	1E-4	5E-5	2E-5
Germanium	4E-5	2E-5	3E-5	<5E-6
Iron	5E-2	3E-2	<6E-3	1E-1
Lanthanum	1E-3	9E-4	6E-4	1E-4
Lead	3E-2	7E-3	2E-2	8E-3
Lithium	1E-3	1E-3	<2E-4	3E-4
Magnesium	1E-1	1E-1	2E-1	4E-1
Manganese	<6E-3	1E-3	<4E-3	8E-4
Molybdenum	1E-4	<2E-4	<1E-4	<1E-4
Nickel	2E-3	8E-4	9E-4	8E-5
Osmium	<2E-4	<9E-5	<9E-5	<3E-4
Palladium	<1E-4	<5E-5	<5E-5	<1E-4
Phosphorus	1E-1	2E-2	1E-1	5E-2
Platinum	<1E-5	<4E-6	<5E-6	<2E-4
Potassium	2E-2	1E-1	9E-2	7E-2
Rhenium	<4E-5	<2E-5	<2E-5	<2E-5
Rhodium	<4E-5	<1E-5	<2E-5	<4E-5
Rubidium	1E-3	2E-4	4E-4	1E-3
Ruthenium	<1E-4	<4E-5	<4E-5	<1E-4
Scandium	<5E-5	<2E-5	<2E-5	<2E-5
Selenium	5E-4	2E-5	2E-4	5E-4
Silicon	<9E+1	<4E+1	<4E+1	<4E+1
Silver	5E-5	1E-5	2E-5	4E-5
Sodium	6E-2	6E-1	5E-1	2E0
Strontium	7E-2	8E-3	9E-3	8E-3
Sulfur	6E-2	1E-1	1E-1	[illegible]
Thallium	<1E-5	<4E-6	<5E-6	<9E-6
Thorium	1E-4	6E-5	9E-5	1E-4
Tin	3E-3	4E-4	1E-3	8E-4
Titanium	<5E0	<2E0	<1E0	<1E0
Uranium	1E-4	4E-5	5E-5	1E-4
Vanadium	2E-3	1E-3	1E-3	7E-4
Ytterbium	<7E-5	<3E-5	<3E-5	<3E-5
Yttrium	6E-4	1E-4	5E-5	1E-4
Zinc	2E-2	9E-3	9E-3	1E-2
Zirconium	6E-3	2E-3	2E-3	1E-3

TABLE XI

DETAILED ANALYSES FOR FT. PECK COMPOSITES

($\mu g/m^3$)

	Ft. Peck 1st Quarter Composite	Ft. Peck 2nd Quarter Composite	Ft. Peck 3rd Quarter Composite	Ft. Peck 4th Quarter Composite
Aluminum	5E-1	1E0	6E-1	1E-0
Antimony	<6E-5	2E-4	3E-4	3E-4
Arsenic	2E-4	2E-4	7E-4	2E-4
Barium	2E-3	3E-3	7E-3	9E-4
Beryllium	<2E-5	<2E-5	<2E-5	<6E-6
Bismuth	2E-4	1E-3	1E-3	2E-4
Cadmium	2E-5	3E-5	1E-4	3E-5
Calcium	1E-1	4E-1	3E-1	1E-1
Cerium	1E-4	2E-4	4E-4	2E-4
Chlorine	3E-1	5E-2	7E-2	8E-3
Chromium	2E-3	9E-3	7E-3	2E-3
Cobalt	8E-5	5E-5	1E-4	1E-5
Copper	3E-3	2E-2	3E-2	1E-2
Fluorine	<6E-2	3E-2	9E-2	<3E-2
Gallium	7E-5	7E-5	1E-4	1E-5
Germanium	<5E-6	1E-5	3E-5	<6E-6
Iron	2E-2	6E-3	6E-2	6E-2
Lanthanum	2E-4	3E-4	5E-4	6E-5
Lead	3E-3	9E-3	1E-2	3E-3
Lithium	<6E-5	2E-3	3E-4	<4E-4
Magnesium	4E-2	9E-2	7E-2	2E-1
Manganese	<4E-3	<3E-3	<3E-3	1E-3
Molybdenum	<1E-4	1E-4	8E-5	<2E-4
Nickel	2E-4	2E-3	5E-3	<7E-5
Osmium	<1E-4	<1E-4	<1E-4	<4E-4
Palladium	<8E-5	<8E-5	<6E-5	<2E-4
Phosphorus	3E-2	7E-2	1E-1	3E-2
Platinum	<1E-4	<1E-4	<9E-5	<3E-4
Potassium	<4E-2	7E-2	2E-1	5E-2
Rhenium	<1E-5	<2E-5	<2E-5	<2E-5
Rhodium	<2E-5	<2E-5	<2E-5	<6E-5
Rubidium	1E-4	1E-4	6E-4	3E-4
Ruthenium	<6E-5	<7E-5	<5E-5	<2E-4
Scandium	<6E-5	<3E-5	<2E+5	<6E-6
Selenium	2E-5	1E-4	2E-4	2E-4
Silicon	1E+1	<5E+1	<5E+1	<3E+1
Silver	1E-5	5E-5	3E-5	2E-5
Sodium	<6E-1	2E-1	9E-1	9E-1
Strontium	<6E-3	1E-2	1E-2	<4E-1
Sulfur	<6E-2	2E-1	3E-3	3E-1
Thallium	<5E-6	<1E-5	<5E-6	<6E-6
Thorium	2E-5	3E-5	1E-4	3E-5
Tin	1E-3	2E-2	1E-3	3E-4
Titanium	<2E0	<2E0	<1E0	<2E0
Uranium	2E-5	8E-5	3E-4	6E-5
Vanadium	4E-4	7E-4	2E-3	3E-4
Ytterbium	<3E-5	<5E-5	<3E-5	<3E-5
Yttrium	5E-5	7E-5	1E-4	5E-5
Zinc	4E-3	1E-2	2E-2	1E-2
Zirconium	6E-4	1E-3	1E-3	4E-4

TABLE XII

DETAILED ANALYSES FOR BELLE FOURCHE COMPOSITES

($\mu g/m^3$)

	Belle Fourche 1st Quarter Composite	Belle Fourche 2nd Quarter Composite	Belle Fourche 3rd Quarter Composite	Belle Fourche 4th Quarter Composite
Aluminum	3E0	1E0	7E-1	2E0
Antimony	2E-4	2E-4	1E-5	2E-5
Arsenic	3E-4	4E-3	6E-4	3E-4
Barium	2E-2	5E-3	3E-3	8E-3
Beryllium	<1E-5	<1E-5	<2E-5	<8E-6
Bismuth	1E-3	1E-3	5E-4	2E-4
Cadmium	2E-4	2E-4	4E-5	5E-5
Calcium	1E0	<3E0	6E-1	6E-1
Cerium	8E-4	8E-4	4E-4	4E-4
Chlorine	8E-3	1E-2	4E-2	<2E-2
Chromium	9E-3	1E-2	8E-3	3E-3
Cobalt	1E-4	4E-4	5E-5	6E-4
Copper	2E-2	2E-2	1E-2	2E-2
Fluorine	2E-2	9E-2	1E-2	<2E-2
Gallium	2E-4	2E-4	7E-5	4E-5
Germanium	6E-6	2E-5	<7E-6	8E-6
Iron	4E-1	3E-1	7E-2	6E-2
Lanthanum	6E-4	8E-4	3E-4	2E-4
Lead	5E-2	3E-2	9E-3	2E-2
Lithium	3E-4	<3E-4	8E-5	<4E-4
Magnesium	5E-1	6E-1	8E-2	2E-1
Manganese	7E-4	6E-3	<3E-3	2E-3
Molybdenum	9E-5	5E-4	4E-5	<2E-4
Nickel	1E-3	3E-3	3E-3	6E-4
Osmium	<2E-4	<3E-4	<1E-4	<5E-4
Palladium	<1E-4	<2E-4	<6E-5	<2E-4
Phosphorus	2E-1	3E-1	6E-2	4E-2
Platinum	<2E-4	<3E-4	<1E-4	<4E-4
Potassium	2E-1	1E-1	6E-2	8E-2
Rhenium	<3E-5	<1E-5	<3E-5	<2E-5
Rhodium	<3E-5	<5E-5	<2E-5	<7E-5
Rubidium	1E-3	4E-4	6E-4	4E-4
Ruthenium	<1E-4	<1E-4	<6E-5	<2E-4
Scandium	<2E-4	<1E-4	<2E-5	<8E-6
Selenium	1E-4	2E-4	1E-4	2E-4
Silicon	<7E0	<2E+1	<3E+1	<6E+1
Silver	2E-5	3E-5	3E-5	2E-5
Sodium	<5E-1	9E-2	<6E-1	1E0
Strontium	2E-2	1E-2	8E-3	<6E-3
Sulfur	2E-1	3E-1	1E-1	6E-2
Thallium	<6E-6	<6E-6	<7E-6	9E-5
Thorium	2E-4	1E-4	6E-5	7E-6
Tin	7E-4	1E-3	2E-3	4E-4
Titanium	<3E0	2E-1	<3E0	<1E0
Uranium	4E-5	5E-5	4E-5	8E-6
Vanadium	1E-3	2E-2	1E-3	1E-3
Ytterbium	<2E-4	<3E-5	<4E-5	<4E-5
Yttrium	2E-4	9E-5	1E-4	7E-5
Zinc	1E-2	3E-2	1E-2	7E-3
Zirconium	3E-3	3E-3	3E-3	1E-4

All detection limits reported are actual calculated values. Therefore, depending upon internal standard adjustments, sample size differences, choice of analysis, isotope, and spectral background, these values may differ somewhat from sample to sample. Tables XIII-XVII list the results for the individual samples collected at Newcastle, Glendive, Garrison, Ft. Peck, and Belle Fourche sites, respectively.

TABLE XIII

INDIVIDUAL FOURTH QUARTER FILTERS FROM NEWCASTLE

($\mu g/m^3$)

(All Data Rounded to One Significant Figure)

	6/5/75	6/11/75	6/17/75	6/23/75	6/29/75	7/5/75	7/11/75	7/17/75	7/23/75	7/29/75	8/4/75	8/10/75	8/16/75	8/22/75	8/28/75
Aluminum	2E-1	3E-1	1E-2	<7E-2	1E0	6E-1	3E-1	1E0	3E0	3E0	1E0	4E-1	8E-1	6E0	1E0
Antimony	<3E-5	<3E-5	<3E-5	9E-5	7E-5	<3E-5	<3E-5	<3E-5	7E-3	<3E-5	<3E-5	<4E-5	<3E-5	<4E-5	9E-5
Arsenic	6E-4	<5E-5	6E-5	<7E-5	8E-5	6E-5	2E-4	3E-4	6E-4	8E-5	1E-4	2E-3	6E-4	4E-3	9E-5
Barium	2E-3	5E-3	7E-4	2E-3	2E-2	5E-3	1E-2	1E-2	3E-3	6E-3	2E-3	1E-2	1E-2	6E-2	6E-2
Beryllium	<3E-6	<3E-6	<3E-6	<4E-6	<3E-6	<3E-7	<3E-6	<3E-6	<3E-6	<4E-6	<4E-6	<4E-6	<3E-6	7E-6	2E-5
Bismuth	7E-4	5E-4	2E-4	6E-4	6E-4	2E-4	6E-4	2E-4	6E-4	5E-4	2E-4	7E-4	2E-4	8E-8	2E-4
Cadmium	6E-5	<3E-5	<2E-5	<4E-5	<2E-5	<2E-5	<2E-5	5E-5	5E-5	<2E-5	<1E-5	2E-4	<3E-5	<3E-6	<3E-5
Calcium	1E-1	1E-1	1E-1	5E-1	8E-1	7E-1	3E-1	4E-1	4E-1	5E-1	1E0	4E-1	<1E-1	1E0	1E0
Cerium	1E-4	4E-4	2E-5	6E-5	9E-4	4E-4	3E-4	1E-4	2E-4	4E-4	2E-4	3E-4	2E-4	4E-1	2E-3
Chorine	<1E-2	<2E-3	<1E-2	<6E-3	3E-3	<4E-3	<7E-3	<7E-3	<7E-3	<8E-3	<8E-3	<7E-3	<5E-3	<1E-2	<1E-2
Chromium	3E-4	<8E-4	2E-3	2E-3	<1E-2	2E-3	2E-3	2E-3	3E-3	2E-3	4E-3	3E-3	5E-4	8E-3	4E-3
Cobalt	4E-5	3E-5	7E-6	9E-6	1E-4	1E-4	3E-5	2E-4	3E-5	1E-4	1E-4	1E-4	3E-5	9E-4	2E-4
Copper	1E-2	<2E-3	5E-3	1E-2	3E-2	1E-2	2E-3	3E-2	5E-3	1E-2	6E-3	3E-2	5E-3	4E-2	2E-2
Fluorine	<1E-2	<3E-2	<1E-2	<3E-2	3E-2	<3E-2	<1E-2	8E-3	<1E-2	4E-2	1E-2	1E-2	<3E-2	3E-1	1E-1
Gallium	2E-5	5E-5	<3E-6	4E-6	5E-5	3E-6	2E-5	1E-5	2E-5	2E-5	2E-5	1E-4	2E-5	7E-4	2E-4
Germanium	<3E-6	<2E-4	<3E-6	<4E-6	7E-6	<3E-6	<3E-6	<3E-6	<3E-6	<4E-6	8E-6	<4E-6	<3E-6	7E-6	8E-6
Iron	5E-1	1E0	2E-4	2E-2	3E-1	5E-1	2E-1	5E-1	2E-1	1E0	1E0	1E0	1E-1	7E0	1E0
Lanthanum	7E-5	1E-4	<7E-6	1E-5	2E-4	2E-4	9E-5	4E-5	9E-5	2E-4	1E-4	2E-4	1E-4	1E-3	1E-3
Lead	6E-3	5E-3	5E-4	5E-3	3E-2	3E-2	8E-3	3E-2	1E-2	6E-3	4E-3	3E-2	4E-3	3E-2	2E-2
Lithium	5E-4	[illegible]	4E-4	3E-4	<1E-4	7E-4	<2E-4	1E-4	7E-4	2E-3	8E-4	5E-3	<1E-4	5E-3	2E-3
Magnesium	4E-1	[illegible]	6E-2	6E0	3E-1	2E-1	8E-3	5E-2	3E-1	2E+1	2E0	4E-1	4E-1	2E0	1E0
Manganese	3E-2	[illegible]	3E-3	1E-2	2E-2	1E-2	3E-3	1E-2	3E-2	3E-2	6E-2	3E-2	3E-3	2E-1	3E-2
Molybdenum	<8E-5	<4E-5	<1E-4	<6E-5	<7E-5	<1E-4	<9E-5	<9E-5	<9E-5	<3E-5	<9E-5	<1E-4	<3E-5	<8E-5	<1E-4
Nickel	1E-4	[illegible]	<1E-4	<1E-4	<1E-4	<1E-4	9E-5	2E-3	<1E-4	<3E-5	<1E-4	1E-4	<1E-4	3E-3	5E-4
Osmium	<6E-5	[illegible]	<5E-5	<7E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<6E-5	<6E-5	<5E-5	<5E-5	<6E-5	<6E-5
Palladium	<3E-5	[illegible]	<3E-5	<3E-5	<3E-5	<3E-5	<2E-5	<2E-5	<2E-5	<3E-5	<3E-5	<2E-5	<3E-5	<3E-5	<3E-5
Phosphorus	2E-1	[illegible]	1E-1	2E-1	2E-1	1E-1	1E-1	2E-1	1E-1	4E-1	1E-1	1E-1	4E-1	4E-1	4E-1
Platinum	<4E-5	<6E-5	<4E-5	<5E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<5E-5
Potassium	1E-1	[illegible]	3E-3	3E-3	5E-2	2E-1	1E-1	1E0	1E-1	3E-1	6E-1	6E-1	2E-1	5E0	6E-1
Rhenium	<1E-5	[illegible]	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5
Rhodium	<7E-6	[illegible]	<7E-6	<1E-5	<1E-5	<1E-5	<7E-6	<7E-6	<2E-6	<8E-6	<8E-6	<8E-6	<7E-6	<7E-6	<8E-6
Rubidium	1E-4	[illegible]	<2E-5	<3E-5	5E-4	2E-4	4E-4	4E-4	2E-4	5E-4	5E-4	3E-3	1E-4	7E-3	5E-3
Ruthenium	<2E-5	[illegible]	<2E-5	<3E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5
Scandium	<1E-5	[illegible]	<1E-5	<1E-5	<1E-5	<1E-5	1E-5	<1E-5	<1E-5	1E-4	5E-5	1E-4	<1E-5	9E-4	2E-4
Selenium	5E-5	[illegible]	<3E-6	<2E-5	5E-5	5E-5	3E-5	8E-5	3E-4	5E-5	4E-5	2E-4	5E-5	5E-4	6E-5
Silicon	<6E0	[illegible]	<6E0	<6E0	<6E0	<5E0	<7E0	<7E0	<6E0	<1E+1	<2E+1	<1E+1	<1E+1	<3E+1	<1E41
Silver	<2E-5	[illegible]	<2E-5	<2E-5	<2E-5	<1E-5	<1E-5	5E-5	1E-5	<1E-5	<1E-5	2E-4	2E-5	2E-5	2E-5
Sodium	<3E-1	[illegible]	<2E-5	<1E-5	<4E-1	<1E-1	<9E-2	3E-1	<3E-1	<2E-1	<1E-1	<1E-1	<3E-1	5E-1	<5E-1
Strontium	<2E-3	[illegible]	<2E-3	1E-4	4E-3	5E-3	<4E-3	4E-3	4E-3	<4E-3	5E-3	5E-3	<2E-3	2E-2	5E-6
Sulfur	2E-2	[illegible]	<3E-2	<7E-2	2E-1	2E-2	<5E-2	2E-2	6E-2	2E-2	8E-2	7E-2	<5E-2	2E-1	8E-2
Thallium	<7E-5	<7E-5	<7E-5	<9E-5	<7E-5	<7E-5	<7E-5	<7E-5	<7E-5	<8E-5	<8E-5	<7E-5	<7E-5	<8E-5	<8E-5
Thorium	7E-5	<6E-5	<7E-5	<9E-5	1E-4	<7E-5	7E-5	9E-5	<6E-5	1E-4	5E-4	3E-4	<7E-5	4E-4	3E-4
Tin	2E-4	[illegible]	<2E-4	1E-3	7E-4	2E-4	2E-4	4E-4	1E-4	<2E-6	<4E-5	1E-3	2E-4	9E-4	3E-4
Titanium	<2E0	[illegible]	<2E0	4E0	2E0	<2E0	2E0	2E0	9E-1	<1E0	<2E0	2E0	<9E-1	7E-1	1E0
Uranium	<4E-5	[illegible]	<4E-5	<5E-5	5E-5	<3E-5	<3E-5	5E-5	<3E-5	5E-5	<3E-5	1E-4	4E-5	2E-4	1E-4
Vanadium	5E-4	[illegible]	2E-5	8E-5	1E-3	1E-3	4E-4	1E-3	4E-4	5E-4	3E-3	8E-3	2E-4	8E-3	5E-3
Ytterbium	<9E-5	[illegible]	<9E-5	<1E-4	<8E-5	<8E-5	<8E-5	<8E-5	<8E-5	<9E-5	<8E-6	<8E-5	<8E-5	<1E-4	<1E-4
Yttrium	4E-5	[illegible]	1E-6	1E-5	1E-4	1E-4	9E-5	9E-5	9E-5	4E-5	2E-4	4E-4	1E-5	1E-3	5E-4
Zinc	3E-3	[illegible]	7E-4	4E-3	1E-3	2E-3	5E-3	5E-2	5E-3	8E-5	6E-3	5E-2	1E-3	2E-2	6E-3
Zirconium	1E-4	[illegible]	<2E-4	2E-4	2E-3	6E-4	6E-4	6E-4	6E-4	1E-4	2E-4	4E-3	1E-4	1E-2	8E-3

TABLE XIV

INDIVIDUAL FOURTH QUARTER FILTERS FROM GLENDIVE

(μg/m³)

(All Data Rounded to One Significant Figure)

	6/5/75	6/11/75	6/17/75	6/23/75	6/29/75	7/5/75	7/11/75	7/17/75	7/23/75	7/29/75
Aluminum	9E-2	3E-2	8E-2	4E-1	9E-1	<2E-1	1E0	2E0	5E-2	1E-1
Antimony	<2E-5	<1E-5	<2E-5	<1E-5	<1E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5
Arsenic	<8E-5	<7E-5	6E-4	<6E-5	<6E-5	3E-4	<8E-5	2E-4	9E-5	3E-4
Barium	3E-3	5E-4	2E-3	5E-4	5E-4	2E-3	3E-3	7E-4	<6E-4	6E-4
Beryllium	<3E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<3E-5	<3E-5	<3E-5	<2E-5
Bismuth	1E-4	2E-4	3E-4	2E-4	3E-5	3E-4	5E-5	1E-4	5E-5	1E-4
Cadmium	4E-5	<4E-5	<5E-5	<2E-5	<3E-5	<5E-5	7E-5	<5E-5	<2E-5	7E-5
Calcium	1E-1	1E-1	4E-1	1E-1	4E-1	2E-1	2E-1	2E-1	1E-1	2E-1
Cerium	3E-4	1E-4	4E-4	1E-4	3E-4	1E-4	3E-4	1E-4	6E-5	1E-4
Chlorine	<5E-3	<4E-3	<8E-3	<7E-3	<6E-3	<3E-3	<3E-3	<6E-3	<1E-2	<3E-2
Chromium	1E-2	4E-3	7E-3	7E-4	3E-4	2E-3	1E-3	4E-3	5E-3	4E-3
Cobalt	<3E-5	<1E-5	<7E-6	<1E-5	3E-5	<8E-6	<8E-6	5E-5	<8E-6	2E-5
Copper	2E-2	2E-2	3E-2	2E-2	3E-3	1E-2	4E-3	2E-2	1E-2	1E-2
Fluorine	<5E-2	<3E-2	<4E-2	<4E-2	<3E-2	6E-3	<6E-3	<6E-2	<1E-2	2E-2
Gallium	<9E-6	6E-6	3E-5	2E-5	6E-6	8E-6	8E-6	8E-6	<8E-6	8E-6
Germanium	<9E-6	1E-5	<7E-6	<6E-6	<6E-6	2E-5	<8E-6	<8E-6	<8E-6	<8E-6
Iron	7E-2	[illegible]	3E-[illegible]	2E-2	2E-1	7E-2	2E-1	2E-1	2E-2	8E-2
Lanthanum	1E-4	5E-5	1E-4	8E-5	1E-4	8E-5	1E-4	2E-5	3E-5	1E-4
Lead	4E-3	3E-3	2E-2	2E-3	3E-3	9E-3	4E-3	4E-3	2E-3	4E-3
Lithium	2E-3	2E-3	5E-4	9E-4	1E-3	7E-4	2E-3	6E-4	<2E-4	6E-4
Magnesium	2E-1	<4E-2	1E-1	1E-1	1E-1	2E-2	2E-1	2E-1	8E-2	2E-1
Manganese	6E-3	<3E-3	7E-3	<3E-3	3E-3	6E-4	<4E-3	6E-4	2E-3	1E-3
Molybdenum	<3E-4	<1E-4	<9E-5	<5E-5	<1E-4	<6E-5	<7E-5	<7E-5	<3E-4	<1E-4
Nickel	<2E-4	1E-4	6E-4	9E-5	<1E-4	<6E-5	<1E-4	<2E-4	<2E-4	9E-4
Osmium	<3E-4	<1E-4	<1E-4	<9E-5	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4
Palladium	<4E-5	<5E-5	<5E-5	<5E-5	<5E-5	<6E-5	<6E-5	<6E-5	<6E-5	<6E-5
Phosphorus	1E-2	1E-4	9E-3	<2E-2	3E-2	<2E-2	<2E-3	5E-1	2E-3	3E-2
Platinum	<1E-4	<7E-5	<8E-5	<7E-5	<7E-5	<9E-5	<1E-4	<9E-5	<1E-4	<9E-5
Potassium	3E-2	<2E-2	1E-1	5E-3	1E-1	3E-2	3E-3	2E-1	8E-2	2E-1
Rhenium	<4E-5	<3E-5	<2E-5	<2E-5	<2E-5	<2E-5	<3E-5	<3E-5	<3E-5	<2E-5
Rhodium	<8E-5	1E-5	<2E-5	<1E-5	<1E-5	<2E-5	<2E-5	<3E-5	<2E-5	<2E-5
Rubidium	2E-4	1E-4	8E-4	2E-4	7E-4	1E-4	2E-4	3E-4	<4E-5	2E-4
Ruthenium	<6E-5	<4E-5	<5E-5	<4E-5	<4E-5	<5E-5	<5E-5	<9E-5	<5E-5	<5E-5
Scandium	<9E-5	<4E-3	<2E-5	3E-5	<3E-5	<3E-5	<4E-5	<3E-5	<4E-5	<3E-5
Selenium	1E-4	1E-4	1E-4	<6E-5	3E-5	4E-5	3E-5	4E-5	3E-5	4E-5
Silicon	3E+1	3E+1	3E+1	3E+1	2E+1	<3E+1	3E+1	4E+1	<4E+1	<4E+1
Silver	5E-5	1E-4	1E-4	3E-5	8E-5	<2E-5	3E-5	<2E-5	4E-5	3E-4
Sodium	3E-1	7E-2	6E-1	7E-1	4E-1	9E-1	8E-1	9E-1	2E0	3E0
Strontium	<5E-3	<5E-3	<5E-3	<5E-3	<2E-3	4E-3	<4E-3	<3E-3	<7E-3	<6E-3
Sulfur	<9E-2	<7E-2	9E-2	<7E-2	<8E-2	<8E-2	<9E-2	1E-1	3E-3	8E-3
Thallium	<8E-5	<5E-3	<3E-5	3E-5	<3E-5	4E-5	<4E-5	<4E-5	<4E-5	<4E-5
Thorium	3E-5	3E-5	3E-5	<3E-5	3E-5	<3E-5	<4E-5	3E-5	4E-5	4E-5
Tin	2E-4	<3E-4	2E-3	<3E-4	<3E-4	3E-4	<4E-5	<3E-4	<4E-4	<3E-4
Titanium	[illegible]	<1E0	<3E0	<2E0	<3E0	<2E0	<3E-4	<2E0	2E0	<2E0
Uranium	[illegible]	2E-5	2E-5	<2E-5	2E-5	2E-5	<2E0	3E-5	<3E-5	3E-5
Vanadium	[illegible]	3E-4	6E-4	6E-4	8E-4	2E-4	4E-4	6E-4	2E-4	2E-4
Ytterbium	[illegible]	<5E-5	<5E-5	<5E-5	<5E-5	<6E-5	<7E-5	<7E-5	<8E-5	<6E-5
Yttrium	[illegible]	2E-5	1E-4	9E-5	4E-5	3E-5	4E-5	2E-5	2E-5	2E-5
Zinc	[illegible]	9E-3	8E-3	7E-3	2E-3	2E-3	3E-3	4E-3	9E-3	3E-3
Zirconium	[illegible]	<4E-4	5E-4	3E-4	1E-4	<2E-4	<3E-4	<4E-4	<2E-4	<3E-4

TABLE XV

INDIVIDUAL FOURTH QUARTER FILTERS FROM GARRISON

($\mu g/m^3$)

(All Data Rounded to One Significant Figure)

	6/5/75	6/11/75	6/17/75	6/23/75	6/29/75	7/5/75	7/11/75	7/17/75
Aluminum	2E-1	<1E-1	<3E-2	1E-1	5E-1	2E-1	2E-1	1E-1
Antimony	3E-4	<5E-5	<4E-5	1E-4	1E-4	3E-3	3E-4	1E-5
Arsenic	9E-4	2E-4	2E-4	9E-4	<2E-4	9E-4	<2E-4	8E-4
Barium	4E-2	4E-3	9E-3	4E-2	4E-2	1E-2	4E-2	8E-3
Beryllium	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5
Bismuth	4E-4	2E-4	6E-4	6E-4	2E-3	6E-4	6E-4	2E-4
Cadmium	<4E-6	1E-4	<4E-5	<4E-5	1E-4	1E-4	6E-5	1E-5
Calcium	2E0	2E0	<2E+1	2E0	3E0	5E0	2E0	2E0
Cerium	3E-4	3E-4	2E-4	3E-4	8E-4	8E-4	8E-4	1E-4
Chlorine	9E-5	<3E-2	9E-5	7E-4	5E-2	1E-3	5E-4	<2E-2
Chromium	1E-2	1E-2	2E-2	6E-3	1E-2	1E-2	1E-2	6E-3
Cobalt	1E-4	4E-4	2E-5	1E-4	9E-5	4E-4	4E-4	1E-4
Copper	5E-2	5E-2	5E-2	5E-2	8E-2	5E-2	4E-2	5E-2
Fluorine	<5E-2	<3E-2	<1E-2	<4E-2	<4E-2	<2E-2	<2E-2	<4E-3
Gallium	8E-5	2E-5	6E-6	3E-5	6E-6	2E-4	8E-5	1E-4
Germanium	<4E-6	<6E-6	<6E-6	<6E-6	<6E-6	3E-5	<6E-6	<5E-6
Iron	3E-1	[illegible]	1E-1	3E-1	2E-1	7E-1	6E-1	3E-1
Lanthanum	2E-4	[illegible]	7E-5	2E-4	2E-4	6E-4	6E-4	8E-5
Lead	2E-2	[illegible]	8E-3	2E-2	4E-2	4E-2	2E-2	1E-2
Lithium	1E-3	<3E-4	<3E-4	<6E-4	<6E-6	2E-3	6E-4	9E-5
Magnesium	2E-1	1E-1	1E-1	4E-1	6E-2	1E-1	3E-1	3E-1
Manganese	2E-2	1E-2	4E-3	2E-2	2E-2	7E-3	6E-3	2E-2
Molybdenum	<3E-4	<2E-4	<2E-4	<7E-5	<6E-5	<1E-4	<1E-4	<2E-4
Nickel	2E-4	2E-4	9E-4	2E-4	2E-4	6E-4	9E-4	5E-4
Osmium	<2E-5	<4E-5	<9E-5	<9E-5	<9E-5	<9E-5	<9E-5	<8E-5
Palladium	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5
Phosphorus	[illegible]	[illegible]	<1E-2	8E-3	8E-2	8E-3	6E-3	4E-2
Platinum	<[illegible]	<[illegible]	<7E-5	<7E-5	<7E-5	<7E-5	<7E-5	<6E-5
Potassium	[illegible]	[illegible]	9E-2	1E-1	3E-2	3E-1	1E-1	2E0
Rhenium	<[illegible]	[illegible]	[illegible]	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5
Rhodium	<[illegible]	[illegible]	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5
Rubidium	[illegible]	[illegible]	6E-4	2E-3	4E-3	3E-3	2E-3	1E-3
Ruthenium	<[illegible]	[illegible]	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5
Scandium	<[illegible]	[illegible]	<8E-5	<8E-5	<8E-5	6E-4	<8E-5	3E-4
Selenium	[illegible]	[illegible]	1E-3	3E-4	3E-4	1E-3	3E-4	2E-1
Silicon	[illegible]	[illegible]	<5E-1	<5E-1	<4E+1	<2E+1	<2E-1	<4E-1
Silver	[illegible]	[illegible]	8E-5	2E-5	2E-4	3E-4	8E-5	8E-5
Sodium	1E0	2E0	3E-1	1E0	1E0	<5E-5	3E-1	1E0
Strontium	[illegible]	1E-2	8E-3	3E-2	4E-2	3E-2	2E-3	1E-2
Sulfur	[illegible]	4E-1	3E-1	6E-1	6E-1	6E-1	1E-1	5E-1
Thallium	<[illegible]	<3E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4
Thorium	[illegible]	5E-5	<4E-5	4E-5	5E-5	3E-4	1E-4	7E-5
Tin	[illegible]	4E-3	5E-3	3E-3	1E-2	2E-3	2E-3	2E-3
Titanium	[illegible]	2E0	3E0	3E0	3E-1	2E0	8E0	2E0
Uranium	[illegible]	2E-5	3E-5	6E-5	6E-5	8E-5	6E-5	6E-5
Vanadium	[illegible]	3E-3	1E-3	3E-3	2E-3	1E-2	3E-3	6E-3
Ytterbium	<4E-4	<1E-4	<4E-4	<1E-4	1E-4	<4E-5	<1E-4	<1E-4
Yttrium	3E-4	3E-5	3E-5	3E-4	7E-4	7E-4	3E-4	1E-4
Zinc	2E-2	4E-2	2E-2	3E-2	8E-2	8E-3	2E-2	2E-4
Zirconium	3E-[illegible]	1E-3	2E-3	2E-3	1E-3	6E-3	2E-3	1E-2

	7/23/75	7/29/75	8/4/75	8/10/75	8/16/75	8/22/75	8/28/75	9/3/75
Aluminum	8E-1	2E-1	<2E-2	1E-1	<3E-2	<7E-2	<1E-1	2E-1
Antimony	4E-4	1E-4	<2E-5	1E-4	<5E-5	<6E-6	3E-4	1E-4
Arsenic	3E-4	8E-4	<2E-4	3E-4	<2E-4	<2E-4	<2E-4	<2E-4
Barium	8E-2	4E-2	2E-3	8E-3	1E-3	2E-3	4E-3	9E-3
Beryllium	<2E-5	<2E-5	<1E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5
Bismuth	2E-2	6E-4	5E-5	2E-4	<5E-5	7E-5	<6E-5	7E-5
Cadmium	<4E-5	1E-4	<1E-5	3E-5	<2E-5	<2E-5	<2E-5	<2E-5
Calcium	2E0	2E0	6E-1	<3E-1	8E-1	2E0	2E0	2E0
Cerium	1E-3	8E-4	8E-5	1E-4	4E-5	1E-4	2E-4	2E-4
Chlorine	<2E-2	<8E-3	<6E-3	<1E-2	<1E-2	<8E-3	<1E-2	<1E-2
Chromium	1E-2	6E-3	4E-3	2E-3	2E-3	6E-3	2E-3	6E-3
Cobalt	2E-4	6E-4	<4E-6	7E-5	2E-5	4E-5	2E-4	4E-5
Copper	7E-2	2E-2	9E-3	2E-2	1E-2	2E-2	1E-2	3E-2
Fluorine	<1E-2	<2E-2	<7E-3	<2E-2	<1E-2	2E-2	5E-2	<4E-2
Gallium	7E-5	2E-4	4E-6	7E-5	2E-5	3E-5	4E-5	5E-5
Germanium	<5E-6	<6E-6	<4E-6	<5E-6	<5E-6	<6E-6	1E-5	6E-6
Iron	5E-1	6E-1	3E-2	3E-1	3E-2	8E-3	1E-1	3E-1
Lanthanum	5E-4	2E-4	2E-5	6E-5	<1E-5	4E-5	7E-5	8E-5
Lead	2E-2	2E-2	1E-3	1E-2	1E-3	4E-3	1E-2	2E-2
Lithium	2E-4	9E-4	<2E-4	5E-4	<9E-5	1E-4	<3E-4	3E-4
Magnesium	1E-1	3E-1	<3E-2	3E-1	5E-5	2E-1	2E-1	3E-1
Manganese	2E-2	6E-3	<2E-3	3E-3	6E-3	<2E-3	7E-3	2E-2
Molybdenum	<1E-4	<6E-5	<1E-4	<6E-5	<4E-5	<4E-5	2E-4	<1E-4
Nickel	5E-4	3E-4	<1E-4	3E-5	<3E-4	1E-4	2E-4	2E-4
Osmium	<8E-5	<8E-5	<6E-5	<8E-5	<8E-5	<8E-5	<9E-5	<8E-5
Palladium	<4E-5	<4E-4	<3E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5
Phosphorus	4E-2	<1E-2	<5E-3	3E-2	<1E-2	<1E-2	8E-3	5E-2
Platinum	<6E-5	<2E-5	<5E-5	<4E-5	<6E-5	<7E-5	<7E-5	<7E-5
Potassium	2E-2	8E-2	<2E-2	7E-2	<2E-2	<5E-2	1E-1	3E-1
Rhenium	<2E-5	<2E-5	<1E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5
Rhodium	<1E-5	<1E-5	4E-6	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5
Rubidium	1E-3	4E-3	2E-4	7E-4	1E-4	3E-4	2E-3	2E-3
Ruthenium	<3E-5	<4E-5	<3E-5	<2E-3	<4E-5	4E-5	<4E-5	<4E-5
Scandium	<7E-5	3E-4	<5E-5	<7E-5	<7E-5	<7E-5	<8E-5	<7E-5
Selenium	8E-4	8E-5	3E-5	2E-4	1E-4	2E-5	8E-5	1E-4
Silicon	<4E-1	2E-1	<2E-1	<4E-1	<5E-1	<5E-1	3E-1	3E-1
Silver	2E-4	2E-4	1E-5	2E-5	2E-5	2E-5	2E-[illegible]	7E-5
Sodium	1E0	3E-1	<3E-1	1E0	<8E-4	3E-1	3E-1	1E0
Strontium	4E-2	1E-2	<3E-3	<4E-3	<4E-3	<5E-3	<5E-3	1E-2
Sulfur	8E-1	1E-3	3E-3	1E-3	<5E-2	3E-1	3E-1	1E-1
Thallium	<9E-5	<1E-4	<4E-5	<9E-5	<1E-4	<1E-4	<1E-4	<1E-4
Thorium	4E-5	6E-5	<2E-5	<3E-5	<4E-5	<4E-5	<4E-5	<4E-5
Tin	4E-3	5E-3	6E-4	7E-4	2E-4	7E-4	8E-4	2E-3
Titanium	9E0	9E0	4E0	6E-1	2E0	<2E0	2E0	3E0
Uranium	2E-3	3E-4	<4E-6	2E-5	<2E-5	2E-5	<2E-5	<2E-5
Vanadium	2E-3	6E-3	4E-4	2E-3	2E-4	1E-3	3E-3	3E-3
Ytterbium	<1E-4	<3E-4	<4E-5	<1E-4	<4E-4	<1E-4	<1E-4	<1E-4
Yttrium	6E-4	7E-4	2E-3	8E-5	5E-4	4E-4	1E-4	1E-4
Zinc	3E-2	2E-2	2E-4	7E-3	8E-3	8E-3	2E-2	4E-3
Zirconium	3E-3	8E-3	1E-4	4E-4	<3E-4	6E-4	6E-4	2E-3

TABLE XVI

INDIVIDUAL FOURTH QUARTER FILTERS FROM BELLE FOURCHE

(μg/m^3)

(All Data Rounded to One Significant Figure)

	6/5/75	6/11/75	6/17/75	6/23/75	6/29/75	7/5/75	7/11/75	7/17/75	7/23/75	7/29/75	8/4/75	8/10/75	8/16/75
Aluminum	3E-1	2E-1	<4E-2	<3E-1	<2E-1	<2E-1	<2E-1	<2E-1	<2E-1	2E-1	<8E-2	<2E-1	<4E-2
Antimony	6E-4	3E-4	4E-4	<7E-5	<1E-4	2E-4	<7E-5	<7E-5	6E-4	2E-3	8E-4	6E-4	8E-6
Arsenic	8E-3	3E-3	8E-4	<3E-4	5E-4	<3E-4	<3E-4	4E-4	4E-4	3E-3	1E-3	1E-3	4E-4
Barium	9E-3	8E-4	5E-3	1E-2	5E-3	3E-3	5E-3	1E-2	2E-2	2E-2	5E-3	8E-3	1E-3
Beryllium	<3E-6	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5
Bismuth	7E-4	1E-4	3E-4	3E-4	1E-4	1E-4	1E-4	8E-5	<7E-5	2E-4	2E-4	1E-4	1E-4
Cadmium	1E-4	1E-4	2E-5	1E-4	<2E-5	2E-5	3E-5	<8E-6	1E-4	7E-5	1E-4	2E-5	<8E-6
Calcium	3E0	2E0	3E0	3E0	3E0	3E0	2E0	3E0	3E0	1E-1	2E0	3E0	3E-1
Cerium	4E-4	4E-4	2E-4	3E-4	4E-4	1E-4	7E-5	2E-4	4E-4	1E-3	4E-4	2E-4	1E-4
Chlorine	<2E-2	<3E-2	7E-4	<2E-3	<2E-2	<2E-2	<2E-2	<3E-2	<2E-2	<5E-2	<1E-2	<4E-2	<2E-2
Chromium	8E-3	8E-3	8E-3	2E-2	6E-5	1E-2	3E-3	8E-3	6E-3	8E-3	3E-3	8E-3	8E-3
Cobalt	2E-4	2E-4	5E-5	5E-5	5E-5	2E-5	2E-5	5E-5	2E-4	3E-4	3E-5	2E-2	<2E-5
Copper	3E-1	2E-1	8E-2	7E-2	2E-2	2E-2	4E-2	3E-2	8E-2	7E-2	3E-2	3E-2	2E-2
Fluorine	<3E-2	<4E-2	<6E-2	<1E-2	<6E-2	<6E-2	<3E-2	<6E-2	<2E-2	<6E-2	<1E-2	<3E-2	<1E-2
Gallium	4E-5	1E-4	8E-6	8E-6	2E-5	<8E-6	8E-6	<8E-6	7E-5	3E-4	8E-6	7E-5	8E-6
Germanium	<8E-6	<8E-6	<8E-6	<8E-6	<8E-6	<8E-6	<8E-6	<8E-6	<8E-6	8E-6	<8E-6	<8E-6	<8E-6
Iron	2E-1	4E-1	2E-1	5E-2	2E-1	2E-1	2E-1	4E-1	4E-1	4E-1	2E-1	3E-1	<1E-2
Lanthanum	3E-4	3E-4	5E-5	1E-4	1E-4	4E-5	5E-5	1E-4	1E-4	6E-4	1E-4	1E-4	1E-4
Lead	2E-2	2E-2	2E-2	2E-2	1E-2	2E-3	7E-3	9E-3	2E-2	5E-2	8E-3	2E-2	5E-3
Lithium	<3E-4	1E-4	3E-4	<3E-4	1E-3	<3E-4	<8E-5	2E-4	8E-4	3E-3	<8E-6	3E-4	<3E-4
Magnesium	5E-1	4E-1	5E-1	2E-1	1E-1	2E-1	2E-1	4E-1	2E-1	4E-1	5E-2	2E-1	6E-2
Manganese	8E-3	3E-2	8E-3	8E-3	<3E-3	4E-4	7E-4	8E-3	5E-4	8E-3	<3E-3	2E-2	8E-3
Molybdenum	2E-4	<2E-4	<9E-5	<4E-5	<1E-4	<2E-4	<7E-5	<3E-4	<2E-4	<2E-4	<2E-4	<2E-4	<8E-5
Nickel	1E-3	2E-3	3E-3	5E-3	2E-4	7E-4	8E-4	2E-4	7E-4	9E-4	1E-4	3E-4	<2E-4
Osmium	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4
Palladium	<6E-5	<6E-5	<4E-5	<6E-5	<6E-5	<6E-5	<6E-5	<4E-5	<6E-5	<4E-5	<4E-5	<4E-5	<6E-5
Phosphorus	6E-2	4E-2	1E-2	6E-2	<2E-2	6E-2	<2E-2	<2E-2	<3E-2	1E-2	<2E-2	<1E-2	<2E-3
Platinum	<9E-6	<9E-5	<9E-5	<9E-5	<9E-5	<9E-5	<9E-5	<9E-5	<9E-5	<9E-5	<9E-5	<9E-5	<9E-5
Potassium	9E-2	2E-1	5E-2	2E-1	2E-1	4E-2	5E-2	2E-1	2E-1	4E-1	4E-2	2E-1	<3E-2
Rhenium	<2E-5	<7E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<7E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5
Rhodium	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-2	<2E-5	<2E-5	<2E-5
Rubidium	2E-3	7E-3	1E-3	1E-3	2E-3	9E-4	1E-3	2E-3	2E-3	5E-3	4E-4	1E-3	2E-4
Ruthenium	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<3E-5
Scandium	<4E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4
Selenium	4E-4	1E-4	4E-5	1E-4	8E-5	2E-5	<3E-5	1E-4	1E-4	1E-4	1E-4	3E-4	4E-5
Silicon	3E-1	<6E-1	7E-1	<6E-1	<6E-1	<6E-1	<6E-1	<4E-1	<3E-1	<6E-1	<3E-1	<4E-1	<3E-1
Silver	2E-6	<2E-5	4E-5	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	3E-5	3E-4	<2E-5	<2E-5	<2E-5
Sodium	3E0	2E0	4E0	3E-1	3E-1	3E-1	<6E-1	3E-1	3E-1	2E0	<6E-1	3E-1	<6E-1
Strontium	1E-2	2E-3	9E-3	5E-3	2E-2	4E-3	<4E-3	4E-3	3E-2	2E-2	<6E-3	4E-3	<6E-3
Sulfur	3E0	4E-1	4E-1	1E-2	2E-1	2E-4	2E-2	2E-1	4E-1	2E0	2E-1	3E-1	2E-1
Thallium	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4
Thorium	<5E-6	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	<5E-5	5E-5	2E-5	3E-5	<2E-5
Tin	2E-3	3E-3	6E-3	3E-3	1E-4	3E-3	1E-3	1E-3	1E-3	2E-3	9E-4	1E-3	1E-3
Titanium	3E0	1E0	3E0	3E0	2E0	1E0	<5E0	3E0	3E0	3E0	3E0	3E0	3E0
Uranium	<2E-5	<2E-5	2E-5	<7E-5	<2E-5	3E-5	<2E-5	<2E-5	<2E-5	5E-5	2E-5	2E-5	<2E-5
Vanadium	2E-3	8E-3	2E-3	2E-3	2E-3	7E-4	2E-3	2E-3	3E-3	8E-3	7E-4	3E-3	3E-4
Ytterbium	<1E-4	<3E-4	<1E-4	<1E-4	<1E-4	<1E-4	<3E-2	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4	<1E-4
Yttrium	4E-4	4E-4	2E-5	8E-5	4E-4	6E-4	5E-5	1E-4	4E-4	9E-4	4E-5	4E-4	8E-6
Zinc	3E-2	3E-2	4E-2	6E-2	3E-3	1E-2	1E-2	1E-2	3E-2	2E-2	1E-2	1E-2	3E-2
Zirconium	2E-3	2E-3	6E-4	2E-3	5E-4	2E-3	6E-4	9E-4	2E-3	4E-3	5E-4	5E-4	5E-4

TABLE XVII

INDIVIDUAL FOURTH QUARTER FILTERS FROM FT. PECK

($\mu g/m^3$)

(All Data Rounded to One Significant Figure)

	6/5/75	6/11/75	6/23/75	6/27/75	7/5/75	7/11/75	7/23/75	7/29/75	8/4/75	8/10/75	8/16/75	8/22/75
Aluminum	1E0	2E-1	1E-1	5E-1	5E-1	1E-1	1E0	1E0	5E-1	1E-1	1E0	4E-1
Antimony	1E-4	5E-5	5E-4	7E-4	2E-3	7E-4	2E-4	2E-3	6E-4	8E-4	2E-4	3E-3
Arsenic	3E-4	<4E-5	1E-3	[illegible]	3E-4	4E-4	2E-4	5E-4	4E-5	4E-4	6E-5	9E-4
Barium	1E-3	7E-4	1E-3	7E-3	6E-3	1E-3	4E-3	1E-2	4E-3	4E-3	4E-3	3E-3
Beryllium	<2E-5	<2E-5	<1E-5	<1E-5	1E-5	<2E-5	<2E-5	<3E-5	<1E-5	<2E-5	<2E-5	<1E-5
Bismuth	1E-4	2E-4	1E-3	3E-4	3E-4	4E-4	1E-3	4E-4	2E-4	4E-4	4E-4	4E-4
Cadmium	1E-5	<3E-5	4E-5	4E-5	4E-5	4E-5	5E-5	6E-5	3E-5	5E-5	6E-5	2E-5
Calcium	3E-1	3E-1	2E-1	8E-1	8E-1	9E-2	6E-1	6E-1	5E-1	6E-1	1E-1	6E-2
Cerium	2E-4	6E-5	9E-5	2E-4	2E-4	1E-4	6E-4	2E-3	5E-4	6E-4	3E-4	2E-4
Chlorine	<4E-2	<1E-2	<4E-2	<1E-2	3E-3	6E-3	<2E-2	<7E-3	<4E-3	<7E-3	<4E-3	<3E-3
Chromium	<1E-3	7E-4	6E-3	6E-3	4E-4	3E-3	3E-3	1E-3	3E-3	3E-3	3E-3	2E-3
Cobalt	3E-5	4E-5	2E-5	1E-4	1E-4	1E-4	3E-4	3E-4	3E-5	3E-5	2E-5	2E-5
Copper	5E-2	1E-1	5E-2	5E-2	2E-2	1E-2	3E-2	2E-2	1E-2	9E-3	2E-2	2E-2
Fluorine	<3E-2	<3E-2	<4E-2	<6E-2	<3E-2	<2E-2	<6E-2	<4E-2	<2E-2	<2E-2	<2E-2	<3E-2
Gallium	3E-5	<6E-6	<6E-6	7E-5	6E-6	<6E-6	3E-5	3E-5	6E-6	1E-5	2E-5	<5E-6
Germanium	6E-6	<1E-5	<6E-6	<6E-6	6E-6	<1E-5	<6E-6	<6E-6	<6E-6	<5E-6	<1E-5	<5E-6
Iron	2E-1	3E-1	4E-2	5E-1	2E-1	5E-2	3E-1	3E-1	3E-1	2E-1	6E-2	8E-2
Lanthanum	2E-4	1E-4	2E-4	6E-4	6E-4	1E-4	8E-4	8E-4	2E-4	3E-4	2E-4	2E-4
Lead	9E-3	6E-3	3E-2	3E-2	4E-3	1E-2	1E-2	2E-2	6E-3	1E-2	1E-2	2E-2
Lithium	4E-3	2E-4	2E-3	2E-3	2E-3	6E-4	2E-2	2E-3	2E-3	2E-4	2E-4	<9E-5
Magnesium	3E-1	1E-1	2E-2	1E-1	2E-1	<3E-2	3E-1	1E-1	1E-1	1E-1	1E-1	1E-1
Manganese	4E-3	5E-3	2E-2	1E-2	3E-3	3E-4	2E-2	9E-3	7E-3	9E-3	1E-3	1E-2
Molybdenum	<1E-4	<4E-5	<1E-4	<1E-4	1E-4	<1E-4	<2E-4	<2E-4	<5E-5	<4E-5	9E-5	<1E-4
Nickel	6E-4	7E-5	4E-5	3E-4	5E-4	<1E-4	7E-5	<2E-4	<1E-4	<2E-4	9E-5	<1E-4
Osmium	<9E-5	<9E-5	<9E-5	<9E-5	9E-5	<1E-4	<1E-4	<9E-5	<9E-5	<8E-5	<8E-5	<8E-5
Palladium	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<5E-5	<9E-5	<4E-5	<4E-5	<4E-5	<4E-5
Phosphorus	2E-1	1E-1	2E-1	2E-1	8E-2	8E-2	9E-2	3E-1	8E-2	9E-2	9E-2	6E-2
Platinum	<7E-5	<7E-5	<7E-5	<7E-5	<7E-5	7E-5	<7E-5	<7E-5	<7E-5	<7E-5	<4E-5	<6E-5
Potassium	2E-2	2E-2	6E-2	2E-1	9E-2	<4E-2	1E-1	2E-1	<4E-2	8E-2	<3E-2	<3E-2
Rhenium	<2E-5	<2E-5	<2E-5	<2E-5	<2E-5	<3E-5	<3E-5	<3E-5	<2E-5	<2E-5	<2E-5	<2E-5
Rhodium	<4E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5	<1E-5
Rubidium	7E-4	1E-4	1E-4	6E-4	6E-4	1E-4	8E-4	2E-2	7E-4	3E-4	3E-4	1E-4
Ruthenium	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-5	<4E-4	<4E-5	<4E-5	<4E-5
Scandium	<3E-5	<4E-5	<3E-5	4E-5	4E-5	<4E-5	5E-5	6E-5	<3E-4	<4E-5	<4E-5	<3E-5
Selenium	2E-5	9E-5	<6E-6	1E-6	8E-5	1E-5	8E-5	6E-6	1E-4	2E-5	<5E-6	<5E-6
Silicon	<4E0	<4E-1	<4E-1	<4E-1	<4E-1	<4E-1	<5E-1	<4E-1	<5E-1	<4E-1	<4E-1	<3E-1
Silver	1E-5	1E-4	1E-4	1E-4	2E-4	2E-5	2E-5	3E-5	2E-5	2E-5	6E-5	2E-5
Sodium	9E-1	2E0	8E-1	<9E-1	4E-1	1E0	7E-2	1E0	9E-1	1E0	1E0	8E-1
Strontium	<4E-3	<5E-3	2E-3	2E-3	<3E-3	3E-3	4E-3	<5E-3	<4E-3	<5E-3	4E-3	<4E-3
Sulfur	2E-1	3E-1	6E-1	2E-1	2E-1	8E-2	5E-1	1E-1	8E-2	2E-2	8E-2	<1E-1
Thallium	<3E-5	<4E-5	<3E-5	<3E-5	<3E-5	<3E-5	<4E-5	<4E-5	<3E-5	<4E-5	<4E-5	<3E-5
Thorium	<3E-5	<3E-5	<3E-5	9E-5	4E-5	<3E-5	5E-5	5E-5	4E-5	<4E-5	5E-5	<3E-5
Tin	1E-3	1E-3	5E-3	2E-3	9E-4	1E-2	3E-2	3E-3	2E-3	2E-3	1E-3	2E-3
Titanium	<3E0	<3E0	<3E0	<2E0	<2E0	<2E0	<2E0	<2E0	<2E0	<2E0	<2E0	<1E0
Uranium	<1E-5	2E-5	2E-5	4E-5	2E-5	<1E-5	2E-5	3E-5	3E-5	2E-5	2E-5	2E-5
Vanadium	8E-3	4E-3	3E-3	2E-2	7E-3	3E-4	2E-3	2E-3	7E-4	8E-4	3E-4	3E-4
Ytterbium	<9E-5	<9E-5	<9E-5	<8E-5	<8E-5	<4E-5	<5E-5	<5E-5	<4E-5	<5E-5	<5E-5	<4E-5
Yttrium	2E-4	1E-4	6E-6	2E-4	7E-5	8E-5	3E-4	6E-4	2E-4	6E-4	2E-4	6E-5
Zinc	2E-2	4E-2	6E-3	3E-2	3E-2	1E-2	5E-2	2E-2	2E-2	2E-2	2E-2	4E-2
Zirconium	3E-4	9E-4	1E-3	1E-3	9E-4	1E-3	2E-3	7E-4	8E-4	1E-3	2E-3	1E-4

4.0 DISCUSSION OF RESULTS

The results of each set of filters demonstrate a fair consistency. Four factors must be kept in mind when using or analyzing these data:

(1) Spark source mass spectrometery used in the survey made is at best ±30%, with the true accuracy dependent on background, standards and the amount and nature of sample. For these samples, the results are felt to give a reasonable order of magnitude level of the various elements.

(2) The nature of the filter material is in question. Although the sampling contractor supplied blanks and supposedly used the same filters in all cases, the behavior of the individual filters under analysis raises some doubts as to the uniformity of filter materials.

(3) The sample loading was very low, too low, in fact for the sampling contractor to be able to weigh the filters. All results are based, therefore, on flow measurements.

(4) The filter loadings available were from separate Hi-Vol samples taken concurrently. A direct comparison indicates that correspondence with the membrane samples is poor. This is probably due to the difference in sampling rates and location of the two samples.

Irrespective of these problems, it is felt that the results presented in this report give a usable semi-quantitative indication of the relative trace element backgrounds in the Northern Great Plains area.

To show some measurement of the reliability of the data, the individual results of the fourth quarter samples were averaged and compared with the results of the fourth quarter composites. These data, along with the ranges for the individual analyses are given in Table XIII.

With few exceptions, even though the individual samples show a wide range, the composites and averages are generally within a good enough agreement to lend credence to the data base.

Comparison of individual filters is complicated by the absence of total loading measurements. The data shown in Table XIX are from the High-Volume samplers located near the membrane samplers used for trace element analysis. Unfortunately the strong differences in total grain loadings are not reflected directly in the trace element analyses. Two factors may be responsible for this finding: (1) the membrane samples were operated at much lower flows than the Hi-Vol samplers, perhaps affecting total grain loading though differences in turbulence; and (2) the composition of the particulates is variable as a function of location and meteorological conditions. The very low levels of the trace elements, frequently below the detection limits of the instrument, also make variations difficult to detect.

Ambient standards for the trace elements are virtually nonexistent. Cadmium and mercury emissions are regulated in some smelter applications. The maximum permissible level of beryllium averaged over a 30-day period is 0.01 $\mu g/m^3$ (CO-182). This standard is applied to the following industries.

(a) extraction plants, ceramic plants, foundries, incinerators, and propellant plants which process beryllium oxide, beryllium alloys, or beryllium-containing waste; and

(b) machine shops which process beryllium, beryllium oxides, or any alloy when such alloy contains more than 5 percent beryllium by weight.

This is significantly higher than the ambient levels found of $\sim 10^{-6}$ $\mu g/m^3$ in the Northern Great Plains.

The data acquired during this program represent a usable data base for the ambient conditions near each sampling point. The levels of the trace elements are consistantly low indicating that any gross increases in individual elements, for example 50-100%, caused by emissions from a point or mobile source should be detectable. It is strongly recommended, however, that any future work in this area pay strict attention to sound sampling procedures. Trace element sampling requires the use of special low ash filters, not fiberglass, to provide a low background. Also sampling should be designed such that weighable quantities of dust are collected. Trace element sampling should be specially designed into an ambient dust monitoring program. In this way, reliable, credible results are insured. The very low concentrations of ambient trace elements and the potential significance of small changes in individual elements makes this of vital importance.

TABLE XVIII

COMPARISON OF FOURTH QUARTER COMPOSITES WITH RANGE AND AVERAGE OF FOURTH QUARTER INDIVIDUAL FILTER TRACE ELEMENT ANALYSES ($\mu g/m^3$)

	Newcastle			Glendive			Garrison			Belle Fourche			Ft. Peck		
	Average	Range	Composite	Average	Range	Composite	Average	Range	Composite	Average	Range	Composite	Average	Range	Composite
Aluminum	1E0	1E-2/3E0	8E-1	5E-1	3E-2/2E0	1E0	<2E-1	<2E-2/8E-1	4E0	<7E-1	<4E-2/2E-1	2E0	5E-1	1E-1/1E0	1E-0
Antimony	<4E-5	<3E-5/7E-3	3E-5	<2E-5	<1E-5/<2E-5	<9E-5	3E-4	<6E-6/5E-4	9E-5	5E-4	8E-6/6E-4	2E-5	9E-4	5E-4/3E-3	3E-4
Arsenic	6E-4	<5E-5/2E-3	1E-4	2E-4	<6E-5/6E-4	<4E-5	4E-4	<2E-4/9E-4	2E-4	2E-3	<3E-4/8E-3	3E-4	4E-4	4E-5/1E-3	2E-4
Barium	3E-2	7E-4/2E-2	8E-3	1E-3	5E-4/3E-3	6E-3	2E-2	2E-3/8E-2	5E-3	8E-3	5E-4/2E-2	8E-3	4E-3	7E-4/1E-2	9E-4
Beryllium	<4E-6	<3E-7/<4E-6	<4E-6	<2E-5	<2E-5/<3E-5	<8E-6	<2E-5	<1E-5/<2E-5	<5E-6	<2E-5	<2E-5/<2E-5	<8E-6	<2E-5	<1E-5/<2E-5	<6E-6
Bismuth	4E-4	2E-4/7E-4	1E-4	1E-4	3E-5/3E-4	1E-4	2E-3	<5E-5/2E-2	7E-5	2E-4	<7E-5/7E-4	2E-4	4E-4	1E-4/1E-3	2E-4
Cadmium	<4E-5	<1E-5/2E-4	1E-4	4E-5	<2E-5/7E-5	2E-5	4E-5	<6E-6/1E-4	3E-5	6E-5	<8E-6/1E-4	5E-5	6E-5	1E-5/6E-5	3E-5
Calcium	5E-1	<1E-1/1E0	4E-1	2E-1	1E-1/4E-1	9E-1	3E0	<2E-1/<2E+1	4E-1	2E0	1E-1/3E0	6E-1	4E-1	6E-2/8E-1	1E-1
Cerium	6E-4	6E-5/4E-3	5E-4	2E-4	6E-5/4E-4	2E-4	4E-4	4E-5/1E-3	4E-3	3E-4	7E-5/1E-3	4E-4	4E-4	9E-5/2E-4	2E-4
Chlorine	<7E-3	<5E-3/<1E-2	<8E-3	<8E-3	<3E-3/<3E-2	2E-2	1E-2	9E-5/5E-2	<1E-2	<2E-2	7E-4/<5E-2	<2E-2	<1E-2	3E-3/<4E-2	8E-3
Chromium	3E-3	<8E-4/<1E-2	5E-3	4E-3	3E-4/1E-2	8E-3	8E-3	2E-3/2E-2	2E-2	8E-3	6E-5/1E-2	3E-3	3E-3	4E-4/6E-3	2E-3
Cobalt	1E-4	7E-6/9E-4	2E-4	2E-5	<7E-6/5E-5	8E-6	2E-4	<4E-6/4E-4	1E-4	2E-3	<2E-5/2E-2	6E-4	9E-5	2E-5/3E-4	1E-5
Copper	1E-2	<2E-3/4E-2	3E-2	1E-2	3E-3/3E-2	3E-2	4E-2	9E-3/8E-2	2E-2	7E-2	2E-2/2E-1	2E-2	3E-2	9E-3/1E-1	1E-2
Fluorine	<4E-2	8E-3/3E-1	<2E-2	<3E-2	<1E-2/6E-3	3E-2	<2E-2	<4E-3/<5E-2	<3E-2	<4E-2	<1E-2/<6E-2	<2E-2	<3E-2	<2E-2/<6E-2	<3E-2
Gallium	8E-5	3E-6/7E-4	6E-5	1E-5	6E-6/[illegible]-5	<8E-6	6E-5	4E-6/2E-4	2E-5	5E-5	<8E-6/3E-4	4E-5	2E-5	<5E-6/7E-5	1E-5
Germanium	<4E-6	<3E-6/8E-6	4E-6	9E-6	<6E-6/2E-5	<8E-6	7E-6	<4E-6/3E-5	<5E-6	<8E-6	<8E-6/8E-6	8E-6	<7E-6	<5E-6/<1E-5	<6E-6
Iron	1E0	2E-4/7E0	4E-1	1E-1	1E-2/2E-1	2E-2	3E-1	3E-2/7E-1	1E-1	2E-1	<1E-2/4E-1	6E-2	2E-1	4E-2/5E-1	6E-2
Lanthanum	2E-4	<7E-6/1E-3	3E-4	8E-5	3E-5/1E-4	1E-4	2E-4	1E-5/5E-4	1E-4	2E-4	<4E-5/6E-4	2E-4	4E-4	1E-4/6E-4	6E-5
Lead	1E-2	5E-4/3E-2	1E-2	6E-3	2E-3/2E-2	8E-3	2E-2	1E-3/4E-2	8E-3	2E-2	2E-3/5E-2	2E-2	1E-2	4E-3/3E-2	3E-3
Lithium	8E-4	<1E-4/5E-3	4E-5	1E-3	<2E-4/2E-3	1E-3	5E-4	<6E-6/1E-3	3E-4	5E-4	<8E-6/3E-3	<4E-4	3E-3	<9E-5/4E-3	<4E-4
Magnesium	1E0	8E-3/6E0	2E-1	1E-1	2E-2/2E-1	4E-1	2E-1	5E-5/3E-1	4E-1	3E-1	5E-2/5E-1	2E-1	1E-1	2E-2/3E-1	2E-1
Manganese	3E-2	3E-3/2E-1	3E-3	3E-3	6E-4/7E-3	<3E-3	1E-2	<2E-3/2E-2	8E-4	8E-3	4E-4/3E-2	2E-3	9E-3	1E-3/2E-2	1E-3
Molybdenum	<8E-5	<3E-5/<1E-4	2E-5	<1E-4	<5E-5/<3E-4	<3E-4	<1E-4	<6E-5/2E-4	<1E-4	<2E-4	<7E-5/2E-4	<2E-4	<1E-4	<4E-5/<2E-4	<2E-4
Nickel	4E-4	9E-5/3E-3	8E-4	4E-4	<6E-5/9E-4	3E-3	3E-4	3E-5/6E-4	8E-5	1E-3	1E-4/5E-3	6E-4	2E-4	4E-5/6E-4	<7E-5
Osmium	<5E-5	<5E-5/<7E-5	<3E-4	<1E-4	<9E-5/<1E-4	<6E-4	<8E-5	<6E-5/<9E-5	<3E-4	<1E-4	<1E-4/<1E-4	<5E-4	<9E-5	<8E-5/<1E-4	<4E-4
Palladium	<3E-5	<2E-5/<3E-5	<2E-4	<6E-5	<5E-5/<6E-5	<3E-4	<1E-4	<3E-5/<4E-4	<1E-4	<6E-5	<6E-5/<6E-5	<2E-4	<4E-5	<4E-5/<5E-5	<2E-4
Phosphorus	2E-1	1E-1/4E-1	6E-2	6E-2	1E-4/5E-1	2E-2	3E-2	<5E-3/8E-2	5E-2	3E-2	<1E-2/6E-2	4E-2	1E-1	6E-2/2E-1	3E-2
Platinum	<4E-5	<4E-5/<5E-5	<2E-4	<9E-5	<7E-5/<1E-4	<5E-4	<7E-5	<5E-5/<7E-5	<2E-4	<9E-5	<9E-5/<9E-5	<4E-4	<7E-5	<6E-5/<7E-5	<3E-4
Potassium	6E-1	3E-3/5E0	3E-1	8E-2	5E-3/2E-1	<5E-2	2E-1	<2E-2/2E0	7E-2	3E-1	<3E-2/4E-1	8E-2	7E-2	2E-2/2E-1	5E-2
Rhenium	<1E-5	<1E-5/<1E-5	<1E-5	<3E-5	<2E-5/<4E-5	<3E-5	<2E-5	<2E-5/<1E-5	<2E-5	<2E-5	<2E-5/<7E-5	<7E-5	<2E-5	<2E-5/<3E-5	<2E-5
Rhodium	<8E-6	<7E-6/<1E-5	<4E-5	<2E-5	<1E-5/<2E-5	<9E-5	<1E-5	8E-6/<1E-5	<4E-5	<2E-5	<2E-5/<[illegible]-5	<7E-5	<1E-5	<1E-5/<1E-5	<6E-5
Rubidium	1E-3	<2E-5/7E-3	2E-3	3E-4	<4E-5/8E-4	6E-4	2E-3	1E-4/4E-3	1E-3	2E-3	2E-4/5E-3	4E-4	5E-4	1E-4/2E-3	3E-4
Ruthenium	<2E-5	<2E-5/<3E-5	<1E-4	<5E-5	<4E-5/<6E-5	3E-4	<4E-5	<3E-5/<4E-5	<1E-4	<5E-5	<5E-5/<5E-5	<2E-4	<4E-5	<4E-5/<4E-4	<2E-4
Scandium	1E-4	<1E-5/9E-4	4E-5	<4E-4	<2E-5/<4E-3	<8E-6	1E-4	<5E-5/6E-4	<2E-5	<1E-4	<1E-4/<1E-4	<8E-6	4E-5	<3E-5/6E-5	<6E-6
Selenium	9E-5	<3E-6/5E-4	1E-4	6E-5	3E-5/1E-4	2E-4	6E-4	2E-5/2E-3	5E-4	1E-4	2E-5/4E-4	2E-4	4E-5	<5E-6/1E-4	2E-4
Silicon	<10E0	<5E0/<31E0	<3E0	3E+1	2E+1/4E+1	<5E+1	7E0	<2E-1/2E+1	<4E+1	<5E-1	<3E-1/7E-1	<6E+1	<7E-1	<3E-1/<4E0	<3E+1
Silver	3E-5	<1E-5/2E-4	2E-5	8E-5	<2E-5/3E-4	2E-4	3E-4	1E-5/3E-4	4E-5	3E-4	<2E-5/8E-4	2E-5	6E-5	1E-5/2E-4	2E-5
Sodium	<2E-5	<1E-5/5E-1	<4E-1	1E0	6E-1/3E0	2E0	8E-1	<5E-5/3E0	2E0	1E0	3E-1/4E0	1E0	9E-1	7E-2/2E0	9E-1
Strontium	4E-3	5E-6/2E-2	1E-2	<5E-3	<2E-3/<7E-3	7E-3	1E-2	<3E-3/4E-2	8E-3	1E-2	<4E-3/2E-2	<6E-3	4E-3	2E-3/<5E-3	<4E-3
Sulfur	6E-2	2E-2/2E-1	5E-3	7E-2	3E-3/1E-1	8E-3	3E-1	<5E-2/6E-1	3E-2	7E-1	2E-2/4E0	6E-2	2E-1	2E-2/6E-1	1E-1
Thallium	<7E-5	<7E-5/<8E-5	8E-6	<5E-4	<3E-5/<5E-3	<8E-6	<1E-4	<8E-5/<1E-4	<5E-6	<1E-4	<1E-4/<1E-4	5E-5	<3E-5	<3E-5/<4E-5	<6E-6
Thorium	2E-4	<6E-5/5E-4	8E-5	3E-5	<3E-5/4E-5	6E-5	6E-5	<3E-5/2E-4	1E-4	<4E-5	2E-5/<5E-5	7E-5	4E-5	<3E-5/9E-5	3E-5
Tin	4E-4	<2E-4/1E-3	1E-4	4E-4	<3E-4/2E-3	8E-4	2E-3	2E-4/1E-2	8E-4	2E-3	1E-4/6E-3	4E-4	5E-3	9E-4/3E-2	3E-4
Titanium	2E0	7E-1/4E0	<8E-1	<2E0	<3E-4/2E0	<2E0	3E0	1E-1/9E0	<1E0	3E0	1E0/<5E0	<1E0	<2E0	<1E0/<3E0	<2E0
Uranium	6E-5	<3E-5/2E-4	8E-5	3E-5	<2E-5/<2E0	6E-5	3E-5	3E-6/8E-5	1E-4	<2E-5	<2E-5/5E-5	6E-6	2E-5	<1E-5/4E-5	6E-5
Vanadium	2E-3	2E-5/8E-3	1E-3	4E-4	2E-4/8E-4	3E-4	3E-3	2E-4/1E-2	7E-4	2E-3	7E-4/8E-3	1E-3	4E-3	3E-4/2E-2	3E-4
Ytterbium	<9E-5	<8E-5/<1E-4	4E-5	<6E-5	<5E-5/<8E-5	<3E-5	<1E-4	<1E-5/1E-4	<3E-5	<1E-4	<1E-4/<3E-3	<4E-5	<6E-5	<4E-5/<9E-5	<3E-5
Yttrium	2E-4	1E-5/1E-3	2E-4	4E-5	2E-5/1E-4	5E-5	3E-4	5E-6/2E-4	1E-4	3E-4	8E-6/9E-4	7E-5	2E-4	6E-6/6E-4	5E-5
Zinc	7E-3	7E-5/5E-2	1E-2	5E-3	2E-3/9E-3	8E-3	2E-2	2E-4/8E-2	1E-2	2E-2	3E-3/6E-2	7E-3	3E-2	6E-3/5E-2	1E-2
Zirconium	2E-3	1E-4/1E-2	1E-3	<3E-4	<2E-4/5E-4	5E-4	2E-3	1E-4/4E-3	1E-3	1E-3	5E-4/4E-3	1E-4	1E-3	1E-4/2E-3	4E-4

TABLE XIX

MEAN GRAIN LOADINGS FROM HIGH VOLUME SAMPLERS LOCATED NEAR THE MEMBRANE SAMPLER SITES

($\mu g/m^3$)

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Newcastle	24.9	8.3	11.3	40.3
Glendive	18.7	11.4	13.5	23.7
Garrison	31.5	40.0	18.6	34.1
Ft. Peck	18.8	7.1	13.0	6.8
Belle Fourche	19.1	8.9	14.9	39.2

5.0 REFERENCES

1) Brown, R., Jacobs, M. L. and Taylor, H.E., American Laboratory, 4, p. 72, (1972).

2) Taylor, H. E., and Brown, R., Inst. in Mining and Met. Ind., 2, p. 21, (1974).

3) Trace Analysis by Mass Spectrometry, Ed. Ahearn, A. J., Acad. Press, New York, p. 297, (1972).

4) "The Environmental Protection Agency Northern Great Plains Ambient Air Monitoring Network, Vol. I", Environmental Protection Agency, Rocky Mountain Region, Region VIII, (November, 1975).

5) Code of Federal Regulations. 40 Protection of Environment. Revised edition. Washington, D.C., General Services Admin., Office of the Federal Register, (1973).

APPENDIX

Report No. 1

Statistical Evaluation of Blank Fiberglass Filter Pads Used in Northern Great Plains Resource Project

February 18, 1975

by:
H.E. Taylor
R. Brown

Contract No. 68-02-1383

I. PURPOSE

The purpose of this study was to determine the mean levels and statistical variation of trace elements in blank fiberglass filter pads prior to the analysis of filters loaded with air particulates. This data was compared with typical results acquired on two loaded samples provided by the Environmental Protection Agency. All data was obtained by spark source mass spectrometry.

II. SCOPE

Multi-element analytical data was acquired on each of eight separate 8½" x 11" blank fiberglass filter pads. Each filter was statistically sampled by removing eight one inch square segments from one inch wide diagonals cut from corner to corner of the filter pads. These eight square inches of filter were ground into a fine powder in an agate mortar and pestle. A separate composite of each of the eight blank filter pads was prepared in this fashion, such that a statistically accurate composite was available for each pad.

Table I tabulates the printed number on each blank pad that was sampled. In addition, the numbers of the two typical loaded samples are also listed.

TABLE I

Identification Number and Weight of Eight Blank Fiberglass Filter Pads and Two Typical Loaded Samples

Identification	Filter No.	Weight (g)
Blank	002060	4.2643
Blank	004030	4.3124
Blank	009030	4.3975
Blank	013060	4.3088
Blank	016060	4.2712
Blank	021030	4.3161
Blank	023060	3.8444
Blank	026030	4.4354
Sample	800036	4.9575
Sample	800038	4.8053

0.1000 gram of each powdered composite was blended with 0.1000 gram of ultra high purity graphite, and internal standards of indium and rhenium were added. Each of these mixtures was compacted into electrodes and spectra from the mass spectrometer was obtained for each sample under identical instrumental parameters.

The two typical loaded filters were prepared in the following fashion. The unloaded margin of sample No. 1 was cut and removed from the loaded area. This margin was ground into a powder, and 0.1000 gram was prepared as described above. The loaded area of the filter was sampled as described above into eight randomly taken one inch squares from the diagonals of the filter. The ground composite of each sample was thoroughly mixed, and 0.1000 gram was subsampled and blended with 0.1000 gram of high purity graphite. By back calculating from the weight of one square inch of filter material, the 0.1000 gram sample was shown to be equivalent to approximately 1.7 square inches of surface area.

III. RESULTS

Table II lists the data from the determination of trace elements in the blank fiberglass pads. This data is presented both in the units of ppm wt. in the bulk filter material, and also in terms of µg/sq. inch based upon the mean weight/unit area of the blank pads. The data is presented in this form so as to be more directly comparable to the typical loaded filter data.

Error terms are also presented. These were determined based upon accepted statistical data treatment techniques. The 90% confidence interval was used to represent the error data.

TABLE II

Element	Blank Data				Loaded Sample Data		
	mean (ppm wt.)	± error[a]	mean (µg/in.^{2})	± error[a]	Blank #1 (µg/in.^{2})	Sample 1 (µg/in.^{2})	Sample 2 (µg/in.^{2})
U	1.2	1.2	0.065	0.065	0.034	0.071	0.10
Th	6.0	6.9	0.32	0.37	0.21	0.21	0.36
Bi	0.42	0.17	0.023	0.009	0.034	0.029	0.26
Pb	6.4	5.1	0.35	0.28	1.2	0.31	0.42
W	0.46	0.41	0.025	0.022	0.048	0.048	0.056
Hf	1.7	1.5	0.092	0.091	0.040	0.083	0.15

TABLE II (con't)

Element	Blank Data mean (ppm wt.)	± error[a]	mean (µg/in.^{2})	± error[a]	Loaded Sample Data Blank #1 (µg/in.^{2})	Sample 1 (µg/in.^{2})	Sample 2 (µg/in.^{2})
Lu	0.07	0.02	0.004	0.0001	0.004	0.004	0.005
Yb	0.56	0.30	0.030	0.016	0.037	0.028	0.038
Tm	0.03	0.02	0.002	0.001	0.002	0.002	0.002
Er	0.14	0.08	0.008	0.004	0.008	0.017	0.013
Ho	0.06	0.05	0.003	0.003	0.004	0.007	0.004
Dy	0.90	0.83	0.049	0.045	0.036	0.071	0.072
Tb	0.15	0.13	0.009	0.007	0.007	0.011	0.011
Gd	0.61	0.48	0.033	0.026	0.036	0.029	0.048
Eu	0.55	0.43	0.030	0.023	0.014	0.029	0.054
Sm	0.90	0.79	0.049	0.043	0.021	0.050	0.084
Nd	16	9.9	0.86	0.53	0.77	0.56	0.78
Pr	2.6	1.3	0.14	0.070	0.12	0.51	0.12
Ce	37	20	2.0	1.1	1.7	0.83	1.3
La	9.0	5.3	0.49	0.29	0.25	0.29	0.47
Ba	130	68	7.0	3.7	5.1	3.0	7.8
Cs	0.029	0.048	0.002	0.003	0.001	0.004	0.004
I	0.23	0.18	0.012	0.010	0.018	0.021	0.021
Te	0.06	0.05	0.003	0.003	< 0.004	< 0.004	< 0.004
Sb	0.10	0.05	0.005	0.007	0.006	0.016	0.006
Sn	2.4	3.0	0.13	0.16	0.55	0.10	0.14
Cd	0.32	0.15	0.017	0.008	0.043	0.037	0.019
Ag	0.04	0.02	0.002	0.001	0.004	0.002	0.003
Mo	1.0	0.66	0.053	0.036	0.059	0.059	0.13
Nb	8.0	4.5	0.43	0.24	0.59	0.36	0.36
Fr	150	63	8.1	3.4	5.9	7.1	9.0
Y	11	7.4	0.59	0.40	0.43	0.39	0.44
Sr	67	1.3	3.6	0.070	4.0	4.0	4.0
Rb	1.7	0.26	0.092	0.014	0.15	0.065	0.066
Er	1.1	1.1	0.059	0.059	0.015	0.21	0.078
Se	0.12	0.12	0.006	0.006	0.010	0.014	0.014

TABLE II (con't)

Element	Blank Data mean (ppm wt.)	± error[a]	mean (μg/in.^{2})	± error[a]	Loaded Sample Data Blank #1 (μg/in.^{2})	Sample 1 (μg/in.^{2})	Sample 2 (μg/in.^{2})
As	1.6	0.97	0.086	0.052	0.13	0.20	0.13
Ge	0.32	0.33	0.017	0.018	0.015	0.012	0.016
Ga	4.2	2.1	0.23	0.11	0.37	0.25	0.25
Zn	12	9.9	0.65	0.53	1.2	1.8	0.96
Cu	10	6.4	0.54	0.35	1.1	1.2	1.4
Ni	14	6.1	0.75	0.33	1.1	1.1	1.1
Co	0.52	0.63	0.028	0.034	0.045	0.034	0.017
Fe	1900	1040	100	56	100	170	350
Mn	17	9.4	0.92	0.51	1.2	1.2	0.84
Cr	39	26	2.1	1.4	2.7	1.4	1.9
V	75	61	4.0	3.3	5.9	5.9	4.5
Ti	1600	1800	86	97	104	100	84
Sc	20	33	1.1	0.033	1.2	0.89	2.4
Ca	Maj	Maj	Maj	Maj	Maj	Maj	Maj
K	340	480	18	26	21	14	14
Cl	140	120	7.5	6.5	14	14	14
S	110	96	5.9	5.2	17	100	28
P	360	260	19	14	17	14	6.1
Al	Maj	Maj	Maj	Maj	Maj	Maj	Maj
Mg	5%	2.1%	2700	1100	3400	3400	3500
Na	6900	8700	370	470	530	590	360
F	2250	2750	120	150	71	71	160
B	Maj	Maj	Maj	Maj	Maj	Maj	Maj
Be	0.53	0.50	0.029	0.027	0.033	0.071	0.072
Li	27	31	1.5	1.7	3.9	3.9	3.9

a 90% confidence interval

IV. CONCLUSION

As can be seen from the data presented in Table II, most all elements are present as impurities in the fiberglass materials, and as was predicted, they are not uniformly distributed throughout all filter pads.

The degree of elemental enhancement of loaded samples over blank levels is not sufficiently high to allow accurate blank corrections to be performed. This is illustrated by noting that in Table II, the loaded values are often lower than the value of the upper 90% confidence limit for the blank measurements. Perhaps with more heavily loaded samples, the background levels would be less significant.

In summary, it is apparent that this fiberglass material is not suitable for the sampling of particulate matter when trace element analysis is to be performed. The combination of high background levels of trace elements in the fiberglass material and the inability to separate the particulate loading from the fiberglass material prior to analysis precludes the ability to achieve accurate analyses.

REPORT NO. 2

Statistical Evaluation of Blank Fiberglass Filter Pads in Northern Great Plains Resource Project

March 17, 1975

by:

H.E. Taylor
R. Brown

Contract No. 68-02-1383

I. PURPOSE

The purpose of this study was to determine the mean levels and statistical variation of mercury in blank fiberglass filter pads prior to the analysis of filters loaded with air particulates. This data was compared with typical results acquired on two loaded samples provided by the Environmental Protection Agency. All data was obtained by combustion/amalgamation atomic fluorescence spectrophotometry.

II. SCOPE

Analytical data was acquired on each of eight separate 8½" by 11" blank fiberglass filter pads. Each filter was statistically sampled by removing eight one inch square segments from one inch wide diagonals cut from corner to corner of the filter pads. These eight square inches of filter were ground into a fine powder in an agate mortar and pestle. A separate composite of each of the eight blank filter pads was prepared in this fashion, such that a statistically accurate composite was available for each pad.

Table I tabulates the printed number on each blank pad that was sampled. In addition, the numbers of the two typical loaded samples are also listed.

TABLE I

Identification Number and Weight of Eight Blank Fiberglass Filter Pads and Two Typical Loaded Samples

Identification	Filter No.	Weight (g)
Blank	002060	4.2643
Blank	004030	4.3124
Blank	009030	4.3975
Blank	013060	4.3088
Blank	016060	4.2712
Blank	021030	4.3161
Blank	023060	3.8444
Blank	026030	4.4354
Sample	800036	4.9575
Sample	800038	4.8053

Each of the composited samples was analyzed by heating 0.1000 gram to 850° C. in a dynamic oxygen atmosphere. The vapor is passed through a quartz combustion tube at 1000° C. and amalgamated on gold wool. The mercury is thermally deamalgamated in an argon stream, and passed through an atomic fluorescence cell where it is excited by 253.6 nanometer radiation. The fluorescence signal is measured by a solar blind photomultiplier tube, and the resultant signal is amplified and displayed on a strip chart recorder. The sample signals are compared to the signal observed from NBS standard reference material 1633-fly ash.

III. RESULTS

Table II lists the data from the determination of mercury in the blank fiberglass pads. This data is presented both in the units of ppm wt. in the bulk filter material, and also in terms of μg/sq. in. based upon the mean weight/unit area of the blank pads. The data is presented in this form so as to be more directly comparable to the typical loaded filter data.

Error terms are also presented. These were determined based upon accepted statistical data treatment techniques. The 90% confidence interval was used to represent the error data.

TABLE II

Blank Data		Loaded Sample Data	
Mean (ppm wt.)	0.050	Sample 1(μg/in.^{2})	0.016
Error (ppm wt.)	±0.020	Sample 2(μg/in.^{2})	0.010
Mean (μg/in.^{2})	0.002		
Error (μg/in.^{2})	±0.0008		